Sustainable approaches to community management of groundwater in Deccan Traps[1]

By Yugandhar Mandavkar[2]

Abstract

Communities in peninsular India are getting increasingly dependent on groundwater resource for meeting their domestic and productive needs. Due to deterioration of recharge conditions on one hand and increased demand on the other, this relatively accessible and reliable resource is strained, thereby making it difficult for the poor communities to access it for their domestic, agricultural (irrigation) and livestock needs. Irrigation accounts for the largest segment of this demand.

Official policies and groundwater regulations at best provide the guiding principles for water management in a generalised manner. These are seldom put into practice unless communities come forward to self regulate and self manage the resource. Lack of overall knowledge and understanding about the resource is the main hindrance in social participation and community action in this regard, because prediction of groundwater behaviour in Deccan Traps, like in other hard rock areas, is always a challenge because of complex hydrogeological formations.

For effective community action for sustainable use and conservation of a depleting resource, it is necessary to evolve a community based mechanism and socially acceptable norms. The paper presents experience of GRASP in District Buldhana, Maharashtra, India demonstrating successful management practices through systematic capacity building of community on scientific understanding of groundwater behaviour and promoting institutional arrangements that are democratic and decentralised in nature.

The paper argues that sustainability has to be designed in the management model based on scientifically assessed parameters that are understood by the users.

Keywords : aquifer, community management, capacity building, groundwater assessment, Deccan Traps, GRASP

Introduction

Groundwater continues to serve as a reliable source of water for a variety of purposes, including industrial and domestic uses and irrigation. In many developing countries, reliance has turned to dependency and the establishment of perceptions of access and use that are intensely private irrespective of the legal status of the groundwater. The development of energised pumping technologies in the mid-twentieth century has induced depletion of shallow aquifers (FAO, 2002).

The impacts of long-term abstraction are readily apparent in regions where springs and seepage zones disappear or where users have to dig or drill deeper to chase a locally falling phreatic or piezometric level. Sustainability or balanced yield of an aquifer assumes that a steady state can be achieved in which water levels are stabilised. This narrow focus is often misleading, as all groundwater abstraction involves drawdown and this process can have a time-lag of many years before a new equilibrium is established in large aquifers of low transmissivity/storativity ratio. This could be mistaken for continuously-declining groundwater levels in some cases (GW-MATE, 2006).

Groundwater plays a central role in the maintenance of India's economy, environment, and standard of living. Groundwater resource is an important source of drinking water and food security for nearly a billion of Indian population, with approximately 85% of the water used for domestic purposes and more than 50% of that used for irrigation is drawn from groundwater source. It is an important factor in building India's ability to feed its rapidly growing population. Access to groundwater can be a major driver for poverty alleviation and economic development in rural areas (World Bank; 2007).

The drought-prone interior Maharashtra is especially dependent on groundwater resources for drinking and domestic needs, as well as for agriculture. Despite a limited potential, groundwater is intensively abstracted as a sole and accessible resource in absence of availability or accessibility of surface water. The aggregate impact of numerous individual pumping decisions, while highly conditioned by the hydrogeological status of the pumped aquifers, is evident in falling groundwater tables, and at places, declining water quality.

