

Ponds and Landslides

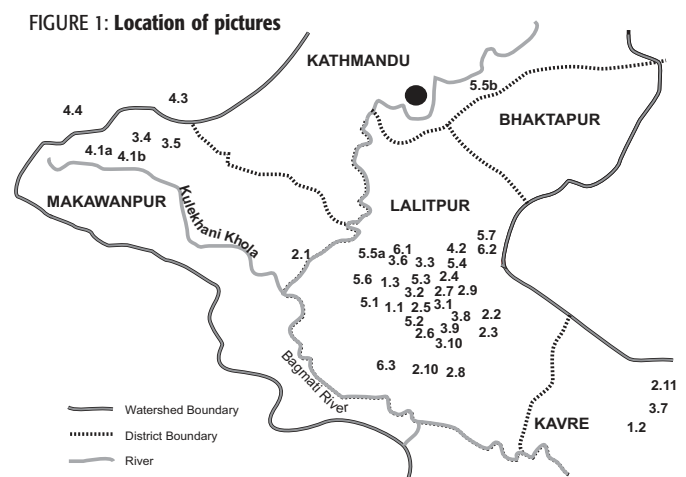
Water culture, food systems and the political economy of soil conservation in mid-hill Nepal

BACKGROUND

The following narrative is a brief English synopsis of the book *Pokhari Ra Pahiro* (Ponds and Landslides) in Nepali. It is a story which began in 1987 with construction of dugout ponds in the hills to regulate monsoon runoff, thus reducing soil erosion and improving farm productivity. Between 1987 and 1997, about 1000 dugout ponds of various shapes and sizes were rehabilitated or dug anew in the hills of Lalitpur and Kavre districts in central Nepal. Prudently laid out, these ponds have proved effective in saving land from erosion, in stabilising landslides and gullies, and in improving farm productivity. They were also found to be effective in promoting vegetative cover and maintaining soil moisture in the drier hill slopes.

These efforts of some watershed managers were attempts to revive currently not fashionable traditional water harvesting techniques, which some local farmers were still using. The stories portrayed in the book debunk conventional myths regarding the relationship between water and forest, myths whose persistence has rendered futile the efforts to save land resources by mere afforestation. This well-intentioned campaign of re-vegetating barren hill slopes has remote relationship, if it has any at all, in maintaining soil moisture or reducing erosion in the farmlands that support the livelihood of poor farmers in the hills.

At the end of the narrative, some personal reflections have been provided on why this traditional technique of managing monsoon runoff gradually lost its significance for our rural development efforts in the mountains. The need to tell these stories of what has sometimes been referred to as “subaltern water” (or water as dealt with at the grassroots of Himalayan hamlets) began to be felt at the conclusion of my 12-year involvement with Bagmati Watershed Project (BWP) in 2000. Since the original idea was to tell them through pictures, the following sections have been organised around these vignettes whose locations are depicted in Figure 1, and the year the picture was taken is placed with the caption in brackets.



Pictures 4.5 and 4.6 (not indicated in map) are taken from places in Dolakha and Sindhapalchok 125 and 69 kilometer respectively, east of Kathmandu



SECTION 1

LAND, FOREST, WATER AND LIVELIHOOD

Nepal's first agricultural conference, held in 1958 in Kathmandu, analysed the catastrophic floods and landslides of 1954 and concluded that

“degrading natural resource base, declining soil fertility, and the rising pressure on land resources have led to deterioration of farms and farming system, resulting in migration of youth from the hills for jobs in other countries, who return home when they are old, weak and unable to work to make a living in the poor homestead” (HMG, 1958).

Fifty years later the situation largely remains unchanged. A large number of youth work as migrant labourers because they cannot feed their families from the income of their farms, let alone meet the rising aspirations of family members. Efforts made in the last four decades to restore degrading natural resources did not bring the expected outcomes. Though the forest-centric watershed management efforts did help increase vegetation cover in the degraded watersheds, it had little or no impact on reducing water induced disasters and enhancing farm productivity. Nor did the efforts help in increasing water availability in the dry non-monsoon season to support dairy and vegetable farming. As indicated by FAO research, more trees did not yield more water (FAO, 2008). Floods and landslides continue to damage farms; and integrated use of land, water and forest, on which the mountain farming system depends, continues to weaken. What would a well managed farm capable of supporting farmers look like in the Nepalese hills? A comparison of the following three mountain farms provides some clue.

