Chapter 5

Social Aspects and Local Water-harvesting Systems:

A Review of the Prevailing Systems in Hindu Kush-Himalayan Communities[1]

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Introduction

The main objective of this paper is to look at social aspects of different local water-harvesting systems, on the basis of the case studies reviewing some of the prevailing water-harvesting systems in different parts of the Hindu Kush-Himalayas. Social components refer to all social decisions and actions by households in a community about different activities in relation to water harvesting. Social components include individual responsibilities, participation, and rules and regulations that have evolved over time in terms of who gets how much water at what time, penalties for violators, appointment of office bearers, and the issues concerned with transport, distribution, and use of water for household and agricultural purposes. The focus here is household use, although other uses are also taken into consideration. While there are similarities among the cases, there are also important differences as each area has developed its own unique features over the years.

Five different systems and their underlying social systems are discussed,although the information from the case studies is not equally comprehensive. The first one is from Kabhrepalanchok district in Nepal, followed by Tehri Garhwal (India), Ladakh (India), Mustang (Nepal), and Balochistan (Pakistan). While some systems like the *pabhchu* (in Ladakh) are very old, they are not static and, depending on the needs, have changed over time. For instance, even in the *pabchu* system, providing meat as a form of payment to another community for permission to harvest water has been replaced by cash contributions. The rich diversity of social mechanisms involved in local water harvesting emphasises the important role of community participation in the past. Today there are attempts to introduce new forms of community participation in local development activities, but these are undertaken without adequate understanding of existing systems. The next section briefly discusses some of these social dimensions in different areas of the Hindu Kush-Himalayas.

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1 This chapter is based on the Case Studies from India, Nepal, and Pakistan prepared for the Water Harvesting Project of ICIMOD.

***MUL, KUWA AND KULO* (CHA KHOLA WATERSHED IN KABHREPALANCHOK-NEPAL)** [Lohani and Banskota 1999]

Mul, Kuwa, and Kulo are commonly used local terms for describing springs, wells, and irrigation channels respectively. Only a few households are lucky enough to be next to these water bodies. For most households, water has to be carried from a distance—for both drinking and irrigation. It is to transport and share water smoothly that households get together and work out different approaches for supplying sufficient water at the right time and to the right place.

There is a long history of group action for water harvesting in the Cha Khola watershed. Traditionally it has involved the supply of labour and the use of local skills. Little cash was used. Rules for water distribution are agreed upon and a system for regular repair and maintenance is established. Much of this is informal and agreed upon by word of mouth and passed on from one generation to another. More formal management bodies are also being created, although these are reported to be dominated by local elite groups or local politicians. The area in question is predominantly settled by Tamang ethnic groups along with a few other groups such as the Bhramin, Chettri, and Newar. The settlements are, however, ethnically homogenous. There are no major differences in water-harvesting practices among ethnic groups. The social response to water harvesting has varied according to changing needs over the years rather than according to ethnicity. Being relatively well endowed with water resources, it has not been difficult to solicit the collective action needed, as the demands made on households for water harvesting are not very taxing.

Tapping Mul (Springs)

There are different responses to the use of springs. One response has been for individual households to use polythene pipes to bring water from the spring directly to their homes. There is little or no collective action here. All the costs are borne by the individual concerned. In some instances, the individual provides limited amounts of water to other households, at least for drinking. The second response is one in which well to do households provide most of the resources needed to tap water, but the water is used by all the neighbours. Because of the difficulty in getting cash contributions, well to do households provide the cash while others contribute free labour. The third response consists of sharing the costs for water equally among all members of the community. The fourth response consists of mobilising external support from different sources to meet the costs of water supply systems. In such cases, local people may contribute their labour. Whenever there is any type of permanent construction, a formal committee is established and registered with the local authorities. If local households are benefitting from the system, it is the custom for one member from the user households to help with the maintenance and repair of the system. With the growing use of polythene pipes, maintenance now involves cash contributions as well as labour for the replacement of damaged pipes.

Operating Kulo (Irrigation Channels)

There are different types of *Kulo*. Some are micro-systems involving two to five households irrigating about one hectare. Others are larger systems that involve 15-20 households and irrigate about 2—25 hectares. In the area, there is also one externally funded irrigation system involving 400 households and irrigating about 150 ha. This has established a separate management system.

