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MANAGING THE INVISIBLE

Understanding and Improving Groundwater Governance

Draft Report

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WATER PARTNERSHIP PROGRAM

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ACRONYMS AND ABBREVIATIONS

AMCOW	African Minister’s Council on Water
APDAI	Andhra Pradesh Drought Adaptation Initiative (India)
APFAMGS	Andhra Pradesh Farmer Management Groundwater Systems Project
AusAID	Australian Agency for International Development
CAAC	Catchment Area Advisory Committee (Kenya)
CAS	Country Assistance Strategy
CGWA	Central Ground Water Authority (India)
CGWB	Central Ground Water Board (India)
CSEC	National Council for Water and Climate
CWRAS	Country Water Resource Assistance Strategy
DAWASA	Dar es Salaam Water and Sewerage Authority (Tanzania)
DAWASCO	Dar es Salaam Water and Sewerage Company (Tanzania)
DFGG	Demand for Good Governance
DFID	Department for International Development (UK)
DoS	Department of Statistics (Jordan)
DWA	Department of Water Affairs (South Africa)
DWQ	Drinking Water Quality
EMPOWERS	Euro-Mediterranean Participatory Water Resources Scenarios
EPA	Entry-Point Activity
ET	Evapotranspiration
FAO	Food and Agriculture Organization
FSU	Former Soviet Union
GAC	Governance and Anti-Corruption
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEF-IW	Global Environment Facility International Waters
GMMR	Great Man-Made River
GNI	Gross National Income
GRACE	Gravity Recovery and Climate Experiment
GRIP	Groundwater Resource Information Project (South Africa)
GW	Groundwater
GWMATE	Groundwater Management Advisory Team
GWP	Global Water Partnership
IAEA	International Atomic Energy Agency
IAH	International Association of Hydrogeologists
IEG	Independent Evaluation Group
IGRAC	International Groundwater Resources Assessment Centre
IWRM	Integrated Water Resources Management

JICA	Japan International Cooperation Agency
Ksh	Kenya Shilling
M&E	Monitoring & Evaluation
MENA	Middle East & North Africa (region)
MoWI	Ministry of Water Infrastructure (Jordan)
NABARD	National Bank for Agriculture and Rural Development (India)
NGO	Nongovernment Organization
NSAS	Nubian Sandstone Aquifer
NWRS	National Water Resource Strategy (South Africa)
NWSSIP	National Water Strategy (Yemen)
OECD	Organization for Economic Co-operation and Development
PE	Political Economy
PES	Payment for Environmental Services
PROFODUA	Water Rights Formalization Programme (Peru)
R	South Africa Rand
SADC	Southern Africa Development Community
SANS	South African National Standards
TTL	Task Team Leader
TWIWA	Transport, Water, Information and Communication Technology Water Anchor
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific & Cultural Organization
UNESCO-IHP	United Nations Educational, Scientific & Cultural Organization – International Hydrological Program
URV	Unit Reference Value
WARMS	Water Authorisation Registration and Management System (South Africa)
WASREB	Water Services Regulatory Board (Kenya)
WBI	World Bank Institute
WQAA	Water Quality Assessment Authority (India)
WRMA	Water Resource Management Authority (Kenya)
WRSS	Water Resources Sector Strategy (World Bank)
WRUA	Water Resource Users Association (Kenya)
WTE	Water Trading Entity (South Africa)
WUA	Water User Association
WWQ	Waste Water Quality

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EXECUTIVE SUMMARY

The Groundwater Challenge

Groundwater is playing an increasingly important role in domestic, industrial and agricultural water supply.

With the advent of the tubewell and driven by the rapid growth of demand for agricultural and municipal water, annual global groundwater extraction has increased in recent decades from 100 km^3 a year in 1950 to a current estimated use of about 800 km^3 a year (Wada et al., 2010; Margat, 2008). Today, 43 percent of global irrigation (Siebert et al., 2010) as well as more than 50 percent of the world's drinking water supply (Zekster and Everett, 2004) and a large share of global industrial activity depend on groundwater. In addition to its capacity to answer growing water demand, groundwater also provides unique opportunities to cope with increased climate variability due to climate change.

While this ever increasing reliance on groundwater has gone largely unnoticed, it has become a vital economic input.

Groundwater has become a major contributor to GDP. In a large number of countries, it is the foundation on which agriculture, urban development, rural jobs and safe drinking water supply systems have been built. Indeed, access to groundwater through private tubewells was a key factor in South Asia's Green Revolution. This explosion of groundwater use has occurred in a largely unplanned and uncontrolled way, taking place almost unnoticed in many countries because of its decentralized nature.

In many places the unplanned and massive use of groundwater has resulted in serious and growing problems of depletion and quality deterioration.

In many locations, over-abstraction has resulted in sharp declines in the groundwater table and, at times, even to exhaustion of the resource. In other areas, groundwater resources have been gradually rendered useless as a result of pollution. Major sources of groundwater pollution are infiltration of untreated wastewater under cities, pesticides and nitrates from agricultural activities, and effluents from industrial and mining activities. Probably even more dramatic is the loss of groundwater resources due to pollution from natural sources that is often aggravated as a result of poor aquifer management. Natural pollution sources include saline water intrusion in coastal aquifers and pollution by toxic elements present in aquifers or adjacent geological layers like arsenic, fluoride and radioactive isotopes.

Notwithstanding the increasing number of examples of deteriorating groundwater conditions knowledge on the status of groundwater resources is scattered and there is a lack of solid data.

The quality of information on the availability and use of groundwater resources is highly variable from one country to another. Global assessments of groundwater resources often lack recent data on the status of groundwater resources for a large number of countries and systematic information on groundwater quality is even scarcer. For these reasons it is not possible to draw a clear global picture on the scale of groundwater depletion and pollution but the number of reports suggests that the situation in a number of countries is critical.

Climate change and increased climate variability is likely to add additional stresses to water resources availability, including groundwater.

Climate change will have an impact on all components of the hydrological cycle and result in changes in the seasonal and geographical distribution of water on the planet. Climate change may negatively impact groundwater resources in case of changes in groundwater recharge due to changing river discharge or rainfall patterns. Climate change may also lead to an increased pressure on groundwater resources in case of reduced availability of surface water resources. But groundwater also has a unique potential to adapt to climate change – primarily as a result of its buffering potential against increased climate variability.

Why should we care?

Groundwater plays an essential and increasing role in global drinking water supply and food security.

It is estimated that 2 billion people worldwide depend on groundwater for drinking water. Its regional importance is demonstrated by its provision of 70% of drinking water in the EU, 80% of rural water supply in sub-Saharan Africa, and 60% of agricultural irrigation in India (IAH, 2006). Brown (2008) argues that uncertainty about continued access to shallow groundwater circulation presents a risk to world food production[1]. The relative importance of groundwater in staple crop production is between 14-18% of global cereal production and up to 50% or greater of cereal production from irrigated areas (Burke et al, 2012).

Groundwater depletion and contamination will result in spiraling costs for water access, claiming valuable economic resources with the poor suffering most.

At the start of groundwater exploitation, fresh water was easy to find and available at limited cost because of the shallow depth and short transportation distances from the point of use. In the case of groundwater depletion, the level of water in the aquifers drop and the quality of remaining water deteriorates. Over time, the freshest and most easily accessible water is depleted, leaving behind marginal quality water at much greater depth. Deeper wells, larger capacity pumps and additional treatment facilities will be needed to make the water potable. The combination of deteriorating water quality, increasing depth and growing distance from centers of use creates a 'perfect storm' of extreme water scarcity and spiraling cost.

Because of it's local availability and generally good quality, limiting treatment costs, groundwater is often cheap compared to alternative sources of supply. When nearing depletion supply from groundwater will have to be replaced by more expensive alternatives, claiming valuable economic resources that are not available for other investments. Increased water costs will translate in higher water bills, impacting the urban poor and middle classes most, or in higher fiscal cost.

[1] Particularly in the context of predicted 70% increase in agricultural production by 2050.

Need for Governance

New, more effective governance is essential to respond to the challenges outlined.

Governance—the operation of rules, instruments and organizations that can align stakeholder behavior and actual outcomes with policy objectives—has to respond to these serious problems. Essentially, governance frameworks are ill-adapted to control the sharp increase in the private exploitation of groundwater.

As a result of its defining characteristics, groundwater governance is inherently more complicated than that for surface water.

Unlike surface water, *groundwater is easily appropriated simply by capturing it (the 'law of capture')*. Although like surface water it is a common pool resource, the fact that groundwater is not readily visible combines with well technology to allow individuals to establish de facto rights to the water under their land. Also unlike surface water, *there is no built-in need to cooperate within a governance framework*. The individual character of groundwater frees the user from constraining governance or cooperation with neighbors. Finally, it is *hard to measure this unseen resource*, and it is difficult to manage what you cannot measure. All attempts to impose governance over groundwater and to bring groundwater within an integrated water resources management (IWRM) framework have to take account of these three characteristics.

Governance today also has to take account of the reality that in many locations "the cat is out of the bag."

Once groundwater rights have been asserted ahead of a governance system that might have contained them, it is incredibly difficult to recover control. This is especially true in countries where all the incentives are in favor of development and abstraction, particularly where agricultural policy coincides with farmers' own motives to produce ever more. These external incentives are compounded by the powerful incentives inherent in the resource itself that lead farmers to prefer groundwater to all other water sources.

Despite the magnitude of the challenges and problems, groundwater governance has not been on the agenda of decision makers.

Groundwater has failed to feature prominently in water policy dialogue at the local, national or global level. As a result, its governance has not kept pace with increasing demands and technological advances. Analysis of the World Bank portfolio shows that despite the sound analytical studies and available expertise, there has been a decline in the number of groundwater projects financed. Moreover, of those financed few included a component on groundwater governance.

The aim of this report is, therefore, to help to put groundwater and its governance at the top of the agenda for decision makers and practitioners.

To that end, the report tries to answer the following questions:

- Why has groundwater governance failed to stop the emergence of very serious threats to the resource?
- What are the impediments to improving groundwater governance?

- What are the options to overcome those impediments?

The report set out to analyze how the political economy influences groundwater governance but soon it became clear that to understand impediments to better groundwater governance other concepts had to be considered as well. Implicit in the report's approach is recognition of the importance of groundwater resources in promoting developing country adaptation to predicted climate changes.

The analysis draws on country level experience in implementing global approaches to groundwater governance. This comprises in-depth case studies from five countries: India, Kenya, Morocco, South Africa and Tanzania. Analysis of impediments to improving good governance and options to overcome them also include best practice experiences obtained from an analysis of non-Bank international groundwater experiences from a various countries and transboundary aquifers.

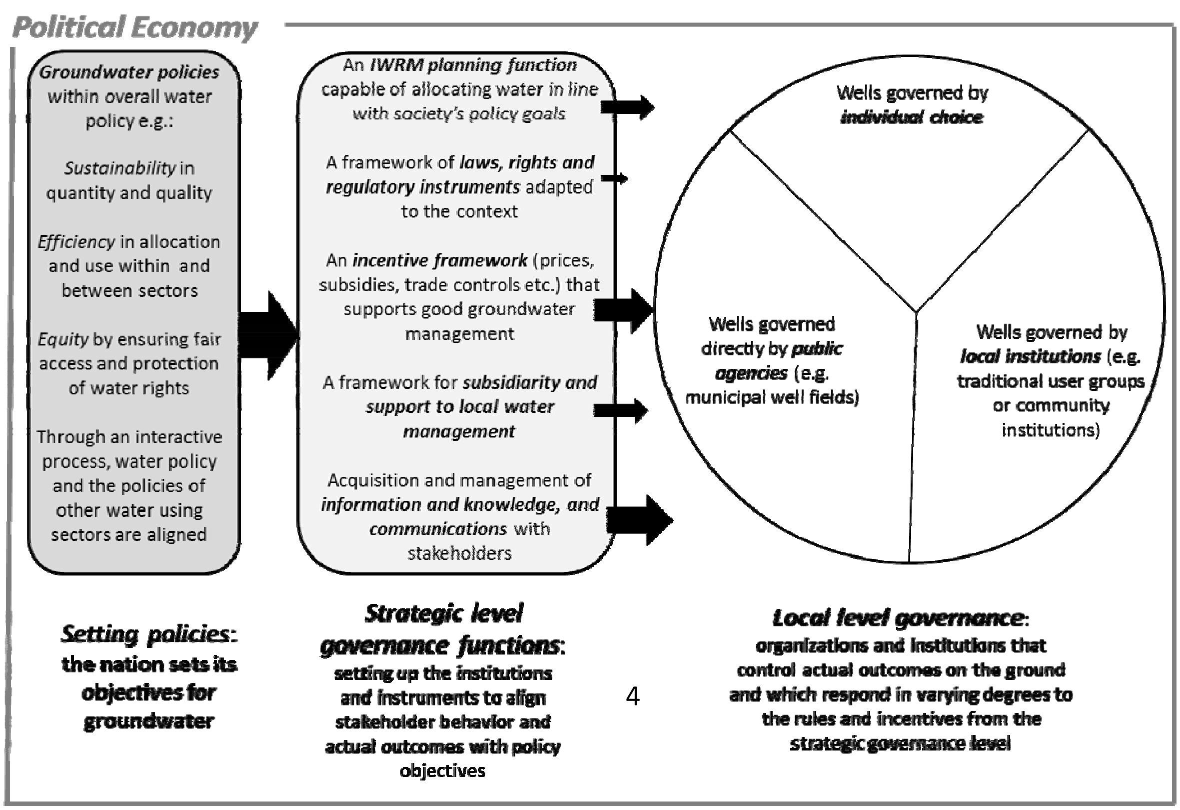
Analytical Framework

The framework used for the analysis distinguishes three parts to the groundwater governance system: the policy level, the strategic level and the local governance level.

Nations establish their groundwater objectives at the policy level. Strategic level governance is the stage at which a nation puts in place institutions and instruments to align stakeholder behavior and actual outcomes with policy objectives. Finally, local level governance involves the organizations and institutions that control actual outcomes on the ground, and respond in varying degrees to rules and incentives. The framework is sketched out in Figure 1.

The framework also applies to the specific case of transboundary aquifers. Politics and institutions condition local-level action. Nonetheless, actors at the local level are ultimately those that make or break transboundary groundwater regimes (Walter, 2011).

Figure 1 - A Framework for Analyzing and Assessing Groundwater Governance



Case Studies of National Governance Arrangements

In all countries studied, groundwater development and abstraction have taken place ahead of governance arrangements, leading to depletion and quality deterioration.

The case studies provided a rich variety of lessons, many of which were common to all the countries. All countries studied were suffering depletion and quality deterioration of the aquifers to a greater or lesser degree. All five countries had policy frameworks in place, but groundwater policies were generally poorly articulated with those of the water-using sectors, particularly agriculture.

Formal governance arrangements were largely top down, although there were some cases of decentralization to the basin level as well as some moves towards creating partnerships with local collective management organizations. However, in every case the rights and regulation approach to governance was proving to be not well-adapted to the fast changing realities of the "groundwater revolution", and everywhere implementation capacity fell far short of the ambitious regulatory provisions.

Information, knowledge sharing and communications were insufficient to support management or to foster good governance.

Public agencies were also underfinanced and lacked the capacity to do an adequate job.

At the local level, there was generally a big disconnect between the regulatory regime and facts on the ground, and in some cases local collective management was substituting for more formal governance.

For example, rules on drilling and abstraction, on pollution and on protection of recharge zones were not always applied on the ground. Some initiatives to delegate management to the basin level appeared more promising. At the local level, there were a number of interesting examples of collective management and self-regulation, but these were weakly embedded and little linked to public sector support structures.

Constraints and Options for Setting Good Groundwater Policy

The Influence of Context

Groundwater is particularly challenging for governance because millions of well owners have appropriated it, and they respond more to powerful economic incentives than to the rules governance would impose.

Groundwater is a common resource but, driven by strong economic incentives, people have established de facto individual rights to groundwater. Moreover, they are competing with each other to extract as much as possible as quickly as possible with no inherent incentives to aim for sustainability. Governance is further challenged by the fact that groundwater, while it is part of the hydrological cycle, is largely unseen and even specialists are hard pressed to describe the resource and its interactions in sufficient detail to plan for and manage it.

Governance has to be adapted to the context and to capacity, and be tailored to the size and nature of the problem as well as to the objective targeted.

The challenge is increased by the local specificity of groundwater given that each area has its own physical, geographical and socioeconomic characteristics. Governance also has to adapt to the state of development and to the problems that past assertion of rights and abstraction behavior have produced. In some cases the problem is over-abstraction and depletion, in others water needed by fast growing towns is “locked in” to lower yielding agricultural uses, and in yet other cases the challenge may be compromised quality or recharge. Usually, these problems do not occur in isolation, but more than one of them will exist at the same time. All these features need to be taken into account in assessing governance options, which have to be adapted to the context and to capacity, and be appropriate to the problem at hand and the policy objectives targeted.

Setting Good Policy and Handling Political Economy Factors

Policy makers have little incentive to strengthen groundwater governance.

Although most national policies target sustainability, equity and efficiency, there is a gap between stated policy and what actually happens. Policy makers have short horizons and inadequate information, and they are reluctant to put forward policies that constrain the profitability of groundwater use because this affects powerful constituencies and often the poor, as well. Policy makers prefer high-profile surface water investments to the long and politically costly struggle to impose order on a largely ungoverned groundwater sector.

Champions of change need to choose their causes carefully, identifying the really critical issues, and preparing and presenting the options persuasively

These options should, as far as possible, reconcile the incentives of decision makers and stakeholders with some approximation of good groundwater policy. A first step is usually to obtain the budget and necessary approvals to carry out essential resource assessments and establish a reliable monitoring and reporting system.

Governance at the Strategic Level

IWRM and Cross-Sectoral Harmonization

Groundwater is the “poor relation” in water resources management and is often over-ridden by economic interests, particularly agriculture.

Although most countries have adopted policies and have set up organizations for integrated water resource management, groundwater struggles for its place in integrated water planning. Governments often fail to provide the capacity and budgets needed for implementing the groundwater parts of these plans. Improving groundwater governance requires stronger groundwater agencies.

The case needs to be made for the integration of groundwater into planning, for policy harmonization and (if possible) for multi-level governance.

Governments need to align instruments and harmonize sector policies, planning and implementation at all levels, not only at the center. Some good examples of this multi-level governance for groundwater are emerging.

Developing and Applying Governance Approaches

The analytical framework above distinguished two governance approaches aiming at influencing the behaviour of individual stakeholders, and both are found in most countries:

- A *rights and regulation approach* awards (or recognizes) legal water rights to users and then ensures that users are respecting the terms of the award through a regulatory system.
- An *incentives-based approach* uses positive and negative incentives that typically affect the profitability of water use to align pumping behavior at the wellhead with policy.

These apparently opposing approaches are in reality often applied in a conjunctive manner and can be complementary. In addition to these approaches the framework identifies the concept of subsidiarity that is often applied in addition to any of the 2 other approaches.

- A *subsidiarity approach* delegates responsibility for groundwater management to the local level, usually to stakeholder interest groups.

Rights and regulatory approaches are very demanding to implement and are usually resisted by stakeholders.

While they are the most precise instruments for matching behavior at the wellhead to society's goals, these approaches are usually impeded by massive institutional and operational problems. Rights and regulation approaches have run into problems of defining, issuing and regulating quantified rights. Where these systems have been applied, they have also faced significant problems of organizational capacity, usually receiving scant compliance from well owners. In addition, like many systems that recognize past appropriations of the commons, they tend to confirm inequitable patterns of resource ownership.

However, for bigger and formal sector users, rights and regulation approaches are more feasible and can be the best option.

Designing and implementing such systems can be done in some circumstances, but it requires a realistic feasibility assessment, especially of the cost and benefits compared to those from an incentives or subsidiarity approach. Combinations of approaches may be possible, such as for example, registering just the bigger, more formal users (who can also be required to pay for the privilege), while adopting a subsidiarity approach for smaller users. However, care will always be needed to protect the rights of the smaller users.

Adjusting the incentives structure is a mechanism that even a weak government can undertake, but adjustments are politically difficult and can have negative or unintended consequences.

Positive and negative incentives are very powerful determinants of behavior and, in the case of groundwater, governments are usually able to adjust them easily. Thus, they are attractive mechanisms, especially in a poor country with limited administrative capacity. Options include adjusting input prices like energy or output prices like farm produce; providing subsidies to encourage specific behaviors; or imposing bans on crops or on irrigation methods, for example. However, these approaches have also big disadvantages. Adjusting prices often produces unintended consequences and can be politically damaging. Subsidies are expensive and lend themselves to corruption. Bans often run counter to economic efficiency.

Delegating to local governance structures can produce good results, and a framework for encouraging subsidiarity should be in place.

In principle, *subsidiarity* (that is, delegating management to the lowest possible level) is attractive because it comes closest to the actual decision makers, the millions of individuals drilling and operating wells. In some cases, collective management approaches at the local level have demonstrated good outcomes, often in partnership between stakeholders and local public agencies or projects. In most countries, the enabling framework should certainly encourage such approaches.

A mix of approaches will normally be indicated. This requires flexibility, adaptation, and keeping an eye on equity.

Overall, there is no one right approach. In each context, one or more of the three approaches may be better (see Table 1). Flexibility, piloting initiatives, and learning and adapting as needed are likely to be good stances. Particularly important is to adapt approaches to implementation capacity. In all approaches, it is essential to keep an eye on equity considerations, as there are powerful incentives pushing towards resource capture by the more powerful.

Table 1. Governance Approaches to Groundwater (including the requirements of each and when they might be the most indicated)

Requirements	**Which approach may be the most effective?**		
	Rights and regulation	**Incentive structure**	**Subsidiarity**
Is there a legal framework of rights and regulatory instruments that is adapted to the situation and which is implementable? If yes…	✓		
Is there a pattern of groundwater users complying with authority? If yes…	✓		
Is the approach administratively simple and low cost?	✓	✓	✓
Is there strong social capital and/or a history of agreed water rights and collective management at the local level? If yes…		✓	✓
Is intersectoral water transfer an objective? If yes…	✓	✓	
Is there a serious depletion problem? If yes…			✓
Is there a serious pollution or recharge problem? If yes…	✓		✓

Information, Knowledge and Communications

Information, knowledge and communications functions are essential components of good groundwater *governance*.

Information on groundwater is very weak in most countries. This is due to high costs of collection, to prevalent capacity and skill gaps, and to lack of commitment and resources. Information is needed not only on aquifer characteristics but on uses and users in order to understand behavior and trends. Once collected, information has to be available to managers and to all stakeholders through an open information policy.

It is thus vital to persuade governments to invest in information and knowledge.

Economic assessments showing the value of groundwater and the cost of inaction may help persuade decision makers to invest in groundwater information and knowledge. Innovative ways of gathering part of the information through stakeholder participation or by using remote sensing technologies may lower costs. Increased attention should be paid to getting to know uses and users, and to understanding the motives and incentives that local people face.

Communications with stakeholders is the key to developing governance systems with which stakeholders feel invested.

Very importantly, transparency, dialogue and interactive communications and learning are key to strengthening stakeholder ownership of governance, and to improving compliance and thereby outcomes.

<u>Conflict and Conflict Resolution</u>

Hitherto rare, conflict over groundwater is becoming more frequent.

The early stages of the groundwater revolution saw little conflict because groundwater extracted by tubewell was a new and abundant resource. In addition, because of the nature of groundwater, conflict has typically been much less than in the case of surface water. However, there are many potential sources of conflict now emerging due to over-abstraction, pollution, or changes in land use. Owners are often also in conflict with public agencies (for example, over regulation).

Furthermore, climate change is introducing costs and risks that are hard to manage, including increased demand for groundwater and reduced recharge, with consequent heightened risk of conflict. Disputes have also started to emerge between states over transboundary aquifers.

Although new dispute resolution mechanisms are being set up and old ones are being adapted, results vary.

Results are mixed regarding dispute resolution mechanisms. Traditional ones are difficult to adapt to the tubewell. Nevertheless, some are showing adaptive capacity and modern dispute resolution mechanisms are also being set up, sometimes alongside the old. Overall, dispute resolution mechanisms may be modern or traditional, centralized or local, but the key criterion is that they be accepted as fair by all parties.

The Role of Participation and Local Collective Management in Good Groundwater Governance

Empirical evidence suggests that participation and local collective management can be effective approaches to good water governance.

Participation appears to be effective in improving outcomes because it increases stakeholder ownership and because stakeholders often have access to information and can devise solutions better than or complementary to those delivered from the top down. Perhaps the most important aspect of participation is that it can align government objectives with those of local people. This gives the local stakeholders incentives to manage the groundwater well, and can empower them by giving them influence over outcomes during the implementation process.

Participatory approaches to groundwater management range from consultation to fully delegated groundwater management.

The more bottom-up the approach, the stronger the participation and empowerment of local stakeholders. Clearly the level of participation will depend on the local context, with the need for skilled support increasing as participation moves towards local collective self-management. In all this, it is salutary to recall that, in practice, local stakeholders are already managing most of the world's groundwater. In this sense, participation could be seen as much as participation by government agencies in local governance arrangements as vice versa.

Despite this potential there are many impediments to participation and local collective management.

Frequently, the legal and institutional provisions do not empower collective management institutions. For example, water user associations may be consulted over basin plans, but they rarely have any power to participate in decisions. At the local level, there is usually much more experience in collective management of surface water, and stakeholders are often very slow to adapt to the quite different demands of groundwater.

There is a risk that participatory approaches may reflect existing inequalities.

The more powerful may either dominate participatory deliberations or not participate at all. A further aspect of this asymmetry of power is that most people do not own any groundwater, but they are nevertheless stakeholders. Ways to include and empower these people are often hard to negotiate, especially when there are social or cultural barriers. An equally challenging inclusion issue is how to get the participation of those who are not directly benefitting from the resource but who may be polluting or hampering recharge.

As groundwater problems intensify, incentives to participation and collective management grow.

User participation is complicated by the physical invisibility of groundwater systems, which make it harder to agree on the problems and the responses and make monitoring more difficult. In fact, unless people agree there is a problem, stakeholders may not see the point of cooperating. However, crisis and the threat of climate change may change attitudes. Overall, a combination of social and physical conditions is likely to determine whether people cooperate. For example, settings where stakeholders are fewer and where resource dynamics are easier to understand are more conducive to cooperation.

Partnerships between local stakeholders and public agencies are an effective approach, but this requires long-term commitment on both sides.

Most successful collective groundwater management has not been done by local people alone, but in partnership with a public agency, which can provide knowledge, capacity building, and so forth. However, engaging in participatory approaches is costly and requires long-term commitment from public services and communities.

Experience yields some do's and don'ts: build on existing social capital, promote equity and inclusion, start in areas of good potential, go step-by-step, and learn lessons and adapt.

It seems that costs are less and outcomes better where participatory approaches build on existing social capital, and so interventions should be adapted to take advantage of it. Principles of equity and social fairness demand that the voices of the less powerful should also be heard, and this is something that public agencies can advocate. Interventions could start in areas with potential for success and where intervention costs are lower, in the expectation of spontaneous replication.

There is a wide range of methods and tools available to support stakeholder participation.

Experience around the world has yielded a number of approaches and tools that can be adapted and replicated. A suite of interactive learning processes has been developed that provides a range of flexible learning-by-doing approaches to developing institutions for collective water management. As part of this study, a simple readiness checklist was prepared to test whether the conditions for effective collective management of groundwater are in place. Finally, in general it is not a question of either/or, both top-down rules and public services as well as bottom-up local collective management are needed for effective groundwater management.

Getting Started Towards Improved Groundwater Governance

This report contains a perhaps bewildering set of issues and recommended actions. But every journey starts with the first steps. The following is a list of entry point activities on how to initiate help to countries to improve groundwater governance. Of course, not all these activities are applicable everywhere, but they are offered as a menu of options presenting a wide range of possible actions. These actions can be implemented independently or as a combination of actions.

Actions have been grouped in 5 different families:

- **Engage with the policy makers** to understand their concerns and constraints. Go outside the water ministry to seek harmonization and support from agriculture, planning, finance, and municipal development agencies. Carry out an economic analysis of key issues and present it persuasively. A multitude of tools exist including natural capital accounting, assessment of the opportunity cost of groundwater or wealth accounting of groundwater services. Recruit champions and try to come up with win-win agendas. Link governance reform to investment, if relevant.
- **Agree with policy makers on investment in groundwater knowledge**, and offer technical and financial support if needed. Focus not only on resources but on uses and users to identify hot spots. Draw on the results to persuade policy makers of the need for action. Link the results to an analysis of governance needs.

- **Help government to chart a reform path towards better groundwater governance**. Assess the needs and constraints to good governance, following the methodologies in this report. Identify what approaches are best indicated (rules and regulation, incentives, subsidiarity) and work out a reform path over time, as well as an actions and investment plan.
- **Help build strong groundwater organizations/departments/agencies** to ensure groundwater's place in IWRM planning and to strengthen their support to the governance approaches chosen. Match their capacity to the tasks decided upon. Dialogue with government to ensure that the organizations have adequate resources, including skills and budgets.
- **Identify the scope for collective management, and devise ways to support it.** Work at the project and local level, in tandem with agriculture colleagues and those involved in decentralization or local level government.

1. BACKGROUND AND INTRODUCTION

Groundwater as a Resource

What is groundwater?

Groundwater is defined as all water which occurs in the soil and geological formations below the land surface. An aquifer is a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs.

Traditionally groundwater was accessed through open wells that were constructed by sinking a hole in the ground deep enough to reach the groundwater table. Well depth is limited (typically less than 30 m) and wells are therefore not suited to draw water from deeper aquifers. A tubewell is constructed by driving a tube into the earth to a stratum that bears water, before drawing that water to the surface via hand-, electric- or fuel-powered pumps. Tubewells can draw water from deeper aquifers and can reach in extreme circumstances depths of more than 2000 m like some water supply wells for the city of Riyadh in Saudi Arabia.

The proliferation of tubewells in the second half of the 20^{th} century has been facilitated by their relative ease of construction (not requiring dewatering and only minimal lining material) coupled with improvements and price reductions in construction and pumping technologies (IAH, 2006).

Current Importance

Excluding water locked up in ice-caps and glaciers, groundwater constitutes 97 percent of the world's readily available freshwater. While historically it has not generally been exploited as heavily as surface water, recent large-scale development has meant that, today, it forms the foundation for social and economic development in many regions, particularly developing countries, which While historically it has not generally been exploited as heavily as surface water, recent large-scale development has meant that, today, it forms the foundation for social and economic development in many regions, particularly developing countries, which account for 71 percent of global water withdrawals.

It is estimated that groundwater is used for 43 percent of global irrigation water use (Siebert et al., 2010), 40 percent of total industrial withdrawals, and 50 percent of total municipal water withdrawals (Zekster and Everett, 2004) while also sustaining important ecosystem functions.[2] Beyond its sectoral importance, groundwater is often the sole water source in arid and semi-arid areas. It has been fundamental to rapid urban and rural development in Africa, Asia and Latin America. More than 1.5 billion urban dwellers depend on groundwater (Salman, 1999). Although spatial and sectoral reliance on groundwater varies greatly, it meets over 75 percent of national water needs in some countries.[3]

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[2] There are uncertainties with the estimates. For example, Siebert et al. (2010) consider different approaches to estimating groundwater use for irrigation (the largest component of total groundwater use) and opt for a compilation based on national statistics and expert judgement as being the most reliable, albeit with considerable uncertainty.

[3] Including Estonia, Iceland, the Russian Federation, Jamaica, Saudi Arabia, Georgia, Swaziland, Mongolia, Libya, and Lithuania (International Groundwater Resources Assessment Centre (IGRAC))

Furthermore, groundwater is predicted to play an increasingly critical role in addressing future global water needs. Developing country demand is expected to increase by more than 25 percent by 2025 (from 2010). Brown (2008) argues that uncertainty about continued access to shallow groundwater circulation presents a risk to world food production[4]. The relative importance of groundwater in staple crop production is between 14-18% of global cereal production and up to 50% or greater of cereal production from irrigated areas (Burke et al, 2012).

A study by Konikow (2011) indicates that groundwater depletion, as a distinct hydrologic factor, is a small but nontrivial and increasing contributor to sea level rise. Cumulative groundwater depletion represents a transfer of mass from land to the oceans that contributes to sea-level rise.

Besides its capacity to answer growing water demand, groundwater also provides unique opportunities to cope with increased climate variability. Given its ever rising importance in answering global water demand and its potential for climate change adaptation it may seem odd that groundwater protection and management receive so little attention from the development community and remain low on the policy agenda. This paradox can be explained by the nature of groundwater and its unique characteristics.

Inherent Challenges

Groundwater differs from surface water in a number of characteristics (see Annex 1), which have implications for the development of appropriate governance structures.

The most striking feature of groundwater is its general invisibility, both physically and politically. The rapid and widespread increase in groundwater use has been termed by some hydro-geologists as a "silent revolution" due to its occurrence largely in an unplanned and uncontrolled way and almost without notice in many developing nations (Llamas and Martinez-Santos, 2005). In addition, the dynamics of many groundwater systems are not well understood. Furthermore, the ability to use groundwater "on credit" is a major advantage when facing increasing climate variability; however, it also poses a significant hazard to the sustainability of the resource if not governed effectively. A balance between meeting short-term needs and long-term utilization (and ecosystem demands) must be established.

Concurrently, and related to the physical challenges, groundwater is typically undervalued by governments (both in developed and developing countries), meaning that it is often weakly governed and underfunded and underrepresented in water policy discourse.

Major Threats to Groundwater Systems

The quantity and quality of groundwater resources globally is threatened by unsustainable water withdrawals and consumption. This demand for groundwater is the result of rapid population and economic growth, and increasing urbanization and commercial agriculture, and is largely untrestrained by workable governance systems. Threats can be categorized into three major issues: (i) overabstraction; (ii) encroachment over or degradation of recharge areas; (iii) and deterioration in groundwater quality. The first two can lead to depletion of the groundwater resource, and the second and third can affect its quality to the point where it may be unusable. The nature of groundwater as a common pool resource exposes it to Hardin's "tragedy of the commons," where inadequate management may lead inexorably to

[4] Particularly in the context of predicted 70% increase in agricultural production by 2050.

its degradation.

Overabstraction of groundwater commonly occurs when landowners assert their rights to develop and abstract the water beneath their land, which is the general practice. There have usually been no governance constraints on these de facto rights. As the well owner becomes aware that, in fact, the resource is shared, incentives are created to develop and pump out as much water as possible as quickly as possible. In many countries, these incentives are strengthened by price signals, particularly cheap diesel or electricity prices. In some areas, this combination of perverse incentives has led to the rapid depletion of reserves. In addition to using up often irreplaceable reserves, this can lead to rising costs and to rapid quality deterioration well before quantity is used up, as well as to secondary environmental effects and land subsidence (Foster et al., 2000).

Degradation of groundwater recharge areas, often through development activities and/or changes to hydrological regimes, can impact both the quantity and quality of recharge infiltrating into aquifers. A major challenge is determining the location and boundary of recharge areas and then controlling land uses there.

Deterioration of groundwater quality can come about through contamination from either point or diffuse sources. Aquifer vulnerability is highly dependent on physical characteristics (i.e. unconfined or confined) and local geology. While some contamination can occur naturally (for example, from naturally high levels of arsenic, fluoride and iron), anthropogenic sources generally pose a much greater threat. Pollution can render aquifers unusable if not controlled and remediation is often very difficult and expensive. Thus, the management focus should be on early, preventive actions combined with monitoring.

In addition to the three major threats identified above, *climate change* will likely have a profound impact on all stages of the hydrological cycle (precipitation, evaporation, runoff, river flows, groundwater recharge and discharge) affecting water availability and use across transboundary, basin, and local levels.

Why should we care?

Groundwater plays an essential and increasing role in global drinking water supply and food security.

It is estimated that 2 billion people worldwide depend on groundwater for drinking water. Its regional importance is demonstrated by its provision of 70% of drinking water in the EU, 80% of rural water supply in sub-Saharan Africa, and 60% of agricultural irrigation in India (IAH, 2006). Brown (2008) argues that uncertainty about continued access to shallow groundwater circulation presents a risk to world food production[5]. The relative importance of groundwater in staple crop production is between 14-18% of global cereal production and up to 50% or greater of cereal production from irrigated areas (Burke et al, 2012).

Groundwater has a unique potential for climate change adaptation

Groundwater reserves provide a first rate buffer against *climate variability* and any associated decline in other water sources, and will play an increasing role where aridity is on the increase. In addition, groundwater's typically delayed response to climatic variability and its protection from evaporation means

[5] Particularly in the context of predicted 70% increase in agricultural production by 2050.

that it provides a water source that is itself naturally protected from increased variability under climate change. However, any compromised quantity and quality of groundwater resources may erode its advantages.

Groundwater depletion and contamination will result in spiraling costs for water access, claiming valuable economic resources with the poor suffering most.

At the start of groundwater exploitation, fresh water was easy to find and available at limited cost because of the shallow depth and short transportation distances from the point of use. In the case of roundwater depletion, the level of water in the aquifers drop and the quality of remaining water deteriorates. Over time, the freshest and most easily accessible water is depleted, leaving behind marginal quality water at much greater depth. Deeper wells, larger capacity pumps and additional treatment facilities will be needed to make the water potable. The combination of deteriorating water quality, increasing depth and growing distance from centers of use creates a 'perfect storm' of extreme water scarcity and spiraling cost.

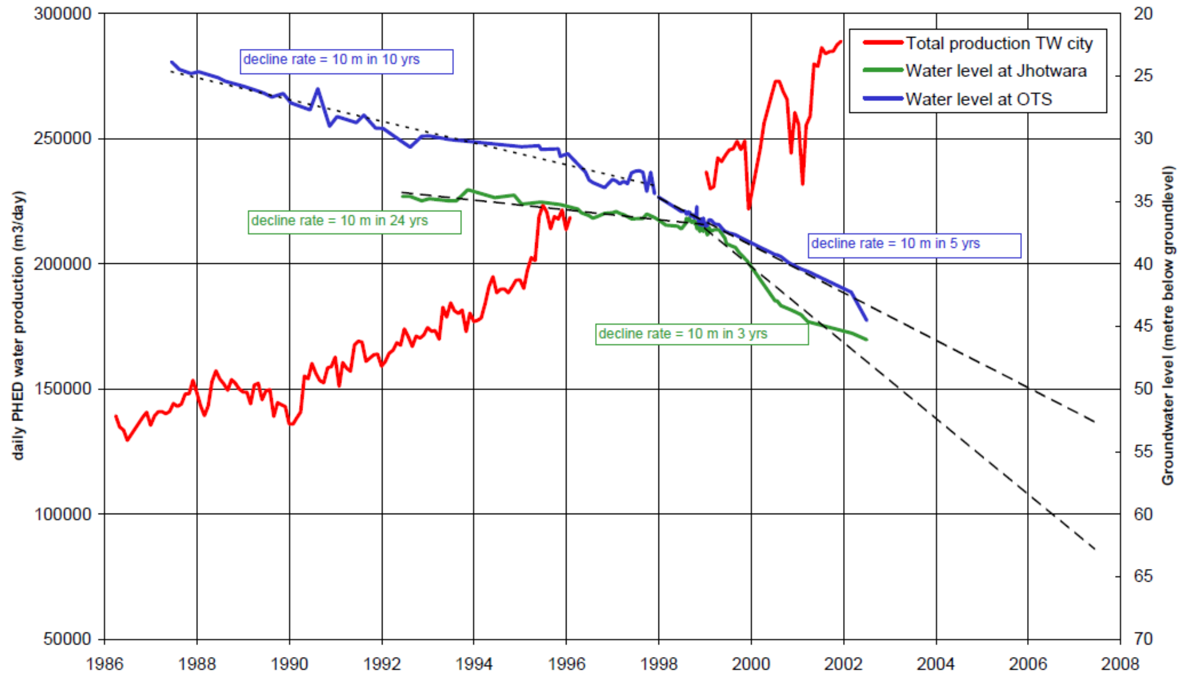
Because of its local availability and generally good quality, limiting treatment costs, groundwater is often cheap compared to alternative sources of supply. When nearing depletion supply from groundwater will have to be replaced by more expensive alternatives, claiming valuable economic resources that are not available for other investments (see Box 1 and Figure 2).

Box 1. Groundwater depletion in Rajasthan, India

Jaipur is the capital of the Indian state of Rajasthan with a population of more than 3 million people. Up until 2009, more than 90% of the drinking water supply was provided by groundwater using more than 800 public water supply wells. The cost for production, distribution and treatment cost for drinking water amounted to less than 4 Rs/m^3 (ANTEA, 2004). Absence of regulation and increasing competition with thousands of private water supply wells within the city limits and thousands of irrigation wells in the vicinity of the city resulted in rapidly declining groundwater levels in the regional alluvial aquifer (Figure 1).

Confronted with a predicted exhaustion of the local groundwater resource within less than 2 decades and a deteriorating groundwater quality, the Government of Rajasthan approved the Bisalpur Water Supply Project, which, since 2009, has supplied the city with water from the Bisalpur dam, located 130 km SW of Jaipur. Phase 1 of the Bisalpur Project has a capacity of 400 MLD and represents an investment of US$120 million. High investment and operation cost result in an estimated drinking water cost of 17 Rs/m^3.

Figure 2 - Groundwater abstraction (red line) versus declining groundwater levels (blue/green lines) in Jaipur, India.



Source: ANTEA, 2004.

Need for Governance

Governance is understood as the operation of rules, instruments and organizations that can align stakeholder behavior and actual outcomes with policy objectives (Chapter 2). This governance has to respond to the serious problems outline above. Essentially, there has been a surge in the uncontrolled private exploitation of the resource, and governance frameworks have been ill-adapted to control it. The result has been depletion and quality deterioration and, in some cases, the misallocation of the resource to uses on which society places a lower value.

Groundwater governance is inherently more complicated than surface water governance because of three defining characteristics. First, unlike surface water, *groundwater is easily appropriated*. Although groundwater, like surface water, is a common pool resource, well technology combined with the fact that it is invisible, allow individuals to establish de facto rights to the water under their land. Second, unlike surface water, *there is no built-in need to cooperate within a governance framework*. The individual character of groundwater frees the user from constraining governance or cooperation with neighbors. Third, it is *very hard even for specialists to measure this unseen resource*, and it is difficult (although not impossible) to manage what you cannot measure. All attempts to impose governance over groundwater—and indeed to bring groundwater within an integrated water resources management framework—have to take account of these three characteristics.