Picture 1.1: A prosperous village

The houses in this typical Nepali village of the middle mountain region of Nepal show the economic status of the families. A closer look reveals that several houses have corrugated tin roofs, which belong to the economically better-off families. Some houses have tile roofs that belong to the average-income families, while the few houses belonging to the poor families have thatch roofs.

The families with tin roofs earn their living from a combination of sources including a relatively large landholding, sufficient number of livestock, government service, remittance income, construction work and other off-farm sources of income. The other families are not fortunate enough to have diversified income sources and therefore have not been able to replace thatch or tile with tin.

Leveled terraces are seen around the village. They are cultivated to produce food. Fuelwood and fodder are collected from forests around the valley. Fodder from the forest and farm residue sustains livestock, which in turn, produces manure to replenish soil fertility in the terraces. Domestic water demands including that for livestock are met by water collected from the springs located at about half an hour walking distance from the village. The introduction of polythene pipes in recent years has allowed water from these sources to be brought closer to the village. The village looks, and actually is, relatively well-off.

Picture 1.2: An average mountain village

This is another typical Nepali village in the middle mountain region. A closer look reveals that most of the houses have tile or thatch roofs belonging to the poor families. The biomass-based economy of the village is generally supported by sloping terraces that produce food, and by small forests around the village that produce fuelwood and fodder. The water needs are met by collecting water from the springs located in the valleys at about half an hour walking distance. The available land and water in the village do not seem to have the potential to produce enough food to support the present population let alone a growing one.



Picture 1.1: A prosperous village in Bhattedanda, Lalitpur (1987)



Picture 1.2: An average village in Kavre (1987)

Picture 1.3: Settlement close to the ridge

It shows an isolated house located close to the ridge of a degraded hill slope where very thin forest exists. Buckwheat is growing on the sloping terraces. Traces of old terraces just below the farmland (seen as grass-covered fine lines across the slope in the picture), indicate that these slopes were cultivated in the past, but it is difficult to estimate their age. One can say with confidence that the farmer cultivated these slopes to produce food, but we don't know for how many years before they were abandoned. The question is: why were such steep and narrow terraces cultivated in the first place and why were they abandoned? It was believed in the 1970s that the farmers had moved onto marginal lands like this for cultivation due to growing population resulting in increased demand for food, fodder, and fuel; and in the process they engaged in wholesale deforestation. This Myth of Himalayan Degradation is now seen as too simplistic (Thompson *et.al.* 2007, Thompson 2008, Ives 2004).

Productivity of farmland is very poor as indicated by buckwheat, which is grown where maize or other summer crops cannot grow profitably due to low soil fertility. There is no water source in the close vicinity of this land, and this hill slope never had a lush green forest due to lack of soil and moisture. Like many hill terraces, this farm also remains fallow all winter due to lack of water and is eventually abandoned when the depleting soil fertility gives diminishing returns. The family members work as seasonal wage labourers to earn supplementing income, and diminishing land productivity is inversely proportional to the number of months they spend outside their village as wage labourers. The terraces at the lower part of the farm have eroded into steep slope, giving a clue as to how the landscape changes due to unregulated runoff of the monsoon.

The question is: will the conventional forest-centric conservation efforts help improve the condition of the farm shown in picture. 1.2 to the level of farm as seen in picture. 1.1, or will the continued erosion degrade it to the condition shown in picture. 1.3? The answer to this question is neither easy nor straight forward. However, the situation described in the following section helps us first to understand the problems of mountain farming before proposing effective solutions.



