Groundwater Governance: The Indian Scenario

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Abstract: Groundwater is the primary source of irrigation, domestic and industrial use in India. Over-exploitation of ground water during the past three decades has led to falling water tables, deteriorating groundwater quality and pollution necessitating a long-term policy to protect its overuse. Switching over from development to management, supply-side to demand-side management, enacting and forcing groundwater laws, establishing clear tradable property rights, pricing of ground water, installing licensing and permitting systems, strengthening institutions/processes to enable management, creating incentives, etc. are some of the means to impart sustainability to groundwater use in the country.

INTRODUCTION

Between them, India, Nepal, Bangladesh, Pakistan and China use over 300 billion m^3 of ground water annually, nearly half of the world's total annual use, mostly in agriculture – a business of US $ 25 billion (Shah, 2005). The groundwater economy of South Asia is huge (Table 1) and is mainly in the hands of the farmers, private and informal sectors with no or very limited regulation (Bhatti, 2002). Policy measures to regulate groundwater overdraft, such as enacting and enforcing groundwater laws, establishing clear tradable property rights for water, pricing of ground water, installing licensing and permitting systems, have all been discussed in South Asia and China. Nobody seems to disagree with the need for these measures yet no Asian country has yet been able to effectively deploy any of those even as the groundwater situation is turning rapidly from bad to worse.

In India, with growing population, increase in welfare and rising economic output, the risk of unsustainable use of ground water is becoming more evident by the year. Reports of groundwater level declines, wells running dry, health hazards due to arsenic, fluoride or other naturally inherent, or waste- or farm-use derived chemicals are abundant, contributing to a general perception of an out-of-hand, almost irreversible development process. The challenge now is to make the transition from development to sustainable management of the resource base, which is a much more complex task. However, to combat and reverse this trend various initiatives at different scales have been tried out and it appears that with growing signs of resource depletion and degradation and with growing awareness of the problems, a gradual move towards reaction is seen. Section 7 of National Water

Table 1. Role of South Asia's groundwater economy

Country	*Annual groundwater use (billion m^3)*	*Number of groundwater structures (million)*	*Extraction per structure (m^3/year)*	*Imputed value of groundwater used/year (billion $)*	*% of population dependent on groundwater*
India	150	19	7900	6	55-60
Pakistan	45	0.5	90,000	1.2	60-65
China	75	3.5	21,500	2.5	22-25
Iran	29	0.5	58,000	NA*	12-18
Mexico	29	0.07	414,285	NA	5-6
USA	100	0.2	500,000	NA	1-2

*NA: Not Available

Policy (GOI, 1987; GOI, 2002) highlights the groundwater development issues of over-exploitation, groundwater recharge, social equity, conjunctive use of surface and groundwater, and the need for regulations that are relevant to groundwater resources.

CONTEXT SPECIFIC STRATEGIES

In terms of groundwater quantity and number of people involved, by far the largest growth in groundwater use has occurred in sustaining subsistence cropping which is the main stay of millions of poor people in developing agrarian economies in India (Moench, 1992). From the resource governance viewpoint: (1) they are dominated by large diffuse masses of small users who are neither registered, nor licensed, operating as they do in totally informal irrigation economies untrammeled by laws and regulations, (2) the groundwater use support large numbers of poor people but generate little wealth in absolute or relative terms, (3) small holders have huge stakes in groundwater irrigation because it has served as one of the largest and most potent poverty reduction programme in recent decades (DebRoy and Shah, 2003), and (4) since science, technology and management tend to get attracted to wealth generation than to poverty reduction, the groundwater use attract far less management inputs.

