Chapter 3
Policies, Programmes, and Institutions in Promoting Local Water Harvesting in the Indian Himalayas

V.S. Saravanan

1. Introduction[1]

The Himalayan mountain system is both fragile and dynamic, and is one of the principal sources of fresh water in the Indian sub-continent. In fact, increasing erosion and loss of topsoil, leading to downstream flooding and general environmental degradation have been subjects of debate, uncertainty, and confusion (Ives and Messerli 1989) from the 1980s. Since then, restoration of the ecology through community-based initiatives received considerable attention in policies, especially in the 1990s. However, many of these policies fall short of expectation because of lack of understanding of the community and environment. This report calls for a contextually relevant policy that promotes joint activities between the community and state by facilitating community-based initiatives to restore the fragile ecosystem.

The study builds on the extensive study of traditional water-harvesting structures in the Himalayan region by the Centre for Science and Environment. From the case study literature from Himachal Pradesh, Mizoram, Jammu and Kashmir, and Uttar Pradesh and based on field visits to the Uttar Pradesh (UP) hills, the study recommends a thorough investigation in order to formulate an appropriate policy for the region. It provides a framework for debate about the nature of its implementation in a particular region.

The following section broadly describes the dynamic nature and the dichotomy of the development that needs to be considered in promoting water harvesting in the region. The third section provides a detailed review of the traditional water-harvesting systems in four ecologically categorised areas in the Himalayan region and the factors that have led to their deterioration or decline. Current policies and programmes are critically reviewed in the fourth section, and the relevance of water-harvesting technologies promoted by the government, NGOs, and communities examined. In addition, the paper calls for an understanding of the functioning of community-based institutions and the role of development agencies in promoting participatory governance. The study calls for a policy

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that combines the efficiency of traditional communities with that of government institutions through joint activities promoting efficient water harvesting in the Himalayas. It concludes by discussing implications of policies on the Himalayan region.

2. THE DIVERSE AND DYNAMIC HIMALAYAS

The Himalayas constitute a unique and complex system of fold mountains that is geologically active and dynamic. The mountain range stretches about 2,800 km and are about 380 km wide. The Himalayas cover a total area of about 5, 94,437 sq. km with a population of 30.5 million: the population has increased by about two thirds since 1971 (Bandyopadhayay 1999). The range in India stretches from the river Indus in the West to the river Brahmaputra in the East, broadly encompassing the Trans-Himalayas (Ladhak, Lahul, and Spiti), Western Himalayas (Jammu and Kashmir, parts of Himachal Pradesh, and Uttar Pradesh hills), Eastern Himalayas (Darjeeling district of West Bengal, Sikkim, and Arunachal Pradesh), and the North Eastern hills (Mizoram, Manipur, Tirupura, and Nagaland, and Meghalaya) (Table 3.1).

Table 3.1: **Area (sq.km) and population (in '000s) of the states in the Indian Himalayas**

State/ Sub-region	Area (sq.km)	Population 1971	Population 1981	Population 1991
Jammu and Kashmir	222,236	4,617	5,982	7,719
Himachal Pradesh	55,673	3,460	4,238	5,171
UP Hills Districts	51,125	3,822	4,780	5,926
Sikkim	7,596	210	316	404
Arunchal Pradesh	83,743	468	628	865
Nagaland	16,579	516	773	1,216
Manipur	22,237	1,073	1,434	1,837
Mizoram	21,081	332	488	686
Tripura	10,186	1,556	2,060	2,745
West Bengal (Dargeeling)	3,075	782	1,016	1,300
Meghalaya	22,489	1,012	1,328	1,775
Total	579423	12848	23043	29644

Source: Bandhyopadhayay1999

The Himalayan mountains are a critical determinant of the climate in the Indian subcontinent. In the winter, they serve as an effective barrier to the intensely cold continental air blowing southwards towards India, to keep it comparatively warm. . During monsoon, they force the rain-bearing winds from the south to deposit moisture on the Indian side. The rainfall pattern demonstrates a decreasing trend along the Himalayan arc from east to northwest; matched by a general decrease from south to north with each successively higher topographic alignments from the Siwalik foothills to the Greater Himalayas producing windward maxima and leeward rain shadows. The climate within the Himalayan region varies considerably. On one hand, cold deserts in the Trans-Himalayas and, on the other, dense rainfall in the north-eastern Himalayas resulting in unusually low flows or superabundance of water. However, this does not always remain the same. For instance, in 1992, there was no rainfall in Nepal, it was sparse in the eastern Himalayas, but the Indus basin in the west was ravaged by floods (Bandyopadhyay and Gyawali 1994). At the micro-level it varies to a great extent. Local mountains strongly influence its distribution. With minor ranges, spurs, and valleys running in different directions, rain-bearing winds

often enter only through narrow gaps. The northern slopes and east-west oriented valleys usually receive less precipitation because of the rain-shadow effect than southern slopes or north-south oriented valleys. Rainfall also varies with altitude (CSE 1991).

Water supplies are affected by the geodynamically active mountain system. It is estimated that the upliftment of the Himalayan region at the rate of seven mm per year is accelerating the rate of erosion from 0.13 mm per year in dry season to 0.91 to 3.38 mm per year during the rains (Valdiya 1997). This has resulted in voluminous production, sometimes 500 to 1,000% of the suspended bedload that fills valleys and reservoirs (Valdiya 1997). It is estimated that sediments from the Himalayan rivers contribute a quarter of the ocean's sediment (Valdiya 1997). Over this massive landscape, human activity has wrought enormous ecological changes over the last few centuries. Large areas have been deforested, agriculture has expanded, vast road networks have been built, and numerous dams have been constructed or are under construction.

This complex mountain system consists of high mountains, intermontane valleys, and plateaux that produce one of the largest renewable supplies of fresh water to more than a billion people. However, this life-giving ecosystem brings misery and deprivation to a large number of people caused by climatic, physiographic, geologic, and man-made factors.

The dichotomy of development in the Indian Himalayas

The water resources in the Indian Himalayas are estimated (CSE 1991) to be about 1,20,700 million cubic metres in average annual flow. Of the three major rivers in the Himalayan region, the Brahmaputra, Ganges, and Indus have an average annual flow of about 606.7,390, and 210 million cubic metres per year, respectively. This water has the potential to generate 28,150 megawatts of electricity and to contribute about 2,46,000 million cubic metres of water for irrigation (Valdiya 1997). However, the complexity of the region makes one question the reliability of using this potential. For instance, Valdiya estimates that 15% of the rain water is able to percolate down through the ground of treeless slopes to recharge the springs, the remaining 85% flows as surface runoff and causes floods (Valdiya 1997). On the contrary, Kumaon University scientists reveal that most of the rains become subsurface flows and only 0.3 to 1.3% of rainfall flows as surface water. The non-forest area has more surface flow but with less magnitude (CSE 1991). This is corroborated by scientists in Nepal who have argued that, even during heavy storms, surface runoff is rare and of small amounts, the presence or absence of forest makes little difference (CSE 1991). However, the Himalayan glaciers that cover about three million hectares or about 17% of the terrain are a unique reservoir that supports the mighty river systems. Controversy notwithstanding, the evidence shows that there is enough water in the Himalayan region; a 'too-little-too-much-water' syndrome.