Picture 1.3: A farm close to the ridge in Bhattedanda, Lalitpur (1988)



SECTION 2

LIVELIHOOD TRAPPED BETWEEN TOO MUCH AND TOO LITTLE WATER

The monsoon rains help in producing food and recharging groundwater reserves; but too much of it and too intensely causes landslides, gullies and erosion. Heavy downpours destroy land, vegetation, and water sources; they wash away soil nutrients and restrict mobility in the hills. The types of erosion and the extent of damage caused by the monsoon rains in the mountainous area varies considerably from the valley to the ridge. Come winter, the mountain communities are faced with the other extreme – too little water. In absence of water, farms remain fallow with little prospect for irrigation as most water sources are located either far away from the farms or at lower elevation requiring pumping, which the poor farmers cannot afford. Milk and meat production, which is not only an integral part of mountain food system but also a source of cash income, drops significantly as grasslands become dry.

The examples below illustrate some of the key problems caused by too much or too little water. Though farmers have different ways of coping with water problems at different locations in the mountains, past efforts of watershed management failed to examine site specific problems and integrate farmers' efforts of managing runoff from the ridge top to the valley bottom.



Picture 2.1: Landslide at the border between Lalitpur and Makawanpur districts (1988)



Picture 2.2: An old landslide at Bukhel, Lalitpur (1991)

Picture 2.1: Catastrophic landslides

Landslides are constant threats to the lives and properties of mountain dwellers. They not only destroy villages and farms but also choke the natural drainage (streams and rivers) with sediment, and destroy irrigation canals, water supply lines (pipes) and roads. A huge amount of national development budget spent to build and maintain them forces additional commensurate amounts for rehabilitation and repair of damaged infrastructures. The vegetation on the land slip slope is lost for decades, which means a loss of fodder for livestock in the nearby villages. Regeneration of natural vegetation is generally difficult on large landslides due to lack of soil and moisture.

Landslides are inherent problems of the still rising Himalayas because it is the youngest, geologically weakest and fragile of mountain ranges. Heavy monsoon downpour causes mass failure of inherently unstable slopes on a large scale and at depths far below the root zone of trees. Forest cover, while desirable for many good reasons, plays little or no role in stopping such mass wasting.

Picture 2.2: Loss of water sources

Landslides, probably by undermining the piezometric lines and groundwater flow patterns, destroy water sources in the mountains. This landslide, which is about 50 years old, is still devoid of vegetation indicating lack of soil and moisture to support

regeneration of any natural vegetation. Such landslides contribute to high runoff generation, with very little water infiltrating below the surface when it rains. With existing springs lost, villagers have to cross the landslide to go to other water sources beyond to fetch water for their cattle and other domestic uses.

Picture 2.3: Restricted mobility

Once a landslide occurs, it adds perpetual problems to the villagers. Crossing a landslide like this is very difficult and risky, especially when it rains and one is carrying a heavy load of drinking water or other goods. Despite the extreme difficulty in repairing trails on such steep slopes, villagers need to keep the trail functioning all year round. Some trails passing through landslides are just not possible to rehabilitate due to continuing slippage and mass wasting, although villagers build and rebuild them every year. The

development worker in the picture is trying to find a toehold to cross the most difficult part. To avoid this trail for him would mean taking an alternate route requiring a walk of at least an additional one hour uphill. Hence they try to avoid going to such villages, which limits the frequency of their field visits and consequently deprives the villagers of developmental contacts. Treating this landslide with conventional methods is expensive and, for planners, economically difficult to justify the required investments. There are hundreds of villages across the mountains with similar problems induced by landslides.

Picture 2.4: Active gullies

Gully formation and its expansion is a common problem in the mountains. Along the ridges, the runoff drains through small depressions and walking trails, which is the beginning of a stream. As the water flows down the slope, the channel expands in size and collects more runoff. Eventually the depression develops into a gully. During high intensity rainfall, the runoff over-tops the small depression and tend to flow into new areas forming new gullies. Similarly, when additional water comes to an old gully (a rodent or crab hole, rotten roots of trees, or slipping of a small stone in the runoff channel can change the direction of flow), the gully expands. In both cases it generates huge amount of debris, which increases the erosivity of runoff and destroys the land and vegetation downstream. But when the runoff coming into a gully changes its course at the gully head, such gullies do stabilise after few years.