Governance today also has to take account of the reality that in many locations "the cat is out of the bag." Once groundwater rights have been asserted ahead of any governance systems that might have contained them, it is incredibly difficult to recover control. This is especially true in countries where all the incentives are in favor of development and abstraction, particularly where agricultural policy coincides with farmers' own motives to produce ever more. These external incentives are compounded by the powerful incentives inherent in the resource itself that lead farmers to prefer groundwater to all other water sources.[6] Governance frameworks have proved very frail in the past to resist such powerful motives. Traditional and local governance developed to manage springs or oases have rarely been able to adapt to the new tubewell technology. Very few governments have been able to align agricultural policy with good water resources management, and even fewer have been able to recover control over groundwater once that control has been lost.

Groundwater governance has not been much on the agenda of decision makers. Despite the magnitude of its challenges and problems, as well as its importance to the livelihoods of a large proportion of the world's population, groundwater governance has not been subject to adequate policy and management attention, particularly compared to surface water. Groundwater has failed to feature prominently in water policy dialogues at local, national or global levels and, as a result, its governance has not kept pace with increasing demands and technological advances. However, select experiences from the case profiles of the Groundwater Management Advisory Team (GWMATE) demonstrated that integrated solutions for groundwater management and governance can lead to successful results.

Governance frameworks (Chapter 2) can provide a structure within which implementation of operational decisions (management) can occur, benefiting groundwater users (including the poor) and serving as a platform for the implementation of longer-term integrated water resources management principles. IWRM approaches include sharing of groundwater resources among competing users (including the environment) equitably and transparently, and in conjunction with surface waters.

It is a basic tenet of this report that improved governance arrangements are central to managing the "silent revolution." The need to promote awareness and action on groundwater governance to clients, coupled with increasing demands from the clients themselves, means that effective *groundwater governance measures should be a high priority water sector issue for the Bank*. This report contributes to those goals.

World Bank Groundwater Portfolio

The World Bank incorporates groundwater into its lending and analytical work including projects in Water Supply and Sanitation, Irrigation and Drainage, Energy,[7] and analytical assistance. The portfolio of Bank-supported groundwater work is reviewed briefly below.

Lending Projects

Decline in the Proportion of Groundwater Projects — Despite a substantial increase in investment in water portfolio projects since 2003, there has been a decline in the number and value of Bank groundwater projects. This decline is counter to the intention expressed in the 2003 Water Resources Sector Strategy (WRSS), where groundwater was identified as a sector priority.

Potential reasons for the low share of groundwater in water sector lending include: a general lack of

[6] Groundwater is usually cheap, of excellent quality, can be turned on and off like a tap, has natural storage, is ideal for supplementary irrigation, and so on.

[7] The Bank has provided funding for investigations and development of geothermal energy sources.

appreciation by borrowing countries of both the potential of groundwater and the need to invest in its management; a reluctance of governments to borrow funds for groundwater investments compared to more prestigious and visible surface water infrastructure projects; and internal incentives at the Bank (to lend) that could be favoring investments in larger surface water infrastructure.

The most important reason, however, is probably the nature of public investment in groundwater. Most groundwater development is a private sector activity, and public intervention is mostly in governance, knowledge, management, capacity building, and institutional development. These are soft but extremely difficult and burdensome investments that are not inherently very attractive to governments.

Even if governments and the Bank were to increase this type of investment (see below), it would remain a small share of total investment lending. WRSS forecasts estimate that funding for water sector projects will increase to between $21 and $25 billion over FY10-13 (World Bank, 2010a). Groundwater software investment would need only a small share of this total, but those investments could require the Bank's knowledge and expertise even more than for surface water. It will be essential to ensure that there are incentives for the Bank and for governments to identify and invest in groundwater governance projects.

From Groundwater Development to Groundwater Conservation — Bank groundwater-specific projects have shifted in focus from development in the 1990s to mitigation, conservation, and enhancement more recently (World Bank, 2010a; World Bank, 2009) (Figure 3).

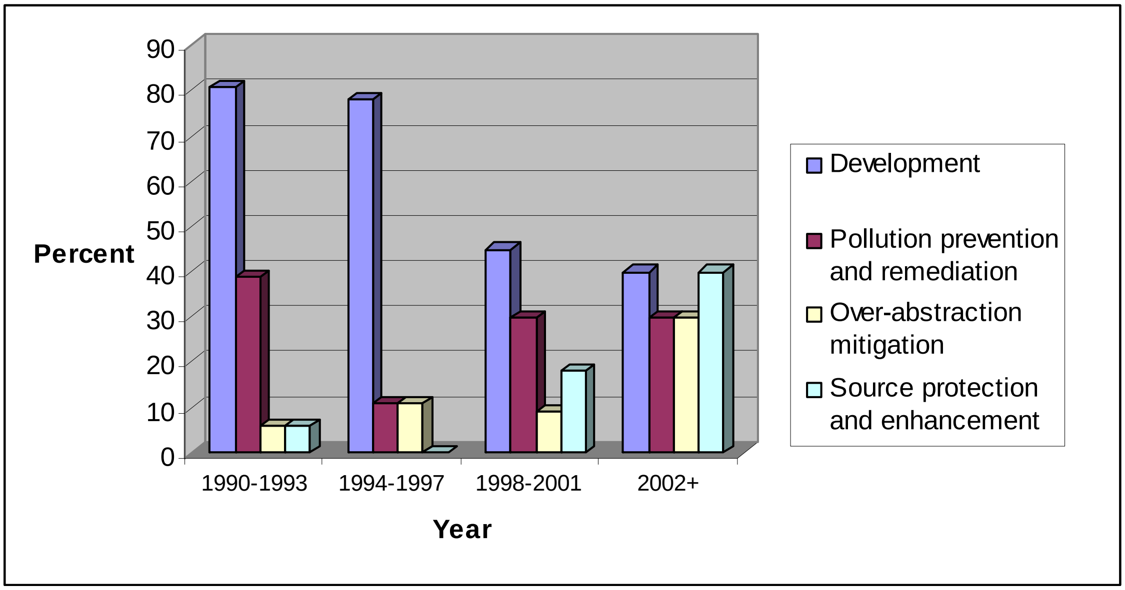
However, technical rather than policy means have been predominant and very little attention has been given to establishing management frameworks to protect groundwater resources before development pressures arise. Only two of the 46 groundwater-focused projects (both GEF-funded) that were reviewed were concerned with protecting a resource in advance of its exploitation.

Support to Governance Activities — Project emphasis on groundwater governance activities across the Bank portfolio is limited but increasing. Central governance components, such as institutional reform, devolution of management responsibility, and intersectoral coordination, did not form major components of projects with groundwater components during the 1997-2007 period. However, groundwater-specific projects did focus more on governance components, with over a quarter helping to transfer responsibilities from central institutions to the local level.

Two GEF-funded transboundary groundwater projects active between 1997 and 2007 were focused on improving governance and developing analyses of issues and strategic action programs among the relevant countries. They also included in-country projects that provided assistance in instituting formal water rights and developing models for calculating safe yields.

Improved knowledge of the resource was the most common governance component, with less focus on clarification of entitlements to access. Policy and legislation can provide support for management of abstraction volumes and controlling polluting activities. However, policy or legislative reforms were scant. None of the 47 groundwater-focused projects supported water resource policy change and only four included legislative changes. Additionally, little emphasis was placed on raising public awareness or on financial reforms, and scant information about the specific features of groundwater and its management was evident (despite the need to overcome common misunderstandings about groundwater).

Figure 3 - Primary Issues Addressed by the Focused Groundwater Projects



Note:Columns add to more than 100% because some projects addressed more than one primary issue.

While over a quarter of the projects with a focus on groundwater contained components that increased water user charges, the introduction of charging systems that more holistically reflect true resource costs and values was not pursued. However, some projects successfully promoted innovative approaches combining improved management and governance of groundwater and recognized the need to control water consumption rather than water use or withdrawal. Some integrated approaches to planning and management, including institutional cooperation and development at national, river basin, and provincial levels to promote a balanced top-down (from national and river basin levels) and bottom-up (participation from water user levels) management approach were evident.

Analytical Work

Country Water Resources Assistance Strategies — Country Water Resource Assistance Strategies (CWRAS) have been successful as a strategic tool for leveraging Bank engagement and dialogue on water issues (World Bank, 2010a). They provide a forum for discussing the major water resources issues facing a country or region and propose ways in which the World Bank can integrate water resources into its Country Assistance Strategies (CAS). While not providing in-depth details, the CWRAS provide insights into the major groundwater issues in the respective country and region and may be useful for prompting policy dialogue.

A review of CWRAS reveals that the most frequently identified groundwater issue[8] is overuse, followed by contamination in specific regions (such as Eastern Europe, and Asian and African cities). Degradation of recharge areas was considered a less serious issue where identified.

Country Water Resource Assistance Strategies are becoming increasingly prominent for governance in

[8] In ten of nineteen CWRASs

cases where resources had been overabstracted. However, none of the CWRAS that proposed increased exploitation of groundwater included any governance activities to help manage the increased pressure on the resource.

GWMATE and Knowledge Products — During the late 1990s and early 2000s, the Bank produced a number of technical publications on groundwater. In 2001, in partnership with DFID and support from the Dutch Government, it formed the Ground Water Management Advisory Team (GWMATE) to provide expert technical support for the Bank's work.

In addition to the Bank's knowledge products on urban and rural groundwater management, legal and policy aspects, and groundwater quality management, GWMATE produced an internationally recognized series of reports[9] and case study illustrations on key aspects of groundwater governance. GWMATE also provided significant technical assistance to Bank staff and country managers.

One GWMATE strategic overview paper[10] dealt specifically with groundwater governance, and provided a checklist of twenty technical, legal and institutional, policy coordination, and operational criteria for evaluating groundwater governance provision and capacity (which was used in Chapter 3 of this report for the case study analyses). Other GWMATE briefing notes dealt with aspects of groundwater governance including different legal approaches (Briefing Note 4), abstraction rights (Briefing Note 5), stakeholder participation (Briefing Note 6), and economic instruments (Briefing Note 7).

Portfolio Synopsis

In conclusion, despite the Bank's sound analytical studies and available expertise, there has been a decline in the number of groundwater projects that it has financed, and few of them have had a component on groundwater governance. Furthermore, the lack of willingness from governments to support this sector is partly explained by a limited appreciation of both the potential of groundwater and the importance of its governance and management. However, select experiences from GWMATE's case profiles demonstrated that integrated solutions for groundwater management and governance can lead to successful results. The main lesson is that helping countries to better manage their groundwater resources requires an intensive focus on the governance arrangements needed to achieve sustainability, efficiency and equity. Hence, the value added of this report is to synthesize global best practice options that can then form part of government/Bank dialogue and investment.

Report Objectives, Methodology and Communications

Objectives

This report forms part of the GEF-funded project on "Groundwater Governance: A Global Framework for Country Action" under the International Waters focal area, and includes partners from the FAO, GEF-IW, IAH, UNESCO-IHP and the Bank. The project includes a broad review of issues, challenges and lessons drawing from national and transboundary case studies. This report is one of twelve thematic papers and has a specific focus on the political economy of groundwater governance.

[9] 16 GWMATE Briefing Notes

[10] Strategic Overview Paper 1

The aim of this study is to analyze the impediments to better groundwater governance within a given political economy and propose recommendations to address key governance issues. Put simply, the report tries to answer the questions:

- Why has groundwater governance failed to stop the emergence of very serious threats to the resource?
- What are the impediments to improving groundwater governance?
- What are the options to overcome those impediments?

Implicit in the report approach is recognition of the importance of groundwater resources in promoting developing country adaptation to predicted climate changes.

Overarching objectives also include addressing the general invisibility problem related to groundwater, as well as strengthening the ability of Bank teams to undertake political economy and governance analyses related to groundwater (and thereby enhance the effectiveness of Bank operations in the water sector).

Methodology

The methodological approach of this study utilizes three lines of analysis to achieve its objectives.

First, the Bank's existing knowledge base of major groundwater management issues is synthesized in this chapter to draw lessons about support for groundwater governance. These lessons are taken from experience gained through GWMATE-supported work, the IEG review of World Bank water-related activities, the Water Anchor's portfolio review, as well as a review of CWRAS and other internal Bank documentation.

Secondly, the analysis draws on country level experience in implementing global approaches to groundwater governance. This comprises in-depth case studies from five countries: India, Kenya, Morocco, South Africa and Tanzania (Table 2).

Table 2. List of Case Study Countries and Reason for Study

Region	Country	Reason for Analysis
Africa	Kenya	Long-term Bank support for water resources development and management. Additionally, opportunity to learn for engagement in further work in Africa region.
Africa	South Africa	Acknowledged example of leading water resources policy and legislation and sound technical capacities. Additionally, opportunity to learn for engagement in further work in Africa region.
Africa	Tanzania	Long-term Bank support for water resources development and management. Additionally, opportunity to learn for engagement in further work in Africa region.
Middle East & North Africa	Morocco	Long-term Bank support for water resources development and management.
South Asia	India	Long-term Bank support for water resources development and management.

The case studies identify key policy and governance impediments and explore opportunities for groundwater management responses under different socioeconomic and physical settings. The case study reports were developed by consultants with extensive experience in the five countries.

Thirdly, best practices obtained from an analysis of non-Bank international groundwater experiences were used in the analysis chapters[11], which also draw lessons from the case studies.

Intended Audiences

This report has two primary audiences. In recognition of the low profile of groundwater governance provisions, it aims to promote the concept more widely to Bank clients, external donors and partners, and a more general audience of academic and civil society organizations. More specifically, World Bank operational staff in the water sector, including water sector specialists, political economy and governance specialists, and in-country teams where water is a significant part of the Bank's engagement.

Dissemination and Learning

Knowledge management and opportunities for collaborative learning have been built into the study. Dissemination and learning events will be organized as part of the broader "Groundwater Governance: A Global Framework for Country Action" project with collaborative partners. In addition, specific regional training events conducted for World Bank Task Team Leaders (TTLs).

Report Structure

This report is structured in seven chapters.

Chapter 1 – Background and Introduction – provides an overview of the status of groundwater resources and their need for improved governance. Given this imperative, the chapter outlines the report objectives, methodology, and structure as well as a synopsis of the Bank's portfolio of experiences relating to groundwater.

Chapter 2 – Governance and Political Economy – defines the key concepts of governance and political economy and sets out the analytical framework used in the report.

Chapter 3 – Country Case Studies of Governance Arrangements – provides a description of these arrangements. It presents the context and primary issues related to groundwater governance in the five case study countries. The governance issues highlighted from the case studies are further discussed in Chapters 4-6.

Chapter 4 – Constraints and Options for Setting Good Groundwater Policy – looks first (4.1) at the determining influence of context to explain why groundwater problems have emerged as they have and how context limits the governance response to those problems. This then provides the background for a discussion (4.2) of options and constraints for formulating responsive groundwater policy.

Chapter 5 – Governance at the Strategic Level – examines three governance approaches (rights and regulatory approaches, the use of the incentive system, and subsidiarity and support to local water

[11] Chapters 4, 5 and 6

management) and assesses how a balance between them might be struck. There is a discussion of key implementation requirements, particularly the role of information, knowledge and communications as well as of conflict resolution mechanisms.

Chapter 6 – The Role of Participation and Local Collective Management in Good Groundwater Governance – looks at the promising but vexed potential for improving outcomes through participatory and collective management approaches.

Chapter 7 –Towards Improved Groundwater Governance – starts (7.1) by illustrating two country cases where groundwater is an important resource and where governance reforms have been implemented in an attempt to improve outcomes in line with the nation's policies. On the basis of this implementation experience, the second part of the chapter (7.2) summarizes lessons and options and suggests how to select governance options appropriate to each situation, and how these options may best be operationalized.

2. GOVERNANCE AND POLITICAL ECONOMY

In order to set the stage for this report, this chapter provides some definitions of concepts used, and then describes the analytical framework that has driven the presentation of findings from the case studies in Chapter 3, the analysis of constraints and options in Chapters 4-6, and the discussion in Chapter 7 of possible ways to apply the options.

Definition of Five Concepts Used

"Governance" is an elusive concept. Everyone has a general idea of what it means, but attempts at defining it do little to provide the layman a working grasp of what is meant. "Political economy" has an equally fugitive meaning in the minds of most readers. For this report, we propose simple working definitions of governance and political economy and of three concepts that also underlie the analysis; namely, subsidiarity, and the distinction between governance at the strategic level and at the local level. While these definitions may not be completely defensible or comprehensive, they are distilled from a wealth of literature (see Annex 2), and have guided the authors in writing this report. These definitions are:

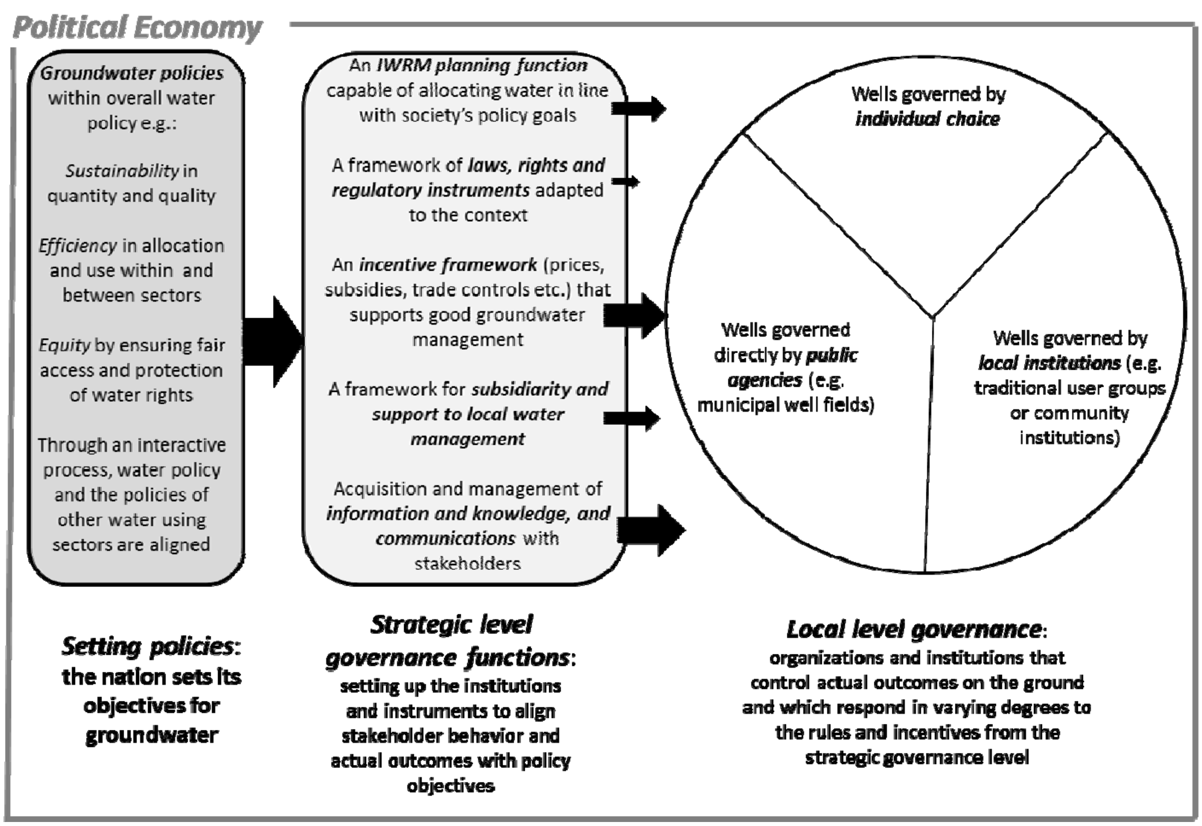
Governance	The operation of rules, instruments and organizations that can align stakeholder behavior and actual outcomes with policy objectives
Political economy	The way in which different stakeholders influence policy, governance and resource allocation, and thereby influence outcomes
Subsidiarity	Water management practiced at the level of the lowest feasible hydrological unit
Strategic level	The level at which decision makers decide policy, make laws, determine regulatory instruments, establish the incentive framework and set up and run agencies to implement these things
Local level	The level at which individuals, organizations and institutions determine actual outcomes in local water management areas and at the well head

Analytical Framework

Well established and well regarded analytical frameworks exist for water generally. For example, leading examples of such holistic water frameworks have been developed by the European Union (Water Directive) and the OECD (2011). Whilst these frameworks include provision for groundwater through principles of IWRM, they provide insufficient detail for addressing specific groundwater governance requirements as proposed in this report. Hence, a groundwater-specific analytical framework, based on an extensive literature review[12] and which is compatible with those more generic frameworks, has been developed as outlined in Figure 4. Full details of the framework and its theoretical underpinnings are presented in Annex 3. The framework presented in Figure 4 distinguishes three parts of the groundwater governance system.

Strengths of the framework include its flexibility to be adapted to specific country situations (as demonstrated in Chapter 3 of the report in an applied example for Yemen) and its ability to highlight issues at the various levels (policy, strategic, and local) and across those levels. The framework has been developed in recognition of the variation in concepts (incentives, enforcement, etc) and tools (financial subsidies, regulation, etc) that may be applied at each level. Additionally, while the framework is considered conceptually robust and sufficiently detailed for the purposes of this report, it does have the capacity to be refined for further analysis of interactions between levels.

Figure 4. A Framework for Analyzing and Assessing Groundwater Governance



[12] Including a hybrid of different frameworks developed by Huntjens (2011), Huntjens et al., (2010, 2011a, 2012), Pahl-Wostl & Lebel (2010).

Setting policies refers to the processes by which a nation establishes its objectives for groundwater, integrates those policies with water, land and environmental policies, and aligns and harmonizes them with other related policies affecting groundwater (notably, agricultural policy, trade policy, regional and urban development policies, and policies on the division of public and private responsibilities, decentralization, and the role of stakeholder participation). The framework illustrates a paradigm *good groundwater policy* that might provide for:

- *Sustainability* in quantity and quality,
- *Efficiency* in allocation within and between sectors to the highest societal value, and
- *Equity* by ensuring fair access and protection of water rights.

Strategic level governance denotes the institutions and instruments designed by a nation to align stakeholder behavior and actual outcomes with policy objectives. For the purposes of the simplified analytical framework, five components are distinguished:

- An *IWRM planning function* capable of allocating water in line with society's policy goals;
- A framework of *laws, rights and regulatory instruments* adapted to the context;
- An *incentive framework* (prices, subsidies, trade controls, etc.) that supports good groundwater management;
- A *framework for subsidiarity* and *support to local water management* on a partnership basis; and
- Acquisition and management of *knowledge and information* about the resource and its uses, and *communications* with stakeholders.

Local level governance involves the organizations and institutions that control actual outcomes on the ground and respond (in varying degrees) to the rules and incentives from strategic level governance. This level includes, in descending order of responsiveness to strategic level governance:

- *Public agencies* (ministry branches, local authorities, basin agencies), which could be expected to more or less reflect policies and strategic level governance at the local level. These agencies may directly control part of the resource (e.g. municipal well fields) or they may influence outcomes by the application of a regulatory regime, or by working in partnership with local collective management institutions or with individuals.
- *Local collective management institutions*, including collective organizations; and rules, sanctions and dispute resolution mechanisms developed by communities and interest groups.
- *Individual well owners*, whose well development and abstraction behavior are (in the absence of respect of any other governance system) determined by individual, household or family goals.

This framework was tested against all the elements in the literature and against practice, and it has proved fairly robust. The analysis in Chapter 3 is set out with this framework in mind, and Chapters 4-7 are organized according to it. Some aspects of governance (for example conflict resolution) that are not expressly listed have nonetheless been captured and are discussed within the framework. Once a groundwater governance framework is in place, a variety of management instruments can be implemented (see Annex 4).

3. COUNTRY CASE STUDIES OF GOVERNANCE ARRANGEMENTS

This chapter presents the context, main issues and groundwater governance arrangements in the five case study countries of India, Kenya, Morocco, Tanzania and South Africa. The chapter is structured to first identify the drivers and level of groundwater development in terms of both quantity and quality. Governance arrangements and issues at the policy, strategic and local levels are then identified. The governance issues highlighted in this chapter are discussed in detail in subsequent chapters of this report.

A Range of Contexts and Issues on Groundwater and Its Governance

Case studies in India, Kenya, Morocco, and Tanzania were selected due to the Bank's long-term support for water resources development and management in those countries, particularly its engagement on groundwater in India and Morocco. In addition, South Africa was selected because of the strength of its water resources policy and legislation, and sound technical capacities. In addition, the lessons learned there may be applicable to future Bank engagement in other countries in the southern Africa region[13].

These five countries illustrate a range of levels of development of groundwater, from India which has developed over 100 percent of its sustainable yield, to Tanzania which has developed only 3 percent of its sustainable yield.[14] These countries also provide a range of hydrogeological settings[15].

Drivers of Groundwater Development

Agriculture and water supply are the main drivers of groundwater development, but urbanization, mining and tourism also play an important role in groundwater use as well as in pollution of groundwater.

India

Millions of private wells have been developed in India in the last five decades (Figure 5). Two-thirds of agriculture now depends on groundwater, and the sector is the largest user of the resource, accounting for 91 percent of total groundwater volume withdrawals (Aquastat, 2010). Additionally, groundwater is a critical source of water supply, providing 85 percent of rural drinking water, along with an increasing share of urban and industrial water supply.

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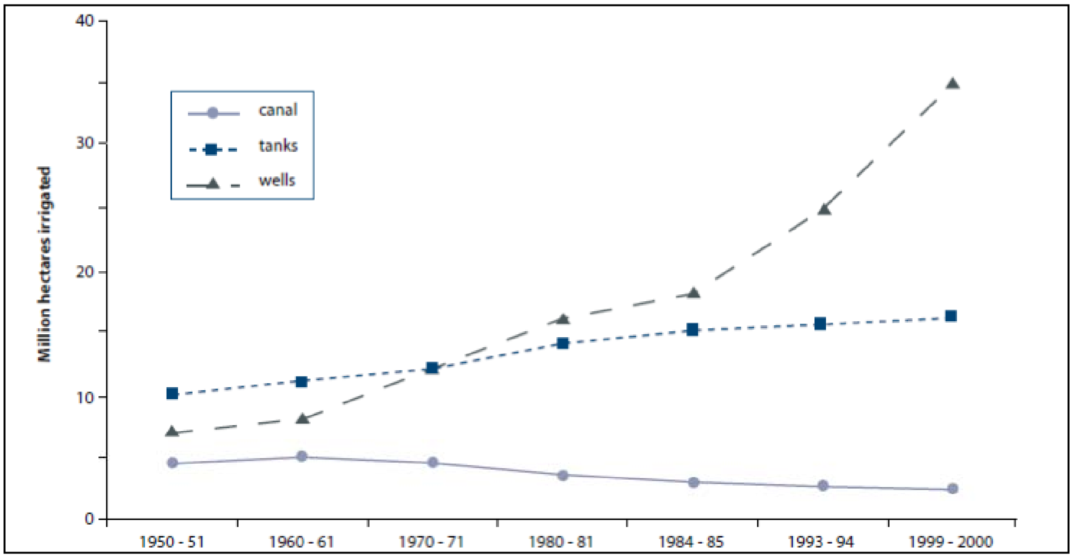
[13] Opportunities exist in Namibia, Mozambique and Zambia.

[14] In countries where the total national sustainable groundwater yield has not been exceeded, local cases of overexploitation may still be evident.

[15] A summary matrix of regulatory and operational governance features of case study aquifers assessed against GWMATE features is provided in Annex 5.

Figure 5. Evolution of Canal, Tank and Well Irrigation in India



Source: Bhatia, 2005, cited in World Bank, 2005 and World Bank, 2010e.

This rapid development has been driven by a combination of the availability of tubewell technology, government support and subsidies, and farmer preference for the inherent advantages of groundwater over other sources.

The remarkable expansion in groundwater use in India has been prompted by a number of factors, including: (i) poor service delivery from public water supply systems, leading many farmers as well as rural and urban households to turn to their own private supplies for irrigation and potable use; (ii) new pump technologies and credit facilities, making the construction and operation of private tubewells affordable even for households with modest incomes; (iii) the independence, flexibility and timeliness of groundwater, which presented an attractive alternative to the technically and institutionally less responsive provision of surface water through public systems; and (iv) government electricity subsidies that have shielded farmers from the full cost of pumping, establishing a pattern of groundwater use that has proved very difficult to change (World Bank, 2010).

Morocco

In Morocco, groundwater accounts for 30 percent of overall water supply, including both irrigation and urban consumption (Bzioui, 2004).

In the two aquifers studied (Haouz and Souss), irrigation was far and away the dominant user, accounting for more than 90 percent of groundwater abstraction. Of this, two-thirds is used for highly productive private irrigation schemes, and the remainder is used for lower value cereal crops. Both contribute considerably to national agricultural exports (Aquastat, 2000 or 2010?). In public irrigation schemes, the exploitation of groundwater resources has increased exponentially in many parts of the country for similar reasons to India; namely, easy access, reliable supply, and affordability. Additionally, several large cities depend partially or entirely on groundwater for their potable supply. Groundwater is the only source of water in many arid regions. Tourism, Morocco's third largest economic sector, is also placing increased pressure on groundwater resources, particularly in inland areas.

South Africa

In South Africa, agriculture accounts for two-thirds (64 percent) of groundwater use, with municipal and rural water supply and mining requirements accounting for the balance.

Groundwater is also used extensively by the mining sector (Department of Environmental Affairs, 2010) and many rural districts have been served by groundwater resources in recent years, helping to ensure sustainable livelihoods for many communities. Some urban areas are already dependent on groundwater, while other major cities (such as Cape Town) are considering aquifer development to meet future demands.

Kenya and Tanzania

In Kenya and Tanzania, groundwater is mainly used for municipal and industrial supply. Groundwater plays a critical role in the Kenya economy. Reliance ranges from use as an increasingly important supplementary source for domestic, commercial and industrial purposes in Nairobi (which generates approximately 50 percent of national GDP) to almost complete reliance in the coastal tourist hubs and ports. Rural towns and communities are overwhelmingly reliant on groundwater for potable supply, particularly in the arid and semi-arid lands that account for 80 percent of national land area. In Tanzania, groundwater development has generally comprised shallow wells for domestic purposes in both rural and peri-urban areas where surface water supply distribution networks do not exist or are unreliable. Additionally, many urban areas exploit groundwater to augment supply from surface water sources.

Level of Groundwater Development and Emerging Problems

Overabstraction of Groundwater in India and Morocco

In India, overabstraction is becoming an increasing problem, already affecting almost one-third of the resource.

On aggregate, India is withdrawing more than the estimated safe yield (Table 3). As a result, an increasing number of aquifers are reaching unsustainable levels of exploitation, with a 2004 nationwide assessment classifying the condition of 29 percent of groundwater blocks as semicritical, critical or overexploited. The potential social and economic consequences of overabstraction are serious, as aquifer depletion is concentrated in many of the most populated and economically productive areas. Climate change will put additional stress on groundwater resources. For example, progressive reduction of the Himalayan glaciers is expected to lead first to a surge, then a decline, in associated base flows in the main Ganges tributaries, with consequent impacts on the extensive aquifer systems underlying the Ganges basin.

Morocco is beginning to experience problems similar to those of India.

In Morocco, the more intensively used aquifers, including the two case study aquifers, are overdrawn. In one aquifer, annual abstraction rates exceed the sustainable yield by almost 60 percent, resulting in a reduction in groundwater levels of about 40m over 20 years. The other aquifer studied has also suffered from a continuous drop in the water table since the early 1970s, with annual reductions since 2000 sometimes exceeding 2m/year over parts of the aquifer.

Table 3. Estimates of Current Groundwater Use*

	India	Kenya	Morocco	South Africa	Tanzania
Gross national income per capita (US$)**	1040	730	2520	5820	440
Rainfall (mm)	2168	1063	426	520	1148
Pop density (people per km^2)	360	70	71	41	47
Groundwater availability (Mm^3/yr)	432,000 (renewable resource)	2,100	10,000 (renewable resource)	30,520	30,000 (renewable resource)
Safe yield (Mm^3/yr)	216,000 (est.)	1,040	5,000 (est.)	10,353	15,000 (est.)
Current usage (Mm^3/yr)	251,000 (withdrawal)	180	3,170	1770	460
Percentage use (%)	116	17	63	17	3

* Where safe yields are not known they have been set at 50 percent of recharge. Different terminology and methods of calculation mean that these data cannot be compared between countries.

**GNI obtained from World Bank (2010g).

Emerging Problems of Overabstraction in Kenya, South Africa and Tanzania

Opportunities remain for further development in Kenya, Tanzania and South Africa, but a strong governance framework needs to be developed if the problems of overabstraction and depletion are to be avoided.

In many countries, especially in sub-Saharan Africa, there remain opportunities to develop groundwater resources further. Kenya, South Africa and Tanzania are currently using only small fractions of the estimated sustainable yields of many of their groundwater systems (Table 3). However, development needs to occur under a strong governance framework if issues of overabstraction, pollution and degradation of recharge zones are to be avoided. For example, in Dar es Salaam, Tanzania, municipal water supply comes partly from a shallow coastal aquifer, which is vulnerable to sea water intrusion, and partly from the Ruvu River, whose base flow has recently decreased due to a combination of climate variability, catchment deforestation and use changes, as well as unlicensed upstream abstraction. The recently discovered deep Kimbiji aquifer provides a substantial opportunity for meeting the city's water supply needs for the foreseeable future. If this groundwater resource is developed responsibly and managed in conjunction with local surface water sources, the city water supply could be assured for the coming decades and be well buffered against the uncertainties of climate change.

Already, some localized over-abstraction is occurring.

Although at a national scale many groundwater systems in these three countries are not under immediate threat, there are already cases of local overabstraction. For example, in Kenya, the Nairobi aquifer system is overabstracted partly due to a proliferation of unregulated private boreholes. The Naivasha Basin basal aquifer experienced over 14 m water level decline between 1999 and 2004 due to intensive abstraction for horticulture. In South Africa, two of the case study aquifers, the Dinokana-Lobatse dolomite aquifer and the Botleng dolomite aquifer, are considered to be at risk of overexploitation. In Tanzania, overabstraction is not a severe or widespread problem on a national scale, but groundwater levels in some aquifers underlying urban areas have been falling persistently.

Groundwater Quality Issues

In India, pollution and salinization are growing problems and arsenic contamination is emerging in some areas.

Groundwater pollution is more prominent in India than in the four other case study countries. India often contains concentrated clusters of polluting industries such as tanneries and textile mills, and the resulting pollution has, in an increasing number of regions, rendered the groundwater resource useless before it is exhausted. Pollution sources infiltrating into aquifers typically include: (i) haphazard disposal of untreated urban and industrial wastes (such as discharges from tannery operations); (ii) fecal contamination due to inadequate sanitary arrangements as witnessed by extremely high nitrate levels in aquifers below cities that are intensively used for drinking water supply; and (iii) the overapplication of fertilizers, pesticides and insecticides on agricultural fields. Additionally, aquifers in arid and semi-arid regions are increasingly affected by salinity, and overpumping of coastal aquifers is leading to seawater intrusion. Arsenic contamination is problematic in some parts of India and has necessitated access to deeper uncontaminated sources. Likewise, high aquifer fluoride concentrations are widespread across about one third of India's districts.[16]

Pollution from agriculture and mining is also becoming a problem in South Africa.

Agricultural groundwater contamination sources in South Africa are most commonly nitrate-based, with fertilizers, pesticides, herbicides and growth hormones contributing to quality problems. Other groundwater contaminant sources include salinization from extensive irrigation, and infiltration of waters from mining activities (commonly referred to as "acid mine drainage"). Hexavalent chromium from chrome ore processing and radionuclide contamination from gold mining operations also pose threats to groundwater quality.

Although the problem is not yet widespread in Kenya, groundwater quality in some aquifers has been affected by agricultural, industrial and human pollution.

Point-source nitrate pollution has been recorded at livestock watering points, while high-density informal settlement is associated with bacterial contamination of groundwater beneath some major centers. Overabstraction has also led to salinization of some coastal groundwater, and naturally elevated fluoride concentrations occur in groundwater along the Rift Valley belt. One study in 2009-2010 found that one third of boreholes supplying drinking water exceeded the national drinking water standard for fluoride concentration (1.5 mg/L), meaning that approximately 10 million Kenyans were potentially exposed to elevated concentrations.

To date, quality problems have emerged only locally in Tanzania

Generally, groundwater quality in Tanzania is acceptable for most uses, although there are problems of

[16] 196 districts out of India's 640 districts and 19 states out of 28.

high salinity and high fluoride concentrations in some areas, and localized contamination in others. Salinity issues arise in coastal areas and in the central region where there are high evaporation rates and poor drainage. High fluoride concentrations occur in the north-east areas surrounding the Rift Valley system. Localized cases of pesticide and petroleum hydrocarbon pollution of groundwater have been reported. Widespread use of on-site sanitation in urban areas contributes significantly to the pollution of shallow aquifers, which is an important water supply source for the urban poor.

Governance Arrangements and Groundwater Management

The relation between governance arrangements and groundwater outcomes was assessed for all five case study countries. The analysis presented here follows the framework set out in Chapter 2, first assessing policy formulation issues, continuing with the strategic level governance functions, and finally discussing the operation of governance at the local level.

Policies for Groundwater and Alignment with other Sectoral Policies

Alignment of Policies on Groundwater Abstraction and Use

In all countries studied, several sectors were vying to abstract groundwater and having an impact on or benefiting from groundwater resources. The most widespread use is in agriculture, particularly in India and Morocco, but mining development, urbanization, and tourism are also important drivers of groundwater development and pollution. *There is a clear need for a harmonized policy framework to coordinate water resources policy with the policies of the water using sectors*.

In practice, however, the alignment of policies regarding groundwater has yet to be achieved in any of the five case study countries.[17] There are many examples where sectoral policies, at best, hamper good groundwater management and, at worst, jeopardize the resource. In India, the sectoral linkage between groundwater use and power policies that provide electricity to farmers at a heavily subsidized flat tariff is so prominent that it is referred to simply as the "energy-groundwater nexus." In a nutshell, water resources policy in India aims at groundwater conservation and sustainability, while agriculture and energy policies are driving in the opposite direction, creating strong incentives to overabstraction.

Part of the problem is organizational because there are no mechanisms to align water policy and other sectoral policies.

In Morocco, there is a lack of effective coordination of the water sector with other sectors (agricultural, urban, etc.), which affects water resources, including groundwater. Current policies are characterized by a predominantly vertical sectoral approach with serious deficiencies in terms of horizontal coordination between the water sector and other sectors. For example, responsibility for water resource management lies with the river basin agencies under the water ministry, while the heaviest water using sector (irrigated agriculture) is under the jurisdiction of the agricultural ministry. Moreover, intersectoral mechanisms to coordinate policy and planning are not systematic. For example, although the water ministry participated in discussions about the Plan Maroc Vert, this has not led to a systematic alignment of policies. The lack of mechanisms to align policies on groundwater underlies many of the impediments to groundwater

[17] There are some partial exceptions such as the use by the Tanzanian government of the Lands Act to control rapidly increasing groundwater pollution in an important aquifer. However, it should be noted that this is the exception rather than the rule.

management, to the point where the Moroccan case study states that "intersectoral policy coordination .... is the weakest link of the entire groundwater governance chain."

The problem is well recognized in all five countries but, so far, it has been beyond the capacity of the governments to achieve the necessary harmonization of policies. For example, although the Kenyan draft Groundwater Protection Policy proposes that a National Standing Committee be established to deal with cross-sectoral issues under the guidance of the ministry in charge of water affairs, no action has yet been taken.

Alignment of Policies on Groundwater Pollution Prevention and Protection of Recharge Areas

The cross-sectoral linkages needed for policies on groundwater pollution prevention and protection of recharge areas were weak in all case-studies

These policies affect a wide range of stakeholders, including land use planners, industrial and mining enterprises, and local governments, all of whom have limited incentives to protect groundwater. In Kenya and Tanzania, there is a very limited understanding of the land surface-groundwater linkage among professionals of the relevant sectors and, as a consequence, there is no strategic awareness of the need to protect groundwater resources. In both countries, there are examples where local councils have granted approval for developments that have jeopardized recharge areas, partly because of a lack of information, and partly because councils do not possess any groundwater expertise and do not understand the importance of protecting recharge areas (see Box 2).

Box 2. Groundwater and Land Use Planning in Kenya and South Africa

Kenyan law does not provide for groundwater to be taken into account in land use planning. Groundwater Conservation Areas in Kenya are linked to land use planning and therefore related to other legislation like the Physical Planning Act and Environmental Management and Coordination Act. However, analysis shows that neither act makes specific mention of the conservation of groundwater resources as a relevant consideration in formulating physical developments plans and environmental planning. This is a particularly acute problem with respect to the Nairobi Aquifer System, which is subject to intense exploitation. To date, the only physical plan that has been prepared is for the Karen Langata area of Nairobi. Though gazetted, it is not officially recognized by the City Council of Nairobi and therefore has not been enforced.

In South Africa, provisions such as the polluter-pays principle have been established to protect groundwater from pollution from mining, but they have not yet been implemented. The discharge or decant of contaminated water and highly saline effluents from mining activities and/or abandoned mines is a serious environmental threat and social concern. In particular, acid mine drainage from gold mines in the Witwatersrand area and coal mines in Mpumalanga need urgent attention, but the problem has not been addressed despite the fact that South African legislation governing mine closures requires the rigorous mitigation of both biophysical and socioeconomic impacts.

Source: Mumma et al., 2011; South Africa case study

In South Africa, sectoral integration is limited by lack of cooperation and coordination among government agencies even though the National Environmental Management Act is supposed to guide such integration.

Governance at the Strategic Level

Laws, Rights and Regulatory Instruments

The country studies concluded that, in general, laws, rights and regulatory instruments governing groundwater were well designed but that improvements were possible and, most importantly, implementation was a major challenge.

According to the stakeholders consulted during the study, all five countries have formal governance arrangements that, while open to improvements, should provide a framework for groundwater management. These arrangements included provisions for groundwater quantity and quality monitoring, drilling permits and groundwater rights, tools to reduce groundwater abstraction, and stakeholder participation. Some countries also impose sanctions on illegal well operation, groundwater abstraction charges, land use controls over polluting activities, and levies on polluting discharges. Basin authorities are in charge of implementing most of the activities related to groundwater in Morocco, Tanzania and South Africa, while groundwater governance in India and Kenya relies on national or state authorities.

However, stakeholder consultations also identified gaps in these arrangements. For example, they stated that Moroccan policies could include more emphasis on demand management, and that the governance frameworks in Tanzania and Kenya place disproportionate emphasis on surface water management, a bias reflected in implementation with regard to financing, staffing, planning, and execution of water management. Nevertheless, in all the countries, stakeholders considered that the fundamental problem was not the inadequacies of governance frameworks but difficulties in implementing the policy as well as legislative provisions that impede good groundwater governance and management.

Although India historically had a strong framework and effective enforcement capacity for top-down groundwater planning and regulation, it is now eroding. In addition, public organizations are not adapting readily to new approaches in support of local collective management.

