

# Sustainable Groundwater Management Contributions to Policy Promotion

Strategic Overview Series Number 1

## Groundwater Governance

### conceptual framework for assessment of provisions and needs

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*The aim of this overview is to provide a concise outline guide to governance provisions as they relate to the groundwater resource base. It deals with the assessment of current governance status and identification of future governance needs in relation to the efficient and sustainable use of groundwater resources as a water-supply source and by dependent ecosystems, and their effective management and quality protection against quasi-irreversible degradation.*

#### SCOPE AND CONTEXT OF GROUNDWATER GOVERNANCE

##### The Concept of Governance

- Governance has recently been defined by the UNDP as the exercise of political, economic and administrative authority in the management of a nation's affairs at all levels — and thus comprises the mechanisms, processes and institutions through which the citizens of the nation articulate their interests, mediate their differences and fulfill their legal rights and obligations.
- It follows that 'water governance' involves the corresponding framework for effective water resources management, including the delivery of all water services in a socially-responsible, environmentally-sustainable and economically-efficient manner — and comprises the processes of defining policy options, of translating them into goals, of providing institutions, procedures, means, monitoring and accounting, of enabling stakeholder participation, and of taking responsibility for outcomes. Especially key considerations in this respect are the relations, linkages and accountabilities of the corresponding public, civil, professional and private stakeholders. In turn 'groundwater governance' (as a subset of the above) is focused on the exercise of appropriate authority and promotion of responsible collective action to ensure sustainable and efficient utilization of groundwater resources for the benefit of humankind and dependent ecosystems.

- However, given the character of groundwater as a typical ‘common pool resource’, it is inherently vulnerable to the so-called ‘tragedy of the commons’ in which actual and potential stakeholders act solely in their own individual short-term self-interest rather than taking into account long-term communal requirements. Thus in situations of evident excessive exploitation with falling water-table or of progressive quality deterioration due to inadequate protection, there is always the risk that they increase (rather than moderate) their extraction and/or relax (rather than intensify) their protection simply because of the perception that their personal interest in the resource cannot be assured through individual action.
- The character of groundwater also means that links with the governance of the environment, and other land and water resources are highly relevant – and since societal demands for improved environmental quality and climate change adaptation are growing they could exert a positive influence on the drive for improved groundwater resource governance and avoiding ‘the tragedy of the commons’.

### **The Intimate Land-Groundwater Linkage**

- Groundwater resources are highly dependent upon land-use (and changes in land-use) in the main ‘aquifer recharge areas’, which exert a direct influence on both the rates and quality of recharge — and as such groundwater governance cannot be addressed in isolation from consideration of the processes determining or controlling land-use.
- Moreover, whilst various legal regimes and community regulations have been devised to control individual or group access to groundwater, their implementation often involves high transaction cost and can be rather labour-intensive. Thus in some countries private land ownership still appears to exert the most direct control over access to groundwater, and this in turn leads to the perception of groundwater being a ‘private resource’, whose use rights are solely related to land ownership.
- In urban environs land-use classification and control are generally the domain of municipal or local government, and the absence of mechanisms whereby water resource agencies can influence the process is a frequent governance weakness. Moreover, in many developing nations legislation to cope with undesirable land-use practices is often weakly enforced or even non-existent — and progress with implementing controls in the interest of groundwater are highly dependent upon stakeholder awareness and participation.
- On the other hand, rural land-use practices and the intensification of agricultural production (which also exert a very strong influence on groundwater recharge rates and quality) are strongly influenced by national agriculture and food policy in general and also by market incentives for deforestation and for ploughing-in pasture land.

## Cross-Sector Drivers Impacting Groundwater

- It is essential to recognise the importance of 'external drivers' on groundwater resource use and pollution pressure — and procedures to influence associated macro-level policy decisions are likely to be required as part of strengthening groundwater governance.
- The more common types of 'external driver' include :
  - the process of urbanization, especially given the potential 'coupling' between in-situ sanitation and groundwater, and the frequent inadequacy of utility water supplies
  - political (land-jurisdiction) boundaries impeding the rational development of protected peri-urban well fields for major urban water-supply and influencing the discharge points of potentially-polluting effluents
  - planning and development of industrial and mining enterprises
  - the development of tourism facilities where this is a major source of income.And in agricultural areas these drivers often include factors such as :
  - the unreliability or absence of alternative surface water-supplies
  - highly subsidized or flat-rate electrical energy tariffs for water-well pumping
  - general subsidies on water-well construction, irrigation technology, fertilizers and pesticides, etc
  - guarantee prices for certain crop types.