India is facing unsustainable groundwater use in western unconfined alluvial aquifers as well as in peninsular hard-rock region where aquifers have little storage but precipitation is relatively better. Three large-scale responses to groundwater depletion in India have emerged in recent years in an uncoordinated manner, and each presents an element of what might be its coherent strategy of resource governance (Shah, 2005):

1. Energy-irrigation Nexus

Throughout India, the groundwater boom was fired during the 1980's by government support to tubewells and subsidies to electricity supplied by state-owned electricity utilities to farmers. The invidious energy-irrigation nexus that emerged as a result and wrecked the electricity utilities and encouraged waste of ground water are widely criticized. However, hidden in this nexus is a unique opportunity for groundwater managers to influence India's groundwater socio-ecology. Even while subsidizing electricity, many states have begun restricting power supply to agriculture to cut their losses. With intelligent management of power supply to agriculture, energy-irrigation nexus can be a powerful tool for groundwater demand management (Shah et al., 2003).

2. Inter-basin Transfers to Recharge Unconfined Alluvial Aquifers

In western India's unconfined alluvial aquifers, it is being increasingly realized that groundwater depletion could be countered by importing surface water. One of the major uses of the Sardar Sarovar Project in Gujarat is to recharge the depleted aquifers of North Gujarat and Kachchh using the Narmada water. Also, a key consideration behind India's proposed interlinking of northern rivers with peninsular rivers is to counter groundwater depletion in western and southern India.

3. Mass-based Recharge Movement

In many parts of hard-rock area, groundwater depletion has invoked a mass movement for rainwater harvesting and recharge, which interestingly has failed to take off in unconfined alluvial aquifers. Hydrologists keep writing the obituary of the recharge movement, but the movement has spread from eastern Rajasthan to Gujarat, Madhya Pradesh, Andhra Pradesh and Karnataka.

APPROACHES TO STABILIZE HEAVILY-STRESSED AQUIFERS

The technical strategies to confront situations of excessive and unstable groundwater exploitation include (IAH-NNC, 2003):

- Demand-side management interventions
- Supply-side engineering measures

It is always essential to address the issue of constraining demand for groundwater abstraction (Table 2), since this will normally contribute more to achieving the groundwater balance in the arid and densely populated areas. Complementary local supply-side measures such as rainwater harvesting, aquifer recharge enhancement with excess surface runoff and urban wastewater reuse should always be encouraged where conditions are favourable. These are often important in terms of building better

Table 2. Demand-side and supply-side actions for groundwater resource management

Level of action	*Demand-side management interventions*	*Supply-side engineering measures*
Irrigated agriculture	• Real water-savings secured in part from: - Low-pressure water distribution pipes - Promoting crop change and/or reducing irrigated area - Agronomic water conservation	• Local water harvesting techniques • Appropriate recharge enhancement structures (either capturing local surface runoff or sometimes with surfacewater transfer)
Main urban centres	• Real water-savings sometimes secured from: - Mains leakage and/or water use reduction - Reducing luxury consumption (say garden watering, car washing)	• Urban wastewater recycling and reuse (including controlled and/or incidental aquifer recharge by both in situ sanitation and main sewerage)

relationships with groundwater users and can provide an initial focus for their participation in aquifer management. In general, the Indian response to groundwater depletion has been supply-side, rather than demand-side.

FROM DEVELOPMENT TO MANAGEMENT

Groundwater management rather than development is the major challenge facing water resource organizations in the coming decades. Three factors argue strongly for this shift in focus: (a) the already dominant, and continued strong momentum, towards groundwater development through private initiatives, (b) the rapid expansion of groundwater management problems across many developing countries, and (c) the major organizational and other challenges facing development of effective groundwater management systems (World Bank, 1999). In principle, the groundwater threat can be met, provided national administrations can build a tight resource management regime well in time that includes both demand- and supply-side interventions. However, in reality the actions are too supply-side oriented; precious little is being done to reduce demand for groundwater or to economize on its use.

With rapid expansion in groundwater extraction, development-related problems have begun to emerge. The number of critical and over-exploited blocks increases exponentially. Substantial declines and fluctuations in the water table can occur long before extraction exceeds recharge. This can have major impacts on other users and the environment. Environmental concerns associated with development and pollution is major. Competition between uses is also a substantial point of concern. The impact of agricultural pumping on the availability of rural drinking water has been clearly documented (Wijdemans, 1995). In arid and hard rock zones, the problem is probably much more widespread resulting in major social, financial and institutional implications. Deeper water levels necessitate more technologically complex and expensive drinking water systems to the order of 1000 to 1500% (World Bank, 1998). Further, increases in arsenic, fluoride, iron and salinity above acceptable levels have been directly correlated with pumping rates and declines and fluctuations in the water level.

