Chapter 7

Local Water Harvesting Technologies and Management Systems in Cha Khola Micro-watershed of Kabhrepalanchok District, Nepal

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1. Background and Information on Study Area

Introduction

The hills and mountains of Nepal, which are a part of the Hindu Kush-Himalayan range, are endowed with abundant water resources. However, most of the resources exist in situ and are yet to be harvested for human and other uses. Consequently, most people in the mountainous region do not have year-round access to water to meet their ever-growing needs for drinking, washing, irrigation, livestock, and other essentials. In many places, households have to walk a long distance to fetch water for drinking. Agricultural productivity and cropping intensity are similarly constrained by the unavailability of an assured water supply. This is a serous problem, especially for the communities who are heavily dependent on agriculture for their survival.

Much of the water available is contributed through precipitation, and as much as 75% of the precipitation occurs from June–September. Such non-uniform precipitation over time makes the withdrawal or consumptive uses of the water resources available that much difficult. However, in spite of the apparent difficulties, the local people have used their ingenuity to harvest and store rain water for productive uses within the limitation of their technology and financial wherewithal. Several indigenous water-harvesting systems dot the landscape of the hills and mountains and are the mainstay of the local people's survival and well-beings.

The indigenous water-harvesting systems are many and varied. They are generally small-scale, site-specific, and depend, among others, the water-holding capacity of the soil, topography or slope of the land, climatic factors, the availability of materials, and the skill and experience of the local people. Moreover, they are deeply rooted in the local milieu. A systematic analysis of the evolution and dynamics of these systems would greatly help to understand the underlying critical factors and processes, crystallising a more balanced view of the indigenous management systems, technologies, and their interfaces. The lessons learned from such an analysis would enable the formulation of more flexible and constructive external interventions and better informed policies and legislation to improve and sustain local water-harvesting systems (LWHS).

This is one of the six case studies commissioned by ICIMOD on local water-harvesting technologies and management systems in micro-watersheds of the Hindu Kush-Himalayas as part of its programme activities in water harvesting (1997–98) under the first Regional Collaborative Programme (enclosed terms of reference). This case study from the mid-hills of Nepal discusses the key findings of the field inquiry into the techniques and methods practised by the people of Cha Khola micro-watershed of the Kabhrepalanchok district for harvesting and management of local water resources, highlighting the critical issues for the sustainable development of LWHS.

The case study begins with a detailed description of the micro-watershed, in terms of its physical as well as socioeconomic characteristics. This is followed by a discussion on local water supply and management systems and on comparative analysis of different systems. The next chapter outlines the status of human and institutional capacities in the area. The final chapter examines relevant policies, tracing their implications for water harvesting. The focus of the study is on local experiences with water-harvesting practices, with reference to the broader issue of policy intervention.

Study methodology

This case study broadly followed the methodological guidelines provided by ICIMOD. Accordingly, the study has introduced the concept of a micro-watershed as a unit of enquiry. This is because the watershed concept enables the assessment of temporal and spatial water balance in a watershed as well as its water contribution downstream. Out of the three micro-watersheds identified for the purpose in the given district, the Upper Cha Khola micro-watershed was finally selected. The overriding consideration in the selection of the watershed was its all-weather accessibility because the survey work was scheduled for the monsoon months.

A field survey of the water sources and individual LWHSs (also the micro-hydel project being implemented) and discussions with the local people on various aspects of LWHS, including the performance of the prevailing institutions,[1] were undertaken. For socio-economic information, Participatory Rural Appraisal (PRA) of three wards, one each falling in the top, middle, and bottom of the watershed, was carried out. A further probe into the socioeconomic dynamics of the identified LWHSs, including the history of the resource, was undertaken by using a detailed checklist in Nepali (the copy translated is attached as Annex 1) with the assistance of a local NGO.

After receipt of the data collection report from the NGO, discussions were held with the key informants (Messrs. Krisna P. Bagagain, Sher B. Tamang, and Lal B. Tamang) to cross-check the NGO's findings and for further clarification. A short field visit was also undertaken during the winter months to assess the seasonal differences in water supply and management practices. In addition, photo-interpretation of aerial photos (1996) of the study area was carried out, and the results were compared with the 1978 LRMP map to determine the changes in broad land-use patterns. Secondary information of the two VDCs, with dominant portions falling into the watershed, were collected from different sources, among which were the relevant VDCs and wards and other institutions in Dhulikhel, and, wherever relevant, this information was used to characterise the socioeconomic situation in the watershed.

1 Because of a very limited number of intervention schemes within the watershed, two nearby schemes, Chhap Raniban and Lapsekhola Chainpur Water Supply Scheme, were also visited to get a feel of the existing organisations and their performances, but these schemes are not specifically discussed in this report.

The study area

The study area–a micro-watershed representing the mid-hills of Nepal, is located in the north-east edge of Kabhrepalanchok (the given district), which is a district adjoining Kathmandu. The area was selected within the frame of the guidelines provided by ICIMOD and taking into account the definition of a micro-watershed of the Department of Soil Conservation and Watershed Management. A comparative method of selection was adopted based on ten characteristic features of the micro-watersheds. Table 7.1 provides some information on the three micro-watersheds identified, from among which the Upper Cha Khola micro-watershed was selected as it met more closely the conditions set out in the guidelines.

Table 7.1: **Basic features of the upper Cha Khola micro-watershed**

	Upper Cha Khola Micro-watershed
Area and Shape	12.2 sq. km.; bat-shaped
Inhabitant	Thickly populated with 438 households
Accessibility	Close to an all-weather road (Nagarkot)
Climate	Warm temperate (15-20 C) and humid
Stream Types	1st, 2nd and upper reaches of third order streams
Vegetation	Cultivated land 82%; shrubland 6%; forest land 12%
Slope and Aspects	NE-SW with >60% slope dominant and well drained
Altitude	1,000 to 2,151 (masl)
Weather Station	One at Nagarkot
Agency for Collective Work	Rural Energy Development (UNDP)

The Upper Cha Khola watershed (UCKW) adjoins Nagarkot–a popular tourist resort some 20 km east of Kathmandu. Its proximity to Kathmandu was advantageous to the study in that it enabled consultants to make repeat field visits. With the upper boundary lying along the ridge at Nagarkot, the watershed is partially accessible by motor vehicle. However, despite a fair weather road that is being built in some parts, a large part of the watershed is accessible only by foot.

The UCKW lies between latitudes 27° 41' 28" to 27' 43' 21" and longitudes 85° 31' 25" to 85° 33' 28" and covers an area of 12.2 sq.km. (Figure 7.1). It falls into two VDCs: Naldung and Nayagaon. Included are ward 2 and a substantial portion of wards 7, 8, and 9 of Naldung VDC and ward 4 and parts of wards 2 and 3 from Nayagaon VDC. Wards 7, 8, and 9 are in the upper reaches, ward 2 of Naldung in the middle (in fact, elongated across the watershed from the uppermost ridge to the lowest basin), and the remainder of 2, 3 and 4 wards in the bottom of the watershed. The three wards in which PRA was undertaken are 8 and 2 of Naldung and 2 of Nayagaon.

Background to study area

Geology and soil

Within the watershed, the land form is dominated by alternating ridges and valleys. The main valley runs along the Cha-Khola draining from SWW to NEE, more or less dissecting the watershed into two halves. A dendritic (tree-like) drainage pattern is widespread along the outskirts of the micro-watershed, while core parts tend to exhibit a sub-parallel drainage pattern (Figure 7.2).

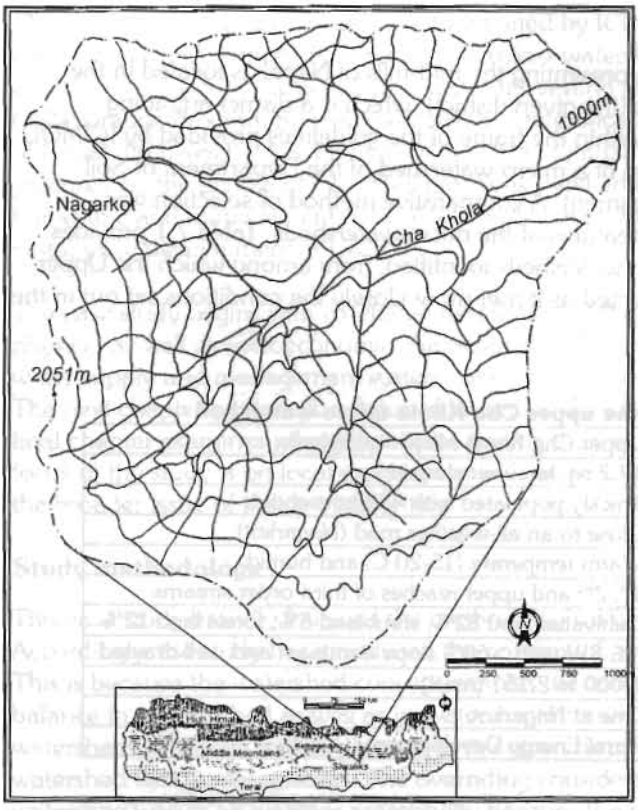

Figure 7.1: **Topographic map of Cha Khola Micro-watershed contour interval: 100m**

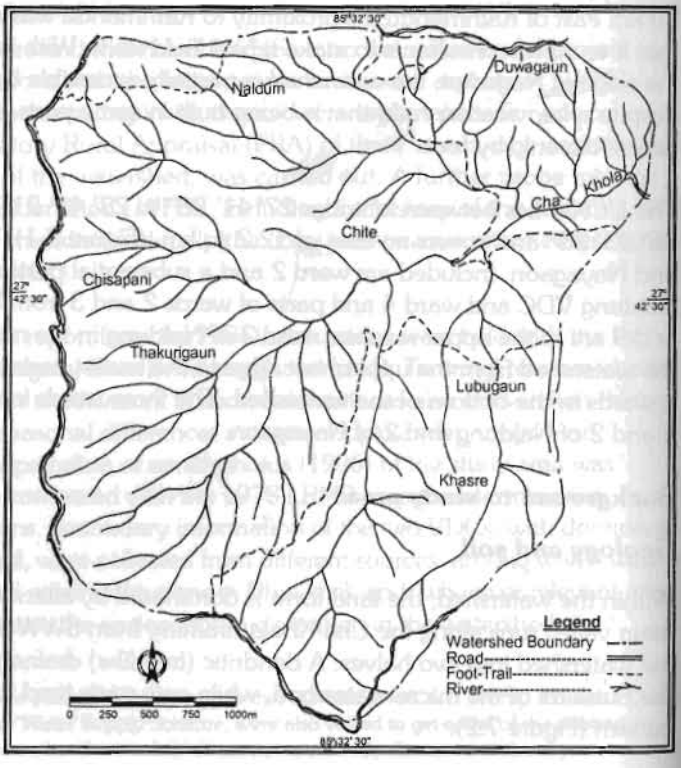

Figure 7.2: **Drainage map of Cha Khola Micro-watershed**

Three broad types of sloping face are recognised, namely, East, North, and South. In conformity with the aforementioned drainage pattern, islands of moderately sloping (15–30% slope) hills are encircled by steeply sloping (30–60%) hills (Figure 7.3). Over 90% of the watershed is covered with hill slopes falling into the categories of slope class III and/or IV. The remaining 10% are covered by centrally located patches of scarp of slope class V. Normally, hill slopes in classes III and IV are used for agriculture (growing rice during monsoon) by developing level terraces, while scarp land is left for natural shrub.

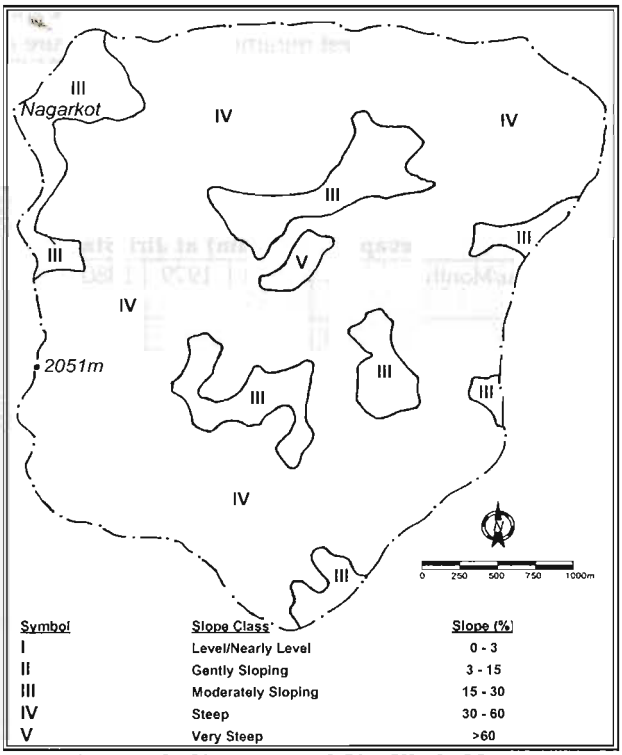

Figure 7.3: **Slope map of Cha Khola Micro-Watershed**

Broadly the watershed has a medium-class drainage texture. The average distance between first-order streams varies between 125 to 300m. On the periphery, surface runoff is of high speed while in the central parts it slow downs to medium speed. Soil textures and underlying rocks are typically neither fine nor coarse but contain mixtures of particle sizes.

There is no geological map of the UCKW. Hence inferences had to be drawn from the photo geographical map (1" = 1 mile) of the Dhulikhel-Dolalaghat area (sheets 72E/10, 72E/14). This indicates that the rock formation of the Kulekhani formation, consisting of micaceous quartzite and biotite schists, would continue in western parts of the micro-watershed while the lower portions of the Cha Khola would be comprised of a variety of crystalline rocks ranging from gneisses to biotite schists to garnetiferous quartzites and marbles.