It is this syndrome that helped human societies in the Asian uplands as well as those in the plains to flourish for generations. Traditionally human societies have developed the means to use the mechanical energy of water for micro-hydel power and intricate local institutions have developed to use water for irrigation and domestic needs. In the lower basins, fine silt deposited by the annual floods created new land and improved the fertility of the soil. However, in recent decades there has been increasing outside interest in the Himalayan environment. One of the foremost is manifest in the increasing accessibility made possible by building roads. This not only led to the beginning of pressure on water resources in the region, but also neglected the importance of traditional irrigation systems causing an increased threat of natural disaster in the region (CSE 1991).

One of the prime motivations for large-scale intervention into Himalayan water supplies was the demand for irrigation, flood control, and hydro-electricity from the people in the Himalayan plains and, more recently, the demand for water supplies to major cities. All these have combined to promote construction of large dams to ensure the necessary modulation of water flow. It enhanced political acceptability, while undermining economic and technical feasibility (Singh 1997). Underestimation of flood flow and inadequate understanding of hydrogeology and man-made floods were serious limitations to these programmes. The strong plea to intervene in the region, to build large dams as a basis for fighting the poverty of the lowland population was derived largely from the economic interests of the plains. This is clearly visible in the 1950s and 1960s when extensive canal networks were built in the Gangetic plains of Uttar Pradesh, the Punjab, and Haryana, while there were no interventions in the Indian Himalayan states apart from Jammu and Kashmir. On the other hand, investments that are directly in the interests of mountain village economies were far too marginal (Bandyopadhyay and Gyawali 1994).

Environmental problems in the region emerged as a result of the negative effects of the very process of development and of the conditions of poverty and underdevelopment of the mountain village communities. This 'dichotomy of development' assumes importance in considering water harvesting in the Himalayan belt for use in space and time. Any effort in this direction must not only integrate the social and environmental conditions of the region, but also understand the geodynamically active mountain systems.

3. THE STUDY AREA

The complex Indian Himalayas encompass diverse physiography, geohydrology and rainfall patterns. These diverse environmental settings can be dealt with in four homogeneous ecological regions; the Trans-Himalaya, Western Himalaya, Eastern Himalaya, and Northeastern Hill ranges.

Trans-Himalayan region

The Trans-Himalayan region, consisting of Ladakh in Jammu and Kashmir and Lahul and Spiti in Himachal Pradesh, characterises the cold desert area of the region. The average annual rainfall decreases from 279 mm in Lahaul and Spiti to 140 mm in Ladakh on the edge of the Tibetean Plateau. In this wild and desolate region it is surprising that in Lahul and Spiti about 84% of the total work force is engaged in agriculture and about 0.2% (3,007/1,220,000 mha) of the land is under cultivation. In Ladakh, a major proportion of the precipitation is in the form of snow, and it is difficult to use for irrigation. However, a large area of cultivable land depends on irrigation from snow and glaciers. Snow and glaciers melt slowly throughout the day and water is available for irrigation only in the evening, too late for cultivation. In addition, the demands of farmers at the same time and for a short time period also influences the water supply.

In this arid land people have developed intelligent ways of using water. People divert the melting water from glaciers towards evening, with the help of guiding channels, to a small tank, locally called a *zing*. The stored glacier water is then used the following day in the fields. To ensure equity in distribution, villagers elect a water official known as a 'churpun'. The churpun ensures that each farmer gets an adequate supply of water in proportion to the area of land he owns and disputes are rare. The community maintains the canals. Such a system is prevalent in the Ladakh region. In Lahul and Spiti, the community largely depends on traditional diversion-based channels. For instance, in Spiti, the people have

devised an ingenious system of tapping glacier water from a distance through kul. This system is over a century old. The water rights in this system are exclusively owned by the members of 'bada ghar' (big houses). This hierarchical system distributed water on the basis of the demand for labour being spread over the entire harvest season. This spacing of the need for labour does away with the danger of demand peaking at the same time throughout the valley and provides a firm basis for community labour. However, during water shortages, water distribution creates tension. This system of sharing water is renewed and adjusted every season according to need.

The western Himalayas

In contrast, the western Himalayas that stretch from Kashmir to Uttarkhand in Uttar Pradesh receives an average annual rainfall of about 1,000 mm and, because of its moderate temperature, has been a favoured belt for habitation. The soil is fertile, and the abundant water on the gentle sloping terrain has been tapped through ponds to support the staple crop; viz. , paddy. The abundance of water has led communities to largely depend on the streams, springs, and ponds, for drinking and for agriculture. In the Uttarkhand region of the Uttar Pradesh hills, the abundance of water has resulted in diversion of flowing streams through channels called 'guhl' or 'khul'. These systems were managed by community-based regulations that ensured sustenance for the people.

Jammu, lying in the sub-Himalayan hills, and the adjoining plains have ponds that have been one of the main sources of water supply. However, after Independence investments were made to provide drinking water by installing dug wells in the beds of rivulets. However, water is supplied only two to three days a week in the so-called 'covered' villages and still 20% of the villages are not covered (Singh 1997). During summer, people resort to the ponds for water. Unfortunately, most of these ponds are in disuse and neglect and village institutions have since collapsed.

One of the impressive experiments in water harvesting was in Jagti village in the dry Kandi region. A long concrete dam, called Jagti reservoir, was constructed across the Bilani *nullah* at low cost and in a short span of time by the local community. This reservoir is an improvement over the ponds in terms of checking excess surface runoff, erosion, and floods and has already revived the dried springs and wells in the region. The 'khul' in Himachal Pradesh have met with a similar fate.

The new economic opportunities, introduction of 'Panchayati Raj' institutions, and community development programmes have, however, led to adverse effects on community-managed water-harvesting systems (Gopinath 1997). In the changed settings, traditional institutions are rapidly becoming formal with cash as a medium of exchange. With the introduction of 'Panchayati Raj', Block Development Officers have an option of 'ad hoc' grants for repair and maintenance of these systems, if the community can muster up the contributions. Generally, the repair work costs more than the grant amount, and the community is unable to mobilise such large amounts. This increasingly encourages the community to hand over the community system to the authorities. In addition, deforestation in the catchment areas and increasing withdrawal of water supplies have exacerbated the situation.

The eastern Himalayas and the northeastern hill ranges

This forms an intense rainfall zone of the Himalayan region. However, the water resources are rarely tapped because of the rugged nature of the terrain. Hence, the living standards of

the people depend on rainfed agriculture through 'Jhum' cultivation. However, the community has developed an indigenous water-harvesting system for settled agriculture. This is practised in the form of irrigated terrace cultivation in parts of Nagaland and a few villages of Meghalaya. Channels are dug to irrigate these fields. Some of these systems involve use of bamboo pipes to irrigate the fields. Apart from this, natural springs are also used for drinking purposes. The spring water is brought through bamboo pipes or collected at the source itself. Another most recent practice is roof-top water harvesting in Mizoram.

Irrigated terraced paddy cultivation is predominant on the gentle and sometimes on steep sloping terrain. The region has diverse kinds of irrigated terraced cultivation: the Angami system, practised by the Angami tribes and the 'Zabo' system practised by the Chakhesangs. The Angami system of terraced cultivation depends on seasonal or perennial streams, natural springs, and, in rare cases, ponds where rain water is harvested. The system is comprised of a protected forests on the hilltop; well-planned water harvesting tanks and cattle yards, one below the other, in the middle, and paddy fields in the foothills.