Emerging environmental challenges associated with groundwater development are significant in arid areas. Dropping water tables due to groundwater extraction often have major implications for the base flows of streams directly affecting the downstream users at critical times, vegetation ecologies and wetlands. Environmentally sustainable management rather than development is the key need.

Over the coming decades, groundwater management will need to address the broad array of resource and allocation problems. In arid zones, overdraft, pollution, poor quality, and the impacts that declining water table have on the environment must be addressed. Approaches to groundwater management need to be broadly integrated. Mechanisms must be found to ensure that water is allocated to high value uses. Access to ground water can be a major engine for poverty alleviation and economic development in rural areas.

STRENGTHENING LEGAL FRAMEWORKS, INSTITUTIONS AND PROCESSES TO ENABLE MANAGEMENT

Management of ground water will require institutions capable of addressing problems that vary greatly both in character and in scale. Legal frameworks and institutional approaches will need to respond to this variability as well as to the interests and concerns of local populations. Management often requires actions at the individual level. Institutional solutions to sustainable groundwater management that have a chance to work may pose complex issues of equity. In this context, institutional frameworks that enable effective participation of local users and communities in the management process are essential. Participation involves a dialogue between users and governmental authorities over the nature and goals of techniques of groundwater management. Institutional structures must, therefore, provide local communities and users as well as the government with a degree of real power to shape management approaches.

The large number of users is perhaps the reason that India and other developing country governments tend to rely more heavily on laws, rather than permits, to regulate groundwater use and abuse. However, they have yet to deliver effective regulations. In India, a Central Ground Water Authority (CGWA) has been established to address the problems of groundwater overdraft. The legal and legislative role of the CGWA is to develop model groundwater legislation and encourage states to adopt it. Figures 1 and 2 show the management process proposed in current versions of the model legislation.

In addition to rights reform, administrative and management frameworks are needed. Some of the key principles include:

- Create an institutional framework that enables rather than specifies.
- Design frameworks to include rather than exclude options.
- Separate institutions with responsibility for generating information from those with management functions (regulatory, resource provision, and so forth).
- Create processes that encourage systematic, integrated approaches to identifying management problems and options in participation with local communities. Key features of Integrated Resource Planning (IRP) are:
  - Equal attention to demand as well as supply management.
  - Involvement of stakeholders in the planning and decision making process.

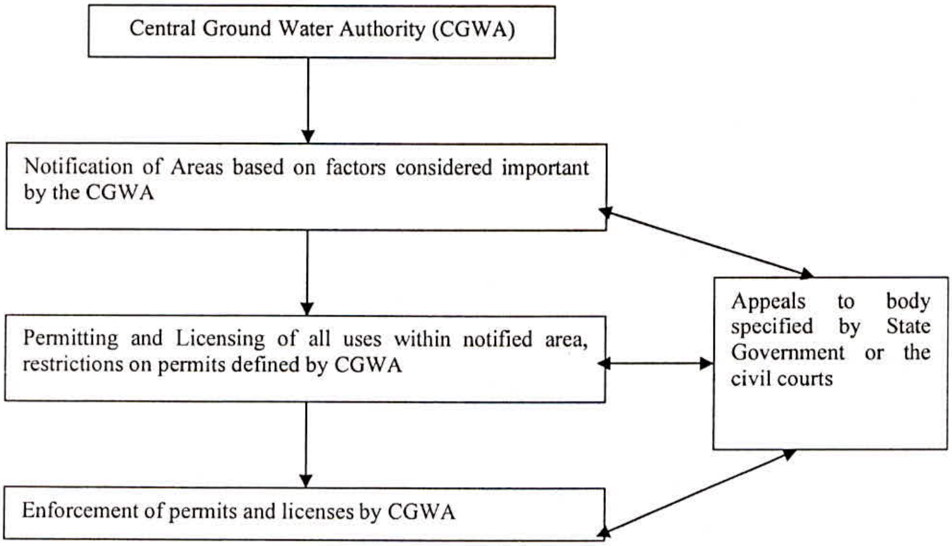

Fig. 1. Management process implicit in the proposed legislation.