A major thrust fault separating the Nuwakot Group of rocks from the Bhimphedi Group of rocks is exposed near the confluence of the Cha Khola and Asi Khola would probably continue further to the north. Some cross-cutting minor faults seem to exist along parts of the Cha Khola and Asi Khola.

Local geomorphology, geology, and soil tend to favour the water-holding capacity of the watershed. The heterogeneous nature of soils and sub-soils, along with low porosity and permeability, help reduce infiltration or deep percolation of water. The surface configuration also provides an opportunity to develop local depressions for water harvesting and storage with little cost.

Climate and precipitation

The elevation of the watershed ranges between 1,000 to 2,051 masl. As in other mid-hill areas of Nepal, a warm temperate and humid climate prevails over the watershed area.

Temperature records from Nagarkot station indicate that the highest average maximum air temperature and the lowest minimum air temperature are respectively 23°C in August and 2°C January. Within this temperature range, the mean annual pan evaporation and mean daily pan evaporation at Jiri station (this is the only station near the watershed measuring evaporation) are recorded to be 37.6 mm and 3.1 mm respectively (Table 7.2). Farmers have also reported hailstorms, wind, and frost as climatic problems sometimes encountered.

Table 7.2: **Pan evaporation (mm) at Jiri Station (elevation- 2,003 masl)**

Year/Month	1977	1978	1979	1980	1981	1982	1983	1990	Mothly Mean
Jan	3.1	2.5	1.8	1.9	1.5	3.0	3.1	1.9	2.35
Feb	2.1	2.6	3.9	2.4	2.7	3.1	3.8	2.1	2.84
Mar	3.6	3.2	3.7	3.2	3.0	4.9	4.0	2.9	3.56
Apr	3.4	3.0	4.1	4.3	4.1	9.0	5.0	3.7	4.58
May	4.1	2.4	4.4	4.1	3.7	6.9	5.0	3.7	4.29
Jun	2.9	2.4	4.4	4.2	4.0	5.3	5.0	3.8	4.00
Jul	2.2	2.0	3.4	3.6	4.2	5.2	5.6	3.3	3.69
Aug	1.5	2.0	NA	4.3	4.7	4.8	4.7	3.1	3.59
Sep	2.4	1.9	3.1	3.3	3.8	3.4	3.6	2.7	3.03
Oct	2.0	2.5	2.6	3.3	3.3	3.3	NA	2.9	2.84
Nov	1.8	1.8	2.4	2.4	2.6	2.1	2.5	2.2	2.23
Dec	1.6	1.8	2.0	1.8	3.5	2.0	NA	1.4	2.01
Average day	2.56	2.34	NA	3.23	3.43	4.42	NA	2.81	
Annual	30.7	28.1	NA	38.8	41.1	53.0	NA	33.7	

Mean Daily Pan Evaporation at Ziri =3.13 mm/day
Mean Annual Pan Evaporation at Ziri =37.57 mm
Source: DHM

A substantial amount of precipitation occurs within the micro-watershed. Monthly precipitation records over a period of twelve years from 1987–99 at Nagarkot station and at Panchakhal station (given here for comparison) are shown below in Table 7.3. Average annual precipitation at Nagarkot and Panchkhal are 1,814.1 and 1,093.2 mm respectively, monsoon months (June to August) alone accounting for nearly 75% of the precipitation.

Table 7.3: **Precipitation data from the upper hills (Nagarkot) and the lower foothills (Panchkhal)**

	Monthly Precipitation (mm) at Nagarkot (Elevation 2,163m)							
Year/Month	87	88	89	90	91	92	93	94
Jan	0.0	0.0	32.8	0.0	40.3	24.0	NA	28.1
Feb	0.0	17.3	15.8	31.7	1.6	24.5	NA	29.8
Mar	0.0	28.6	24.2	56.3	21.9	0.0	45.2	21.0
Apr	0.0	87.8	6.6	168.2	66.7	20.8	27.8	10.8
May	0.0	142.4	NA	146.9	189.1	132.8	250.9	192.6
Jun	279.7	387.6	NA	282.2	278.7	267.3	333.8	402.8
Jul	494.6	156.3	366.7	551.1	330.9	387.0	327.1	416.4
Aug	454.2	420.6	567.1	465.4	537.1	582.9	543.5	620.8
Sep	242.9	177.6	375.3	308.9	261.2	302.0	238.2	256.6
Oct	152.6	11.8	10.4	112.9	0.0	21.7	91.2	7.8
Nov	0.0	10.2	3.5	5.5	0.0	28.7	0.0	53.2
Dec	21.2	71.0	0.0	2.9	14.3	7.4	0.0	15.1
Annual	1645.2	1511.2	NA	2132.0	1741.8	1799.1	NA	2055.0

Average Annual Precipitation at Nagarkot =1,814.1 mm

Table 7.3: Cont....

	Monthly Precipitation (mm) at Panchkhal (Elevation 865m)							
Year/Month	1987	1988	1989	1990	1991	1992	1993	1994
Jan	0.0	0.0	51.5	0.0	23.0	8.0	10.5	NA
Feb	16.0	25.3	7.4	34.7	8.9	23.5	18.5	NA
Mar	16.0	91.2	16.9	36.1	62.3	0.0	27.1	8.0
Apr	123.5	47.2	2.5	51.5	10.7	9.8	54.1	11.0
May	48.5	111.3	121.8	177.7	140.5	21.6	27.5	79.0
Jun	NA	173.4	116.0	190.9	172.6	125.0	187.2	239.3
Jul	NA	228.8	311.7	267.1	183.3	223.9	265.1	283.4
Aug	NA	341.1	266.4	268.7	290.1	260.5	291.5	306.2
Sep	NA	152.1	254.5	143.5	163.9	144.1	80.8	226.4
Oct	NA	10.5	2.4	42.3	0.0	33.7	16.0	0.0
Nov	NA	8.8	0.0	0.0	0.0	24.0	7.6	15.2
Dec	NA	69.6	0.0	0.0	13.0	8.0	0.0	1.0
Annual	NA	1,259.3	1,151.1	1,212.5	1,068.3	882.1	985.9	NA

Land resources and use

The total land area of the watershed is 1,220 hectares, of which 145.1 hectares (11.89%) are forest, 67.2 hectares (5.5%) shrub, and 1,007.4 hectares (82.5%) terraced land with 50–75% cultivation (Figure 7.4). The cultivated land is predominantly level terraces interspersed with sloping terraces; only 13.1 hectares of land near the flood plain of the Cha Khola is purely level terrace. On the level terraces (locally known as *khet*), rice in monsoon and cereal in winter/dry season is the dominant cropping pattern, while maize is the main crop on sloping terraces *(bari)*.

Compared to 1978 (Figure 7.5), the current land use has undergone significant change. As seen in Table 7.4, the shrub area has decreased by 83.1%. This is accompanied by a 907.6% increase in forest area and a 24.6% increase in cultivated area (the seemingly extraordinary growth in forest area in percentage terms is largely due to the low base). Evidently, a substantial part (198.7 ha) of the shrub area has been brought under cultivation while another similar lot (130.7 ha) has gone to afforestation, mainly under community forestry, over the review period. Partly because of this reduction in common shrub land, combined with the regulated access to community protected forest, the local farmers have switched over to stall-fed buffalo rearing. Local people also confirmed that the encroachment on public land (mainly conversion of adjoining public land into private during land registration surveys) is widespread in the area. Such complaints are more commonly heard in the Nagarkot area.

Forest resources

There has been a noticeable change in the attitudes and interests of local people regarding the value and significance of forest cover to their economy. This was primarily induced by

Figure 7.4: **Land utilisation map, 1996 of Cha Khola (Interpretation of aerial photos from Department of Survey**

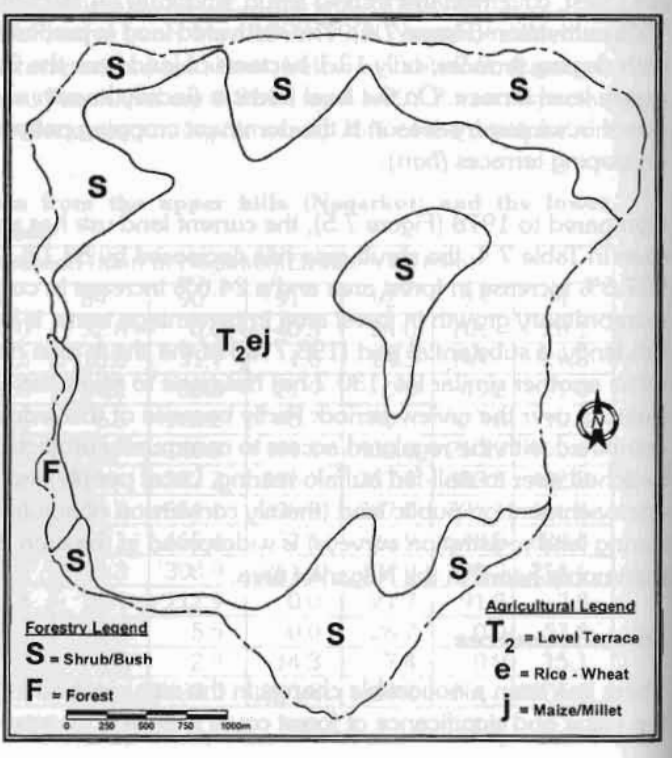

Figure 7.5: **Land utilisation map, 1978 of Cha Khola Micro-watershed (as per LRMP map)**

Table 7.4: **Land use change in the watershed, 1978–1996**

(Area in ha)

Land Use Type	1978 LRMP	1996 Photo Interpretation	Difference	Per Cent Change
Forest	14.4	145.1	+130.7	+907.6
Shrub	396.9	67.2	-329.7	-83.1
Cultivated (50-75%) :	808.7	1007.4	+198.7	+24.6
Level Terrace	*808.7*	13.1		
Level/Sloping Terrace		994.3		
Total	1,220	1220		

the reduction in shrub land (i.e., brought under cultivation) and the restriction on entry to natural forests imposed by the government in different locations of the watershed, on the one hand, and the need for green grasses and fodder for the thriving animal husbandry in the area for milk production, on the other. Local people have also responded by gradually reducing grazing animals, such as cows, and replacing them by buffaloes, primarily a stall-feeding animal (green grasses and fodder, however, are needed even for stall-fed animals)

These developments and changes motivated people to engage in afforestation and preservation of the existing community forest land. The introduction of a community forestry programme has also contributed to this process. Currently a total of 83 hectares of land (not included as government protected forest) has been either preserved as forest or afforested. The area under preserved forest and afforestation in three different locations (not in the total area) of the watershed are presented in Table 7.5 below. *Sallo,* (pines: *Pinus roxburghii), Dhupi,* (juniper: *Juniperus recurva), Masala,* (eucalyptus: *Eucalyptus camaldulensis), Painyu,* (prunus: *Prunus cerecoides), Lapsi, (Choerospondias axillaris)* and *Uttis* (himalyan alder: Alnus nepalensis) are the plants grown on afforested land. Preservation and afforestation activities are carried out through different users' groups.

Table 7.5: **Preservation and afforestation area (ha)**

	Naldung	Chitte	Nayagaun
Preserved Area	-	50	12
Afforested Area	12	7	2

Source: Field Enquiry

Water resources

With an average annual rainfall of 1,800 mm, the watershed is endowed with abundant water resources. The watershed has a network of the first, second, and upper reaches of the third order streams. The Cha Khola and its four tributaries: the Satipani Khola, Dandebhare Khola, Rohini Khola, and Ghyampe Khola are perennial streams traversing the watershed. Dividing the watershed into near-equal segments, they feed numerous springs/water sources in the area. During monsoon, the number of such springs and tributaries multiplies many times. Sketch maps of major streams and their tributaries during rainy and dry seasons are presented in Figures 7.6 and 7.7 respectively. Largely due to the favourable geology and soil condition, the water sources are quite uniformly spread throughout the watershed area. This is one reason why the land in the watershed is extensively terraced and intensively cultivated. Overall, the watershed appears to be water surplus in relation to the current land use. This observation is also corroborated by a simple calculation based on evapotranspiration. Using the rainfall data from Nagarkot station and pan evaporation data from Jiri station, the exercise shows that there would be a surplus of 447 mm of rain water even based on the assumption that the entire watershed is under actively growing green grass cover (Table 7.6). There will, however, be seasonal fluctuations in the magnitude of such surplus. Furthermore, the fact that the watershed is continuously contributing to

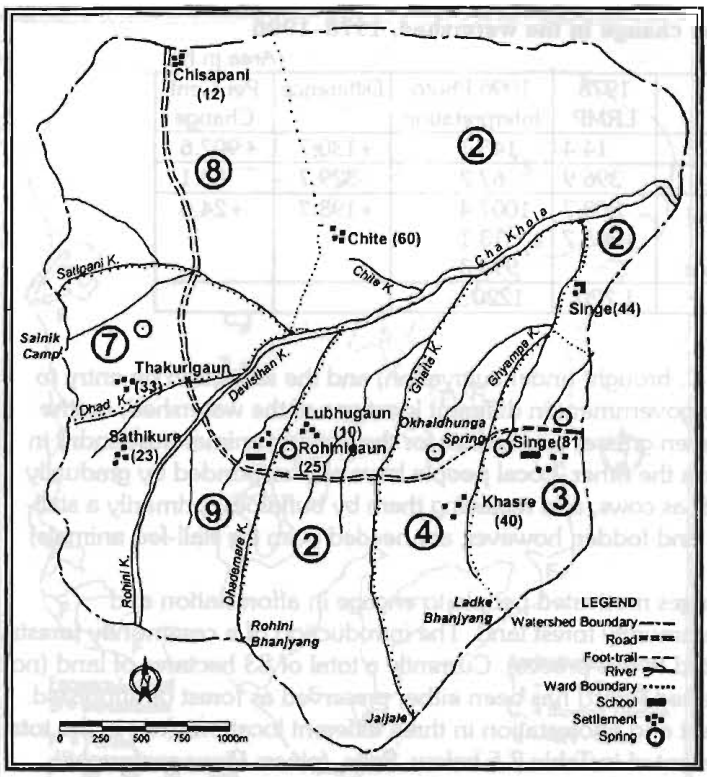

Figure 7.6: **Field sketch map of Cha Khola Micro-watershed (during rainy season)**

