3.3 Lessons from the case studies

3.3.1 Initial observations

The locations and research questions addressed by the case studies are described in Section 1.1. Table 3.1 summarises aspects of the settings for each of the detailed case studies.

Before examining specific factors that shape the opportunities and constraints users face in developing and sustaining group management initiatives, we make some more general observations. Below we compare groundwater management experiences across the case studies, drawing out important similarities and differences.

First, while the underlying causes of groundwater overdraft are common between case studies, symptoms and responses vary. In all cases, well yields have declined to varying degrees, according to (a) the degree of groundwater development that has taken place, (b) the storage and transmission capacities of the aquifer and (c) the rainfall pattern, these factors having a degree of interdependence. For example, two villages were studied as part of the Comman Project in the Coimbatore area of Tamil Nadu. The depth of weathering of the underlying hard rock is quite different in each village (see Section 3.3.2). Although well yields are declining, one of the villages is underlain by a more deeply weathered aquifer, which has a higher storage and permeability. Farmers there are still exploring for and developing groundwater. In the village with the shallower weathered profile, well yields have fallen from unsustainable levels in the 1990s, reaching equilibrium. There is little point to further exploration due to the limited storage of the aquifer.

These changes in hydrogeological conditions can be traced through to their impacts on livelihoods, though cause-effect relationships are not always clear-cut. In the case-study villages of Satlasana Taluka, for example, the incomes of many households have declined as returns from groundwater-based agriculture have fallen with falling water levels (Box 3.3). People have coped by diversifying agriculture and livelihoods. In Coimbatore, on the other hand, the diversification is not merely a coping strategy (Box 3.4). Shifts out of agriculture are occurring not just as a result of the 'push' of a declining groundwater economy but because of the ‘pull’ of higher, more secure, incomes on offer in the rural non-farm and urban economies. Secondly, community-*level* initiatives in watershed development and related activities are being conducted in each of the case study areas, based in part on the establishment of user groups, with and without the involvement of administrative and Panchayat Raj institutions. Watershed development initiatives all emphasise enhanced recharge of groundwater, and a range of other farm and non-farm interventions. The local benefits watershed development programmes can bring are not in dispute here; what is less clear is the extent to which they are attributable to changes in groundwater conditions, as opposed to enhanced soil moisture retention and farming practices. Only in the Arwari River Basin and Pani Panchayat schemes has *group* mobilisation around *demand-management objectives* been attempted, and then as a complement to supply-side activities. In the case study villages of Satlasana, there is rich experience of community-mobilisation around various natural resource management and harvesting objectives, including joint forestry management. These now extend to consider watershed treatment and irrigation practices, but not (yet) *group* controls on groundwater *access, abstraction and use* to agreed management objectives (Box 3.5). The case study villages in Coimbatore are similar in this respect, though here there is no embedded NGO, and no experience of group management beyond that needed for government-financed watershed development.

Thirdly, in both the Pani Panchayat and Arwari cases, the role of an external civil society organisation has been instrumental in catalysing and sustaining collective action. In Satlasana too, VIKSAT (a local NGO) has played a fundamental role in building community awareness of, and interest in, natural resource management. In both the Satlasana and Arwari cases, village-level institutions are embedded in higher-level, federated institutions that help (a) adrress potential inter-village disputes, for example around the construction of groundwater recharge structures; and (b) empower people by connecting them with a wider circle of allies with whom they can mount a more effective lobby.

Fourthly, while collective action on water conservation objectives is found in two of the case studies (see above), common property management is not. What is the distinction? The essence of common property is the power to exclude outsiders, such that CPRs become, in effect, private property for the group (Box 3.2). Yet in each case study, groundwater continues to be exploited under conditions of open access, with controls only on use. Hence in the Arwari Basin and Satlasana, informal norms restricting crop choice, and indirectly groundwater *use*, occur in a context of unrestricted groundwater *access,* with users continuing to drill new boreholes and deepen existing ones. Exclusion (to those outside the basin) operates solely through physical boundaries – and is therefore 'leaky' - not through negotiated rights or norms defining who has, or does not have, 'property'.