Three distinct gully heads are seen in this picture. There is a fresh head in the foreground followed by a relatively old gully head in the middle, and an older one in the background. All three have a common gully further down. What could have happened here is that the runoff getting into the gully changed its course due either to breaking or deepening of the channel, which guided the runoff to new area, inducing the forming of a new gully head. With no more runoff coming into it, the old head stabilised. This is a process by which orographic diversity is developed in the mountain landscape; and it goes unnoticed as long it does not directly affect lives and properties. However, this process clearly shows that if we can regulate the runoff properly we can stop existing gullies from expanding or even being initiated in the first place.



Picture 2.3: Landslide at Bukhel, Lalitpur (1991)



Picture 2.4: Gullies at Dalchoki, Lalitpur (1990)

This example also shows how important it is for the farmers to know which area is stable, and which is not. Here the farmer abandoned the land near the fresh gully head but has re-started cultivation near the old and stable gully head. This phenomenon shows two processes – how the precious piece of land is being lost when landscape changes due to gullies, and how farmers use stable areas to grow food even in places where the likelihood of profitable production is minimal. The farmer is aware of these limitations but has no other choice.

Picture 2.5: Village on residual soils

The problems facing the villagers is specific to the area where they are located. This village is on the residual soil (i.e. soil formed in situ from weathering of parent material) along the ridge of the mountains. Due to its location very little water is available around the village (see also figure 2). The watershed area above the village is small. Most of the springs are located at lower elevations making gravity water supply systems unfeasible. Crop productivity is limited not so much due to shortage of soil nutrients but largely due to water shortage. In places where water has been made available by pipes, farmers in such villages have been able to grow winter vegetables. But the irony is that there are very few springs and water sources available above the village area. In winter, this area gets frosts and families need additional firewood to keep themselves warm. The area also gets snow sometimes, which stays for few days, but does not help to build soil moisture because the thin snow deposits that accumulate here evaporates quickly due to wind near the ridge.

Since the slope is steep, terrace risers are relatively high causing frequent terrace failure (see also pictures. 2.6 and 2.10 for terrace edge failure and the reason why farmers cut terrace risers). Usually, the rainfall intensity near the ridge is high, causing high surface erosion in these farms. Gullies tend to advance from below, which gradually destroys the cultivated terraces. Farmers grow fodder trees at the edge of the land to stop gully from advancing uphill. The houses are sparsely located due to shortage of land for cultivation, slope of the land and limited water sources.

Picture 2.6: Terrace edge failure

It is common to find zigzag farm terraces with failed edges in the hills. During the rainy period when water from the surface and from the subsurface of the terrace accumulates at its edge, the terrace edge becomes heavy. Fine soils accumulated at the edge generally hold more water adding additional weight to the terrace riser. It is common to plant shrubs and trees along the terrace edges to protect it from erosion. What is forgotten is that the trees and shrubs also add weight when they grow bigger,



Picture 2.5: Village on residual soil, Bhattedanda, Lalitpur (1990)

Picture 2.6a: Failed terrace edge, Dalchoki, Lalitpur (1993)



especially on a tall riser with higher capacity to hold moisture. Consequently, the shrubs planted along a terrace edge made of fine soils becomes a problem. When the weight of the accumulated water and that of the plants become more than the terrace riser slope can stand, they fail.

These slope failures (picture 2.6a), which are usually small and shallow in dimension, are taken as small problems; but when one looks at them from a hydrological point of view, the story changes. These failures are deep enough to guide runoff into a narrow channel during the following rain and initiate a long gully (picture 2.6b). Land managers usually tend to ignore such small 'seeds' of larger future problems that grow into a potential hazard in the following years. One should also bear in mind that these changes are happening near the ridge area; and any changes at this place has multiple effects downstream. Many well-intended advices, such as planting trees, can have unintended adverse consequences, as has happened in this case of shrub planting along the edge, if the science is misunderstood. One has to see the direction of flow of water (which can change easily while preparing land for cultivation) before applying measures to check erosion; and early runoff management is relatively less costly and can save a great deal of potential problems later.