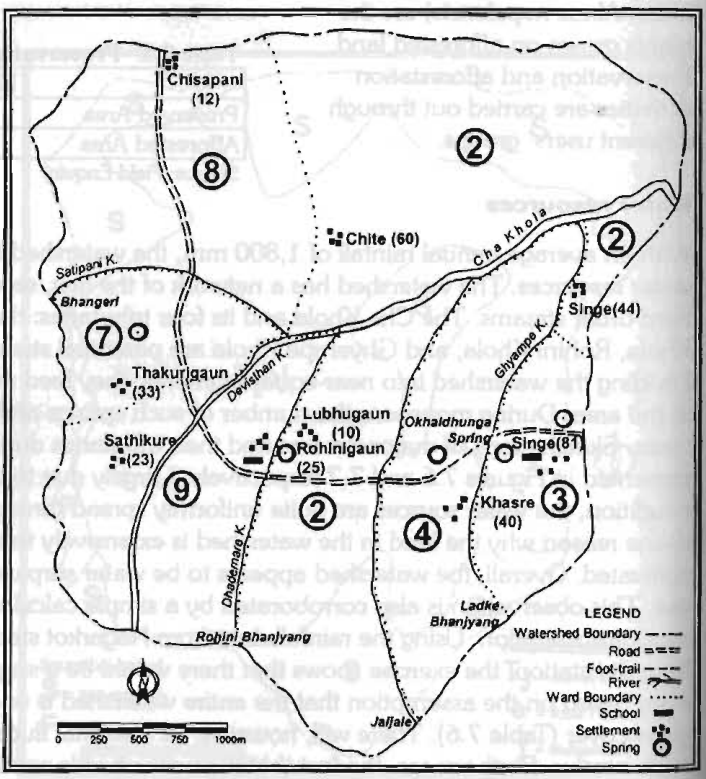

Figure 7.7: **Field sketch map of Cha Khola Micro-watershed (during dry season)**

Table 7.6: **Calculation of total evapotranspiration using rainfall and pan evaporation data**

Station	Mean Annual Rainfall (mm)		Annual ETO (mm)	Water Surplus (+) /Deficit (-)
	P	Pe (effective)	Kpan*Epan	Pe–ETO
Nagarkot				
	1827	1246	799	(+) 447

Note : Annual Pan is derived from Jiri station.

downstream flow is another indication of its surplus status. The minimum flow or discharge of the Cha Khola at the outlet point of the watershed is measured at around 65 lt/sec.

Mineral resources

There are no reported economic mineral deposits in this area. However, abundant slag is found in the vicinity (Bhimsendanda) of the study area. The carbonate rocks exposed in Bhimsendanda and lower parts of the Cha Khola (probably equivalent to Bhainsedobhan marble) contain chalcopyrite (copper sulphide), malachite (copper hydroxide), and magnetite (iron oxide).

People and communities

Cha Khola Watershed is constituted of whole or parts of seven wards of the Naldung and Nayagaon Village Development Committees of Kabhrepalanchowk district. All three wards, namely, ward nos 2, 3, and 4 of Nayagaon VDC, are situated at lower elevations of the Upper Cha Khola Watershed, whereas three wards, namely, ward nos 7, 8, and 9 of Naldung VDC, are situated at upper elevations. Ward no 2 of Naldung is rather uniquely situated, as it is elongated across the watershed encompassing the uppermost ridge to the lowest basin of Cha Khola. There are 10 major settlement clusters, some having two to three smaller satellite settlements comprising five to six households. The distribution pattern of settlements by elevation and administrative units is presented in Table 7.7.

The total number of households in Cha Khola Watershed is 438 with an average estimated household size of 7.72. The total population of the watershed is estimated to be 3,381. The distribution of households by Ward is presented in Table 7.8.

Table 7.7: **Distribution pattern of settlements by elevation and administration**

Naldung VDC			
Ward No.	2	Luha, Rohini	Chitte
	7	Thakuri Gaun	
	8	Chisapani, kafling, Danda Thumko, Gorung	
	9	Sathipure	
Nayagaun VDC			
Ward No.	2		Nayagaun
	3		Singe
	4		Khasre

Source: Field visits

Table 7.8: **Distribution of households by ward**

Naldung VDC		
Ward No.	2	138
	7	33
	8	130
	9	23
Nayagaun VDC		
Ward No.	2	44
	3	70
	4	40
Total		438

Source: Field enquiry

The ethnic composition of the study area is characterised by predominance of the Tamang ethnic group. Out of 438 households, 358 households belong to the Tamang ethnic group, the rest are Brahmins, Chhetri, Newar, and some minor ethnic groups. Settlement clusters are ethnically also homogenous. Even smaller ethnic groups are not living together with other groups. As for example, Rohini, belonging to ward no 2 of Naldung, is a Brahmin village and Chisapani, a major settlement in ward no 8 of Naldung, is a 100% Newar. Similarly, in settlements situated at lower elevation also, the ethnic composition within the settlement is homogenous.

The Cha Khola Watershed area has only one primary school. Children attend schools in neighbouring VDCs and in Bhaktapur district. The average adult literacy rate of Naldung and Nayagaon VDCs as presented in the Kabrepalanchowk DDC document is around 33%. Field enquiries and impressions provide a varied scenario of literacy in different settlements within the watershed area. As for example in Brahmin and Chhetri settlements, such as Nayagaon of Nayagaon VDC Ward No 2, the average literacy rates of men and women are 85 and 70% respectively. This extraordinary achievement in literacy, as reported by the local people, is due to extensive literacy programmes run by the Red Cross, Rural Energy Development Project, and other NGOs. The literacy levels in other settlements are far lower. In some Tamang settlements, such as Chisapani of Naldung VDC Ward No. 8, the literacy rate for women is less than five per cent.

Cultural practices related to water harvesting are not explicit. The demand for water among Brahmin and Chhetri groups is more pronounced than among the Tamangs and is consistent with their agricultural and animal husbandry practices. Water harvesting for irrigating *khet* (irrigated level terraces) is a prime preoccupation among the Brahmins and Chhetris who own and operate most of the *khet* in the watershed. Harvesting water for irrigation needs collective action which, culturally and traditionally, has induced local people to form informal social groups. Harvesting drinking water also demands collective action, although on a smaller scale. Depending upon the proximity to water sources from individual houses, smaller groups of households are formed to maintain and clean *kuwa* (wells). Larger (user) groups are being formed presently, mostly motivated by the introduction of a piped water system supported by occasional external assistance.

Watershed economy

The Cha Khola Watershed communities are primarily dependent on farming supplemented by animal husbandry for their livelihood and employment. A small percentage (less than 10%) is employed in off-farm occupations.

As estimated from the latest photo map of 1996, the total cultivated area in the watershed is nearly 995 hectares. The average size of holdings differs from settlement to settlement. For example, the average size of holding per household in three locations of the watershed is reported as follows (Table 7.9).

Table 7.9: **Size of holding per household (in ha)**

Naldung W. No –8	0.65
Naldung W. No–2 (Chitte)	0.50
Nayagaun W. No –2	1.00

Source: Field Inquiry and Estimates

The proportions of *khet* (level terraces) and *bari* (sloping rainfed terraces) vary from location to location depending upon availability of water from streams feeding the Cha Khola River. At higher elevations, such as in Naldung Ward No 8, the proportion is 12:88%, whereas it was reported to be 50 : 50% in Chitte, the lowest elevation of watershed area in Naldung VDC Ward No 2. It was reported to be 40 : 60% in Nayagaon VDC.

The cropping pattern in the watershed area is paddy and maize planted respectively on *khet* and *bari*. The main cropping patterns on *khet* and *bari* at different locations by elevation are presented as follow (Table 7.10).

Table 7.10: **Cropping pattern in Cha Khola**

(in % of paddy area)

Khet	Naldung	Chitte	Nayagaun
Main Paddy-Wheat	70	100	75
Main Paddy-Potato	5	-	insignificant
Main Paddy-Fallow	25	-	-
Early Paddy- Main Paddy	-	-	25
Paddy-Mustard	-	-	10
Black Gram and Soyabean crops are	-	-	-
grown on bunds with main Paddy	-	-	-
Avg. Cropping Intensity	-	-	-
	160	195	200

(in % of maize area)

Bari	Naldung	Chitte	Nayagaun
Maize /Millet relayed	30	95	75
Maize –Mustard	20	-	-
Maize – Potato	insignificant	insignificant	20
Maize- Radish	5	-	-
Maize /Soyabean /Masyan	5	insignificant	5
Avg. Cropping Intensity	175	200	210

Source: Field Enquiry and Estimated

The cropping intensities for both *khet* and *bari* are lowest in areas situated at higher elevations of the watershed. The average productivity of principal crops also differs from area to area. The average yields of various crops grown in the watershed area are as follow (Table 7.11).

Table 7.11: **Crop yields (MT/ha)**

Crops	Naldung	Chitte	Nayagaun
Early Paddy	-	-	5.96
Main Paddy	1.50	4.50	5.96
Wheat	0.95	1.39	2.53
Maize	5.05	5.05	2.53
Potato	2.50	-	4.79
Mustard	1.44	-	-
Millet	2.18	2.91	2.91

Source: Field Estimates

Two major cropping patterns were observed in the watershed and the cropping pattern on *khet* and *pakho* are different. Main paddy, early paddy, and vegetables are grown on *khet*, whereas maize, millet, and different types of pulses, beans, and potatoes are important crops grown on *pakho* (rainfed slope lands).

Agricultural productivity is directly related to the availability of water and application of chemical fertilizer. Traditionally, much of the farm nutrient was supplied through farmyard manure, but, with growing scarcity of fodder, reliance on chemical fertilizer, especially for paddy, is increasing.

The present volume of chemical fertilizer used, as reported by local farmers during the field visit, however, appears to be far lower than properly required. Paddy, wheat, and maize are crops that receive chemical fertilizer. Maize is treated with compost also. The average applications of chemical fertilizer on paddy, wheat, and maize, as estimated by the local

people, were 200,100, and 200 kg per hectare respectively. The total estimated consumption of chemical fertilizer in different areas is presented in Table 7.12.

Table 7.12: **Chemical fertilizer use (kg/yr.)**

Naldung	400
Chitte	500
Nayagaun	750

Source: Field Enquiry

Animal husbandry is becoming one of the significant sources of cash income for local farmers. The pattern of livestock holdings in all locations and at all elevations was not reported to be significantly different. She-buffaloes are the principal livestock raised. The number of cows is insignificant. Except in Rohini and in Nayagaon villages where the communities are Brahmin, a couple of cows are raised for religious purposes, cattle raising is virtually absent from the entire watershed. The average numbers of different livestock raised by the local people are estimated as follow (Table 7.13).

Table 7.13: **Type of livestock (No./household)**

She Buffalo	2-3
Goat	4-5
Chicken	5-6
Cow	insignificant
Oxen	Not permanently raised

Source: Field Enquiry

The case of oxen is quite unique. Local farmers on an average keep a pair of oxen for ploughing. These animals are bought at the beginning of the ploughing season and are sold after the ploughing is completed. Oxen are bought and sold in seasonal livestock bazaars held in neighbouring areas. One of the principal reasons for this strange practice is reported to be because of its cost effectiveness and shortage of grazing area.

Milk production and sales have become a dominant feature of the watershed economy. As reported by the local people, the daily average sale of fresh milk is four litres. The average annual milk production has been estimated to be nearly seven per cent. Sale of goats is also an important source of cash income for local people. Most of the goats are sold locally to nearby military barracks and traders from Bhaktapur. The average annual household income from the sale of goats was reported to be Rs 5,000.

There are altogether eight rice and flour mills in the watershed area. With the growth of Nagarkot as a tourist resort, local people have gained easy access to market for a few local vegetables. With the cash income from the sale of milk, the village economy is gradually transforming into a cash economy. Currently a micro-hydroelectric project is under construction as a cooperative enterprise.

2. LOCAL WATER SUPPLY AND MANAGEMENT SYSTEMS

Introduction

As in other areas of the Nepalese mid-hills, the pattern of water use in the watershed area is confined to drinking and irrigation. In Nagarkot, where drinking water sources are at lower elevations than the township, local people were observed harvesting rain water from the slanted rooves of their homes. The water is collected through pipes to containers or ditches dug in the homestead for later use. Such water is generally used for cleaning pots, washing clothes, and for livestock and vegetable farming.

The Cha Khola Watershed features a system of big and small streams and springs (*mul*) feeding the Cha Khola River. During the rainy season there are altogether 15-16 major streams and small rivulets that drain rain water into Cha Khola River. During the dry season,

only five major streams contain some water. These are the Satipani, Devithan, Dangore, Rohini, and Ghyampe streams. All other streams and rivulets become dry. The general pattern of rain water harvesting for irrigation is dependent on the availability of water in existing streams during different seasons. For drinking water and other domestic purposes, local people are dependent on nearby *mul* (springs) or *kuwa*. As observed during the field visits in both rainy and dry seasons and reported by the local people, most of the drinking water requirements are met through tapping water from the *mul* and drawing through polythene pipes to settlements. This way of tapping drinking water is not specific to any settlement located at any elevation. This is the general method of harvesting drinking water in the entire watershed. The technique for tapping water is very simple. Pipes are inserted into the *mul*. No reservoir is constructed.