Finally, it is difficult to identify and 'weight' the factors that are important in making group management feasible. For example, how does one gauge the relative importance of 'charismatic leadership' and 'enabling external conditions'? And to what extent can an abundance of one positive influence compensate for the absence of others? Below, we attempt to draw some conclusions, but note the importance of underlying principles, or issues, rather than specific institutional-resource models that 'work' or 'don't work'. Table 3.2 summarises these in relation to each of the case studies.

Table 3.1 Summary of the settings for the detailed case studies

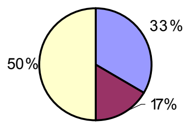
Case study location	Lead partner organisation	Case study setting	Geology	Climate	No. households within study villages	Specific issues of interest
Satlasana, Gujarat	VIKSAT	Three remote villages in the foothills of the Aravilli Hills	Fractured and weathered granites	Single monsoon season – average annual rainfall 603 mm	475	Role of village federation in NRM, and potential for extension into groundwater management
Coimbatore District, Tamil Nadu	Tamil Nadu Agricultural University	Two villages ~30 km to the east and north-west of the industrial city of Coimbatore	Basement rocks with differing thicknesses of weathering	Bimodal rainfall season - average annual rainfall 702 mm	1850	Growth of the non-farm economy – causes and outcomes
Arwari River Basin, Rajasthan	Institute of Development Studies	Six remote villages, located in the upper, middle and lower reaches of a well-defined river catchment of 1,055km^2	High relief basement rocks with varying thicknesses of sediment within valley bottoms	Single monsoon season - average annual rainfall ~500 mm	1490	Effectiveness of Village Water Councils and Arwari River Parliament in controlling abstraction

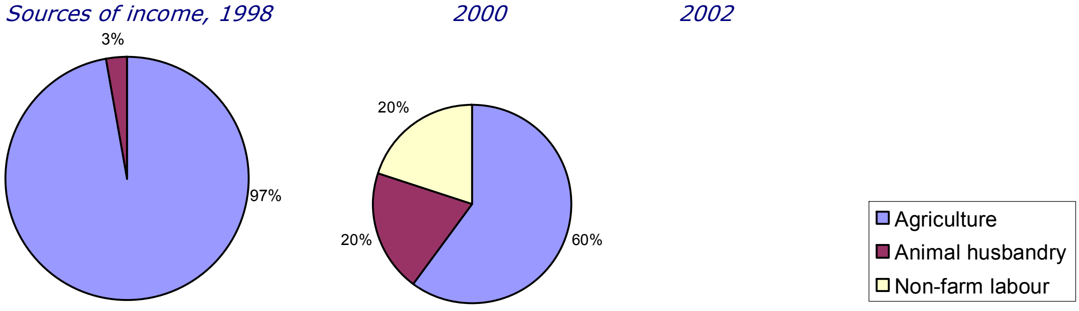
Box 3.3 Responses to groundwater overdraft and drought: a household story from the village of Bhanavas, Satlasana Taluka, Gujarat*

Vijesinh's story is typical of many in the Satlasana area of Gujarat, where households have had to come to terms with successive drought years, and a longer-term decline in groundwater availability and access.

Vijesinh has a family of five, including his mother, wife and two small children. He lives in a house with concrete roof, brick walls and cement floor, built six years ago when times were easier. The family owns 5 ha of land, which used to be cultivated and irrigated with a dug well. The well was deepened to 80 feet in 2000, when the water level dipped and could provide enough water only for 3-4 months and not enough to irrigate all five hectares. In 2001, Vijesinh excavated a 120-foot borehole in the dug well (creating a dug-cum-borewell), with Rs 35,000 borrowed from a local moneylender at 3 per cent interest/month. He has yet to repay the loan.

Prior to 1998 – the first year of drought – the household followed the general cropping pattern of the village: groundnut, bajra and castor during the monsoon; castor, wheat and fodder crops in winter; and bajra during the summer. From 1998, however, the family had to reduce the area under cultivation because of groundwater scarcity. The area under water-intensive wheat was cut back first. By 2002, the household was only able to grow 1.2 ha of wheat, 2.5 ha of castor and 1.2 ha of fodder (rajko). Vijesinh used to keep eight animals, including four buffaloes, two bullocks and two calves. In 2001, he sold two bullocks for Rs 5000, using the money to buy fodder for the remaining animals. However, the severe shortage of fodder that developed later in the year prompted further distress sales, and the calves were eventu[...] a token Rs500 just to ensure the survival of the cows. At the san[...]esinh attempted to supplement household income, and spreac[...]gaging in a variety of non-farm labouring activities, including constru[...]n nearby towns. Changes in family income over time are illustrated below.





