Sustainable Groundwater Management
Concepts & Tools

Briefing Note Series Note 6*

Stakeholder Participation in Groundwater Management
enabling and nurturing engagement

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(Revised from 2002 version*)

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Why should stakeholders participate in groundwater management?

- Groundwater stakeholders are those who have an important interest in the resources of a specified aquifer. This may be because they use groundwater, or because they practice activities that could cause or prevent groundwater pollution, or because they are concerned with groundwater resource and environmental management (Table 1). Since in many instances surface water should be managed conjunctively with groundwater for irrigation or municipal and industrial wastewater may pose a threat to groundwater quality, stakeholders should also (where appropriate) include representatives of surface water irrigators and/or municipal authorities and industrial organizations. The potential range of stakeholders is large and their active participation should contribute to the sustainability of groundwater resources and related economic activity.

Table 1: Potential range of interests and activities of groundwater stakeholders*

SECTOR	WATER-USE CLASSES	POLLUTING PROCESSES	OTHER CATEGORIES
Rural	domestic water supply subsistence agriculture commercial irrigation livestock rearing	household waste disposal intensive cropping wastewater irrigation farmyard drainage	drilling contractors surface irrigation providers drainage & flood management authorities sand & gravel mining operators land use planning authorities watershed management educational establishments professional associations journalists/mass media
Urban**	water utilities private supply	urban wastewater disposal/reuse municipal landfills	
Industry & Mining	self-supplied companies	drainage/wastewater discharge solid waste disposal chemical/oil storage facilities	
Tourism	hotels and campsites	wastewater discharge solid waste disposal	
Environment***	river/wetland ecosystems coastal lagoons		

* beyond local water resource, land planning and environmental protection agencies

** although stakeholder participation is relevant to urban groundwater management and pollution control it is not considered further in this paper, since it follows a completely different dynamic being dominated by utility and municipal policy issues

*** usually represented by some form of NGO and/or local authority

- Groundwater resource use and subsurface pollution pressure are influenced by 'external drivers' – such as macro-level social, economic and environmental planning, urbanization and land-use changes, agricultural policies (including fertilizer and pesticide subsidies, guarantee prices for certain crops, etc), highly-subsidized or flat-rate electrical energy tariffs for waterwell pumping, general subsidies on waterwell construction, support to watershed conservation and recharge enhancement, and the promotion of improved irrigation technology. All of these factors can affect the physical sustainability and chemical quality of the groundwater resource.

- **Stakeholder participation in some form or other is essential because it :**
  - disseminates understanding of issues that can be the impetus for up-scaling of good practices in the sustainable use of groundwater – management decisions taken unilaterally by a regulatory agency without social consensus being often impossible to implement
  - enables essential management activities (such as monitoring, inspection and charge collection) to be carried out more effectively through cooperative efforts and shared burdens
  - mobilizes user self-regulatory capacity within an appropriate context – if there are many users and/or limited institutional capacity groundwater management would otherwise be impossible
  - counteracts corruption in groundwater management, whether it arises in government or amongst stakeholder themselves
  - facilitates the coordination of decisions relating to groundwater, land-use and waste management and generally reduces cross-sector contradictions.

- Groundwater management decisions taken with participation of stakeholders should bring :
  - social benefits – because they promote equity amongst users and avoid groundwater access being dominated by a few
  - economic benefits - because they encourage balance with long-term potential of the resource, avoid resource collapse and optimize pumping costs
  - technical benefits – because they usually lead to better estimates of water abstraction and more precise understanding of the groundwater balance
  - management benefits – because they trigger local stakeholders initiatives to implement demand and supply measures and reduce the cost of regulation.

  Additionally, and very importantly, participatory management of highly-stressed aquifers should help take otherwise unpopular decisions where (at least in the short run) benefits to a number of stakeholder groups are decreased because they agree to change groundwater consumption patterns in the long-term communal interest.

What are the institutional mechanisms for stakeholder participation in groundwater management?

- The participation of stakeholders can take many forms. At its most basic level it can occur even without formal organization – and there are several examples of groundwater being managed at local level by strong community values and norms without groundwater user associations or the initiative of a water resource regulatory agency. Stakeholder participation in groundwater management can take place at various territorial levels – ranging from individual waterwells to an aquifer system and even to the river basin or national level – and should be encouraged at all levels since it can make an important contribution to groundwater conservation, management and protection.