## Geographic Scale – a Key Issue for Groundwater

- Groundwater is a widely-distributed but essentially local resource. Thus to understand whether effective governance arrangements are in place one has to get down to sub-national (provincial and district) level at which most 'groundwater bodies' (resource management units – usually parts of aquifer systems) exist — but also to relate these as necessary to the overall basin in which they occur.
- GW-MATE operational experience has shown that it is not adequate to evaluate the situation solely at national level – since at this level there is often a 'semblance of sufficiency' that does not stand more detailed scrutiny. But since sub-national evaluations cannot realistically be undertaken everywhere, it is important to be selective and focus upon priority groundwater bodies or aquifer systems.

## ESTABLISHING A GOVERNANCE FRAMEWORK FOR GROUNDWATER ISSUES

### A Logical Typology of Groundwater Issues

- GW-MATE experience suggests that the most appropriate typology for considering groundwater governance status and needs is based upon a pragmatic classification of 'groundwater bodies' (Table 1) – there being an intimate linkage between the characteristics and status of groundwater bodies and the question of why and how governance needs to be strengthened to achieve effective on-the-ground implementation of agreed management and protection measures.

**Table 1 : Typology of groundwater bodies with situations and processes involved**

OVERALL TYPOLOGY OF GROUNDWATER BODY	SUB-DIVISIONS BY TYPE OF SITUATION OR PROCESS INVOLVED #
<p><b>(1) At Risk of Extensive Quasi-Irreversible Aquifer Degradation and Subject to Potential Conflict Amongst Users ###</b></p>	<p><b>(A) Under Intensive Exploitation</b> (provoking land subsidence, saline or polluted water intrusion) ##</p> <p><b>(B) Vulnerable to Widespread Pollution from Land Surface</b> (depends on aquifer vulnerability and pollutant pressure) ##</p> <p><b>(C) Undergoing Depletion of Non-Renewable Storage Reserves</b> (normally in aquifers with low contemporary recharge)</p>
<p><b>(2) Subject to Potential Conflict Amongst Users ### but not at Risk of Quasi-Irreversible Aquifer Degradation</b></p>	<p><b>(A) With Growing Large-Scale Abstraction</b> (especially in aquifers with high T/S ratio)</p> <p><b>(B) Vulnerable to Local Point-Source Pollution</b> (depends on aquifer vulnerability and pollutant pressure) ##</p> <p><b>(C) With Shared International/Interstate Resources</b> (latter in federal nations with decentralised water management)</p>
<p><b>(3) Insufficient (or Inadequate Use of) Scientific Knowledge to Guide Development Policy &amp; Process</b></p>	<p><b>(A) But Potential to Improve Rural Welfare &amp; Livelihoods</b> (not fulfilling potential role in achieving MDGs)</p> <p><b>(B) With Presence of Natural Quality Problems</b> (especially with health impacts at low concentrations/eg: As, F) ##</p> <p><b>(C) But Scope for Large-Scale Planned Conjunctive Use</b> (either for urban water-supply or irrigated agriculture) ##</p>

# although covered by this typology it may be preferable in practice to treat urban groundwater situations as a separate cross-cutting category  
 ## in all these cases the intrinsic susceptibility or vulnerability to the given type of problem varies widely with aquifer type  
 ### users should be taken to include important groundwater-dependent ecosystems

- The typologies relating to groundwater pollution and quality concerns (1B, 2B & 3B) can exist alongside the other categories of groundwater management problem described – and thus these sub-divisions should not be regarded as mutually exclusive.
- Moreover, the use and protection of groundwater resources in and around important cities can encompass various of the above issues. But given the special dynamics of the urbanization process, and the fact that there is an intimate link between the provision and operation of the water infrastructure and the surrounding environment in which groundwater bodies occur, it may be found more practical to consider the governance arrangements for urban groundwater as a separate cross-cutting category.