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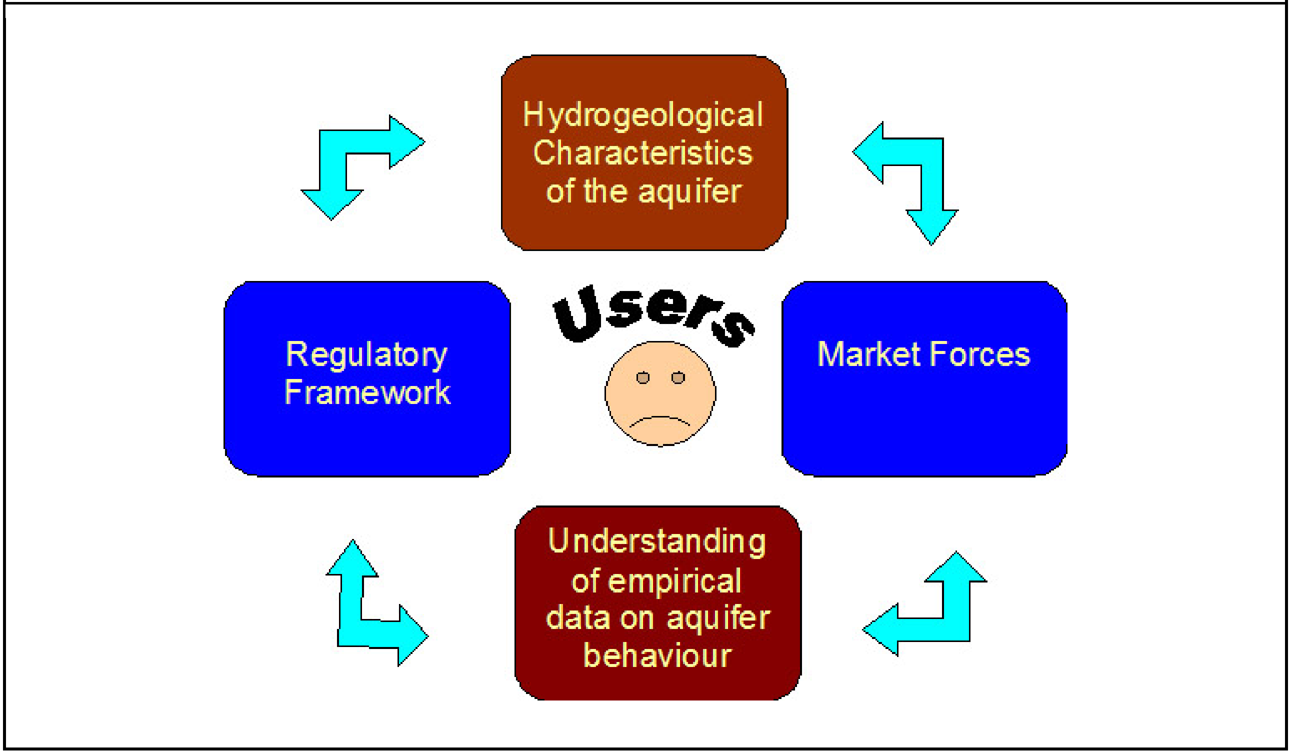
2 Vice-Chairperson, Grass Roots Action for Social Participation (GRASP), V-18, New Shreya Nagar, Aurangabad - 431005, India. E-mail : yugman10@yahoo.com, grasp_agd@sancharnet.in; URL : www.grasp.org.in

1. Factors affecting groundwater usage

The phenomenon of excessive abstraction of groundwater and corresponding social behaviour could be attributed to four interconnected factors, namely, hydrogeological characteristics of aquifer; understanding of empirical data on behaviour of aquifer; regulatory framework; and market forces affecting farm economics (Fig 1).

Fig 1 : Factors influencing groundwater abstraction



1.1 Hydrogeological characteristics of aquifer : This basic information, established using whichever methods, is essential for designing the groundwater management strategy. In hard rock regions of central Maharashtra, one often encounters multi-layer aquifers[3] or strata of permeable formations separated by impermeable material, i.e. the reddish hydrothermally altered top surface of basalt. It is important to know the lateral and vertical expanse of such strata and their specific yield. Most of central Maharashtra is characterised by highly weathered vesicular amygdaloidal basalts upto a limited depth. It is separated by a thin mantle of amygdalooidal basalt which is free from cracks and fractures and has low permeability producing very extensive low yielding aquifer.

1.2 Understanding of empirical data on behaviour of aquifer : The behaviour of groundwater users is greatly influenced by their understanding of aquifer and water availability. In rural areas, it is based on their observations of the wells, which constitute the main conduit of tapping groundwater, over a very long periods sometimes extending to a few generations. The author has interacted with several farmers capable of correlating water availability in their wells with rainfall distribution, flows in nearby streams, storages volume and duration in nearby reservoirs, as well as the overall cropping pattern in the village or the neighbourhood.

1.3 Regulatory framework : In the last couple of years, Government of Maharashtra has been trying to bring in a legistation to regulate groundwater abstraction. It organised consultations on the National Water Policy on various forums. It also constituted a state level Water Resources Regulatory Authority (MWRRA). However, like in many countries, groundwater is a common property resource with extremely high use value, as against a private property of the landowner[4].