- **The most basic criterion for stakeholder participation is the acceptance of specified values and norms for groundwater abstraction and use** – which can be effective in bringing community use of groundwater in line with resource availability and achieving shared understanding of resource limitations. Specific examples include community bans on specified high water-consumption crops or certain types of waterwell, and changes in cropping pattern. In more complex situations (for example extensive aquifers or intensive competitive use), such norms will not suffice and more formal organization will be needed to facilitate and sustain groundwater management.

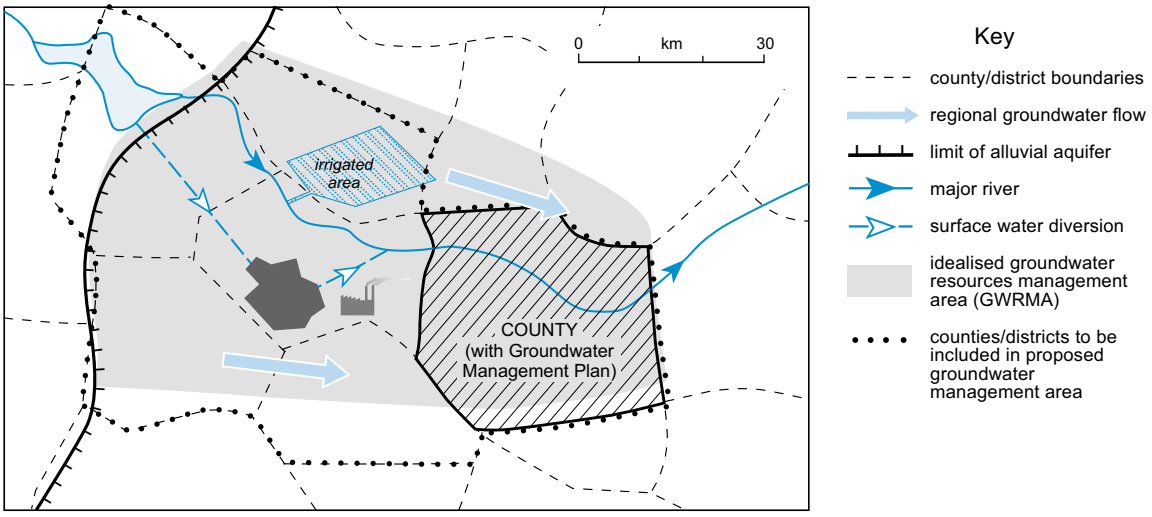
- Local organization of water users have existed since time immemorial in some countries – distributing groundwater from wells or springs to their members for irrigation, and collecting operational charges and settling water disputes in accordance with customary rules. Such groups are here called **water-user associations (WUAs)**. Often the remit of WUAs is limited to operation and maintenance of the irrigation water supply and distribution systems, and only weakly linked with the management and protection of the resource. It is important to broaden their agenda (or to create special organizations) to address groundwater resource management and protection with recognized legal rights and duties, and to vest them with judicial personality, so as to facilitate their work and enable contractual relations with local water and land regulatory agencies.

- In some cases WUAs relate to both surface water and groundwater sources, and here the specific rights and duties of groundwater users must be clearly defined. In the case of small aquifers irrigators may join to form **groundwater user groups (GWUGs)** and **village water-supply councils (VWSCs)** often play a key role for drinking water-supply protection (and in some cases sanitation) in rural areas, and their roles can be extended to manage demand and enhance supply. In the case of small aquifers and/or situations with weak government institutional capacity, **non-governmental organizations (NGOs)** can be of great help for promoting stakeholder participation and groundwater management, but they need to be supported or overviewed by the local water resources agency.

- In the case of larger high-yielding aquifers, which often include more diverse interests but smaller numbers of individual users, higher-level stakeholder participation through an **aquifer management organization (AMOR)** is required. This type of organization needs to be established more widely as the institutional mechanism for stakeholder participation in groundwater management at aquifer level – and should include all local WUAs, GWGs and VWSCs, and other main categories of stakeholder (Table 1). AMORs should also include representatives of national and/or local groundwater resource agencies and of the corresponding local government authority, and in some circumstances can (and should) be formed at the initiative of the water administration, especially when zones with critical groundwater status are declared.