### Identification and Prioritization of Needs

- The governance framework required to address each of the above issues is significantly different. It is important to register that only categories (1A-C) strictly relate to protection of the ‘natural resource base’ against permanent degradation (through indiscriminate practices by some members of society) – which in one sense has to be the most pressing area for strengthening of governance provisions.

- At the other extreme – and important in the developmental sense – are typologies 3A-C for which the central issue is whether national and/or local organizations have the established remit and adequate finance to identify and evaluate groundwater resources, and to promote their use efficiently in the policy for (and practice of) groundwater development to achieve the UN-MDGs in relation to rural water-supply and/or food security.
- The starting point to assess the adequacy of existing provisions and to offer specific recommendations for their improvement is careful consideration of :
  - the stage of development of the groundwater body
  - the typology(ies) into which the groundwater body fall(s).
  - the preferred approach in terms of management measures.
- In relation to specific management measures the following general pointers should prove useful when considering how they can be facilitated through an improved governance framework:
  - Groundwater Resource Issues — rationalizing the abstraction from heavily-exploited aquifers, conserving the recharge area of aquifers, and improving the understanding of under-utilized aquifers
  - Groundwater Supply Issues (especially for urban and rural domestic water-supply) — local source conservation measures through establishment of protection areas/perimeters, and adequate quality monitoring for early diagnosis of potential problems.
- Groundwater Management Action Plans should be in existence for specific priority groundwater bodies at risk of irreversible degradation – including the required investments for supply-side and demand management interventions, and a clear institutional structure as regards authority and responsibility. A pragmatic framework for the elaboration and implementation of a such a plan is outlined in Figure 1, for which the corresponding types of governance provisions are indicated. An important observation here is that the balance of the management measures selected and the management instruments utilized (discussed in more detail below) should depend upon a diagnosis of the resource setting (hydrogeologic condition and socioeconomic situation), which in essence both define the problem and shape the solution.
- Even in countries where all the pieces required for sustainable groundwater management are in place, going from isolated measures to a coordinated plan paradoxically may prove difficult. The solution may lie in providing leadership through nominating ‘groundwater body management champions’ to ensure improved coordination and continuity.

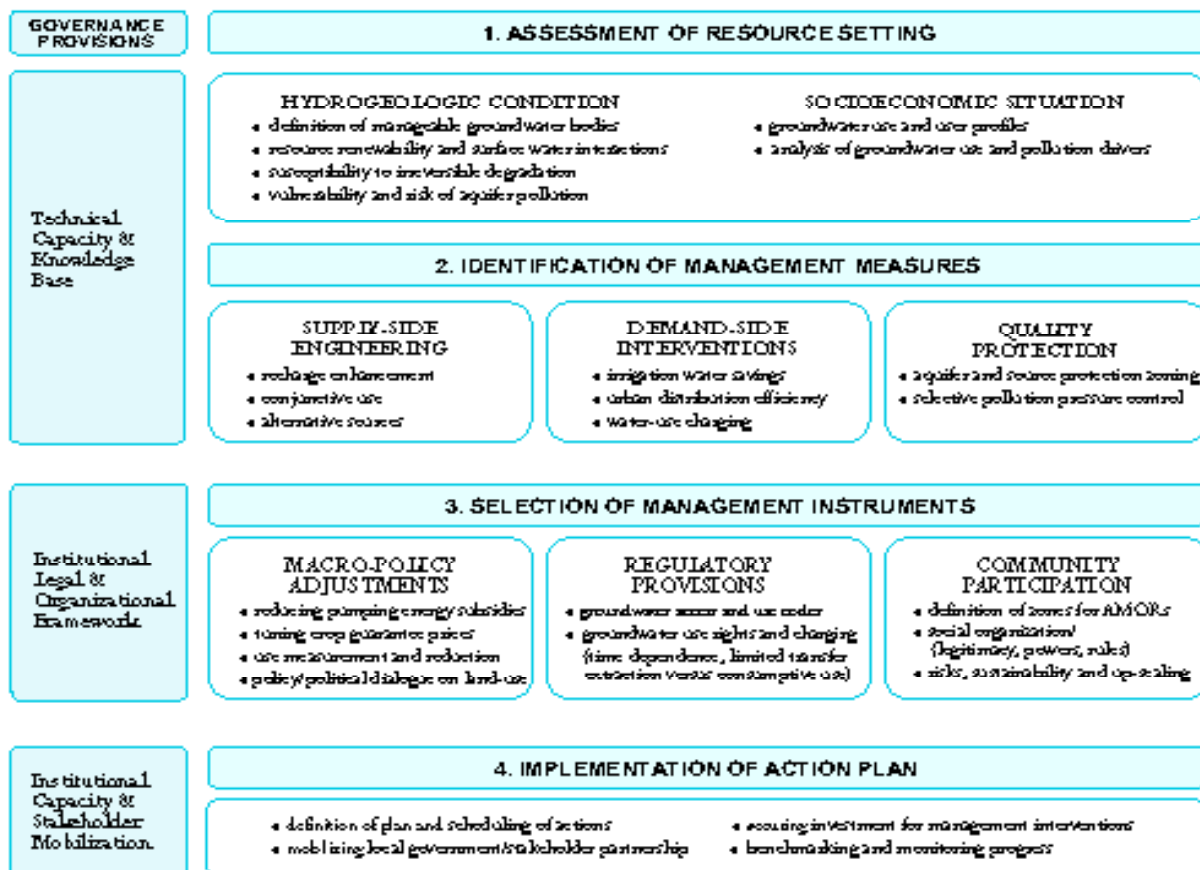
## **PRINCIPAL INSTRUMENTS FOR SOUND GROUNDWATER GOVERNANCE**