Source: Mudrakartha et al., 2003. Note: the decreasing size of the pie charts illustrates a decline in the family's total income since 1998.

The charts indicate how, in the period since 1998, (a) overall household income has declined, (b) returns from agriculture have decreased significantly, and (c) dependence on animal husbandry (principally milk sales) and the non-farm economy has increased. What such charts do not show are the more subtle impacts on household welfare recorded during field work, including (particularly *for poorer households) postponement of marriages and other important social functions and, for some caste groups, 'mass marriages' to reduce household expenditure.*

These trends – agricultural contraction, shifts within agriculture, and shifts between the farm and non-farm economy – are seen across wealth groups within villages and across villages in Satlasana more generally. However, incentives and outcomes vary between different types of household. In Vijesinh's case, diversification has been adopted as a coping strategy to reduce risk and increase labour days. In other cases, although in the minority, diversification into non-farm activities has occurred because of the 'pull' of higher, more secure incomes on offer in the diamond-polishing industry and service sector, rather than 'push' factors related to changing groundwater conditions.

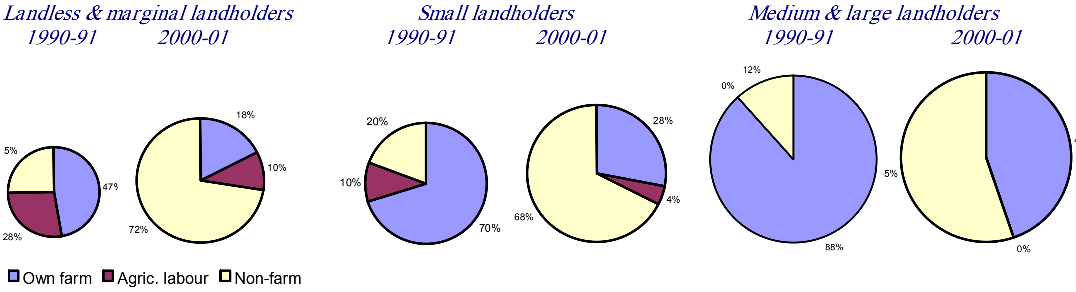
* *The collection of this information was partly supported by the project 'Adaptive strategies for responding to floods and droughts' www.i-s-e-t.org/asproject.*

Box 3.4. Livelihood diversification in Coimbatore, Tamil Nadu

Understanding the range and dynamics of livelihood options, and the choices made by different groups within communities, is an essential starting point for any evaluation of community interest in groundwater management. The Comman case studies highlight a diversity of livelihood strategies that are shifting in response to declining groundwater access and independently of it as new opportunities develop in the non-farm economy. These 'push' and 'pull' factors can create increasingly divergent interests in groundwater conservation, rather than a collective incentive to preserve stocks for shared, long-term livelihood strategies.

Evidence from Coimbatore illustrates how household and wider regional economies can change rapidly as urban-rural links and communications improve. Here, we see some of the positive drivers and outcomes of diversification, and how diversification and specialisation can occur at the same time but at different levels. In the villages of Kattampatti and Kodangipalayam, for example, many wealthy households have specialised in textile manufacture as congested urban centres out-source production. Poorer households - the landless and marginal farmers – also appear to have benefited, with new labouring opportunities in the power loom sheds providing a way of increasing household labour days and incomes and spreading risk. At the same time, the proportion of income derived from agriculture has declined. Poorer groups shift to cultivating less water-intensive crops, increasing rainfed agriculture and land left fallow. In summary then, the range of economic options has increased, with a shift away from employment and income dependence on agriculture across wealth groups:

Changes in household income over time: Kodangipalayam village, Coimbatore



Source: Palanisami 2003.

In Satlasana (Box 3.3), on the other hand, the 'push' factors are more obvious, as

Box 3.5 Community institutions and household perceptions in Satlasana, Gujarat

The villages of Bhanavas, Nana Kothasana and Samrapur, in Satlasana Taluka, sit in the foothills of the Aravalli Hills in the north-east of Gujarat. Farmers in this area traditionally practised rainfed agriculture, but changed to groundwater-irrigated agriculture in the 1980s and 1990s. However, the level of groundwater abstraction required to maintain the boom in irrigated agriculture was not sustainable and, since the mid-1990s, agricultural production has declined. The problems associated with reduced groundwater availability have been exacerbated by the drought of recent years. In response to declining agricultural production, people became more dependent on animal husbandry; this itself has become difficult during the drought due to the lack of fodder. With the loss of agriculture-based livelihoods, many have been forced to migrate to nearby districts for sharecropping and further, in search of non-farm employment.