Water supplies for domestic purposes

The principal sources of water for general domestic uses are wells (*kuwa*) and taps. Before the introduction of piped water for domestic (mainly drinking) purposes, almost the entire population was dependent on *kuwa* for drinking water. With the funds for drinking water made available through government and philanthropic non-government agencies and organisations over the last several decades, there has been a shift from *kuwa* to piped water supplies. However, as explained in an earlier paragraph, the piped water systems installed are not constructed with a commonly specified technique. In all such systems installed by the local people, there are no provisions for intake reservoirs and/or distribution reservoirs. Polythene pipes are inserted into *mul* and pipes laid to bring water to settlements. There are three distinct patterns observed in privately tapping *mul* with pipes to bring drinking water to settlements. In some settlements a well-to-do household might buy the pipes and bear all the costs of tapping the *mul* and allow neighbours to use the water also. The second pattern is that a well-to-do household puts the most money into the venture and others contribute smaller amounts. In the third pattern, all interested households contribute an equal amount of money and, depending upon the settlement pattern, two to three outlets are built. In Naldung area, the first two patterns were reported. The third pattern of contribution was reported in Chitte. This privately-owned and operated piped water system is widespread throughout the settlements in the watershed. In a very few small settlements at lowest elevations, where sources are either not nearby or simply do not exist, local people rely on *kuwa* as sources of drinking water. Dursable is one such settlement located at the lowest elevation in Ward No. 2 of Naldung VDC.

The second form of tapping *mul* for drinking water is formal, as the official budget of the DDC or NGO is involved. The number of such officially-aided piped water schemes is very small though; as such there are only two schemes. The oldest is located in Nayagaon Ward No. 2. The scheme is called *Muldharo* Simikhet Nayagaon drinking water scheme. The then District Panchayat donated Rs 6,000/ for the purchase of pipes and fittings. Local people contributed labour on an equal basis. The said *mul* is located on the fringe of the settlement. Local people added to the external fund and developed a more permanent structure to protect the water source to regulate water supplies through the pipes. There are three water taps built at equal distances in different locations. A formal committee for construction and or management purposes was formed. However, occasional repair and maintenance work is carried out by users on their own initiative. Until now, no cash has been required for repair and maintenance. No conflicts have been reported regarding use of this scheme.

Over the last 20 years, this has remained the sole source of drinking water for 36 households of Nayagaon village. Last year the Nayagaon villagers finalised a plan for

constructing a new drinking water scheme to augment the volume of water from the existing scheme. The water source would be the Chhote Dando *Mul*. For this, the Red Cross has agreed to provide funds and local people will be contributing five per cent of the total cost. Villagers have organised themselves into a formal group which is participated in by women on an equal basis. The group is also formally registered.

The other externally funded drinking water scheme in the watershed was built in 1998.A sum of Rs 30,000/ was provided by the District Development Committee (DDC) through Naldung Village Development Committee. The scheme was previously planned to serve three settlements of Ward No. 2 of Naldung: Rohini, Luha, and Chitte. However the funds were insufficient for all the settlements. Accordingly, the plan was revised to supply drinking water to Rohini and Luha only. A Users' Committee was formed consisting of households from Rohini and Luha. The chairman and secretary were both local inhabitants of Rohini village, a predominantly Brahmin village. Currently, 35 households in Rohini and Luha villages are said to have been provided with piped water. Unlike in the Nayagaon scheme there is no intake reservoir. Instead the pipe has been directly inserted into the *mul*. However, according to the people from Luha, and as reported by the Chitte Ward chairman, the size of the pipe from the *mul* to Rohini village was bigger than from Rohini down to Luha village. This discriminates against Luha as water is in shorter supply by the time it reaches them. In addition, the committee has also been unable to properly present the expenses of Rs 30,000 to the VDC. As the reaction of the committee leaders could not be solicited, no definite conclusion can be drawn from the said allegations. It is a fact, nevertheless, that a serious conflict arose right from the commencement of the scheme.

Although there has been a decline in use of *kuwa* in some settlements at lower elevations because of the popularity of piped water, they are still a source of drinking water. During the monsoon, the quantity of water in the *kuwa* is abundant with overflow. With the onset of the dry season, most *kuwa* start to dry out and the quality of water deteriorates. The surroundings of *kuwa*, which are usually filthy, become a fertile breeding ground for organisms that are harmful to humans as well as animals, as some of the larger *kuwas*, which do not completely dry out, become overcrowded. Increase in the frequency of collecting water is the cause. Other than *kuwa* and piped water, a few local people use *kholcha* (rivulets) to compensate for the shortage of drinking water for livestock. Bunds are built to check the meagre water flow.

However, *kholcha* are used more for filling small earthen ponds built subject to proximity to the settlement for the purpose of supplying water for livestock. Building ponds is a common method of water harvesting in the watershed. This has become a necessity because of the rising number of stall-fed buffaloes. As reported by the local people, there are on avcrage five buffalo ponds per settlement. Ponds are filled by rain water during the wet season. During dry season, however, ponds are filled in different ways. In some villages, where *kholcha* still contain water, people were observed building bunds to create ponds. Ponds were observed built close to *mul* (springs), and seepages are diverted to fill the pond. Some ponds are filled with piped water. In Chitte, a lower evaluation settlement in Naldung VDC, local people made ponds in the middle of the irrigation canal. They said that it is healthy for animals to use flowing water.

Generally ponds fed by small rivulets, irrigation canals, and *mul* and built on public lands are common property. Such ponds are cleared through collective labour twice a year. Other ponds on private lands are used individually.

Collection of rain water from rooves was observed in Nagarkot, a popular tourist resort. The local people said the water collected is used for domestic purposes other than drinking. Small tea shops and local households fetch drinking water from *kuwa or mul* several metres (sometimes 7-10 minutes' walk away) down the slope. All tourist hotels meet their daily water requirements by pumping water from personal reservoirs built around a number of *mul*.

Water supply for irrigation

The other principal use of water is for irrigation. Similar to other mid-hill areas of Nepal, people in the watershed area are dependent on agriculture for their livelihoods. The quality of life in these areas has always remained proportional to agricultural productivity and production. Irrigation influences production. Rice and wheat are the main crops grown on *khet*. Rainfed non-irrigated *bari* produces corn, millet, and different kinds of pulses and potatoes. It is the productivity and cropping intensity of *khet* that matter most in the economy of the farm household.

Cha Khola watershed features nearly 15 major streams (*khola*) and smaller rivulets (*kholcha*) that feed the Cha Khola, which drains the watershed. During the dry winter season hardly five streams contain water that can be used for irrigation of crops—mainly wheat. Regardless of elevation there are numerous indigenous irrigation systems built by the local people. The size of the system, in terms of the number of households involved and/or area of land irrigated, varies greatly. The micro-systems involve two to five households and irrigate not more than one hectare of land, whereas the largest irrigation system irrigates 20-25 hectares of land and involves 15-20 households. There is only one externally funded irrigation system in the watershed. This system, namely, the Cha Khola Irrigation Scheme, irrigates more than 150 hectares of land operated by more than 400 households in Nayagaon VDC.

Locally built irrigation systems are operated through oral, collective agreement among users. The technology is simple to the extent that the flow of streams and/or *mul* are diverted through dug channels to fields. No permanent structure of any form is built, Every season when irrigation is required each of the user households participates in cleaning channels and fixing diversions generally by diverting water by blocking the flow of the stream with boulders. Almost all, locally-built irrigation structures are at least two to three generations old. During rainy season when intake and low earth-lined channels wash away in the floods, local users collectively, usually at a rate of one person per user household, repair the system. With all such locally built and operated irrigation systems, the code for sharing water is the same. Upstream farmers irrigate the fields first then lower stream farmers are allowed to irrigate their fields in turn.

In the rainy season, as the volume of water at the source is abundant, the adequacy of water usually does not become a problem. But, during winter when the primary source of irrigation water, i.e., streams, dry out, farmers supplement the water from streams with water from several *mul*. In Naldung VDC Ward No. 8, dependence on *mul* to irrigate wheat crops has given rise to direct conflict with the hotels in Nagarkot that tap and pump out *mul* water in large volumes.

As stated in the earlier paragraphs, none of the locally built irrigation systems has a formal management committee to look after repair and maintenance and operation of the systems. No cases of conflict in sharing of either efforts to maintain the system or use of water were

reported during the field enquiry. Cases of cheating on irrigation schedules were resolved with as tern warning from fellow users. There are two principal ethnic groups residing in the watershed. These are Tamangs and Brahmins, but no variation in technique and/or management system was reported between these two ethnic groups.

Other than numerous mini- and micro-sized, locally built and operated irrigation systems there is only one large and externally funded irrigation scheme in the watershed.

Cha Khola irrigation scheme was previously (before 1986) locally built from a set of smaller irrigation systems. Later, users of fragmented systems came to an understanding to join the different systems into a single big system that would assure an increase in flow of water and also reduce the cost of maintenance. With the promise of procuring external support from Mr. Sailendra Kumar Upadhaya, a politician, local people initiated this new venture. An international Non-Government Organisation, CARE Nepal, was approached. However, a conflict about local contributions arose between upstream and downstream (of the canal) farmers that could not be resolved. Upstream farmers refused to contribute to construction of the entire length of the canal and claimed that water from the existing system was adequate for them. However, downstream farmers badly needed the water, especially for winter crops (principally wheat and vegetables). Owing to the long distance (nearly 9 km) between the intake and the water available for downstream farmers from the existing system, the supply was extremely inadequate. They were, therefore, willing to contribute to the entire length. As the said conflict about the contribution issue could not be resolved, CARE Nepal withdrew. Later the Government gave the money through SINKALAMA for construction of the scheme. All expenses were borne by the Government. Local users did not have to contribute. The conflict was thus resolved. The total budget spent on the scheme was Rs 1.4 million. Currently, the scheme irrigates mote than 150 hectares of *khet* belonging to 400 households in Ward Nos. 1, 2, 3, and 7 of Nayagaon VDC. The total length of the earth-lined canal is nine kilometres.

In 1995, the scheme was formally registered as a users' group. The name of the scheme is Singe Chainpur Irrigation Water Users' Organisation. The 400 user households elect, from among themselves, nine members for the executive committee every second year. The committee has fixed water charges at Rs 600 per hectare for *bari* and Rs 1,200 per hectare for *khet*. The entire length of the canal is cleaned twice a year for the rice and wheat crops. The committee has hired two permanent watchmen to guard the canal and regulate distribution of water to individual fields. Conflicts arising in the operation of the scheme are resolved at committee meetings. So far no conflicts have been reported after formation of the group.

In the watershed, water harvesting in the fields was not a major activity. However, the problem of protecting lower terraces from overflowing water drained from upper terraces was a major activity. This problem is managed by making small outlets at the corners of the fields and on each layer of terraces to maintain a constant level of water in the paddy fields. Usually the water retention bunds for paddy and wheat fields are 15-16 cm and 10 cm respectively. In addition to regular bunding of paddy and wheat fields, local farmers clean the weeds from the terrace walls every year. This unusual practice is carried out to prevent rats from making holes in terraces and hence to check water from seeping out of the fields. The height of the weed-free terrace walls is kept less then 90 degrees to prevent them from collapsing under heavy rain. As new terracing has became prohibitively expensive, farmers are giving more attention to maintenance of existing terraces.

Bunds are also used for crop plantation. Different kinds of legumes and beans, such as soyabeans and black gram, are grown on the bunds of paddy fields. Similarly peas, soyabeans, and masyang (a kind of local bean) are planted on the bunds of *bari* (sloping terraces) with standing maize crops.

Changes in Water Supply and Diversification of Uses

There has been a general increase in demand for water as a result of population growth and increase in farming owing to net addition to cultivated land. Consequently, new water sources are being tapped to harvest water. Also, hotels and resorts in Nagarkot compete with local people for drinking water. Also, because of escalating land prices, many local farmers have sold their land to hoteliers and moved to settle at lower elevations. This movement of people has also changed the demand pattern for water and many of the settlements of Naldung VDC have reported difficulty in obtaining an adequate amount of water all year round. The most noticeable change has been observed in the tendency of people to tap *mul* through polythene pipes. This practice has greatly helped increase the supply of water to homes.

The current effort to build a micro hydroelectric plant is the first major attempt to harvest water on a large scale by the people in the watershed. This project is being constructed with partial assistance from the Rural Energy Development Project of UNDP and with inputs from the local people. After completion, a total of 20.25 kilowatts will be generated. About 125 households (55%) will benefit from this project. Water from the Cha Khola has been diverted to generate the power. These beneficiary households have collectively raised about 40% of the total investment required for the project. This project has been implemented through a participatory approach, and the local community has the final say in all matters pertaining to the project.

Resource Mobilisation in Water Harvesting Management

Generally, in the past, most water-harvesting projects have been developed through the Government or grants made available through foreign-supported projects. One problem with such projects has been poor maintenance. Within the last few years, a new approach has evolved in which beneficiaries have been greatly involved in project design and implementation as well as in sharing the costs of the project. This new partnership approach is showing promise. However, there are variations in the nature of projects developed through the partnership approach, especially in sharing resources between the beneficiaries and the supporting agency.

Maintenance is usually carried out by local people or the beneficiaries who regularly clean, repair, and maintain drinking water sources and irrigation canals. In such cases, local contributions are generally in terms of the labour supplied and generally do not involve any form of cash payment. However, in the case of piped water systems, which not only demand regular maintenance but also require cash to replace pipes and pipe fittings, a management body that is able to raise the funds required for regular maintenance becomes essential.