### **Legal and Institutional Provisions**

- In assessing the current status of governance provisions it is useful to distinguish between:
  - Primary Legislation : the national and/or state Constitution and Water Law as approved by the legislature, and related government structure and general organization that has to be consistent with the primary legislation



Figure 1 : Pragmatic framework for elaboration of an action plan for control of excessive groundwater abstraction or pollution pressure with corresponding governance provisions



- Secondary Legislation : the organizational arrangements for groundwater management and protection (comprising regulations, rules, orders, decrees, procedures and by-laws dealing with implementation details) which are issued by the Executive as empowered by Primary Legislation
- Responsible Government Departments : their function, structure, capability for implementation and coordination mechanisms with other relevant units.
- It is often politically difficult and time consuming to amend the legal and institutional provisions for groundwater governance, and thus groundwater management and protection will often be found (or advised) to follow a ‘parallel track’ approach by first identifying how to implement preferred management and protection measures within the existing framework, second defining the most feasible local organizational arrangements and only then attempting to introduce legal reforms where they can be realistically implemented.

## Stakeholder Participation

- Since groundwater management is more about influencing the behavior of individual groundwater users and potential polluters, than top-down allocation of a clearly-defined natural resource, the process of facilitating and empowering stakeholder participation is an especially critical groundwater governance instrument (almost regardless of the precise type of issue that needs to be addressed) because:
  - management decisions taken unilaterally by a regulatory agency without social consensus are often impossible to implement
  - essential management activities (perhaps including monitoring, inspection, fee collection, etc) can be carried out more effectively and economically through cooperative efforts and shared burdens
  - the integration and coordination of decisions relating to groundwater resources, land use and waste management is facilitated.
  
- A necessary pre-requisite for mobilizing stakeholder participation is that the regulatory agency has put emphasis on generating a reasonably comprehensive and detailed inventory of groundwater users, uses and use status – and from this established a ‘user profile’ for each groundwater body requiring management measures.
  
- It should be noted that traditional Water Users Associations (WUAs) for the management of irrigation systems are not enough alone to ensure stakeholder participation for groundwater resources. And there is a definite need of a system for higher-level user and stakeholder participation, called here an aquifer management organization (AMOR), to be formed at the initiative of the water resource regulatory agency, in which all WUAs and other main categories of stakeholder are represented.
  
- Stakeholder participation is an essential provision for sound groundwater resource governance, but generally needs to be complemented by a local government agency playing the following roles:
  - making complex groundwater situations understandable so that stakeholders can participate on a more informed basis
  - empowering stakeholder organizations, so they and not government can lead on local processes
  - ensuring all stakeholders are properly represented irrespective of their individual economic and political influence
  - establishing a sound and implementable groundwater resource rights system for controlling large users and protecting small ones – appropriate from the overall basin and groundwater body perspective and adapted to the operative level of community-based management.