VIKSAT has pioneered natural resource management through collective action in Gujarat since 1985, initially through joint forest management in Sabarkantha District. In 1993, VIKSAT moved into water resources, working with the Tree Grower's Cooperative Societies in 32 villages in the Gadhwada region of Mahesana District. In 1995 these 32 Societies joined to form a federation named the Gadhwada Jal Jamin Sanrakshan Sangh, which sets out to protect water and land in the Gadhwada region. The Gadhwada Sangh's initiatives in water initially focussed on individual economic decisions that impinged on sustainability of water resources but has recently, with the support of VIKSAT, been pushing an integrated approach to water resource management. The activities it promotes are those commonly undertaken in watershed development, including improved irrigation techniques, changing cropping patterns, the use of field bunds and the installation of check dams. However, even with two decades of involvement in the region, VIKSAT has made little progress in developing, with the community, norms that would limit access and withdrawal of groundwater. Some of the underlying reasons can be understood with reference to the table below, summarising household views on potential solutions to groundwater scarcity in the villages of Bhanavas, Nana Kothasana and Samrapur:

Household views on potential solutions to water shortage	*Number (%) N = 29*	
Provision of community wells for irrigation	*13*	*(45%)*
Improvement in irrigation technology (sprinklers; drip etc)	*11*	*(38%)*
Further changes to cropping pattern (less water-intensive crops)	*9*	*(31%)*
Watershed treatment – e.g. increasing no. anicuts and medbandi	*5*	*(17%)*
Community (village)-level irrigation systems	*4*	*(14%)*
Community restrictions on groundwater pumping	*4*	*(14%)*
Secure water from outside sources	*4*	*(14%)*
Revival of traditional, communal irrigation systems e.g. tanks	*0*	*(0%)*

Source: Mudrakartha et al., 2003. Note: water shortage relates to groundwater for irrigation use only; drinking water supplies are piped in under the Dharoi Group Water Supply Scheme (Gujarat Water Supply and Sewerage Board)

Drawing on these results and the findings of more open-ended household and group discussions, several points emerge.

- *Firstly, the most popular, community-based option is the provision (by an external actor) of shared irrigation wells. However, these are viewed as additional to, rather than a substitute for, existing (private) wells. In other words an extension of groundwater access rather than a reallocation of existing supply.*
- *Secondly, community self-regulation is widely perceived as unrealistic in the absence of any regulatory framework, and certainly not favoured by those with most to lose in the short term – particularly larger landholders with substantial 'sunk' investments in groundwater infrastructure. Indeed, the prevailing entitlement regime, in which landholders are free to draw as much water as they need, or can afford, is viewed as legitimate by those with and without access. Nonetheless, broad support for enabling regulation by the government was articulated (well spacing; well depths), under which the community could then take on some management control through a Samiti – a village water council or*

3.3.2 The interface between resource and management group

At the beginning of the project, a distinction was drawn between aquifer management and groundwater management. At a local, community level, therefore, a critical question is whether small parts of an aquifer (beneath the management group) can be effectively 'closed off' to outsiders, such that the groundwater conserved is largely accessible to the group alone. Case study findings and groundwater modelling suggests that the ability to exclude non-participants from management initiatives is difficult. Hydrogeological boundaries are not easy to define and, even in hard-rock environments where groundwater flows are limited, the likelihood that users will be able to capture the benefits that issue from their collective efforts, over limited geographical scales, is not assured.

Chapter 2 described the varying characteristics of aquifers: whereas some span many hundreds of kilometres in the case of the deep sedimentary basins; others, the result of the weathering of crystalline rocks such as granites or basalts, may span little more than a few hundred metres. This scale issue has great relevance to the feasibility of local management of groundwater.