In the watershed, the source of water to Nayagaon piped water scheme is an old *mul*. The *mul* is well protected and over time people have developed a permanent structure to control seepage and maintain a clean supply of water. Pipes were laid to supply water through three taps to the settlements. The pipes were provided by the Village Development Committee

(VDC). The cash expenses were borne by the people themselves through equal contributions. To oversee the regular repair and maintenance of the scheme, a maintenance committee is also functional. Members of the committee are chosen among the water users. The other piped water scheme is located in Ward No. 2 of Naldung. It serves Rohini and Luha villages. A sum of Rs 30,000 was provided by the DDC through Naldung VDC. A formal committee was formed for its construction. There was no local contribution.

Resource mobilisation and local people's participation in community irrigation systems is similar to drinking water schemes. During cropping seasons, when irrigation is needed, farmers collectively dig small earth-lined channels to divert water either from streams or from *mul* to their fields. Every farmer participates through equal contributions of labour, but there is no permanent body or committee formed in the case of irrigation. Collective labour is solicited as and when needed.

However, in the case of the permanent irrigation scheme (Cha Khola Irrigation Scheme), there is a committee for the regular maintenance and distribution of water for irrigation. This committee consists of members elected from the users of irrigation facilities. Annual water charges of Rs 1,200 per hectare for *khet* and Rs 600 per hectare for *bari* are collected from each user. The committee uses the fund for paying the salaries of two watchmen. Water distribution is based on agreed rules and is monitored by the committee. Upstream farmers get the water first. The scheme was initiated by a politician who was also able to organise the financial resources (through CARE Nepal) necessary for its construction. But the scheme could not take off as local contributions to be shared between upstream and downstream (of canal) farmers could not be agreed upon by the beneficiaries. Later, when a government grant (Rs 1.4 million) was made available, the system was constructed.

Resource mobilisation in the current micro-hydel project is different. The UNDP Rural Energy Development Project (REDP) is guiding local people to enable them to make decisions by themselves on every aspect of project planning, implementation, and operation and management, including fund raising. The guiding principles of the project are based on organising the local beneficiaries, initiating savings, developing skills, encouraging women's participation, and protecting the environment.

After the project's technical feasibility study was completed in July 1997, the DDC chairman, the manager of REDP, and the ward chairman from the project area (Nayagaon VDC) agreed to propose that the local people take over ownership of the project. This ownership involved making decisions about project implementation, distribution, and maintenance and formation of an organisation to undertake the entire implementation of the project. Subsequently, eleven community organisations, (COs), of which six had male membership and the remaining five female membership, were formed in the project area. Each CO looks after a particular type of community concern identified in the REDP principles. All members of the community organisations are involved in some aspect of the project. A management committee, constituted of members of the COs, has also been formed. This committee is the final decision-making authority. The role of local bodies, such as the VDC, is advisory only. The VDC chairperson is invited to the management committee meeting. In CO and management committee meetings, political and personal matters are strictly not entertained. The committee chairperson has no discretionary power whatsoever. Issues, however minor they may be, are brought up in the meeting for discussion. Community mobilisation work is facilitated by a local NGO, stationed in Dhulikhel, under the REDP contract and approved by the local people.

As provided for by REDP policy, 50% of the project cost is provided by the REDP, five per cent each by the DDC and VDC, and the local people have to provide the remaining 40%. Local people have borrowed collectively from the Agricultural Development Bank (ADB) using land as collateral. Landless households have participated by contributing cash or labour. Households' contributions are not perceived differently as contributions by rich or poor or small or big farmers. There is equal participation by all. Landless households who cannot put collateral for the ADB loan have been asked to contribute cash or labour equal to the amount of an individual share of the loan.

Every household will receive an equal number of watts of electricity and will be allowed to purchase a fixed share (but equal) in the project. It is envisaged that income will be generated by selling electricity to the diesel mills, saw mills, poultry farms, milk chilling plant, cheese factory, and households outside the project area.

Institution Building and Conflict Management

The practice of forming organisations to carry out development work is recent in the watershed as in the case of the Nayagaon piped water scheme, the Cha Khola irrigation system, and the ongoing micro-hydel project. Beneficiaries have formed permanent bodies of elected members, developed their charter, and formulated rules. Conflicts arising are generally resolved according to the rules. Special problems are sorted out in periodic committee meetings. Offenders are warned.

There were some cases of conflicts arising in the past even in those schemes that had committees of local users to supervise the construction and distribution of water among participating users. Therefore, what the method of committee formation also matters. As stated earlier, the conflict arising about local contributions between upstream and downstream farmers in the Cha Khola Irrigation Scheme was not resolved, rather the case of conflict itself became redundant when the Government later took care of all the expenses for the scheme. Currently, the scheme has been properly organised. It is now a registered users' group. All 400 user households elect the committee, pass the rules of operation, and resolve conflicts through a previously agreed upon set of rules.

The latest case of conflict was reported in a piped water scheme built in 1998.The DDC through Naldung VDC had provided a grant of Rs 30,000 for the construction of piped water to serve three settlements: Rohini, Luha, and Chitte. As the funds were insufficient to serve all of them, Chitte withdrew from the scheme voluntarily and a committee was formed for construction. The chairman and secretary both belong to Rohini village. The other seven members were chosen from Rohini and Luha. There was no participation of all the potential users. The chairman established the committee and forwarded the names to the VDC. The VDC gave the money to the committee chairman. No permanent reservoir has been made as the intake. The pipe has been inserted into the *mul* located in Rohini village. Two types of pipe were bought – bigger pipes were laid in Rohini and smaller pipes extended down to Luha. The people from Luha report that there is no water flowing to Luha. The committee has not yet presented the statement of expenses to the VDC. There is no formal committee responsible for operation and management of the scheme. As this scheme was officially launched, as per the rules a users' committee was formed, but the transparency was absent.

The other case of conflict reported was about the increasing use of water by hotels and shortage of water for irrigation. There are 37 standard tourist hotels, all pumping copious amounts of water from nearby *mul* up to the hotels. As reported by local people, this has

greatly reduced the flow of water from the lower *mul* once used extensively for irrigation in winter. Besides open drainage of waste water people complain that the hotels have polluted the *mul* used for drinking water. Naldung VDC has formed a Public Property Protection Commission and has sent written complaints to hotel owners. There has been no response yet. Hotel owners claim they have pumped water from *mul* that belong to their property. Local people disagree. They argue these are public lands encroached upon by the hotel owners. The conflict has not been resolved.

Some years back, a conflict had arisen about the right of way to lay pipes for bringing water to a lower elevation settlement above Singe Village through a village. Pipes were laid across private land and the owners opposed this. As this village had its own drinking water source, owners had no incentive to allow the use of their land. Users of the intended scheme had not devised any compensation mechanism, from our impressions, they did not have any intention of doing so either. In addition, the money spent on construction was also not collected from users. It was provided by the Government. The project was abandoned in the absence of a resolution to the conflict.

The ongoing micro-hydel project is the most elaborate and transparent undertaking in the watershed. Its managing committee foresees likely areas of conflict and ways to resolve them through its eleven community organisations. Transparency and accountability are the necessary preconditions to minimising chances of conflict, and both are pronounced in this project.

Women's Empowerment

Of the 11 community organisations, five are women's organisations in the hydropower project. Women's participation in this project is direct, and they are involved in decision-making, according to both the men and women contacted during our field visits. In other schemes, women's participation was limited to fetching water, and their opinions and judgements were seldom heard. Recently, the Red Cross has provided money to construct another piped water system in Nayagaon. In this scheme women participate on an equal basis.

Issues

If properly harvested, the supply of water in the watershed should be adequate to meet the needs. During the rainy season, a number of *mul* spring up from which water is harvested. In higher elevation settlements, such as Naldung, water scarcity is relatively more pronounced, but it cannot be said to be in short supply. The problem with these settlements is that villages are scattered. However, with proper management, supplies can be improved.

Nagarkot, the popular tourist resort, is located at the highest point in Naldung VDC. All the settlements and agricultural fields are located below Nagarkot. There are presently 37 tourist hotels in Nagarkot. This is the development that has taken place over the last 15 years. All hotels have installed their own water pump-sets to lift water from privately built water reservoirs located on the slopes above the settlements and agricultural terraces. Most of the reservoirs are fed water from *mul* located on land owned by the hotels. During the field visits, pump-sets were observed to be running for more than 12 hours a day. Heavy pumping of water up to the hotels has given rise to complaints from the local people.

People complain, for instance, that owing to the large volume of water pumped up from the *mul*, the lower *mul* used by local people as sources of drinking water and irrigation either completely dry out or the volume of water decreases significantly during the dry season. The case of Chandra Surya Tole, a settlement just below Nagarkot, illustrates this claim. A stream called the Danda Thumka Kholcha is the principal source of water for irrigation for the winter wheat crop grown on 20-25 hectares in Chandra Surya Tole. Local people reported that, 10 to 15 years ago, the flow of water from Kholcha was sufficient to irrigate the wheat crop. Now the flow of water has decreased greatly creating a shortage of water for irrigation.

The other complaints against hotels concern the waste water discharge from hotels to open slopes, polluting drinking water sources located along the lower slopes and their illegal encroachment on public fallow land, depriving local people of use—particularly for grazing livestock.

Local people formed a body through Naldung VDC in 1997 called the Public Property Protection Commission. It wrote letters to hotels to draw their attention towards rampant pumping of water, open discharge of raw sewage on to slopes polluting drinking water sources, and encroachment on public land. The Ward Chairman of the settlements concerned stated that they have not received any response from the hotel owners yet.

3. External Interventions and Impacts

Interventions

Chronologically speaking, the history of external intervention into local water-harvesting systems in Cha Khola watershed dates back to 1977/78 when the then District Panchayat provided a small grant to construct a piped drinking water system for 36 households in Nayagaon settlement of Nayagaon VDC as reported in the earlier section. This system is working well to date even without a formal management committee, without any conflict. A bigger scheme for irrigation, which was initiated in 1986, failed as a result of conflict about local contributions from upstream and downstream farmers. As mentioned earlier funding was promised by CARE Nepal, but the conflict could not be resolved. CARE Nepal withdrew from the venture and, after a couple of years, the Government bore the entire cost of the scheme (which made the conflict redundant) and the scheme is now operational.

The other government scheme for piped water supply for the people of Rohini, Luha, and Chitte of Ward No. 2 of Naldung VDC in 1998 was another example of government intervention giving rise to local conflicts, as mentioned already.

The latest outcome of external intervention, as mentioned earlier, is a UNDP aided micro-hydro electricity project located in Nayagaon with local contribution of 40% of the total project. The remaining 50% has been provided by the UNDP and the remaining 10% by local bodies. As the local people were consulted extensively right from the planning stage and involved in decision-making at all stages, it has been successful and the plant is now operational.

Impacts of Intervention

External intervention in local development areas has both desirable and undesirable impacts. There is no denying the fact that know how and materials to build infrastructure are

most often beyond the reach of the local community. Over a couple of decades, a significant number of people in rural areas gained access to piped drinking water. This could not have been possible in such a short period of time without injection of external funds. Similarly, external assistance in small-scale hill irrigation schemes has made a significant impact on agricultural productivity and cropping intensity in irrigated areas. These changes have had direct benefits on the local economy. Similarly, due to external intervention in Cha Khola irrigation scheme, where two rice crops and one wheat crop are grown, the tendency of the local farmers to keep buffaloes for milk production is growing. Buffaloes are stall-fed and need plenty of rice straw as feed. Currently, the Cha Khola irrigation command area has the greatest number of buffaloes. Although favourable markets and accessibility also matter, there appears to be a noticeable impact of irrigation schemes on the local economy.

Government and, lately, non-government organisations have played a major role in building infrastructure and providing public services - education, health, and agricultural inputs. External interventions in local water harvesting have focused on developing piped drinking water and irrigation systems.

Such external intervention in local water harvesting has reduced significantly the amount of time needed to fetch water. Previously it used to take on average 30 minutes to fetch a bucket of water in Nayagaon, whereas now the time taken is five minutes.

Such impacts are not reported and observed in other settlements, as these settlements do not have either piped water or irrigation systems. Again, local topography and ratio of *khet* to *pakho* area might have played an important role, besides the lack of these services.

The most undesirable impact of intervention is an increased dependency on external support for local water harvesting. In settlements located in Naldung there are potential sources of water for piped schemes. As external agencies have not come up with the funds, such schemes have not been implemented.

Although it is premature to evaluate the impacts of the micro-hydel project, the likelihood of undesirable impacts is minimal. External interventions and community initiatives and efforts are neatly blended to dispel undesirable impacts. Women's empowerment has been fully promoted in this project.

Comparative Analysis of Different Systems

External interventions through government and NGO involvement in water harvesting in the watershed area have played different roles. Although the end product may be the same, the *modus operandi* adopted in carrying out the work appears to have influenced local attitudes and knowledge. Most of the government undertakings have been in the pattern of 'come, build, hand over and go' Local people's interests and capacity to assume responsibility were seldom incorporated into the planning process. The Cha Khola irrigation and Rohini piped water schemes illustrate this. Success in terms of physical completion of the project sufficed with little regard paid to operation and maintenance. The Government avoided resolving disputes between farmers, as the dispute about cost sharing did not arise since funding was given entirely by the Government. Government line agencies and personnel were insensitive to the local people's needs. In other words, on the one hand, inherent issues were left unattended and, on the other, dependency on external interventions further deepened.

Non-government organisations are recent entrants on the scene. Equipped with increasing support from international agencies the NGOs are intervening in rural work, including harvesting of water for domestic as well irrigation uses. Their approach was observed to be different from that taken by the government agencies. Local people were involved in identifying their needs and preparing them as partners in all aspects of projects, right from the very conceptual stage. Local people are asked to contribute only after their needs are identified and, furthermore, they are assigned the task of managing the project, including operation and regular maintenance work. NGOs do not compromise on these principals. The withdrawal of CARE Nepal is an example.