India is also the only country studied that has established specific organizations for groundwater governance. These are: the Central Ground Water Authority (CGWA), which is responsible for groundwater regulation, and the Central Ground Water Board (CGWB), which is responsible for research, resource assessment and monitoring. However, despite this framework and the country's centralized command and control reflex, the proliferation of tubewells during the "groundwater revolution" has greatly increased the challenge of regulation. While these organizations manage to slow down the drilling of new wells in overexploited areas, they have few tools to influence groundwater use by existing wells. The approach is now being further impeded by lack of implementation capacity, particularly a pronounced lack of the needed specialized groundwater staff at both central and state levels. The Indian case study report found that "…generally, technical, legal and institutional provisions are in a more or less acceptable status but implementation capacity is rather weak." Additionally, where available, staff skill sets continue to be oriented towards groundwater development rather than to the socioeconomic dimensions of groundwater use that are key to effective groundwater governance. Even states such as Andhra Pradesh and Maharashtra, which boast the best groundwater departments in the country, have inadequate staffing strengths and profiles relative to what is required.

The same is true in South Africa where legal changes have been introduced to recognize water rights and to require their regulation, but the capacity to implement the regulatory framework is weak.

South Africa's Water Act requires that licenses for water use be assessed and approved. Lack of implementation capacity to deal with the large number of licenses created a significant backlog, which then prompted introduction of a simplified procedure to address it.[18] The lesson from these experiences is that apparently good governance arrangements need to be matched with implementation capacity.

Most laws and rights systems define water as public property and require licensing, but this approach diverges widely from popular perception and from actual practice.

In South Africa and Tanzania, water laws clearly state that ownership of both surface and groundwater is vested in the state and that land owners must acquire a license to use the groundwater. Despite the fact that the law is clear, there are difficulties in putting it into practice because of the lack of acceptance on the part of stakeholders and the capacity constraints discussed above. In South Africa, for example, the case study laconically records that "…social views of groundwater [ownership] lag behind the formal policy of a public resource, and are tied more closely to land ownership."

In Kenya, while statutory provisions now vest ownership and regulatory powers in the state and supersede the common law right of landowners to access and abstract groundwater beneath their land, decisions on how much water to abstract are still, in practice, left to landowners to make, reinforcing the perception that groundwater is a private good.

In India, groundwater has also traditionally been seen as following the right to land, based on the Indian Easements Act of 1882. In 1996, the Supreme Court instructed the government to establish the CGWA to regulate and control groundwater development. There is now an emerging understanding of the public interest dimension of groundwater, thanks to specific awareness-building campaigns in areas such as Andhra Pradesh.

Delegating Groundwater Management

The capacity problems of local governments have been apparent where attempts were made to decentralize planning and management of groundwater to local authorities.

Local government lacking in groundwater expertise have often delegated responsibility for land use planning and for management of borefields for municipal supply. For example, there was no local government in South Africa that had its own groundwater expertise, and 74 out of 231 local authorities did not employ external technical experts (MacKay and Koster, 2005), despite often facing serious groundwater management problems. Similarly, local Kenyan authorities employed planners but no hydrogeologists and, hence, their ability to adequately address groundwater issues was severely limited. However, larger urban water authorities in Kenya and Tanzania did have better access to groundwater expertise. Some, such as the Dar es Salaam Water and Sewerage Company (DAWASCO) in Tanzania, have hydrogeologist technicians on staff while others hire consultants.

Information, Knowledge and Communications

[18] In addition to the case study examples, Peru also faced similar administrative burdens related to the development of a register of water users.

Information for Groundwater Management

In general, knowledge of aquifer characteristics and exploitation is weak, and this certainly undermines capacity to manage the resource. One recent study of groundwater in Africa (AMCOW 2012) found that "…poor data or inadequate availability of water-related data and inappropriate water information systems" was a major constraint in most of the countries surveyed.

Although basic information on hydrogeology is available, it is often insufficient for detailed planning and management.

With the exception of some aquifers in Kenya and Tanzania, hydrogeological maps suitable for management were available for all the aquifers studied. Tanzania did have access to maps produced by the Southern Africa Development Community (SADC), although they lacked sufficient detail required for management purposes. Information beyond basic hydrogeology is less available. The only aquifers that are adequately delineated for management are the two Moroccan aquifers, the Botleg, Steenkoppies and Bapsfontein aquifers in South Africa, and the Makutupora aquifer in Tanzania.

In addition to knowledge about the groundwater resource itself, groundwater management requires information about its uses. Updated and systematic information about groundwater abstractions for different uses is often lacking and, in most countries, groundwater use is estimated using indirect methods.

In Kenya, resource assessment is at an early stage, and users have virtually no access. A lack of knowledge about the national aquifer systems is also an issue. This is not due to inadequate technical ability, but to limited resources available for conducting the kind of assessment needed, coupled with the complexity of some of Kenya's aquifer systems.[19] Without this information, the ability of managers to regulate pumping, polluting activities and inappropriate land uses is severely restricted.

In Tanzania, information on groundwater is sparse and rarely available. The little data that is available (from past studies and regional water master plans) is not easily accessible or has not been digitized. Furthermore, there is generally inadequate data and knowledge on groundwater resources (static levels, yield, quality, etc.). Aquifer delineation is low or not in place, further hampering management efforts.

There is even less information available on critical aquifer characteristics, such as recharge rates and transmissivities, since these require specialist investigations and modeling. Where some aquifer characteristics are available, as in all four Tanzanian aquifers, it is often as part of externally funded development projects or as a result of localized consultancies and academic studies. Only two Moroccan aquifers had groundwater models available that managers were able to use. Models are generally unavailable in the other countries studied. Moreover, in the aquifers where they do exist (for example, Steenkoppies and Dinokana-Lobatse aquifers in South Africa) there is limited capacity to use them.

Information on groundwater quality is also highly variable.

There have been some assessments of groundwater pollution in the case study aquifers, but these assessments have typically been limited to a small number of pollutants or just a portion of an aquifer. For example, in Tanzania there are very limited studies on groundwater pollution from agro-chemicals even

[19] The Nairobi Aquifer Suite is a case in point; it comprises numerous unconfined and confined beds of lava, old land surfaces and lake beds, which in boreholes that are deep enough may amount to as many as five separate aquifer units.

though these chemicals have been used for decades with limited control.

In discussing the South African aquifers, the case study authors made the important point that, even if there are deficiencies in knowledge, there is often enough information available to make management decisions. *The real shortcoming lies in the lack of human capacity to implement these recommendations and decisions and the limited political will to take action*.

Monitoring

The essential complement to aquifer characterization is subsequent monitoring, and this is generally a weak point.

Some of the most heavily used aquifers do not contain monitoring programs, which are a fundamental requirement for effective management. All case study aquifers, except the Baricho (Kenya), Babati (Tanzania) and Arusha (Tanzania) aquifers, are subject to either widespread or localized overabstraction. Of these, the Makutopora (Tanzania) aquifer has a satisfactory aquifer-wide groundwater level monitoring program and others, such as the aquifers in the Indian states of Maharashtra and Kerala, the two Morrocan aquifers, the Botleg aquifer (South Africa) and the Arusha aquifer (Tanzania), have adequate monitoring programs. Conversely, some of the heavily used aquifers, such as the Nairobi,[20] Steenkoppies and Dar es Salaam aquifers, have only weak or nonexistent aquifer-wide monitoring programs. Other regional monitoring programs rely on water levels from production bores, a practice that can lead to considerable data inaccuracies.

Water quality is not always adequately monitored, but several countries are working hard on improvements.

Urban water authorities, such as the Dar es Salaam Water and Sewerage Authority (DAWASA) in Tanzania that draw on the aquifers for water supply, usually maintain their own water level and water quality monitoring programs to check health-related parameters. Similarly, the Makutopora aquifer (also in Tanzania) has a satisfactory groundwater quality monitoring program. However, some aquifers with serious water quality problems, such as the Houdenbrak and Bapsfontein aquifers in South Africa, have experienced a reduction in groundwater quality monitoring programs, despite serious nitrate contamination issues. Reasons cited for this decline in monitoring include difficulties in gaining access to monitoring boreholes, lack of budget for rehabilitating monitoring boreholes, and lack of field staff to carry out monitoring.

Countries are well aware of the need to improve groundwater monitoring. Recent groundwater monitoring programs have included:

The Department of Water Affairs in South Africa has trialled the Groundwater Resource Information Project (GRIP) in Limpopo province to gather data on groundwater (Box 3).

In Kenya, the Water Resources Management Authority recently instituted a systematic monitoring program that targets most of the important Kenyan aquifers. Water level and quality trends will be collected quarterly, except for intensively utilized aquifers where data will be collected monthly.

[20] Twenty monitoring boreholes are currently being organized by the Water Resources Management Agency in the Nairobi Aquifer System with water levels being collected monthly.

The Water Quality Assessment Authority (WQAA) in India has strengthened the water quality monitoring capacities of states by establishing standardized monitoring protocols and facilitating the creation of state-level Water Quality Review Committees, which review and interpret state water quality data. In addition, the World Bank-funded Hydrology Project has led to major improvements in water quality monitoring in nine states, although additional work remains to reach satisfactory quality standards.

Box 3. The Groundwater Resource Information Project (GRIP) in South Africa

In South Africa, the Groundwater Resource Information Project has gathered enough information to allow integrated water management to be implemented all across Limpopo province.

GRIP is a project of the South African Department of Water Affairs whose aim is to improve data holdings by accessing unpublished or private data as well as new groundwater data collected by visiting boreholes in the field, particularly those in priority areas. It is planned that all GRIP data be entered into the DWA national WARMS database. GRIP will also develop systems and procedures for the collection and verification of unpublished data.

To date, GRIP has been fully implemented in Limpopo province, where it began in 2002. More than 2,500 villages have been visited in the province, 15,500 borehole sites have been verified, and 1,500 pumping tests have been added to the provincial database. Limpopo province probably now has the most extensive and best verified dataset on rural groundwater resources in the country, and enough is known about groundwater in the province to allow it to be much better integrated into general water resource management. The extra data has led to a higher borehole drilling success rate in the province, saving a considerable amount of money.

Source: Pietersen et al., 2011

Access to Information

Access to monitoring records varies across the countries studied.

South Africa is well-served through the recently developed National Groundwater Archive which allows users to upload data remotely. This central database will be strengthened further through the GRIP program (see Box 2). In Tanzania, data is accessible only upon request from the Basin Water Offices. While local data retained at the Basin Water Offices may be accessible to water user associations and local groundwater managers, lack of integration for use at higher levels hampers national strategic assessments and policy development. In Kenya, the draft National Groundwater Policy calls for a national groundwater database, but the database has not yet been established. Most data is retained by the collecting agency, such as an urban water authority, and while theoretically it remains available, in reality it may often be difficult or impossible to obtain. In Morocco, information from groundwater monitoring networks in the Haouz and Souss aquifers is published in periodic reports that are publicly available and accessed via the Internet.

Communicating Information and Knowledge

Generally, there are significant problems over information-sharing that reinforce misperceptions about *groundwater as an inexhaustible resource.*

Even where information exists, information asymmetry often constrains its exchange between different stakeholders. For example, information is typically not in a form that is easily accessible to decision makers or the public. In cases where relevant information is available, there is often ineffective exchange of that information between stakeholders. Ultimately, this ineffective information exchange contributes to the long-standing perception that groundwater is an inexhaustible resource that is the property of the overlying landowner.

India carries out an annual assessment of the groundwater balance within the nearly 6,000 groundwater blocks. This has been an essential tool in mapping groundwater conditions and creating awareness among decision makers. One of the limitations of this system, however, is that the units used for the groundwater assessment exercise are administrative units, mostly at the subdistrict level, without any link to physical boundaries.

Capacity Issues: Limited Capacity and Skills in Organizations

Staff and capacity for implementing groundwater plans and regulations are generally weak and deteriorating.

In all case study countries, the central and regional institutions typically lacked the skills and capacity to carry out their roles adequately. Furthermore, in some cases, institutions struggled to maintain their already limited capacity for implementing water policy and legislation.

In South Africa, a reorganization of the Department of Water Affairs (DWA) led to the dissolution of the Directorate of Geohydrology and the integration of groundwater staff into other directorates. This restructuring left the department without a critical mass or central coordinating point for groundwater management. More generally, staffing challenges were exacerbated by an ageing workforce, emigration of skilled workers, and attraction to higher paid sectors such as mining. The DWA recorded general staff vacancy rates of 50 percent in geotechnical and hydrogeological positions. Within the directorates, for example, in the Directorate of Hydrological Studies, vacancy rates for similar jobs were as high as 70 percent and 66 percent respectively. Similar deficiencies were evident in the Tanzania Ministry of Water, where vacancy rates for hydrogeologists and technicians were 55 percent and 40 percent respectively.

The scale of the human capacity challenge was also illustrated in the Kenya WRMA, which employs only one hydrogeologist in its headquarters and one in each of its regional offices.[21] Yet, the WRMA is required to police more than 4,000 groundwater permits in the Nairobi sub-region alone and about 1,200 permits in the Lake Victoria South region. In Morocco, the recent departure of many senior administration executives and staff (both at headquarter and basin agency level) proved a major handicap for the implementation of groundwater management action plans.

In general, not enough new technical staff and specialists are being trained.

All five case study countries have tertiary institutions where degrees are offered that include groundwater-related units, as well as other institutions where technical staff can be trained. Nonetheless, all case study reports state that there are inadequate numbers of graduates to meet national needs. The Morocco

[21] Apart from the Nairobi subregional office where there were two

case study also states that there are insufficient programs for training staff already working in the sector.

In all countries studied, there were inadequate budgets to implement the governance framework.

Funding remains an impediment to implementing governance arrangements. South Africa, Tanzania, Kenya and Morocco all report shortfalls in operational budgets for groundwater management, or where surface and groundwater budgets are not separated, for water resources management generally. In some cases, this was because the agencies involved were supposed to finance their operations from the regulatory fees collected, and they were not able to collect enough.

In Kenya, for example, the Water Resource Management Authority (WRMA) receives no allocation from the Treasury, and in 2009-2010 collected less than Ksh 400 million (US$4.8 million) of its budgeted expenditure of Ksh 639 million (US$7.7 million) from water use fees.[22] This translated into a 37 percent budget deficit. Likewise, the Morocco basin agencies also had budget shortfalls, although their deficit was covered by the national government.

The situation is somewhat better in South Africa because water resource management activities are mainly funded through revenue from charges collected by the Water Trading Entity (WTE), and from allocations from the government's Exchequer Account. While the WTE has generated sufficient income to meet its operating costs, it has been unable to make budgetary provision for the maintenance or rehabilitation of existing assets because the agricultural water charges are insufficient to provide for such cost recovery.

Governance at the Local Level

Low Enforcement of Regulatory Measures

Four locally relevant regulatory measures are analyzed here: control of groundwater abstraction, prevention of pollution, protection of recharge zones, and control of borehole and well development. All five countries have difficulties in implementing the regulations.

Control of Groundwater Abstraction

All countries studied are trying to implement top-down regulatory and licensing approaches, but implementation is very slow and the impact on resources is hard to detect.

Three of the five case studies (with the exception of India and Morocco) demonstrate only weak or completely deficient tools for controlling groundwater abstractions at the local level (Annex 5). Only the Souss Massa River Basin Agency in Morocco has developed a formal agreement with groundwater users at the local level (Box 4), although whether this will work in practice remains to be seen. Beyond the Souss Massa basin, there is a lack of acceptance by irrigators of the provisions of the legislation on groundwater abstraction. In the Haouz aquifer, the tools are available but the water institutions lack the capacity to use them.

In India, overabstraction is driven by the perverse energy incentive that makes it difficult to enforce controls on groundwater abstractions. In Kenya, groundwater users are required to self-assess the quantity of water used, with the consequence that most groundwater users are believed to take water in

[22] Chiefly from corporate and industrial users only

Box 4. Aquifer Management Contract Approach in the Souss-Massa Area in Morocco

The Souss-Massa River Basin Agency developed groundwater management action plans and incorporated the main provisions of the action plan into a framework convention signed by key regional stakeholders in the water sector. This convention specifies the responsibilities of stakeholders and their financial contribution to funding the action plan.

These measures have been discussed and agreed upon by the agency and the key regional stakeholders and include: (i) approval of simplified procedures for delivering well/borehole drilling permits and abstraction licenses; (ii) organization of the drilling profession; (iii) water conservation measures; (iv) restrictions on new irrigation development; and (v) awareness building and communication. These measures limit new entrants and provide incentives to current users to sign on to contracts in order to be formally recognized as users and become eligible to receive support for water conservation measures. Implementation of the contract approach is in its initial stages; hence, it may be too early to judge results.

Source: Morocco case study report

excess of their license conditions. Finally, in Tanzania, water user permit requirements are gradually being implemented and wastewater discharge permit requirements are gradually being recognized, but implementation is still far from satisfactory.

Pollution Prevention

The case studies show a widespread inability to control activities that pollute groundwater (Annex 5). South African legislation requires waste discharge permits, but the system for implementing them has not yet been established. In the Steenkoppies aquifer, for example, there is little capacity to levy fees on pollution discharges. Similarly, in Tanzania, the enforcement of discharge permits is very poor, and mostly limited to large wastewater producers from industry and urban water authorities. In India there are adequate instruments provided in the law to control groundwater pollution for point-polluting activities but these do not address large scale diffuse pollution by agricultural chemicals or through lack of sanitation. Also, the capacity to use these instruments is weak. Tannery wastes, for example, are being contained through measures such as common effluent treatment plants but the technology has not been widely adopted due to cost restraints. Morocco demonstrates some positive results: While pollution cannot be directly controlled under Morocco's Water Law by the river basin agencies because of implementation difficulties, other laws are used to check groundwater pollution, including environmental legislation and solid waste management legislation.

Protection of Recharge Zones

Controls over land use activities and protection of recharge areas are lacking in most of the countries. Such protection at the terrestrial interface may help protect the long-term quantity and quality of aquifer recharge at the source of replenishment. In Morocco, controls are available but there is little capacity to implement them in the two catchments studied. Similarly, in South Africa, protection of recharge zones is included in some national instruments such as the National Groundwater Strategy,[23] but the reality is that there is little practical ability to carry them out. However, the protection of the recharge area of the Makutopora aquifer in Tanzania from pollution illustrates that, when there is sufficient political will, obstacles to management can be overcome. Such land use control may help promote the sustainability of groundwater utilization and reduce the need for costly (and sometimes ineffective) quality remediation interventions.

Control of Borehole and Well Development

The regulation of drilling activities and new boreholes is included in the water legislation of South Africa, Tanzania, Kenya and Morocco, but these provisions are difficult to enforce. In Morocco, the agencies in the two basins studied have only a weak capacity to implement these provisions or to take action against illegal well operations (Annex 5). In South Africa, only one of the 19 case study aquifers (Steenkoppies) has an acceptable capacity to implement the required provisions. The South African case study concludes that "…instruments to prevent well construction and sanctions for illegal wells are non-existent." The Tanzania case study also concluded that the guidelines governing the private sector well-drilling industry have been ineffective.

Alternative Approaches Through Participation and Collective Management

Examples of Local Collective Management

Local water management and self-regulation are good alternatives or complements to top-down regulation.

The case studies suggest that, in some circumstances, increased participation of local collective management institutions may be more effective than regulation. The example of Hivre Bazar village in India (Box 5) illustrates what can be achieved through active user participation in rule enforcement.

In all the countries studied, there were examples of local people organizing themselves for groundwater management, with or without government help.

The community in Tabata, Ilala District in Dar es Salaam City, Tanzania, developed groundwater sources and managed them without government assistance.

Another well-developed groundwater-based community water supply system in Dar es Salaam, Tanzania, is the Kwa Ngilangwa scheme in Mwananyamala ward, established in July 2005 through the formation of a Water User Association (WUA).

In Kenya, Groundwater Resource Users Associations remain uncommon, although two groundwater-specific Water Resource User Associations (WRUAs) are being established in the Baricho and Tiwi regions.

[23] The National Groundwater Strategy states that "Land-use planning has to consider groundwater resources as a precious and finite resource, and take all necessary measures to protect groundwater resources and their recharge mechanisms in the long run."

Box 5. Self-organized Groundwater Management in India Conserves the Resource, Improves Incomes and Increases Land Values

Hivre Bazar village in Maharashtra state has a long history of drought and land degradation. In the most favorable years almost 60 percent of the land can be irrigated, but in drought years wheat and summer crops have to be radically reduced.

A concerted effort on groundwater management began in 1994 under the leadership of an informed and charismatic Village Council Chief. The Village Council decided to cooperate to maximize benefits from existing groundwater. They prohibited expansion of borewells for agricultural irrigation, undertook comprehensive reforestation and water harvesting, and banned sugar cane cultivation because of its high water use.

Most importantly, in 2002 the Council introduced crop-water budgeting at the level of the village. In dry years villagers are asked to reduce their proposed irrigated area and to grow low-water demand crops, with mutual surveillance usually being enough to achieve compliance. No change in groundwater abstraction rights is implied. The community merely controls access to groundwater and advocates which crops can be irrigated.

Such proactive groundwater management has resulted in a marked contrast between Hivre Bazar and most surrounding villages. At the household level, the benefits of community land and water management have meant a marked increase in household incomes (to over US$500/yr on average) and the appreciation of land values in the past 15 years.

Source: Garduno et al, 2011; GWMATE Case profile No. 22

The example of Hivre Bazar village in Maharashtra state in India (Box 4) provides a striking example of how a self-organized WUA can bring about improvements in groundwater management when the social structure and the hydrogeological conditions are favorable. The Hivre Bazar example also illustrates the powerful effect of individual champions who can lead and direct stakeholder involvement. However, a limitation to this approach may be whether it can be scaled up to larger groundwater systems.

<u>Examples of Public Sector Support to Local Collective Management</u>

Participatory and collective management approaches have been greatly strengthened by the sharing of information and by capacity building.

Building an understanding about the special characteristics of groundwater among its users, as well as among those whose actions have an impact on groundwater (through, for example, polluting activities), is a first step towards effective stakeholder participation. The Kenya case study notes the importance of targeted sensitization and education programs because groundwater users generally have a very poor understanding of their responsibilities for managing the common resource. Unfortunately, the case studies do not provide any good examples of systematic educational programs. Lack of community knowledge is often compounded by a similar lack of expertise within local governments. No local government in South Africa has its own groundwater expertise. Similarly, most Kenyan local authorities employ planners but no hydrogeologists, although larger urban water authorities have better access to groundwater expertise.

In some cases, public services have become the community's partner in awareness-raising.

The government of Tanzania provided training to the community-based organization managing the Kwa Ngilangwa groundwater system. In Morocco, the basin agencies organize awareness building campaigns to familiarize groundwater users with the risks of overexploitation and groundwater pollution by agricultural activities and wastewater dumping. However, these campaigns were limited (JICA, 2007).

Although these steps towards supporting local collective management are so far tentative, there is evidence that this is an effective path in certain circumstances.

Overall, the case studies suggest that regulation often proves difficult for reasons of capacity and nonacceptance by stakeholders. There is evidence that groundwater governance can sometimes be delegated with a focus more on enabling users to manage interactions among themselves rather than promoting a one-way, top-down management hierarchy. However, to date in the five case study countries, support to the decentralized stakeholder-driven approach is still weak. Annex 5 suggests that the level of public sector/stakeholder cooperation in groundwater management in the five countries ranges from inadequate to weak. Nonetheless, some exceptions in specific aquifers demonstrated adequate capacity for public/stakeholder partnership, indicating some gradual achievement of progress.

Indeed, working models of community-based groundwater management in partnership with public agencies have been successfully promoted in Andhra Pradesh, India, for almost twenty years.

With the support of local NGOs, Andhra Pradesh has pioneered for almost two decades the promotion of community-based groundwater management through different projects, including World Bank-financed initiatives (Garduño et al., 2009). For example, one of the projects involved farmer communities in a program of groundwater education and monitoring using simple devices and methodologies. Farmers then engaged in discussion on how best to arrange their cropping patterns. Although most of this experience remains at the pilot-project stage, analyzing the conditions for success could suggest lessons for replication.

If community-based management in partnership with public agencies is an indicated route, this requires policy decisions, an enabling legal framework, and specific arrangements for support.

Although several of the collective management examples studies did not receive government support, they all needed to operate within a framework of country laws, regulations and water strategy that recognize, or at least accept, community participation and collective management as legitimate, and provide a necessary measure of support, such as information on aquifer characteristics.

Summary of Main Findings from the Case Studies

The case studies have provided a rich variety of lessons, and many of these lessons were shared by several or all of the countries studied. All countries and study areas were suffering depletion and quality deterioration of the aquifers to a greater or lesser degree. All five countries had policy frameworks in place, but groundwater policies were generally poorly articulated with those of the water-using sectors, particularly agriculture. Formal governance arrangements were largely top-down, although with some decentralization to basin level and some moves towards partnerships with local collective management organizations. However, everywhere the rights and regulation approach to governance was proving not well adapted to the fast changing realities of the groundwater revolution, and everywhere implementation capacity fell far short of the ambitious regulatory provisions.

Information on aquifers and on groundwater use was generally weak, although adequate for management approaches to be determined. Information sharing was everywhere poor, and systematic communications programs were rare. Public agencies in general lacked staff and resources, were underfinanced, and lacked the capacity to do an adequate job.

At the local level, there was a big gap between the regulatory regime and facts on the ground. Rules on drilling and abstraction, on pollution and on protection of recharge zones were little applied. Some initiatives to delegate management to the basin level appeared more promising. At the local level, there were a number of interesting examples of collective management and self-regulation, even though these were weakly embedded and not strongly linked to public sector support structures.

These experiences and the issues arising provide the main empirical base for the analysis of issues and options in the rest of this report.

Lessons from Governance Reforms & Application of Conceptual Framework

In addition to detailed review of the five national case studies, examples have been drawn from the literature and applied examples to specifically illustrate:

- National attempts at groundwater governance reform (in Spain and Jordan);
- Challenges and potential benefits of transboundary aquifer cooperation (from South America and North Africa); and
- National application of the analytical framework (to Yemen).

National Groundwater Governance Reforms

This section highlights two countries where groundwater governance reforms have been implemented in an attempt to improve outcomes and align them with the nation's policies. There were considerable problems in implementing these reforms and the outcomes have been below expectations. The successes and weaknesses, both in the initial reforms and in the way in which they were implemented, provide lessons for other countries facing similar problems and planning governance reforms. A synopsis of experiences is provided here, with further elaboration in Annex 6.

Spain[24]

In Spain, groundwater is an important water source, providing about one fifth of total irrigation water. Historically, groundwater was a private and unregulated resource but problems of over-development and competitive over-abstraction led the government to initiate major reforms.

The 1985 Water Law required that:

[24] Based on information provided by Alvar Closas, DPhil candidate, University of Oxford.

- Well owners register their wells and a nationwide well inventory and register be created;
- River basin authorities manage and regulate groundwater as part of overall integrated water resources management;
- Over-exploited aquifers were to be the subject of a special, more intense, regulatory regime; and
- Users were to participate through groundwater users associations

These reforms were clearly in line with best practice. However, they proved unpopular in some regions and have been widely disregarded. Some of the result are listed below.

- Unlicensed wells have proliferated (the official number of wells is 500,000, but estimates place the actual number as high as 2 million.
- Under-funding has prevented the newly-created river basin authorities from compiling a full well inventory and, as a result, from completing an assessment of the groundwater resource.
- The river basin authorities have been unable to enforce the regulatory regime, partly from lack of budget and staff and partly because of widespread resistance to compliance.
- Subsidies to commercial irrigated agriculture have resulted in increased abstractions and accelerated groundwater depletion.

The gap between expectations and results is considerable, and the experience may provide some lessons of value outside Spain. The causes of the problems and potential lessons that stem from them are listed below.

Problem: *The reforms were implemented without adequate prior consultation* and, in consequence, were not accepted by the most important stakeholders.

Lesson: However arduous, a national consultation process inclusive of all stakeholders is the best way to shape a reform program that will have widespread stakeholder adhesion.

Problem: *Water resources policy and agricultural policy were not aligned*. While water resources policy was to push for sustainable management of the groundwater resource, agricultural policy subsidized expansion of agriculture and agricultural water use, resulting in unsustainable levels of groundwater abstraction.

Lesson: The policy-making process for water resources is best developed in dialogue with agencies responsible for water using sectors, and the resulting policies for water-related activities (agriculture, urban development, regional planning, industrial development, etc.) must be aligned.

Problem: Although the reform followed the best practice principle of subsidiarity, basin level *management of groundwater exploitation clashed with interest groups* at the basin and local levels who see the activities of the river basin authorities as very politicized, bringing the river basin authorities into continual conflict situations.

Lesson: Where governance reforms have important regional and local implications, development of the reforms and their implementation need to be conducted with scope for continual dialogue with regional and local stakeholders.

Problem: *Well owners and water users did not buy into participation in collective management* and the groundwater users associations have not functioned because well owners do not have trust in the governance system of which they form part. Well owners also seek financial support from the government as an inducement to implement changes.

Lesson: In addition to up-front debate on the shape of the reform program, implementation needs to be accompanied by a continuous communication campaign and by support to aspects of the program that bring gain as well as pain (see Chapter 6 on entry point activities).

Problem: *The river basin authorities lacked the human and financial resources to do the job* assigned to them

Lesson: Governance systems need to be adapted to implementation capacity. Adequate provision for financing and capacity building of implementing agencies is essential.

Jordan

Use groundwater for agriculture in the Jordanian highlands has led to depletion and the drying up of springs and oases, including the world-renowned *Ramsar Convention* Azraq Oasis. At the same time, the highland cities are very short of water and are pumping from the Jordan Valley up over 2,000 m in elevation and for considerable distances. The average annual abstraction from renewable aquifers exceeds recharge. At present abstractions are 160 percent of average recharge, with consequent depletion of reserves and decline in the water table. In addition, fresh fossil water from the non-renewable reservoir in Disi-Mudawwara is used for municipal and industrial purposes in the city of Aqaba as well as for agricultural purposes. Future use of this aquifer is earmarked for municipal purposes for the city of Amman.

To relieve the problem of depletion and to test ways of transferring groundwater from relatively lower value agricultural uses to higher value municipal and industrial uses, the 1997 Jordan Water Strategy proposed a new policy, and most of the measures were further included in the 2008-2022 water strategy. The measures are listed below.

- Comprehensive groundwater basin management plans were to be prepared for each aquifer.
- All wells were to be registered and metered.
- Abstraction quotas were to be established for each well as specified in a permit.
- Resource charges were introduced for abstractions in excess of the quota.
- Groundwater user associations were to be established to collaborate on management measures and to facilitate partnerships with the authorities.
- Priority of groundwater allocation was to be given to municipal and industrial uses, to educational institutes and to tourism. Regarding the agriculture sector, priority was to be given to the sustainability of existing irrigated agriculture where high capital investment had been made. In particular, trees irrigated from groundwater were to receive a maintenance quota, on condition that farmers used advanced irrigation methods.

Results to Date

Information on groundwater has improved. The number of monitoring wells has increased to more than one hundred, and monitoring includes both quantity and quality of groundwater. The automation of the network is under study. Groundwater balance and uses are calculated. In addition, exploration of deep groundwater resources has started.

Registration and metering of wells have been successfully achieved but systematic control remains difficult. Most of the wells are equipped with water meters (up to 97 percent of the licensed wells in 2010) and violating wells are filled in. However, controls are handled by a small number of employees of the Water Authority of Jordan, who have inadequate resources to carry out their tasks fully. In addition, meters are still unprotected and likely to be broken or tampered with. Risks of deterioration are reduced because the meters are paid for by the farmers, but tampering is quite easy and could become increasingly widespread.

Collective management of groundwater is still not effective. A legal framework has been established for water users associations. Pilot projects are implementing this approach for surface water irrigation management. In the Jordan Valley, water user associations now cover about 40 percent of farmers. However, participation of groundwater users in management has not been reported.

The price mechanism is doing little to restrain demand. Farmers receive limited signals from the incentive structure about saving water. Many farmers are small users and do not pay water fees because their consumption falls within the quota of 150,000 m3/year per well. These farmers represent the majority of well owners (72 percent of the wells in the Amman-Zarqa and Yarmouk basins) so the price of water is having little impact on abstraction. One possibility that has been raised is to scale down the quota to 100,000 m^3/year per well, which would bring down the proportion of non-paying farmers to 53 percent. For larger farmers, the current price of irrigation water does not seem to be a limiting factor, except those growing on the most marginal land. Venot and Molle (2008) argue that prices are unlikely to enable regulation of groundwater abstraction and significant reduction will only be achieved through policies that reduce the number of wells in use, such as buying out of wells.

Transboundary Aquifer Experiences

In addition to the challenges outlined in the national case studies, transboundary aquifers extending across two or more countries add an additional dimension to governance; introducing the need for regional cooperation. The Nubian sandstone aquifer in northern Africa and the Guarani aquifer in South America are provided as examples of transboundary interactions.

Nubian Sandstone Aquifer[25]

In 1983, Libya initiated a huge civil water works project known as the Great Man-Made River (GMMR), a massive water transfer project that draws from fossil aquifers deep below the interior Sahara to deliver more than five million cubic meters of water per day to cities along Libya's coastal belt. The GMMR has been a source of international tensions in Africa, as the Nubian Sandstone Aquifer (NSAS) is the world's largest fossil water system, which straddles the borders of Libya, Chad, Egypt and Sudan, covering some

[25] Information synthesized from Cobbing et al, 2008; NGS, 2010; Jarvis, 2006; Salman, 2009.

two million square kilometers and estimated to contain 150,000 cubic kilometers of groundwater. The diversion of this non-renewable resource north to Libya's capital has raised concerns about regional ecological impacts.

Nonetheless, the four NSAS countries have embarked on a process to cooperate on the management of the aquifer's water resources. This regional cooperation is built on agreements on data sharing, monitoring and exchange with the incorporation of data into a regional information system. In addition, in 2005, the Nubian aquifer project (IAEA/UNDP/GEF) helped establish a rational and equitable management of the NSAS for sustainable socioeconomic development and the protection of biodiversity and land resources.

The World Bank also faced the issue of transboundary groundwater in 1997 with the Disi-Amman Water Conveyor Project. The Disi aquifer is a fossil, non-renewable aquifer that underlies northern Saudi Arabia and southern Jordan. Jordan had to notify Saudi Arabia of the project, who asked that no well should be drilled within 15 kilometers of the borders in each country.

There are some important areas of higher-transmissivity transboundary aquifers in South Africa that it shares with Botswana, Zimbabwe and Mozambique. These include the alluvium associated with the Limpopo River and areas of dolomite such as the Pomfret-Vergelegen aquifer. These aquifers have the potential for transboundary conflict over shared water, and need to be managed with care. Better data collection, and improved sharing of data, are likely to be central to mitigating and resolving any future conflicts.

Guarani Aquifer[26]

The Guarani Aquifer is a huge hydrogeological system that extends over 1,200,000 km^2 across Brazil, Paraguay, Uruguay and Argentina. The total volume of freshwater is estimated around 40,000 km^3. The current level of exploitation is relatively modest, with total groundwater production estimated to be in the range 1,000-3,000 Mm^3/yr and mainly concentrated in Brazil. However, the aquifer is of growing importance in the potable water supply of towns of the region.

The GEF-funded Guarani Aquifer Program (2002-2008) helped develop a comprehensive management framework, where sustainability and environmental concerns figure prominently, especially those with transboundary repercussions. In August 2010, Argentina, Brazil, Paraguay and Uruguay signed a new agreement for the management of this complex system. The four countries are now involved in the ratification process and in the negotiations of institutional aspects, including discussions regarding an annex to the Agreement on arbitration procedures.

In addition, the goal of the project was to improve knowledge about the aquifer, as well as promote concrete management actions at the local scale, with the necessary level of transboundary integration. One of the project outcomes was the understanding that management of the aquifer is essentially a local set of activities; joint coordinated management is not needed for the entire aquifer. There was insufficient information and knowledge basis (aquifer extent, geology, hydrogeology, hydrogeochemistry, flow dynamics, age of water, etc.) prior to the project to be able to reach this understanding and conclusion.

Four groundwater management pilot projects were funded through the project. In each pilot area, the

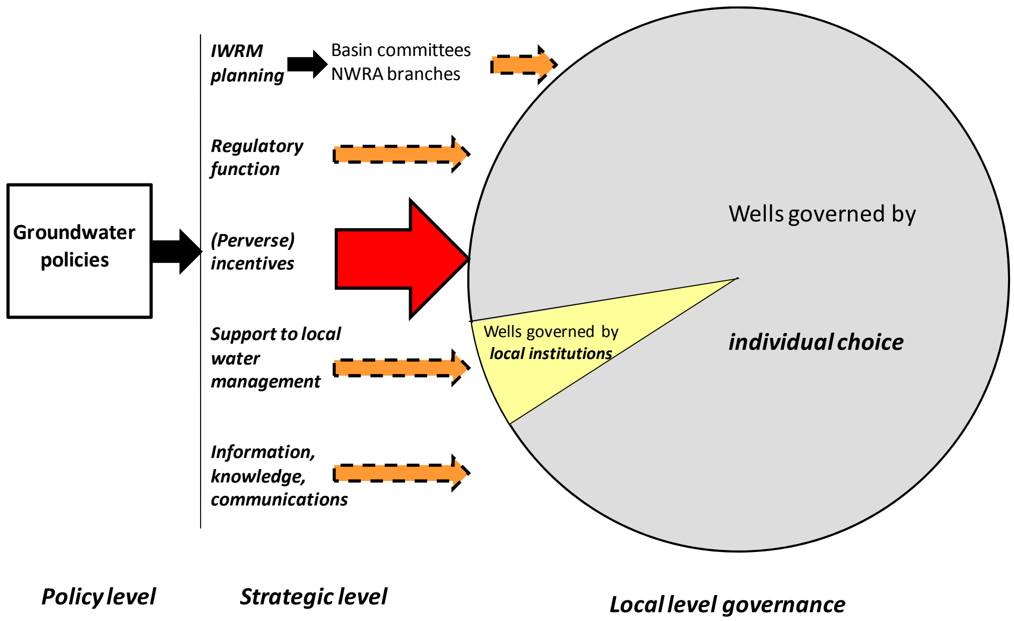
[26] Information sourced from World Bank, 2009

project first established a Local Management Commission composed of several agencies and stakeholders. Later these commissions were transformed into support groups for local management of the GAS. At present they have an information system with all the relevant data for the entire system, including well characteristics, water quality, level of extraction, and other relevant data for monitoring the aquifer.

Application of the Analytical Framework: The case of Yemen[27]

Yemen is one of the driest countries in the world in relation to its population and groundwater represents 70 percent of the total water withdrawal of the country (FAO 2009). The case of groundwater management in Yemen can be used to illustrate the applicability of this analytical framework. The framework can be used practically in order to describe the situation of the country in terms of groundwater governance but also to present specific measures that will help address the water crisis. The way it is conceptualized, the framework can be used to structure the different elements of the groundwater governance setting in Yemen, highlight the weak points of the system and present areas where specific positive actions can be taken. Figure 6 illustrates the framework as adapted to Yemen, with emphasis on existing perverse incentives at the strategic level and a predominance of wells governed by individuals at the local level.

Figure 6. Groundwater governance: the Yemeni case



At the policy level, Yemeni groundwater management policies have not been capable to address the challenges presented by a very fragmented system of water ownership and abstraction rights. Since the creation of the National Water Resources Authority (NWRA) in 1996, the political and regulatory system has struggled to put in place a modern water governance framework in the country. The Ministry of Water Strategy was created in 2004 to help address the recognized deficiencies.

[27] Information synthesized from Ward, 2012.

At the strategic level, subsequent to the Water Law, water user associations (WUAs), water user groups (WUGs) and water councils (WCs) were established to transfer operation and maintenance (O&M) functions of the spate irrigation and groundwater irrigation schemes from the Ministry of Agriculture and Irrigation to the user organizations. Up to now, 65 WUAs, 1 287 WUGs and 2 WCs (in Wadi Zabid and Wadi Tuban) have been established. They have received training on issues such as technical, financial and administrative management, provided by different projects. (Source FAO)

Strategic challenges include a lack of information collection and analysis and insufficient support to basin committees and NWRA branches setup to promote IWRM.

The local level governance arrangements allow small individual farmers to keep their rights. The ownership and management system of water abstraction rights for the majority of wells in Yemen is highly fragmented and in the hands of 100,000 to 200,000 individual well owners. According to the Constitution, surface water and groundwater resources are defined as 'res communis'. However, a landowner has 'precedence' for water taken from a well on his land. In spring-irrigated areas water can be attached to land in the form of 'turns', which give rights to divert the canal into the field for a fixed period of time. The 'turn' can, however, be detached from the land and sold or rented separately. This landowner's 'precedence' has permitted the private development of deep tubewell extraction, which is in some ways in conflict with Islamic principles. Islamic and customary law has no precedent for dealing with a new technology that allows landowners to extract (and sell) unlimited quantities of water from deep aquifers, and modern law has not yet regulated it either.

As a result of the above-outlined situation, there is a lack of mechanisms for transferring water to higher value uses within the Yemeni economy. Additionally, poor performance of water supply to rural and urban communities causes efficiency losses within the system.

To address some of the challenges outlined at each of the levels of analysis, Ward (2012) recommends:

- Promoting a partnership approach (e.g.community-based management);
- Continuing with basin committees and NWRA branches;
- Link water and agricultural governance more closely; and
- Explore market-based water transfers, new business models in urban areas, and lower cost technological innovations where available.

4. CONSTRAINTS AND OPTIONS FOR SETTING GOOD GROUNDWATER POLICY

Chapter 3 presented a rich set of actual results in groundwater that underlined the scale and scope of real problems in groundwater management (particularly the increasing rates of depletion and the growing water quality problems) and the relatively poor performance of the governance systems in place to contain these problems.

The case studies highlighted some gaps between the ideal framework implied by the chart in Chapter 2 and the actual governance arrangements in place in the five countries. In some cases, the governance arrangements represented a paradigm that was poorly adapted to the reality of millions of wells pumping away oblivious of the regulatory regime they were supposed to be respecting. In other cases, the governance regime might have been implementable but the well-resourced, highly competent agencies needed to implement it did not exist.

The rest of this report is devoted to trying to define governance options adapted to the reality of the groundwater challenges, and to the political, social, budgetary and economic context in which those options have to be applied.

The present chapter on groundwater policy looks first (4.1) at the determining influence of context to explain why groundwater problems have emerged as they have and how context limits the governance response to those problems. This assessment then provides a background for a discussion (4.2) of options and constraints for formulating responsive groundwater policy.

Chapter 5 on strategic level governance then examines three governance approaches (rights and regulatory approaches, the use of the incentive system, and subsidiarity and support to local water management) and assesses how a balance between them might be struck. There is a discussion of key implementation requirements, particularly the role of information, knowledge and communications and of conflict resolution mechanisms. Chapter 6 on local level governance looks at the promising but vexed potential for improving outcomes through participatory and collective management approaches.