The locally built irrigated systems are operated through an oral code of practices based on collective agreement among user households. Each member of the household participates in the clearing of channels and repair during the rainy season. The code for water sharing is such that upstream farmers first irrigate their fields followed by downstream farmers. As there is sufficient water during the rainy season, few problems have been experienced. In winter there is insufficient water in the channels and it is supplemented with water from other sources and shared in a manner that is generally accepted. There are no formal bodies to supervise the operation of the local system. Cheating is resolved by a stern warning to fellow users. No serious conflicts have been experienced so far.

A new system was recently introduced establishing a larger irrigation system in Chakhola from smaller ones. Users of a number of smaller irrigation schemes built locally agreed to combine and create a bigger system in order to increase the flow of water and reduce maintenance costs. Conflicts arose about the extent of contribution by upstream and downstream farmers. The upstream farmers were not willing to contribute as they claimed they did not need a new system because they already had adequate supplies of water. As downstream farmers needed the new system because of the long distance between the intake and their fields, they were later willing to contribute fully. However, while this discussion was going on, the government agreed to grant funds for the entire project and the users did not have to make any contribution. A user group has been registered and an Executive Committee of Nine Members from the 400 households was elected. Charges were fixed for irrigation at Rs 600/ha for *bari* (uplands) and Rs 1,200/ha for *khet* (lowlands). The entire length of the canal is cleaned twice, once for the rice season and another for the wheat season. Two watchmen have been hired to guard and regulate the distribution of water. So far there have been no major conflicts in the system.

In the last few years, emphasis on working through local user groups has increased. Externally funded projects have also provided motivators to interact with local people to begin the process of formally organizing themselves, establishing women's groups, and keeping a record of decisions and finances. There is more encouragement for formalising informal methods and practices.

Another important change has been the decline in local contributions to projects funded and managed by government organizations. This has eroded local ownership of many water-harvesting projects. More recently NGOs have been attempting to revive some of the earlier group cultures and practices among various communities.

Conflicts about Water

A conflict arose when upstream farmers refused to pay for the new permanent canal. This was resolved however when the government paid in full for the project. Another conflict involved a number of settlements. All the potential users did not participate. The chairman of the local government (Village Development Committee) formed his own committee and took over the contract. Different settlements later complained about the size of pipes used, lack of water in the pipes, and absence of records about use of funds. A more serious crisis is emerging as hotels on top of the hill buy land with springs and pump all the water to the hotels. Differences have arisen between the hotels and the local community regarding the use of springs, pollution of these springs, access to land for laying pipes and encroachment of public lands. None of this has been resolved so far.

One can conclude from the above discussion that, in the above cases, there are two important social aspects. The first deals with conventional systems which are mainly informal and have a strong oral tradition. The mobilisation of the community for maintenance and repair appears to be the most evident social activity with limited regulation of water distribution through hired watchmen. The second social aspect is being developed in new projects in which the emphasis is on local participation through formal mechanisms for all aspects of local decision-making and management. As these systems are recent, their progress needs to be monitored. Because water supply is relatively plentiful (even if it is critical in the summer growing season), social aspects as reflected by different institutional mechanisms are quite informal and not too well defined in terms of individuals roles. In future, however, this could change as need for water increases with increasing size of families, commercialisation of agriculture, changing seasonal demands for water, and increasing competition for water between agricultural and non-agricultural uses. With an increase in demand and limitation in supply, institutional challenges are likely to increase in future, and experiences from new projects with formal structures will provide valuable lessons.

NAULA, HAUZI, DHARA AND *GUHL* (TEHRI GARHWAL UTTAR PRADESH) [CSWCRTI 1998]

Naula, Hauzi, Dhara, and *Guhl* are local words for wells used by people, ponds for livestock, springs, and irrigation channels respectively in the Garhwali language. Gharkot watershed in Tehri Garhwal of the Indian Himalayas lies between two big rivers, but the area suffers from acute shortage of water, particularly in the upper reaches. The area is mainly inhabited by Rajput and Bhramin groups, but there are also tribal and other caste groups. Settlements are homogeneous in the sense that the Rajput and Bhramin live together, while other tribes and caste groups live separately.