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3 An aquifer is a geological formation capable of yielding useful groundwater supplies to wells and springs. All aquifers have two fundamental characteristics: a capacity for groundwater storage and a capacity for groundwater flow. But different geological formations vary widely in the degree to which they exhibit these properties and their spatial extent can vary with geological structure from a few sq.km. to many thousands of sq.km.

4 The term 'common property' refers to the status of groundwater as a resource to which all overlying landowners generally have access, irrespective of its legal status as a public, common or private resource. In some societies, groundwater is or has been linked to land ownership. In others it is viewed as a 'common heritage' (not to be confused with the British 'common law' system) to which all should have equal access, at least for basic needs. These conflicting positions are enshrined in religious doctrines such as

It creates the situation of conflict between the economic interests of the investor-cum-users and the social obligations of the state to fulfil the basic needs of the deprived sections. This contradiction is brought to the fore by increased recognition of the need for water to be used more efficiently.

Given the problems created by growing water scarcity and pollution, legislations have been widely enacted in many countries to vest all water resources in the state, or to recognise the state's superior right to the management of water resources. The declaration of groundwater as a 'public good' turns the former owner into a user, who must apply to the state administration for a water abstraction and use right. Once the state is the guardian or trustee of groundwater resources, it may (in addition to granting water rights) introduce measures to prevent aquifer depletion and groundwater pollution. Moreover, such legislations tend now to require water resources planning at the level of an entire aquifer or river basin (GW-MATE, 2006).

1.4 Market forces affecting farm economics : Market mechanisms can play a major role in achieving efficiency objectives, and more emphasis is now being given to the nature of water as an economic resource in global debates (Shah, 1993). This emphasis translates into initiatives to clarify water rights, encourage water markets and issue concessions in some countries. However, the process may be stillborn if there is no recognition that water resources, by their very public nature, require regulation and are not amenable to absolute free-market solutions. As these initiatives increase, tensions related to underlying ethical issues can also be expected to rise. If groundwater is viewed as a common heritage to which all have fundamental rights of access, the ethical basis of unregulated concessions or markets that allocate water depending on ability to pay becomes controversial (FAO, 2002, op.cit.).

The observation in western and central Maharashtra showed only sporadic examples of groundwater trade in agriculture sector, sometimes in form of lending a well for a season or so and sometimes as a form of share cropping. The behaviour strongly reflect the influence of farm level economics on farmer's decisions on investments in and expenditure on obtaining groundwater. Decisions of minor investments or short-term adjustments are often driven by the urgency to save a seasonal crop nearing harvesting stage, whereas at the larger investment decisions are driven by the prospects of financial returns a relatively high value crop is likely to offer. The latter is observed in case of horticulture, especially vegetable cultivation; there are sporadic examples of farmers making large investments in wells or in importing water for crops like sugarcane and cotton. It is also a common observation that after acquiring a new irrigation source (such as a well), most farmers go for cultivation of wheat as it is a crop with social status. They gradually shift from wheat to horticulture or vegetable cultivation because of better economics or efficiency.

2. Objectives for Groundwater Management

The generally accepted objective is to achieve a sustainable utilisation of groundwater resources, based on sound management practices rather than development alone. It is expected to address the broad array of resources and allocation problems now emerging; overdraft, poor quality and declines in the groundwater table. In addition, as urban areas and the non-agricultural economy grows, mechanisms are found to ensure that water is allocated to high-value, generally non-agricultural uses. Experts argue that effective management of India's groundwater will require institutions capable of addressing problems that vary greatly both in character and in scale (Aithal, 2002). Simultaneously, legal frameworks and institutional approaches will need to respond to this variability. The local agency responsible for promoting groundwater management needs to define, in consultation with primary stakeholders, realistic targets for groundwater management interventions.

While groundwater supply is largely non-negotiable, as induced recharge may be limited due to site conditions, managing the demand for groundwater is often the only area where there is room for manoeuvre. A variety of approaches and solutions have been offered and tried in different parts of the world in order to promote sustainable management of groundwater resources. These approaches include appropriate technologies, water laws and regulations, and institutional responsed at different levels. It is evident, however, that unless the users themselves take the initiative in the management and regulation of groundwater resources, there is little scope to reverse current trends and sustain the livelihoods that are dependant upon continued access to groundwater mainly because very high investments for groundwater use are made by private individuals. This user-based approach is gaining strength and showing concrete results in certain settings (APFAMGS, 2006).