- Regardless of the size of the aquifer, **stakeholder participation needs to be defined around coherent groundwater bodies.** The delineation of appropriate boundaries for the establishment of a groundwater body (resource management area) for an AMOR (Figure 1), and even for simpler forms of organization in smaller aquifers, is particularly critical. This will not always be straightforward, especially for large aquifer systems with low hydraulic gradients, and sub-division into groundwater bodies will need to be done as logically as possible. When the so-defined groundwater body is part of a large aquifer system, it is important to establish institutional mechanisms to integrate groundwater management and stakeholder participation at the system level. Since most shallower aquifer systems

Figure 1: Hydrogeological basis and administrative approach to delineation of groundwater bodies



are interconnected with surface water systems, AMORs should be represented in river basin agencies – something that at present hardly ever occurs. Moreover, representatives of the various main categories of groundwater stakeholder should also be called upon to comment on high-level policy decisions at national water commission level – in Figure 2 the various possible levels of representation and degrees of interaction, which will vary somewhat according to the specific case, are shown schematically.

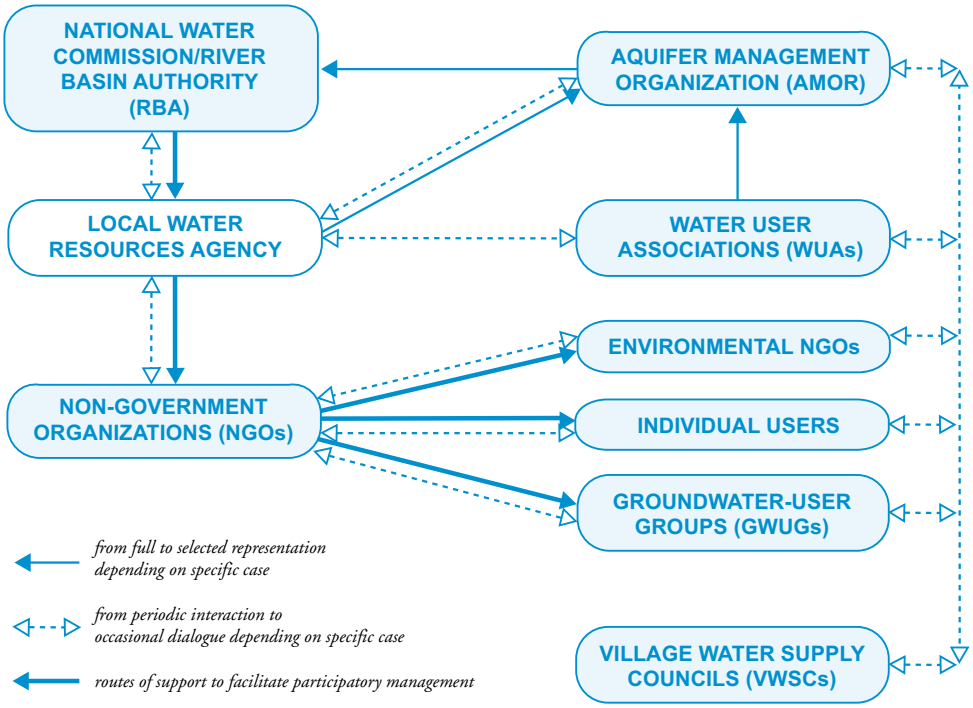
- All stakeholders for a given groundwater body need to be identified, and provision made to ensure their fair representation in the institutional mechanism defined for aquifer management – difficulties can arise where there are large numbers of individual stakeholders with the solution being some form of federation. Some consideration needs to be given to the position of those that do not (yet) use groundwater. It will often not be socially and practically possible to exclude current non-users from using groundwater in the future, and management arrangements that define the rules of access for new users are required.

- Participatory groundwater management does not generally happen spontaneously. The exception occurs where historic events have underscored the importance of groundwater and charismatic local leadership has arisen to address the issue. In other situations the process is likely to be considerably longer and the set-up costs higher, since there may be no acute awareness of the threats to the groundwater and many unconnected users.

Which groundwater management functions can be performed by stakeholders?