The bamboo drip irrigation system is prevalent and so perfected that about 18-20 litres of water enters the pipes per minute and is transported over several hundred metres and finally dimishes to 20-80 drops per minute. This 200 year old system is practised by the tribal farmers in the Khasi and Jaintia hills to water betel leaf plants or black pepper crops. In Mizoram, because of deforestation and soil erosion, people either tap the springs, locally known as 'tuikhur', or depend on rooftop water harvesting for drinking water. Although the people in Arunchal Pradesh have similar patterns of terraced cultivation called 'Apatani', the striking feature of this system is the partial flooding of rice fields and the intricate designs of the contour dams dividing the plots. These traditional systems have something in common: use of local materials and resources to harvest water, all community managed. The systems are managed and maintained by rules and procedures commonly agreed upon by the villagers, as the problem of water supplies is the effect of the cumulative actions of many.

Increasing state-controlled policies

These traditional systems, though prevalent in pockets of the region, have undergone considerable change since colonial rule. The rulers with their doctrine of 'colonial logic' and 'increase in wealth' invaded 'private rights'. The mid -19th Century witnessed consolidation of state control over water resources. Although many different water-harvesting systems were recognised by the colonial rulers (Siddiqui 1992), civil engineers were employed to control and design highly diverse irrigation systems, while the Revenue Department executed the work (Vani 1991). This not only led to creation of a Public Works' Department to supervise and control public works in the country, including irrigation and other water-related work, but also fixed and rendered standard measures for an extremely diverse irrigation system amenable to administrative manipulation. To support the revenue department, the process of 'settlement' was undertaken. This involved two related tasks, one for the assessment of revenue to be collected and, second, for creation of a record of rights (Coward and Walter 1990). These documents were called 'Riwaj-i-abpashi' (Book of Irrigation Customs) and are extant even today in many parts of the Himalayan region and also in various parts of the country, under different names.

To overcome the unequal distribution of rainfall, the colonial rulers introduced a regulated system of canal irrigation, facilitating centralized control. The water laws were formulated by giving the upper hand to the government. In the Kumaon hills of Uttar Pradesh (Vani 1995) the then state government formulated 'Rules Relating to Water Mills and Use of Water in

Kumaon' in 1917 and then again in 1930. This laid down in clear terms the proprietorship of the colonial government over all water resources, declaring that:

> "the water of all rivers and natural streams and of all lakes, natural ponds and other collections of still water within the hill tracts of the Kumaon division are the property of and subject to the control of the state. "

Although the rules recognised the customs relating to water use in the region, they brought in certain changes. The rules provided the right to take a water channel through measured and assessed land of another on payment of an amount of compensation fixed by the revenue court. In addition, all disputes relating to water rights were to be decided exclusively by the revenue court. In fact, the courts replaced the customary rules in practice. In addition, the interest in land revenue brought the colonial rulers in direct contact with the farmers; or with the 'ryot', and this was known as the 'ryotwari' system, or through intermediaries (landlords) for the 'zamin' lands, and this was known as the 'zamindari' system throughout the country. These developments resulted in ownership and moral responsibilities being vested in the state, while the communities were at the receiving end.

Independent India, through its fundamental rights, gave prominence to free access and use of water to citizens; the right to life, extending to any issue involving a threat, or likelihood of the same, that involved water resources. The rights applied to both individuals or groups and imposed on the state the duties of equitable distribution of the resource and of ensuring ecological and environmental improvements and preservation. In contrast, the Constitution of India listed water as a state subject, with access and use by beneficiaries being subject to statutory procedures with the state having a final say. These contradictory statements are a complete departure from the pre-colonial practice of treating water as common property. In fact, Independent India followed the colonial legal structure of state control until altered, repealed, or amended by a competent legislature or authority.

In the initial phase of Indian planning, policies for water harvesting were in the form of grand schemes for major and medium-sized projects to achieve agricultural development on the same pattern as that of the western world; using modern methods of farming, fertilizers, and animal husbandry to increase irrigation potential and areas under command. The planning emphasised the need for a 'stable irrigation' system. There was little mention of the specific context of the Himalayan region (Planning Commission 1993). However, the disappointing performance of the large-scale projects became clear in the 1970s.

The Sixth Irrigation Commission (1973) reports (Singh 1997) :

> "The era of irrigation planning, which has witnessed a phenomenal increase in the investment in irrigation projects, has however been unfortunately marked by sharp and progressive deterioration in the working results. "

It points out that between 1955-56 and 1967-68, the area irrigated by these projects had doubled, but losses from investments had increased 11-fold. The gross receipts had doubled, but the working expenditure had increased three-fold (Singh 1997). In addition to the large- scale interventions, there was consolidation of state control over water resources. The latest of all the 1975 water laws enacted by the Uttar Pradesh, Kumaon, and Garhwal Water (Collection, Retention, and Distribution) Act 1975, applicable in the Kumaon and Garhwal divisions, and the Uttar Pradesh Water Supply and Sewerage Act 1975, applicable

in the whole state, abolished all existing rights over water use, took up the entire responsibility for regulating water and vested in the state the sole authority to regulate and control water.

The importance of comprehensive planning of water resource use in Independent India emerged in the Fourth Plan period. However, a broad policy for development of water resources in the Himalayan region emerged only in the Sixth Five Year Plan. The plan proposed multi-directional treatment of water: conjunctive (multiple and simultaneous) use of water resources, efficient management of irrigation projects, emergence of command area development programmes that take ecological aspects into consideration. One of the significant developments in the Sixth Plan was the importance of developing the hill areas of the country. This led to establishment of the North Eastern Council for integrated development of the North Eastern states. In addition, hill area development in the composite states of the Himalayan and sub-Himalayan regions was promoted through assistance from the centre with the state having primary responsibility. Protection of the fragile and irreplaceable ecosystem of the Himalayan and Western Ghats received considerable attention in the Seventh Plan. Another significant programme in the plan period is the Drought Prone Area Programme. The main thrust of the programme is to restore the ecological balance, through efficient use of scarce resources and conservation of scanty rainfall by arresting its runoff and ensuring farmers' cooperation for management and distribution of water.

The importance given to small-scale water harvesting was limited. The state became a modernising agent by extending its own legal and administrative control. This has changed the traditional production practises and social pattern profoundly. They introduced a number of technical and physical innovations as part of maintenance and repair work. For example, the kul were reinforced with cement or concrete and some complemented with rubber pipes. In addition, many of the hill irrigation systems of the Kumaon region in northern Uttar Pradesh have been formally converted from farmer-managed to Irrigation Department-managed systems (Agarwal and Narain 1997). These interventions, along with the market economy and alternative sources of employment, have adversely affected the traditional social mechanisms to maintain the system, and this has led to a decline in small-scale irrigation systems, referred to in Table 3.2 as other sources. Informal rights were replaced with formal legal rights, cash became a medium of exchange, and this resulted in

Table 3.2: **Net area irrigated (in '000 ha) by sources in himalayan states**

States	Govern-ment Canals	Private Canals	Total	Tanks	Wells (including Tube wells)	Other Sources	Total
Jammu and Kashmir	130	159	289	3	3	15	310
Himachal Pradesh	-	-	-	-	11	88	99
UP Hill	108	-	108	5	118	592	1506
Arunachal Pradesh	-	-	-	-	-	32	32
Nagaland	-	-	-	-	-	56	56
Manipur	-	--	-	-	-	65	65
Mizoram	-	-	-	-	-	8	8
Tripura	28	-	28	2	7	6	43
Meghalaya	-	-	-	-	-	50	50

deterioration in community-based institutions. Nonetheless, in the interior, inaccessible remote regions traditional community-managed water-harvesting systems are still operational (Pande 1995).

The study in the background of these complex regions aims to evolve contextually relevant policy in the Himalayan region by reviewing:

1. The technologies to promote water harvesting in the complex and sensitive mountain system;
2. The relevance of community-based resource management in the present context; and,
3. The role of the government and non-government institutions in promoting such participatory mode of resource management.