3. Experiences of Aquifer Management

On this background, Grass Roots Action for Social Participation (GRASP), a voluntary organisation working for community based natural resources management and rural livelihoods, facilitated community management of groundwater

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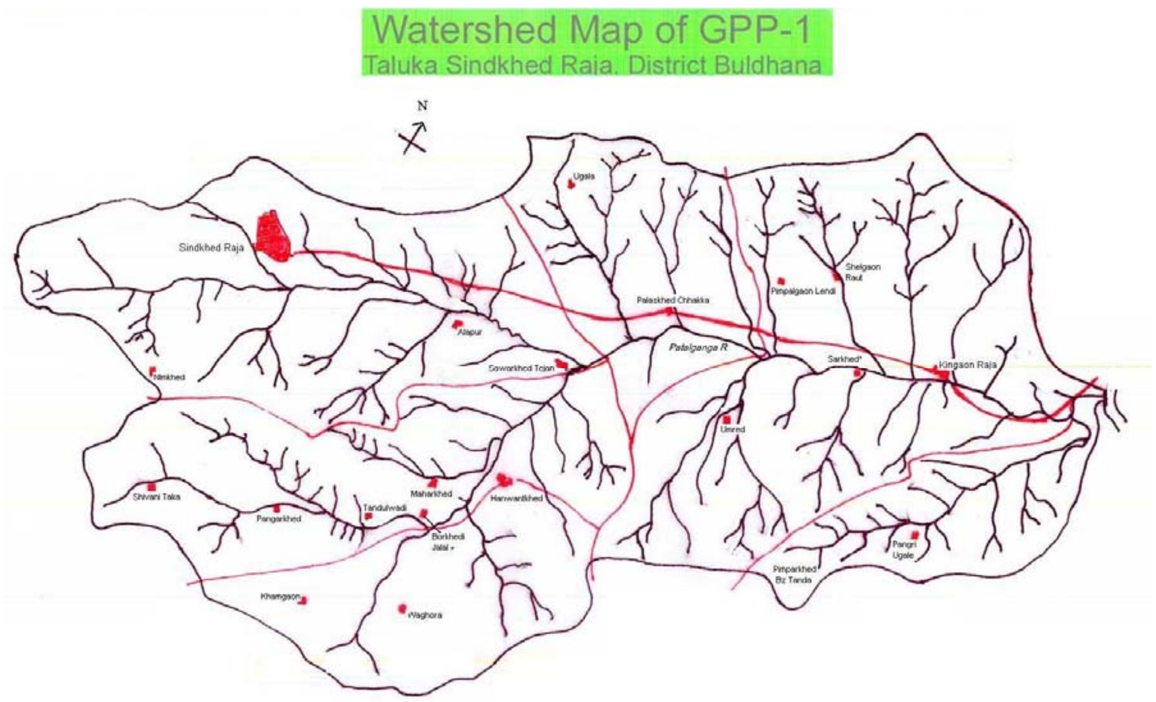
the Shari'a (where the 'right to thirst' is a basic principle) and in western legal concepts dating back to Ancient Rome (in which groundwater ownership follows land ownership). At the same time, rights of access to groundwater have generally been linked to land ownership. Thus, there is often an unclear distinction between the 'private' nature of groundwater rights and its 'public' ownership.

in watershed GPP-1 in Sindkhed Raja block of District Buldhana in Maharashtra from 2005 summer. It was a part of the Aquifer Water Management Pilot under World Bank supported Jalaswarajya Programme of Rural Water Supply and Sanitation Department of Government of Maharashtra.

The pilot area comprises of Godavari-Purna-Patalganga watershed GPP-1, delimited by 19°53’N to 20°01’N latitude and 76°05’E to 76°17’E longitude (toposheet reference 55D/4, 56 A/1 and 56 A/5 of Survey of India). The watershed, running southwest to northeast, comprises of 20 villages under 13 Gram Panchayats spread over an area of 159.68 sq km. The area has dendritic eastward drainage of river Patalganga, which runs southwest to northeast, is a main tributary of river Purna. This watershed has a single outlet located at village Kingaon Raja in the northeast.

The villages falling in this watershed are located along north and south of the State Highway with maximum distance of 10 km (Fig 2). Most villages are connected to this main road by murrum road, motorable in all seasons.