- **There are many ways in which stakeholders can participate in the management of groundwater resources and aquifer systems** – approaches will vary according to both to the specific interests of the stakeholders and the nature of customary rules and rights for water and land in the area concerned.

Figure 2: Desirable institutional interaction in participatory groundwater resource management



This scheme summarizes a typical arrangement, but many variants are possible depending on the geographic scale of the aquifer and the territorial level of local government agencies.

- In principle it has to be in the interest of groundwater users that the resource base is conserved. Moreover, the limits set to groundwater use under resource management plans do not necessarily imply that economic benefits are jeopardized. There is often scope for increasing productivity of groundwater use to compensate for less being abstracted – by using appropriate soil moisture management, improved crop selection and irrigation techniques, that lead to real water-resource saving. The implementation of such measures, however, needs to be triggered by stakeholder participation in groundwater management, and there may even be scope for successful community action on aquifer recharge enhancement. The benefits of participatory groundwater management will be less, and the process more painful, where over-abstraction is really acute and a choice has to be made between radical reduction of irrigated areas or progressive time-limited resource depletion.

- The functions that can be performed in groundwater management are summarized in Table 2. Some measures are relatively easy to implement (maintaining distance between waterwells or bans on certain type of crop). Other measures require more coordination, management and even enforcement – and will be easier to implement if AMORs, GWUGs, WUAs (and local NGOs acting on their behalf) are recognized and supported by the local groundwater agency. It should also be acknowledged that **users must adapt their communal behavior to meet certain agreed groundwater resource criteria.**

Table 2: Summary of functions commonly performed by stakeholders in participatory schemes of groundwater management

FUNCTIONS	LEVEL AT WHICH FUNCTION PERFORMED					
	MINOR AQUIFERS			MAJOR AQUIFERS		
	VWSC/ GWUG	NGO	LAU	WUA	AMOR	RBA
administer/participate in local allocation/ access to groundwater	● +	▲		● X		
groundwater monitoring	● + ✳	▲		● X ✳		
engage in preparation/implementation of groundwater management plans	● + ✳	▲			● ✳	▲ ✳
facilitate shared access and use of groundwater facilities	● +	▲	▲	● X	● ✳	
promote/undertake demand reduction measures	● + ✳	▲	▲	● X ✳	▲	
engage in recharge and retention measures	● + ✳	▲		● X ✳	▲	
mobilize additional sources of water	● ✳	▲	▲	● X	● X ✳	▲
make/participate in binding rules on water use	● +	▲	▲	● X	● X ✳	
implement groundwater protection measures			● + ✳		● X ✳	● X ✳
settle groundwater resource disputes	● +	▲			● X ✳	● X ✳
negotiate and interact with other policy actors			● ✳		● X ✳	● X ✳

VWSC = Village Water Supply Council; GWUG = Groundwater User Group; NGO = Non-Governmental Organisation; LUA = Local Authority; WUA = Water User Association; AMOR = Aquifer Management Organization; RBA = River Basin (or National) Authority/Committee

● main implementer + based on local community organization/rules ▲ supports X requires juridical personality to be conferred on corresponding organization/association ✳ requires formalization of relationship with a local water resources regulatory agency

How can participatory groundwater management be enabled and nurtured?

- **Community engagement in participatory groundwater management only exceptionally comes about spontaneously, and in general will need to be enabled and nurtured by the appropriate offices of government (or NGOs supported and overviewed by government).** Essential facets of such nurturing are :
  - facilitation of interaction amongst the full range of stakeholders
  - dissemination of a broad understanding of the groundwater resource situation
  - promotion of measures to improve the groundwater resource balance (if necessary), through reduced consumptive use and groundwater recharge enhancement
  - provision of a conducive legal and institutional framework
  - setting realistic management targets and monitoring progress.