4. POLICIES, PROGRAMMES AND INSTITUTIONS

In recent decades, there has been a growing interest in reviving community-based water management in government policies. The National Water Policy (1987) is a landmark in this respect. The policy for the first time aimed at planning, developing, and conserving scarce water resources in an integrated and environmentally sound basis. Learning from the success stories of various watershed development programmes carried out by NGOs and by committed individuals, the Policy recognises the importance of people's participation in the development programme. One of the formal moves towards this was introduction of decentralization governance through 'Panchayati Raj' in the early 1990s. It assumes that by formalising community-based 'social' institutions, grounded traditional organisation, collective interests will be represented and activities undertaken on their members behalf. These institutions are also seen as the main vehicle for community-based resource management.

One of the outcomes of the 1987 policy was the National Watershed Development Programme (NWDP) that was introduced in 1994. It emphasised the importance of people's participation in planning and management through Watershed Associations. The NWDP combined the features of the Desert Development Programmes, Drought Prone Area Programme, and Integrated Watershed Development Programme. Although the focus of the programme differs, the prime objective remains land and water resource management (GOI 1994).

The 9th plan identifies 'eco-preservation and eco-restoration' as the main objective of the HADP. These documents view the economic backwardness of mountain communities as being mainly caused by environmental degradation, especially of land and water resources, and that development programmes need to be undertaken with lease damage to the environment. Whether this occurs or not will depend on a more integrated understanding and analysis of mountain ecology and the natural resource potential (GOI 1994).

In addition to forming Watershed Associations, the significance of this programme is that it has set up various institutions to coordinate the work of the Watershed Development, Implementation and Review Committee at state level, the District Rural Development Agency (DRDA) or 'Zilla Parishad' at district level, and Project Implementation agencies (government or non-government organisations) at project level. The project implementing agency is expected to be a multidisciplinary team (plant sciences, animal sciences, civil or agricultural engineering and social sciences) designated as watershed development team. The Watershed Association was set up as a formal institution to ensure participation, and its task is to prepare watershed development plan, monitor and review its progress, solve any

problems that arise, mobilise funds and operate and maintain the assets. To ensure effective participation, the project called for training of project staff and the village community in various techniques. The techniques include record keeping, conducting meetings and liaison with other agencies. The programme has been implemented in the Himalayan states through different funding agencies such as the World Bank, the European Economic Community (EEC); and the government. In addition, the Minor Irrigation Department promotes water users associations to modernise and rehabilitate minor irrigation structures through Farmer Managed Irrigation Systems (FMIS) programme.

In 1992 the Planning Commission of India decided to constitute an expert group to formulate a national policy for integrated development in the Himalayas. The expert group recognised the importance of local NGOs in evolving appropriate technologies and in understanding the felt needs of the people, the importance of institutional restructuring, and the need for establishment of a Himalayan Development Authority (Planning Commission 1993). In response to the expert panel recommendations, a working group was constituted on the Hill Area Development Programme (HADP) for the Ninth Five-year Plan (1997-2002) (Bandopadhyay 1999).

The Ninth Five-year Plan (GOI) emphasises the importance of community-based water harvesting in addition to watershed management in its various programmes. The agriculture programme (GOI) mentions the importance of soil and water conservation to enhance and sustain the productivity of the available land stock, degradation caused by soil erosion, deterioration of hydrologic balance and increasing competing demand for land. The irrigation programme, (GOI) stresses the importance of using water more efficiently by progressive reduction loss of water in conveyance and application, restoring and modernising old irrigation structures, introducing water rationing and promoting Participatory Irrigation Management with full involvement of water users. In terms of minor irrigation, the plan calls for restoration and improvement of minor irrigation systems as part of micro-watershed development, involvement of the community, awareness about judicious use of groundwater, and promotion of crop diversification in favour of crops that need less water than others. To implement and review policy issues in Participatory Irrigation Management (PIM), a high level committee was established in Himachal Pradesh and Uttar Pradesh. These programmes should be adequately funded by the Command Area Development Programme. These community - based initiatives are likely to be given legal status under the irrigation acts of the states. The significance of the ongoing and current policy is the emphasis on minor water-harvesting systems, involvement of the community, and concomitant use of surface and groundwater.

Water harvesting has assumed importance in recent years in India, with the growing recognition of the scarcity of water and emergence of many community-level efforts.

Although NGOs have actively promoted water harvesting through various schemes, in recent years a separate programme for water harvesting has been promoted by government and funding agencies. The Council for Advancement of People's Action and Rural Technology (CAPART), a funding agency under the Ministry of Rural Areas and Employment, has been supporting individuals and NGOs in rain water harvesting under the Advancement of Rural Technologies' (ARTS) programme (CAPART 1999). CAPART has been promoting ferro-cement tanks to harvest water from rooves through NGOs working in mountain communities. An evaluation of CAPART's work pointed out that rain water harvesting is useful and cost effective for mountain areas (CAPART 1999). Although ferro-

cement tanks provide storage for water (other than rain water also during the dry months), a systematic approach to promoting them on a large scale has not yet become part of policy measures.

State governments also realise the problem of water scarcity. In the Himalayan region, the governments of Mizoram (Dunglena 1998) and Uttar Pradesh have promoted rain water catchment systems from roof-tops and springs as one of the main methods of solving water supply and sanitation problems in rural and urban areas of the hills (Dunglena 1998). The Government of Mizoram through the Accelerated Rural Water Supply Programme (ARWSP) and Technology Mission Programme has provided as many as 5,993 rain water tanks in individual houses of 198 villages at a cost of Rs 60 million. The grants are provided by the government and individual households are expected to carry out the maintenance. The programme is encouraging in that it is providing drinking water in rural areas where there is a scarcity. Apart from government efforts, the state has about 10,000 rain water tanks built by communities at their own expense (Dunglena 1998). The government of Himachal Pradesh has gone beyond the programme stage by making water harvesting mandatory. The State Cabinet of Himachal Pradesh recently decided to make rain water harvesting mandatory for all new existing buildings in the state (Max 1999). Himachal Pradesh is the first state in the country to do so, close on the heels of a similar directive limited to the Chennai (Madras) metropolitan area.

At the central level, the Central Groundwater Board (one of the nodal agencies for groundwater development) of the Government of India recently called for efforts to recharge groundwater basins through artificial methods (Central Groundwater Board 1996). The Board's recent National Perspective Plan for Recharge of Groundwater calls for about 59.06 million ha of available subsurface storage space on the basis of hydrogeological study. It proposes storage of monsoon runoff in the unsaturated vadose zone up to three metres below the ground.

A case from Uttar Pradesh Hills

The UP hills are spread over the Himalayan areas of the state, which constitute nine per cent of the Indian Himalayas. They are home to 13% of the population of the Indian Himalayan region (Prasad 1994). An important feature of this hill region is that about 65% of the region is forest and only 13% net sown area (Bandopadhyay 1999). The density of population based on net sown area in the region works out to about 20%, which is much more dense than in the state of UP overall (Bandopadhyay 1999).