The Influence of Context in Determining Groundwater Policy and Governance Systems

The Key Characteristics of Groundwater that Affect Policy and Governance

It is hard to impose a system of governance on groundwater because of its very nature as well as a number of inherent or acquired characteristics described below.

- *De facto appropriation*: Although groundwater is a common pool resource akin to surface water, its unseen characteristic combined with well technology has allowed individuals to establish de facto water rights to what is under their land.
- *An individualized resource*: Although, in principle, groundwater could be a common resource, in practice it is generally abstracted by individual well owners from under their own land. This individual character frees the user from constraining governance or cooperation with neighbors.

- *Strong economic drivers*: In most situations, groundwater is free of charge, of excellent quality, and can be turned on and off like a tap.
- *No inherent incentives to sustainability*: Because each user is accessing a shared aquifer and because groundwater flows, particularly when rapid extraction is taking place, each user is in competition with neighbors in a "race to the bottom."
- *Unseen*: Because the resource is underground, it is hard to quantify and equally hard to manage. Negative impacts may remain unseen for years and no physical limits are visible to the user or decision maker, both of whom can underestimate the problems and convince themselves that there is still time to act.

There are three implications of these constraining characteristics for the formulation of policy and governance options for groundwater. The first implication is that options for groundwater policy and governance need to reflect the challenging characteristics of the resource. A second implication is that governance systems also need to be proportional to outcomes that can reasonably be anticipated. The final implication that might be drawn from this rather daunting list of constraints is threefold: (i) that gaining information is vital, (ii) that a learning approach is essential, and (iii) that countries should expect only moderate outcomes.

Groundwater Within Overall Water Resources

Groundwater has to be seen in the context of the country's overall water resources.

The importance of groundwater in total water resources either locally or nationally will influence the need for development of policy and governance. For example, in cases such as that of India, where groundwater is a very important component of total water resources and is the main resource for a highly important agricultural sector, operation of a workable governance system is a top priority. Again, since groundwater resources and uses are often poorly monitored, the true importance of groundwater in a nation's water balance can be underestimated.

Groundwater has to be considered as part of the hydrological cycle and it may play a variety of roles. For example:

- The main resource may be a fossil reserve, which means that exploitation is akin to mining, and policy needs to determine the rhythm at which it is exploited.
- There may only be shallow alluvial aquifers that are best exploited to the full, consistent with environmental needs.
- There may be strong connectivity between the groundwater table and upstream and downstream flows.
- There may be a series of aquifers, one on top of the other, where different uses and users may have access.

Clearly, in all cases, groundwater policy has to be part of overall integrated water resource management policy, but the policies and governance mechanisms may vary considerably depending on whether there are intergenerational effects of current use (the case of fossil water), or current third party effects or externalities (the case of aquifers with sizable connectivity, the case where wetlands or oasis ecosystems depend groundwater, and so on).

Therefore, in assessing options for groundwater policy and governance, there is a need to evaluate how important groundwater is as a water resource and what is the role of groundwater in the overall cycle and, hence, its role in integrated water resources management. Policy and governance arrangements need to be adapted to the realities of the situation and to the nature of the problems to be solved.

The Impact of Physical, Geographical or Socioeconomic Characteristics

Many physical, geographical or socioeconomic characteristics may affect the kind of governance system that would work best. Examples include:

- Groundwater in a rugged terrain, where visits are difficult, is unlikely to be regulated by outside controls.
- The costs of regulation could be prohibitive if wells are scattered over a wide area.
- Societies with strong traditions of local or tribal autonomy would resist attempts to impose top-down regulation.
- There may be a strong history of directive management, as in former Soviet Union (FSU) countries, and this may make top-down approaches easier.
- Legacies of exclusion may make cooperation between local communities and the state difficult to implement (see Box 6).
- There may be generally low levels of respect for state institutions or the law, or resistance to change or lack of adaptive capacity (see Box 7).

The lesson is that governance structures need to reflect a realistic appraisal of the physical, geographical and socioeconomic realities.

Box 6. Historical Legacies and Participatory Approaches

Historical legacies have profound effects on shaping the way stakeholders engage in participatory management. Macro-level institutions are often the result of traditions going back generations and hence the practical scope for change in the short term may be limited. In South Africa, the legacy of apartheid militated against effective participation, with poor basic education, a history of dependency and a general lack of confidence in politics and policies strongly limiting the involvement of grassroots rural users and citizens. For example, Levite et al. (2003) investigated the quality of participation in the development of the Olifants Catchment Management Agency and showed that meaningful participation of users is not only constrained by lack of information and education, but also by local tensions and by the lack of history of dialogue between users.

Source: Wilson & Perret, 2010; Levite et al., 2003

Box 7. Community Acceptance of Rules Imposed from Above

Community values may lead to lack of acceptance of new rules imposed from higher level institutions. For example, in Morocco, the implementation of demand management measures by the introduction of drilling permits and fees has led to sometimes violent conflict in the Souss-Massa area. Similarly, in Spain, many farmers perceive high-level interventions as an attack on their rights to generate profit and are unwilling to change their water use practices. In many countries, the establishment of water user associations and cooperative societies often fails because of top-down implementation and subsequent lack of ownership (in addition to insufficient financial resources). In such cases, communities may require evidence of tangible benefits to assure their participation, particularly where adversarial relationships between government agencies and communities exist.

Source: Houdret, 2006; Closas, 2012; Olson, 1971.

The Importance of the History of the Development of Groundwater

Policies and governance systems have to reflect the state of development of the resource. In many situations, the "cat is already out of the bag" and returning to an optimal situation is impossible. As a result, governance systems must adapt to the extent to which groundwater is already developed (or overdeveloped). For example, in Tanzania where the resource is only 3 percent developed, it may be possible to implement a model licensing and regulatory system. In the Deccan Traps Basalt Aquifer in Andhra Pradesh, by contrast, where the resource is more than 100 percent developed and where there are over 1.7 million borewells, lower cost and less administratively burdensome approaches are essential.

Adapting Governance to the Nature of the Main Problems

Governance systems should be designed to bring actual outcomes as far as possible in line with policy objectives. Those objectives may vary, depending on the nature of groundwater problems. For example:

- Where rampant depletion is the main problem, governance will focus on reducing abstractions.
- Where agriculture is using the lion's share of groundwater but adjacent cities desperately need water, governance mechanisms to facilitate water transfers from agriculture to municipal and industrial uses are needed.
- Where pollution of aquifers is a real problem, mechanisms will need to be devised to ensure protection from polluting sources.
- Where land use in recharge areas like watersheds is reducing recharge, mechanisms to ensure watershed management and protection are indicated.

The lesson is that governance is not "one size fits all" and systems need to be adapted to the key problems experienced or anticipated.

Groundwater Policy and Political Economy

Stated Policy and "Real Policy" on Groundwater

"Policy" is here loosely defined as a nation setting objectives. In the case of groundwater, stated policy would be context-specific, reflecting some of the considerations discussed in 4.1 above, but would have something to say about the three typical development objectives of sustainability (in quantity and quality), efficiency (in allocation within and between sectors to the highest societal value) and equity (by ensuring fair access and firm entitlements).

In practice, however, there is usually a gap between stated policy and "real" policy, in that "real" policy is not what the country says but what it does. A good example is the case of unsustainable abstractions.

Unsustainable Extractions v. Sustainability Policies

Despite policies for sustainability, overdraft is often the norm rather than the exception. This could simply be due to lack of knowledge, but most commonly reflects a "real" policy to reap short-term economic benefits.

Almost all groundwater policy claims to target sustainability; that is, to ensure that over the medium or longer term abstractions equal recharge. However, continuous overabstraction occurs in many locations, to the extent that it could be seen as the "real" policy. Why does this occur?

In practice unsustainable use of groundwater is quite common for a variety of reasons. It can be the result of ignorance or lack of knowledge about the dynamics of the groundwater system. Since groundwater is invisible there are no direct signs telling a population and its decision makers how critical the condition of the groundwater resources may be, unlike a river that is drying up or whose fish are dying to warn of pollution. Information on the critical status of groundwater resources may not be sufficient to trigger action.

In many cases, the unsustainable use of groundwater reflects a "real" policy. Users have many incentives to overuse (see section 4.1 above) and policy makers turn a blind eye. Faced with urgent needs and limited budgets, decision makers will acquiesce in the use of groundwater above sustainable levels to satisfy water demand (for irrigation, urban or rural water supply and industrial uses), even if there are signs that the groundwater use is beyond levels of long-term sustainability. The case of the Indian energy-groundwater nexus is perhaps the best example (Box 8).

Convincing decision makers to adopt a strategy moving towards sustainable groundwater use has proven to be very difficult and interested groups exert pressure to allow overdrafting.

Lack of support for sustainable use is partly due to lack of political awareness, perhaps stemming from failures to provide adequate information on the groundwater situation to decision makers. However, even where knowledge is available, it is not necessarily turned into political action. The tendency of policy makers is to address short-term needs first and look into poorly known long-term threats later.

Politicians are under pressure from stakeholders and interest groups not to take decisions that have an adverse impact on their immediate needs or gains. For example, powerful lobbies are now involved in defending the interests of groundwater farmers in the United States, India, Morocco, Saudi Arabia, Spain and elsewhere.

Box 8. The Nexus Between Energy and Groundwater in India

In India, politicians and the agricultural lobby fight against bans on groundwater development and promote cheap energy.

India is the most well-known example of a difficult political economy for groundwater management. Shah (2010) explains it this way: "[The] Central Groundwater Board categorizes areas (blocks of around 100 villages) according to the state of their groundwater development from white (underdeveloped) to dark (critical and overexploited blocks). In theory, new tubewells are banned in the latter areas; yet, come an election, and politicians relax the ban,"

There is also a dimension of equity between the better-off and the poorer farmers that heightens existing tensions. Agricultural development banks like NABARD do not finance new tubewells in overexploited blocks, so the poorer farmers cannot access credit for that purpose. Better-off farmers, by contrast, can use their own funds to deepen wells.

Similarly, agricultural power pricing and minimum support prices for crops have emerged as powerful drivers of groundwater use, but reforming the provision of free or cheap power is a politically sensitive question. In some states, such as West Bengal, the government installed meters on all electrified tubewells, introduced remote meter readers, imposed a time-of-the-day power tariff, and cut farm power subsidies. The government was able to do this because the capacity of electric tubewell owners to put up political opposition was limited since less than 10 percent of the shallow tubewells are electrified. This solution cannot be applied in Gujarat state where 800,000 out of 1.1 million irrigation tubewells are electrified and groundwater irrigators organize quickly and easily around power supply and pricing issues.

Source: Shah, 2010

Neglect of Groundwater Issues by Policy Makers

Groundwater reform is politically difficult and can become a low priority.

A second reason for the gap between stated policy and "real" policy is that policy makers tend to see more pain than gain in dealing with groundwater issues. The problems of groundwater are complex and solutions are rarely clear-cut. In the expansion phase of groundwater development, policy makers may find considerable political benefits in promoting development for their constituencies, but once groundwater is well developed and problems start to emerge, downside costs predominate. The agenda becomes one of regulation, demand management, even water charges, none of which hold political advantage. Promoting such a reform agenda would require an expenditure of political capital that few policy makers are prepared to make.

Decision makers find it difficult to take unpopular decisions with immediate socioeconomic impacts to address long-term threats that are building slowly.

As with other natural resource issues, tackling groundwater reform requires a long view and might need sustained commitment for several decades. Few politicians have such vision or stamina. Ironically, it is in hereditary monarchies like Oman, Jordan and Morocco that rulers have been prepared to take such a long view.

One implication is the importance of looking not just at decision makers but also at the interests of their constituencies. For example, reforms that will have significant impacts on agriculture must first be sold to farmers. The common arguments that attribute failure to implement a policy reform agenda solely to a lack of political will ignore the essential requirement of building constituencies of popular support.

Attitudes regarding groundwater are in stark contrast to surface water projects, and this affects public spending allocations.

Politicians tend to favor highly visible infrastructure projects that can bring political gain. This may lead to neglect of investment and recurrent budget allocations for more effective and efficient investments. For example, in relation to groundwater, González de Asis et al. (2009) highlight that large dam projects may be favored over more efficient groundwater developments.

Towards Improved Groundwater Policy

Do the Political Economy Analysis

Understanding the political economy of groundwater is key to any effort to improve groundwater governance.

Political economy questions involve power relations that are difficult to appraise, but understanding them is key to improving outcomes. There is now much evidence to show that the success of development initiatives depends as much on having the right confluence of political factors or avoiding major political risks as it does on having the right technical design (GAC, 2011).

Tools have been developed to analyze and assess the political economy.

Political economy *analysis* is concerned with the interaction of political and economic processes in a society; that is, the distribution of power and wealth between different groups and individuals, and the processes that create, sustain and transform these relationships over time (Collinson, 2003). More specifically, a more thorough *assessment* of the political economy looks systematically at the institutional structures and the formal and informal rules of the game that surround and interact with them (GAC, Mar 2011). Political economy assessments may comprise a variety of analytical tools such as stakeholder analysis, analysis of winners and losers, institutional and governance analysis, and risk assessments (World Bank, 2009; World Bank, 2012) (Box 9).

<u>Provide Decision Makers with the Information They Need to Take Action</u>

Sharing of information both with decision makers and with all stakeholders (including the general public) is likely to improve the quality of decisions.

Raising the level of awareness among politicians, decision makers and stakeholders (including those from other sectors) about the real threats to groundwater resources is the first step in improving groundwater policy and governance. Transparent provision of appropriate information will equip politicians to take decisions in the light of the facts, and also allow stakeholders and the general public to influence those decisions. Box 10 illustrates how threats of groundwater depletion were convincingly presented to policy makers in one country.

Box 9. Identification of Political Risk and Stakeholder Mapping

In order to recognize the political risks faced by a proposed project, there needs to be an assessment of actors (such as politicians or interest groups), along with their attitudes, motives and power to support or oppose. Having identified actors that are likely to oppose a project, it is helpful to assess their channels of influence to gauge the threat they may pose. Finally, it is important to consider the actual impacts political risks could have at different stages of a project cycle if they were to materialize (Schmidt et al., 2012).

In the specific case of groundwater governance, part of this approach may involve stakeholder mapping–a process of particular relevance given the complexity and political nature of the groundwater subsector. Mapping helps to determine the positions, levels of influence and power of different actors, their inter-relationships, and the channels through which influence occurs.

Source: Schmidt et al., 2012; World Bank, 2012;

One first step is to convince decision makers to put aside required budgets for acquiring information.

This could start with the allocation of budgets for groundwater resources assessment and monitoring, to gather the critical knowledge needed on the water resources. Groundwater systems are generally more complex than surface water bodies and information is more costly to obtain. The reality is that in many countries the amount of systematic time-series information on groundwater resources is scarce (IGRAC 2004). Showing the value of groundwater to the nation's economy and the cost of depletion may help to make the point that paying for groundwater knowledge is worth the investment.

The groundwater community needs to adapt the message to align it with the interests of stakeholders by showing the economic impacts of decisions.

Providing decision makers with up to date information on the condition of groundwater resources and their expected life is critical, but in many cases it is not sufficient to trigger much needed action. The importance of groundwater to the national economy may go unnoticed and the contribution of groundwater to the nation's food security, water supply or economic development may need to be made visible. To raise awareness there is a need to demonstrate the real value of groundwater in the economy to convince decision makers that the cost of inaction largely exceeds the cost of action.

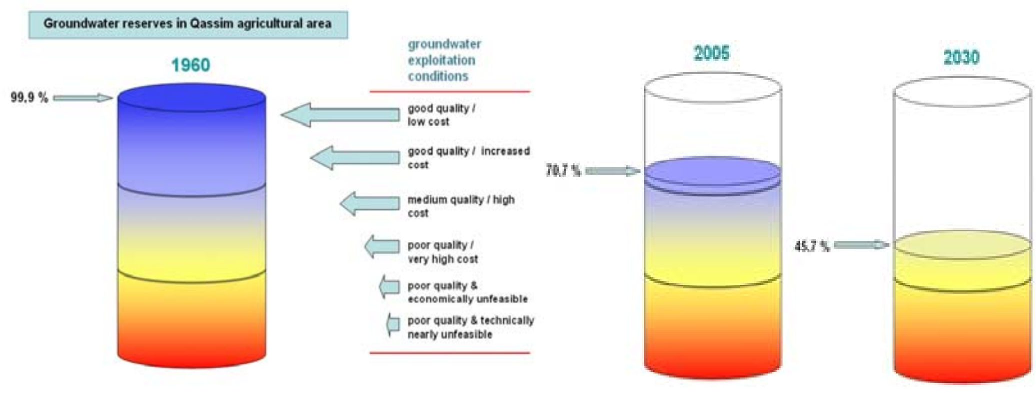
This kind of analysis can be complex and it needs to be disseminated in a form that is easily understood by politicians and the public

This is easier said than done. Groundwater has multiple users and multiple functions, often with cascading effects on other sectors. As a result, decisions (or the lack thereof) about groundwater have an impact on many sectors of the economy. There is a need to develop adequate tools and methodologies for analyzing the groundwater economy to show the value of groundwater and quantify the risk of inaction. These tools need to consider the physical relationships and constraints of groundwater and understand its role with regard to surface water and other environmental entities and functions. Within this physically-based framework economic functions need to be modeled to allow for objective and relevant economic analysis of scenarios and quantifying the short- and long-term impacts on budgets and on individual stakeholder groups.

Box 10. Exploitable….But at What Cost?

In the early 1960s, before the introduction of tubewells and industrial agriculture to the area, groundwater in the Qassim aquifers was in natural equilibrium. At the start of groundwater exploitation, fresh water (blue color) was easy to find and available at limited cost because of the shallow depth and short transportation distances from the point of use. As water mining continued, the level of water in the aquifers dropped, with an ever expanding cone of depression, and the quality of remaining water deteriorated. Some aquifers began to show increased levels of natural radioactive isotopes as a result of this intensive exploitation.

Over time, the freshest and most easily accessible water is depleted (see drums for 2005 and 2030, compared to 1960), leaving behind marginal quality water at much greater depth, affecting far wider areas as the cone of depression further expands. Thus, although the potentially exploitable amount of water in the aquifers is still significant in terms of quantity (about 45 percent by 2030), in part of the region the groundwater will have been depleted and in the remaining areas the poor quality and the much greater depth to the water table mean that producing potable quality water from the same well will now cost very much more. Deeper wells, larger capacity pumps and additional treatment facilities will be needed to make the water potable. The combination of deteriorating water quality, increasing depth and growing distance from centers of use creates a "perfect storm" of extreme water scarcity and spiraling cost.

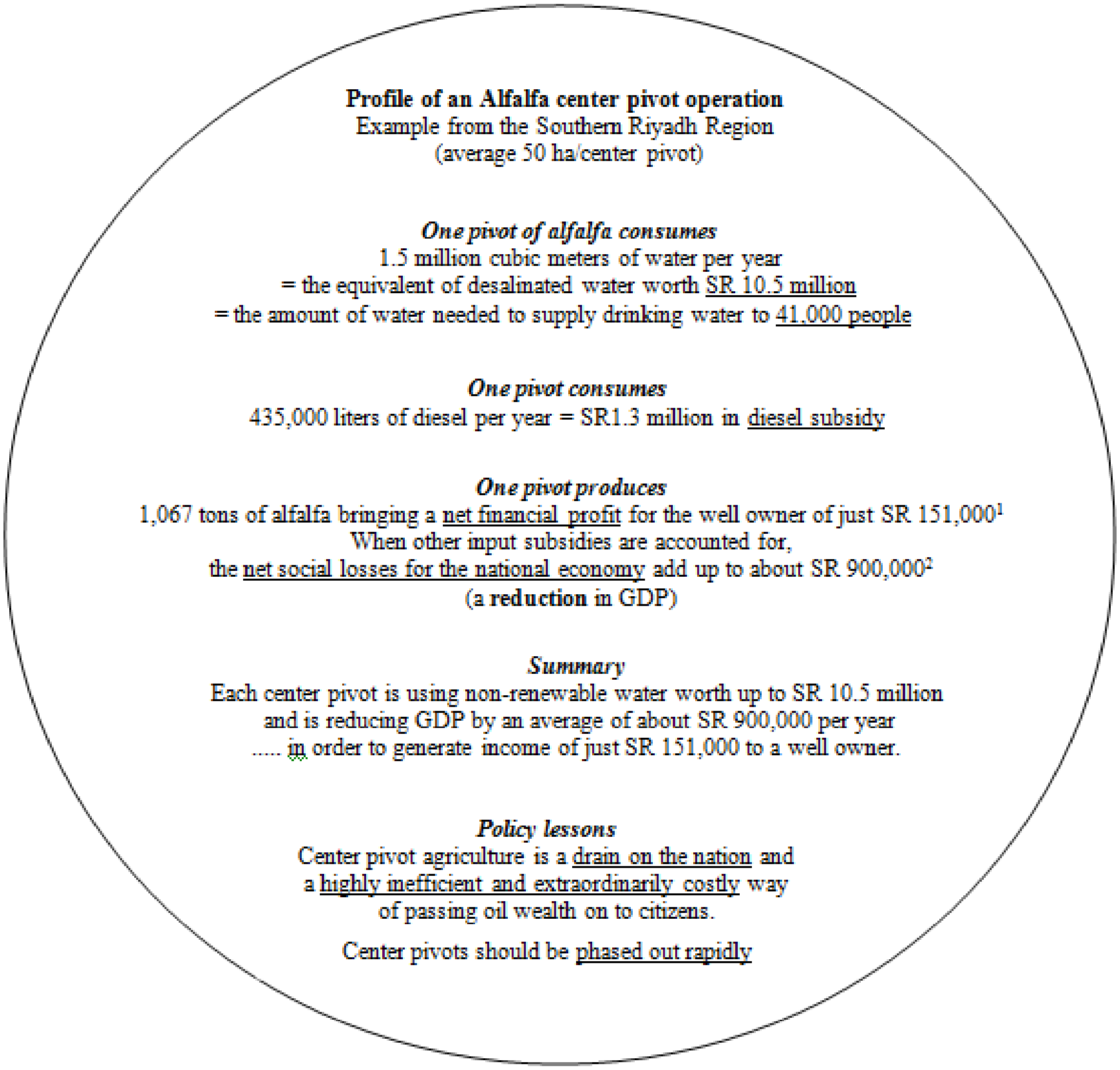


Source: Authors

Once the analysis is done, it needs to be formatted and disseminated in a way that is both understandable by the layman and conducive to informed debate and good decisions.

Figure 7 illustrates a cogent presentation of the economic impacts of groundwater overabstraction in Saudi Arabia.

Figure 7. Economic Arguments for Groundwater Governance and Conservation.



Explanation: Example of using a pivot-shaped presentation to draw the attention of decision makers to economic arguments for groundwater governance and conservation. A pivot is a large round field irrigated by a rotating sprinkler system. There are thousands of pivots in Saudi Arabia utilizing mainly fossil groundwater (Source: World Bank, 2012).

Notes: [1] Net profit excluding land rent;

[2] Net social losses are calculated on the assumptions that 60 percent of pivots use diesel pumps and 40 percent use electricity

Ensure Accountability

Good groundwater governance requires both political and social accountability.

Given the importance of strategic and local level actions for good groundwater governance, both political and social accountability play equally essential roles. Political accountability is when the state makes itself accountable to the public. It is supply-driven and relates to the organization of government systems and how they respond to community demands (WBI, 2009). Political accountability needs to precede, or at least match, social accountability by providing vision and the resources/incentives necessary to facilitate adequate community governance.

Conversely, social accountability[28] is demand-driven and refers to the ability of citizens, service users, project beneficiaries, communities, and civil society organizations to call for greater accountability and responsiveness from public officials and service providers. Social accountability mechanisms (see Box 10 and Annex 7) can be initiated from a variety of sources, but frequently operate from the bottom up. They are particularly relevant to groundwater governance where community engagement plays a critical role in resource management.

Box 10. Social Accountability Tools

There is a large suite of social accountability tools, chiefly centered on the promotion of principles including community ownership, subsidiarity, transparency and accountability (see Annex 7). Examples of the variety of tools available include community reporting and juries, grievance redress mechanisms, social auditing, public expenditure tracking systems from central to local government and community, and many others.

Many of the tools build citizen and civil capacities and awareness through the dissemination of information and promote dialogue between stakeholders. In addition, they may promote analytical and advocacy work and facilitate community engagement in collaborative formulation, decision-making and monitoring activities. Engaged and informed communities can better hold governments accountable for budgeting and service provision and also help to promote locally identified and coordinated actions. Iterative community management may be promoted by incorporating feedback mechanisms (soliciting perceptions on quality, efficiency and transparency), and deliberative participatory instruments may supplement conventional democratic processes. The structure of mechanisms may involve the formation of cooperatives and full community management and ownership of services. Monitoring may involve independent, third-party citizen, and community and civil society organizations.

Hence, social accountability tools may help promote more transparent and accountable management at both the local level (i.e. for collective management arrangements) and between the local level and various higher levels of government.

Source: GAC, 2011; WBI, 2009a

Strengthen the Political Economy Debate

Recent analysis and experience have highlighted how reform programs can be helped forward by a proactive strategy to turn political economy constraints into advantages. Although this enters into the delicate arena of power relations and politics, developing and supporting such programs is entirely in line with the focus on the key role of political economy in getting the right policies and governance into place. Box 11 gives an example of how a strategy to promote reform and overcome political economy hurdles might be designed.

[28] Sometimes referred to as Demand for Good Governance.

Box 11. Design of Strategy to Overcome Political Economy Constraints and Reform Groundwater Policy and Governance

Ways and entry points to push forward a change agenda might include:

Carrying out intelligent analysis and design: as part of the design of groundwater reform programs, analyze the internal political context and power balance of different stakeholder interests and influences as well as institutional structures and processes. "Implementing policy change that threatens deeply-rooted practices and interests requires a good understanding of the power relations that sustain them" (Zeitoun, 2009). Analyze the incentive structure and ensure that incentives can be rebalanced to influence positive change. At the local level, understand the adaptive capacity that exists in every community, and build on it as the key to predicting and promoting change. Balance access and comprehension of information and knowledge about resources and rights in order to empower stakeholders to participate and increase legitimacy and equity.

Taking a strategic approach to engagement: design a targeted engagement strategy for identifying and dealing with opponents of reform. Such a strategy would include policy analysis, PR campaigns, public education, establishing dialogue platforms, and so forth. It will be very important to demonstrate and publicize facts on the ground. While discussions of ideas will influence ministries and academics, evidence of success or changes in incentives are needed to change things on the ground.

Building constituencies. Reform requires a constituency, and time is needed to develop one. The role of leaders, catalysts and educators is important. Donors can contribute materially in this role. Think long term, invest in a learning process. Develop a long-term strategy, and ensure that principal partners in government, civil society and among donors retain the stamina needed. Also, be ready to capitalize on "decisive moments."

Developing capacity. Build up the water ministry and other relevant public agencies, with particular emphasis on improving the accountability of government and public agencies and on improving perceptions of their legitimacy among constituents. Empower water user associations and other weaker interest groups, enhancing their negotiating capacity, etc.

Keeping to policy objectives. Ensure that the fundamental policy goals are always in mind: social equity in terms of fair distribution of benefits, economic efficiency, and environmental sustainability. Ensure a pro-poor bias to all measures, considering for example: (i) increasing the role of women and other vulnerable groups; (ii) poor-sensitive pricing; and (iii) emphasis on participation, accountability, transparency.

Source: Ward, XX; Zeitoun, 2009

5. GOVERNANCE AT THE STRATEGIC LEVEL

The analytical framework presented in Chapter 2 distinguished three levels of governance functions: the policy level, the strategic level, and the local level. Following the discussion of the policy level in Chapter 4, the present chapter looks in some detail at the components of strategic level governance:

- The integrated water resource management (IWRM) planning function (5.1)
- Three governance approaches: (i) laws, rights and regulations; (ii) the incentive framework; and (iii) the framework for subsidiary (5.2)
- The key governance function of information and knowledge and of communications with stakeholders (5.3)
- Mechanisms for conflict resolution (5.4)

The discussion of each comment looks in turn at: (i) the nature of the function; (ii) the typical impediments to good performance; and (iii) options for removing or alleviating the impediments.

IWRM and Cross-Sectoral Harmonization

The Principles and Practice of Integrated Water Resources Management

For the last two decades, water resources management around the world has been aligned on a set of best practices known collectively as integrated water resources management or IWRM.

Although IWRM practices are many and various (there are over fifty "tools" in the Global Water Partnership's "Toolbox for IWRM"), they can be summarized under five principal measures: (i) participation of all stakeholders in accountable governance structures and mechanisms; (ii) separation of water allocation authority from water users; (iii) decentralization and management at the lowest level; (iv) an incentive structure reflecting the value of scarce water; and (v) integrated inter-sectoral management at the basin level. Box 12 gives a synopsis of IWRM best practices.

Most countries have set up specialized water resource management agencies, sometimes as authorities, sometimes as ministries. In some countries (India, for example, see Chapter 3) specialized agencies have been established specifically for groundwater. The basin management approach has been reflected in the establishment of basin management agencies in a number of countries (Morocco, for example, Chapter 3). These agencies are typically responsible for devising and implementing water policies and strategies, for water resources planning, for information, and for regulation.

Although in principle IWRM should consider groundwater adequately, in practice it is often the poor relation, with negative consequences for agencies and for resource management.

One strength of the IWRM approach is that all water sources are considered in the planning framework in an integrated way, so that the role and special characteristics of groundwater are, in principle, fully recognized. However, a risk of this type of approach is that groundwater may not receive the same attention as surface water because of the constraints identified in Chapter 4 (4.1).

Box 12. IWRM - Global Best Practices in Integrated Water Resource Management

Global best practices in water management have emerged over the last twenty years, and most water laws and national water strategies are aligned with these best practices, which are typically grouped under the title " integrated water resource management" (IWRM). Essentially, best practice IWRM sets three goals for good water management, and three principles for forming policies and actions.

Three goals for good water management. The three goals of good water management are (i) social equity, (ii) economic efficiency, and (iii) environmental sustainability.

Under (i) social equity:

- Water services are available for all
- Existing water uses are respected
- Benefits of development are shared equitably, with care for the poorest

Under (ii) economic efficiency:

- Income per drop is maximized
- Water is available for its highest value economic use

Under (iii) environmental sustainability:

- The water resource and the broader environment are not harmed
- The needs of future generations are taken into account

The Dublin statement on water and sustainable development for action at local, national international levels. The four principles adopted by the UN Dublin Conference in 1991 for forming IWRM policies and actions are:

Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment. Effective management of water resources demands a holistic approach, linking social, economic and environmental components across whole catchment areas and groundwater aquifers.

Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels. This involves raising awareness of the importance of water and promotes decision-making at the lowest appropriate level with full public consultation.

Women play a central part in the provision, management and safeguarding of water; Acceptance and implementation of this principle requires positive policies to address women-specific needs and to equip and empower women to participate at all levels; and

Water has an economic value in all its competing uses and should be recognized as an economic good. It is vital to recognize the basic right of all human beings to have access to clean water and sanitation at an affordable price. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources.

Source: Authors; UN Dublin Principles

As a result, groundwater may not be adequately considered in IWRM planning, and this can have very negative consequence for subsequent implementation. In addition to the risk in water management decisions stemming from lack of proper understanding of hydrological relationships, there are often negative consequences for water management organizations, including lack of budget and staff (see Chapter 3). In response, Foster & Ait-Kadi (2012) define hydrologically consistent approaches to reconciling river basin catchments with groundwater bodies within an IWRM framework as one way of addressing such challenges (Box 13).

Box 13. Hydrogeologically consistent approach to reconciling river basin catchments with groundwater bodies for IWRM

Identifying different hydrogeological conditions may be an appropriate spatial framework for addressing groundwater management and protection within IWRM.

Hydrogeological condition	**Water-resource management implications**
Important auifers of limited extent compared to river basin in either humid or arid region	Independent local groundwater-management plans required, but these should recognise that aquifer recharge may result from upstream riverflow, and downstream baseflow will often be dependent on aquifer discharge.
River basin underlain by extensive shallow aquifer system	Surface-water/groundwater relations (and their management) require fully integrated appraisal to avoid double resource-accounting and various problems (including salt mobilisation on land clearance, soil water logging and salinisation from irrigated agriculture, etc.).
Extensive deep aquifer systems in arid regions	Groundwater flow system dominates: there is little permanent surface water and, thus, it is not helpful to adopt a river-basin approach.
Minor aquifers of shallow depth and patchy distribution predominate	Limited groundwater interaction with river basin and (despite socioeconomic importance of minor aquifers for rural water supply) integrated groundwater/surface-water planning and management is not really essential.

Source: Foster & Ait-Kadi, 2012

Impediments to Integrated Management Approaches to Groundwater

Competing Interests and Lack of Cross-Sectoral Cooperation

Agricultural policy and strategy are the dominant drivers of groundwater use in most countries, and alignment between water resources strategy and the strategy for agriculture is very challenging.

The agriculture sector is the main user of groundwater in many countries. Understanding the incentives of this sector is key to achieving sustainable groundwater management. The main issue is that, as agriculture develops, more farmers depend on groundwater for their livelihood, and reforms become socially and politically challenging. The case of the energy/groundwater nexus in India was discussed in Chapter 4 (Box 8). In Morocco, a combination of profit-driven lobbying by farmers and the government's concern for protecting a key economic sector while managing groundwater for sustainability have led to a step-by-step strategy based on the notion of "more income for less drop" (Box 14). However, it is not yet clear whether this actually will result in reduced overdraft and ultimate sustainability of the groundwater resource.

Box 14. Water Efficiency Subsidies in Morocco

In Morocco, subsidies are given to promote water use efficiency, but it is not clear that they produce the expected conservation outcome.
Morocco's agriculture sector has been the main driver of groundwater development, and policies that restrict groundwater pumping are now difficult to implement. The agro-food sector is a pillar of the Moroccan economy. It represents 15 percent of Morocco's GDP and 23 percent of the country's exports (World Bank, 2011).

In particular, the Souss Massa aquifer is used to irrigate crops for high-value export markets and it is one of the most over-abstracted aquifers in the country. The case study report shows that there is a lack of sustained support from elected councils and local authorities for the actions proposed by agencies to enforce groundwater provisions such as control of drilling activities or groundwater abstractions, and groundwater permit requirements.

The "water saving" action most easily accepted in irrigated areas is the conversion of gravity irrigation into drip irrigation systems, which often benefits the farmers by increasing yield and decreasing pumping cost. However, it is uncertain how much water the introduction of drip irrigation will save. In other countries in similar situations, water saving techniques employed in the absence of regulation have led to an increase in water abstractions (Foster et al., 2009). Things may be changing with the new management plan for groundwater in the Souss-Chtouka aquifer, which includes a reduction in areas irrigated by groundwater, at a rate of 1 percent per year.

Source: Morocco Case Study

Groundwater is used as an input to several sectors and, as a result, is affected by several sectoral *strategies. Yet, there often are no mechanisms for alignment of strategies in pursuit of an integrated approach to water resources management.*

The case study reports present many examples of sectors with competing interests, such as agriculture, mining, and land planning or conflicting claims regarding the supply of drinking water, water for irrigation, industrial supply, and minimum flows for sustaining ecosystems.

Development and implementation of management strategies often remain a problem because of poor cooperation between sectoral ministries, poor cooperation across administrative boundaries (see section 4.6), and also the protection of vested interests not only by states but also by important individuals in government, industry and even in the science fraternity. Thus, the process of formulating groundwater strategies should involve not only representatives of the different sectors that depend directly on groundwater (such as agriculture or industry), but also sectors that indirectly affect groundwater (such as urban development, land planning, mining) as well as the whole water sector. A major challenge to groundwater governance is cross-sectoral cooperation. If successful, cooperation between policy fields and sectors provides tremendous opportunities in terms of cost efficiency.

Demarcation of Management Areas

Problems may also arise from the mismatch between hydrological and administrative boundaries.

The geographical mismatch between hydrological and administrative boundaries has often been mentioned as an administrative gap in water governance (OECD, 2011). It is a challenge relevant to both surface and groundwater resources and requires coordination between the authorities. Administrative boundaries are determined by political, geographical and historical factors that may have nothing to do with natural hydrological boundaries (which commonly intersect local, intra-national, or international demarcations). If this mismatch is recognized by the responsible authorities, coordination with all related sectors may contribute to better integrated water management. This discrepancy between hydrological and administrative boundaries is most problematic in cases of transboundary aquifers (described in Box 22 and Box 27). Such barriers may best be overcome via strategic IWRM at basin scales.

Constraints to Factoring Groundwater into Integrated Water Resources Management

Water management agencies often give low priority to groundwater compared to surface water.

The tendency of decision makers to favor visible surface water plans and investments (Chapter 4) is paralleled by similar preferences among planners and engineers. The integration of surface and groundwater budgets can potentially exacerbate this issue. When budget shortfalls occur, it is generally easier to postpone or cancel the less visible groundwater-related activities than the more visible surface water activities. In India, water supply planning and investment at municipal or state levels is almost entirely restricted to large capital investments for the development of new surface water sources (World Bank, 2010).

*When groundwater **is** considered, the focus tends to be on development rather than conservation.*

It is easier to obtain financing for water sector infrastructure than for the software needed for groundwater (such as research, policymaking, monitoring, environmental and pollution control, training, and public awareness). Shah (2010) notes that Indian farmers, NGOs and governments have been far more enthusiastic about augmenting the supply of groundwater resources than managing demand and reducing overdraft. In an analysis of water governance in Kenya, Rampa (2011) observed: "There are strong incentives, including for the government, parastatals and donors, for achieving immediate results on access to water services, while conservation and long-term sustainability of the resource does not seem to be an immediate priority." This problem is exemplified by the comparison between the Water Services Regulatory Board (which receives substantial support and is under pressure to improve access to services) and the Water Resources Management Authority (which receives little government attention).

Integrated water resources management can even be detrimental to groundwater if adequate expertise is lacking. In South Africa, the water sector has been restructured, with groundwater being integrated into all other water management functions, such as planning, information management, and resource protection. The former Directorate of Geohydrology was dissolved and hydrogeologists were redeployed to a number of directorates and integrated with surface water sections. While the purpose of this restructuring was to ensure integrated water resource management, it left the new Department of Water Affairs without a central coordinating point or "champion" for groundwater. The lack of a central focus or champion results in inadequate coordination with and support for regional offices and municipalities. The Indian state of Andhra Pradesh is considering establishing five river basin organizations to take over water resources management functions in the longer term. While there may be potential benefits associated with such a proposal, groundwater-specific challenges identified by the Bank (Apr 2009) include: (i) local-scale groundwater issues not receiving the level of attention they deserve; and (ii) breaking up the critical mass of experienced groundwater professionals in the state government.

Options for Overcoming the Impediments

Aligning Interests and Harmonizing Sector Polices

Correcting the mismatch or conflict among sectoral policies is one of the biggest challenges for groundwater governance.

Typically, the political gain and economic incentives weigh in heavily on the side of the water using sectors, particularly the interests of agriculture and municipal and industrial supply. Within the water sector, the scales are heavily weighted in favor of surface water investment and related management. What governance mechanism can ensure that sectoral policies and integrated water resources management planning promote good groundwater management?

Countries have set up a range of inter-sectoral coordination mechanisms, and there are excellent examples of multi-level governance concerning groundwater.

A variety of approaches to promote inter-sectoral coordination have been developed, including: (i) creating a specialized ministry or water resource management agency with the mandate of coordinating all water-related policy; (ii) confiding a coordination role to a neutral ministry, typically the planning ministry, to reconcile the interests of the water resource managers with the water using sectors; and (iii) creating a high level governance body such as a national water council (such as the water and climate change council in Morocco, or the recently-created National Water Board in Tanzania). Institutional analysts have also proposed multi-level governance as a mechanism to facilitate cross-sectoral harmonization as well as vertical linkages between the center and the local level. China has implemented these mechanisms to improve water and environmental management, including groundwater, in the Hai basin area (Box 15).

Groundwater needs to be adequately factored into IWRM planning.

Where integrated water resources management planning has been adopted, whether at the level of national master plans or at the local river basin level, specific dedicated human and financial resources should be devoted to groundwater. Some activities, of course, are common between groundwater and surface water, so creation of entrenched "empires" needs to be avoided. Cross-fertilization is also useful. For example, groundwater management can benefit from the experiences in surface water with regard to participatory approaches and collective choice arrangements, which are much more developed for surface water management.

Box 15. Multi-level Governance of Groundwater in the Hai Basin, China

The groundwater underlying the North China Plain, within the Hai River basin, is used intensively for irrigated agriculture. Affected aquifers are shallow, unconfined and deeper, and confined aquifers. Some areas have recorded an over 40m drop in the groundwater level, which has increased the risk of salinization, especially along the Bohai coastline.

The objective of the World Bank-financed Hai Basin Integrated Water and Environment Management Project (2004-2011) was to serve as a catalyst for an integrated approach to water resource management and pollution control in the Hai Basin in order to improve the Bohai Sea environment. Based on previous Bank project experience and sector work, the project was focused on new and innovative approaches, many of which concentrated on improving governance.

1. Introduction of the new concept of real water savings whose aim was a reduction in consumptive use or evapotranspiration (ET) rather than just increases in irrigation efficiency (which normally leads to increases in consumptive use of water through increased effective irrigation areas). Experience in China had shown that focusing on improvements to physical infrastructure alone might increase irrigation efficiency, but it could also reduce groundwater recharge by increasing the proportion of rainfall or irrigation water consumed by crops through ET. This reduced availability of water for other users and the environment. Only a reduction in actual consumption of water represents a genuine saving of the resource to the hydrological system. The project introduced ET quotas or targets, which were based on a combination of actual ET values measured with remote sensing technology and models of surface water and groundwater systems.

2. Introduction of institutional mechanisms for cooperation among government departments in different sectors rather than the traditional sectoral line management and top down (command and control) direction. This integrated institutional management comprised horizontal (cross-sectoral) cooperation between ministries, and their national, provincial and county equivalent agencies. The integrated management included establishment of horizontal and vertical project coordinating mechanisms, signing of data sharing agreements, establishment of a joint decision-making conference system at the basin level, and interagency decision-making committees at the county level, and a suite of strategic policy studies and demonstration projects.

3. Introduction of a Basin-wide Knowledge Management (KM) System (including application of remote sensing ET measuring technology) located at the Hai Basin Commission and local governments. This included decentralized knowledge hubs at lower project levels. The system made it technically possible to share and allocate data at both basin and county levels by local governments and water use sectors within the basin. The key is that a quantitative linkage has been established of the monitoring indicators (e.g. target ET and target pollution discharges) between the basin-level and field-level, which greatly facilitated integrated river basin management.