Table 3 : Hydrogeologic and socioeconomic framework of selected pilot groundwater management areas

COUNTRY Aquifer	GENERAL AQUIFER TYPOLOGY	SPECIFIC GROUNDWATER BODY CHARACTERISTICS		
		hydrogeological setting	user profile and socioeconomic situation	groundwater resource issues
ARGENTINA Mendoza-Carrizal Aquifer *(GW-MATE CP6)*	major alluvial deposits	piedmont sediments	export wine, fruit & garlic production	increasing salinity from impeded drainage & hydrocarbon pollution from oil refinery
BRASIL Interstate Apodi Aquifers *(GW-MATE CP16)*	consolidated sedimentary formations	karstic limestone + weakly cemented sandstone	commercial tropical fruit production	intensive abstraction lowers water-table substantially in extended drought
CHINA North China Plain *(GW-MATE CP8)*	vast alluvial deposits	Guantao County groundwater area of alluvial sands	regularly irrigated winter-wheat and occasionally-irrigated summer maize	falling groundwater levels and risk of saline up-coning and land subsidence
MOROCCO Souss-Choutka Aquifers	inter-montane valley deposits	sequence of unconsolidated sediments	export citrus & vegetable production, some public water-supply	intense overexploitation- reducing irrigated area only solution
YEMEN Dhamar, Hadramouth & Taiz Aquifers	minor alluvial deposits	multi-layered thin sediments below 'wadis'	mainly small-scale irrigated agriculture	intense overexploitation – 'orderly aquifer depletion' only solution
INDIA Andhra Pradesh State *(GW-MATE CP19)*	weathered hardrock crystalline basement	multiple small weathered granitic formations	subsistence irrigated agriculture & rural water-supply	severe aquifer depletion, some up-coning of high fluoride groundwater
INDIA Maharashtra State *(GW-MATE CP22)*	weathered hardrock (plateau basalts)	weathered basalts under Hivre Bazaar village	1,000 ha irrigated land and drinking water for 1000 population	aquifer depletion and waterwell yield failure
MEXICO Santo Domingo Aquifer, Baja California Sur	coastal formation	local sand + gravel deposits	commercial irrigated cropping	acute water-table drawdown & saline intrusion
MEXICO San Luis Potosí Aquifer	inter-montane valley-fill	layered aquifer separated by fine lens	mainly public water-supply & some irrigation	intensive abstraction caused land subsidence and up-coning of high fluoride groundwater
MEXICO* Silao-Romita Aquifer, Guanajuato *(GW-MATE CP10)*	inter-montane valley-fill	thick sequence of volcanic & lacustrine alluvial sediments	alfalfa-fed livestock and public water- supply	intense overexploitation - reduction of irrigated area necessary to protect public water-supply

** wide range of examples in similar hydrogeological setting in Guanajuato State, which includes extreme case of Laguna Seca Aquifer where intense overexploitation now means only management possibility is 'orderly depletion to a situation leaving minor groundwater resource availability for limited drinking water-supply'*

Table 4 : Summary of pros and contras of stakeholder participation and user community action in groundwater resources management for the range of GW-MATE-supported pilot projects

COUNTRY (AQUIFER/GW BODY)	MECHANISM/FOCUS OF STAKEHOLDER PARTICIPATION	ACHIEVEMENTS OF STAKEHOLDER PARTICIPATION	LIMITATIONS OF GW MANAGEMENT ACTION
ARGENTINA Carrizal Aquifer – Mendoza	DGI (state water resource regulation/ hydraulic infrastructure agency) has good records of/ relations with groundwater users (and information on their use) and has promoted irrigation WUAs (inspecciones de cauce) and worked closely with major water user/polluter (REPSOL-YPF)	public-private partnership has already mobilized US$ 18+ million for control of hydrocarbon pollution risk and mitigated problems of most-affected groundwater users; general ban on new waterwells has been sustained and new regulations have plugged legal loophole allowing transfer of use rights of salinsed wells	groundwater irrigators reluctant to join WUAs (dominated by canal-water users) thereby impeding structured consultation and promotion of conjunctive use ; some falsely believe petroleum industry contamination (not irrigation water management) is main cause of groundwater salinisation
BRASIL Apodi Aquifers – Ceara (CE) & Rio Grande do Norte (RN) Interstate	rapid development of groundwater intensive use for export tropical fruit production and falling water-table in extreme drought led to full user collaboration with SEMARH-RN in part of aquifer and concern about transboundary interference	RN user collaboration in waterwell use water-level monitoring, promoted formation RN/CE shared aquifer management working group, major SRH-COGERH-CE effort waterwell inventory/ data collection, mobilisation major ANA (federal govt) resources study	decreasing groundwater user concern following sequence of wet years, both CE & RN public administration still not proactive in regularizing and inspecting all major groundwater users, and institutions require further strengthening and decentralization especially in RN
CHINA North China Plain – Guantao County	strong state/local government agencies and village administration capable of promoting real groundwater resource savings through changes in irrigation practice	village-level WUAs encouraged farmers to collaborate in range of engineering, agronomic and management measures to save groundwater, which is viewed as a 'social asset'	still questionable whether farmers have reduced non-beneficial groundwater losses and accept reallocation to urban/ industrial use (original intention) - latter interest not represented in WUAs
INDIA Weathered Granitic Basement – Andhra Pradesh	communiy-based groundwater management (CBGWM) pioneers with government/donor projects involving NGOs to provide 'groundwater resource education' to thousands of farmers	groundwater sustainability and productivity improved through new cropping patterns/practices; benefits from some non-intrusive government facilitation with promotion of irrigation technology/watershed conservation	requires further government incentives to economise on electrical energy use and improve agricultural procurement plus a stronger state groundwater agency to monitor CBGWM progress and aquifer behavior
INDIA Weathered Deccan Basalts – Maharashtra	since 1993 Hivre Bazaar village fine example of CBGWM by effective council (Gram Sabha), led by charismatic council leader (Sarpanch) – who is now appointed by State Government as ambassador to replicate efforts	only dugwells permitted for irrigation, ban on livestock-grazing and sugar-cane/ banana cultivation, successful soil conservation/ recharge enhancement programme, gwl-based cropping plans – transition to drought-resilient economy	some question about sustainability should leadership change and about replicability since although a low-rainfall drought-prone area has relatively-favourable conditions for groundwater recharge enhancement