Drinking Water

Water harvesting in dug-out ponds is an old practice. Water-collection tanks to store percolated water,called *naula* (for use by people) and *hauzi* (for use by livestock), have been constructed throughout the watershed by the community. These are revered by the people: religious rituals are observed at the time of their construction and water purification and treatment are carried out with medicinal plants and fruit and large shady trees are planted nearby. Usually water from a *dhara* or spring is directed to the tanks; and today one finds that they are lined with cement. When water is scarce, a roster for water distribution based on family units that stretch back for three generations is still followed. When a drinking water source is situated between two villages, it is shared during different hours by the villages. In one case, one village receives water from 10 p.m. to 3 a.m. while the other receives water for the remaining period. A village watchmen is paid to check that rules are followed. In some areas water is bought at one rupee per litre during the dry season. Each household can buy about 20-25 litres, usually after a long wait. It is mentioned that, as a result of deforestation, road construction, earthquakes, and inadequate maintenance, many of these ponds, tanks, and springs have dried up or are in the process of doing so. One interesting practice in the area is the use of separate drinking water sources for upper castes (Bhramin and Rajput) and lower caste groups. The custom is that the latter are not permitted to even touch the drinking water sources of the upper castes. When it is absolutely necessary to provide water to lower castes from a source used by the higher castes, a higher caste person collects the water and gives it to the lower caste person.

Tap water supplies are handled by the government. At times of scarcity supply is restricted to 40 litres per family at a time. If more becomes available additional amounts are supplied. On special occasions when some families need more water (such as in marriage ceremonies), neighbours share their quota with the family.

Irrigation

Much of the area is rainfed and only small parts of the cultivated areas near perennial water sources have provision for irrigation. All water-harvesting systems are managed by village communities through the *Gram Sabha* (village assembles). Based on population and cultivated land, water requirement rosters have been kept for almost three generations. Surface flow of water is channelled to a *Guhl* (cement-lined tank). Each filled tank irrigates a defined command area. All the land owners of the area prior to 1950, i.e., before the abolition of the landlord system, are members of the informal group for managing the tank irrigation system. All the land owners prior to 1950 are described as *thok* and each land owner is a *thok*. Each *thok* is the unit of irrigation for different tanks. Any subsequent division of land within the *thok* is not considered as an independent unit. The head of the *thok* is a member of the informal irrigation group. Each *thok* is allotted water for 24 hours. Subdivisions within *thok* are managed internally. *Thok* closer to the water receive it first and pass it on to the next one. As far as possible tanks are filled before releasing the water. It is interesting to note that paddy nurseries are raised near water sources even on others' land by mutual consent and without any payment. During the dry season tail-enders do not demand water because they know it is scarce, but they also do not contribute to maintenance of canals and tanks during this period. The villagers jointly undertake the cleaning and repair of the irrigation system by removing silt and other obstructions from the channels and the tanks once before planting paddy (summer) and again before planting wheat (winter). Each household with irrigated land participates. Those unable to help with the work provide hired labour. Widows and the handicapped are exempt. Maintenance and cleaning of channels inside one's own field is the responsibility of each land owner. When major repairs are needed all beneficiaries contribute an equal amount of labour and funds. Sometimes support is also received from the government. Barter within the groups, i.e., *thok*, is also permitted.

In the past the development of irrigation in the hills was left more or less to the cultivators and was not considered the responsibility of the government. After 1947 the State Government, through its Department of Irrigation, modernised some of the traditional systems and also created a few new ones. Most villagers are of the opinion that the Irrigation Department or the government organizations need not interfere in the existing institutional arrangements for irrigation. Yet, the local community has become more dependent on government support for repair and maintenance. Each group prepares an estimation of the repair and maintenance costs and receives support from the village assembly to proritise activities and forward them to the Minor Irrigation Department for support. The Department has its own rules and priorities. The funds for the approved activities are given to the Chief of the Village Assembly to carry out the work. He works like a contractor for government-supported projects.