4. Development and implementation of sub-basin and county-level Integrated Water and Environmental Plans (IWEMPs) to return surface and groundwater use and pollution discharge to sustainable levels consistent with the project's goals, ET quotas or targets, and water quality targets for water function zones.

5. Participation of the key stakeholders (the farmers) was achieved during project implementation by means of the establishment of Water Users Associations (WUAs) and by providing Community Driven Development (CDD) investments so that farmers' incomes increased considerably while consumptive use of water was reduced. The intention and the result of the CDD/WUA approach was to give farmers' incentives to participate in the whole process of the project design, implementation, operation and management. The communities made decisions on their own choices on the ways to increase their incomes and on how they were going to do water management.

Source: World Bank, 2011

Nonetheless, groundwater requires specialized capacity in term of knowledge and resource monitoring and additional efforts for information and communication compared to surface water (see Box 16). If river basin organizations are in place, groundwater should have its own space with separate responsibilities and budget to reflect its specificity. In some countries, surface water and groundwater are managed by different institutions. In India, for example, there are specialized national agencies for groundwater (see Chapter 3), and coordinating agencies for all groundwater related activities at state level.

Box 16. IWRM in Africa

In many African systems, river basins are the unit of choice for IWRM planning, with a hierarchy of governance organizations and institutions and with groundwater factored in. Of 40 countries surveyed in the AMCOW report of 2012, 60 percent are implementing integrated water resources management at the river basin level, which is a significant increase from only a few years ago. The report recommended strengthening institutional frameworks to support and promote the establishment of effective governance and institutional frameworks for water resources, including groundwater, based on IWRM. Within countries, this could take the form of national committees or councils at the national level, of basin committees or agencies at the basin level, and of local water committees through institutional capacity development and peer to peer sharing of experience at the local level.

Source: AMCOW, 2012

Proactive conjunctive management to resolve scarcity and quality constraints should be encouraged where it can make the difference.

Conjunctive management (that is, managing different parts of the land and water resource continuum jointly to improve outcomes) has several implications for groundwater. For example, the use of aquifers for managed storage of surplus surface water has broad application, ranging from small scale water supply and irrigation schemes to municipal supply where some form of aquifer-storage-recovery is possible. Confined aquifers can also be used for managed recharge with treated wastewater. In addition, the regulation of recharge through land management also offers scope to improve groundwater quality and quantity.

However, dealing with the third party aspects of protection and recharge is difficult.

For example, persuading individuals to reduce chemical inputs on land or change land management and waste disposal practices is harder than persuading them to change abstractions or water use since it is difficult to build in incentives to change (there would be no direct benefit to them if they are not drawing water from the aquifer). This is a very common challenge in watershed management projects, for example. The implications are twofold: (i) land management in the recharge area is an important part of aquifer management, and needs to be included in planning; and (ii) sustainable incentives need to be built in to interventions. Sometimes these can take the form of win-win investments, such as the planting of fruit trees to stabilize the upper watershed, which also produce an income for the farmer. In other cases, payments for environmental services (PES) may have to be considered.

Developing and Applying Governance Approaches

Defining a Governance Approach

The analytical framework in Chapter 2 distinguishes three governance approaches: (i) a rights and regulation approach; (ii) an incentives-led approach; and (iii) a subsidiarity approach.

A rights and regulation approach awards (or recognizes) legal water rights to users and then relies on a regulatory system to ensure that users are respecting the terms of the award. An incentives-based approach uses positive and negative incentives (typically incentives that affect the profitability of water use) to bring pumping behavior at the well head into line with policy. A subsidiarity approach delegates responsibility for groundwater management to the local level, usually to stakeholder interest groups.

The importance of getting the right governance framework up-front is illustrated by the common disconnect between ambitious policy objectives and governance frameworks that are ill-adapted to the realities on the ground.

In all five of the study countries studied (see Chapter 3), public institutions in charge of regulating groundwater abstraction proved unable to implement the policy, especially the control of illegal drilling and groundwater over-abstraction. Morocco is certainly the most advanced country in terms of capacity but the river basin authorities are overloaded and understaffed and policing interventions remain inefficient.

The number of wells and users is a key determinant of whether an approach is feasible or not.

One lesson that could be drawn from the case studies is that if groundwater users comprise only a few water supply providers, regulation by government institutions may be feasible, but controlling groundwater abstraction from a large number of small-scale irrigators requires a level of staff, capacity and budgets that governments cannot afford. In these cases, incentives or subsidiarity approaches may be better suited.

In particular, regulatory systems that depend on the award or regulation of quantified water rights place a huge administrative burden on public agencies.

Issuing permits or groundwater use rights is also a massive administrative challenge. Considerable constraints were observed in all case study countries, and in other countries as well (Mexico and Peru have experienced similar difficulties) (see Box 18).

Taking the framework above, what are the characteristics of these different governance approaches, and when might they be adopted? These questions are answered in the following sections. Here it is important to note that the three approaches are not mutually exclusive. In reality, all governance systems will use a combination of approaches, and may use different ones for different geographical areas or segments of water users.

Rights and Regulatory Approaches

There have been many problems in defining, issuing and regulating quantitative groundwater rights.

A system of formal rights and regulations is very demanding in terms of knowledge, skills, manpower and financial resources. Such systems typically require:

- a legal framework that defines groundwater rights and the related regulatory system
- quantification of the water resource and a monitoring system that relates water abstractions to the groundwater balance and to related changes in the hydrological system
- a full well inventory and a record of existing and historic patterns of water use
- the issue of licenses to each right holder, spelling out the quantity that may be abstracted
- a system of measuring, recording and reporting on actual individual well abstractions (usually by metering)
- a compliance system, normally including inspection
- a legal framework and the police and judicial apparatus for dealing with infractions and for imposing sanctions
- a system for financing the relatively high costs of the regulatory regime

Recognition of existing rights is a common approach that is easiest to put into place when land ownership is clear, but if this still requires individual registration and regulation, it will scarcely reduce the administrative burden.

Patterns of groundwater rights had emerged in all the countries studied. These rights were usually based on the law of capture; that is, people acquired a right to the groundwater by drilling on their own land. These rights were locally recognized in Tanzania where, in some cases, traditional patterns of cooperation over water were established, such as local water rotations and user groups (Sokilea and van Koppen, 2004). Essentially, these groundwater rights are determined by land ownership. Thus, determining who owns the land is a shortcut for determining water rights. However, in many parts of the world, forms of communal tenure, leasehold or sharecropping blur this easy route to attribution.

Key in determining whether to go through the registration and regulation route is whether it is administratively feasible and affordable. Governments need to assess the feasibility and the transaction costs of implementing such a policy where many smallholders are concerned, and weigh the feasibility and the costs against the importance of the policy objective.

Systems based on top down regulations have often run into problems of compliance (see Chapter 3). This is the case, for example, in South Africa where the level of compliance with existing regulations is relatively low. On the regulator's side, there was not enough capacity to monitor compliance or to follow up on infractions, and perhaps there also was a lack of political will to impose penalties. On the side of the well owner or water user, there was little or no acceptance of the regulatory regime and hence no incentive to comply.

Licensing systems essentially create entitlements, which may lead to contentious claims and even steeper administrative challenges.

A system of licenses confers entitlement and responsibility. The government may wish to manage the risks involved by for example, by issuing licenses only for a specific period, or establishing provisions for a progressive reduction of water abstractions, or limiting use to certain crops, or establishing requirements for downward variation in case of drought. However, from the government's perspective, these kinds of specific entitlements and responsibilities place enormous burdens on under-resourced departments. In addition, once entitlements are formally granted, they may be contested and result in legal proceedings (Van Koppen, 2010).

In addition, a rights and regulation system may run the risk of regularizing inequity or even increase it.

The process of establishing rights through an administrative and legal system requires a level of sophistication, time and access to information that few small farmers have. Given that the procedures are the same for larger or smaller users, the smaller users (who have fewer resources) are discriminated against. One solution might be to exempt small users from registration, either for equity or for efficiency reasons, but it is unclear how they can be protected against encroachment. In fact, there is always a risk that the more powerful will be able to appropriate an increasing share of de facto groundwater rights simply because they can drill more and deeper wells, and it is unlikely that a formal rights system would offer much protection in practice. Van Koppen (2010) shows that inequity *increased* with the increasing formalization of the water economy in Sub-Saharan Africa (Volta and Limpopo basins).

Options

In Yemen, for example, groundwater resources were captured by the better off, and traditional governance set-ups could not cope with the challenges of the tubewell. The government's initial response was to introduce a rights and regulation regime, but experience over the years has shown that the administrative capacity, political will and stakeholder willingness to comply that are needed to make this a viable approach are lacking. Not surprisingly, results on the ground are hard to find (Box 17). *The lessons are twofold: first, persistence is vital; and second, governance approaches need to be adjusted to* *reflect experience.* In the case of Yemen, this is leading to a shift away from a rights and regulation approach to one more based on changing the incentive structure (by raising the price of diesel), and on subsidiarity and partnerships between local collective management organizations and decentralized public agencies.

When Might Rights and Regulatory Approaches Be Most Appropriate?

Registration through permits or licenses is an appropriate approach for larger users or the more formalized sectors, but other approaches may be a cheaper and more equitable solution where small-scale users are involved.

Box 17. Reform in Yemen

The policy and legal systems reforms undertaken in Yemen are excellent on paper, but the negligible impacts to date show that top-down prescriptions may work better if they are matched with local collective management.

The political economy of water in Yemen had allowed groundwater resources to be captured by farmers, particularly the more powerful ones, who drilled wells and abstracted water at will. Traditional governance systems could not adapt to the changing situation and conflicts over increasingly exhausted resources grew. Both groundwater quality and quantity declined and costs increased.

In 1996, the government set up the National Water Resources Authority and charged it with issuing and regulating groundwater rights. This weak and under-resourced agency proved incapable of so daunting a task. As a result, wells proliferated and water tables continued to plummet. The government has amended its strategy, which now provides for the following:

- A decentralized management and stakeholder partnership approach, where the underlying hypothesis is that decentralization and promotion of community self-management will improve governance and help reduce resource capture and overdraft.
- Revision of the economic incentive structure for groundwater use, where the underlying hypothesis is that these measures will reduce incentives to over-pumping, enabling farmers to reduce water use while maintaining or even improving their incomes.

The new approach is having some success. Community organizations and user groups are coming together to stop illegal drilling, prohibit water transfers outside the community, protect drinking water sources, invest in recharge infrastructure, and improve irrigation and crop husbandry. Some success in getting "more income for fewer drops" is evident.

Source: Ward et al., 2007

For example, in Saudi Arabia, groundwater abstraction for farming is basically unregulated, but the more formal industrial and oil sector users are the subject of an efficient licensing and monitoring system. It is proposed to extend this approach to larger company farms, which number only a few dozen but account for one quarter of total water use.

Experience shows that where large numbers of small users are involved, incentives and subsidiarity approaches may be the most indicated, particularly collective management approaches. In some cases, the rights and regulation approach may be applied only to larger users, and responsibility for management among small-scale users might be delegated to collective governance arrangements, with informal water rights recognized. However, in this case, the regulatory system will have to ensure that the rights of small users are protected against encroachment from large-scale users. Collective management may empower the small users to defend their rights.

Using the Incentive Structure

A second approach to changing groundwater behavior is to change the incentive structure.

The purpose of this approach is to align incentives; that is, to put in place incentives for pumpers to align their behavior with the government's policy objectives. Essentially, the changes open to governments are: (i) adjustments to input and output prices to affect the profitability of water use (especially in agriculture); (ii) subsidies to encourage specific abstraction and water use behavior; (iii) bans to discourage undesirable behavior; and (iv) facilitation of water markets to align the financial returns a well owner can obtain with the scarcity value of the groundwater in other uses.

Working through the incentive structure is generally attractive to governments because they often control the parameters involved (trade policy, agricultural policy, energy pricing). In addition, the administrative costs are low or zero and the impacts can be swift and considerable. The main disadvantage is that incentives are blunt instruments that can have many unintended or secondary effects. Moreover, behavior responses may turn out to be different from or even the opposite of what was intended.

Table 4 gives some indications of the options available and of some of the advantages and disadvantages, which will help in determining when incentives may be appropriate ways to influence pumping behavior.

The introduction of regulated water markets is an appealing option for a number of reasons.

- It can facilitate the allocation of groundwater to its highest value economic use. Typically, the transfer would be out of agricultural uses (which normally return the lowest income per drop) to municipal and industrial uses (which have the highest value).
- It provides incentives to a well owner to transfer water to higher value uses by raising the return per drop towards the opportunity cost.
- The government can more easily regulate traded water, as it must be conveyed by tanker or pipeline, and it can thus require compliance, for example with: (i) limits on total abstraction through metering and inspection; (ii) control of prices; and (iii) public health requirements.

Table 4. The Pros and Cons of Options for Changing Pumping Behavior through the Incentive Structure

<table>
<tr><th>Options for adjusting incentives</th><th>Pros</th><th>Cons</th></tr>
<tr><td>Adjusting input prices influenced by government e.g. energy, fertilizer, seeds etc.</td><td rowspan="2">Within government power

Easy to administer

Immediate and universal impact

May generate fiscal revenue</td><td rowspan="2">Affects all sectors using the input (especially energy)

Raises consumer prices

Reduces farm incomes

May produce unintended effects*

May be inequitable (e.g. loss of employment)</td></tr>
<tr><td>Adjusting output prices influenced by government e.g. trade controls, cropping pattern controls, crop bans, taxes, official procurement prices</td></tr>
<tr><td>Subsidizing specific behaviors such as more efficient irrigation (drip, greenhouses, etc.)</td><td>Can increase farmers' incomes while reducing water use (more income per less drop)

Positive impact on GDP</td><td>Can be hard to administer

Can be expensive

Open to inequity and corruption

Does not necessarily reduce water use (Jevons paradox)**</td></tr>
<tr><td>Bans on specific irrigation techniques</td><td>May be easy to implement (e.g. ban on center pivot)

May resolve a large part of the problem quickly</td><td>May be hard to implement (e.g. banning flood irrigation)

Direct impact on the value of farmer assets and incomes</td></tr>
<tr><td>Facilitating regulated water markets</td><td>Allows transfer to higher value uses

Profit incentive to comply

Relatively easy to regulate</td><td>Limited to wells near settlements

High cost of transporting the water

May be inequitable</td></tr>
</table>

* For example, raising diesel prices in Yemen led to a shift in farm crops from growing grapes and cereals to the production of the soft drug *qat*, as this was the crop that returned the highest income per drop.

** Jevon's paradox states that if the use of an input is made more efficient, using it is more profitable, so *more* of it will get used.

However, many constraints limit the development of such markets.

- Water is very bulky and expensive to transport so the option only applies in the peri-urban hinterland.
- Pipeline conveyance is not usually economic because of the likely small volumes involved. As a result, transport is done by tanker, which is very much more inefficient in terms of cost.
- Although groundwater is usually individually appropriated, it has common resource characteristics that are inconsistent with all the revenue going to one well owner

Such markets do exist in many countries, usually informally, and for the tanker trade. Attempts to formalize these markets have been made in Jordan. In Yemen, rural to urban water sales by user associations have been piloted.

Other forms of incentives may be devised, depending on the nature of the problem. For example, payments for environmental services (PES) or an ambient tax or subsidy may be imposed.

Negotiated solutions for groundwater protection, such as payment for environmental services (PES), have been shown to be less expensive compared to top-down regulatory solutions. Another possibility is the ambient tax or subsidy, which penalizes or rewards a community if, say, the level of aquifer drawdown is greater or less than an agreed target (see Box 18).

Box 18. Adjusting Incentives for Groundwater Management in the Absence of Information on Individual Groundwater Use

There are multiple examples of cases where effective groundwater management has been implemented without needing to measure the behavior of individual wells.

In India, regulation, water pricing or property right reforms are unlikely to reduce groundwater extraction because of the logistical problems of regulating a large number of small, dispersed users. However, *electricity supply and pricing policy* offers a powerful toolkit for indirect management of both groundwater and energy use. In France's Seine-Normandy river basin district, groundwater use for agriculture is not metered, instead fixed charges per hectare are levied.

Another viable incentive is the *ambient tax* or *ambient subsidy*. It is especially appropriate to groundwater in cases where it is virtually impossible to meter and monitor individual wells. An ambient tax on groundwater could be applied at the community or aquifer against an observed variable (for example the groundwater level or the pollution level) that is affected by individual but not observable decisions (withdrawals, or non-point source pollution). The collective tax (or subsidies) is applied if the variable is above (or below) a specified target.

Ambient taxes have been studied theoretically but not yet applied in the groundwater sector. Some field experiments on biodiversity conservation in Ethiopia show that the high collective tax is an efficient and relatively reliable mechanism to solve the problem of excess exploitation of an open-access common pool resource.

Source: India case study report; Acteon, 2009; Segerson, 1988; Giordana & Montgimoul, 2006; Reichhuber et al., 2009; Also see Annex 4.

Subsidiarity

Subsidiarity (water management at the level of the lowest feasible hydrological unit) is particularly appropriate for groundwater.

Subsidiarity delegates responsibility for management to the lowest feasible level. The nature of groundwater and the way in which it has been developed to date may make local management highly indicated. This is because groundwater resources management is made up of the behavior of numerous individual wells, all of which share common resources. Changing management requires changing the behavior of all wells, and this is most easily done at the aquifer level and below where the wells are few enough that they can be regulated as a group within a discrete hydrological unit.

Subsidiarity does not necessarily mean collective management, but there can be advantages to collective management approaches.

Local branches of ministries or agencies may be close enough to the ground to impose regulation. However, frequently the conditions of capacity and of respect for regulation are not in place. Under these circumstances, there are good reasons why the option of extending subsidiarity to local collective action may be considered. This would allow all the strengths of community management to be mobilized (knowledge, the incentives of self-interest and ownership, accepted patterns of water rights, social and institutional capital, and so on) in areas where water users are few enough that they can agree on self-regulation and where each pumper can see the benefits.

There are many examples where subsidiarity and collective management have proved superior to regulatory approaches, often in partnership between local government agencies and user groups.

The case studies provide a number of examples where local collective management produced good outcomes. In addition, the federal government in Mexico attempted to regulate groundwater abstraction, but they were unable to implement the policy for reasons that included inadequate operational resources, a failure to mobilize user cooperation, and an inability to enforce rules consistently. Instead, the Mexican government decided to support groundwater users associations. In Peru, the government issued water permits to user groups rather than individuals because of similar capacity constraints (Box 19).

Box 19. Water Rights in Peru

In 2004, Peru initiated the PROFODUA (Program for the Formalization of Water Use Rights) program to formalize water use rights. The program has an innovative approach, using water blocks (*bloques de riego*) and issuing individual or communal water licenses or so-called *licencias de agua* (permanent water rights for irrigated areas). The program was initially implemented in coastal regions of Peru and was developed gradually in close coordination with user organizations.

Through the approach based on water blocks, the program has issued an impressive number of new agricultural water licenses (more than 300,000), although many remain to be granted (there are 800,000 farms in the Pacific watershed alone). By issuing bulk rights to water user groups and helping them manage their individual user rights, the program was accelerated and institutional capacity constraints did not become limiting. Rights to use surface water and groundwater were issued in a coordinated manner, since both sources are closely linked in the coastal valleys of Peru.

Source: Vidal, 2010; Guerro Salazar, 2009.

Choosing Governance Approaches

Each situation may require a different approach or a mix of approaches.

Table 5 gives an overview of the conditions necessary to each of the three approaches assessed in this section, together with an indication of which approach might be the most effective under the prevailing conditions. The lessons from Table 5 are that:

- there is no “one size to fit all,” and approaches need to be selected in the light of local conditions and experience
- rights and regulation systems are the most apt to achieve policy objectives, but they are also far and away the most demanding and difficult
- a mix of approaches is likely to be the best way forward in most country situations

Determining the correct balance between governance options may take time and it is crucial to keep the options under review. There needs to be a mechanism for monitoring and evaluating the effectiveness of the measures deployed and for evaluating the transaction costs in relation to results. This process of evaluation can drive a joint learning experience involving all stakeholders, as well as procedures for incorporating lessons through adjustments to policies and to the governance framework. Pilot programs are a good way to test governance options. Groundwater projects may provide a good opportunity to test mechanisms for better management by, for example, piloting partnerships between collective management groups and government agencies.

Table 5. Governance Approaches to Groundwater

Requirements	Which approach may be the most effective?		
	Rights and regulation	Incentive structure	Subsidiarity
Is there a legal framework of rights and regulatory instruments that is adapted to the situation and which is implementable? If yes…	✓		
Is there a pattern of groundwater users complying with authority? If yes…	✓		
Is the approach administratively simple and low cost?	✓	✓	✓
Is there strong social capital and/or a history of agreed water rights and collective management at the local level. If yes…		✓	✓
Is inter-sectoral water transfer an objective? If yes…	✓		
Is there a serious depletion problem? If yes…			✓
Is there a serious pollution or recharge problem? If yes…	✓		✓

Changes to the governance approach can be made as experiences yield their lessons. In Yemen, for example, the 2003 Water Law and the 2004 National Water Strategy (NWSSIP) established the nation's groundwater policy and strategy. In 2008, an exhaustive participatory evaluation of the results was carried out that resulted in proposed revisions to the water strategy. The revisions were debated and agreed to in 2009 and the Water Law was amended to reflect the changes. Essentially, the changes put much more emphasis on collective management and local partnership approaches and much less on attempts at top-down regulation (which had proved largely fruitless).

Adapting Approaches to Implementation Capacity

When one of the main problems facing implementation is the issue of capacity, priority can be given to managing those aquifers that at risk (because of water quality and quantity) and to regulating the main users. For example, the analysis of water users in the Limpopo and Volga basins revealed that the few, often corporate, formal urban and rural users, accounted by far for the largest share of water resources, while the many small-scale farmers only used a tiny fraction of the nation's water resources. Capacity constraints mean that, in practice, governments can only regulate the larger operators through, say, a system of permits. The permit system can also be used to collect water resource fees or other charges (Van Koppen, 2010). This is the approach used in Saudi Arabia, where the unlicensed farm wells pay nothing, but the licensed industrial and oil sector enterprises pay a hefty resource charge.

Ensuring Equity

Fundamental to all groundwater governance is the allocation of water rights and how they are to be administered and protected. Rights and regulation approaches can ensure the protection of existing rights and can also provide a framework for secure transfer of rights, for example in water markets or in negotiated and compensated cession of water rights by farmers to a municipal water supply utility. However, the many constraints to implementing a full rights and regulation system mean that, in practice, most rights will have less formal protection and, as a result, they may be less secure and less tradable (Huntjens et al., 2012; Lebel et al., 2009a). *If a rights and regulation approach cannot be fully implemented, there may be risks to the water rights of others and water transfers or markets may be more difficult to implement.*

Collective management institutions may be able to protect rights and even enter into contracts for water transfers. However, this can only take place if the governance system is able to support such institutions. Based on analysis of water governance systems in the Netherlands, Australia and South Africa, Huntjens et al. (2012) argue that strong water user groups should be able to establish and protect water rights. Pilot programs in Yemen have shown that it is possible for water user associations to agree on rules for water transfer, including selling water to municipal utilities. If, as is likely, countries adopt a mix of rights and regulation and collective management approaches, the legal framework and the governance system need to protect less formal water rights and allow their transfer.

Information, Knowledge and Communications

Information, knowledge and communications are essential components of good groundwater governance. Groundwater management is a knowledge-based activity in which outcomes improve in direct relation to the coverage and quality of data. Knowledge is an essential input to planning for groundwater and to the design of appropriate governance systems. The communication of knowledge to all stakeholders is an essential guarantee of the accountability of sector institutions, and is the key catalyst of stakeholder participation and beneficial social change. For these reasons, countries have invested considerably in groundwater resource assessments and information systems, in using the results for planning and management, and in communicating results to policy makers, stakeholders and managers (see Box 20).

Typical Impediments to Data Collection

Information on groundwater resources is key for decision making in the sector. However, the lack of adequate data and appropriate information systems remain major constraint in many countries. The cases studied highlight several challenges to the collection, analysis and dissemination of information, including: high costs, the large number and diversity of users, little understanding of uses and user behavior, and lack of capacity and skills.

The collection of information on groundwater is costly. Describing the structure of the geological layers and their hydraulic characteristics requires expensive specific studies to assess the complexity of three-dimensional groundwater systems. The case studies in Chapter 3 show that at least some information on aquifers is often available in areas where groundwater is already being used. However, detailed information on groundwater balance and on sustainable yields is often lacking, due to several constraints:

Box 20. Assessing Groundwater Balance in India

In India, the Central Ground Water Board carries out a systematic annual joint exercise with the state governments to assess the groundwater balance in the nearly 6,000 groundwater blocks. The blocks (areas of around 100 villages) are categorized according to the stage of their groundwater development from white (underdeveloped) to dark (critical and overexploited blocks where known groundwater resources have been fully or overdeveloped). Groundwater use is expressed as the annual groundwater draft as a percentage of net annual groundwater availability. The list of overexploited, critical and semi-critical blocks is circulated to the State Pollution Control Boards and the Ministry of Environment and Forests. Those agencies also refer new industries/projects to the Central Ground Water Authority (CGWA) for obtaining clearance for groundwater withdrawal.

This has been an essential tool in mapping groundwater conditions in India and creating awareness among decision makers. One limitation of this exercise is that the units used for the groundwater assessment are administrative units, mostly at the sub district level, without any link to physical or aquifer boundaries.

Source: India Case Study Report.

- Understanding groundwater dynamics involves a continuous monitoring to capture inter- and intra-annual variations of groundwater levels, and this requires the significant allocation of human and financial resources.
- Elements of the groundwater budget (such as recharge, irrigation return, and exchanges with surface water or with other aquifers) might be difficult to assess because they are variable in space and time.
- A further problem is that, even when information is available, it is often difficult to interpret. Even the concept of a safe or sustainable yield is controversial and requires a clear definition between

practitioners when discussing groundwater management objectives (You, 2009). Overall, the general inadequacy of monitoring and evaluation stems in large part from a lack of incentives for stakeholders to expend financial and human resources on something that may only reap rewards in the longer term.

The large number and diversity of users make it difficult to collect data on groundwater use and users. In India, for example, there is no systematic registering of wells and gathering data about millions of private well owners is impossible (Garduño et al., 2011).

Third, even if there is adequate information about the resource, there is usually too little understanding of uses and user behavior to develop adapted governance arrangements. Simply understanding groundwater resource dynamics does not explain *why* changes are taking place, or how those changes may evolve. Yet, that information is essential to defining governance and management arrangements. Insufficient effort has been made to collect information on groundwater use and on the socioeconomic characteristics of users in order to adapt governance arrangements.

Groundwater management thus requires knowledge of users and their objectives. Knowing the users, and taking into account the local incentives framework as well as the opinions, interests, perceptions and willingness to change of stakeholders are therefore vital to creating a groundwater governance solution. Also important is understanding how groundwater use is embedded in the local political and economic context. Knowledge (or its lack) may also groundwater use. For example, groundwater is often thought of as an inexhaustible private resource, which makes users loath to reduce pumping..

There is lack of capacity and of the interdisciplinary team skills (including sociological skills) needed to collect and analyze information about groundwater. The case studies in Chapter 3 show that human resources are often lacking, and that specific attention should be paid to attract and retain experts. With the growing importance of participation and collective action in groundwater management, social expertise will increasingly be needed to promote constructive dialogue between engineers, social scientists, environmentalists and economists within government agencies. Tools used to implement integrated water resource management, such as encouraging multi-disciplinary training for practitioners (GWP 2008), could be used to help address this issue.[29]

Impediments to Turning Information into Knowledge

Once information is collected *it has to be standardized and transformed into knowledge* to be useful for management purposes. Evidence from case studies indicated that the allocation of financial and human resource to facilitate this is limited. This lack of resources, in turn, limits the decision support tools available. For example, in Tanzania the problem is the very limited sharing of data on groundwater, which also limits data analysis. To remedy this situation, the use of computerized systems and the standardization of formats are recommended. The problem in South Africa is that groundwater database or information systems are maintained by different institutions (including the private sector). This hinders compatibility and the inter-agency exchange of data. Of the five countries studies, only Morocco has a decision support systems based on groundwater models that are used by managers.

[29] GWP 2008. Toolbox for Integrated water resources management website. Available at http://www.gwptoolbox.org/index.php

Impediments to Communications

Once the information is collected and transformed into knowledge, the next crucial step is to communicate it effectively to foster the participation of relevant stakeholders. However, evidence shows significant gaps in communication capacity that has constrained participation at all levels.

Moreover, there is also weakness in the effectiveness with which the results of data collection and knowledge are communicated to stakeholders (both users and polluters). Although the dissemination of information is vital to promoting transparency and helps to build understanding and support from the community, there is a generally low level of public awareness about groundwater. A recent review of IWRM in Africa (AMCOW, 2012) cites “low levels of awareness among different stakeholders” as the third most frequent constraint to IWRM development. For example, despite having one of the best monitoring systems among the countries studied, along with the key expertise to analyze the data and develop hydrogeological models, efforts in Morocco are thwarted by a lack of effectiveness in the communication of information. A 2007 survey (JICA, 2007) in the Haouz aquifer area revealed that few farmers had any knowledge of the regulations concerning abstraction permits, drilling of wells, or installation of meters, and that only 15 percent of farmers believed it necessary to conserve water. Despite improved platforms for data availability (such as the Internet), without dissemination campaigns or user participation in groundwater monitoring, communication to users may still be limited.

The problem is often compounded a lack of willingness on the part of the government to share information publicly. This may be linked to centralizing governance arrangements, or to reticence about stakeholder involvement and participatory approaches. Conversely, such historical legacies can also lead to a lack of trust by local communities of higher level institutions.

The unwillingness to share information is often exacerbated in the case of transboundary aquifers due to the reluctance of national governments to exchange data and information with their counterpart administrations because of strategic considerations. Saudi Arabia is an example of a nation where groundwater is of utmost importance, and despite comprehensive hydrogeological and monitoring records of many systems, the information is not shared beyond national boundaries. Yet, in the context of transboundary groundwater systems, information exchange between countries is a first step towards effective management. The need to start working towards practical and effective transboundary agreements for groundwater governance between countries is emphasized by AMCOW (2012), which found at least 38 major transboundary aquifers in Africa, occupying 64 percent of the total land area.

Options for Removing Impediments

Overcoming Barriers to Information Collection and Management

Countries need to invest in improving their knowledge of the physical characteristics of aquifers, and in the continuous monitoring of groundwater quantity, quality and uses. Case study countries, especially South Africa and Morocco, have already undertaken significant measures to improve information on aquifers and establish a monitoring network. Already overused aquifers should be given priority, particularly where stresses are apparent. Future groundwater development projects should establish a viable information collection, storage, analysis and reporting system, paying special attention to how the system will be financed once project implementation is complete.

To lower costs and improve communication with users, India has carried out experiments with participatory monitoring of groundwater. The results have been promising in term of providing farmers with the necessary knowledge, data, and skills to understand and manage groundwater resources without offering any cash incentives or subsidies. Another interesting experience has been observed in South Africa where, to improve data collection and communication, the government developed a nation-wide system of scores to monitor the status of water quality management (drinking water and wastewater, Box 21). Collecting and communicating information in this way ensures accountability of water service providers to the users. To date the program has already resulted in significant improvements in the provision of water services for domestic supply.

Box 21. Monitoring Water Quality and Communicating Results in South Africa

In 2008, South Africa's Department of Water Affairs (DWA) introduced a nation-wide incentive based regulation process to monitor the status of drinking water quality (DWQ) management (the "blue drop system"), and wastewater quality (WWQ) management (the "green drop system"). The aim was to improve the operation and functioning of water services institutions. A so-called drop score is calculated based on a weighted set of criteria and the results are published in DWA blue and green drop reports, and on the DWA web-site (www.DWAF.gov.za) which is open to the public. The blue drop score for DWQ management, for example, is based on the following set of criteria (percent weighting appears in parenthesis):

- Water safety plan (5 percent)
- Process control and maintenance competency (10 percent)
- Efficiency of drinking water quality monitoring program (15 percent)
- Credibility of sample analysis (5 percent)
- Regular submission of DWQ data to DWA (5 percent)
- Drinking water compliance with the South African National Standards (SANS 241) (30 percent)
- DWQ failure response management (15 percent)
- Responsible publication of DWA asset management (5 percent)
- Efficacy of basic DWQ asset management (10 percent)

Once a water services authority scores higher than 95 percent it receives a blue drop status. For the green drop status the score has to be higher than 90 percent. Blue or green drop status will allow consumers to drink water from the taps in the town with confidence, and be secure in the knowledge that wastewater is managed and discharged in a sustainable, environmentally-acceptable manner.

Source: Pietersen et al, 2011.

A number of innovative approaches have been developed with the advent of satellite and aircraft borne sensors. For example, evapotranspiration from crops can be estimated using remote sensing data using algorithms that have been developed over many years (Kalma et al., 2008). Groundwater use can then be estimated if surface water use is known. This method is applied in China to manage groundwater use for irrigation. The technology provides a cost-effective solution to monitoring groundwater use of large number of users. In the China case, a basin-wide application of remote sensing evapotranspiration measuring technology was introduced in the Hai Basin to limit groundwater overdraft and control quotas of groundwater consumed by irrigation (World Bank, 2011, see Box 15).

Another interesting example is the GRACE satellite system, which measures changes in groundwater volumes at a regional scale using extremely sensitive gravity anomaly satellites (Becker, 2006). While the spatial scale currently limits its operational relevance, this technique opens up a path for future applications. Lastly, airborne geophysical methods allow groundwater salinity to be mapped from an airplane. This has been used to locate land salinization across broad areas of Australia and could be used to help monitor progress of salt water intrusion in coastal aquifers. While all these parameters can be obtained through traditional ground-based methods, remote sensing approaches provide coverage of large areas at a fraction of the cost of traditional methods.

Knowing the Users and Their Interactions

Information on groundwater uses and the socioeconomic characteristics of the direct and indirect users of the resource should be considered carefully by decision makers when formulating public policies. The number of users is but one of the important facts to take into account. Also important are current property rights, existing informal arrangements between users, their perception of the resources, and their willingness to change. Collecting and analyzing this type of information requires specific capacity that could be enhanced by setting up multidisciplinary teams that include social scientists.

Regulation or subsidy programs can be useful in establishing a systematic knowledge system. Licensing wells and providing groundwater use rights is often a first step toward improving policy makers' understanding of groundwater users. For groundwater that is not yet being exploited, new wells can be registered through agreements with drilling companies. The task of obtaining information is more challenging in the case of groundwater that is already being exploited. A possible mechanism to gather information on these users is to award grants and provide access to funding with the condition that recipients must provide information on their wells and groundwater use. Crop subsidies are used for this purpose in the Beauce area in France (see Annex 4).

Another way of generating knowledge is to enter into partnerships with local collective management institutions. Entering into partnerships with local formal or informal institutions is another information gathering option. These partnerships could, for example, be used to monitor abstractions or to inventory wells. This can be part of the collective management approaches described in Chapter 6.

Monitoring and Evaluating Groundwater Management Measures

The information system should also include monitoring and evaluation of the outcomes and impacts of policy and of the performance of the governance system. Accountability and performance efficiency are only possible if performance is regularly measured against the agreed standards and poor performance is penalized. This requires well-functioning systems for monitoring and evaluation, particularly because policy evaluation may require long-term monitoring. For example, experience in Europe shows that the physical complexity of agriculture's impact on groundwater makes the evaluation of agro-environmental measures (whose aim is to reduce non-point agricultural pollution of groundwater) a difficult long-term process (OECD, 2010).

Facilitating Communication and Participation

Communication can foster participatory approaches and serve as a catalyst for social change. "Water governance is as much about the art of social change as it is about the science of hydrology" (Currie-Alder et al., 2006). Improved communication may help facilitate participation and social change, particularly by sharing knowledge to increase the society's understanding of invisible groundwater resources, and improving the accountability of institutions responsible for groundwater management.

To promote transparency, communication strategies should be based on: (i) *disclosure* of information; (ii) *demystification* (strengthening the level of awareness and understanding); and (iii) *dissemination* to the public (World Bank, nd). Mechanisms promoting transparency for groundwater-related schemes may include: posting physical information (water levels, abstraction volumes) in newspapers and on community bulletin boards; explaining groundwater-related financial budgets to the community; opening contracting arrangements, reports and decision-making to public scrutiny; publishing performance and annual reports from local governments and regulators by using the media[30] or community radio; and organizing public hearings where stakeholders can share claims, problems, and reach reasonable solutions (Cotlear, 2009). Additionally, the Africa IWRM report (AMCOW, 2012) recommends the establishment of a "good practices guide" to facilitate sharing of water-related knowledge among stakeholders in order to promote capacity development, transparency and cooperation.

More generally, transparency and dialogue strengthen governance and improve outcomes. Multi-stakeholder dialogues, including social learning processes, negotiation and co-production of knowledge are crucial for effective and legitimate water governance and are cross-cutting many of the design propositions discussed in this report. Lebel et al. (2009b) define multi-stakeholder dialogues as "events at which different stakeholders openly engage in facilitated, informed, deliberations." The purposes (and values) of these dialogues are: (i) to reduce conflicts and explore synergies; (ii) explore alternatives; and (iii) shape and inform negotiations and decisions (Lebel et al., 2009b). During these exchanges of ideas it is important to produce outcomes that are directly relevant for planning and decision making. Stakeholders should be involved in analyzing and synthesizing project and process outcomes as well as identifying best practices for governance and implementation (Huntjens et al., 2012).

When Things Go Wrong: Conflict and Conflict Resolution

In the early stages of the modern groundwater revolution, there was little or no "conflict because groundwater extracted by tubewell was a new and abundant resource." The right of individuals to drill boreholes on their own land was accepted. This situation is now changing. Over time, the resource has been depleted and many people are aware that a neighbor's borehole or pumping behavior affects them as well as others. In some cases, the cone of depression of the sinking water table has spread over hundreds of kilometers, resulting in additional costs for deepening wells and pumping from increasing depths. Moreover, some sources have dried up. This creates potential for dispute, and there have been cases of violent conflict (for example in Yemen and Iran). Yet, conflicts over groundwater have been

[30] A free and open media should be encouraged where possible.

much less than those over surface water. This is for several reasons inherent in the nature of the resource and the way in which it is exploited:

Even if negative changes are occurring, they are relatively slow to emerge and supply remains predictable, so there is no decisive moment that might provoke conflict as would be the case, say, of the upstream diversion of a water course.

Groundwater is individualized, and there is no necessary involvement of any third party that may cause dispute unlike, for example, disputes over turns at a surface water canal.

Groundwater is invisible, so that disputable changes in the system are hard to spot even for a hydrogeologist unlike, for example, a dried-up oasis.

There is no apparent symmetry of cause and effect because it is hard to link one individual's behavior to the long-term decline of a vast underground water body. This is not the case of, say, the construction of a dam upstream.

Nonetheless there are many potential sources of conflict over groundwater. Moreover, these conflicts are multiplying as over-exploitation of groundwater resources results in declining water levels, and as water quality declines through contamination and salinization. The case studies identified seven different types of conflict related to groundwater management:

- Conflict due to groundwater pollution (e.g. in Kerala State, India, where Coca Cola Beverages Company had to compensate the local community for over-exploiting groundwater resources and discharging pollutants into the water).
- Conflict due to groundwater over-abstraction (for example in Yemen, see Box 22).
- Conflicts between countries, and within countries, over access to shared groundwater resources (see Box 23).
- Inter-sectoral / inter-basin conflicts (e.g. in Tanzania).
- Conflict regarding roles and responsibilities (e.g. in Kenya).
- Conflicting land uses, for example in Tanzania, land use planning rarely considers groundwater resources potential, and it is common to find encroachment and land uses that limit recharge in aquifer rich areas where groundwater could have been exploited.
- Conflict between farmers and public agencies over regulation as is the case of over abstraction fees in Morocco.

Box 22. Conflicts Resulting from Groundwater Over-abstraction in Yemen's Wadi Bani Khawlan

The upper part of Wadi Bani Khawlan in Yemen's Ta'iz Governorate is covered with crops and lush fruit trees that are irrigated from tubewells. The lower area of the wadi, once also a rich agricultural zone, is now desolate with dry wells dotting the fields. In some areas, pipes still cross the ground ready to transport water to waiting fields, should water somehow return to the wells. In most areas, however, the pipes have been removed and sold since they no longer serve any purpose. Where wells still operate in the lower wadi (mostly at points at which minor side wadis enter the main one), women wait for 6 to 7 hours daily to fill up plastic containers of water for domestic use. Protest and armed confrontation proved useless to stop the upstreamers from drilling ever more wells since those living upstream were stronger. Now most men from the lower wadi have migrated in search of work, joining a disaffected population in the slums of Taiz. A few remain, spending their time and remittance money in the small dusty stores that are remnants of more prosperous days in the valley.

Source: Moench, 1997in Ward & Al-Aulaqi, 2008.

The Changing Institutional Context, Power Relations and the Intensification of Conflict

New tubewell technology and the rapid over-development of resources have produced a pattern of inequitable access to groundwater. Asymmetrical power has led to asymmetrical access to water. Water "flows uphill to money and power" (Reisner, 1993), and the political economy of many groundwater-dependent countries (such as those of the Middle East) does not provide for the accountability mechanisms or educated participation in decision making that would promote more equitable outcomes. Restricted access to land also limits access to water. This takes place, for instance, through the increased privatization of public or endowment land by powerful interests at the expense of poor and vulnerable groups (such as the rural or landless poor).

Climate change is introducing costs and risks that are hard to manage, including increased demand for groundwater and reduced recharge, with consequent heightened risk of conflict. In the Middle East, for example, which is highly dependent on groundwater, high variability and low means in rainfall, exacerbated by climate change, have led to unpredictable declining water resources, variations in supply, and increased disasters (such as floods, drought, etc.). The prospect of further climate change is likely to exacerbate these stresses. According to the Intergovernmental Panel on Climate Change, a precipitation decrease of over 20 percent can be expected over the next century for large parts of the Middle East and North Africa. Also predicted is a likely increase in the frequency and severity of droughts and a reduction in groundwater recharge rates. On the demand side, declining water availability and rising demand is likely to place ever greater stress on already over-exploited groundwater resources and lead to greater risks of conflict (World Bank, 2007; CEDARE:6).

The development of transboundary aquifers may be inequitable and lead to disputes. Emerging nations have begun to assert rights to shared transboundary aquifers, while more powerful nations have developed the resource unilaterally without any comprehensive agreement on benefit-sharing. As mentioned, disputes have already emerged over the Nubian Sandstone Aquifer and the Disi Aquifer.