Picture 2.7: Advancing gullies

The mere look of this landscape could be deceiving. This area of residual deposits, situated at lower elevation than the one in picture 2.5, is not only aesthetically beautiful but also considered good for farming. This can be considered as one of the good lands in the hills for maize cultivation, with good water sources available around it. But there are emerging problems that have gradually destroyed the land. At the lower right of the picture, notice that a gully is advancing uphill eating part of the good terraces. Farmers lose quite a bit of their precious land in this process. Gullies at this stage (when they are just reaching the farms) are considered as small threats. The usual practice is to try to grow plants to stop it from advancing uphill. But that is the wrong reason and wrong medicine: it is the flowing water from heavy monsoon downpours from these very terraces that created this gully. The reason this gully developed, unlike in the landscape in picture 2.5, is because there is enough catchment area within and above the farmland to generate the runoff required to create the gully.

It is therefore important to know the size of the catchment contributing runoff to a particular area to assess the problems of gullies, which one could interpret as worn-out edges of the terraces, which do get stabilised when water flowing into them are somehow



Picture 2.6b: Initiation of gullies from failed terrace edges, Dalchoki, Lalitpur (1992)



Picture 2.7: Farms of Sankhu, Lalitpur (1993)

reduced or diverted. Once stabilised, shrubs and trees colonise such gullies turning part of once cultivated land into forest-like land. The trees in the middle of the farms show that they were once part of the gullies that stabilised naturally when the runoff flowing into them got diverted. When runoff is completely diverted, gullies die, and farmers level the area to produce food without removing the trees. This is one of the reasons that most of the hill farms have trees in the middle of the farmland particularly in the depressions.

Picture 2.8: Village on a colluvial deposit

This village is on a colluvial deposit (i.e. a deposit of unconsolidated mixture of sand, silt, clay and boulders that originally came from a landslide above the slope) located at the foothill. Because these deposits are at the lower elevations, unlike residual deposits, there

are numerous springs and streams around them, allowing the provisioning of water for domestic or farm uses at a lower cost. Land productivity is higher here, primarily due to availability of water and higher temperature, than in the higher elevations with residual soils. The settlements are dense. However, the colluvial deposits have their unique inherent problems: being loose, unconsolidated, and incoherent deposits of soil, gravels, boulders, sand and so on, they are vulnerable to landslides and gullies as well as surface erosion. Sometimes during the heavy rain new gullies start from within the farm. Hydrologically this area is well connected with its watershed above as a result of which landslides from the upper area can deposit coarse debris on them. As described in picture 2.4, if runoff from one of the channels higher up in the watershed gets diverted into another, extra water comes barreling into the existing gullies in the middle of these colluvial deposits. The resulting floods inflict considerable damages to lives and properties. This phenomenon is one where the relationship between the upper catchments and the lower settlements are seen as connected by the monsoon runoff generated from a small area.



Picture 2.8: Village on colluvial deposit, Ikudol, Lalitpur (1990)

Picture 2.9: Valley farms at Bukhel, Lalitpur (1991)



Picture 2.9: Farms in the valleys

Farms in the river valleys are considered important because they are more productive due to soil quality and possibility of irrigation. The silt laden waters of the rivers help build soil fertility without much effort. These farms are suitable for growing rice, considered as highly desirable prestigious food staple in Nepal unlike

rain-fed cereals such as maize or millet. Wider terraces makes farming much easier than narrow hill terraces. However, during the monsoon, valley farms are frequently damaged or buried under sand and debris (see picture. 4.1a).

Picture 2.10: Loss of soil and nutrients

Some farms in the hills are as steep as the one shown here. Land preparation is done before the monsoon to plant maize. The first few showers of pre-monsoon rain (April-May) erode fine soil (Carson, 1985). The erosion continues to take place until the vegetation starts to grow (in June). During the monsoon (June to September) the topsoil is washed by sheet erosion. The eroded soil carrying nutrients accumulates at the edge of the terrace riser.



Picture 2.10: A farm at Chila village, Ikudol, Lalitpur (1989)

The infiltrated rainwater, now called interflow, flows towards the terrace edge through subsurface, carrying soluble nutrients from the soil. Upon reaching the terrace riser water cannot flow further due to its surface tension and hence evaporates leaving the nutrients behind. The nutrients washed by interflow then accumulates at the terrace riser. In the process, the upper part of the terrace becomes devoid of nutrients, fine soil, and moisture, whereas the risers get all of them in substantial amount.