There have been instances of conflicts over water sharing and use. Most conflicts are resolved on the spot by village elders. In case the village elders cannot resolve the conflict, it goes to the Village *Panchayat* (elected council) which seeks the advice of the elders about resolving the conflict.

Water use norms, upkeep of the system, and other practices are also subject to review over time, depending on the circumstances. Insofar as the role of women is concerned, it has been restricted to looking after the water needs of the household and livestock. When men are absent, women also participate in irrigation-related activities. Although women do not represent the *thok* there are no rules that explicitly prohibit their participation either.

A number of important points can be drawn from this example. First, the drying up of ponds and tanks could be to some extent perceived as a consequence of the breakdown in the underlying institutions. This needs to be examined more carefully. Secondly, as in the earlier case, there are two systems operating concurrently: the older one based on the *thok* and the more recent ones introduced by the government. By linking the tanks with irrigation of the *thok*, a system has been established in which it is in the best the interests of the *thok* to maintain the tanks. It is not clear, however, how many *thok* were facing problems with their tanks and why. This aspect also needs to be studied. Third, the dependence on the government for basic repair and maintenance also emphasises the need for an active local system. Earlier, when resources and labour needed to be mobilised from the community, institutional mechanisms that had local legitimacy were very important. Since government support has replaced local contributions, the role of local institutional mechanisms could also be declining, Government assistance may be playing a role in the deterioration of local water-harvesting systems instead of strengthening them.

THE *PABCHU* SYSTEM (Ladakh Hill Council 1999)

The socio-institutional process underlying water sharing between the villages of Sakti and Chemrey in Chem-rak watershed near Leh (Ladakh, India) is referred to as the *Pabchu* System. The Chem-rak watershed has three independent villages: Sakti, Chemrey, and Kharu. Sakti is located in the upper reaches of the watershed and enjoys a natural advantage because it receives water before the other villages. Chemrey is located further downstream and depends on the water coming through Sakti. Kharu is further downstream and has no claim on the water and depends on locally available springs, oozings from marshes and meadows, and the surplus water released by upstream villages.

Under the *pabchu* system the villagers of the downstream Chemrey village use the water for two nights and the intervening day while the villagers of Sakti, with a larger population and more extensive cultivated area, use it for seven days and six nights. In order to begin the *pabchu*, representatives of Chemrey visit Sakti village with meat and beer on the third day of the third month in the Ladakhi calender. At present, Rs 500 is paid in lieu of the meat. Every time Chemrey wants additional water for irrigation, a bottle of barley beer has to be provided to Sakti.

The actual *pabchu* starts on the eighth day of the fifth month of the Ladakhi calender. On this day, one member from each of the 41 families proceed to the canals to divert the water. The team is led by two water overseers, one from each of the major groups, and there are also two supervisors who oversee the entire operation and fix the seals on the mouths of the canals. Each family is responsible for watching certain canals, and this is detremined by drawing lots and is fixed for a period of three years. The water overseers are also elected by the villagers from among persons who are leaders and have influence. This supervisory position, which was held earlier by members from prominent families, is now determined through nomination.

In the past the monastery also participated in and contributed its own religious personnel for the activity, but this practice has stopped. The family representative, water overseers, and supervisors leave for Sakti in the afternoon following the sounding of the Royal Gong. In the late afternoon the water overseers fix a wooden seal on each of the canals so that water can flow to Chemrey. Meanwhile those assigned to watch at various headwaters of the canal proceed to their respective locations. The water flowing down is stored in tanks. In some of the canals water is retained because, if the canals become completely dry, the fish will perish. At five in the evening once again all diversions are closed and water passed on to the tanks storing water for Chemrey. At about four a.m. (when sparrows start singing) on the third day all those who have been guarding the canals for the past two nights start for home, signalling the end of *pabchu*. Thereafter the non-*pabchu* period begins.

The water collected in the two tanks is again distributed by dividing it into four equal parts. One of the major challenges of the *pabchu* system is the fact that 40 or so people have to spend 36 hours guarding 50 or so canals during each round of *pabchu*. It is already difficult to get all the households to participate. Similarly, repairs are undertaken with funds provided by the local government, rather than by the community that has traditionally maintained the system.