The region is increasingly plagued by water shortages compelling a reduction in domestic water consumption, leading to consumption of unhygenic water, and bringing about social conflicts. In March 1993, 75% of the villages were reported to have drinking water. However, whereas pipelines exist, water flow is either inadequate or absent during the summer months. The poorer families suffer the most (Bandopadhyay 1999). A survey of 135 households of seven villages in Garhwal revealed that the drinking water consumption was 1.5 litres per day per person and the total water consumption per capita was only 29 litres per day (Negi *et al.* 1998), which is much less than the WHO standards of 135 litres per capita per day (lpcd). This problem is exacerbated by problems of access to water. Women and children suffer most because they spend about 32 minutes fetching one load of water (19 minutes in rainy season and 56 minutes in summer). Drinking water is collected from springs, and these springs in turn are managed by mountain communities. However, in recent times, increasing centralized control by the state and increasing demand has made

drinking water a scarce resource in mountain regions. The responsibility for establishing piped water supplies in rural parts of the UP hills rests with UP 'Jal Nigam' and maintenance with the UP 'Jal Sansthan', a state sector corporation. However, the institutional structure of these programmes is entirely supply oriented and they lack interface with and the participation of local communities, incorporating few incentives to maximise economic efficiency and social benefit with the resources at their disposal (Bandopadhyay 1999).

The situation is no different for irrigation. With large numbers of people dependent on agriculture and 70-80% of them having an average landholding of 0.8 of a hectare, community- managed irrigation has been the predominant water supply system for agriculture. About 52% (791/ 1506) of the net irrigated area receives water from canals, and two thirds of these are private canals that are community managed. Irrigation from other sources accounts for 42% of the net irrigated area, which is also community managed. With the acceptance of a planned approach to development, creation of state irrigation works began in Uttar Pradesh. A series of Acts in the 1950s and again in 1975 affirmed state ownership of water-harvesting systems. Even though these brought about major changes in legislation, existing users have not been affected in most cases. However, changing water rights has influenced the behaviour of farmers served by new state irrigation systems (Pande and Singh 1997). As in the case of the institutional structure for drinking water, irrigation institutions are also centralized and undermine the community-managed systems.

In 1996, a new drinking water project was introduced in the UP hills with the financial assistance of the World Bank. The new project, named SAWAJAL, has a comprehensive approach to water supply and associated aspects of rural infrastructure. The project is accountable to the local community and, when completed, it becomes their property. One of the significant things about this programmes is that NGOs are considered to be central to the success of this community-based project. NGOs coordinate with the community, follow up on the activity, and promote its capacity for maintaining the project. Discussions with the District Project Management Unit in Almora revealed that the project had covered 775 villages since 1996.

In recent years, government agencies and NGOs have prepared a massive programme to implement community-based water harvesting for irrigation and drinking water. The following sections review the water-harvesting technologies relevant to community-based institutions and the role of the state. It becomes clear that an institutional approach to policy formulation is needed by understanding the dynamic role of the communities and the environment.

Review of water-harvesting technologies

Water-harvesting technologies are of special importance to the people in the hills where traditional services can no longer meet the present day needs of a rapidly growing population. The technology has to protect and meet the needs of mountain communities and of the downstream population, as well as protecting and conserving the environment The technology used for water harvesting varies according to the available sources and supply. Although there are various technologies in use, in mountainous regions of the Himalayas, water can be harvested from the rooves, from catchment area runoff, and by diverting flowing water.

With increasing demand and centralised control, government departments, as for example in the 'Swajal' Project or in watershed development programmes, promote technologies that create assets, generate employment, prevent soil loss, and improve soil productivity. Though

these projects have a participatory approach, participation is mostly seen as a way of getting the work done.

The designs for water-harvesting structures promoted by the government are based on ideals of permanency and financial returns. Although the United States Agency for International Development (USAID), which sponsors the Hill Areas Land and Water Development (HALWD) project in Himachal Pradesh, recognises the importance of temporary designs, the conditions imposed in terms of Financial Internal Rate of Return (FIRR) and Benefit-Cost Ratio call for stable structures (Pande and Singh 1997), and, in most of these cases, this is not possible. This has led to investment of 63 million US dollars. In addition, the Farmer Managed Irrigation Systems (FMIS) implemented by the Uttar Pradesh Irrigation Department (UPID) along with Minor Irrigation and Soil Conservation wing of the Department of Agriculture aims to "chase the illusive and unattainable ideal of permanency in a system and its components and proceed to design the systems accordingly. " (Pande and Singh 1997)

The approach of the government agencies in terms of permanency of technology arises not only from the perspective of financial returns, but also from the perspective of reversing and slowing down the process of environmental degradation. In addition, these designs, such as stream bank protection, stream alignment, check dams, and others, mostly treat the symptoms of environmental problems by some form of reinforcement and resistance and are often prone to failure or outflanking (Hemphill and Bramley 1989).

In contrast, the technologies promoted by communities are temporary, simple, less expensive, and require regular maintenance and management by local people. The 'zing' and 'man-made glacier' (Norphel 1998) in Ladakh, 'kul' in Himachal Pradesh, 'bamboo drip irrigation' in Meghalaya, and roof-top water harvesting in Mizoram are technologies devised by the communities. These technologies are simple, prove to be environmentally friendly, and meet the needs of mountain communities (Table 3.3). However, what makes these systems complex in terms of their revival is the incorporation of water rights of user groups (Pande 1995).

The NGO approach largely seeks to harvest water by promoting indigenous methods that cost less and are efficient despite constraints. Such methods are appropriate on a small scale and can meet the needs of the local population. The Sri Krishna Charitable Trust, a religious group, introduced roof-top harvesting for drinking water supplies projecting it as a cost-effective method, yet there was limited replication of this even within the community (Maikhuri *et al.* 1998). In harvesting surface water for irrigation, as in the Uttaranchal region of Uttar Pradesh, harvesting is mostly based on water allocation and general engineering and many a time, it is a miniature design of a large-scale system (Pande 1995). The objective of water conservation for Doodhatoli Lok Vikas Sansthan (DLVS) in Garhwal region of Uttar Pradesh "goes much beyond soil and land management to magnify the sustained endeavours of the mountain communities, to nourish and revitalise the thinning headwaters of the Himalayan rivers and recharge, and augment water in the upper watersheds. " (Sheena and Sharma 1998) The NGOs' (good organisations) approach in most cases makes community technology sound better than it really is.

Technologies in the past were more localised. However, in recent years, the population explosion, land degradation, deforestation, increasing erosion, floods and droughts (sometimes claimed to be due to global warming) have exacerbated environmental problems from

Table 3.3: **Implication of water-harvesting technologies**

Agency	Wh Technologies	Implications
Government of Jammu and Kashmir: World Bank assisted Integrated Watershed Development Project of the Kandi Areas of the State (Govt. of J and K 1996) SWAJAL Project in UP Hills	1. In situ moisture conservation through vegetative barriers 2. Drainage line treatment to reduce stream and bank erosion through earthen bag check dams and stream bank protection 3. Harvesting the surplus runoff through storage structures.	1. Permanent engineering design 2. Cost of construction and maintenance high 3. Controls the river systems
Doodhatoli Lok Vikas Sansthan (DLVS) (Sheena and Sharma 1998) (an NGO). Sri Krishna Charitable Trust.	1. In situ moisture conservation through tree plantation to recharge groundwater and anchor soil formation 2. Construction of small water ponds in the middle of the watershed augment soil moisture and replenish water. 3. *Gul* or irrigation channels to irrigate terraced fields	1. Semi-permanent structures 2. Innovation from community effort 3. Cost effectiveness
Community Effort (Agarwal and Narain 1997).	1. Zing 2. Kul 3. Terraced Cultivation 4. Man-made glacier 5. Roof-top water harvesting in Mizoram, Uttar Pradesh and Himachal Pradesh	1. Temporary structures 2. Designs in harmony with the natural flow of streams 3. Less costly 4. Requires regular maintenance or rebuilding of the system

the local to the global. This means that technologies balancing the economic needs of the people and protecting them from natural hazards, in both the Himalayan and the downstream regions are required. An understanding of the functioning of river systems and enforceable regulations are needed for this.