## The Groundwater Resource Administration

- GW-MATE operational experience shows that while decentralised groundwater management with some form of stakeholder participation is the most promising approach, there are still key roles for national government to ensure strong state/provincial level agencies such as:
  - allocation of sufficient financial resources and removing bureaucratic obstacles to hiring the required professionals, and recommending adequate salaries and career development (such that they are less vulnerable to corruption)
  - establishing guidelines to address the management of trans-state and internationally-shared aquifer systems
  - providing minimum reference standards for the identification, characterisation, monitoring and evaluation of groundwater bodies 'at risk', and defined procedures for the specification and implementation of management measures appropriate to the level of risk involved.

In respect of this latter role, some of the mechanisms and procedures devised for and defined in the EC Water Framework Directive (October 2000) and the related EC Groundwater Directive (December 2006) should serve as a useful model (especially in larger federal countries), since the principles are clearly defined, readily adaptable and risk based.

- In many cases, the best option will be to promote the evolution of existing agencies at national and/or provincial level from groundwater knowledge provision and advisers on supply development, so as to incorporate the function of 'guardian' of the groundwater resource base. The main functions of such a transformed agency should be:
  - Information & Planning : keeping resource status and user inventories up-dated, monitoring aquifer response in terms of level and quality trends, and providing authoritative information at both the policy and user level
  - Guiding Supply-Side & Demand-Side Interventions: ensuring that proposed measures and investments are scientifically sound, economically reasonable and appropriately coordinated
  - Enabling Community-Based Management: facilitating and promoting community-based initiatives and being a 'lighthouse' for their sustainability and replicability
  - Regulatory Inputs: advising on the technical foundation for resource use administration and pollution control where the regulatory approach is desirable and enforceable.
- In large federal countries the best location for the operational offices of a groundwater resource agency is in state government and in unitary countries in 'regional offices', since at this level they are in a better position to:
  - facilitate cross-sectoral coordination of groundwater-related issues
  - promote government-stakeholder interaction
  - design management approaches specific to groundwater body typologies and user needs.
 Compatibility with River Basin Organizations will also be important and can usually be achieved by statutory participation of personnel in specific committees or activities and/or co-location of operational offices.



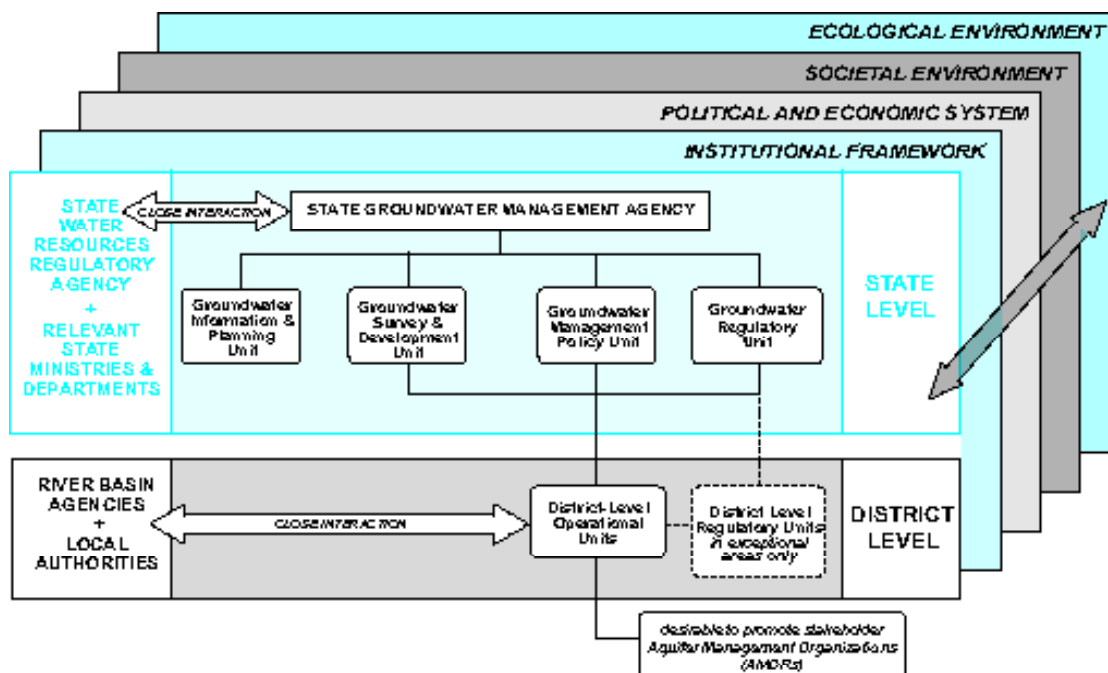
- State Groundwater Development & Management Agencies do not exist in isolation but operate within a multilayered environment (Figure 2). They should be located at such a level in the government hierarchical structure to enable interaction as equals with other sectors, where they can voice their concerns should they be unable to implement management and protection measures because of factors beyond their realm.