Water supplies are always a very sensitive issue between different communities. Sakti and Chemrey have also had many tense moments in the past. However, over time a system considered relatively equitable by both parties has evolved and is accepted by all concerned. It is now facing problems, and these need to be carefully addressed by the community concerned as well as by the government.

First, the extent to which the *pabchu* system can be used to meet water requirements for the whole year is in doubt. With increasing intensification of agriculture,made possible by introduction of other technologies such as drilling and tubewells, the overall value of the *pabchu* system could be decreasing. It still has an important role to play in the critical period during which it has been used. The limited supply of water is the main problem in a situation of rapidly increasing and diversifying demands, and new options are becoming more important.

Second, the *pabchu* system is a labour-intensive process and very taxing upon all the household representatives who participate. With more men seeking jobs outside, the burden is falling on women. If ways can be found to reduce the labour intensity, these should be explored.

Third, support from the government for all kinds of repairs and maintenance has started to undermine traditional willingness and enthusiasm for participation and provision of inputs by the households. The breakdown has reached the stage at which, unless government support becomes available, there will be little repair or maintenance work. This is a recent phenomenon and indicates how quickly traditional practices can fall apart.

Fourth, the *pabchu* system was reinforced by many cultural and religious practices. It was believed that spirits that protected people lived in the springs and marshes and therefore these needed to be kept free from pollution at all times. People were brought together because they worshipped the same gods, and this was further reflected and reinforced by agricultural and cultural activities. Times are changing with increasing monetisation and commercialisation. People appear less and less willing to be bound by traditional practices if they conflict with pursuit of their new economic activities.

Fifth, the introduction of new technologies for water supply systems is also influential to a certain degree. Tubewells, sprinklers, rainwater harvesting, and use of plastic pipes have been practised by both individuals and communities. As individuals become more independent with investments in their own personal systems, they become less willing to participate in *pabchu* and other practices. If there is a more reliable private water-harvesting technology than the ones they have, individuals increasingly invest in these private systems.

The *pabchu* system is not going to be abandoned immediately and, just as it has experienced changes over the years, it is also likely to change even more in future. In the past, the pace of change was relatively slow, but now it will speed up on account of pressures from many different sides. The problem is not so much the survival of any one system, but more the erosion of mechanisms of self-reliance and increasing dependence on external support and inputs. Established social practices fall apart, and effective alternatives take a long time to develop.

The real challenges are for the new institutions that are a part of the local governance system. How will they intervene in future to allocate and regulate the use of very scarce resources without causing conflict and economic loss? Clearly the focus should be on improving the capacity of local organizations based on the strengths of traditional systems.

KUHL, KAREZ AND SAILABA FARMING [Hafez (ed) 1998]

Kuhl are irrigation channels diverted from river/tributaries. These are found frequently in northern areas of Pakistan. *Kuhl* can also be diversions from the collection from a spring. The entire community plays an important role in the construction of the main irrigation channels, as well as in the equitable distribution of water. Depending on the need, wooden and underground channels are used. Considerable inputs are needed for their maintenance, and usually the community works together. The process of irrigating a field begins by flooding the nearest field, followed by the next. In the second irrigation the process is reversed with the last being first.

Participatory management is employed for the distribution of water. Each family is assigned one full day to irrigate its fields. In case there are 20 families, each one's turn will come after 20 days. However, each adjoining family may share water for half a day. On that particular day all family members are busy irrigating their fields. Farmers insert spades in the ground to see if they can be completely inserted. If so, the ground is considered properly irrigated. Another sign of an adequately or well irrigated field is if the soil breaks apart when it is thrown upside down. Complex irrigation schedules have been developed as per the growth of the major crop.

A *Karez* is an irrigation system using underground channels, and it has played an important role in the agricultural development of Balochistan. *Karez* have played an important role in the life of sedentary communities in Balochistan. The role of the government in the past was limited to guaranteeing the land and water rights of the communities along with occasional investments. The government did not interfere with the local water-harvesting system. Water management has been a major community exercise. It has involved the fair and efficient distribution of water, prevention of water theft, and coordination of cleaning and repair work. Special irrigation managers and watchmen are also appointed and are remunerated by the community in different ways. Both of these positions were kept separate from the political leadership in order to ensure that water management was fair and free from

political disputes of any kind. Being dependent on the community also made the position accountable to the community. The maintenance of *karez* has become more and more difficult with rapid depletion of groundwater levels. In some areas, *karez* have disappeared almost completely. While there is awareness of this problem and some effort has been made to protect the *karez*, the future for this system is precarious.