The need for congruence between natural resources and user group boundaries is generally recognised as a key component of common property regimes. Groundwater raises particular challenges in this respect: it is very difficult to know where the boundaries occur as groundwater is a hidden resource, and hydrogeological information – especially at a local level - is limited. We can say, however, that in most hydrogeological environments, aquifer boundaries encompass many communities, particularly in the case of large regional aquifers. A key question explored by the Comman Project is whether small parts of an aquifer (beneath the user group) can be effectively 'closed off' to outsiders, such that the groundwater resources, *augmented and/or conserved*, are largely accessible to the user group alone.

Measures to augment groundwater resources are present across the case studies, and form a key component of most watershed development programmes in India. Recharge structures are designed to retard the flow of water over the land surface, with the aim of increasing infiltration. These structures range from field bunds and small check dams to major percolation ponds. Measures to conserve groundwater through less pumping for crop irrigation are less common. Measures include reducing the area and number of seasons of cropping; cultivating crops with lower water requirements and implementing more water-efficient irrigation methods, such as drip-irrigation. Within the case study areas, group restrictions on groundwater use (though not the right to abstract) are limited to the Arwari Basin and Pani Panchayat initiatives (see Boxes 3.6 and 3.7). The hypothesis is that by enhancing water recharge during the monsoon season, and/or by reducing abstraction during the growing seasons, an increased stock of groundwater (a 'mound') can be created beneath the land of a group of users. This 'mound' can then be accessed later, perhaps to enable drinking water supplies to be maintained during the latter part of the dry season or as a buffer for subsequent years, when rainfall is low. A key question, then, is whether this stock will remain in the control of the user group, or whether it will simply flow away moving-off down the natural regional groundwater gradient, or be pumped away by those outside the group.

Some simple computer modelling was undertaken as part of the Comman Project to gain further insight into this question, using a simplified conceptual model of aquifer systems in India. The model simulates an aquifer with uniform properties and depth. Modelling indicated that even under the most favourable conditions, a *significant proportion* of the water conserved at the scale of a village or group of villages would flow away from its control. The implication is that there must be some physical boundary to the flow of groundwater to ensure the water conserved by the user group is not lost and, therefore, that the user group boundary must be similar in scale to that of the boundary of the aquifer(s) underlying it.

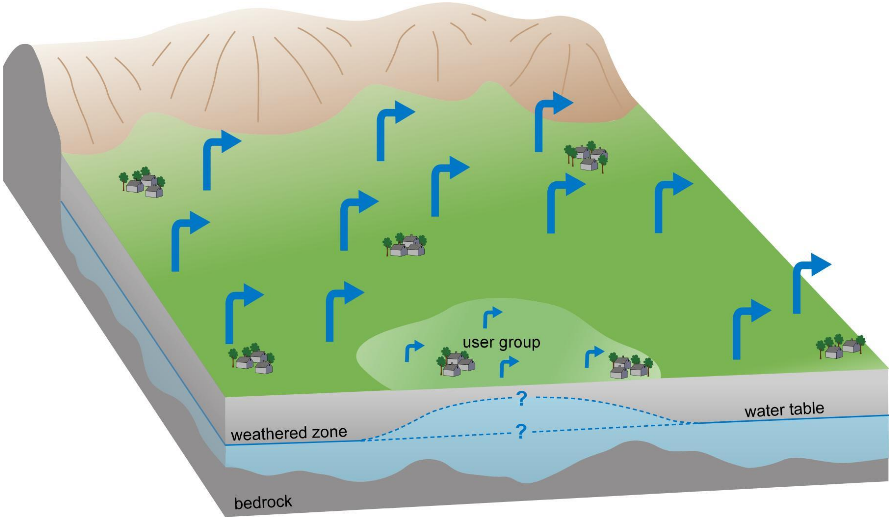
Illustrations of this are given by two of the case studies (see Figure 3.1): the Arwari River Basin and the Pani Panchayats of Maharashtra. In the former case, an enclosed basin comprising a series of enclosed village-scale watersheds with well-defined geologies, creates natural and clearly identifiable hydraulic boundaries. These provide some degree of 'natural' exclusion. As a result individual villages, and the villages within the basin, are able to capture *some* of the benefits of both groundwater recharge and conservation, even though landowners are still able to drill new wells and deepen existing ones. No restrictions apply to accessing and pumping groundwater, so open access within the basin remains. In the Pani Panchayat area, however, physical exclusion is more difficult. The so-called user-group (Pani Panchayat scheme) is small as compared to the aquifer it taps. As a result, those outside the scheme and not bound by group norms are able to 'free ride', pumping for themselves the conservation gains of others.