To devise a technology and regulations to harvest water, it is important to understand stream management problems by:

classifying the streams or rivers into components with ecological emphasis;

1. understanding the interconnectedness of river systems in terms of continuity of sediment transport systems and the aquatic terrestrial ecotone;
2. identifying the ultimate and controlling factors that determine the stream behaviour in different time and space scales; (to help define the sensitivity of the system to disturbance and the recovery period needed following disturbances) ; and
3. careful consideration of the natural time scale of fluvial adjustment.

Such an understanding of the river systems may not be feasible in most inaccessible and complex terrains. However in accessible regions, information could be derived from the knowledge of local resource users through an interactionist approach. Certain studies (Guha 1989) have pointed out that this information may be of significance for impact assessment and monitoring of environmental change. This knowledge if tapped, along with scientific and geomorphic study, will enhance the integral part of policy planning.

Lessons from traditional community-based institutions

The growing concern about poverty, population growth, and environmental degradation calls for a pervasive policy for community-based resource management. Communities are closely associated with the natural resource base (NRB). Their closeness and their diverse interest in these resources enable to accumulate knowledge to monitor resource sustainability, allocate resources, and resolve any conflicts that may arise (Duffield *et al.* 1998). Thus, strong dependence on the local NRB promotes a collective stake in these assets. However, superficially the approach is based on the assumption that a distinct and autonomous community exists apart from 'outsiders' in a local administrative unit of a cultural or ethnic group in a valley; and therefore these homogeneous groups can be used to promote institutions on the principles of participatory governance.

The experience of participatory watershed management in the dynamic Himalayan region indicates that the resources are managed through hierarchy and authority. Community institutions in the Himalayan region, similar to other parts of the country, are often characterised by caste, class, and gender differentiation in access to resources. An assessment of European-assisted Watershed Development Projects in Doon Valley indicates that the projects have been disproportionately beneficial to the dominant caste and interest groups (Ninnan 1998). Despite targetting underprivileged groups (scheduled castes and tribal groups, women, and so on), institutional and social barriers, apart from other constraints, have come in the way of helping those who rank very low on the social scale and poverty profile (Ninnan 1998). In the Kulu region of Himachal Pradesh (Berkes *et al.* 1998) it is no different. The Rajputs in the Kulu village of Goshal and Chichoga are economically predominant and also have social and political control in relation to the scheduled castes (SC), the lower group on the social ladder. Although various structural changes (like land reforms) and participatory modes of watershed development have been introduced, the basic distinction between upper and lower castes has remained, and control of common lands and local politics rests with the dominant castes. Despite the fact that village institutions are formed, as in the Doon watershed project, to empower subjugated groups, they either remain silent or play a secondary role in these fora. The domination of the upper castes and interest groups continues. It is the same situation in water management in kul where water rights are exclusively owned by the 'bada ghars' (big houses) who are in adominant position and suffer the least compared to other secondary users (Agarwal and Narain 1997). Although these community institutions had a flexible approach that suited the local people in the context of earning a living, the hierarchy and monopoly over the resource were characteristics of them.

Traditionally these communal institutions have been part of the larger political process in facilitating their domains of control over the resources and not as autonomous entities, as widely assumed, through which effective resource management can be established. In Uttaranchal, records of the Katyuri Kings (9th to 15th century A. D.) indicate that a large number of 'naula' (small tanks for collection and storage of subsoil flow) and 'dhara' were built during wars against the Muslim rulers (Pande 1995). These heterogeneous authoritative power structures were often challenged and this led to political struggle or sometimes demand for equitable use of resources, rendering them dynamic and promoting ingenious methods of using and conserving environmental resources.

The conventional approach of forming user groups through a participatory programme, as with watershed management and the Swajal project is thought to be representative of the collective interests of the community, and these organisations are expected to undertake

activities on their members' behalf. Although such institutions are new, frequently they are believed to represent the traditional wisdom of collective action. Indeed, they are expected to be a focus of the strength of community-based institutions for effective resource management. Many of the programmes use the community to implement programmes rather getting them to participate in the full process.

In this respect, it is important to understand how users access resources through various claim-making strategies over common property resources (CPR) (Mearns *et al.* 1998) like water. How does the informal community-based institution function? and how effective is it in resource management in modern terms of sustainability?

Water resource systems, like other CPRs, have multiple uses and competing users. For instance, the Ladakhi's revere their streams to maintain their cleanliness. Water, for the people of Ladakhi, is not just important from the economic perspective alone, but also from the social and religious perspectives and hence sanctions and incentives are used in its management. In Ratura, farmer-managed irrigation systems, the farmers gather before the Goddess Chandi's image at the head of the canal to determine maintenance chores and rotation sequences. Any violation of the rules fixed in the temple is unimaginable (Pande 1995). Inherently, temples as institutions enforce water allocation rules. In fact, water is collectively managed by multiple regimes of institutions. In these multiple regime, rights to CPR use have been a social process in which rights are part of socially legitimised claims to a benefit stream (Vira 1995). The claims over resources through rights are not static or stable, but are negotiated through a combination of social, political, and ecological claim-making strategies. In an effort to untangle these complex institutions, studies (Saravanan 1998) elsewhere have indicated that it is important to identify the informal user groups who have major claims. These groups are said to possess sufficient knowledge and skills in resource management. However, it is important as well to identify the relevant characteristics of the users in terms of leadership qualities, homogeneity, heterogeneity, educational characteristics, and others in relation to sustainable management of common property resources.

Another challenge to reviving traditional institutions is the informal existence of these institutions. They do not function by a set of rules in use. Studies elsewhere (Adams *et al.* 1997) indicate that behind every formal set of rules for water rights allocation in place, there is a complex network of 'working rules' to allocate water through stealing and selling. Although, to some extent this makes water allocation more equal by providing the means for those with limited rights to obtain more water and, in some instances, makes this system more flexible, it leads to reconstitution, renegotiation, and redefinition of socially acceptable forms of equitable access.

One of the misunderstandings about community-based resource management is that it was an efficient means of managing resources; meaning that it followed rules and patterns of behaviour that led to self-sustainability (Baland and Platteau 1996). This means that traditional communities evolved mechanisms to address the issues of environment and development—for instance, kul irrigation in the Spiti region of Himachal Pradesh. The community evolved techniques to divert melting water from glaciers into a village tank. This water is shared among users who have been allocated water rights. However, notwithstanding the decreasing or increasing availability of water, there have been no improvements in water harvesting techniques, control of the increasing population, or diversification of economic activities. In fact, these societies do not conceive of their natural

environment nor of their own relationship with it as modern societies do. They perceive that natural resources are provided as an act of kindness by some supernatural agent and shortage of resources is perceived as a temporary phenomenon (Baland and Platteau 1996). Pande, questions the efficiency of these systems (Pande 1995). Sometimes, the resource management practices are coincidental, as with terraced paddy cultivation in Nagaland, but there is no motive of ecological conservation.

In the past, environmental problems were localised and suited traditional institutions. The environment acted as a sink for absorbing the potential inputs. However, in recent years, the population explosion, land degradation, deforestation, increasing erosion, floods, and droughts (sometimes claimed to be due to global warming) have rendered these seemingly localised problems global in nature. The complexity of and limited knowledge about environmental change make uncertainty about the environment inevitable. However, understanding the uncertainty is critical in solving environmental problems. Other studies have indicated that this requires not only that local people become managers of nature, but that the state and other actors manage it also. Wherever it is important, locally based practice should be explored, at the same time taking into account the role and interest of the state as an environmental manager.