The availability of deep tube-wells to pump groundwater has opened the option of high-value horticultural development in many areas. Whenever groundwater can be tapped through pumps, it is being harvested at very rapid rates. There is little regulation of groundwater mining, and in some areas farmers are being forced to put in deeper and deeper tubewells. There is some concern about depletion of groundwater, but little action has been taken to regulate its use. Most of the systems are individual or family based with government providing subsidies for purchasing pumps and electricity.

Sailaba farming is another method of local water harvesting being practised in Balochistan. This is the harvesting of flood water runoff in catchments for crop production. Farmers construct level terraces with embankments to hold water. Terraces are flooded sequentially. The rights of all communities are fully recognised and water is apportioned among them.

The evidence of community involvement in the arid mountain areas of Pakistan is also similar to other areas. The community mechanisms are strong and still exist, but these are beginning to face difficulties. When the *karez* dry up on account of excessive extraction of water by tubewells, the community based system of *karez* management will no longer be feasible and more households will opt for tubewell irrigation, further weakening the *karez* management system. The impact in terms of technology on the breakdown of traditional systems and organizational options is quite apparent in this case.

The *Chyure* System [Parajuli and Sharma 1998]

Ghyakar Khola watershed in upper Mustang in the Trans-Himalayan region of Nepal has some interesting social and institutional features in terms of local water-harvesting systems. Except for irrigation, all other uses of water take place according to the needs of the household. For uses other than irrigation, the supply exceeds demand. As a result, the villagers use water as and when required from their respective systems as long as they remain operational. However, for irrigation, water is allocated to all the villagers based on the water shares they own. Irrigation requires more water than other uses and, during peak periods of irrigation, demand for water exceeds supply. In such a situation, without a principle for allocation agreed upon by the villagers, competition to use scarce water increases and ultimately leads to disputes over water.

Water allocation for irrigation differs according to the crops grown. Cereal crops are irrigated with water allocated according to villagers' water shares, locally known as *chyure*. However, orchards and trees have no defined basis for allocating water as these are new plantations. Villagers irrigate orchards and trees with water not needed for cereal crops.

Water rights for irrigation purposes are attached to the land. Transfer of land rights automatically transfers the water rights of that land. Local inheritance laws prevent the fragmentation of land and water rights. Usually, the eldest son inherits the land. Consequently, the water rights attached to the land are automatically transferred to the eldest son.

The feeder canal conveys water from the source to the irrigation tank from which the flow of water is regulated. Every evening when the tank becomes practically empty, the outlet of the tank is closed and the water from the feeder canal is stored through the night. The stored water is released for irrigation through the outlet the following morning until the tank becomes practically empty. This cycle is repeated daily.

In Ghyakhar village, water is distributed to villagers on a turn by turn basis in a one-week cycle. Distributing water in a one-week cycle makes it easy for the villagers to remember their turn for irrigation. For example, if a villager first receives water on Monday, he continues to receive water on the same day throughout the irrigation period.

In Ghyakhar Village, the water available for irrigation in the gravity canal system is considered to consist of 22 shares. To prepare a rotational cycle for one week, the first 21 shares are divided into seven shares. The remaining twenty-second share is then merged with one of the seven by means of a lottery. In the second cycle of irrigation, this last share is merged with another group for equitable distribution of water. Thus, in each cycle of irrigation, six groups consist of three shares, while the seventh group consists of four shares. The groups are prepared so that land holdings are near one another. By doing so the transport loss during water distribution is minimised. Also, there is a rule that one villager cannot have more than one share in a group irrespective of the total number of shares he/she owns. For example, if a person has four shares he/she will be located in four groups, with a maximum of one share in each group. Thus, each group consists of at least three or more villagers. After forming the groups, the lottery method is used to decide the ordering of irrigation for each of them.