Fig 2 : Location Map of the Project Area



4. Hydrogeological Assessment

The perception and understanding of hydrogeological processes among groundwater users appear to vary considerably (Shah, 1993). The experience in the pilot indicated that the levels of information required in order to design location-specific recharge measures or to prompt suitable management responses had to be culled out through a series of exercises with the community and had to be supplemented with scientific measurement of aquifer phenomenon with the help of experts. Thus, a combination of methods was necessary to obtain usable information for planning.

The Groundwater Survey and Development Agency (GSDA) carried out various studies using methods like mapping of surface features (geomorphology and structural features), well inventory and fluctuations in well water levels (geohydrology) and Vertical Electrical Soundings (VES for geophysical assessment) to define the lateral and vertical extent of the aquifer. Satellite imageries were also used for drawing initial hypotheses for testing through ground truthing.

GRASP carried our rapid assessment of well performance in each village using historical data and recent observation on irrigation practices with the community using PRA tools. The observations and seasonal variations were marked on a resource map and inferences on aquifer characteristics were drawn through guided dialogue with farmer groups in each village. This exercise was useful in creating a general awareness in the community about the nature of the aquifer (in reality, it was multi-layered aquifer in almost all cases), levels of abstractions and its relationship with recharge from the rainfall. It also helped the community understand the water balance situation and its dynamics in each village.

5. Management Strategies

The management strategies used in the project could be broadly categorised into two: supply side management and demand side management as elaborated in the following section. As the users have to manage the groundwater resources they needed access to social and technical knowledge, support in building local level inclusive institutions for management, and for preparing regulatory mechanism. GRASP facilitated these aspects by creating awareness in the communities, building their institutions and providing handholding support.

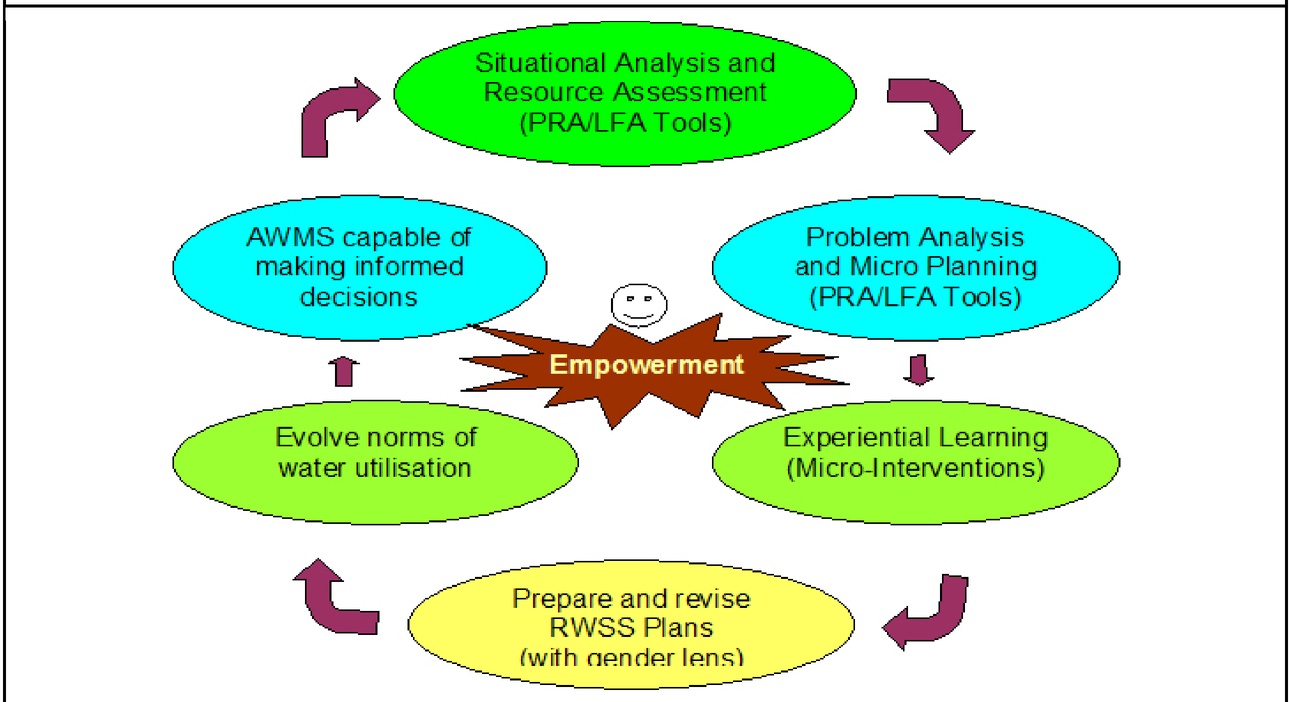
In view of the shallow depth, which naturally restrict groundwater abstraction, and limited groundwater resources of the Deccan Traps basaltic aquifer system, the focus of groundwater management in the project area was set as :