The success or failure of schemes supported by NGOs thus correlate with the degree of institutionalisation taking place. The UNDP supported micro-hydel project in the watershed area is making efforts in this direction. The whole community has been made responsible for making this project a success. Despite the fact that a significant proportion of the costs has been funded by the UNDP, it has succeeded in remaining in the background.

4. HUMAN AND INSTITUTIONAL CAPACITIES

Human Capacity

Human capacity is positively correlated to knowledge and skill, which emerge when proper opportunities are afforded to them. In this respect, basic education is the fundamental precondition. Although the average literacy rate in the watershed is above the national average, the distribution of literate population in the area is extremely skewed. For example, the literacy rate in Nayagaon and Rohini is unusually high at 85% for men and 70% for women. Yet, in Naldung VDC the literacy rate for men is as low as 15% and 2% for women. In this VDC the total number of high school graduates does not exceed 10. In Chitte, a large settlement in Naldung VDC, the Red Cross began to run literacy classes for local women in 1998.According to their rules, the Red Cross wanted to hire a local SLC graduate teacher for the class. It could not find one in the whole of Naldung VDC.

When opportunities were made available to local people they demonstrated their capacity for development. As a matter of fact, external interventions in terms of technology and financial assistance in local water harvesting are also concentrated in a few localities. Out of four externally aided schemes, three of them have been introduced in Nayagaon and the fourth, which received a grant in 1998, is being implemented in Rohini. As stated in the previous paragraph, these two Brahmin communities have an unusually high literacy rate.

In Naldung VDC, even given a low literacy rate and absence of external assistance, local people have developed piped water schemes with their own money. Most of the homes at higher elevation have piped water for domestic uses. There are also numerous indigenous irrigation systems where coverage varies from four to five to 20-25 households. The people of Naldung have demonstrated their skills in tapping springs to bring piped water to their homes.

When opportunities are given local people have demonstrated their ability to exploit and get benefit from them. With the opening of a market for milk, local people have raised milk production to the extent to which they can afford to do so and in line with access to the resources required. Milk production is becoming one of the dominant features of the local rural economy. How people perceive the value of harnessing or exploiting any given opportunity largely determines and demonstrates their willingness and capacity for change or development.

With respect to institutional capacity, the Cha Khola irrigation scheme has been managed over the last few years by the local people through a user group. Local people have been able to demonstrate their capacity to organise and manage themselves to carry out tasks that will benefit them. The case of the micro-hydro project is by far the best demonstration of local people organising themselves to carry out a complex task of implementing the entire hydropower scheme. There has been external support in this context. Through UNDP-REDP, motivators were provided to interact with the local people to begin the process of organisation. After lengthy interactions, local people were motivated to organise themselves. Without their active participation, the hydropower project would not have been forthcoming. This case demonstrates that, with some external help, local people have the capacity to not only organise themselves, but also to execute a complex project such as the micro-hydel project.

Group Action and Management

Group action is part of local culture, as demonstrated by the building of canals and small irrigation schemes that generally do not involve cash investments and are manageable through local skills. Users were made to contribute labour. Rules are made and a system for regular repair and maintenance is established. Usually, some kind of managing body is also established which is dominated by the village elite and, lately, by members of the local political body.

Over time, however, beginning with government initiatives in local development, local contributions and active participation of the local people were gradually minimised as projects were funded and developed by the government. This situation eroded active, local involvement in development activities. More recently, with a change in the political system, NGOs have attempted to rebuild the old group culture. Modern concepts of management, particularly formation of committees, election of committee members from among users or beneficiaries, record keeping, decision-making, preparation, and finalisation of operational rules have been introduced. This is not to say that the modern system of management was imposed upon the local people. More or less informal methods adopted through group mobilisation have been formalised and recorded. Introduction of newer procedures of management are intended to streamline group actions, and these appear to be gaining ground, as witnessed in the case of the ongoing micro-hydel project. Local people's support to and cooperation in this style of management reaffirms their old attitudes about group action.

5. Local Experiences and Implications for Policies on Water Harvesting and Their Impacts

Impact of Policies on Water Harvesting

There are no government policies on water harvesting as such,[2] but several policies with a bearing on water harvesting are in existence. They are sector specific and are codified in Acts and policy statements. Some of the key policies are discussed below, tracing their impacts on water harvesting at local level, wherever relevant.

[2] The Ninth Plan has stated in its irrigation policy that water-harvesting techniques will be tested on a pilot basis to irrigate areas where surface water and groundwater are not available, by storing rain water. The latest policy statement issued by the Ministry of Housing and Physical Planning has also included, under its working policies, the use of water-harvesting methods for supplying drinking water.

Water Rights

The Water Resources' Act, 2049 (1992), which governs the use and development of water resources throughout the country, has established that water is state property, and individuals and community groups will have usufructory rights. Only in the broader national interest can the State revoke users' rights. Three top priority uses prescribed under the Act are drinking water/domestic uses, irrigation, and agricultural uses for livestock and aquaculture. The Act does not require the registration of the customary rights of the existing users. Largely, the Act is favourable to local water harvesting. Although the Act has not resulted in the expected behavioural responses in terms of tangible action (except the micro-hydel scheme being implemented) in the watershed, the local people, particularly those who frequent district headquarters/capital and interact with officials, are gradually becoming aware of the provisions of the Act.

Water rights are an area of concern for local people. This is because, in particular, they have small schemes based on local water sources in the watershed, and these small schemes are not normally taken into account by government development agencies. With external intervention, small schemes are often destroyed and their interests are subordinated to the requirements of large-scale development.[3] Indeed, the local people had problems in the past when an external agency (Department of Irrigation through the ADB-financed SINKALAMA project) tried to reallocate water with a project intervention. They, therefore, value the provisions contained in the Act relating to the protection of the customary use rights and exemption from registration of such rights. Their willingness to invest in the micro-hydel project in the watershed reflects the measure of confidence that the local people now have in their use rights.

Conscious of the difficulty of resolving water-related disputes in the past, they were also appreciative of the provision for a formal dispute settlement mechanism. The Water Resources' Committee at the district level, consisting of a Chief District Officer as chairman and a representative of district irrigation, district water supply, District Development Committee, and so on can decide in the cases of water-use disputes, on the basis of the priority order, the beneficial use or misuse supported by necessary enquiries and investigation.

Water Users' Association/Local Participation

The Water Resources' Act 2049 (1992-3) provides for the formation of the Water Users' Association (WUA) as a legal body: Individuals interested in using water resources in an organised way for communal benefits can form a WUA, as prescribed. The Irrigation Policy (1992) prescribes that the structure of WUA as a legally recognised body, with perpetual succession established and managed by the user farmers for irrigation, with due recognition under the Water Resources' Act 2049, shall be based on the nature and extension of the irrigation system. There shall be at least 20% female users in all the executive units of the WUA. The formal registration of such a WUA should be carried out before the implementation of a project (the Water Resources' Regulations 2050 have laid down a procedure for registration). Similarly, the Water Supply Policy 2054 (1997) has spelled out

[3] There are no cases of destruction of small schemes as such. However, the local people are fully aware of and apprehensive about the potential dislocation that can be caused to their systems by intervention. In course of the discussion, they narrated how protracted the negotiation among the stakeholders was that preceded the co-option of a series of small schemes at the head reach on to the Cha-Khola irrigation as part of system consolidation and extension.

the need to involve autonomous WUAs and local agencies in the planning cycle as well as in the operation and maintenance of water supply schemes. There is, however, no such provision in the case of micro-hydel schemes.

It is increasingly recognised that WUAs/community organisations are a viable institution for the management of common property resources. Empowerment of WUAs by conferring legal recognition would greatly help these organisations to grow institutionally, enabling them to establish formal relations with government agencies, donors/INGOs, and financial institutions. A strong and functioning WUA attracts the direct representation of local people, motivates them to actively participate in decision-making, distributes benefits equitably in a transparent and participatory way, generates a sense of ownership, and eventually produces improved system performance.

In the watershed, there are a number of community organisations (of very informal nature as discussed earlier), and only a few of them are organised. The more organised ones are Cha Khola Irrigation Association, Cha Khola Micro-hydel Users' Association, Rohini Water Supply Users' Association, and Nayagaon Piped Water Supply Users' Association. They have been operating and maintaining local water-use systems, mobilising resources (cash to pay for watchmen and labour for cleaning canals, removing landslides, and so on), settling disputes among members, and holding elections and conducting meetings of members for decision-making. However, the local people reported that the performance of community organisations is not satisfactory, more so in the externally-assisted schemes (the micro-hydel scheme is an exception).[4] Except one (Cha Khola Irrigation Association), these organisations are not legally recognised as they have not been registered with any agency. In the micro-hydel project, the functional group is readying itself for the registration as a cooperative/NGO (because, as noted earlier, legislation has not prescribed any mechanism to register the micro-hydel group). They have already prepared/drafted a memorandum of understanding and bye laws required for registration.

Policy Incentives

The Hydropower Development Policy 1992 has exempted micro-hydel schemes (defined as having a capacity of up to 100 kW) from the licensing and notification requirements. According to the policy document, no license shall be required to operate a hydroelectric project with a capacity of up to 1,000 kW and only for projects in the capacity range of 100 – 1000 kW; and a notice with necessary particulars should be given to the agency concerned before commencing work. The government has also extended financial incentives to micro-hydel schemes, through financial institutions, in the form of a capital subsidy of 50% of the electrical and mechanical costs of a scheme.

[4] When asked to elaborate, the farmers explained that, despite the existence of groups, the members with locational advantage receive precedence over others, and they also have to guard personally, even during the night, against water theft. However, they admitted that such is the case only during water scarcity or drought, which, incidentally, occurs infrequently in the area. Water scarcity in the area mainly connotes delayed rainfall, which reportedly occurs once in three or four years. Still farmers are sensitive to it because, due to intensive (three crops) cultivation, the timing of rainfall is very important for them. So, in point of fact, because of it being an infrequent event with uncertainty of occurrence, there is no incentive for the groups to establish elaborate organisational rules and practices. As reported, they sometimes even resolve disputes by resorting to altercation and muscle power. However, members in small schemes normally being from the same clan, it does not leave lasting impact or bitterness. In the assisted schemes, on the other hand, performance of community organisations has suffered largely due to i) lack of transparency, ii) absence of democratic decision-making, and iii) no users' contributions.

Similar incentives are also provided to irrigation and water supply schemes. The current subsidy rates, as laid out in the Irrigation Policy 2049, range between 60–95% of capital costs depending on irrigation types and development modes (excluding private schemes). In the case of rural water supply, the government policy is to recover at least 10% of capital costs (i.e., the capital subsidy is not to exceed 90%). The government has also been providing subsidies to individuals/groups for the construction of dug-wells and ponds/storage tanks. As a policy, however, the government intends to phase out or gradually reduce the level of subsidies. The expectation is that the reduction/removal of subsidies could improve, among other things, resource allocation at both the budgetary level and at the local level.

To a certain extent, the policy incentives are instrumental in arousing local interest in the micro-hydel scheme and stimulating active participation of the local people in the planning and implementation of the scheme. This scheme is, indeed, an example that demonstrates that subsidy, when combined with other essential elements of project intervention, can make a difference. It can be an effective means of leverage on community resources for local development.

In the other assisted schemes (e. g. , Cha Khola Irrigation Scheme, Rohini Water Supply Scheme, and Nayagaon Piped Water Supply Scheme) however, where the agencies had borne almost the entire cost of construction, excessive subsidy has had rather dysfunctional effects. Strong users' associations have not evolved in these schemes and, as a result, these schemes suffer from the problem of free riding, upstream and downstream conflicts, and the issue of sustainability. Lack of proper maintenance is showing in low levels of service and system breakdowns. What is worse, the people seem to have developed a dependence on the external agency. All this indicates that the beneficiaries have not attached any substantial economic value to these services/schemes. Probably economics did not enter into selection decisions about these schemes. With subsidies covering full costs, agencies and users will not be concerned with the financial viability of a scheme.

Local Experiences and Their Implications

Water Harvesting Practices

As discussed earlier, some simple water-harvesting technologies are in use in the watershed. They include the rooftop harvesting system, terracing/bunding of farms,[5] ponds/tanks, ponds/tanks with pumping,[6] dug pit, spring development, collection/re-use of runoff from field drains, piped water supply, canal irrigation, and micro-hydel schemes (the latter three

[5] In the watershed, farmers have employed terracing techniques very extensively to harvest available water; even steep hill slopes are level terraced. Narrow terraced strips of from 6–8 ft, with a terrace height as high as 8–10 ft, are commonly found. Taking advantage of widespread water sources, farmers have converted sloping terraces (*bari*) into bunded fields for the cultivation of paddy, one of the crops that requires most water. Bunded terraces have proven to be an efficient way to capture runoff/rain water, and they are, in effect, the indigenous structural techniques for soil and water conservation in the hills and mountains. However, because of the high cost of terracing, farmers have not been constructing new terraces and are only maintaining the existing ones. If terraces are not properly maintained, particularly those that accumulate a high concentration of water, structural failure can take place. It also must be recognised that the cost of maintaining terraces too is high.