## AVOIDING FRUSTRATION IN THE QUEST FOR IMPROVED GOVERNANCE

### Economics and Politics of Groundwater Governance

- The economic value of groundwater resources to national economies, in terms of the production they underpin and the costs implied in providing alternative rural and urban water-supplies should they be lost, will usually benefit from better characterization – as will the ‘lost opportunities’ of failing to identify and develop a given aquifer. It is necessary (at least at ‘broad-brush’ level) to demonstrate ‘big risks’ and ‘important benefits’ to make arguments for investment in the strengthening and reform of resource governance ‘politically credible’, especially in the developing world.

Figure 2 : Idealized institutional structure for exercising groundwater governance within a multi-layered social, political and environmental context



- But in some instances even this may not be sufficient – because both politics and power can have a major influence on whether and how governance reforms actually happen. Indeed, the status quo tends (by definition) to benefit the vested interest of some ‘well-established constituencies’ – even with inadequate groundwater governance and negative outcomes for many there will still normally be ‘some winners’! In Table 2 the commoner forms of ‘vested interest’ are summarized. Such vested interest can often lead to repeated failure of soundly-based reform of groundwater governance to facilitate sustainable resource use and effective resource protection, and usually can be classified under the heading of either ‘rational policy distortion’ or ‘biased resource management’.
- In all such cases there may be a ‘fine line’ between:
  - lack of awareness of the status and dynamics of, and risks to, the groundwater resource base
  - the genuine defence of a particular set of related interests
  - outright corruption with total disregard of known negative resource consequences.
- Biased or corrupt behavior is not something exclusive to government, and it can also impede community-based groundwater management when organized minority groups favouring their

**Table 2 : Consequences of distorted groundwater policy and biased resource management**

GROUNDWATER ISSUE	BALANCED APPROACH	DISTORTED OR BIASED INTERVENTION
<b>Serious Aquifer Depletion by Irrigated Agriculture</b>	government provides full resource status assessment and promotes informed dialogue amongst all stakeholders to define coordinated measures involving demand management (real irrigation water saving, higher-value less water-consuming crops) and recharge enhancement with socially-acceptable regulation	only falling water-tables broadcast with unjustified promotion of, and finance facilities for, drilling deeper boreholes and purchasing larger well pumps as panacea (because of vested interest in drilling contractors and/or pump retailing)
<b>Serious Groundwater Pollution Risk by Indiscriminate Urban/Industrial Growth</b>	promote full environmental impact analysis including groundwater pollution considerations with subsequent cross-sector stakeholder dialogue to inform balanced decision-making and (where appropriate) socially-acceptable conditionalities on new development	failure to voice rational objection to development proposal on basis of groundwater risk (because of vested interest in boosting value of related urban land and/or of alternative provision of tankered/bottled water-supplies)
<b>Immediate Threat of Aquifer Saline Encroachment in Area of Irrigated Agriculture</b>	enforcing waterwell drilling and transfer ban for a set period of 5-10 years with investment in detailed monitoring, and subsequent systematic review of all existing/ requested groundwater abstraction/use permits and full stakeholder dialogue on future resource use policy	arbitrarily granting issue or transfer of selected new groundwater abstraction/ use permits and risking further saline intrusion (because of vested interest in boosting value of related agricultural land)
<b>Opportunity for Low-Cost Groundwater Development for Urban Supply</b>	open comparative study promoted of all reasonable possible options for water-supply expansion to evaluate their technical feasibility, economic costs, impacts, risks and lead-times (and alternative of demand management investments included)	priority arbitrarily given to building unjustified new surface-water based infrastructure (because of vested interest in the ‘construction lobby’)