The community institutions possess various positive aspects that are advantageous for effective resource management (Baland and Platteau 1996).

1. They are well informed about the dynamic nature of ecological conditions, although they may possibly misjudge recent changes in the environment or ascribe wrong causes to visible ecological processes.
2. They are well informed about the local technology and economic and social conditions, as well as the problems or constraints that characterise their society. Consequently they are able to devise location-specific rules that are acceptable to resource users and well-suited to local conditions, if effective local leaders are available.
3. They have a low-cost customary regulation of resource use that can be tapped and self-monitoring can be organised by local users.

To form community institutions as a primary base for resource management in the Himalayas, it is important to understand the following.

1. How the resource is used? How the resource is allocated between different users? How do different users make claims over the resources?
2. What are the rules governing the use of and access to resources? What are the motives behind them? How are they formulated?
3. What different water-harvesting technologies are used by the community? What is the purpose behind selection of the technology? How is it maintained?

Such an understanding helps to see how responsibilities can be devolved to the users based on the principle that 'the weaker the social group in terms of collective action, the more it requires centralized control' - 'the stronger the collective action of the community, the more power it can channel into resource management'. Where decentralization and active participation of the communities are the key to resource management, a critical role can be played by the state through a flexible approach that suits and facilitates community institutions. This joint activity will enable genuine power sharing between the state and the community to check potential excessive control by either side (Pinkerton 1989).

Role of the state and other institutions

The policy environment in the 1990s has been dominated by participatory environmental management and decentralization of the development process. The increasing interest has in these is largely guided by the recognition of past failures, mounting costs, enforcement of the participatory approach by the international aid community, and the manifold achievements of NGOs (Thompson 1998).

The Government's National Watershed Development Programme (NWDP) and Farmer Managed Irrigation System (FMIS) programme have been significant in that they moved from traditional bureaucratic functioning to a participatory mode. However, this static functioning has to interact with more dynamic local institutions. The European funded Doon Valley Project (Sheperd 1998) has already run into problems. The project authorities assumed that government bureaucracies are sufficiently familiar with participatory approaches, that they could play their parts, and that training only needed to be provided to user groups and project implementing staff. One of the significant features of the World Bank's Swajal project is that it has established a single agency for implementation (unlike UP's 'Jal Nigam' and UP's 'Jal Sansthan') and tries to promote an interface between government officials and the people through NGOs. This interface is expected to provide information about field conditions and enable project monitoring. Although this is one of the significant initiatives, the project authorities need to have flexibility and creativity to offer a variety of technical and managerial possibilities so that individuals, groups, and communities can choose what suits them best. Training alone will not facilitate participatory functioning, rather reversals in attitudes and practices are needed. In addition, contemporary programmes call for involvement of NGOs in building community institutions. This has led to the emergence of new NGOs in the UP hills to support the World Bank supported Swajal Project.

To evolve a participatory approach to development institutions need to change from being static to being flexible, need to build on their analytical abilities, and need to share information on a wide range of options. One of the common problems faced by government institutions is their target-oriented functioning. This has led to a premature process of implementation that is meaningful in terms of statistics, but meaningless in terms of development. In addition, the field staff need the commitment to implement the programme, and this has to be promoted by the government departments through incentives. The implicit logic of institutional development underlying the participatory approach in the Doon Valley indicates that a significant change in the functioning of the organisations (both government and non-government organisations) is required. Comparatively, the NGO programmes have been successful because of their flexibility, their adaptability to local-level changes, as less target-oriented approach, and small-scale operations.

For wide-scale implementation of the participatory approach, the government and non-governmental agencies have to restructure their internal systems: their structures, procedures, and values to suit participatory governance. Institutionalisation of participation not only depends on exogenous policy factors, it involves changes in the organisational characteristics of development organisations. It also requires the ability to respond rapidly to changes in development needs with procedural flexibility and commitment to devolution of management tasks and responsibilities to proposed beneficiaries. The development organisation needs to be flexible and evolve a coordinated approach that supports the subordinate groups, increasing their access to and control over resources by taking

operational clues from ongoing struggles, knowledge, and strategies. Such operational clues should form part of the broader learning process approach, whereby new skills are acquired by development professionals. This calls for re-orientation of development agencies (both government and non-government) in terms of structural and normative changes (Uphoff 1991). The former involves a change in organisational functioning, creating interdependence between different institutions, and enabling user groups. The latter calls for normative changes that target the people working in the departments through value commitment, organisational culture, and organisational development.

In fact, the government and other institutions can play a complementary role to that of community institutions (Baland and Plateau 1996) by doing the following.

1. Processing crucial information on village resources and their external impacts, providing technical assistance to users (Disseminating crucial information will help to assess the environmental changes taking place, to promote remedial measures and new practices, and to monitor and evaluate the effectiveness of action programmes.)
2. Promoting economic incentives for users to move towards the path of conservation
3. Providing a flexible legal framework that facilitates users by clarifying their territorial rights and by protecting them from outside intruders
4. Devising formal conflict resolution mechanisms to settle disputes at the local level
5. Providing financial and technical support to decentralise monitoring and facilitate local users
6. Improving efficiency of users through diffusion of best practices and working rules
7. Promoting a 'learning organisation' of the government departments through changes in value systems and attitudes

5. Implication for Policy

An institutionalist approach is needed for holistic, realistic, and flexible water-harvesting policies for the Himalayan region; an approach in which both the state and community jointly manage the water resource. The holistic policy should focus on diverse institutions with social differences.

In a region where uncertainty and complexities are part of the ongoing ecological process, understanding environmental changes makes it difficult to devise strategies for management. To understand these complexities the social sciences need to understand the characteristics and dimensions of environmental problems. To devise a strong environmental policy, dialogue between science and the community to generate future visioning, networking, truth telling, and learning is needed. Given the uncertainties prevalent in the environment, water management policies cannot be fixed, they must be responsive, adaptive, and open to the unexpected—continuously testing, examining, and monitoring the unknown implications of different trajectories of environmental change.

Thus, the policy for the Indian Himalayan region has to provide a framework within which a debate, both scientific and political, takes place about the nature of its implementation in a particular region (Trudgill and Keith 1997). It is important to understand that such a policy might work well in one place, at one time, and on one scale, but might not be relevant or true for other times, places, or scales. In addition, such a policy should not extrapolate beyond the period for which it was initially meant.