Box 23. Conflict, Adaptive Capacity and a Shifting Equilibrium in Yemen's Wadi Dahr

Yemen has an age-old history of water conflict and of subsequent accommodations to change. Wadi Dahr, close to Sana'a, had a long, well-documented history of managing its water resource. Rules had been agreed over centuries through an evolving process of conflict, contentious judgments, and ultimate development and acceptance of new rules that progressively crystallized into "established tradition."

In 1970, the tubewell burst into the finely balanced water economy of the wadi. A downstream community in the wadi complained to shaykh's court that upstream motor pumps had reduced the stream flow and disturbed "laws and customs…by which we have been guided for thousands of years."

This new conflict was resolved, but not by the courts. The rich and influential downstream farmers simply invested in the new pump technology themselves. "The stream dwindled and died, but no one with influence any longer cared." A new equilibrium emerged: assets were rebalanced and concentrated a little more in the hands of the richer. The conflict was resolved—even if not fairly—and a new "established tradition" emerged.

Source: Mundy, 1995.

Dispute Resolution Mechanisms Today

In many countries it is clear that traditional water governance systems, set up to deal with springs, qanats, run-off, spate flows or hand-dug shallow wells, have little capacity to deal with disputes over tubewells (see Box 23). Yet, some traditional systems are adapting. For example, many communities in Yemen have revived an old customary law on well spacing and increased the regulated distance between wells to up to one kilometer.

A few modern dispute resolution mechanisms are being set up, sometimes alongside the old, but with mixed results. In general, governments have not developed the flexible and participatory institutional mechanisms and accountability structures needed to respond to emerging groundwater conflicts. Where new systems of dispute resolution have been established, results have been mixed. In some cases, governments are introducing modern forms of dispute resolution but are unable to fully implement them. For example, the formal conflict resolution mechanism set up in Kenya has never heard a single case, whereas older traditional mechanisms continue to be effective, and modern user associations are also showing their ability to settle disputes (see Box 24). In some cases, these introduced forms of governance can undermine traditional governance systems, creating a hybrid system that can even increase conflict.

Solutions

Good governance capable of flexible and adaptive responses is the best way to solve disputes even before they start. A first approach is to ensure good water governance that will either prevent conflictual situations from emerging, or will have the adaptive capacity to change and to remove the cause of conflict. A good example of this is the evolution of a new water governance system in Western Australia to solve a conflictual situation between water resource management and water using sectors (Box 25).

Box 24. Modern and Traditional Dispute Resolution Systems in Kenya

The Kenyan government established the Water Appeals Board to help resolve a new generation of disputes. The Board, however, is barely active. Rampa (2011) found that "modern complaint and feedback mechanisms are extremely weak, often cumbersome and undermined by the informal arrangements so common in the sector. The formal mechanisms often do not work, and the Water Appeals Board, mandated to handle disputes in the water sector, has not heard any case since its establishment with the 2002 reforms."

By contrast, a number of Water Resources User Associations (WRUAs) in Kenya are reported to be effective in resolving water use conflicts, particularly in those catchments that are prone to water use conflicts. However, WRUAs are voluntary associations and therefore they are not uniformly spread across the country. Groundwater management WRUAs are rare, although two groundwater-specific WRUAs are being formed in the Tiwi and Gongoni areas in the Athi catchment; and three exist in the Tana catchment (at Lamu, Hindi and Mpeketoni/Lake Kenyatta).

Source: Rampa, 2011.

Dispute resolution mechanisms may be modern or traditional, centralized or local, the key criterion is that they be accepted as fair by all parties. As disputes will inevitably occur, it is essential to have in place mechanisms for conflict resolution that are accepted as fair by all parties. These may be traditional (such as that in Yemen, see Box 26) or modern. In situations where there is confidence in the judicial system, water courts are an option. Where principles of subsidiarity are being applied, modern water user associations may be formally or informally mandated to resolve disputes.

Box 25. Resolving Conflicts between Water Management and Water Using Sectors in Australia

In Western Australia, the roles of water service providers were separated from water resource managers in 1996. The objective of this change was to ensure that water resource management took into account all water needs and that allocations were not subjectively biased towards public water supply. This was a fundamental change to organization and human relationships that had required a long and painstaking participatory process to resolve. The process culminated in a series of water forums and the "Premier's Water Symposium" in 2002. The State Water Strategy, the establishment of a Ministerial Water Council, a new Office of Water Strategy in the Department of Premier and Cabinet, and the Premier taking responsibility for water were all important steps in resolving conflictual issues in water management in Western Australia.

Source: Huntjens et al., 2012.

Box 26. Traditional Resolution of Water Disputes in Yemen's Tribal Areas

In Yemen, resolution of water conflict in tribal areas follows a traditional pattern. In case the conflict has turned violent, which is common, any respected person (*modareek)* can call a cease fire. There is then a mediation process, often by the clan head (*aqil*)) or the head of the tribe (*sheikh*) to agree to the terms of a truce, and to broker an ultimate settlement. In case of legal technicalities, a tribal specialist of customary rights and duties (*maragha*) can be called in. His decision is final.

Source: Al-Shaybani, 2005.

Transboundary water management to resolve or avoid disputes can follow good practice that has been established in a number of river basins worldwide, including the Indus, Mekong and Nile basins. Only a few treaties and agreements address transboundary aquifers. On the basis of a survey of 400 freshwater treaties and agreements, about 15 percent were found to include provisions for groundwater (Jarvis 2006). Of the over 240 transboundary aquifer systems mapped across the world, only the Guaraní Aquifer System in South America (described in Chapter 3), the Nubian Sandstone Aquifer System in North Africa (described in Chapter 3), the Northwest Sahara Aquifer System, and the Lullemeden Aquifer System in Africa have embarked on cooperation.

Best practice in transboundary water management and conflict resolution seeks to achieve the goals of fair distribution of benefits, economic efficiency and environmental sustainability through agreement on some level of cooperation. Lessons on the process of negotiating cooperation on transboundary waters show that it is essential to act early, that time and stamina are needed, and that communications, transparency, and stakeholder inclusion are vital. Lessons on tackling the substantive cooperation issues show that there is a need to analyze the political economy and to form strategies to overcome opposition. A progressive and flexible institutional strategy is needed. Typically, the process proceeds in a sequence, working from technical cooperation towards institutional and political cooperation. This allows confidence and habits of joint work and cooperation to develop, while generating essential knowledge. The economic strategy should concentrate on sharing benefits rather than on sharing water. Here, early identification of one or two joint multi-purpose operations is helpful, as they could bring evident economic benefit.

6. THE ROLE OF PARTICIPATION AND LOCAL COLLECTIVE MANAGEMENT IN GOOD GROUNDWATER GOVERNANCE

Chapter 5 discussed subsidiarity (delegating water management to the lowest feasible level) as a governance approach particularly suited to groundwater. It also indicated that participation and local collective management can, under some circumstances, be the most effective approaches to good water governance, or at least play a key role in good governance. These approaches are particularly important because they may offer solutions to many of the challenges presented by other governance approaches. This chapter assesses in more detail the pros and cons of participation and local collective management as well as the options open to countries and stakeholders.

Why is Participation Particularly Appropriate in Groundwater Management?

Participation can improve outcomes because it increases stakeholder ownership. In addition, stakeholders often have access to information and can devise solutions better than or complementary to those delivered from the top down.

As outlined in Chapter 5, the basic rationale for factoring participation into groundwater governance is that the goal of aligning groundwater management at the local level with policy objectives requires changes in the behavior of all the wells in a groundwater management area. This means that it requires the cooperation of all the stakeholders who are pumping out the groundwater or benefitting from it. Essentially, groundwater management cannot work without taking into account stakeholders' information and perspectives and without their collaboration.

Stakeholder involvement and "buy-in" or ownership, is crucial for identifying acceptable trade-offs, for negotiating distributions of costs and benefits and for reaching consensus (Ashby, 2003). This form of ownership often needs to be established across a range of institutions and levels of decision-making (Martin and Sutherland, 2003).

A second reason for promoting stakeholders participation is that their involvement is key to coping with the complexities and uncertainties of groundwater governance. Stakeholders bring in a wider range of perspectives on needs, impacts and options, and deliberating them openly (Huntjens, 2011). Local well owners and groundwater users have knowledge about the technical characteristics, about how water is used and why, and about local governance institutions like water rights, collaborative management arrangements, water sharing agreements, provisions for sustainability such as well spacing rules, and so on.

Perhaps the most important aspect of participation is that it can align government objectives with those of the local people, so giving local stakeholders incentives for good groundwater management. Well owners and local groundwater users reasonably view groundwater as their resource, whatever the legal texts might say. They will also have their own objectives for the development and use of the resource. For example, they may place priority on maximizing household food self-sufficiency; increasing income from sales of cash crops; ensuring the village's potable water supply; maximizing groundwater abstraction before the resource runs out, and so on. These objectives may coincide with the government's policy objectives (e.g. sustainability, efficiency, equity) or, as is usually the case, they may be at odds with the "top down" view of how things should be done. Since each well owner is virtually sovereign over his or her pumping behavior, the government will never achieve its policy objectives unless they are aligned with those of the local population.

Participation can help to align objectives and empower local stakeholders in subsequent implementation by giving them influence over outcomes. This alignment of objectives is essential to providing the incentives to local stakeholders to manage groundwater well. Here the role of participation is twofold: informed exchanges to align objectives and collaboration in order to achieve those objectives. Evidently the scope for participation in local groundwater governance is vast.

Local collective management is also more likely to take account of the needs of future generations. In addition, participatory approaches, which empower local people by giving them influence over outcomes, may improve sustainability. If a well owner is convinced that changing pumping behavior will slow or halt resource depletion, he or she may well collaborate in collective groundwater management, taking account of the needs of his or her children.

The Range of Participatory Approaches

Experience shows a whole range of participatory approaches to groundwater management, from consultation to fully delegated groundwater management. Table 6 lists some of the main approaches in order of progression from top down to bottom up, and in sequence of increasing intensity of participation and empowerment of local stakeholders.

Clearly the level of participation will depend on the local context, with the need for skilled support increasing as participation moves towards local collective self-management. Stakeholder ownership and incentives increase with the level of participation. However, there is a key role for public agencies at all levels, and this role requires increasing levels of skill at each successive level, until the last two (high, very high) levels in Table 6, which call for:

- Water resources assessment and monitoring skills to advise on planning and management for resource sustainability;
- Social and institutional skills to support the development of governance institutions at the local level; and
- Technical skills to advise on efficiency of water allocation and use.

A Certain Humility of Approach to Participation Is in Order

Groundwater planners naturally tend to think of participation in terms of permitting increasing degrees of stakeholder participation in the governance, planning and management set ups determined by the government. But the reality (the default option) is that groundwater governance, planning and management arrangements are at present almost entirely in the hands of the local stakeholders who decide how much water to abstract, and often whether to drill another well or two. In this sense, Table 6 could be reinterpreted as levels of participation by government agencies in local governance arrangements. Participation is as much, or more, a way for public agencies to share in and strengthen local governance arrangements as it is for local stakeholders to be factored in to government's governance set up.

Table 6. Participatory Approaches

Nature and level of participation	Typical organizational set up	Level of empowerment
Data collection	Local water resources management agency consults local stakeholders to obtain information	Negligible
Consultation about national or local water strategy	Consultants or planners consult focus groups	Low
Government launches projects to address specific management issues, e.g. irrigation agronomy, water use efficiency, rural water supply	Project team works with a contact group or project-specific user group	Moderate
Participatory water resources planning, e.g. for a local catchment	Local water resources management agency works with a stakeholder user group or traditional community group	Moderate
Collaboration on specific water resource management functions, e.g. reciprocal data gathering and sharing		
Partnership to implement a local water resources management plan	Local water resources management agency works with a user association or traditional community group, providing knowledge, capacity building and support to self-regulation by the association	High
Water resources management delegated to stakeholders	A local user association or federation of associations takes responsibility for local aquifer management and self-regulation, with technical support from the local water resources management agency	Very high

What Are the Impediments to Participation and Local Collective Management?

Frequently, the legal and institutional provisions do not empower collective management institutions. Case studies shows that despite the notional integration of participation in the strategies and regulatory frameworks of several of the study countries, the corresponding institutional arrangements for participation at the basin or aquifer level and below are not adequate. According to Ostrom (2005), most individuals affected by operational rules should be able to participate in modifying them. In large-scale resource systems such as a river basin or major aquifer, it is important to enhance the participation of those involved in making key decisions about the system (Huntjens et al., 2012).

Several countries have made efforts to provide for stakeholder consultations at the basin level and by implication at the aquifer level. However, results in the case studies were disappointing, with little or no focus on groundwater aspects of water resources management. In addition, the stakeholders consulted apparently had little influence over the outcomes (see Box 27).

Box 27. Participation and Empowerment in Kenya

Catchment area advisory committees (CAAC) were established under Kenya's Water Act to advise regional managers of the Water Resources Management Authority (WRMA) on water resources management issues. The CAAC has a statutory membership of fifteen persons drawn from stakeholders, including relevant sectoral institutions in government, the private sector and civil society. Members may be drawn from the ministries responsible for lands, forests, mines, agriculture and others. Nongovernmental organizations working in the area of water supply, many of whom construct boreholes, could also be represented. However, the current membership constitution of these advisory committees gives no special attention to representation by persons dealing particularly with groundwater management issues. This is the case in the catchment areas within which the four case study aquifers fall. In addition, because the nature of these committees is advisory, they have limited influence on decision making. The WRMA regional offices are under no obligation to heed their advice and are not accountable to the CAACs.

Source: Mumma et al., 2011.

Box 28. Water Resource User Associations in Kenya and Participation in Local Aquifer Management

As a first step towards formalizing participation in groundwater management, Kenya's Water Act provides for water users (organized as WRUAs) to participate in water resources management. It envisages that where the water resource in question is groundwater, a water resources user association would be formed to manage it. No distinction is drawn between groundwater and surface water resources.

For example, the 12 WRUAs established in the Lake Naivasha have:
- Conducted abstraction surveys and water permit compliance surveys for both surface and groundwater;
- Monitored and checked flow meter status (for both);
- Provided direct feedback to the WRMA on applications for water permits (for both);
- Sensitized water users on water use regulations and their obligations (for both); and
- Provided a forum through which water conflicts can be resolved.

Partly as a result of the WRUAs, new rules have been developed that propose both catchment and groundwater protection (The Lake Naivasha Catchment Area Protection and Groundwater Conservation Area Rules), and under which the Lake Naivasha Catchment Area Water Allocation Plan was gazetted in 2011. At present, the powers of the WRUAs are limited to what is allowed under existing legislation. Under the proposed rules, they are expected to be key in education, checking water use compliance, and in promoting water use efficiency.

These rules have yet to be enacted into law. This is the first time a Groundwater Conservation Area has been proposed under water legislation since before independence, and may show the way forward.

Source: Mumma et al., 2011.

At a lower level of the small aquifer or micro-catchment, *community groups or more formal water user associations can manage groundwater resources, usually in conjunction with other parts of the hydrological cycle*, including surface flows, groundwater recharge, diversions and abstractions, and consumptive water use. However, these organizations and the institutional arrangements associated with them usually focus on the more easily managed parts of the cycle, particularly surface water diversions and consumptive use, and much less on groundwater resource management issues like recharge, prevention of pollution, and aquifer management. There have been attempts by governments to promote water user associations specifically for groundwater or for groundwater within an IWRM approach, but these are generally in the pilot phase (see Box 28).

Participatory Approaches Risk Reflecting Existing Inequalities

One of the key problems with participation is who gets to participate. Through decades of experience with participatory approaches, it has become clear that empowering local people shifts the balance in decision-making to the local level but, at the same time, risks strengthening existing patterns of power and wealth. This is a particular risk in the case of groundwater management where rights to the common resource have been "captured" by those with the power and wealth to drill wells. Put simply, the larger the surface area and the more financial capital a person has, the more groundwater that person will "own." Moreover, this share can be increased further by pumping from deeper sources and at a faster rate than others.

The consolidation of this unequal power (and, hence, distribution of groundwater) has two implications for participation. First, the more wealthy and powerful landowners may have a predominant voice in participatory processes (see Box 29). Second, these landowners may not be interested in participating in collective management arrangements that give an equal voice to smaller interests, or to stakeholders who do not actually own a share of the resource.

A further aspect of this asymmetry of power is that most people in any area do not own any groundwater, but they are nevertheless stakeholders. In principle, groundwater is a common asset of the entire community: the livelihoods of landless laborers or herders may depend on groundwater, drinking water sources require protection of groundwater quantity and quality, access by women to groundwater is a vital part of household management and family health. Yet, a user association made up only of well owners may not properly represent the interests of the majority in a community. This was recognized in South Africa (Box 29), but requirements that user associations include women and the marginalized prove very hard to implement.

Social Dynamics and Barriers to Participation

Social barriers can significantly limit the active participation of some members of society. Common social barriers relate to gender, ethnicity and caste and can extend to interactions at local, national, and even international, levels. At the local level, minority groups may be excluded from participating in decision-making and accessing facilities, while at higher levels individuals may experience discrimination such as being overlooked for positions within institutions. Such barriers make it difficult to achieve inclusive and integrated social development. Identification of stakeholders and understanding of the complexity of their relationships are crucial, but even if provision for inclusion is written into the process, there can be great difficulty in implementing them (see Box 30).

Box 29. The Powerful May Dominate Participatory Water Management Processes

The Kenya Water Act provides for the general public to participate in water resources management decisions, particularly as regards water use (abstraction, etc.) by lodging objections and comments when an application for water use is made. These mechanisms are designed to enable the general public and interested stakeholders (particularly the WRUAs) to become involved in decision making. The key weakness of these mechanisms is that they depend on the public to become proactive and to have the knowledge, time and resources to become involved. The result has been that they have been used largely by the more powerful or educated persons rather than members of the general public.

During the development of Morocco's regional water master plan, the two river basin agencies involved in the management of the aquifers analyzed in the case study involved the majority of stakeholders in the consultation process. To do so, they established commissions, and placed the master plan up for discussion before being submitting it for the approval of the National Council for Water and Climate (CSEC). However, the lack of local associations representing all the groundwater users at the aquifer level marred the consultation process.

Public participation processes during the development of the proposal to set up South Africa's Catchment Management Agency were conducted in several water management areas. South Africa is also working to convert top-down irrigation boards into participatory water user association. However, the process is protracted, and one of the reasons is the difficulty in meeting race, gender and sector representation quotas for stakeholder participation and for constitution of management committees (a requirement of the Department of Water Affairs). The reality is that there are very few female farmers and very few previously disadvantaged individuals with water use entitlements.

Source: Mumma et al., 2011; Morocco case study; South Africa case study.

Some Physical Characteristics of Aquifers Constrain Participation

User participation is complicated by the physical invisibility of groundwater systems. This may make it difficult for users to visualize trends in changes in quantity or quality of groundwater and their implications for use. Indeed, this problem was apparent in most of the cases studied. UNESCO (Mar 2012) recommends popularizing groundwater information and system behavioral dynamics to render groundwater more visible to users.

Some hydrogeological settings (with fewer stakeholders, or easier to understand resource dynamics) are more conducive than others for engaging communities in groundwater management. Studies in India show that where there are fewer stakeholders and the resource is better understood, stakeholders are better able to cooperate on groundwater management. Farming communities in hard-rock aquifer areas that implemented rainwater harvesting and aquifer recharge quickly saw a change in water levels in their wells. Conversely, in large alluvial aquifers with high transmissivities, this kind of palpable change was not apparent to users. Shah (2010) observes: "This has created a strange paradox in India's groundwater scene. Large pockets of arid alluvial aquifer areas—Punjab, western Uttar Pradesh, Haryana, western

Rajasthan and North Gujarat—have excellent aquifers with large storage; yet these are the areas where farming communities depend on ‘competitive deepening’ of their wells to chase declining groundwater levels. In many hard rock areas with intensive groundwater development for irrigation, farming communities have, over the past four decades, moved from unfettered private exploitation of groundwater to recognizing the shared nature of the aquifer space and thence to groundwater adaptive management of water resources at local watershed level.” This suggests that willingness to engage in collective management is likely to be greater in management areas where fewer stakeholders are involved and where the benefits of groundwater management can be measured and felt.

Incentives to Participate Vary with the Perception of the Problem

Stakeholders may not see the point of cooperating in areas where there is no record of water scarcity. Groundwater users do not feel the need to develop strong cooperative arrangements until their resources are clearly under threat. Kahkonen (1999) finds that in relation to water supply, the relative degree of water scarcity in a community affects the returns to, and emergence of, collective action. Households in communities with relatively scarce water supply have the highest expected returns and thus the strongest incentives to act collectively. On the other hand, households with absolute scarcity or abundant water supply have low expected returns to collective action and thus weak incentives to cooperate. Crises may be able to change the existing negative equilibrium, promote a new urgency and create new constituencies for reform. Formal or informal user groups can be created during the groundwater development phase to anticipate this situation. The user groups can have various objectives, such as providing advice on irrigated crop management for farmers, maintaining pumps and boreholes, or discussing the allocation and price of water. Box 30 provides an example of effective incentives for farming communities.

Box 30. Farmers Can Reduce Groundwater Use and Still Earn Higher Incomes: The Andhra Pradesh Farmer Management Groundwater System Project

Several programs in India have supported community groundwater management. The most substantial project in terms of geographical coverage and methodology is the *Andhra Pradesh Farmer Management Groundwater Systems Project* (APFAMGS).

APFAMGS did not include investments in infrastructure. The emphasis was instead on *increasing the collective understanding of the groundwater resource*. Farmer measurement of basic hydrological parameters was to be the basis for coordinated crop planning by groundwater-dependent farmers. APFAMGS is active in 62 hydrological units (sub-basins), spread over seven districts in Andhra Pradesh. The average population size of a hydrological unit is about 10,000 people, and the average number of direct groundwater users in a hydrological unit is 400. The total population benefitting from the program was about two thirds of a million people.

A number of activities were undertaken in each of the hydrological units:

- Promoting *participatory hydrological monitoring* – with farmers measuring their own water levels as well as running local rainfall stations
- *Crop water budgeting* for the entire hydrological unit on the basis of available recharge

– with farmers deciding for themselves how to adjust their cropping system

- *Farmer water schools*, to improve understanding of groundwater, introduce water saving techniques and change cropping patterns – largely run by farmers
- The impact of the APFAMGS activities has been analyzed from the detailed database that the project maintained. In more than half of the hydrological units with predicted negative water balances, farmers *adjusted their crop choice* reducing the proportion of crops that require a relatively large amount of water to grow. In particular, water-intensive rice cultivation was reduced or even eliminated.
- There has also been a significant *increase in the use of improved field irrigation, moisture conservation and micro-irrigation methods*, which rose from 15 percent of the area in 2005-2006 to 34 percent in 2007-2008. The increase concerns methods that involve both subsidized investment (in particular drip and sprinkler systems), and also methods that concerned unsubsidized management measures adopted by farmers (such as check basins or the use of vermicompost).
- As a result, *water tables have risen*, and, most importantly, *better groundwater management did not result in lower returns but rather the opposite*. The net value of agricultural outputs in all the hydrological units in the project was higher than in the pre-project period with increases ranging from 6 percent to over 100 percent. In non-project areas, on the other hand, the net value per hectare dropped by up to half as groundwater availability dwindled.

The **lessons** are:

- Knowledge and awareness are key to persuading farmers that they can manage groundwater more sustainably.
- There are many ways to reduce groundwater use, some requiring investment (and perhaps subsidy), some of them simply requiring farmer knowledge and effort.
- With careful management, farmers can reduce groundwater use and earn higher incomes.

Source: Taher et al., 2011; van Steenbergen, 2010.

The Challenge of Third Party Stakeholders and Externalities

It is important to also factor in polluters and others who may not be direct users of groundwater but whose activities affect the quantity or quality of the resource. These persons may benefit from polluting the resources (by not implementing preventative measures or by denuding the catchment and reducing infiltration capacity), but they have little incentive to rectify their actions because they do not benefit from the resource itself. Inequity may be exacerbated if the benefits derived by these people have a negative impact on other users.[31] Mutually acceptable arrangements between users and polluters need to be found to address this problem by changing behavior and promoting actions in the local public interest.

[31] The case studies yielded examples of private benefits derived at the expense of others.

Challenges to the Mobilization of Support for Long-term Participation

Although the principle of user participation is included in national strategies and legal frameworks of the countries studied, the participation of groundwater users in decision-making processes is still in its infancy. Changing institutional mandates takes time and building participation requires specific capacity. India and South Africa have made some progress, but the challenge of initially mobilizing support is compounded by the persistent task of maintaining long-term participation and interest in the management of the resource. While the case studies and literature demonstrate examples of short-term enthusiasm, particularly when stakeholders rally around a project with external inputs, maintaining consistent government support and stakeholder engagement in participatory processes is often difficult. Promoting ownership and establishing a clear functional framework where rewards are visible and achievable are vital to ensuring that stakeholders remain engaged for the long term.

Improving Participation and Local Collective Management

Enhancing Participation by Building on Social Capital

Social capital is the internal social and cultural coherence of society, the norms and values that govern interactions among people and the institutions in which they are embedded (Kahkonen, 1999). Generally, if social capital already exists, this reduces the cost in time and effort of mobilizing stakeholders for participatory approaches (Brondizio, 2009) (see Box 31). The existence of social capital through formal and/or informal ties, including non-water related community networks and associations, promote collective action and coordination within a community (Kahkonen, 1999). In relation to the management of common-pool resources, Ostrom (2001) lists several attributes of users and communities that facilitate engagement, including trust and reciprocity and prior organizational experience (see Annex 2). *Costs are less and outcomes better where participatory approaches build on existing social capital.*

Intervention should be adapted to the existing levels of social capital. Creating groups or patterning behaviors through project interventions is a notoriously risky business because institutions set up at the government's behest and with incentives attached tend to focus on garnering subsidies and to fade away at the end of the project (Gugerty and Kremer, 2000; Grootaert and van Bastelaer, 2001). But where social capital already exists it can provide a first class platform on which to build. Hence, an operational understanding of social and institutional fabrics needs is vital (Grootaert, 2001; Collier, 1998).

Principles of equity and social fairness demand that the voices of the less powerful should also be heard. Participation design in programs should be attentive to the needs and unique requirements of minority groups (REC, 1999; Renn et al., 1995; Lebel et al., 2009a). Stakeholder participation is a crucial and integral part the water sector reform in South Africa. To ensure stakeholder participation, a well-designed and elaborate process was adopted for the development of water related policies and legislation[32].

[32] As a result of the diverse nature of the South African population, and because water means different things to different people, several different approaches and methods were used to consult about the National Water Resource Strategy (NWRS). In order to reach all the stakeholders, information on the strategy was presented verbally, visually and in writing at national level sectoral workshops and public consultation meetings and open houses held in each of the water management areas (WMAs) throughout the country. A total of 29 national level sectoral workshops and public consultation meetings and open houses were held in different areas within each WMA, with more meetings in the larger WMAs. Thousands of issues and comments were gathered during the meetings and in writing and submitted to the Department of Water Affairs and Forestry. Source: Maharaj and Pietersen, 2005

Box 31. Social Capital Provides a Basis for Participation in Morocco

Social capital is one of the five capital assets recognized as a basis for development (together with human, natural, financial, and physical capital). The accumulated body of evidence demonstrating social capital's importance to development potential makes its identification and measurement important. While measuring social capital is difficult and can require a combination of qualitative, comparative and quantitative methodologies, levels of trust, civic engagement, and community involvement can be used as general proxies.

In Morocco, the comparison between groundwater irrigator communities in two over-abstracted areas provides an interesting illustration of the difference in cooperation potential due to social capital In the Tadla aquifer area, farmers access groundwater through informal local arrangements and share the water. These arrangements allow the survival of thousands of small farm holdings. Building on the existing cooperation, social scientists used role-playing games to identify common interests and develop collective strategies in the Tadla aquifer area. In contrast, there was scant cooperation among farmers in the Souss Massa aquifer area, and many small farmers were forced to sell their land because they lacked the financial capital to invest in deep drilling and water-saving localized irrigation, because their plots of land were small, and also because of differing access to drilling permits.

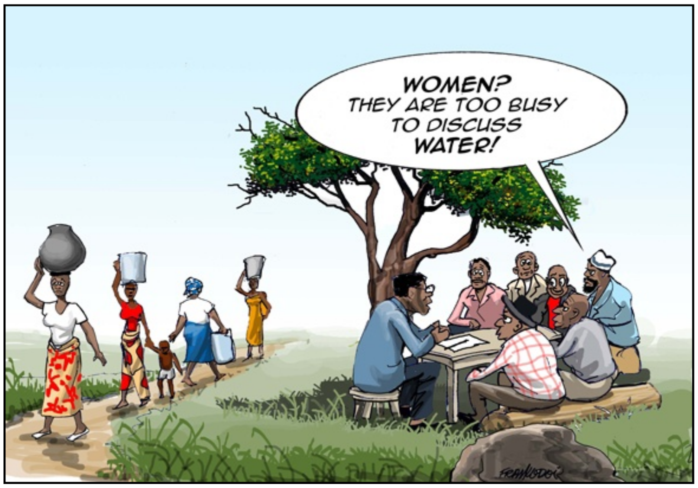
Source: Carney, 1998; Woolcock & Narayan, 2000; Ammar Boudjellal et al., 2011; Houdret, 2006.

Yet, there is still a long way to go, particularly on gender inclusion. While the 2012 Africa IWRM report (AMCOW, 2012) described implementation of gender activities in over half of the countries studied, only one country (out of 40) reported full implementation of gender mainstreaming in water resources management and development (see Figure 8). Additionally, greater engagement with the burgeoning youth population is also critical (as recommended in the Africa Water Vision 2025 report).

Interventions could start in areas with potential for success and where costs are lower, in the expectation of spontaneous replication. The most cost-effective approach would normally be to start in the water management areas where there is the highest probability of success and spontaneous proliferation, while also considering the highest benefit for the cost and effort expended (Nkansa and Chapman, 2006; Perez and Tschinkel, 2003; AusAID, 2000). However, *a concern with efficiency should not lead to the exclusion of vulnerable but lower potential water management areas nor to the exclusion of the poor or marginalized.*

Equity would require early interventions also in water management areas that are under stress and where the livelihoods of the poor are vulnerable. In addition, within each water management area, although efficiency would suggest addressing principally the problems of the larger water users, equity demands that the interests of all users, even those not owning a share of the resource, be included. These challenges emphasize the difficulty of involving all relevant stakeholders and balancing their perspectives, while still maintaining efficient processes.

Figure 8. Participatory Processes Excluding Minority Groups



(Source: World Bank Water & Sanitation Program (WSP), 2012).

The promotion of local collective management can link policy (aimed at sustainability, efficiency, equity) to actual outcomes. Field experience in a number of projects has yielded methodologies that have been successful in improving local collective management initiatives and in linking them to the broader policy and governance structure. Box 32 gives an example developed for the Middle East and North Africa region but which could be adapted and applied in many country situations.

A step-by-step approach is normally indicated, with entry point activities designed to bring visible benefits. Changing pumping or water use behavior may cause pain before it brings gain. Interventions may therefore require entry-point activities[33] (EPA) to offset perceived sacrifices made by local stakeholders in the broader public interest. It is better, however, to avoid inducements in the form of subsidies because they are not sustainable and behaviors may revert when the subsidy ends. Instead, entry point activities could comprise improvements that need to be done anyway but which may bring quick benefits, such as agronomic or irrigation improvements (such as changes in cropping patterns and irrigation and soil-moisture conservation techniques for improved groundwater management), which could lead to improved farmer returns and promote their continued participation (World Bank, Apr 2009) (see Box 33).

Processes to Promote Participation

There are many ways to promote participation in groundwater management, and they can be adapted to local situations

There is a wide range of methods and tools available to support stakeholder participation. A suite of 'interactive learning processes' has been developed that provide a range of flexible learning by doing approaches to developing institutions for collective water management (see Box 34 and Annex 8).

[33] Typically applied in watershed development, EPAs are basically meant for gaining a foothold in the community and in the process, earning the goodwill of villagers before embarking on planned activities. They involve building rapport with the community, and strengthening and sustaining it throughout the intervention and thereafter (Dixit et al., 2007).

Box 32. Methodology for Promoting Intermediate and Local Participatory Governance

The EMPOWERS (*Euro-Mediterranean Participatory Water Resources Scenarios*) project was initiated in Jordan, Palestine and Egypt to link government policy objectives and the governance set-up to the actual behavior of groundwater users

EMPOWERS adopted a participatory approach to action research in water governance, developed collaboratively by a wide range of civil society and government partners in the MENA region. Its objectives included increasing the influence of stakeholders (particularly the poorest and most marginalized) on the planning and decision-making process for the use and management of water resources; and enhancing vertical and horizontal linkages and information flows between water stakeholders.

EMPOWERS provided for a partnership approach to the six stages in the management cycle: visioning, assessing, strategizing, planning, implementing and reflecting. Each cycle reflected a continuous process of experimentation, adaptation and learning, making identification of local solutions possible.

The EMPOWERS approach provided a framework for specialists to support a stakeholder-driven process, overcoming the weaknesses of approaches that focus entirely on top-down decisions made by specialists or bottom-up decisions made by people who are uninformed.

It focused on the local level, in the belief that water governance can only be sustainable if based on the agreement and involvement of water users, and that the vast majority of day-to-day decisions around the provision of water services are taken at those levels, but that local collective groundwater management needs the support and guidance of public agencies located as close as possible to the area being managed.

Although the guidelines that emerged from EMPOWERS reflected the organizational and governance realities in the MENA region, they could be adapted and applied to many other country.

Source: Moriarty et al., 2007; WBI, 2009b.

For example, water managers, local communities and hydrogeologists can use these methods to collaborate on local water resources planning and to define and support specific groundwater resource management functions (see Table 6). The suitability of a specific method will depend on its characteristics (e.g. the expertise and facilities needed, the intensity of interaction that it allows and the level of formality) as well as on the demands of the process at a given time (e.g. objectives and intended level of participation, background of the stakeholders and the available budget and expertise) (Huntjens et al., 2011b).

Box 33. Promoting Participatory Water Conservation in Andhra Pradesh

The *Andhra Pradesh Drought Adaptation Initiative* (APDAI) was a World Bank-financed project that experimented with rural community adaptation measures in chronically drought-prone and economically vulnerable areas. A unique pilot initiative of the project involved villagers sharing groundwater by pooling borewells, which brought rewards to both the farmers owning the wells and to those without prior access to them. The pilot aimed to move groundwater out of the individual into a community domain (introducing collective management), while also encouraging the transition to crops that consume less water. A shared pipeline system, which all group members take turns to operate, also led to collective arrangements by borewell owners.

Agreed community regulations and guidelines included:
- No new borewells are to be constructed in the next 10 years;
- One bore well must be rested every day (for a 20 percent reduction in water/electricity use);
- The land under irrigation should be reduced proportionally during droughts;
- All shareholders must use water-saving cultivation methods;
- Crop plans must be made for the season, with priority given to food and fodder crops; and
- The area under paddy is to be reduced, with no paddy cultivation during cool/dry season.

Reductions in groundwater overdraft were achieved in parallel with equal or increased incomes for all scheme participants, which maintained their enthusiasm. Some of the project measures are being mainstreamed into state government schemes. The approach has the potential to benefit many more farming communities, particularly in arid areas.

Source: World Bank, Mar 2010; World Bank, Apr 2009.

Local communities everywhere have developed collective ways of monitoring and managing groundwater that are adapted to the local situation. For example, Table 7 lists (in decreasing order of visibility) twenty groundwater management activities that could be monitored, and therefore controlled by collective decision. The table then lists (in increasing order of difficulty), corresponding techniques that local collective management groups in Yemen have employed to monitor and regulate groundwater in their own micro-catchments or local aquifers. The interest of Table 7 is essentially simplicity:

- It lists groundwater management activities that are visible and therefore can be monitored.
- It lists corresponding very simple management measures that a community concerned about their dwindling water resource could easily decide upon.

In actual practice, all of the highly visible activities (along with many of the moderately visible ones) have been the subject of management measures decided by Yemeni communities.

Box 34. Interactive Learning Processes to Promote Participatory Management

A list of interactive learning techniques derived from Huntjens et al. (2011b) and UNEP (nd) is provided in Annex 8. The choice of interactive learning method(s) will vary depending on circumstances and objectives, and include backcasting, brainstorming, case studies, focus groups, foresight, group model building, multi-stakeholder dialogue, nominal group technique, reframing, or role playing games.

For example, role playing is a type of game in which the participants assume roles and collaboratively create stories. Participants determine the actions of the characters they are playing based on their characterization, and the actions succeed or fail according to a formal system of rules and guidelines. Role playing games can be linked to group model building. In this type of application, models can be represented in terms of role playing games wherein the participants are not simply observing the model from the outside, but actually embedded in the game as actors making decisions about management.

In contrast to the traditional methods of training, the foundation of interactive training is the principle of multilateral communication, depicted by a minimal focus on the point of view of the educator. Instead, training methods focus on the organization of the process of effective communication, in which the participants in the process of interaction are more mobile, more open and active (UNEP, nd).

Source: Huntjens et al, 2011b; UNEP, nd.

As part of this study, a simple readiness checklist was prepared to test whether the conditions for effective collective management of groundwater are in place. The doyenne of analysts of collective action in relation to common pool resources, Nobel Prize winner Elinor Ostrom, has argued, along with many others, that local collective management approaches are best able to deal with common pool resources like groundwater. The basic logic proposed is that groundwater users can recognize the problems of depletion, quality deterioration and so on, and will have the incentive to work together if cooperation promises significant benefits in terms of access, sustainability or efficiency. Based on prior research and on analytical work done specifically for this report, ten criteria have been identified (Table 8) for judging how appropriate local collective management may be for any groundwater situation and how well it is likely to succeed.

Generally, it is not a question of “either/or,” both top-down rules and public services as well as bottom-up local collective management are needed for effective groundwater management. A key challenge for policy-makers is how best to integrate important bottom-up learning processes with top-down high-level policy strategies and visions. A number of countries (for example, the Netherlands, the Czech Republic, Hungary, South Africa, Australia, and Thailand) are experimenting with institutional innovation in water resources management to find a balance between processes of bottom-up participation, decentralization and central coordination. Water governance regimes where these processes are more balanced seem to be characterized by a higher adaptive capacity (Huntjens et al., 2011a).

le 7. Monitoring and Managing Groundwater: Visibility and Implications for Local Management and Public Interventions

er management activities	How can the activity be monitored?	What management measures are possible?
ly visible activities		
rilling new wells	Presence of drilling rig	Moratorium on new wells
eepening or replacing ting wells	Presence of drilling rig, irrigation activity	Local agreement on maximum depths, moratorium on deepeni
pacing of wells	Presence of drilling rig	Employment of traditional well spacing rules (e.g. 500 meters apart)
elling water to tankers	Presence of tankers	Forbidding sales outside the area, or forbidding sales for qat
bstraction for domestic er	Simple observation, as domestic water is hauled by people or donkeys. Piped use can be metered	Local regulation to protect sources Ban on use of domestic water for irrigation
rop type	Simple observation of crops in the field	Ban bananas, alfalfa, or other crops with high water demand
rop area	Simple observation of cropped area	Limits on expansion
onveyance	Simple observation of water conveyance from source to field	Requirement to install lined canals or pipes
stribution	Simple observation of irrigation techniques in-field	Flood, furrow, basin, sprinkler, bubbler, drip
erately visible activities		
Duration of irrigation	Observation of pumps in operation	Local agreement to limit pumping (hours, seasons)
Fuel consumption	Observation of purchase and consumption of liters of diesel	Local agreement to limit diesel use (as proxy for pumping)
Excess irrigation	Observation of excess water, weeds	Local agreement to improve water use efficiency
Providing water to neighbors	Observation of pipes, water flows, tankers	Local bans could be imposed
Depth to water table	Measurement in wells of meters from surface	Target depths could be established
Well recovery rate	Measurement of hours to restore level	
Aquifer recharge	Measurement of changes in the water table and well yields	Terracing, check dams, basins
visibility activities		
Quantity abstracted	Metering of m3, or pumping hours	Agreement on quotas
mpact on other wells and ngs	Drying up nearby wells or springs, cone of depression	
Aquifer transmissivity	Can assess from local experience. Can analyze lateral flow, meters per unit of time technically	
Aquifer storage capacity	Can assess from local experience. Can analyze m3 of water per m3 technically	

ce: Adapted from a table originally prepared by Bryan Bruns

Table 8. Ten Criteria and Ten Questions to Assess Readiness and Capacity for Collective Management

Criterion	Key question
1. Adequately defined boundaries of the resource	Do stakeholders have enough knowledge to be able to relate actions to results?
2. Agreement on access	Do stakeholders agree on who may access the resource and how?
3. Fair distribution of risks, benefits and costs	Are "big" well owners prepared to cooperate with decisions?
4. Collective choice	Are all key stakeholders empowered to take part in decisions?
5. Monitoring and reporting	Do stakeholders have confidence in the measurement and reporting on compliance with decisions and on results?
6. Graduated sanctions	Can stakeholders use appropriate sanctions to compel compliance?
7. Conflict resolution	Do all stakeholders agree on a mechanism for adjudicating disputes?
8. Recognition of the group	Is there any external challenge to the stakeholders' right to organize and operate?
9. Adaptive capacity and flexible processes	Can stakeholders adapt in the light of experience or changed circumstances?
10. Links to other governance systems	(*where the aquifer is larger or more dynamic*) Can stakeholders fit in with other governance systems for the same resource (another association, a federating structure, a basin agency…)?

Source: Annex 2

Note: the first question looks almost the hardest, but in most cases local people will have enough information to be able to define a working concept. And even hydrogeologists are challenged on the boundary question.

Despite the need to shift the balance of governance towards the local level and more participatory approaches, there will always be the need for a certain degree of top-down governance, for example in the areas of policy, basic rules, knowledge management and cross-fertilization of experiences, transboundary issues, capacity building, setting of standards and conflict resolution.

Even where bottom-up governance or decentralization are working, the state still needs to play an active role in groundwater governance. It can support the mobilization of people in local processes, aid in neutralizing local power asymmetry, provide funds for local initiatives, provide technical and professional services to help local capacity building, guarantee quality standards, invest in larger infrastructure, coordinate in externalities that span more than one local administration, facilitate learning processes, and collaborate with local stakeholders for the enforcement of law (Bardhan, 2002).

7. TOWARDS IMPROVED GROUNDWATER GOVERNANCE

Chapters 4 to 6 assessed the state and prospects of groundwater governance, looking at the functions of governance, at the impediments to good governance, and at options for overcoming these impediments.

On the basis of this implementation experience, this chapter summarizes all the lessons and options discussed throughout the analysis and suggests how to select governance options appropriate to each situation, and how these options may best be put into operation.

Selecting and Operationalizing Options to Improve Groundwater Governance

Despite the magnitude of the challenges and problems, groundwater governance has not been much on the agenda of decision-makers. Groundwater has failed to feature prominently in water policy dialogue at the local, national or global level and, as a result, its governance has not kept pace with increasing demands and technological advances.