- promoting recharge measures and encouraging recharge practices
- discouraging unproductive private investments in constructing/ deepening irrigation bore wells, which have a very low chance of encountering an adequate groundwater supply
- improving the productivity of existing groundwater irrigation use, through the elaboration of realistic village crop-water plans that maximize farmer income whilst reducing groundwater use by increasing water productivity

6. Capacity Building Strategy

During the planning phase 2005-06, GRASP began the work on two aspects of capacity building of communities and planning water resources development strategy. It began with basic awareness on physical and social situation in the villages using Participatory Rural Appraisal (PRA) tools like social map, resource map and transect walk, and sometimes venn diagram. It was supported by an awareness raising campaign while simultaneously emphasising on importance of community involvement in the pilot. It was done through a series village meetings and separate meetings with women and marginalised sections. Resource Literacy was promoted using PRA maps and diagrams to discuss the water and sanitation situation in each village, along with awareness camps to introduce hydrologic cycle, concept of groundwater and village water balance. This knowledge, which was developed from the observations of the community and supplemented by scientific studies, was used as a basis for guiding principles and norms of groundwater use. The overall methodology of awareness raising and capacity building could be summarised is the following diagram (Fig 3).

Fig 3 : Capacity Building Methodology



7. Supply side interventions

Measures of runoff augmentation were planned and located in a manner so as to induce groundwater recharge. Various soil and water conservation measures included Earthen Nalla Bunds (ENB), Cement Nall Bund (CNB), Farm Ponds (FP), Well Recharge (WR), Continuous Contour Trenches (CCT), Loose Boulder Structures (LBS), and in urban area, Roof Water Harvesting (RWH). The interventions were identified on the basis of community preferences drawn from various participatory exercises and simultaneously using the scientific data by GSDA. A summary of supply side interventions is presented in the following table (Table 1).

Table 1 : Supply side interventions

		Proposed works for recharge						
S No	**Village**	**ENB**	**CNB**	**FP**	**WR**	**CCT**	**LBS**	**RWH**
1	Hanwatkhed	2	3	3	10	132		
2	Khamgaon	3	2	3			5	
3	Pangarkhed	0			10	50		
4	Kingaon Raja		13	13	10			
5	Maharkhed	2	3	5	6	100		
6	Borkhedi Jalal	2				66		
7	Tandulwadi		1	2	3	35	5	
8	Palaskhed Chakka		7	6	5		5	
9	Pangri Ugale		3	3	5		5	
10	Jaipur Tanda		3	3	5		3	
11	Pimpalgaon Lendi		6	5	5	25	10	
12	Shelgaon Raut		3	6	5	23	5	
13	Nimkhed		2	3	3			
14	Savkhed Tejan	4	9	8	5	80		
15	Shivni Taka	2	5	10	3	60	7	
16	Ugala		2	2	5		5	
17	Umrad	3	7	8	5	65	5	
18	Sarkhed				5			
19	Waghora	3	2	5	5	10		
20	Sindkhed Raja	5	14	32	5	100		15
	TOTAL	**26**	**85**	**117**	**100**	**746**	**55**	**15**

8. Demand Side Interventions

It was noted that local knowledge about groundwater-level fluctuations in shallow systems is often sophisticated and prompted individual or group level decisions on customary regulation in times of water-table recession in rabi (post monsoon) season. With shallow circulation systems prevailing in the pilot area, pumping local aquifers intensively before dry-season recession sets was found to be a pragmatic strategy of the local farmers. It was also noted that the popular knowledge of aquifer behaviour was available with a few observant farmers based on their observations over years, and that there was no mechanism to share this knowledge either within the village or across the villages.