Each group receives water for one day. Usually the irrigation time starts at about five in the morning and ends in the evening when the tank becomes empty. Depending on the cropping season, the *gempa* (executive body of village representatives) decides the duration for each group. It is the responsibility of the *gempa* to close and open the tank at the time specified.

Although the time-sharing rotation is a popular method of distributing water equitably, in Ghyakhar this method is not practised. The reason it is not practised is that time-sharing by rotation is suitable only for uniform flow. In Ghyakhar, since water is released from an irrigation tank, outflow is not uniform. There is more water in the morning and it decreases gradually throughout the day. This means that villagers have had to adopt 'irrigation in turns'. Water from one villager's terrace is diverted to another villager's terrace after the former finishes irrigating his/her terrace. However, the number of terraces each farmer is authorized to irrigate in turn depends on the water shares owned in that group.

In this village, equity among the groups is determined on the basis of time-sharing. For example, each group receives water for one day. However, within a group, equity is neither determined with respect to the flow nor with respect to the time water is received, but rather on the basis of the number of terraces each villager irrigates in his/her turn, and this depends on the water share he or she owns. For example, if a villager with 0.5 units of water shares is allowed to irrigate one terrace in his or her turn, another villager with a one-unit water share is allowed to irrigate two terraces, one after another. This measure of equity has advantages over the time-sharing measure of equity because it accommodates soil types, terrace conditions, and conveyance losses.

The *gempa* members are responsible for operation of the system. In case of problems the *gempa* members depute a person to inspect it.

System maintenance involves repairing the intake, cleaning the canals, and desilting the irrigation tank. Wherever closed polythene pipes are used, either in gravity canals or in piped canal systems, pipes choke occasionally, requiring maintenance. From experience (by hammering the pipe on its top surface), the villagers can trace the points in a pipeline that are choked. The maintenance activity in this case involves cutting and rejoining the pipes after removing the debris.

To maintain a gravity canal system, resources are mobilised according to a villager's water shares. However, to maintain the modern, piped canal system and water mills, households contribute equally, although the actual use of water (benefit from the systems) may not be the same for all households. For example, a household with a large number of family members may use more drinking water than a smaller houshold. The main reason for this system is that it keeps administrative costs low.

The irrigation tanks are desilted once a year, usually after the monsoon season. Maintenance immediately after winter requires mobilisation of more resources than at other times, especially labour. With the use of polythene pipes in the canals, maintenance requirements have decreased. In each maintenance period, the *gempa* members decide upon the day for maintenance and labour is mobilised according to need. The amount of labour mobilised is always in proportion to the number of water shares in a gravity canal system. For example, in Ghyakhar, depending upon the volume of work 44, 22, or 11 labourers are mobilised. When a total of 44 labourers are to be mobilised, a villager with a one-unit water share provides two labourers. Note that the total number of water shares in Ghyakhar is considered to be 22 *chyure*.

Unlike the gravity canal systems, there is no fixed timing for the maintenance of piped canal systems and water mills. They are maintained as and when needed and their maintenance requirements are quite low. The fact that many of the canals have been aligned through the village has reduced the amount of time it takes the women to fetch water for the household and indicates some gender sensitivity in the water-harvesting system.

In Ghyakhar no water-related disputes have been reported. However, in nearby Chaile Village, it was learned that sometimes minor disputes occur over the distribution of water for irrigation of orchards and on-farm trees, as there there are no defined water distribution rules for irrigation of these new cropping activities. Interviews with the villagers in Chaile indicated that, with increasing demands for water, villagers are thinking of enforcing rules for new crops. The *gempa* members still resolve water-related disputes.

Being relatively isolated, these villages in Trans-Himalayan areas of Nepal have faced little pressure from outside, indicating that they have quite strong traditional irrigation management systems. New materials, such as plastic pipes and cement, have been introduced. The rapid escalation in demand for water seen in other areas is also not apparent here to the same extent. Agricultural intensification and diversification have also been somewhat slow, although there are indications that some modification is needed for off-season irrigation of orchards and tree farms. The types of change seen in other areas, such as commercialisation of the local economy and the undermining of traditional sociocultural and religious systems, is also limited at present, but could become stronger in

the future. The relationships of local organizations with the government and other development bodies in the area are changing as the need for improving technologies and various types of support increases. Changes become inevitable for the future, and it will be important to monitor these.