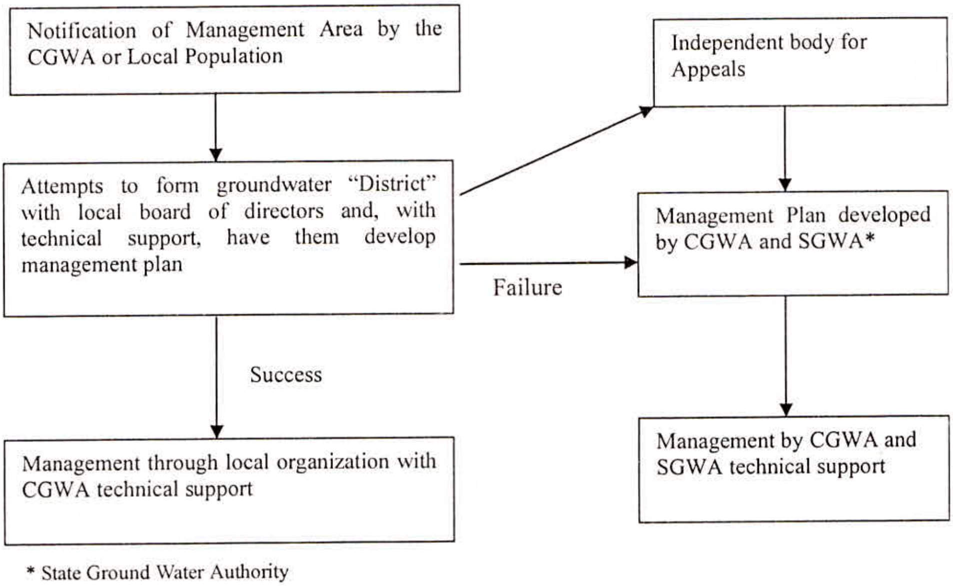

Fig. 2. Alternative management framework.

- Integration of a broad array of social objectives and the factors affecting these.
- Iteration – the 'plan', while providing a basis of action, is continuously re-evaluated as experiences, options and new issues emerge.

- Develop institutions that enable the use of conjunctive management approaches.
- Include checks and balances as part of framework and process design.

The approach proposed above seeks to address some of the social factors that have, so far, blocked effective management. Specific components that may help are (1) establishment of a process that includes education and involvement of stakeholders in the identification of management needs and options, (2) initial emphasis on management through creation of a local institution governed by a local board of directors, (3) presence of an independent water tribunal, and (4) creation of a package of incentives and disincentives to assist notified areas.

Three sets of issues that are to be addressed for the success of model regulations are:

1. Generalized regulations may be essential in some or possibly most instances. Given, however, the potential opportunities missed and inherent tendency toward conflict, centralized regulation should be held in reserve in case other management approaches prove ineffective.
2. It may be more productive to initiate a series of management pilot projects and use the experience gained as a basis for developing new legislative instruments.
3. Markets are emerging as a major allocation mechanism in a number of countries, when utilization of water in an aquifer has progressed to the extent of the available rechargeable resources. Pilot projects are needed to start the process in arid zones.

TECHNIQUES AND INCENTIVES FOR SUSTAINABLE GROUNDWATER MANAGEMENT

As a framework to understand the motives and issues at stake, Table 3 attempts to spell out the policies/driving forces, the management issues and requirements, and the technical issues and requirements at the macroscopic (society/government) as well as the microscopic (local/farmer) level (Anonymous, 2005).