The aim of this report has been to help to put groundwater and its governance at the top of the agenda for decision makers and practitioners by answering the following questions:

- Why has groundwater governance failed to stop the emergence of very serious threats to the resource?
- What are the impediments to improving groundwater governance?
- What are the options to overcome those impediments?

This final section summarizes all the lessons and options discussed, and suggests how to select governance options appropriate to each situation, and how these options may best be operationalized. The section follows the framework used for analysis throughout the report, which distinguished three parts to the groundwater governance system:

- the *policy level*, where a nation sets its objectives for groundwater;
- *strategic level governance*, where a nation puts in place institutions and instruments to align stakeholder behavior and actual outcomes with policy objectives; and
- *local level governance*, comprising the organizations and institutions that control actual outcomes on the ground, and which respond in varying degrees to rules and incentives.

The Governance Challenge

Groundwater governance is particularly challenging because, although it is a common resource, some individuals have established de facto rights. They exploit these rights driven by strong economic incentives and competing with each other to extract as much as possible as quickly as possible and with no inherent incentives to aim for sustainability. Governance is further challenged by the fact that groundwater is an unseen part of the hydrological cycle, and even specialists are hard pressed to describe the resource and its interactions sufficiently to plan for and manage it.

The challenge is increased by the local specificity of groundwater, each area with its own physical, geographical and socioeconomic characteristics. Governance also has to adapt to the state of development and to the problems that past assertion of rights and abstraction behavior have produced. In some cases the problem is over-abstraction and depletion, in others water needed by fast growing towns is being diverted to lower yielding agricultural uses, and in still others the challenge may be compromised quality or recharge. In most cases, more than one of these problems will be present.

All these contextual features need to be taken into account in assessing governance options, which have to be adapted to the context and to capacity, and appropriate to the problem to be solved and to the policy objectives targeted.

Governance at the Policy Level

Setting good policy and handling political economy factors

Although most national policies target sustainability, equity and efficiency, there is usually a gap between stated policies and what actually happens. Policy makers have short horizons and inadequate information, and they are reluctant to put forward policies that constrain the profitability of groundwater use because this affects powerful constituencies (and often the poor, as well). Policy makers prefer high profile surface water investments to the long and politically costly struggle to re-impose order on a largely ungoverned groundwater sector.

- Champions of change need to choose their fights carefully, identifying the really critical issues. They also need to prepare and present options persuasively.
- Options should, as far as possible, reconcile the incentives of decision-makers and stakeholders with some approximation of good groundwater policy.
- The first step should be to obtain the budget and approvals to carry out essential resource assessments and set up a reliable monitoring and reporting system.

Governance at the Strategic Level

IWRM and Cross-Sectoral Harmonization

Although most countries have adopted policies and established organizations to address integrated water resource management (IWRM), groundwater struggles for its place within integrated water planning. Moreover, governments often fail to provide for the capacity and budgets needed for implementing the groundwater parts of these plans. Groundwater suffers, too, from weak coordination of policy and plans. Good groundwater management is very often over-ridden by powerful interests, particularly from agriculture which is, almost everywhere, the main user of the resource.

- Integrate groundwater into water resource planning and implementation, and provide adequate budgets and staff for groundwater within sector agencies. Succesful integration of groundwater in IWRM requires strong groundwater organizations/departments/agencies to ensure groundwater's place in IWRM and to obtain adequate budgets for groundwater specific monitoring, studies and investments.
- Align instruments and harmonize sector policies, particularly with the policies of heavy water-using sectors like agriculture.

- Strengthen horizontal and vertical coordination, working towards the kind of multi-level governance for groundwater that is emerging in some areas (for example, in China's Hai basin).

Developing and Applying Governance Approaches

The analytical framework in Chapter 2 distinguished three governance approaches, some or all of which are found in most countries:

- A *rights and regulation approach* awards (or recognizes) legal water rights to users and then relies on a regulatory system to ensure that users are respecting the terms of the award.
- An *incentives-based approach* uses positive and negative incentives that typically affect the profitability of water use to bring pumping behavior at the well head into line with policy.
- A *subsidiarity approach* delegates responsibility for groundwater management to the local level, usually to stakeholder interest groups.

Rights and Regulation Governance Approaches

Rights and regulatory approaches are very demanding to implement and are usually resisted by stakeholders.

Rights and regulatory approaches are the most precise instruments for matching behavior at the well-head to society's goals. However, they are usually impeded by massive institutional and operational problems. Everywhere, rights and regulation approaches have run into problems of defining, issuing and regulating quantified rights. Where these systems have been put into practice, they have run into big problems of organizational capacity and have usually received scant compliance from well owners. Also, like many systems that essentially recognize past appropriations of the commons, they tend to confirm inequitable patterns of resource ownership.

- Adopting a rights and regulatory approach requires a realistic up-front assessment of the feasibility, especially of the costs and benefits compared to those from an incentives or subsidiarity approach.
- For bigger and formal sector users, rights and regulation approaches are more feasible and can be the best approach. They can also raise much needed revenues to finance groundwater management.
- Combinations of approaches may be possible, for example registering just the bigger, more formal users (who can also be made to pay for the privilege), while adopting a subsidiarity approach to smaller users.
- Care must always be taken to protect the rights of the smaller against the bigger.

Using the Incentives Structure

It is easy, even for weak governments, to adjust the incentives structure (for example, by phasing out energy subsidies, which often drive groundwater depletion). While doing so can be an essential component of groundwater governance, making such adjustments is politically difficult and can have negative or unintended consequences. Positive and negative incentives are very powerful determinants of behavior and, in the case of groundwater, governments are usually able to adjust incentives easily, making them an attractive mechanism. This is especially the case in a poor country with limited administrative capacity. Table 9 indicates the pros and cons of different options.

Table 9. The Pros and Cons of Options for Changing Pumping Behavior Through the Incentive Structure

Options for adjusting incentives	Pros	Cons
Adjusting input prices influenced by government (e.g. energy, fertilizer, seeds, etc.)	Within government power Easy to administer Immediate and universal impact May generate fiscal revenue	Affects all sectors using the input (especially energy) Raises consumer prices Reduces farm incomes May produce unintended effects (e.g. raising input prices may alter agricultural crop selection) May be inequitable (e.g. loss of employment)
Adjusting output prices influenced by government (e.g. trade controls, cropping pattern controls, crop bans, taxes, official procurement prices)		
Subsidizing specific behaviors such as more efficient irrigation (drip, greenhouses, etc.)	Can increase farmers' incomes while reducing water use (more income per less drop) Positive impact on GDP	Can be hard to administer Can be expensive Open to inequity and corruption Does not necessarily reduce water use (Jevons paradox)*
Bans on specific irrigation techniques	May be easy to implement (e.g. ban on center pivot) May resolve a large part of the problem quickly	May be hard to implement (e.g. banning flood irrigation) Direct impact on the value of farmers' assets and incomes
Facilitating regulated water markets	Allows transfer to higher value uses Profit incentive to comply Relatively easy to regulate	Limited to wells near settlements High cost of transporting the water May be inequitable

*Jevons paradox is that if the use of an input is made more efficient, using it is more profitable, so *more* of it will get used

- Adjusting input prices (like energy) or output prices (like farm produce) provides very powerful signals, as agriculture is normally far and away the biggest user. In particular, phasing out energy subsidies would be the quickest way of reducing overdraft in many situations. Attention is needed to secondary consequences (for example, rise in the cost of transport and in consumer prices generally), to mobilizing political constituencies, and to protecting the poor.
- Subsidies to encourage specific behaviors are a more targeted way of affecting outcomes, but they are expensive and open to corruption.
- Bans on crops or irrigation methods are direct and relatively easy to implement, but may run counter to economic efficiency.
- Where transfer of water (e.g. from agriculture to mining and industry) is needed, market-based transfers of groundwater can be considered. Attention is needed, however, to economic efficiency and to equity impacts within the aquifer.

Subsidiarity: Delegating to Local Governance Structures

Subsidiarity, or delegating management to the lowest possible level can produce good results. It is attractive because it places management closest to the actual decision-makers, that is, the millions of individuals drilling and operating the wells. In some cases, collective management approaches (often in partnership between stakeholders and local public agencies or projects) at the local level have also demonstrated good outcomes.

- An enabling framework for encouraging subsidiarity should be in place.

Choosing Among Governance Approaches

A mix of approaches will normally be indicated- and flexibility, adaptation, and an eye on equity are needed

Overall, there is no one right approach to governance. *A mix of approaches will normally be indicated, coupled with flexibility, adaptation, and a focus on equity*. In each context, one or more of the three approaches may be better, as Table 10 below shows.

Table 10. Governance Approaches to Groundwater

Requirements	Which approach may be the most effective?		
	Rights and regulation	Incentive structure	Subsidiarity
Is there a legal framework of rights and regulatory instruments that is adapted to the situation and which is implementable? If yes…	✓		
Is there a pattern of groundwater users complying with authority? If yes…	✓		
Is the approach administratively simple and low cost? If yes…	✓	✓	✓
Is there strong social capital and/or a history of agreed water rights and collective management at the local level? If yes…		✓	✓
Is inter-sectoral water transfer an objective? If yes…	✓	✓	
Is there a serious depletion problem? If yes…			✓
Is there a serious pollution or recharge problem? If yes…	✓		✓

- Flexibility, piloting initiatives and learning and adapting as needed are likely to be good stances.
- It is particularly important to adapt approaches to implementation capacity.
- In all approaches, it is essential to keep an eye on equity considerations, as there are powerful incentives pushing towards resource capture by the more powerful.

Information, Knowledge and Communications

Information, knowledge and communications functions are essential components of good groundwater governance. Without information, groundwater is very hard to manage. Without communications, compliance with a governance framework is unlikely.

*Information on groundwater is, in most countries, a very weak spot*Due to high costs of collection, to prevalent capacity and skill gaps, and to lack of commitment and resources from policy makers. Information is needed not only on aquifer characteristics but on uses and users, in order to understand behavior and trends. Once collected, information has to be available to managers and to all stakeholders through an open information policy.

- It is important to persuade governments to invest in information and knowledge.
- Lower cost ways of gathering information should be tried (through stakeholder participation or using remote sensing or other new technologies).

- Increased attention is needed to getting to know uses and users, and to understanding motives and the incentives local people face.
- It would be useful to set up monitoring and reporting on the outcomes and impacts of policy and on the performance of the governance system, so that findings can feed back into intelligent adjustments.

Communications with stakeholders is the key to developing governance systems that have the buy-in of stakeholders. Very importantly, transparency, dialogue and interactive communications and learning are key to strengthening stakeholder ownership of governance, and to improving compliance and thereby outcomes.

Promote transparency, dialogue and interactive communications and learning as a key component of groundwater governance.

Finding the way out of deadlock: natural capital accounting.

Without reliable, systematic and updated information on the status and uses of groundwater resources it is not possible to inform decision makers to trigger corrective actions and to allocate the required budgets for improved monitoring. Without structural budgets the required knowledge base will never be build.

Only during crises like droughts, that draw the attention to the critical situation of groundwater resources, funds are made available and political support can be mobilized to take action because the value of groundwater becomes suddenly visible. A way out of deadlock is to translate the value of water, in supporting economic activity, ensuring water and food security, providing climate change adaptation potential or in supporting ecological services like sustaining wetlands, into an economic cost. Natural capital accounting of groundwater can help demonstrate the critical role groundwater plays in many rural economies and show the economic benefits of proposed policy measures.

Conflict and Conflict Resolution

Hitherto rare, conflict over groundwater is becoming more frequent. Because groundwater extracted by tubewell was a new and abundant resource, the early stages of the groundwater revolution saw little conflict. In addition, because of the nature of groundwater, conflict has typically been much less than in the case of surface water. However, there are many potential sources of conflict now emerging due to over-abstraction, pollution, or changes in land use, and well owners are often in conflict with public agencies, for example over regulation.

Depletion, competition and the impacts of climate change are intensifying the scope for groundwater conflicts, which are tending to intensify and become more frequent as the resource becomes fully developed. This has been compounded by the fact that, in many areas, development has produced a pattern of inequitable access to groundwater. In addition, climate change is introducing costs and risks that are hard to manage, including increased demand for groundwater and reduced recharge, with consequent heightened risk of conflict. Disputes have also started to emerge between states over transboundary aquifers.

Dispute resolution mechanisms are being set up, and old ones are adapting, but with mixed results. Traditional dispute resolution mechanisms have difficulty in adapting to the tubewell, but some are showing adaptive capacity. A few modern dispute resolution mechanisms are also being set up, sometimes alongside the old, but with mixed results.

- Good governance capable of flexible and adaptive responses is the best way to solve disputes even before they start.
- Dispute resolution mechanisms may be modern or traditional, centralized or local – the key criterion is that they be accepted as fair by all parties.
- For transboundary aquifers, ways to avoid or resolve disputes can be developed based on the positive experience in various river basin initiatives.

The Role of Participation and Local Collective Management in Good Groundwater Governance

Empirical evidence suggests that participation and local collective management can be effective approaches to good water governance. Participation appears to be effective in improving outcomes because it increases stakeholder ownership and because stakeholders often have access to information and can devise solutions better than or complementary to those delivered from the top down. Perhaps the most important aspect of participation is that it can align the objectives of the government with those of local people. This gives local stakeholders incentives to good groundwater management, and can empower them in subsequent implementation by giving them influence over outcomes. Local collective management is also more likely to take account of the needs of future generations.

In addition, participatory approaches may improve sustainability. If a well owner is convinced that changing pumping behavior will slow or halt resource depletion, he or she may well collaborate in collective groundwater management and take into account the future needs of his or her children.

There is a range of participatory approaches to groundwater management, from consultation to fully delegated groundwater management. The more bottom-up the approach, the stronger the participation and empowerment of local stakeholders. Clearly, the level of participation will depend on the local context, with the need for skilled support increasing as participation moves towards local collective self-management. In all this, it is salutary to recall that, in practice, local stakeholders are already managing most of the world's groundwater. In this sense, participation could be seen as much as levels of participation by government agencies in local governance arrangements as vice versa.

Despite this potential there are many impediments to participation and local collective management. Frequently, the legal and institutional provisions do not empower collective management institutions. For example, water user associations may be consulted over basin plans, but they rarely have any power to participate in decisions. At the local level, there is usually much more experience in collective management of surface water, and stakeholders are often very slow to adapt to the quite different demands of groundwater.

There is a risk that participatory approaches may reflect existing inequalities. The more powerful may either dominate participatory deliberations or not participate at all. A further aspect of this asymmetry of power is that most people in any area do not own any groundwater, but they are nevertheless stakeholders. Ways to include and empower these people are often hard to negotiate, especially when there are social or cultural barriers. An equally challenging inclusion issue is how to get the participation of those who are not directly benefitting from the resource but who may be polluting or hampering recharge.

As groundwater problems intensify, incentives to participation and collective management grow. User participation is complicated by the physical invisibility of groundwater systems, which make it harder to agree on the problems and on the responses and make monitoring more difficult. In fact, unless people agree that there is a problem (for example, in cases where water scarcity is not yet apparent), stakeholders may not see the point of cooperating. However, a crisis and the threat of climate change may change attitudes. Overall, a combination of social and physical conditions is likely to determine whether people cooperate. For example, settings where stakeholders are fewer and resource dynamics are easier to understand are more conducive to cooperation.

Partnerships between local stakeholders and public agencies are an effective approach that requires long-term commitment on both sides. Most successful collective groundwater management has not been done by local people alone, but in partnership with a public agency, which can provide knowledge, capacity building, and so on. However, engaging in participatory approaches is costly and requires long-term commitment from both public services and from communities.

Experience yields some do's and don'ts.

- Costs are less and outcomes better where participatory approaches build on existing social capital. Thus, interventions should be adapted to the existing levels of social capital.
- Principles of equity and social fairness demand that the voices of the less powerful should also be heard, and this is something which public agencies can push for.
- Prioritization in so vast a field is important, and so interventions could start in areas with potential for success (see Box 36) and where costs are lower, in the expectation of spontaneous replication.
- Concern for efficiency should not lead to the exclusion of vulnerable but lower potential water management areas nor to the exclusion of the poor or marginalized members of society.
- A step-by-step approach is normally indicated, with entry point activities designed to produce visible benefits.
- Experience around the world has yielded a number of approaches and tools that can be adapted and replicated. This will result in mutual learning because many communities will have better ideas than those of the public agency.
- Finally, in general it is not a question of either/or, both top-down rules and public services *and* bottom-up local collective management are needed for effective groundwater management.

There are many ways to get collective management to work. The most persuasive argument in favor of collective management is the success of some partnerships between public agencies and local people. Box 35 describes a successful approach at low cost that has already brought benefits not only of sustainability but also of increased incomes to two thirds of a million people.

Box 35. Determining When Collective Management Is More Likely to Work and Getting Started

- Where fewer stakeholders are involved
- Where the benefits of management can be measured and felt
- When there is a perception that there is a problem, perhaps driven by a critical moment
- Where social capital already exists that is appropriate to the task (e.g. equitable, pro-poor) and is adaptable and capable of adopting innovations
- Where there is community solidarity, especially when it is inclusive of women and the marginalized
- When there is relatively less inequity in resource ownership or access to resources

Getting Started

- Start early before the problems become too great
- Go step-by-step in a sequence, with monitoring and evaluation and adjustments built in
- Balance equity with efficiency
- Factor in externalities

Source: Authors.

Starting the Journey Towards Improved Groundwater Governance

This report contains a perhaps bewildering set of issues and recommended actions. But every journey starts with the first steps. The following is a list of entry point activities on how to initiate help to countries to improve groundwater governance.

Of course, not all these activities are applicable everywhere, but they are offered as a menu of options presenting a wide range of possible actions. These actions can be implemented independently or as a combination of actions.

Actions have been grouped in 5 different families:

- **Engage with the policy makers** to understand their concerns and constraints. Go outside the water ministry to seek harmonization and support from agriculture, planning, finance, and municipal development agencies. Carry out an economic analysis of key issues and present it persuasively. A multitude of tools exist including natural capital accounting, assessment of the opportunity cost of groundwater or wealth accounting of groundwater services. Recruit champions and try to come up with win-win agendas. Link governance reform to investment, if relevant.
- **Agree with policy makers on investment in groundwater knowledge**, and offer technical and financial support if needed. Focus not only on resources but on uses and users to identify hot spots. Draw on the results to persuade policy makers of the need for action. Link the results to an analysis of governance needs.

- **Help government to chart a reform path towards better groundwater governance**. Assess the needs and constraints to good governance, following the methodologies in this report. Identify what approaches are best indicated (rules and regulation, incentives, subsidiarity) and work out a reform path over time, as well as an actions and investment plan.

- **Help build strong groundwater organizations/departments/agencies** to ensure groundwater's place in IWRM planning and to strengthen their support to the governance approaches chosen. Match their capacity to the tasks decided upon. Dialogue with government to ensure that the organizations have adequate resources, including skills and budgets.

- **Identify the scope for collective management, and devise ways to support it.** Work at the project and local level, in tandem with agriculture colleagues and those involved in decentralization or local level government.

8. ANNEXES

Annex 1 – Comparison Between Surface Water and Groundwater Characteristics

Table 11. Surface Water and Groundwater Characteristics

Characteristic	Surface water	Groundwater
Visibility	Resource immediately apparent	Resource not apparent
Accessibility	Largely restricted to riparian lands	Accessible to all overlying lands
Volume	Small volumes (rivers) but most potentially available	Large volumes but top fraction most available
Residence times	Short (days to weeks to months)	Long (months to years to centuries)
Flow velocities	Moderate-to-high for watercourses	Very low
Drought propensity	Generally high	Generally low
Evaporation	Small-moderate losses for rivers; high for reservoirs	Negligible losses
Resource evaluation	Lower cost, but still uncertainties	High cost, significant uncertainty
Abstraction impacts	Immediate	Delayed and dispersed
Quality	Highly variable	Generally of good quality although some groundwater is highly saline; can also contain natural contaminants such as arsenic and fluoride
Pollution vulnerability	Largely unprotected	Variable natural protection
Pollution persistence	Mainly transitory	Often extreme
Public perception	Aesthetic, predictable (but reservoirs imply loss of valuable land)	Mythical, unpredictable
Investment	Low-high cost of equipment and infrastructure; private and public investment	Relatively low cost of equipment; usually private investment
Cost of pumping	Relatively cheap to pump per m^3.	Pumping costs vary considerably with deep aquifers requiring lifts of hundreds of meters.

Synthesized from Llamas, 1998, World Bank 2000

Annex 2. Governance and Political Economy

The Relevance of Governance and Political Economy to Good Groundwater Outcomes

Governance is defined by the UNDP (2000) as "the system of values, policies and institutions by which a society manages its economic, political and social affairs through interactions within and among the State, civil society and the private sector" and relates to the broad social system of governing. Understanding governance allows us to match a nation's policy objectives with the mechanisms for translating those objectives into outcomes

Empirical evidence shows a strong causal relationship between good governance and better development outcomes (Cotlear, 2009). Governance assessments have traditionally focused on *formal* governance structures and processes, and less on the interactions between actors or institutions. In recent years, however, governance analysis has looked more at the way these formal structures actually work, taking into account the underlying political economy and placing an emphasis on power relations, incentives, and formal and informal processes (UNDP et al., 2009).

Political economy refers to the way the political environment and the economic system influence each other. It is concerned with "the distribution of power and wealth between different groups and individuals, the processes that create, sustain and transform these relationships over time" (Collinson, 2003). It has become widely accepted that understanding the political economy context of reforms is useful from a diagnostic perspective in order to be able to assist countries effectively in designing and implementing development strategies and policies (World Bank, 2009). The approach followed in the present report includes an analysis of the political economy as part of the study of governance.

Water governance is defined by GWP (2012) as "the political, social, economic and administrative systems that are in place, and which directly or indirectly affect the use, development and management of water resources and the delivery of water services at different levels of society" (Rogers and Hall, 2003). As a subset of the above, groundwater governance is concerned with the enabling conditions (policies, the planning function, the framework of laws, rights and regulations, the incentive framework, and the organizations set up to implement them) for developing and managing groundwater resources in a socially responsible, environmentally sustainable and economically efficient manner.

Theoretical Background: Why Groundwater May Pose Particular Governance Challenges

Common pool resources like groundwater require specific governance arrangements if the objectives of sustainability, efficiency and equity are to be attained. Common pool resources are those where there are few barriers to access but where abstraction by one user diminishes the pool available to others (examples include fisheries, forests, pastures or water). Hardin (1968) proposed that common pool resources face overuse and ultimate destruction because individuals have no incentive to curtail their use of the resource. Anyone preserving it for future use simply leaves it for others to consume. In addition, over-abstraction often imposes costs on third parties through, for example, subsidence of overlying lands, changes in water quality and loss of groundwater dependent ecosystems. According to Hardin, the only solutions are for either *government control* or *privatization of the resource* so that users will have an incentive to ensure sustainability. Ostrom et al. (1999) have pointed out that *collective management of common pool resources* is an alternative approach that has been successful historically. It can avoid some of the shortcomings with government control, such as excessive overhead costs and lack of management capacity, and some of the problems of privatization, such as inequitable access to the resource.

Groundwater is an extreme case of a common pool resource because it is very easy to appropriate by simply tapping the resource lying under one's own land; that is, "individualizing" it. There is inherent tension between this individualization and the interests of the general run of users. Groundwater and the social system that depends on it (household, community, economic sectors, rules and institutions) are involved in complex mutual interactions (Andeies et al., 2004; Walker et al., 2006; Berkes et al., 2003). As a result, simple models of governance and behavior are of limited value. Research suggests that the analysis of system resilience should change focus from looking at optimal states and the determinants of maximum sustainable yield, to focusing on *adaptive resource management* and *adaptive governance* (Walter, 2004). The bottom line is that a multidisciplinary approach that includes the social sciences is key to understanding and improving groundwater governance.

Groundwater users have incentives to find solutions to local issues when coordination yields substantial benefits. As Schlager (2007) points out, "owners of closely situated wells, for instance, may readily realize the effect that their pumping has on one another as water levels in their wells decline under heavy pumping and begin to recover as they reduce their abstractions." In this case, the "ability of resource users to monitor resource stocks" and "well-understood dynamics of the resource" are observable and can provide a basis for two key characteristics for successful cooperation. Users may be willing to rely on spatial or temporal restrictions on the use of the resource. Unfortunately, *information* on groundwater budgets is often lacking because it is difficult to collect and to analyze (World Bank, 2009). Defining aquifer boundaries, structure or capacity requires assistance from engineers and hydrologists. Also, groundwater users themselves cannot easily determine the number of other pumpers, how much water they are taking, the effects of their pumping on the overall productivity of the groundwater basin, and so forth. Tackling appropriation problems for groundwater is therefore not always easy.

Ross and Martino-Santos (2007) examined the relevance of the design principles proposed by Ostrom and others (1991) for sustainable groundwater management and governance within the context of a comparison of groundwater irrigation management in Australia and Spain. These examples share some favorable features for internal self-management including well-defined resource boundaries and long-term resource tenure. Other aspects are more problematic, including agreement on sustainable resource yields, users' involvement in setting resource management rules, and users' capacity to establish their own resource management arrangements (including effective monitoring and sanctions). A further challenge identified by these authors is to establish incentives for collaboration that link user benefits with their contribution to the water management regime.

Lastly, Ostrom's (1993) design principles for sustaining long-enduring, common pool resource systems on a local scale, and those for establishing or sustaining a governance system to deal with the challenges and uncertainties related to complex, cross-boundary groundwater systems may be expected to be distinct for several reasons (e.g. Healey et al., 2003; Rotmans, 2005; Grin, 2006). First, complexity is substantially increased since larger-scale water resources usually must be managed across different timeframes and at different scales (local, regional, national, international). Second, and in contrast to traditional planning for infrastructure, governments and stakeholders at all levels need to be flexible under changing conditions when determining groundwater policies and measures. This is especially the case when considering the uncertain impacts of climate change (Hallegatte, 2009) and socioeconomic developments on groundwater systems. Third, knowledge about the effectiveness of alternative interventions is incomplete and the knowledge that does exist, and is important to management, is often dispersed among several stakeholders (Huntjens et al., 2012).

For dealing with complexities and uncertainties related to groundwater governance and climate change adaptation, additional or adjusted institutional design propositions are necessary that facilitate the learning processes. This is especially the case for dealing with complex, cross-boundary and large-scale resource systems, such as the groundwater systems in Morocco, Kenya, Tanzania, South-Africa and India analyzed in this report. We provide a set of ten refined and extended institutional design propositions for groundwater governance and climate change adaptation (see Table 12), based on the work of Ostrom (1993, 2005) and Huntjens et al. (2012). Together they capture structural, agency and learning dimensions of the governance challenge and *they provide a strong initial framework to explore key institutional issues in groundwater governance*. These institutional design propositions support a "management as learning" approach to dealing with complexity and uncertainty. They do not specify blueprints, but encourage groundwater governance tuned to the specific features of local geography, ecology, economies and cultures. The report, especially in chapter 5, highlights some of the principles and suggests ways to implement them.

Table 12. Ten Institutional Design Propositions for Complex (Ground) Water Governance Systems and Climate Change Adaptation

Institutional Design Proposition	Explanation
1) Clearly defined boundaries	Defining the boundaries of the resource system and of those authorized to use it can be thought of as a first step in organizing for collective action (Ostrom, 1993). When confronted with social and physical challenges (e.g. the impacts of climate change on groundwater), it is important to clarify who is affected by this problem and who has the responsibility, capacities, access to resources and information to deal with it (Huntjens et al., 2012).
2) Equal and fair (re-distribution of risks, benefits and costs)	Those who receive the highest proportion of the water also pay approximately the corresponding share of the fees (Ostrom, 1993). Within the context of climate change, or other external disturbances, it is important that stakeholders at risk are given opportunities to participate in reshaping and reducing the risks to which they are projected to be exposed. This requires engagement with, and strong representation of, groups likely to be highly affected or especially vulnerable (Huntjens et al., 2012).
3) Collective choice arrangements	Most individuals affected by operational rules can participate in modifying them (Ostrom, 2005). In large-scale resource systems it is important to enhance the participation of those involved in making key decisions about the system, e.g. on how to adapt to climate change (Huntjens et al., 2012).
4) Monitoring and evaluation	Monitors who actively audit CPR conditions and appropriator behavior are accountable to the appropriator and/or are the appropriator themselves (Ostrom, 1993). Additionally, it is also important to monitor and evaluate decision-making and the development and implementation of policies (Huntjens et al., 2012). An important measure is to have agencies at least review the impacts of their policies and other interventions (Huntjens et al., 2012). The process of monitoring and evaluation serves to adjust the course of action and motivate those driving the processes. Actions and objectives can then be adjusted based on reliable feedback from the monitoring programs and improved understanding (Nyberg, 1999).
5) Graduated sanctions	Appropriators who violate rules are likely to receive graduated sanctions (depending on the seriousness and context of the offense) from other appropriators, from officials accountable to these appropriators, or from both (Ostrom, 1993).
6) Conflict prevention and resolution mechanisms	Appropriators have rapid access to low-cost, local arenas to resolve conflicts among appropriators or between appropriators and officials (Ostrom, 1993). In complex water governance systems we can also observe a number of conflict prevention mechanisms, such as timing and careful sequencing, transparency, trust-building, and sharing of (or clarifying) responsibilities (Huntjens et al., 2012).
7) Minimal recognition of rights to organize	The rights of appropriators to devise their own institutions are not challenged by external governmental authorities (Ostrom, 1993).
8) Nested enterprises / polycentric governance	The design of robust systems of common pool resources that are larger and more dynamic (as in the case of transboundary river basins or groundwater systems) and also involve multiple stakeholders is characterized by the presence of governance activities organized in multiple layers of nested enterprises (Ostrom, 2005). Nested enterprises are functional units to overcome the weakness of relying on either just large-scale or only small-scale units to govern complex resources systems.
9) Robust and flexible processes	Institutions and policy processes that continue to work satisfactorily when confronted with social and physical challenges but, at the same time, are capable of changing (Huntjens et al., 2012). Building trust and reciprocity are important elements of a robust and flexible process (Huntjens et al., 2012). Robustness of a water governance system may be enhanced by cross-sectoral policy integration or mainstreaming climate adaptation, because it reduces the incidence of large adverse side-effects and feedbacks or maladaptation (Dovers and Hezri, 2010).
10) Policy learning	Policy and institutional adjustments based on commitment to dealing with uncertainties, deliberating alternatives and reframing problems and solutions (Huntjens et al., 2012).

Source: Based on Ostrom (1993, 2005) and Huntjens et al. (2012).

Annex 3. Analyzing Groundwater Governance

A bespoke theoretical framework was synthesized from the literature as a basis for analysis and for the identification of governance gaps and possible ways forward. The analysis drew examples from both the literature and a detailed review of the governance arrangements of five countries to understand the main issues and bottlenecks for groundwater improvement. The synthesized theoretical governance analysis framework and the more applied approach to the case studies, capturing issues across both strategic and local levels, are presented here.

Dimensions of Groundwater Governance

This section summarizes essential dimensions that need to be addressed to analyze water governance capacities and related challenges. The framework presented below is a hybrid of different frameworks developed by Huntjens (2011), Huntjens et al. (2010, 2011a, 2012), Pahl-Wostl and Lebel (2010) and the OECD report on Water Governance (2011). For the purposes of the analysis in this ESW report a distinction is made between context, water governance capacities and performance as presented in Figure 9.

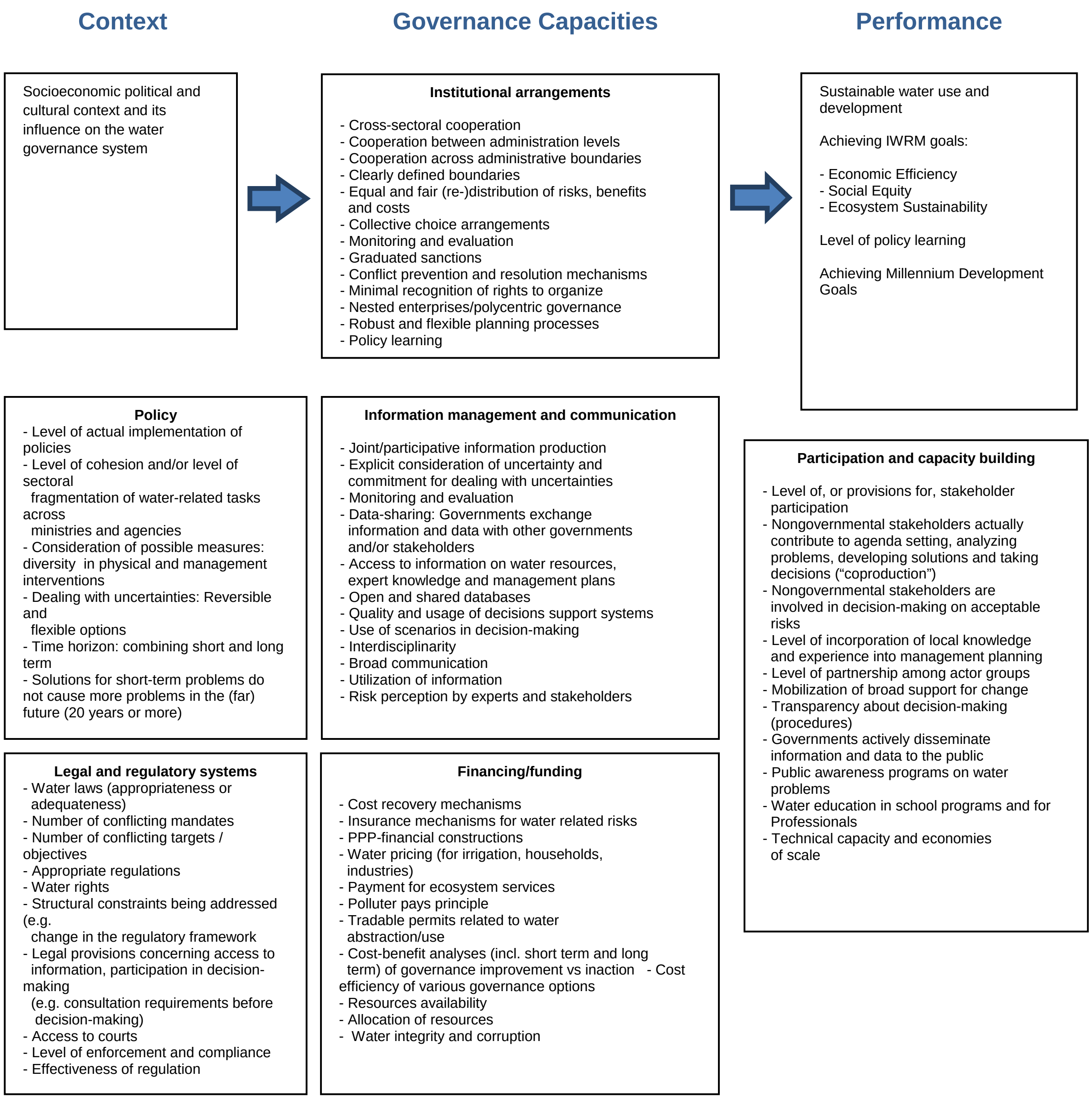
The socioeconomic, political and cultural contexts for water governance vary greatly among places and countries with respect to histories of settlement, ethnicities, and class and gender relations. Hence, the context in which a water governance system is embedded has a strong influence on the system and its performance. As a result, institutional reforms may lead to quite different outcomes. To move away from simplistic panaceas, context variables need to be taken into account (Ostrom et al., 2007; Harrison, 2006; Pahl-Wostl, 2009; Pahl-Wostl and Lebel, 2010).

The six elements presented above are not mutually exclusive, and there might be cross-cutting issues and interdependencies. For example, sectoral fragmentation of water-related tasks across ministries and agencies is considered a policy gap, a legal gap and an institutional gap, albeit from a different perspective and/or different indicators.

It is important to note that this report uses the analytical framework as a heuristic device in order to identify and highlight predominant governance issues based on the case studies. This means that not each and every variable of the framework will be covered and/or described in full detail (Chapters 4 and 5), but only the ones that stand out according to the empirical analyses.

This report does not attempt to fully evaluate the performance of different modes of governance, although this has been put forward by many authors as a key focal area for future research (Jordan, 2009; Biermann et al. 2009; Pahl-Wostl, 2009; Huntjens, 2011). Measures for the performance of a groundwater governance system should allow for assessing and evaluating the degree of satisfaction with the current state of groundwater governance. Obviously a governance system should achieve its stated goals. Failure of doing so is a clear sign of a non-satisfactory performance without alluding to any normative claims (Pahl-Wostl and Lebel, 2010). This report does not take performance into account in the case study reports, but it is strongly recommended as a follow-up activity.

Figure 9. ESW Theoretical Analytical Framework for Water Governance (developed by P. Huntjens)



Judging performance, or the effectiveness, of a water governance system is challenging for several reasons. First, identification and attribution of specific outcomes is often confounded by other social and political processes that surround the management and governance of water resources. Second, the outcome of management measures is uncertain due to the complexity of the system to be managed and uncertainties in environmental and socioeconomic developments influencing the performance of implemented management strategies. It is therefore important to monitor the water governance systems for a longer period and on a frequent basis. Third, the relevance and meaning of indicators for success or failure may be judged differently by different groups, leading to different assessments of the performance of water governance systems (Pahl-Wostl et al., 2007). Nevertheless, some approaches are likely to be useful without alluding to any normative claims. One approach is to assess the achievement of stated goals (for example the Millennium Development Goals related to water resources or IWRM goals), including economic efficiency, social equity and ecosystem sustainability. Process criteria are also useful for assessing performance, such as access to resources like information, clear task definition, structured decision-making and cost-effectiveness. Governance systems that make an effort to elicit consideration of alternatives should also take into account other criteria related to being visionary and deliberative (Dore, 2007).

In governance systems confronted with disturbances, crises and/or external changes, such as the impacts of climate change and related uncertainties, it is important to assess the level of policy learning (Huntjens et al., 2011). A formal comparative analysis of eight water governance systems in Europe, Africa and Asia has shown that systems with a higher level of policy learning also have more advanced adaptation strategies in place for dealing with the impacts of climate change on water resources (Huntjens et al., 2011).

Annex 4: Incentives and Tools for Groundwater Management: Description and Conditions for Application

This annex describes the main instruments used to manage groundwater, with a specific focus on economic instruments. Advantages and disadvantages of each instrument are discussed and illustrated through examples.

Prescription

Description - This strategy consists of prescribing the water quantity (or quality[34]) allocated to each user or to a group of users through quotas. Quotas can placed on volumes (requiring a water meter system) or on time (for collective irrigation wells for example). Quotas on volume are often determined each year depending on the recharge.

Pros and cons – Quotas are one of the main instruments used to manage water demand for irrigation (Molle and Berkoff, 2008) and groundwater over-abstraction (Giordana and Montgimoul, 2006). Reasons of this predominance include transparency, ability to ensure equity, capacity for adjusting to inter-annual recharge variability, and limited losses of incomes (Molle and Berkoff, 2008). If water supply is short of demand by, say, 30 percent, quotas consist in reducing every user 's supply by 30 percent, while regulation through prices consists of raising prices until the least economically efficient operators reduce their overall demand by 30 percent (Molle, 2009).

However, regulation through quotas involves high transaction costs associated with implementation and enforcement, especially when there are millions of scattered borehole owners in the countryside. In addition, quotas foster equity at the cost of efficiency because the government agency does not have the information to best allocate the water between users. In addition, the system often lacks flexibility in response to a changing environment. Quotas may be subject to arbitrariness if their definition is not transparent. Enforcement and control requires strong and credible institutions, and few users or a participatory approach for collective quotas. Lastly, a quota system provides less incentive to change user behavior compared to other instruments (Tiwari and Dinard, 2003).

Examples - Quotas help conserve groundwater in Israel. Quantity and quality standards are established by the Water Commissioner. Farmers are not allowed to use water in excess of the amount allocated to them, even if they have their own well. Water meters at the well are read and controlled by staff of the Water Commissioner's office. In 1999, after severe depletion of the country's water resources, the Water Commissioner imposed a 40 percent average reduction in water quotas for agriculture (1998 was set as the basic year for the cut), which was increased to 50 percent in 2000-2002 (World Bank, 2006). Note that in addition to the quota system, farmers pay their water following an increasing block rate.

Individual and collective quotas are used in France to cope with water scarcity, with an increased participation of users. In the Beauce area, where groundwater was severely depleted after several droughts, the representatives of the irrigators' association and the authorities decided to meet annually and assess aquifer trends. At these meetings, they come to agreements on the maximum volume available and the quotas for farmers. In order to receive European Union subsidies, users must provide information on the location of wells and install water meters.

[34] Regulatory instruments are also the most common instrument used to address non-point source pollution.

Mexico and Spain also have a quota system, but the impact of this strategy on groundwater conservation is uncertain. In Mexico, the government announced the decision to withdraw unused portions of groundwater quotas, which generated a “use-it-or-lose-it” reaction among farmers (Shah, 2007).

Penalty

Here we discuss two types of penalties: groundwater pricing, and fees and taxes. Groundwater pricing involves imposing and increasing volumetric tariffs. Fees and taxes include taxes on production and other inputs (energy, fertilizers, or pesticides), as well as taxes imposed on the proportion of the area under irrigation, taxes that depends on the technologies and practices used, and betterment levies on land. These types of penalties can be combined in instruments such as the two-part tariff, which involves a volumetric and a per hectare tariff.

Pricing groundwater - Water pricing is the most commonly used economic instrument for quantitative (ground)water management of domestic and industrial uses. It is also a means to cover maintenance costs and support water management programs. The level and structure of water prices vary between countries and regions, leading to different effectiveness in providing incentives for sustainable water use and different levels of cost recovery (Acteon, 2009). Volumetric rates, increasing block rates or seasonal rates (peak and off peak prices) are often applied, although decreasing block rates for water supply may also exist (to account for the decrease in marginal cost; however, this reduces the incentive to conserve water).

Charging the full cost is almost never socially and politically possible. Depending on the standpoint, the price of water should relate to the marginal cost (economic efficiency), the social opportunity cost (allocative efficiency, which includes present and future uses), or the environmental cost (ecological efficiency). In addition, price should also take into account the farmers' willingness to pay. Reviews of international experiences show that users are never charged the full price of water (Molle 2009). In practice, prices are the result of a compromise between economic efficiency and social acceptability. In the agricultural sector, the use of (ground)water pricing is mainly oriented toward revenue generation and recovery of administrative cost, rather than toward economic efficiency or incentives for users to change consumption patterns (Tiwari and Dinar, 2003; Molle, 2009). Even in many developing countries, the water utility charges tariffs that are substantially below the full cost of service (Nauges and Van den Berg, 2006).