Table 4 : *Continued*

COUNTRY (AQUIFER/GW BODY)	MECHANISM/FOCUS OF STAKEHOLDER PARTICIPATION	ACHIEVEMENTS OF STAKEHOLDER PARTICIPATION	LIMITATIONS OF GW MANAGEMENT ACTION
MEXICO **Santo Domingo Aquifer – Baja California**	COTAS formed, but following unenforceable federal regulations, larger farmers bought-out small farmers and invested in modernizing irrigation technology	more than 60% reduction in groundwater abstraction during 1995-2006, groundwater abstraction metering installed and maintained with monitoring of groundwater levels/quality – full agreement on future groundwater and soil conservation measures	concern about socioeconomic consequences of displacement of smaller farmers
MEXICO **San Luis Potosi Valley Aquifer**	COTAS formed by private users, municipal water-supply utility and state government – latter constructing surface water dam/reservoir to reduce groundwater dependency	good cooperation with full waterwell inventory, users directory and well metering; participatory drafting of regulations to stabilise aquifer and reserve deep good-quality groundwater for potable supplies	concern that federal-level may not endorse and financially support aquifer stabilization plan
MEXICO **Silao-Romita Aquifer – Guanajuato**	since 1998 state govt. has strongly supported cross-sector groundwater management associations (COTAS) and promoted aquifer management actions via this route	COTAS have raised awareness leading to watershed conservation programmes, numerical aquifer models have been prepared by CEAG (state water agency) and federally aquifer stabilization plans elaborated	waterwell drilling bans ineffective due to poor enforcement and COTAS not able to mobilise effective action to reduce net abstraction and stabilise aquifer water-levels; inadequate devolution of resource admin from federal-level to state and COTAS
MOROCCO **Souss-Choutka Aquifers**	basin water resources agency has strategy to stop further extension of irrigated areas, improve irrigation efficiency/water productivity and subsequently negotiate reductions in groundwater irrigated area	aquifer numerical model used to inform stakeholders and reach management agreement (Contrat de Nappe) reached, which includes subsidized drip irrigation, requests demand constraints and accepts regulatory provisions	negotiated non-binding approaches favoured over agreed reduction of irrigated area – thus resultant 'real groundwater savings' questionable and further complicated by dispute over numerical model parameters
YEMEN **Dhamar, Hadhramout & Taiz Aquifers**	strengthening capacity of local communities for groundwater use planning/monitoring simultaneously with provision of improved irrigation technology and aquifer recharge enhancement	WUAs established and have led to change to less water-consuming crops (incl. reduction of qat) and some real groundwater resource savings	groundwater recharge and storage still very limited and questionable whether agricultural production sufficient to pay back loans for improved irrigation technology – and still lack of transparency about resource status