During land preparation, in order to distribute the nutrients throughout the terrace, the farmer cuts the slice of the nutrient-rich terrace riser and places it on the upper area of the terrace below. This is a traditional practice generally misunderstood by land management experts during the 1970s, who believed that cutting terrace risers would degrade land quality. However, the practice does increase the slope of the land when soil is brought down while preparing land.

Picture 2.11: The ultimate desolation

This picture shows a hill slope severely damaged by landslides, active gullies, surface erosion and all possible combinations of degradation processes. Broadly, this slope had two major land uses before it was degraded to this stage. The upper part of the hill was under forests followed by cultivated terraces at the lower elevation. There were numerous streams and gullies that originated from the forested areas and ran through the farms, providing water to the farms and villages. The cultivated terraces that existed in the lower areas have disappeared. Remaining terraces in the middle of the slope, which have



Picture 2.11: A ruined mountain slope at Sishakhani, Kavre (1994)

now been abandoned, are threatened by the landslides that are advancing uphill on both sides. The terraces have become dry due to lowering of water table by gullies and landslides around them earlier than they would have been otherwise.

As explained in picture 2.1, once landslides change the landscape and destroy vegetation on it, they not only damage the livelihood base of the farmers who depended on the land but also affect people and environment downstream. Landslides change the hydrological regime of the area: existing springs disappear and new ones may appear in new locations not conducive to use by old settlements. Most of the rainwater flows as runoff, offsetting the hydrological equilibrium below the landslide. Flash floods occur after each rainstorm, and debris from the landslide is deposited on low lying farms and river bed.

Building a road or an irrigation canal, which is considered to play key role in rural development, through this part of the hill is extremely difficult. Even drinking water pipes cannot be sustained on such a slope. Stabilising this landslide with conventional engineering techniques is hugely expensive, while bioengineering technique is inadequate. The question is: how do we tackle problems of this scale that affect the poorest in the remote hills?

The remaining terraces provide some clue to the past land use of the area. There were farms all over the lower slope that provided livelihood to a whole village. Now the story is different. The land is in ruins. People who lived on this land have migrated to other areas. A recent report in the media suggests that village displacement by landslides continues in other parts of Nepal as well. About 300 families in Kholigaun village of Baitadi District in the far-west and about 35 families in Gauda village in Lamjung District of west Nepal were displaced three times by recurring landslides (Kantipur, 2009). The situation seen in the picture 2.11 did not occur due to a one-time event like a big landslide or an earthquake, but due to a gradual and continued action of erosion, gully formation and eventually soil loss and mass wasting. Unregulated runoff associated with faulty management of land continually destroyed the entire slope over a period of several decades.

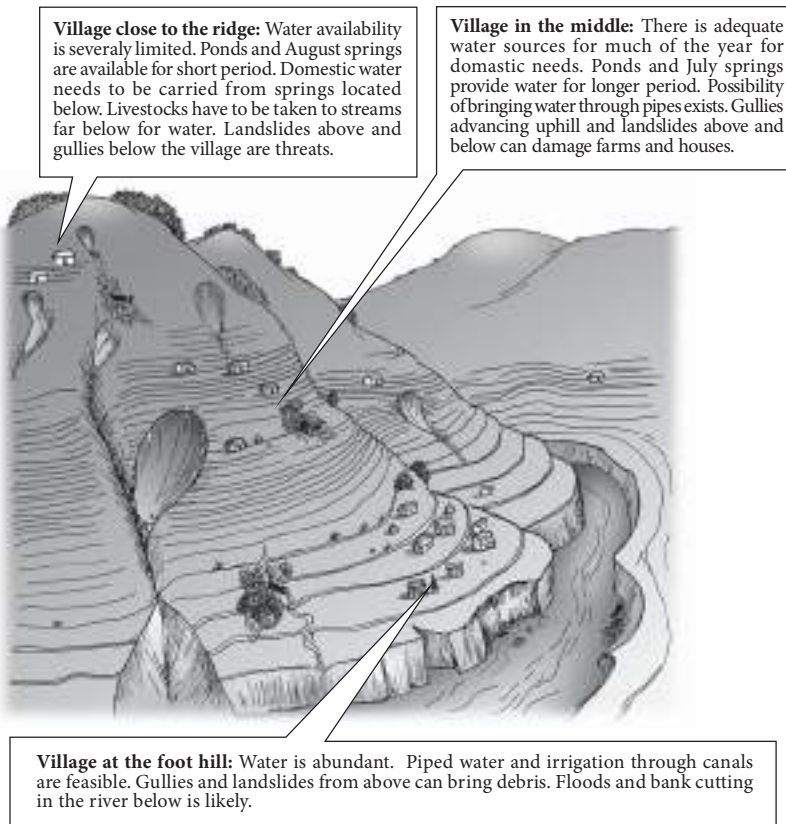
A grayscale photograph of a person carrying a large, woven basket on their back, walking through a field. The person is seen from behind, and the basket is quite full. The field appears to be a mix of dirt and sparse vegetation. The overall tone is somber and reflective.