CONCLUSIONS

The foregoing discussion of social aspects, particularly institutional arrangements behind local water harvesting, provides only a few examples from a vast range of alternatives that vary from watershed to watershed, from one farming system to another, and from one community to another. When water needs are limited and supplies are relatively plentiful, there is little regulation, except perhaps in exceptional circumstances. However, when demand exceeds supply in critical planting periods, the community must step in to regulate the distribution of water supplies in a manner that is most suitable for the community.

Notions of acceptability are not always the same. In rainshadow areas, where the growing season is limited and all the available agricultural land must be irrigated, the emphasis is on providing water as quickly as possible to all land owners. In many cases the system is quite rigid and strictly enforced for the irrigation of all land. The ownership issues apparently take a secondary role. Intricate arrangements ensuring that water reaches the targetted areas are made; this is a system supported by all aspects of local life. Today some of these are falling apart for many different reasons. Irrigating all the land possible does not mean extending it unrealistically. After a point downstream, villages have no water supplies. In other cases, water appropriation rights are based on control of water sources and there is no consideration of other users.

Contributions from participating households are agreed upon in terms of maintenance. The concept of water shares goes quite far back, in some instances as far back as one hundred years. What is very clear is that with increasing scarcity of water during critical planting periods, the guidelines for water use will become more specific and the enforcement stricter.

Traditional systems, as indicated from the discussions so far, have a number of very important advantages. First there is participation by all households, contributing to a strong sense of ownership and responsibility for the systems. To a great extent this has been possible because of the similarity of activities in sociocultural, religious, and economic life. Most of the people practised subsistence agriculture and when there was no water there was no food. The sense of belonging to the community and identifying with all its priorities and problems was also reinforced by collective participation in cultural and religious events.

The next important aspect was that conflicts were resolved on the spot, and this was accepted by the people. Changes were slow, but the systems were not static. Another factor was that the systems were relatively simple and could be operated and maintained by local households. In some instances, special persons were appointed, but in most cases the local households participated in and rebuilt the system every time it broke down.
There are, however, a number of important problems also.

- Irrigation management has concentrated only on the main crop grown in a specific period, and water use at other times is unregulated. As some households will increase cropping intensity and diversify crops, their demand for water will rise, creating conflicts

over the off-season use of water as well as about the maintenance of water systems. This aspect needs to be studied in future.

- The traditional systems are labour intensive to a large degree and, with changing socioeconomic conditions and with household members either outmigrating or taking up work outside the agricultural sector, it is becoming difficult for households to provide the required labour inputs. This is probably the biggest problem. The alternative is to use hired labour, and this increases the cost of repair and maintenance. In some areas finding hired labour may be a problem.
- The entire water allocation system is based on the prevailing system of land distribution. When the land distribution is unequal, water access is also unequal, and, as households become more aware of this as a result of ongoing sociopolitical changes, there will be less willingness to participate in traditional systems and increasing interest in finding private solutions to water problems or in moving towards more equitable participatory systems.
- Households have the option of using individualised systems when they have access to new technologies. This reduces the willingness of households to participate in and contribute to collective systems. Tubewells, pumps, and electricity have facilitated the development of individual systems in many areas.

Insofar as the future of the social systems behind local water harvesting in mountain areas is concerned, it is essential to examine to what extent they can be improved in order to cope with the different incoming challenges. One crucial task is to retain the advantages of community participation and at the same time incorporate the new skills needed to make these more efficient and equitable in managing available water resources. The allocation of water between crops, between seasons, between sectors, and between households is likely to become a very complex issue in the future; an issue requiring a difficult balancing act between equity and efficiency considerations. As agricultural modernisation results in the adoption of new crops and practices, water requirements are likely to change drastically and the existing system should be able to cope with this without creating too many conflicts. The roles of external support and organizations are going to be very important in this transition. In the past, all the systems were completely self contained. However, with new requirements new inputs are needed to make these efficient and self-reliant in future. This is an area in which external support can play an important role.

Refereces

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