- It is helpful to those promoting participatory groundwater management to learn from recent experience in this area. In its 10 years operational experience in the developing nation context worldwide, GW•MATE has been able to assess and contribute to a number of cases whose achievements and difficulties provide useful lessons – Table 3 provides a summary of the main hydrogeologic and socio-economic conditions in the corresponding areas from which stem the following observations :
  - **hydrogeologic conditions** – in relatively small aquifers with non-complex hydrogeology and reliable annual recharge it requires less effort to achieve effective participatory groundwater management than in large aquifers with less clearly-defined groundwater bodies
  - **groundwater user profiles** – heterogeneous user groups and absentee stakeholders make it more difficult for participatory management than do socially more homogeneous user groups
  - **resource issues** – participatory management is easier if there is scope for restoring a reasonable groundwater resource balance without seriously impacting existing livelihoods (although this may not always be possible).

  In Table 4 the focus, achievements and limitations of participatory management are summarized for the same aquifers and areas introduced in Table 3 – from this the wide range and varying success of participatory management experienced will be evident.

- To promote stakeholder engagement in groundwater resource management it is often necessary to broadcast the importance of these resources and their vulnerability to depletion and degradation – a task that needs to be facilitated by government often through the mobilization of NGOs. The initial approach is normally to present, using local communication channels and the mass media, the current status of groundwater (availability and quality) together with predictions of the consequences of not taking some form of management action. Where groundwater users have already been involved themselves with hydrological monitoring communication will be easier.

- But this is generally not enough, and education (as distinct from awareness) programmes will need to be developed and promoted at various levels – focusing on the remedial action to be taken and on how to sustain such action institutionally. It will be useful to map the existing local communication network, identifying 'message senders' and 'message receivers'.

- When developing the preferred role of the local government water resources agency in participatory groundwater management it is advisable to adopt the following criteria :
  - **make complex groundwater situations understandable** by providing clear information on the hydrological balance of the groundwater body concerned (wherever possible using modern software with user-friendly visual interfaces to share understanding of system behavior under different management scenarios) and engaging stakeholders in aquifer monitoring – stakeholders will usually then be willing to consider management interventions and to accept advice on whether their own ideas are technically and economically sound
  - **empower stakeholder organizations** and avoid patronising ('officials know best') postures, since it must be accepted that stakeholders have to be the main actors in the participatory management process with government assisting them in identifying strategic issues and implementable solutions
  - **ensure all stakeholders are properly represented** irrespective of their individual weight in terms of land tenure and water rights or their economic and political influence
  - **establish sound, implementable and socially-acceptable resource allocations** so that the interests of stakeholders are reasonably protected with third party and environmental concerns also being

taken into account, but retaining sufficient flexibility to allow for a component of reallocation to more socially, economically or environmentally beneficial uses or in the light of revised resource evaluations as a result, for example, of climate change
- **promote improvements in groundwater use efficiency** by providing guidelines on measures that will maintain income levels whilst reducing water consumption – including 'real resource saving' measures, alternative cropping patterns, improved soil moisture management, etc
- **combine participatory management with investment in recharge enhancement** since if groundwater users themselves engage in augmenting resources their sense of ownership of the resources will also be enhanced.

- While conflict amongst groundwater users is generally best settled by the parties themselves, situations may arise in which conflicting parties prefer to have an external body (such as a government agency or high-profile NGO) promoting settlement (so that they do not have to confront each other directly).

- Where excessive groundwater abstraction from an aquifer drives a number of farmers out of agriculture because of the escalating cost of access to groundwater and/or its diminishing supply, wealthier farmers usually consolidate their agricultural production resulting in migration of displaced farmers to neighboring urban areas – the public administration concerned with groundwater resources must anticipate such phenomena and decide how it can best act in the broader public interest.

- In most developing nations public information offices deal with narrowly-focused communication programmes, implemented through the national media without systematic assessment of impact. This approach is not well-suited to the technical complexity of groundwater resource management nor to the social aspects of stakeholder participation. A more appropriate approach to communication would need to be compatible with existing networks within which local groundwater agencies work. The stakeholder focus should be on building capacity to access, use and generate information – thus in groups with different capacities traditional community outlets, the mass-media and modern information channels all need to be considered.

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