BIBLIOGRAPHY (NOT NECESSARILY CITED IN THE TEXT)

Adams, W. M. ; Elizabeth, E. ; Watson and Samuel K. Mutiso. (1997) 'Water Rules and Gender: Water Rights in an Indigenous Irrigation System'. In *Development and Change*, Vol. 28.pp. 726.Kenya: publisher not given

Agarwal, A. ; and Narain, S. , (eds) (1997) *Dying Wisdom. State of India's Environment 4. A Citizens' Report*. New Delhi: Centre for Science and Environment

Baland, J. and Platteau, J (1996) *Halting Degradation of Natural Resources: Is there a role of Rural Communities?* Oxford: FAO and Oxford University Press

Bandyopadhayay, J. and Gyawali, D. (1994) 'Himalayan Water Resources: Ecological and Political Aspects of Management'. In *Mountain Research and Development*, Vol. 14, No. 1

Bandyopadhyay, J. (1999) *Approach to Sustainable Human Development in the Indian Himalaya: With Focus on the Himalayan Areas of Uttar Pradesh*, A Concept Paper. Calcutta: Indian Institute of Management

Berkes, F. , Davidson-Hunt, L. and Davidson-Hunt, K. (19980 'Diversity of Common Property Resource Use and Diversity of Social Interests in the Western Himalaya'. In *Mountain Research and Development*, Vol. 18, No. 1, pp 19-33

CAPART (1999) *Survey Study of Rain-water Harvesting from the Roof-tops in India*. New Delhi: CAPART (unpublished)

Central Groundwater Board (1996) 'National Perspective Plan for Recharge to Groundwater by Utilising Surplus Monsoon Runoff'. In Proceeding of Seminar on *Artificial Recharge of Groundwater*, organised by Central Groundwater Board, on 15-16 December, New Delhi: Ministry of Water Resources, Government of India

CSE (1991) *Floods, Flood Plains and Environmental Myths - State of India's Environment*. A Citizens Report 3. New Delhi: Centre for Science and Environment, 44

Duffield, C. ; Gardener, J. S. ; Berkes, F. ; and Singh, R. B. (1998) 'Local Knowledge in the Assessment of Resource Sustainability: Case Studies in HP, India and British Columbia, Canada'. In *Mountain Research and Environment*, Vol. 18, No. 1. pp 35-49

Dunglena (1998) 'Rain Water Catchment System of Aizawal: The State Capital of Mizoram, India', Paper presented at the Stockholm Water Symposium, August 10 -13

Gopinath, C. (1997) 'Himachal Pradesh: Tapping Mountain Rivers'. In Agarwal, A. and Narain, S. (eds) *Dying Wisdom: Rise and Fall of India's Traditional Water-harvesting systems*, pp 43. New Delhi: CSE

Government of India (1994) *Guidelines for Watershed Development*. New Delhi: Ministry of Rural Areas and Employment, Department of Wastelands Development

Government of India, (undated) *Ninth Five Year Plan 1997-2002* (updated), Draft Prepared at the Internal Meetings of the Planning Commission, Volume 2. New Delhi: Planning Commission

Government of Jammu and Kashmir (1996) *Bird's Eye View of Dudhganga Sub-Watershed of Integrated Watershed Development Project (Hills), Jammu and Kashmir,* A World Bank Aided Pilot Project for Management of Kandi Areas. Srinagar: GO J&K

Guha, R. (1989) *The Unquiet Woods: Ecological Changes and Peasants Resistance in the Himalayas.* Oxford: Oxford University Press

Hemphill and Bramley (1989) *Protection of River and Canal Banks.* London: Butterworths

Ives, J. D. ; and Messerli, B. (1989) *The Himalayan Dilemma.* London: Routledge

Maikhuri, R. K. ; Semwal, R. L. ; Visvakarma, S. C. R. and Rao, K. S. (1998) 'Low Cost Water Harvesting Technology for Life Saving Irrigation for Crops and Afforestation Programmes in Himalaya'. In *Research for Mountain Development: Some Initiatives and Accomplishments,* pp 54

Max, M. (1999) *'Himachal Pradesh to Harvest Rain'.* In *Down to Earth.* New Delhi: CSE

Mearns, R. ; Leach, M. and Scoones, I. (1998) 'The Institutional Dynamics of Community-based Natural Resource Management: An Entitlements Approach', Paper Presented at the International Conference on Studies on Common Pool Resources, Vancouver, Canada

Mosse, D. (1998) 'Making and Misconceiving Community in South Indian Tank Irrigation', Draft Paper Presented at 'Crossing Boundaries' (Conference of the International Association for the Study of Common Property), Vancouver, June 10-14

Negi, N. C. S. ; Joshi, V. and Kumar, K. (1998) 'Growing Fears of Drinking Water Crisis in Himalayan Mountains'. In *Hima - Paryavaran* Newsletter. Almora: G. B. Pant Institute of Himalayan Environment and Development

Ninnan, K. N. (1998) 'An Assessment of European-aided Watershed Development Projects in India from the Perspective of Poverty Reduction and the Poor'. In *Centre for Development Research (CDR),* Working Paper 98.3. Denmark: CDR

Norphel, C. (1998) 'An Alternative Approach to Rain Water Harvesting in Ladakh', Paper Presented at the CSE Conference on Potential of Water Harvesting: Technologies, Policies and Social Mobilisation, 3-5 October, New Delhi

Pande, U. C. (1995) *Design by Experience: Hill Irrigation in the Indian Himalayas.* New Delhi: Joginder Sain and Bros

Pande, U. C. ; and Singh, A. (1997) 'Western Himalaya" In Agarwal, A. and Narain, S. (eds) *Dying Wisdom: Rise and Fall of India's Tradtional Water-harvesting Systems.* New Delhi: CSE

Pinkerton, E. (ed) (1989) *Co-operative Management of Local Fisheries: New Direction for Irrigation Management and Community Development.* Canada: University of British Columbia

Planning Commission (1993) *National Policy for Integrated Development in Himalayas,* Report of the Expert Group. New Delhi: Government of India

Prasad, R. C. (1994) 'Some Economic Features of Indian Himlayan Region'. In *ENVIS Bulletin - Himalayan Ecology and Development.* Almora: GBPIHED

Saravanan, V. S. (1998) 'Sustaining Community-based Resource Management: Case Study of Tank Irrigation Systems in Tamil Nadu', M. Phil Dissertation, University of Cambridge. Cambridge. Subsequently Presented in Conference on Potential of Water Harvesting. 3-5 October. New Delhi

Sheena and Sharma, P. N. (1998) *Ripples of the Society: People's Movements in Watershed Development in India,* PWMTA and FARM Programme. New Delhi: Gandhi Peace Foundation and Food and Agricultural Organisation (FAO)

Sheperd, A. (1998) 'Participatory Environmental Management: Contradiction of Process, Project and Bureaucracy in the Himalayan Foothills'. In Blackburn, J and Jeremy Holand (eds) *Who Changes- Institutionalising Participation in Development,* pp 88-99.London: Intermediate Technology

Siddiqui, I. A. (1992) 'History of Water Laws in India. ' In Singh, Chhatrapati (ed.) *Water Law in India.* Water Project Series. New Delhi: Indian Law Institute

Singh, S. (1997) *Taming the Water: Political Economy of Large Dams.* New Delhi: Oxford University Press

Thompson, J. (1998) 'Participatory Approaches in Government Bureaucracies: Facilitating Institutional Change'. In Blackburn, J and Jeremy Holland (eds) *Who Changes- Institutionalising Participation in Development,* pp 108-120. London: Intermediate Technology

Trudgill, S. and Keith, R. (1997) 'Environmental Science and Policy: Generalisations and Context Sensitivity'. In *Transaction of Institute of British Geographers,* Vol. 22

Uphoff, N. (1991) *Managing Irrigation: Analysing and Improving the Performance of Bureaucracies.* New Delhi: Sage Publication

Valdiya, K. S. (1997) 'Environmental Status Assessment: The Himalaya'. In *Himalaya.* Vol. 18, No. 12, New Delhi

Vani, M. S. (1991) *Role of Panchayat Institutions in Irrigation Management: Law and Policy.* New Delhi: Indian Law Institute

Vani, M. S. (1995) 'Law and Policy on Water Resources in Kumaon and Gharhwal'. In *The Farmer Managed Irrigation Systems Network,* No. 13. Sri Lanka: International Irrigation Management Institute

Vira, B. (1995) *Rights, Property Rights and Their Protection - Implications for the Analysis of Environmental Policy,* OCEES Research Paper 2. UK: Oxford Press