Clearly the simplifications made within the conceptual model used are great. Aquifers, in particular shallow, hard-rock, weathered zone aquifers are not uniform in nature. In these geological environments, the lateral variability in the degree of weathering may be significant. Here, enhanced zones of weathering may exist that create relatively isolated pockets of aquifer, when the water-level falls below a certain depth. As a result, in these situations, individual farmers may be able to benefit to a degree from the measures they undertake to conserve water.

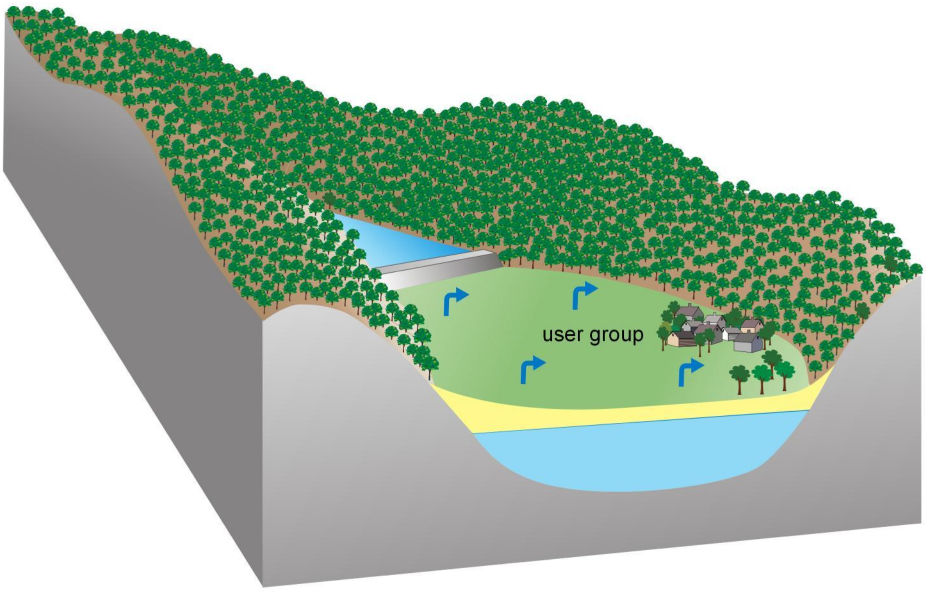
However, the variability of weathering within hard-rock aquifers is very difficult to predict or assess. For example, the two Comman case study sites in the Coimbatore area of Tamil Nadu, located 20 km apart, are both underlain by crystalline basement rocks. Due to the different mineralogy, grain size and structure of the rocks, the shallow weathered layer is quite different in nature at the two locations (see Figure 3.2). In Kodangipalayam the weathering is limited; the shallow aquifer is typically 10 m deep. In the Kattampatty, it is typically 35 m deep. In Kodangipalayam, the aquifer is very patchy with outcrops seen in many locations; in Kattampatty, the aquifer extends laterally for up to kilometres and could be described as regional. The potential to ring-fence the water conserved would appear to be greater in Kodangipalayam, but even with detailed hydrogeological investigation, it would be difficult to assess to what degree.

So, to summarise, the scale at which groundwater management must take place to be effective is highly dependent on the geology. Groundwater management requires that the boundaries of the resource be known. Even where this is possible, resource and institutional boundaries may not match. Where resource boundaries are large, it is challenging to scale-up user group initiatives to match as the transactions costs of collective action increase with group size.