Table 3. Issues and requirements in understanding and managing groundwater resources

	Policy/driving force	*Management issues*	*Management requirements*	*Technical requirements*
Macroscopic scale	Preserve agriculture for the security of poor farmers and food self-sufficiency	How to reach food security, not necessarily through food self-sufficiency? How to ensure livelihood of poor part of population?	• Reform of agricultural policies • Direct/indirect proactive regulation of raw materials, water, energy • Institutional capacity	An overview of groundwater resources (quantity and quality, opportunities and limitations to use)
Microscopic scale	Income generation, crop yield maximizing	How to save/ augment water in various sectors/ locations without sacrificing economic output?	• Reactive, local management schemes • Community awareness	Understanding groundwater recharge, availability, use and savings/ augmentation potential at local scale

Seen in this background and realizing that groundwater management, apart from the development of resource, is in its incipient phase in India. Traditionally the management is only weakly hinged on research. Shift from development to management necessitates a shift in emphasis on techniques and technologies. Although skills in designing wells and pumps will not lose relevance, a much broader array of end-use and land-use planning, operations and recharge technologies or techniques will become of central importance. Overall, management techniques are likely to be of far greater importance than the limited array of structural technologies used in association with them (Table 4).

In many arid zones the critical technological challenge is to use less water more efficiently to produce the same or greater benefits. In addition to demand-side management, spread of low-water-intensity cropping systems is equally important. Research is needed both to estimate the extent to which shifts in cropping patterns could reduce the agricultural demand for water and to determine the mechanisms through which appropriate shifts could be encouraged.

Table 4. Proposed matrix for groundwater regulation and management

Reorient the approach to groundwater management	• Shift the emphasis from development to management • Integrate environmental considerations
Create legal and regulatory mechanisms	• Create legal frameworks, institutions and processes to enable management • Evaluate existing and potential roles for water markets
Reform institutional structures and operations	• Reorient government organizations • Create data and analytical tools essential for management
Introduce techniques and incentives for sustainable groundwater management	• Identify techniques and programmes for sustainable groundwater management • Improving agricultural power supplies and pricing structures • Channel investments to emerging needs

Demand-side management is also important with regard to emerging pollution problems. From a groundwater perspective, the identification and encouragement of low-chemical-intensity agricultural practices could be a core management technique. Pollution could also be avoided through land use planning involving limiting the extent of pollution-generating activities in recharge area.

Conjunctive management of water resources would involve the integrated operation of surface and groundwater systems to meet an array of context-dependent social, environmental and other objectives. Surfacewater systems would be operated in conjunction with activities to recharge and manage groundwater aquifers. The objectives are to maximize the availability of water, reliability and environmental values. Given the complexity of conjunctive management, the information requirements and the institutional obstacles that need to be addressed, pilot projects are essential to gain practical experience. It is also to be ensured through participation of stakeholders, local communities and relevant government agencies that the pilot projects precede smoothly.

EPILOGUE

In the business-as-usual scenario, problems of groundwater over-exploitation will only become more acute, more widespread, serious and visible throughout India in years to come. Nevertheless, the groundwater administration still operates in development mode, treating water availability as unlimited, and directing their energies towards enhancing production, despite the fact that symptoms of over-exploitation are too clear (Siddiqi and Tahir-Kheli, 2004). Gearing up for management of ground water entails four important steps:

1. Information gathering and resource planning by establishing appropriate systems for groundwater monitoring on a regular basis and undertaking systematic and scientific research on the occurrence, use and ways of augmenting and managing the resource;
2. Initiating some form of demand-side management through:
   a. A control on borehole drilling to ensure effective and efficient water use;
   b. Registration of users through a permit or license system to prevent abuse of groundwater resources;

   c. Appropriate laws and regulatory mechanisms;
   d. A system of pricing that aligns the incentives for groundwater use with the goal of sustainability;
   e. Promotion of conjunctive use;
   f. Promotion of precision irrigation and water-saving crop production technologies and approaches;
3. Initiating supply-side management through:
   a. Promoting mass-based rainwater harvesting and groundwater recharge programmes and activities;
   b. Maximizing surface water use for recharge;
   c. Improving incentives for water conservation and artificial recharge; and finally
4. Undertaking groundwater management within a framework of integrated water resources management and providing a basis for standardized data collection and reporting procedures.

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