friends and family by, for example, not denouncing illegal drilling of new water wells in ground-water conservation areas or the ground disposal of pollutants in groundwater protection zones. Since corruption is a very sensitive issue, being potentially associated with a criminal offence, it is difficult to deal with, but certainly requires consideration in the context of improving overall groundwater governance.

### Identifying and Addressing Impediments to Governance Reform

- The first step has to be to understand why groundwater governance reforms and/or day-to-day resource management and protection fail, through the analysis of existing arrangements and mapping-out stakeholder incentives. A new World Bank good-practice framework for analysis of the ‘political economy’ of governance failures is useful in this respect – the problem-driven approach that GW-MATE has evolved for the assessment of groundwater management needs and implementation impediments appears to be closely aligned with this framework (Table 3).

**Table 3 : Problem-driven governance and political-economy analysis for diagnosing groundwater resource degradation**

<p><b>VULNERABILITIES &amp; CHALLENGES</b></p>	<p><b>What is the evidence of poor outcomes to which weak governance contributes?</b></p>	<ul style="list-style-type: none"> <li>- groundwater depletion and salinisation in spite of existence of nominal control measures</li> <li>- water-supply source and agricultural land abandonment by poorer farmers</li> <li>- growing costs of pollution of potable groundwater supplies in spite of potential pollution control powers</li> <li>- unrepresentative and ineffective stakeholder participation leading to cynicism</li> </ul>
<p><b>GOVERNANCE ARRANGEMENT &amp; CAPACITY</b></p>	<p><b>Which are the related underlying institutional and legal deficiencies?</b></p>	<ul style="list-style-type: none"> <li>- groundwater resource agencies with inadequate linkages to influence other ministries and inability to voice concerns to stakeholders and the media</li> <li>- lack of legal regulations addressing specific groundwater issues and concerns</li> <li>- counter-productive policies on energy and crop pricing and other relevant subsidies</li> <li>- inadequate budget allocation for groundwater agencies and bureaucratic restriction on their hiring appropriate professional staff</li> <li>- lack of mechanisms to ensure integrity and accountability and limit scope for corruption</li> <li>- university courses geared only to groundwater science and not to resource management</li> </ul>
<p><b>DRIVERS OF POLITICAL ECONOMY</b></p>	<p><b>Why are things this way and policies/ institutions not being improved?</b></p>	<ul style="list-style-type: none"> <li>- employ groundwater user and polluter profiles to understand dynamics of the status quo</li> <li>- review current land ownership, water allocation, rent distribution and social trends</li> <li>- assess political will to support groundwater agencies in enforcing relevant legal regulations</li> <li>- identify evidence of vested interest in expenditure on irrational groundwater-related policy measures and expenditures</li> </ul>
<p><b>IMPROVING GOVERNANCE PROVISIONS</b></p>	<p><b>What are the key first steps towards a more robust set-up?</b></p>	<ul style="list-style-type: none"> <li>- more open information and improved communication</li> <li>- increasing independence of resource management agencies</li> <li>- transparency on resource bulk allocations and/or individual use rights</li> <li>- counterbalancing sanctions with incentives for improved compliance</li> <li>- promoting political interest in sustainable resource management</li> </ul>

## The Critical Role of Information and Communication

- An effective Information & Communication System is the key to transparency (and hence accountability) on groundwater issues, and is thus a critical pillar of any resource governance framework. It should provide not only fundamental technical information on resource status, trends and vulnerabilities, but also a guide to the complex network of public agencies, groundwater users and other stakeholders involved. Appropriate media need to be used to ensure that this information explicitly reaches all concerned.
- In most developing nations public information offices often deal with narrowly-focused programs, implemented mostly through national media and without systematic assessment of impact. This approach is not well-suited to the technical complexity of groundwater and the social aspects of stakeholder participation. A more appropriate approach would need to be compatible with the networks within which groundwater agencies work and be geared to facilitate rational groundwater development and participatory management. It should also be reviewed periodically for effectiveness.
- Groundwater resources managers need to voice their concerns in national debates and help to empower society by:
  - being frank about the consequences of ‘business as usual’
  - acknowledging capacity limitations for policy implementation
  - providing transparent information to counteract vested interest through ensuring accountability
  - challenging macro-policies which are highly counterproductive in terms of groundwater sustainability