Figure 3.1

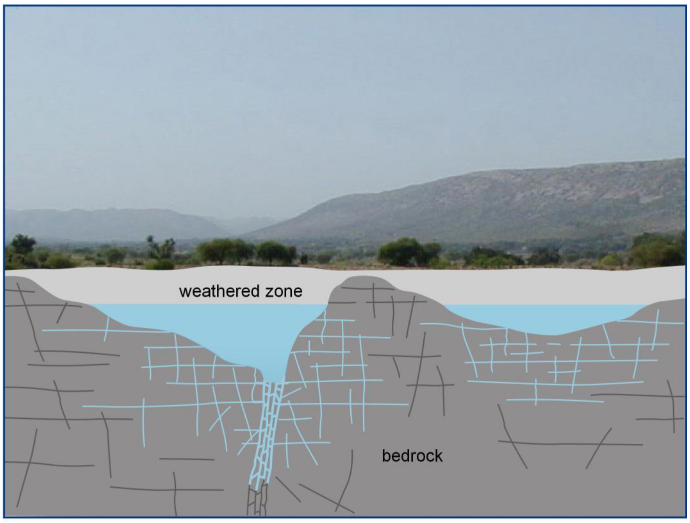


Having developed a set of norms to reduce groundwater abstraction and implemented measures to increase recharge, can one groundwater user group remain in control of the water they have conserved while those around continue to pump heavily? Will a 'mound' of water develop beneath the land for their future use, or will this water simply flow away, becoming accessible to surrounding outsiders? The results of the Comman Project suggest that in many geological settings it would be impossible for the group to retain exclusive control over the benefits of their conservation efforts (see the Pani Panchayat case study village in Box 3.7).



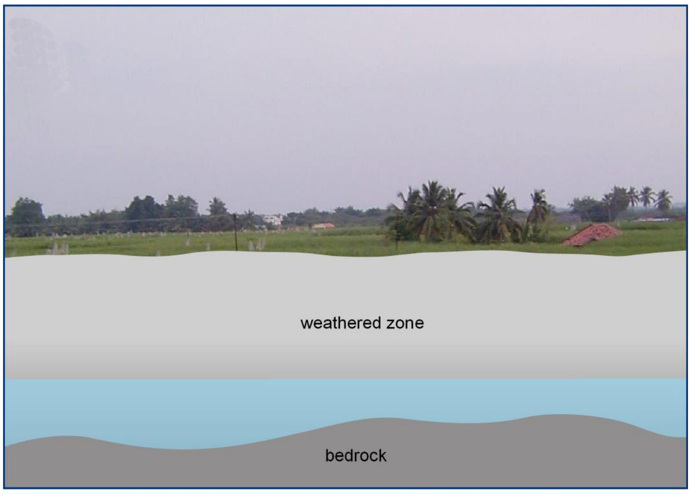
In the Arwari River Basin, the incised valleys in the upper reaches have natural boundaries to groundwater flow. They also form good sites for constructing high capacity check dams. Although groundwater is lost from the village catchment by lateral flow down-gradient, the influence of abstraction beyond the village boundary is not likely to be significant.

Figure 3.2



Kodangipalayam area

Schematic diagrams to illustrate the variability in the nature of the shallow weathered zone in hard-rock aquifers within tens of kilometres, as with the two case study villages in Coimbatore District



Kattampatty area

Box 3.6 Conserving the benefits of watershed treatment in the Arwari River Basin

The activities of the NGO, Tarun Bharat Sangh (TBS) in the Arwari River Basin, Rajasthan, have received a great deal of attention over recent years. TBS began working in the basin in 1985, supporting the construction and rehabilitation of traditional water harvesting structures called Johads (small check dams), as well as field bunding and other watershed 'treatment' activities. Around 300 structures have now been constructed or rehabilitated within a basin of approximately 1050 km^2. Specific impacts reported include: the return of perennial flows in the Arwari River; positive outcomes for rural livelihoods across wealth groups; a reversal of out-migration, and a new sense of intra and inter-community empowerment, following the formation of village water councils (VWCs) and, at the basin level, the Arwari Water Parliament (AWP) in 1998.

The Arwari River Basin Parliament

The AWP is an informal, non-government forum set up in 1998 (with the support of TBS) to address wider inter-village issues arising from watershed development in the basin, and to promote community control and management of water, land and forest resources more generally (Rathore, 2003). The full parliament meets twice yearly, with representation from the basin's 70 villages (through VWCs), and a limited external membership of 'experts' and academics. The parliament discusses, and then agrees, informal rules restricting individual behaviour, which are then conveyed downwards to individual villages through elected VWC representatives. These are then discussed and implemented at village level entirely through social or moral pressure. Informal norms are discussed, and if necessary revised, at each parliamentary meeting. They currently include:

- *A ban on the sale of fish produced in the water stored behind anicuts or johads*
- *A ban on the use of pumps to lift surface water stored in anicuts*
- *Agreement not to sell land for industrial activity that might compromise collective water resource management efforts*
- *Restrictions on the use of chemical fertiliser*
- *Restrictions on crop choice, specifically limiting production of cotton and sugar cane to household use only, not commercial sale. Field work suggests this restriction is adhered to widely.*

Demand management lessons

TBS has worked in the Arwari basin area for many years, supporting and encouraging community self-help. It is a trusted organisation, with a legitimate and charismatic leadership. Importantly, watershed activities began with support for the building of treatment structures, creating a tangible entry point for community mobilisation. Moreover, the hydrogeological and topographic characteristics of the basin, and the micro-watersheds within it, created conditions in which the benefits of group action around recharge could be quickly appreciated. Only once these activities were firmly established was the issue of demand raised, and then through a higher level organisation – the basin parliament – ensuring that VWC members were involved, and consulted, in decision-making. This has helped create a climate of mutual assurance: users feel confident that if they abide by the rules, others will do likewise.

It needs to be emphasised that, thus far, the groundwater restrictions agreed extend only as far as crop choice. Crops are visible, and it is easy to see whether other users are abiding by the parliament's code. Neither the VWCs, the AWP nor TBS has yet sought to extend these voluntary codes to include direct restrictions on well drilling and pumping. These would be

Box 3.7 The Pani Panchayat initiative: decoupling land and water rights

In the early 1970s, Naigaon village, located in a drought-prone area of Pune District, Maharashtra, saw the beginning of an initiative in water rights and distribution, called Pani Panchayat. It was initiated by the late Mr Vilasrao Salunkhe, and has since been carried forward through the NGO Gram Gourav Pratisthan (GGP). It originally involved some 40 participants. Water security for every family, including the landless, was the goal of the experiment. Salunkhe believed that watershed planning can only be successful within low rainfall environments if drinking water is prioritised and agricultural uses restricted to the cultivation of less water-intensive crops.

There are currently 25 schemes in place (Sharma et al, 2003). These schemes are based on either a groundwater or surface water communal source. Within a Pani Panchayat village, typically a third of the land area is brought under the control of the scheme. The purchase of land and the subsequent development of the scheme (e.g. well construction, terracing and bunding, purchase of pumps and pipework) is usually funded or loaned by GPP with 20 per cent of the cost borne by the community. Hydrological parameters, such as groundwater level, surface water level and/or rainfall are used to assess the amount of water that can be distributed during the year for crop irrigation. At least in some schemes, external monitors are used to operate pumps and ensure the agreed norms are followed. GGP provide the role of external auditor and arbitrator.

The scheme is then managed on the following principles:

- *Land and water is distributed based on the number in each family involved, including the landless. Typically 1.2 ha of irrigated land is apportioned to each family member, and an upper limit of 1000 m^3 per capita per annum is provided (although the actual limit is decided upon the availability of water for a particular year).*
- *Only seasonal crops are irrigated. Water-intensive crops such as sugarcane are not permitted and irrigation is allowed only for 8 months.*
- *Water and land rights are not linked. Water rights rest with the scheme members' community and are not transferred with land sale.*

Notably the surface water schemes, which predominate in the higher rainfall zones are proving more successful. This may be partly because they are based on a source which is visible, making it easier to estimate the optimum distribution of water. The Naigaon model scheme, located in a very low rainfall zone of ~400 mm/a, is based on a single groundwater source. The Naigaon watershed is located on the Deccan basalts that occupy approximately 500,000 km^2 of India. The aquifer underlying Naigaon has relatively high storage and permeability for this type of hard rock. The scheme has survived several droughts successfully but is currently endangered by gradual deterioration of the surrounding environment. Although no major demographic changes are reported, there has been an enormous technical change, i.e. wells being deepened, converted to dug-cum-borewells and the introduction of deep borewells, and the conversion from diesel engines to electric pump sets. This has meant a progressive increase in groundwater abstraction in the area surrounding Naigaon, resulting in significant groundwater depletion effects being felt in the area and a decline in the water levels in the main Pani Panchayat communal well. The scheme clearly cannot operate in isolation from the surrounding communities.

Pani Panchayat schemes are initiated and operated under a range of other limitations, in particular the lack of official backing from the Government. This makes it difficult to obtain Government subsidies for the scheme (normally available for small and marginal farmers) and Government permission to dig community open or borewells (Sharma et al, 2003).