[6] To give a few examples, a resort hotel (out of some 37) in Nagarkot with 34 beds consumes, on the average, around 5,800 lt of water daily. It has constructed a concrete tank of 25,000 lt in capacity to collect water from a spring inside its own compound, and the water collected is pumped to an overhead tank. According to the hotel management, the water supply is sufficient to meet the guests' demands for eight months, and they face water shortage only during four months: September–December. In these deficit months, particularly when occupancy rate exceeds 80% or if there is a large conference, they even have to buy water in tankers from

based on diversion of rainfed rivers and springs). All these systems tap rain water and store it in drums, tanks, farms, and also within the soil profile on an hourly, daily, or weekly basis (long-term or interseasonal storage was not seen). The catchments of these systems are rooftop, agricultural farm, and defined areas from which rain flows into the springs. The Cha Khola and its tributaries up to the point of extraction; catchments of most of the springs, and rivulets are reportedly small and largely common property areas.
Barring a few externally-supported ones, these water-harvesting systems are low cost, simple, and extremely easy to manage and maintain. As reported, the majority of the systems are seasonal, and the externally supported ones run all year round. However, alternative sources further afield are available for drinking water. Drinking water is collected mostly by women/girls from springs or other sources in Gagri and takes on average, half an hour (varies seasonally). Wherever possible, individuals or groups of households have used polythene pipes extensively to bring water to their homesteads. Water is only sold in the market area (local shopkeepers reported paying Rs 10–15 for a 40-litre container; and these small shopkeepers harvest water from their rooves). The local people, in general, and those on the Naldung side, in particular, are not sanitation conscious. In fact, a water supply scheme aided by UNICEF[7] mainly to create awareness of sanitary practices had failed to accomplish the intended objective (it is learned that the services of two female workers employed in the initial stages to keep the surroundings of the water source clean were terminated after six months because of lack of local financial support, and recently the *Samaj Sewa Samuha* of Kuntabesi is becoming involved in activities in sanitation awareness).

Clearly, the local people's choice of water-harvesting technologies is basically driven by economics; unless they perceive real value for their efforts, they will not go for it. External intervention to be successful should, therefore, create value, as perceived by the local people. In point of fact, local people in many places do not see much value even in the intervention that seeks to provide assured water supplies.[8] This is mainly for two reasons: availability of alternative local water supply and general lack of awareness about sanitation. So it is more a question of costs (maintenance and organising costs only because investment is free any way) in relation to perceived/realised benefits. Nevertheless, the micro- hydel project appears to have succeeded in creating a perceived value for its product. The measure of the value can be judged from the fact that people really fear the prospect of

Kathmandu (a 12,000 lt tanker costs around Rs 5,000). When asked why they are not considering roof-top water harvesting or runoff harvesting instead of paying such a high price for imported water, the management explained that they have surplus water during June, July, and August in the existing spring itself, which they can store by having bigger or additional tanks. It is not necessary for them to go for other alternatives. However, they have not been doing so because the hotel occupancy rate during those months has not steadied at the threshold level, and therefore outsourcing of water is still a better option to bridge the occasional demand-supply gap. Similarly, one other hotel is meeting its water needs by constructing a water tank on public land (actually, there is confusion as to the exact status of ownership of this piece of land, and the hotel owner has reportedly not paid any royalty to the government) and pumping water from the tank to the hotel situated uphill. The current arrangement is that water is collected from the spring during the night and in the daytime the spring water is used by local inhabitants for washing and other purposes. As reported, there has been no conflict over water use.

7 This scheme was not discussed earlier because the scheme falls outside the watershed though it is in Naldung VDC.

8 For example, with regard to the water supply rehabilitation/augmentation scheme recently initiated by the Red Cross in Ward 2 of Nayagaon VDC, a number of sceptics were found who genuinely believe that people may not participate and hence the scheme is not worth the effort because the targeted beneficiaries already have access to drinking water. The Red Cross has reportedly multi objectives including improvement of sanitation.

exclusion from the beneficiary group.[9] It is to the micro-hydel project's credit that it managed to identify and cater to the local people's felt needs. Local people are seen to have attached greater importance to electricity for lighting houses (saving of kerosene), viewing TV/movies, listening to radio (replacement of battery), and for children's education, i.e., reading/writing during the night. They also see earning opportunities by selling electricity to grain and saw mills, cheese factories, or any other industry.

It is also a fact that apparent abundance of water does not preclude the use of water harvesting; it simply demands as much additional effort to find sites/techniques that create value. Neither water shortage or seasonal gap is automatic justification for water harvesting. The downstream farmers of the Cha Khola irrigation system, for example, found it more remunerative to maintain the system by themselves rather than having their own separate water-harvesting/storage scheme to meet the water shortage during the season.[10]

To many in the watershed, water harvesting means making full use of 'available' water in the most cost-effective way. Given the choice, they also seem to prefer small catchments or local sources for water harvesting to be able to exercise collective/individual control over the entire system (seen were cases of afforestation, to protect catchments of water sources, and preventing people from defaecating near sources used for drinking water). This preference for 'local' is also a manifestation of their desire for low costs, predictability of supply (source fully understood), and ease of management. The micro-watershed approach to the study and promotion of water harvesting at the local level thus seems to fit in well with the local concept of water harvesting.

Local Management Systems

The management systems prevalent in the area range from simple household collection arrangement in case of rooftop harvesting system to a rather elaborate system managing interpersonal relations (among 121 beneficiaries households) and agency-users' coordination in the micro-hydel scheme. However, the dominant pattern is 'informal' management or working arrangement.[11] The key characteristics of such management practices, as understood from the field interview, are flexible organisational arrangements, a committee style of decision-making, management control largely reflective of local social hierarchy/relations, rules and sanctions grounded in customary practices and local values, information flow by contacts/word of mouth, coordination by mutual understanding and interaction, work allocation/delegation by convenience and capability, overlapping/ multiple responsibilities of members, voluntary nature of work, seasonal or intermittent activities,

[9] To give one instance, recently, when the ADBN local office declined to release a loan (and associated subsidy) to the project on the grounds that some of the beneficiaries had overdue personal loans, the users' association issued a notice to the defaulting members that they would be denied electricity unless their dues were cleared by the stipulated date, and they reportedly cleared them.

[10] The farmers at the tail-end of the Cha Khola Irrigation Scheme frequently face difficulties in channelling water to their area and also have to bear a disproportionate share of system maintenance. Technically speaking, they can have their own alternative system to irrigate their *bari* by, say, constructing a community pond to capture rain water. They have not done so, however, and instead preferred to stick to the Cha Khola Irrigation Scheme. They must have found the *status quo* more cost effective.

[11] These organisations are visible and activated only when there is action or a purpose to be accomplished. There is no set rule for regulating the relations between members and their activities, and working procedures can be changed with mutual understanding to suit the new needs and conditions. Even the more organised Cha Khola Irrigation showed flexibility by co-opting new members and becoming a larger association than the original small group. That these organisations, in whatever forms, have endured the stress and strain of time indicate their strength and adaptability.

dominance of interpersonal relations, preponderance of group action, leadership by performance or political/external links, and social accountability.

While this management style has its own strengths, it has some in-built disadvantages. As reported, these organisations do not always operate fairly and in a participatory mode; some are actually monopolised by the local elite. Given the local environment characterised by social and cultural heterogeneity and rife with political rivalries and caste conflicts, [12] local disputes frequently spill over into organisational performance and outcomes. To a great extent, the local politics is an extension of the rivalry among political parties and interest groups at the national level. It is basically a quest for grass-root control over resources, institutions, and vote banks to wield political power for their own or group ends. More often than not, deliberate actions are required to break the existing nexus and to steer clear from local politics. The micro-hydel project has done this tactfully, [13] through an extensive programme of training, consultation, and exposure, as seen in its success in bringing local leaders of rival political camps together in the organisation (one as chairman and another as manager). The project has also managed to make the organisation broad-based and transparent through, among others, a deliberate process of one-and-all participation, inclusion of female members, and regular mass meetings.

Another weakness of these community organisations relates to their unfamiliarity with accounting, record-keeping, and banking practices. For that reason, they often face difficulties in handling large amount of funds and, sometimes, also in maintaining financial integrity[14]. They also find it difficult to meaningfully interact with a formal system or external agency (notwithstanding the fact that they treasure near-complete information about the local environment). While this emphasises the need to impart fresh skills to the local people, this also calls for a different management style and intervention strategy on the part of the development agency. In fact, the apparent success of the micro-hydel project can be attributed to the fact that they internalised this reality, tailored their approach to the local needs and capabilities, and oriented their field staff, particularly the group organisers, to be people-friendly.

Customary Water Rights

The local people have been exercising their customary water rights over a very long period of time. The customary rights in the area are based on the principle of prior appropriation which means that older established rights have precedence over new rights. This is normally operationalised by denying the right to extract water from any point within 500 metres

[12] To give an example of the extent of political rivalries, an ailing Tamang teacher was socially ostracised by a section of his community loyal to the rival political party on the grounds that he took drinking water from a lower caste Damai, and this dispute went to the supreme court. This also indicates the strength of social sanctions in the area.

[13] Strict adherence to the REDP organising ground rules: 'no personal matters and no political matters', 'no scheme unless all-inclusive organisation' and the leadership and political neutrality of an NGO as a group mobiliser stand out as the key factors for bringing the rival political factions together. High perceived value of the project output, REDP's demonstrated success in other parts of the district, and waning political interest (a local leader stated that the people are gradually realising the futility of local in-fighting as no parties are seen to deliver the goods) also facilitated creation of the right atmosphere for concerted action.

[14] In the Rohini Piped Water Supply Users' Group, for example, it is partly because of unfamiliarity with the accounting that the only statement of expenses the group has maintained is a pipe purchase bill for Rs 12,000 (out of Rs 30,000 of reported total expenses). Similarly, for the same reason, a sense of misgiving is brewing in the group savings' scheme under the micro-hydel project regarding the use of members' deposits when the total has not even exceeded Rs 10,000.

upstream from the existing water diversion point/delivery system. [15] In the case of Cha Khola, a dispute arose in 1992 between the upstream and downstream farmers even beyond the above limit. [16] The dispute was finally resolved after the upstream farmers agreed to replace the permanent structure with a temporary diversion, assuring the existing lower system of adequate water during the dry months. This dispute was basically arbitrated by local people: senior/respected citizens and community groups. This case goes to show that local people have indigenous dispute settlement mechanisms (which at times may seem unnecessarily protracted).

Investment normally entitles a person to customary water rights. Irrespective of social status, if someone has contributed to the creation of assets, he/she will have access to the assets or the benefits resulting from the assets thus created (though access may not be equitable). The farmers downstream in the Cha Khola irrigation system, for example, have the social legitimacy to direct the canal flow to their area (of course with night watchmen in different places) because they have been investing in the maintenance of the system. Part of the confusion over the Chhap Raniban water supply scheme (this scheme is not within the watershed) is also investment-related: the ownership of the system is not clearly defined. The agency left after completing the project without handing it over to the District Development Committee or the local beneficiaries. The lessons that can be learned from these cases are that (i) users' contributions should be encouraged in the broader context of reinforcing their right to benefit or to broad-based benefit sharing and (ii) transfer of ownership or handing over of systems should be an integral part of the project cycle.

Interdependency of Resources

The local people are increasingly appreciative of the interdependency of resources. It has dawned on them that depletion of one resource has corresponding negative effects on others, and that managing the links across resources and property regimes is essential for sustainability of benefits. This was, indeed, a time tested wisdom which they have relearned in recent years. They learned from their recent bitter experience of the seasonal drying up of water sources caused by deforestation of catchments (as mentioned before, drying up of water sources in Naldung is also partly due to overexploitation by hoteliers in Nagarkot). To recharge the springs again, they have now afforested and protected large parts of the catchments; and this is the case particularly in the small catchments feeding their main drinking water sources.

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15 Such customary rights, however, do not exist in relation to subsurface water. It is therefore the downhill farmers of Naldung who are dependent on seepage water fed by springs uphill that are finding themselves helpless in protecting their interests in the face of a score of hoteliers in Nagarkot trapping and using up almost all the nearby springs for commercial purpose. The seriousness of the situation can be gauged from the development of the Public Property Protection Commission under the aegis of the Naldung VDC formally protesting against the hotel managements' misuse and monopolisation of water.

16 The dispute started when the Department of Irrigation came to develop/extend the Cha Khola Irrigation system with a permanent diversion structure. As the stakeholders, the beneficiaries of the Cha Khola Irrigation, the users of an existing downstream scheme (which does not fall within this watershed), and SINKALAMA project staff were directly involved in the dispute. The downstream farmers were against the complete damming of the Cha Khola insofar as it would adversely affect the flow feeding their system, particularly during the lean season. This dispute lasted for over a year and was finally resolved through several rounds of negotiation after the Department of Irrigation and the farmers of the Cha Khola Irrigation agreed to build a previous construction across the Khola for water diversion. Many influential people, including the local politicians and departmental staff, contributed to the resolution of the dispute. The spinoff from this dispute is the reinforcement of customary water rights, even in the modern context, through agency intervention.

On a broader level, this new development represents the revival of the tradition of maintaining common property. There were examples of local people giving up their private property for common goods. A landholder in Nayagaon VDC, for example, had contributed a piece of farm land on which a spring was located for community water supplies and had instructed his family members not to cultivate that portion of land. This water supply system has been running for several years, serving more than 30 households in the vicinity. In general, the local people believe in common property management regimes, partly because the local community schemes are small and membership boundaries can be well defined and cost of cooperation for individuals is not high. Capitalising on such rooted local values, the micro-hydel project is promoting functional groups for different resources (e. g. , a forest functional group, energy functional group), with the long-term view of creating interlocking institutional arrangements for managing interdependent resource systems.

Development/Change as a Process

Though seemingly risk averse, the local people are not wary of change. They have been taking initiatives and also cooperating with external agencies (though in varying degrees). They, however, go through rather a long process of consultation, evaluation, internalisation, negotiation, and adoption before taking action or participating actively. This process can be facilitated by external inputs, particularly of hardware, but cannot be drastically shortened. External intervention that seeks to cut short this institutional process does so at its own cost. The case of Cha Khola Irrigation illustrates this point.