Pros and cons – The merits of introducing a price for water are its potential to increase water conservation and government revenues, and improve the government’s knowledge about water use.

Increased water conservation – especially in the domestic and industrial sectors just after the implementation of the pricing policy. In Canada, water use was 70 percent higher in 1999 when consumers faced flat monthly rates rather than volume-based rates. However, this impact wanes once the volumetric rate is in place because demand is rather inelastic.

Increased government revenues – and, in addition, cover (part of) the cost of service and administrative costs (including monitoring and control).

Improved government knowledge about water use – calculating the full cost of water is also a way to quantify the externalities and inefficiencies in the system, which can be addressed using other instruments.

The main drawbacks include increased costs for users, the fact that it is an expensive water conservation strategy, and the lack of incentives it provides in the irrigation sector.

Increased costs for water users and concomitant reduction in equity – poorest users must be protected from their potential inability to gain access to water because of the financial constraints imposed by its price. It is essential that negative incentives be accompanied by positive measures offering attractive alternatives (market opportunities, subsidies for modernization, technical advice, etc.) and exit options with compensation.

Volumetric pricing is needed to address water conservation issues makes this strategy expensive, especially when applied to the agricultural sector. Small users who abstract less than a given volume of water can often access water free of charge because, in such cases, the costs of collecting the fee may outweigh potential revenues. Remote sensing techniques can be used to calculate groundwater use (Kemper, 2007).

Water prices in the irrigation sector are generally low and do not provide incentives to save water (Molle, 2009). In this case, water pricing could be used as a means to raise revenues to pay for groundwater programs rather than as an incentive to conserve water.

Examples - Balilia et al. (2001) used a combination of simulation and optimization techniques to analyze the impacts of irrigation water pricing and agricultural policy scenarios on aquifer conservation in Iran's Hamadan-Bahar plain. Their analysis indicates that water pricing by itself can considerably reduce the agricultural demand for aquifer groundwater.

The best known case of water pricing for agricultural use is in Israel where all irrigation diversion and delivery points are metered and closely monitored. The extraction fee reflects the scarcity value of water (not the cost of supply) and complements the quota system. Other economic incentives have stimulated the use innovative technologies, most obviously in irrigation, but also in manufacturing and urban water use.

Water pricing was introduced in Jordan in 2002 as a demand management tool (El Nasar, 2009). Before then, the system relied on water permits issued by the Water Authority that specified the maximum volume of abstraction for a well (quota). Under the new system, the prices levied depend on the volume extracted annually (which is free for less than 150,000 m^3, with an increasing block rate for higher volumes). During the first few years of implementation (2002-2007), there was a significant reduction in over-pumping of groundwater (El Naser, 2009). However, enforcement of metering requirements has not been easy because of technical, financial and administrative constraints. More than a quarter of existing wells are unlicensed and fees are not collected from the majority of wells used for agricultural. When this fee structure was established, the amount of water pumped by some small farmers actually increased to the free-of-charge limit (USAID, 2007). Currently, the price of water for irrigation does not seem to be a limiting factor for farmers, except for those growing on the most marginal land. Venot and Molle (2008) argue that substantial increases in volumetric charges would not result in major water savings, but would further decrease the income from low-value or extensive crops. A shift towards high-value crops would raise water productivity, but would also entail a transfer of wealth to the government and to wealthier entrepreneurs. According to these authors, prices are unlikely to enable regulation of groundwater abstraction and significant reduction will only be achieved through policies that reduce the number of wells in use (such as buying out the wells).

Six of Canada's thirteen provinces and territories charge for groundwater extraction (Nowlan, 2005). Generally, only industrial or commercial users pay fees, and usually only when water usage reaches a relatively high level. Water use measuring is generally imposed as a condition of licensing. The social and environmental costs are external. For example, Ontario defines full cost as the "…full cost of providing the water services [including] the source protection costs, operating costs, financing costs, renewal and replacement costs, and improvement costs associated with extracting, treating, or distributing water to the public and such other costs as may be specified by regulation."

In the United States, California assesses an annual water rights fee to each holder of a permit or license based on the volume of water in acre-feet (one acre-foot = 1233 cubic meters or 1.2 million liters) authorized for diversion under that water right permit or license.

Other taxes and fees - The range of taxes or fees that indirectly affects groundwater uses is large, and the choice depends on the policy objective and the targeted users. To limit agricultural groundwater abstraction, taxes (or decreases in subsidies) on energy or on irrigated crops are often proposed to address the issues of lack of information. For non-metered agricultural abstraction, fixed charges per hectare can be used, as for example in the Seine-Normandy river basin district in France (Acteon, 2009). In developed countries, taxes are also used to address diffuse pollution issues. In theory, environmental taxes should be based on the Pigouvian concepts of equating marginal benefits with marginal cost. However, doing so requires information on both of these variables, which may be expensive. For industries whose level of consumption is unknown, an industry-specific coefficient can be applied for transforming abstraction into consumption (Acteon, 2009). Current levels of taxes and charges remain very low compared to production cost. For example, in the Netherland, the price of groundwater accounts for 0.03 percent of the industry turnover (Ecotec, 2001).

The ambient tax is proposed by the economic literature to solve diffuse pollution problems and could be adapted to manage groundwater when individual withdrawals cannot be observed (Segerson, 1988; Giordana and Montgimoul, 2006). To design the ambient tax, authorities must begin from an observable variable that, although it is affected by individuals, the individual decisions are not observable. One example would be withdrawals (unobservable decision) of groundwater (observable variable). Another example is the level of pollution (observable variable) and or non-point source pollution (unobservable decision). The variable in these equations is the collective tax (or subsidies) applied, which would be above (or below) a specified target.

Pros and cons – Some of the advantages of relying on taxes to affect groundwater use does not require knowing individual withdrawals. In addition, in some cases, tax changes can influence behavior, and they can become a source of addition resources for the government, which can then use those funds to support projects for alternative supply or environmental protection.

However, setting up a tax mechanism requires a high level of information in order to quantify the users' demand functions and the environmental impacts. Moreover, the political acceptability of relying on tax mechanisms may be quite limited. For example, energy pricing is often an effective means to subsidize rural producers, so the social impact of increasing energy prices should be carefully assessed.[35] Finally,

[35] Kemper (2007) suggests providing lump sum payments for poor farmers rather than subsidies for everyone.

collective taxes may breed an implicit unfairness in that complying individuals may pay for the gains of others.

Examples - In India, regulation, water pricing or property right reforms are unlikely to reduce groundwater extraction because of the logistical problems of regulating a large number of small, dispersed users. However, electricity supply and pricing policy are powerful tools for indirect management of both groundwater and energy use.

Although estimates of the price elasticity of taxes on pesticides is low, these taxes exist in Denmark, Norway, Finland, Sweden, France and Belgium, where reductions in pesticide use have been noticed after their introduction (Acteon, 2009).

Ambient taxes have been studied theoretically but rarely applied. In Ethiopia, some field experiments show that the high collective tax is an efficient and relatively reliable mechanism to solve the problem of excess exploitation of an open-access common pool resource (biodiversity conservation) (Reichhuber et al., 2009).

Property Rights

Description - The total maximum volume that can be extracted is converted into a number of individual (or collective) rights (also called concessions, permits, licenses, or entitlements), which can be allocated to individual (or collective) users. Usually, property rights are assigned on the basis of traditional rights, resource mobilization patterns and land entitlements. The basic difference between a quota and a right allocation is that the former may have various conditions attached to it, including a predetermined price, and be subject to modifications based on external conditions and number of users (Tiwari and Dinar, 2003). The ability to trade rights introduces an increase option for allocative efficiency, provided the water rights system is well codified (Kemper, 2007)

Pros and cons - Systems based on property rights are used to ensure an optimum allocation of water within or between sectors. The allocation of ownership to water users can also increase farmers' willingness to invest in water conserving technologies (Tiwari and Dinar, 2003).

However, groundwater rights do not resolve the problem of over-exploitation. Experience shows that the level of abstraction rarely decreases. In addition, setting up property rights requires strong institutions to ensure a credible sanctioning system and to protect against the development of potential monopolies. Besides, markets may not be very active if transaction costs are high. Lastly, shifting from quotas (resource owned by the state allocated for a specific use) to tradable water rights may encounter cultural resistance as well as opposition from vested agricultural interests (Molle, 2009)

Examples - Water markets have been established in the United States, Australia, Chile, Spain and Mexico. In Chile, market incentives to promote more efficient water use, particularly within the agricultural sector, have not worked as expected, and irrigation efficiency remains low nationwide (Bauer, 2005). Similarly, most groundwater user groups in Mexico have not restricted total use of the aquifer (Kemper, 2007). In the Rio Grande water market (New Mexico), annual and permanent water rights are leased and traded, usually within the same sector. Although it has led to an efficient allocation, it resulted in little investment in efficient technologies, and total water use has actually increased. Issues of fairness were also raised, as smaller and poorer user organizations and municipalities face a disadvantage (Acteon, 2009).

One of the areas where groundwater abstraction has decrease is Arizona, where total permitted abstraction volume decreases were based on assumed changes in technology (Kemper, 2007). Shah (2008) reports that, out of 431 groundwater basins in California, only 19 are actively managed, implying some restrictions on pumping. Active management basins are generally overlain by highly urbanized areas where governments or municipalities can easily buy water rights to serve high paying urban consumers. In all the rest, groundwater management is passive, basically involving federal government grants to build infrastructure to import surface water and supply it to users.

Payments

Description - This category includes investments for alternative resources (dam), and subsidies to induce changes in behavior (improved practices, for example) to improve equity, or to assist the economic transition to a less consuming activity. For example, subsidies of technological improvement (e.g., in the form of tax credits or grants) in water conservation technologies can be paid to the farmers on the basis of per unit water saved or designated types of water saving technologies. This will be efficient in term of water saving only if farmers do not expand their field or increase their cropping cycle (but incentives are great).

Voluntary approaches are being increasingly applied, especially for limiting diffuse pollution. They include, for example, contracts on specific agricultural management practices that specify compensation payments to farmers. Competitive payments where users should be proactive can also be used; this also allows shifting the information burden to the landowners. As payment value is often difficult to price, voluntary agreement creates a market to value environmental services.

Subsidies to assist the economic transition of changing from agricultural to nonfarm systems may include proactive migration and commuting, access to transport and markets, access to social networks, access to credit and financial institutions, or access to education (Moench, 2007). The resources to carry this out can be provided by the government, by the water agency that collects water or pollution fees, or by those who pay for environmental services, who could be private entities (Salzman, 2005).

Pros and cons - This strategy is often well-accepted by groundwater users, and can be a solution when enforcement of other instruments is not possible for political reasons.[36] Payments can accelerate changes in behavior and encourage them to be more in line with sustainable practices. Voluntary agreements provide additional flexibility and can be adapted to local constraints. As noted by Montginoul (2011), these arrangements could be used to manage groundwater if farmers have financial incentives to adhere, if society accepts to pay the cost of these arrangements, and if they are only temporary measures that help farmers to change their behavior. According to her study, the absence of arrangements organized up to now on groundwater can be explained by: “the difficulty of identifying liabilities and defining what we understand by overexploitation, the absence of water rights and the limited economic interests of an overexploited aquifer for which the consequences will appear only after a very long period of time.

Subsidies or payments should to be implemented only for the transitional period required for making a shift towards the adoption of water saving technologies or practices. Otherwise, there is a risk of making farmers overly dependent on such grants and credits. In addition, the impacts on poor households and rural employment opportunities of eliminating these subsidies could be potentially high (Tiwari and Dinar,

[36] For example, when reforms may be subject to local, state and national coercion because users (farmers especially) are part of the polity.

2003).

Arguments for payment are controversial as it means paying polluters to reduce their harms. Unable to force the polluting or abstracting source to pay for the costs it imposes, the beneficiaries must instead pay the source to reduce its activities. Some may argue that effective nonpoint source regulation and enforcement could be feasible (Salzman, 2005).

Examples - A classic example of a government paying for improved groundwater management is illustrated by the Pegeia aquifer in the western part of Cyprus. Several measures were undertaken to reverse increasing exploitation trends, and address potential sea water intrusion and pollution risks. First the development of alternative water supply sources for irrigation financed by the government reduced drastically abstraction by farmers. Then, financial incentives were proposed to promote technological adjustments aimed at water conservation in the domestic sector.[37]

In Morocco, the change in irrigation technology (switch to drip irrigation) is subsidized by the government. Again, this strategy can save water if farmers do not expand their field or increase their cropping cycle.

In Europe, agro-environmental subsidies can be granted to famers who stop irrigation on plots located in water scarce regions. This measure is used for instance in the Marais Poitevin region (France), which is suffering from high water stress. However, only a limited number of contracts have been signed so far. Investigations of farmers showed that the level of the subsidy was not sufficient. In addition, there is high uncertainty on the length of time during which the subsidy will be available (Acteon, 2009).

Only few voluntary agreements on groundwater were found in the literature. One well-described example is that of Vittel in France (Salzman, 2005). In the Boutonne river basin in France, which suffers from important water shortages combined with water quality problems, a drinking water company has been acquiring boreholes from farmers to access good quality groundwater in exchange for financing reservoirs for irrigation (Acteon, 2009).

[37] INECO Guideline towards the application of institutional and economic instruments for water management in countries of the Mediterranean basin (INECO project).

ex 5. Assessment of Case Study Aquifers Against GWMATE Regulatory and Operational Governance Featu

13. GWMATE Assessment of Case Study Aquifers

ernance ture	India						Kenya				Morocco				South Africa										Tanzania		
	Punjab		Maharashtra		Kerala		Merti	Nairobi	Tiwi	Baricho	Souss-Chtouka		Haouz		Botleng		Steenkoppies		Bapsfontein		Houdenbrak		Dinokana-Lobatse		Makutupora	Babati	Arusha
	Provision	Capacity	Provision	Capacity	Provision	Capacity					Provision	Capacity	Provision	Capacity	Provision	Capacity	Provision	Capacity	Provision	Capacity	Provision	Capacity	Provision	Capacity			
ng permits & use rights	2	0	3	1	3	1	1	1	1	1	2	1	2	1	2	1	2	2	2	1	1	1	2	1	3	3	3
s to reduce abstraction	2	0	2	1	2	1	0	0	0	0	2	3	2	0	1	1	1	1	0	0	0	1	1	1	1	1	1
s to control ehole drilling	2	0	2	1	2	1	0	0	0	0	2	1	2	1	2	1	2	2	0	0	0	0	1	1	0	0	0
ctions against al well ration	2	1	2	1	2	1	0	0	0	0	2	1	2	1	1	1	3	2	0	0	0	0	0	0	0	0	0
d use controls polluting vities	-	-	-	-	-	-	0	0	0	1	2	1	2	1	1	0	2	1	1	1	0	0	0	0	0	0	0
ernment tution as urce guardian	1	0	2	1	2	1	1	1	1	1	2	1	2	1	1	1	2	2	1	0	1	1	1	1	0	0	0
nmunity fer anizations	1	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0	2	2	0	0	1	1	1	0	1	1	1
lic cipation in management	2	1	2	1	2	1	1	0	0	0	0	0	0	0	1	1	2	3	1	0	1	1	1	1	1	1	1
management on Plans	0	0	2	1	1	0	0	0	0	0	3	2	2	1	3	0	0	2	0	0	1	0	2	1	1	1	1

osent; 1 = Weak; 2 = Acceptable with room for improvement; 3 = Satisfactory

Annex 6. Groundwater Management and Governance in Spain and Jordan

Spain[38]

In Spain, approximately 75 percent of groundwater abstracted is used to irrigate 30 percent of the total irrigated area. Overall, groundwater provides 20 percent of the total water used for irrigation in Spain (Molinero et al., 2011).

Historically, groundwater abstraction rights in Spain were tied to land ownership. The first Spanish Water Law in 1879 gave private groundwater rights to every land owner. Groundwater was defined as a private domain and remained outside the control of the state.

The first major reform of the 1879 Water Law occurred in 1985. The new Water Law redefined groundwater abstraction rights and declared all aquifers as public domain. The state would regulate groundwater abstractions through concessions for all users issued by River Basin Authorities. The new law, however, left the historical private groundwater rights in the hands of their owners, giving them the option to either (i) retain their private property rights until 2038 and then seek to convert them to a concession or (ii) remain private permanently but register their rights in the Catalogue of Private Waters (Molinero et al., 2011).

The reticence of groundwater users to lose any formal historical private rights coupled with the inability, lack of funds and the politically controversial aspect of government enforcement of these measures has led to a situation where thousands of wells have been constructed outside the regulatory framework established by the 1985 Water Law (Fornes Ascoiti et al., 2005). Despite different state-wide programs since the mid-1990s to rectify the lack of control of groundwater abstractions and to quantify and establish an inventory of groundwater rights in Spain, the results have been partial and inconsistent due to *lack of funding* and difficulties obtaining the cooperation of farmers and well owners (Fornes Ascoiti et al., 2005). Additionally, the *increasing politicization of water management* competencies between River Basin Authorities, the newly formed regional governments after the end of 40 years of centralizing dictatorship, and the central government in Madrid, has also helped fuel the conflict between users and the state. As a result, although the existing number of wells is officially around half a million, studies have ventured to suggest that up to 2 million wells might exist in Spain (Molinero et al., 2011).

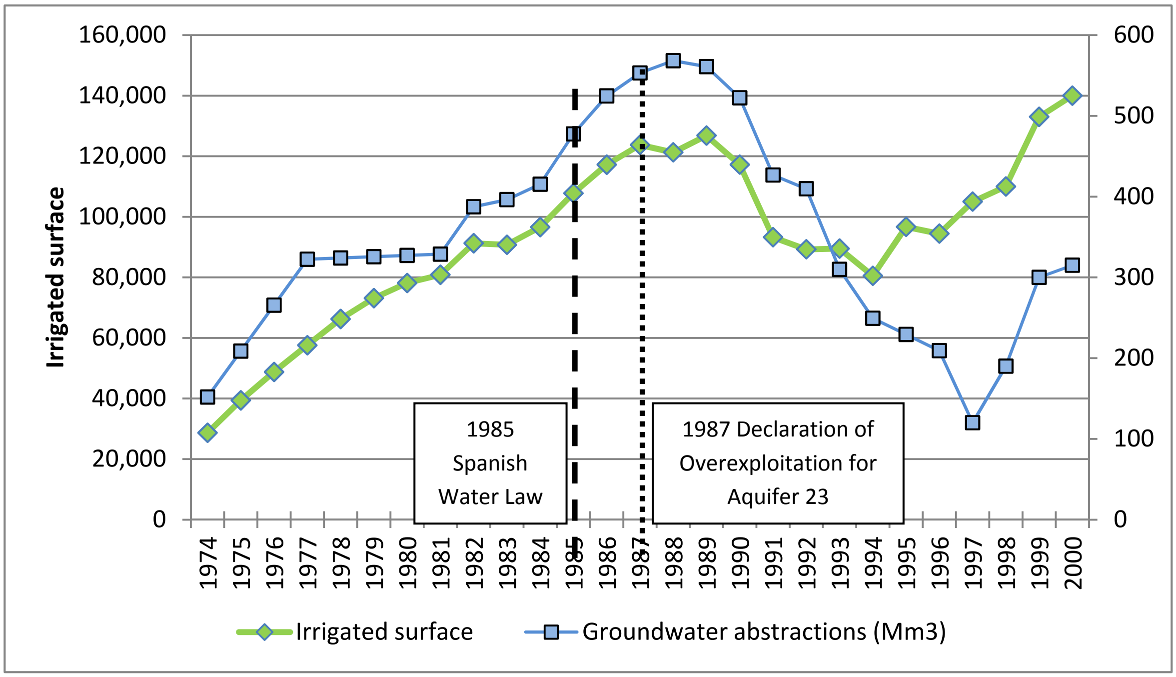
Over-abstraction of Groundwater in Spain: The Case of La Mancha and Aquifer 23

Until 1985 the lack of regulation and public control associated with the establishment of *exclusively private groundwater abstraction rights* went in parallel with the development of intensive irrigation and increase in crop yields that brought significant economic and social benefits for agrarian communities. The fact that no mechanisms to control groundwater abstractions existed led to an unsustainable situation where socioeconomic structures depended on fragile environmental processes of groundwater replenishment.

[38] Section written by Alvar Closas, DPhil candidate, University of Oxford, based on ongoing research.

In the region of Castilla-La Mancha (central Spain), traditional groundwater irrigation via a shallow water table served to sustain the basic food needs of the population. Aquifer 23 in La Mancha naturally covered 55,000 hectares holding more than 12,000 million cubic meters of water before modern irrigation began in the 1970s. The transformation of dry and extensive agriculture into intensive groundwater irrigation through large public irrigation projects and the support of private initiatives through *subsidies* (national and European through the Common Agricultural Policy) caused the water table to fall by up to one meter a year in the past thirty years. From the 1970s to the 1990s, groundwater irrigated land increased from 34,000 hectares to 130,000 hectares (See Figure 10). By 1987 the irrigated area represented 6.6 percent of the total increase in irrigated surface at the national level. Between 1970 and 1990 the region has seen a ten-fold increase in land area irrigated for agriculture (Bromley et al., 2001).

Figure 10. Irrigated Surface and Groundwater Abstractions in Aquifer 23, La Mancha



Source: Based on Lopez-Gunn and Hernandez Mora 2001 and Martinez Cortina 2011.

The *new legal framework* put in place with the 1985 Water Law also allowed the state to declare aquifers overexploited and to *enforce special regulation regimes* of emergency groundwater abstraction rights. The new Water Law grants River Basin Authorities large management powers to enforce pumping restrictions in both the public and private property regimes as well as the creation of *groundwater user associations* (Molinero et al., 2011). For Aquifer 23 in Castilla-La Mancha, the declaration of overexploitation was approved in 1987 along with the emergency management plan for the aquifer.

In spite of these measures, the *lack of enforcement and control* powers of the River Basin Authority, the profitability of water-intensive crops at the time and several drought episodes have led to an increase in illegal pumping since the 1990s. Prosecution by the River Basin Authority of *illegal abstractions* and *unsuccessful attempts to install water meters* have also partially paralyzed its resources and helped sustain a generalized sense of distrust and impunity among farmer groups (Martinez-Santos et al., 2008).

Opportunities for Groundwater Governance in Spain

In many places, the lack of regulation existing as a consequence of the system of private groundwater rights resulted in the depletion of groundwater levels and the development of an *unsustainable socioeconomic and natural disequilibrium*. The depletion of groundwater reserves in places like La Mancha not only emphasizes the need to develop regulatory systems to control groundwater abstractions, but also exemplifies the complex and inter-connected reality between natural and social systems

Under the 1879 Water Law, water user participation was understood in Spain as the right of every irrigator to establish self-governing institutions for the common management of water for irrigation. The changes brought by the new 1985 Water Law expanded this concept and allowed *collective management* institutions to have an active presence not only at the local level but also in higher levels of the formal structure of water management decision-making (Lopez-Gunn, 2003).

However, due to the highly politicized water management arena, the acceptance of this new regulatory framework by water users remains incomplete. The negative reaction at the local level of *initiatives imposed from the top down* and the *lack of trust* by many individual farmers and irrigators undermines the proven self-government capacities of this type of institutional arrangements. In addition, unsustainable practices incentivized by heavy public subsidies and animosities between users and the state have also distorted the potential for success of these organizations (Lopez-Gunn and Martinez-Cortina, 2006).

The fragmented political reality of groundwater management institutions in Spain shows the need to establish clear institutional rules to foster the potential of local social capital for groundwater management. However, these rules have to be accompanied by flexible and adaptive solutions aligned with the different social, economic and environmental needs derived from the use of groundwater

The *lack of independent and de-politicized groundwater knowledge* increases the levels of uncertainty and conflict and decreases the capacities of individuals and the state to jointly address the need for sustainable groundwater management. The use of *modern technology* to monitor and map groundwater abstraction (e.g. meters, remote sensing) needs to be implemented and placed in the hands of independent regulators.

Finally, management of groundwater governance in Spain also needs to pay attention to the *transitional stages of groundwater governance regimes.* The translation of historical abstraction rights (private rights) into new institutional structures (concession, regulation and control) might open the door to future conflicts that can remain latent for a long time. Such management needs to be flexible to cope with the sometimes chaotic nature of groundwater abstraction rights, which can become challenging without strict regulation and enforcement.

Jordan

Jordan is one of the world's most water scarce countries. In response to historical over-exploitation of many national aquifers, a 1997 *national water strategy* (supported by the World Bank) promoted a paradigm shift from supply augmentation towards *demand-management instruments*[39] to help control groundwater abstraction. It was intended to maximize utilization and minimize wastage through the promotion of water use efficiency and conservation measures to contribute to *social and economic development and environmental protection*. Pricing policies were deemed to assist in controlling groundwater abstraction and shifting towards higher-value crops. In the 2000s, a *Groundwater Control Bylaw* established a quota of 150,000m^3/yr per well and a *block tariff system* was activated beyond that quota for upland areas. To achieve that, *Groundwater User Associations* at the groundwater basin level were to be established and *participatory approaches* promoted to facilitate cooperation with decision-making authorities. Hence, the national objectives for groundwater are aimed at development of the resource and its protection and management, and the measures needed to bring the annual abstractions from the various renewable aquifers to the sustainable rate of each.

The challenge was to devise a system to control illegal groundwater abstraction, license well drilling, and code and record the location of groundwater abstraction sites nationally. To facilitate this, Jordan has established a detailed *metering system* and thorough *national accounting system* that relates physical water flows to the economy and enables an environmentally extended input-output analysis. Data are collected and analyzed from across the country, including real-time and telemetry data, and stored in a central database for analysis. A range of software-based analysis and planning tools have been integrated into national planning and operations processes. The process has been accompanied by a promotion of cooperation between the Ministry of Water Infrastructure (MoWI) and the Department of Statistics (DoS). A *national water information system* could ultimately contribute to an even more comprehensive national environmental information system.

The *groundwater policy* provides comprehensive guidance on many pertinent issues related to resource exploitation; monitoring; resource protection, sustainability, and quality control; resource development; priority of allocation; regulation and control; legislation and institutional arrangements; research, development and technology transfer; shared groundwater resources; and public awareness. Some of the more innovative guidance issues include: specific investigation of brackish waters for augmentation purposes; compilation of oil and gas drilling data to understand deep aquifer potentials; advanced technology utilization (i.e. telemetry and automation); specific fossil aquifer management conditions; cooperation with the Ministry of Agriculture to regulate type and application rate of surface applicants; groundwater priority allocation to activities deemed to have higher returns in economic and social terms; comprehensive groundwater basin management plan for each aquifer; cooperation with other

[39] Demand management options include measures as diverse as participatory water management, modernization and rehabilitation of existing water supply projects, technical on farm improvements, conservation methods, reuse of treated wastewater, rainwater harvesting, water pricing or reallocation policies, etc. (Venot&Molle, 2008).

organizations that may impact the water sector; regional data exchange; and farmer education on groundwater protection.

While many see Jordan as an example that may have replication potential for other MENA countries and beyond, authors such as Venot and Molle (2008) question the merits of increasing volumetric charges by suggesting that prices may be unlikely to regulate groundwater abstraction and that significant reduction may only be achieved through policies that reduce the number of wells in use. Perhaps only time will tell whether Jordan's approach is effective and sustainable.

Sources: Venot and Molle, 2008; Al-Jayyousi, 2000; MoW&I, nd; Solutions for Water, nd

Annex 7. Social Accountability Tools

Budget Literacy Campaigns are efforts (usually made by civil society, academics, or research institutes) to build citizen and civil society capacity to understand budgets in order to hold governments accountable for budget commitments and to influence budget priorities.

Citizen Advisory Boards are groups of volunteers representing different stakeholders at the national or local level that come together with the common aim of helping to improve water provision.

Citizen Charter is a document that informs citizens about the services to which they are entitled as users of a public service, the standards they can expect for a service (timeframe and quality), remedies available for nonadherence to standards, and the procedures, costs and charges. The charters entitle users to an explanation (and in some cases compensation) if the standards are not met.

Citizen Report Card is an assessment of public services by the users (citizens) through client feedback surveys. This is not simply a data collection tool, but, more importantly, being an instrument for exacting public accountability through the extensive media coverage and civil society advocacy that accompany the process.

Citizen/User membership in decision-making bodies is a way to ensure accountability by allowing people who can reflect users' interests to sit on committees that make decisions about project activities under implementation (project-level arrangement) or utility boards (sector-level arrangement).

Citizens' Juries are a group of selected members of a community that make recommendations or action proposals to decision-makers after a period of investigation on the matter. Citizens' juries are a deliberative participatory instrument to supplement conventional democratic processes.

Community Contracting is when community groups are contracted for the provision of services, or when community groups contract service providers for the construction of infrastructure.

Community Management is when services are fully managed or owned by service users or communities. Consumers own the service directly (each customer owns a share) when they form cooperatives. This requires strong bylaws, clear account-keeping procedures, payment through banks, a regular schedule for meter reading and billing, annual auditing, and small operating staff with clear reporting lines to the user committee.

Community Monitoring is a system of measuring, recording, collecting and analyzing information, and communicating and acting on that information to improve performance. It holds government institutions accountable, provides ongoing feedback, shares control over monitoring and evaluation, engages in identifying and/or taking corrective actions, and seeks to facilitate dialogue between citizens and project authorities.

Community Oversight is the monitoring of publicly-funded construction projects by citizens, and community-based and/or civil society organizations participating directly or indirectly in exacting accountability. It applies across all stages of the project cycle, although the focus is on the construction phase.

Community Scorecard is a community-based monitoring tool that assesses services, projects, and government performance by analyzing qualitative data obtained through focus group discussions with the community. It uses the community as its unit of analysis to monitor local facilities. It usually includes interface meetings between service providers and users to formulate an action plan to address any identified problems and shortcomings. It solicits user perceptions on quality, efficiency and transparency. Users reveal priorities and score the performance of providers; the interface meeting is at the heart of the process.

Grievance Redress Mechanism (or *complaints-handling mechanism*) is a system by which queries or clarifications about the project are responded to, problems with implementation are resolved, and complaints and grievances are addressed efficiently and effectively.

Hybrid Citizen Report Card (CRC) / Community Scorecard (CSC) involve both surveys and community score cards. The results of the CRC are used in the CSC as evidence for the discussion. Two providers are needed to compare results. Impacts are combined at the national and local levels. Both tools complement each other and both help contribute to progress.

Independent Budget Analysis is a process where civil society stakeholders research, explain, monitor and disseminate information about public expenditures and investments to influence the allocation of public funds through the budget.

Information Campaigns are processes to provide citizens with information about government plans, projects, laws, activities, services, and so forth. A variety of approaches can be used such as public meetings, mass media, printed materials, public performances, and information kiosks.

Input Tracking (or input monitoring) refers to monitoring the flow of physical assets and service inputs from central to local levels.

Integrity Pacts are a transparency tool that allows participants and public officials to agree on rules to be applied to a specific procurement. It includes an “honesty pledge” by which involved parties promise not to offer or demand bribes. Bidders agree not to collude in order to obtain the contract; and if they do obtain the contract, they must avoid abusive practices while executing it.

Independent Water Budget Analysis - This refers to analytical and advocacy work by civil society and other independent organization aimed at making public budgets more transparent and at influencing the allocation of public funds through the budget. Once the budget has been formulated and made public, civil society can continue to demand accountability by undertaking independent budget review and analysis (IBA) exercises.

Participatory Budgeting is a process through which citizens participate directly in budget formulation, decision-making, and monitoring of budget execution. It creates a channel for citizens to give voice to their budget priorities.

Participatory Focus Groups and Surveys - NGOs specialized in water can facilitate the implementation of focus groups and surveys to better understand users’ needs and demands

Participatory Physical Audit refers to community members taking part in the physical inspection of project sites, especially when there are not enough professional auditors to inspect all facilities. Citizens measure the quantity and quality of construction materials, infrastructure and facilities.

Participatory Planning convenes a broad base of key stakeholders, on an iterative basis, in order to generate a diagnosis of the existing situation and develop appropriate strategies to solve jointly identified problems. Project components, objectives, and strategies are designed in collaboration with stakeholders.

Procurement Monitoring, in the context of DFGG, refers to independent, third-party monitoring of procurement activities by citizens, communities, or civil society organizations to ensure there are no leakages or violation of procurement rules.

Public Displays of Information refers to the posting of government information, usually about projects or services, in public areas, such as on billboards or in government offices, schools, health centers, community centers, project sites, and other places where communities receive services or discuss government affairs.

Public Expenditure Tracking Systems (PETS) in Water track flows of funds from central to local government, and to utilities. They locate and quantify political and bureaucratic capture, leakages, misallocation, and so on. It is a quantitative/auditing tool, most useful if planned more than once.

Public Hearings are formal community-level meetings where local officials and citizens have the opportunity to exchange information and opinions on community affairs. Public hearings are often one element in a social audit initiative. The objective is to examine the opinions of everyone regarding critical issues affecting the community.

Public Reporting of Expenditures refers to the public disclosure and dissemination of information about government expenditures to enable citizens to hold government accountable for expenditures.

Social Audits of Water Sector/Policy - A social audit aims to make public institutions or private entities more accountable for the social objectives they declare. Citizens monitor how resources are used to achieve social objectives and examine cost and finance (but this is not its central concern). These audits can rely on surveys and then propose solutions and also assess performance and results.

Study Circles are small groups (diverse, usually 8-12 participants), democratic, peer-led discussions that provide a simple way to involve community members in dialogue and action on important social and political issues. Community-wide study circle programs involve many study circles happening at the same time across a community. They provide a basis for problem solving, and lead to action at many levels. In addition, they create new personal relationships and community networks.

User Management Committees refer to consumer groups taking on long-term management roles to initiate, implement, operate, and maintain services. User management committees are for useful increasing participation as much as they are for accountability and financial controls.

Users' Representation in Water Regulatory Boards include representatives from professional associations related to health, engineering, law, and so on. Members must be water users. Regulators mediates conflicts

Water Watch Groups to provide feedback to regulators- Regulators can use organized groups of citizens at regional levels to gather feedback and decentralized data about water provision. *Sources: GAC, nd; WBI, 2009c*

Annex 8. A Model for Participatory Learning and Interactive Learning Techniques

Strategies for groundwater need to evolve to reflect experience through a learning approach. Adaptive (ground)water management implies a real paradigm shift in (ground)water management from what can be described as a prediction and control to a management-as-learning approach. Such change aims at increasing the adaptive capacity of groundwater aquifers at different scales. Examples of structural requirements for a water management regime to be adaptive are summarized in Table 14. Two different regimes characterized by these two different management paradigms are contrasted as the extreme, opposing ends of six axes. Depending on the context, bridging the gap between the two paradigms may take time, but developing policy mechanisms for facilitating learning processes may be a first step.

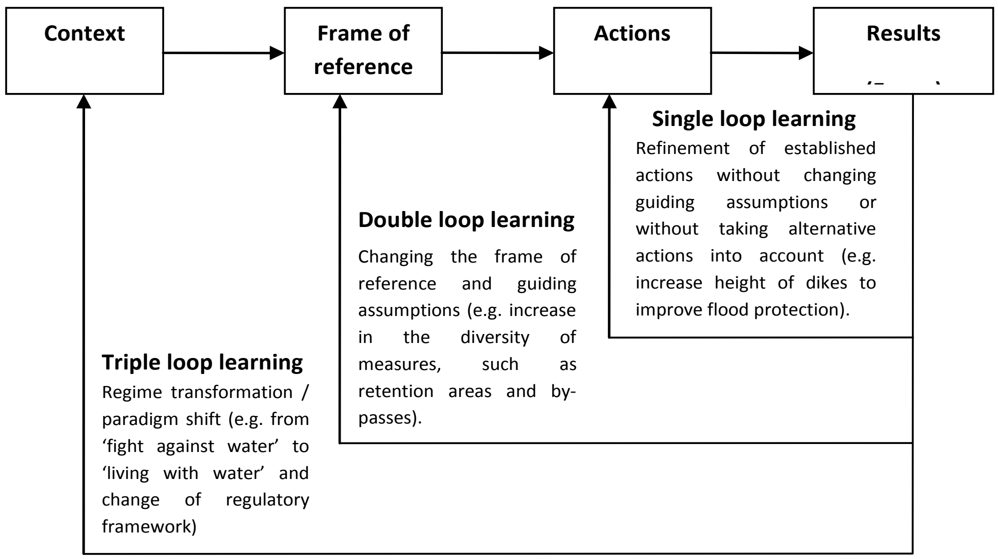
Table 14 - Different Regimes and Their Characteristics (From: Pahl-Wostl et al., 2005)

Dimension	Prediction, Control Regime	Integrated, Adaptive Regime
Governance	Centralized, hierarchical, narrow stakeholder participation	Polycentric, horizontal, broad stakeholder participation
Sectoral Integration	Sectors separately analysed resulting in policy conflicts and emergent chronic problems	Cross-sectoral analysis identifies emergent problems and integrates policy implementation
Scale of Analysis and Operation	Transboundary problems emerge when river sub-basins are the exclusive scale of analysis and management	Transboundary issues addressed by multiple scales of analysis and management
Information Management	Understanding fragmented by gaps and lack of integration of information sources that are proprietary	Comprehensive understanding achieved by open, shared information sources that fill gaps and facilitate integration
Infra-structure	Massive, centralized infrastructure, single sources of design, power delivery	Appropriate scale, decentralized, diverse sources of design, power delivery
Finances and Risk	Financial resources concentrated in structural protection (sunk costs)	Financial resources diversified using a broad set of private and public financial instruments

Improving legal provisions concerning access to information and participation in decision-making (e.g. consultation requirements) may be a first step towards increased policy learning. Increased levels of policy learning lead to more advanced coping strategies in governance systems confronted with social and physical challenges (Huntjens et al., 2011a). Policy learning is defined by Hall (1988) as a “deliberate attempt to adjust the goals or techniques of policy in the light of the consequences of past policy and new information so as to better attain the ultimate objects of governance.” It is important to take into account that learning takes place at different levels beyond just refining established actions or single-loop learning (Figure 11). Advanced information management and integrated cooperation structures discussed in the sections above are key factors leading to higher levels of policy learning. Advanced information management may be considered the lubricating oil within cooperation structures.

Partnership approaches among stakeholders improve this learning process. Developing and sustaining capacity through increased interaction between stakeholders and institutions (for example, joint field visits or common training session) is needed to build up experience to cope with the uncertainty and complexity of socio-ecological systems.

Figure 11. Triple Loop Learning Concept



Source: Derived from Hargrove (2002), and adjusted by Huntjens et al. (2011a). Reproduced here with the permission of Robert Hargrove, 2011.

Results from empirical analyses show, for example, that centralized political and economic systems, privatization, commercialization of the environment, rigid bureaucratic systems, and political secrecy and poor public access to information can impede social learning. The quality of the interaction, the shared ownership of a task or project, openness for mutual testing and contradiction, and the opportunity for reflexive moments are all important components of such a practice (Pahl-Wostl et al., 2007a).

A sample of interactive learning techniques includes backcasting, brainstorming, case studies, focus groups, foresight, group model building, multi-stakeholder dialogue, nominal group technique, reframing, and role-playing games.

Backcasting is a method to develop normative scenarios and explore their feasibility and implications. Important in the sustainability arena, it is as a tool with which to connect desirable long-term future scenarios to the present situation by means of a participatory process. The method is used in situations where there is a normative objective and fundamentally uncertain future events that influence these objectives. The central question of backcasting is "if we want to attain a certain goal, what actions must be taken to get there?"

Brainstorming is a group creativity technique designed to generate a large number of ideas for the solution of a problem. Many variants are available, including: nominal group technique (often used in GMB), group passing technique, team idea mapping method, electronic brainstorming, directed brainstorming, individual brainstorming, question brainstorming.

Case studies provide the ability to analyze, ask relevant questions, develop decisions and defend one's point of view. They also improve the participant's communicative skills, help develop the ability to see a situation from several different angles and to take into consideration various factors that influence the situation. Case studies also help to develop and analyze several decisions.

Focus groups are broadly defined as meetings to obtain public understandings on a distinct area of interest in a permissive environment (Morgan, 1997). In a relaxed atmosphere, a group of six to eight people share their ideas and perceptions. Within a smaller group, the participants usually feel that they have a larger influence on the discussion, and it is easier to tempt reticent participants to contribute.

Foresight is a tool for developing visions, understood as possible future states of affairs that actions today can help bring about (or avoid). Foresight is a non-deterministic, participatory and multidisciplinary approach. It can be envisaged as a triangle combining "Thinking the Future," "Debating the Future" and "Shaping the Future."

Group Model Building is a method for facilitating the deep involvement of a group of individuals in the building of a model of a particular management system, in order to improve group understanding about that system, its problems and possible solutions, which will directly or indirectly lead to better management decisions (Hare, 2003). When using such a method, the model itself is not the product of the process; the product is the generation of common understanding among model builders during the process.

Multi-Stakeholder Dialogue (MSD) aims to bring relevant stakeholders or those who have a stake in a given issue or decision, into contact with one another. The key objective of an MSD is to enhance levels of trust between the different actors, to share information and institutional knowledge, and to generate solutions and relevant good practices. The process takes the view that all stakeholders have relevant experience, knowledge and information that ultimately will inform and improve the quality of the decision-making process as well as any actions that (may) result. With sufficient time, resources and preparation, an MSD can be a very effective tool for bringing diverse constituencies together to build consensus around complex, multifaceted and in some cases, divisive issues.

Nominal Group Technique is used to structure group work aimed at gaining consensus on priority setting and/or highlighting topics of importance in the management system. To overcome the problems of domination and marginalization of the group members, the technique begins with a round-robin collection of participants' ideas about a subject in private. This enables all participants' view to be collected fairly. Each participant's ideas are then presented for critical appraisal and discussion by the group in a facilitated group workshop. The ideas are then ranked in this workshop by the group using some form of voting/ranking system. The highest ranked idea is then set as the idea of highest priority and importance to the group. This technique is good for getting groups to prioritize ideas belonging to a single theme, however, it does not work well for multiple themes and if quick decisions are required (Hare, 2003).

Reframing is an intervention stimulating participants to go beyond their own frame of reference and to approach a problem or relationship from a different perspective. It is possible to use such intervention when processes are stagnated on content and/or social relationships.

Role Playing Game (RPG) is a type of game in which the participants assume the roles of characters and collaboratively create stories (Waskul and Lust, 2004). Participants determine the actions of their characters based on their characterization, and the actions succeed or fail according to a formal system of rules and guidelines. Role playing games can be linked to group model building. In this type of application, models can be represented in terms of role playing games wherein the participants are not simply observing the model from the outside, but actually embedded in the game as actors making decisions about management.

Sources: http://www.unep.org/IEACP/iea/training/guide/default.aspx?id=1193; Adapted from Merri Weinger, Teacher's guide on basic environmental health

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