Based on this background situation, the pilot adopted a three-pronged strategy to promote appropriate institutions for community management of groundwater, evolve norms of groundwater use, and establish a community mechanism of groundwater assessment and monitoring. In the last three years, GRASP has successfully completed the first two components, and is planning to start the third one from this year. Collective crop planning based on assessment of groundwater availability in post rainy season would form an important tool in the process. It is expected that the supply side interventions would be completed in the coming work season, after which the groundwater monitoring mechanism would be tested, and if needed, improved upon for one hydrologic cycle.

8.1 Community institutions : Appropriate community institutions have been established at two levels, at village level and at the aquifer level. Village Water and Sanitation Committee (VWSC), to work as an empowered committee of the Gram Panchayat, is the main institution at village level to look after all planning, implementation and monitoring aspects. It is the primary organisation to constitute the membership of the Aquifer Water Management Sabha (AWMS). The AWMS members select from amongst themselves the representatives to Aquifer Water Management Association (AWMA), which is executive arm of the AWMS. The AWMS periodically reveiws the water balace situation at the aquifer level and formulates the guidelines for water management. The AWMA helps the VWSCs to implement these guidelines in their respective villages and monitor it.

8.2 Norms and guidelines : While planning various supply side interventions during 2006-07, the AWMS deliberated upon and developed various norms and guidelines for groundwater management and approved it to be implemented and over the next few years. The main characteristic of these norms is the dynamic nature of determining limits on abstraction and uses of groundwater on the basis of water balance situation from time to time. Village level collective crop planning before every crop season is an important aspect of the process.

8.3 Hydrologic Monitoring : It was started with preparation of water balance situation of every village and the aquifer as a whole. Raingauges were installed at five locations in the aquifer, for which rainfall data is being maintained by the respective VWSC. Wells have been identified for water table monitoring in each village. The AWMA would monitor the groundwater situation across the aquifer and provide feedback to the AWMS for remodelling the management norms. It is proposed to implement it the coming year (2010-11) on experimental basis and formalise it from the next year.

9. Conclusions

Pragmatic management strategies are needed to increase the effectiveness of groundwater supply provision at village level as well as aquifer level. In the case of minor aquifers, and especially in more difficult conditions, locating groundwater recharge sites requires more systematic hydrogeological consideration.

Managing in absence of complete information is the biggest challenge. It is possible to build, through a systematic dialogue process, a broad community level understanding of aquifer characteristics and properties, including the factors controlling their vertical and lateral extent and their groundwater quality aspects. Such information base needs to be built up since such information will not generally be available from existing literature.

Appraising the community on economic value of groundwater resources is a prerequisite for demand side management. Such quantification is possible using any one or a combination of more than one of the following techniques.

- Contingent valuation, which essentially involves asking people how much they would pay to maintain the resource or services dependent on it under carefully specified conditions.
- Hedonic pricing, e.g. obtaining a measure of the value of groundwater through differences in the value of lands with and without access to it.
- Derived demand and production cost analysis, essentially estimating the contribution of water to profits within a given set of economic activities.
- Loss analysis, estimating the value of groundwater as equivalent to the total social costs incurred when drought or depletion constrain economic activity.
- Averting behaviour in which the value of groundwater is estimated by the investments made to avoid water shortage.
- Substitution, the value of groundwater as equivalent to the least cost alternative source of supply for meeting the same set of services.

Due to the dynamic nature of all aspects of managing groundwater resources, any method proposed for managing in the presence of gaps must also be dynamic. An adaptive management approach is recommended. It is an inherently flexible approach in which resource managers establish desired outcomes, develop hypotheses about how the groundwater resource will respond to applied pressures, develop management strategies designed to achieve the desired outcomes, and implement monitoring programmes designed to test the hypotheses about groundwater response and to test the effectiveness of the management strategies. Changes to the hypotheses and management approaches are made on the basis of the monitoring results and, over a longer time-frame, any changes in the desired outcomes.

For adaptive management to work correctly, certain initial assumptions about the resource being managed must be made. Broad guidelines from the official policies or from similar examples elsewhere (case studies) may be used as *a priori* standards, preferably using slightly conservative or safe assumptions. As more information becomes available, through monitoring, investigations and research, the assumptions can be relaxed, since the cause and effect of management decisions can be better predicted.

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