Originally, Cha Khola Irrigation was a small community-managed scheme. CARE Nepal (INGO) had tried to extend the system in 1985. After protracted negotiations, this attempt was, however, aborted because of the lack of consensus between the upstream/headreach and downstream/tail-end farmers about the amount of their contribution. Upstream farmers were opposed to a uniform rate of contribution by all farmers and some of them even refused to contribute at all. As an acceptable formula could not be determined, CARE Nepal, which places great emphasis on farmers' participation, withdrew its support from the project. Subsequently, a government agency (the Department of Irrigation) intervened with a large amount of donor funding to finance the project almost entirely. The financial incentive or gift that the agency provided helped all the differences disappear, cutting short the project development time. But the project could not reap the desired benefits, and it is being sustained largely by the downstream farmers (made possible by the fact that the system is reasonably stable, entailing low maintenance cost). The lessons from this kind of example appear to have been learned by the Micro Hydel Project which does not have time-bound disbursement or physical completion targets.

Assimilation of External Inputs

The local people have demonstrated their capacity to assimilate external inputs and technologies. The degree of assimilation, however, depends largely on the value of inputs. If the people perceive value, they are ready even to accept the apparently complex schemes as micro-hydel. By and large, there is willingness to contribute and acquire skills for managing the innovations. In fact, 'people's contribution' is invariably the true measure of the economic value of intervention for the local community. The agency-financed water supply schemes in the watershed, for example, are not being properly maintained (even the one implemented by a NGO outside the watershed) largely because they are not demand-driven and, consequently, local people have made virtually no contribution to their implementation. On the other hand, there are instances (in the district) of local people

taking over agency implemented schemes in which they see tangible gains (but such a take-over may not be equitable compared to the managed hand-over).

Coping with Emerging Adversities

Although the assessment is preliminary, it appears that the local people have been coping with the emerging adversities reasonably well. They seem to have indigenous coping strategies, both at the household and community levels. The local people have generally exploited available opportunities, managing whatever limited productive assets they have for securing and stabilising income. There may be a variation in the strategies of the poor from those of the non-poor in that the former makes use of inferior options most. But the point is that even the poor have all along been coping with the problem of scarcity and deprivation through household adjustments (in terms of consumption, savings, and employment) and community actions.

Some people reported that they resort to seasonal migration and dis-saving or sales of assets to make ends meet. The reporting households have large (above average) family sizes and high dependency ratio. As mentioned earlier, the local communities embarked on collective action to protect their water sources. In fact, some of the local water-harvesting practices can be traced to the local people's quest for survival in the harsh hilly environment. It is reported that urbanisation and proximity to Kathmandu have created some difficulties for the local people in managing the community assets and resources. While growing attraction for service relegated farming in some families to a secondary occupation, the problem of retention of trained manpower prevented them from undertaking technological innovations. The 'competition' for water between commercial and domestic/agricultural uses is also a problem emerging which is attributable to urbanisation.

Critical Issues and Recommendation

Lack of a Distinct and Precise Definition of Water Harvesting

The concept of water harvesting is not understood fully by the local people. For some, it is simply trapping rain water in an artificial pond, tank, or drum. For others, it means all kinds of productive use of water. Even government officials and development agencies appear to be confused; but quite a number of them tend to interpret water harvesting narrowly as collection of rain water from hill slopes or man-made catchments to provide low-cost water supplies for domestic uses. Some also include runoff agriculture under water harvesting. While all this may indeed be true, it is useful to have a distinct and precise definition to facilitate meaningful operationalisation of the concept in the field. Based on field observations, one way of looking at water harvesting could be as something that empowers local people, i.e., a means of conferring on households the control over water and its uses.

Lack of Awareness of Cost Effective WH Technological Innovations

Local people are not aware of new WH technologies or innovations. Whatever they have accomplished thus far is largely based on their own indigenous knowledge and skills. What they need now is fresh solutions that are superior to the traditional ones. As technology, management, and capital are the things that the local area is generally deficient in, they need to be offered a menu of promising technologies from which they can choose a cost-effective one. In addition, local people need awareness about WH technologies that are already available. What seems to be lacking is a communication system to disseminate information to them.

Lack of Catalytic Agency to Promote Local Water Harvesting

A major problem in the way of promoting water-harvesting schemes is the lack of 'appropriate' institutions. Although various agencies are involved in the water sector with varying degrees of effectiveness, most of these agencies, including NGOs, follow a conventional approach, which is not normally suitable for promoting sustainable local water harvesting. Small-scale water-harvesting schemes, which seek to empower individual households and build as well as sustain local initiatives, entail a different development approach and organisational orientation. An action research agency that operates in an 'informal' mode following a process approach, and that is sensitive to local subtleties and constraints, should fit the bill. Such an agency normally specialises in social intermediation and would be effective in spreading local WH schemes if adequately supported by, say, a 'social fund' administered by an 'enlightened' NGO. Based on experiences in other countries, the essential characteristics of the fund are autonomy, transparency, and participatory and in-built monitoring.

Protection of Customary Rights and WH Systems

The Water Resources' Act, 2049 has recognised customary water rights, granting legal status to indigenous water-use systems. Nevertheless, this is not communicated to the local people who are generally unaware of the provisions of the Act. While well coordinated dissemination of legal and policy information is necessary, equally essential is the strengthening of institutional arrangements to enforce the provisions of the Act, particularly to extend the reach of the enforcement system to local areas. Whenever disputes cannot be settled through the customary informal ways, local people should be able to take recourse to the formal system at a minimal cost. Only then can the legal status conferred by the Act carry real meaning and local WH systems be protected. Another issue with the Act is related to the water users' groups. The Act does not recognise the groups unless they are registered with the designated office. Given that casual groups of households are involved in the small-scale local WH schemes, this provision of the Act may pose some problems to development agencies that cannot deal with informal groups.

Information Gap

The government (including local government) officials in the district do not acknowledge the repository of knowledge that exists at the local level. It is typical of policy-makers and implementers in Nepal to ignore indigenous knowledge and systems. In fact, failure of many of the development experiments in the past can be traced to this information gap. Research agencies have a better appreciation of local information. However, they too have not been effective in communicating the information available to the implementers, tracing their implications. Nor have they come up with innovative ways of grafting institutions on to local structures and practices. The project management cycle practised by donor agencies as well does not incorporate learning from the local people as an essential stage of the management cycle. While bridging this knowledge gap is essential, documentation of local resource management practices, resource dynamics, skills and capacity, and changing preferences/expectations of local people are not sufficient. Effective linkages have to be established between the providers of indigenous knowledge and programme implementers for action in the field.

Lack of a Focal Point at the Local Level

There is no focal point at the local level to direct and coordinate diverse activities and act as a reference point of contact and information dissemination centre. A UNDP-financed

Participatory District Development Programme is making efforts to create/update the information base in each Village Development Committee (VDC) of the selected districts—including Kabhre. However, of the two VDCs falling into the micro-watershed of this study, only Nayagaon has maintained a database on socioeconomic aspects of the VDC. While this data management effort should proceed, ways and means must be found to enable VDCs to take a more proactive role in local development management.

Next Course of Action

As follow up, the following activities should be initiated: i) development of a Water Harvesting Framework, ii) preparation of Water Harvesting Guidelines and Technological Manual, and iii) creation and management of a Water Harvesting Network/Site with special reference to the Hindu Kush-Himalayas.

Annex 1
Check List

Case Study on Local Water Harvesting Technologies and Management Systems in Micro-watersheds of HKH

Rapid Participatory Rural Appraisal

I. LWHS Type (irrigation, watersupply and others)
- Name of the System
- Location

II. History of the System

1. Original Construction
   - When?
   - Who initiated and directed?
   - Amount and sources or resources invested: cash, labour, materials?
   - Basis for internal resource mobilisation: household, landholding?
   - External resources?

2. Improvements/rehabilitation/expansion
   - When have major inputs and improvements been made?
   - Who initiated it? When? What was done?
   - Internal or external resources?
   - Basis for internal resource mobilisation?
   - Are regular external resources given?
   - Area or beneficiaries increased?

III. Description of the System

1. The Physical System and Hydrology
   - Source Type (*mul*, *nala*, ponds, rivers, wells, others?
   - Name of water source?
   - Catchment area (approx)?
   - Rights to water in the source: upstream and downstream systems?
   - Seasonal variation of water source?
   - Discharge in canal at extraction (if applicable)?
   - Flood frequency?
   - Water quality: salt, lime, etc?
   - Water constraints to expansion/intensification of irrigation?

2. Size of the System
   - Number of beneficiaries?
   - Types of benefit/use (irrigation of crops/vegetables, drinking, bathing and washing only, for livestocks, fisheries, recreation, cottage industry, mixed)?
   - Quality and seasonality of benefits (min. and max. benefits or beneficiaries, water quality, min. and max. fetching time, adequacy with this system)?

3. Technology of LWH (artificial pond, river-based canal/river harvesting, subsoil storage, spring development, stone spouts, bamboo or plastic piped water supply, hydraulic rams, water wheels, sprinklers, dug-wells)?

4. Water Conveyance and Distribution (canals, pipe, standpost, sprinkler, or no conveyance system)
   - Type of construction, materials, quality, and condition?
   - Intake/diversion/drop structures/measuring devices (exist?)
   - Distance from source to first field/household?
   - Capacity of canals (if applicable)?
   - Density of canals (high, low, reasonable)?
   - Condition of rock and soil along the alignment (chances of disruption)?

5. Drainage/Sanitation Condition?

6. Soil Fertility and Suitability for Irrigated Agriculture: Head, Tail and Middle (if applicable)?

Operation and Maintenance

1. Operational Tasks (frequency and magnitude of effort)
   - Basis of water allocation (number of persons/livestock, land area, soil type, investment)?
   - How allocation changes during scarcity?
   - Method of water distribution for each or group of households, or in the case of irrigation, for each crop and variation during each crop: rotation (who and how initiated, frequency of turn); continuous flow; contract; turns (head to tail), water trading?
   - Distribution during water shortages: rotation among outlets, among field neighbours within outlet, rationing among households in the case of drinking water?
   - Match between water distribution and allocation: method of matching, proportioning weir, timed rotation?
   - Relationship of water distribution to physical infrastructure?
   - Who is responsible for water distribution activities, particularly at the time of scarcity?

2. Routine maintenance
   - What work is done?
   - Frequency?
   - Purpose: improve performance, preventive>
   - How long does it take?
   - Who initiates and directs work?
   - Who pays, in what form and how much?

3. Emergency maintenance
   - Reasons?
   - Frequency ?
   - How long does it take?
   - Who determines it is an emergency?

- Who organises and leads the work?
- Who pays in what form and how much?

4. Extent of agency involvement in this communal system
   - What agency is involved?
   - What inputs are provided and how frequently?

V. Institutions and Social Environment

5. Social structure
   - Landholding pattern?
   - Nature of tenancy (criteria: owner, tenant, sharecropper)?
   - Ethnic and religious composition of the beneficiaries?

6. Organisation for irrigation operation and maintenance

   a) *Membership*
   - Criteria: land, water share, crop, tenancy, official position, contractual, ethnic (exclusions), gender, age, labor, investment input?
   - Membership in other system?
   - Absentee members?
   - Free?

   b) *Roles and positions*
   - For each position: method of nomination, appointment, tenure. remuneration (cash, in kind, labour exemption)?
   - Appointed functionaries?
   - Chairman?
   - Vice-chairman?
   - Secretary?
   - Treasurer, and so on?
   - Water supply and/or system damage monitor?
   - Crier?
   - External communications?
   - Moderator of meetings?
   - Tool keeper?
   - Number of women among the functionaries?
   - Committees: regular and ex officio?
   - Informal leaders?
   - Relationship of political leadership to system?

   c) *Tiers of organisations*
   - Federation/unitary?
   - System/distributory?
   - Village/farm channel (*mauja*)?

   d) *Meetings*
   - Regular: time, place, who calls or ad hoc?
   - Extra/emergency?
   - Purpose: resource mobilisation, accounts, maintenance, conflict?

- Attendance: landlords, tenants? Only beneficiaries? women? landless?
- Penalty for not attending?
- Leadership: moderator, minute keeper, how selected?
- How are resolutions passed? vote, consensus?
- Records of meeting?

7. Conflict and conflict management
   - Cause, nature, frequency of conflict?
   - Specific to benefit-sharing (equity related issues) or making contributions or free rein?
   - Internal or external to the system (with local government)?
   - Among systems/water rights?
   - Non-water issues?
   - To whom is the first appeal for conflict resolution and what is the step-by-step procedure for difficult cases?
   - What is handled within the organisation and what is taken outside?
   - Police cases?
   - Court cases?
   - WDDC involvement?
   - Rules and sanctions?
   - Records of conflict resolution?

8. Water Rights
   - Sharing with other system?
   - Permit, rent, prior appropriation, riparian?
   - Customary rights?

9. Internal Resource Mobilisation
   - Purposes for resource mobilisation?
   - Basis: same as water allocation?, household, preferential treatment for women-headed household, less benefiting member, lower caste member or landless?
   - Type of resource: cash labour, in kind (remuneration, etc), animal, bullock cart, local knowledge?
   - Annual quantity of each type of resource?
   - Sanctions for not contributing?
   - Annual amount realised from fines, how collected and used?
   - Where are funds and in-kind resources held? Is there intermediate (short-term loans) use?
   - Discrimination against contribution: caste, sex, age?
   - Contractual arrangements for maintenance: method, reason?
   - Resource generating activity: mill?

External resources
- Purpose?
- Source: connections, contacts?
- Who (person) initiated contact with outside agency, incumbent or previous experience in government position?
- Frequency?
- Type: cash, food-for-work, cement, gabion wire, technical advice?
- Equipment: bulldozer, jackhammer?

10. Organisational development

- Changes over time in: rules, resource mobilisation, processes for electing functionaries, and so on?
- Changes in decision-making process, incorporation of women, democratic and transparent?
- Terms and conditions of external agency for providing aid and resolving conflict and its effects (positive or negative)?
- Changes in relationships with other systems, agencies: water sharing when temporary?
- damage in canal, sharing resources for maintenance?