### A Corollary - Groundwater Governance Benchmarking Criteria

- The cumulative operational experience of GW-MATE in assessing the effectiveness of existing provisions and capacity for the exercise of adequate groundwater governance (in areas where groundwater resources are experiencing significant stress from intensive development and/or pollution pressure) can be distilled into a priority list of benchmarking criteria (Table 4).

**Table 4 : Check-list of 'top-20' benchmarking criteria for the evaluation of groundwater governance provision and capacity**

TYPE OF PROVISION/ CAPACITY	CHECK LIST			RANKING	
	No.	CRITERION	CONTEXT	provision	capacity
Technical	● 1	Existence of Basic Hydrogeological Maps	for identification of groundwater resources		
	● 2	Groundwater Body/Aquifer Delineation	with classification of typology		
	● 3	Groundwater Piezometric Monitoring Network	to establish resource status		
	● 4	Groundwater Pollution Hazard Assessment	for identifying quality degradation risks		
	● 5	Availability of Aquifer Numerical 'Management Models'	at least preliminary for strategic critical aquifers		
	● 6	Groundwater Quality Monitoring Network	to detect groundwater pollution		
Legal & Institutional	● 7	Waterwell Drilling Permits & Groundwater Use Rights	for large users, with interests of small users noted		
	● 8	Instrument to Reduce Groundwater Abstraction	waterwell closure/constraint in critical areas		
	● 9	Instrument to Prevent Waterwell Construction	in overexploited or polluted areas		
	● 10	Sanction for Illegal Waterwell Operation	penalizing excessive pumping above permit		
	● 11	Groundwater Abstraction & Use Charging	'resource charge' on larger users		
	● 12	Land-Use Control on Potentially-Polluting Activities	prohibition or restriction since groundwater hazard		
	● 13	Levies on Generation/Discharge of Potential Pollutants	providing incentive for pollution prevention		
	● 14	Government Agency as 'Groundwater Resource Guardian'	empowered to act on cross-sectional basis		
Cross-Sector Policy Coordination	● 15	Community Aquifer Management Organisations	mobilizing and formalizing community participation		
	● 16	Coordination with Agricultural Development	ensuring 'real water saving' and pollution control		
	● 17	Groundwater-Based Urban/Industrial Planning	to conserve and protect groundwater resources		
Operational	● 18	Compensation for Groundwater Protection	related to constraints on land-use activities		
	● 19	Public Participation in Groundwater Management	effective in control of exploitation and pollution		
	● 20	Existence of Groundwater Management Action Plan	with measures and instruments agreed		

*Priority* ● *groundwater extraction related* ● *groundwater quality related* ● *groundwater extraction and quality related*



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## Further Reading

European Commission 2008 Groundwater protection in Europe. EC Official Publication ISBN 978-92-79-09817-8 (Luxembourg).

Foster S & Kemper K 2002-09 GW-MATE Briefing Note Series : Sustainable Groundwater Management – Concepts & Tools. World Bank-Washington DC [www.worldbank.org/gwmate](http://www.worldbank.org/gwmate) .

Foster S & Kemper K 2002-09 GW-MATE Case Profile Collection : Sustainable Groundwater Management – Lessons from Practice. World Bank-Washington DC [www.worldbank.org/gwmate](http://www.worldbank.org/gwmate) .

Nanni M & Foster S 2005 Groundwater resources – shaping legislation in harmony with real issues and sound concepts. *Water Policy* 7 : 543-550.

World Bank 2009 Problem-driven governance and political economy analysis – a good practice framework. World Bank-Washington DC.

World Bank 2009 Deep wells and prudence – towards pragmatic action for addressing groundwater overexploitation in India. World Bank-Washington DC.

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