SECTION 3

ENDLESS STRUGGLE

A mountain farm is like a bowl with holes that leak. Unlike the farms in the hill valleys where nutrients are constantly replenished when flooded with silt-laden water from the rivers, mountain farms continually lose nutrients as well as their water holding capacity due to erosion. Hence hill farmers must struggle ceaselessly to add manure to produce food. Livestocks largely fed by fodder from farm, forests and grassland produce the required manure, which maintains soil fertility. Consequently hill farmers need to keep herds of animals not just to produce milk or meat, which in turn puts pressure on women to collect fodder from forests and engage in livestock rearing and compost making. When the rate of nutrient loss in farms exceeds the rate of its replenishment (caused by increased erosion, loss of access to forests, reduced livestock or workforce to maintain livestock), food production falls. When this decline crosses a threshold, farmers abandon the land and look for alternate source of income. In the process, the farmer who was a master of his land with a place in the rich sociocultural milieu is displaced as a wage labourer in the “satanic mill” of the urban market, bereft of his socio-cultural wealth that gave his life some meaning. While this process of degradation may be gradual in the mountains, it is usually abrupt in the hill valleys where flash floods can bury livelihoods under boulders and sand casting.

FIGURE 2: Water related problems specific to the location of villages

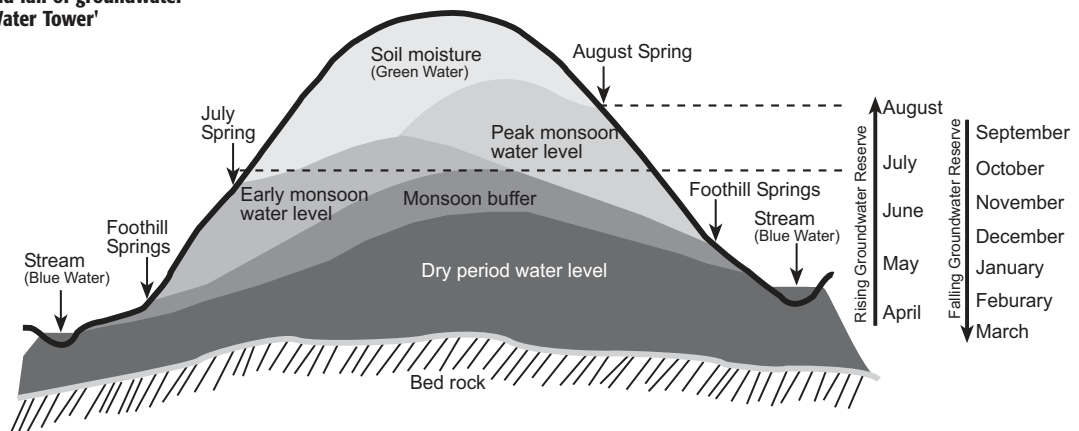


Picture 3.1: Winter drought

The soil moisture in the farms and the amount of water available around the villages depend on two things: the location of the village and how much water has been saved in the soil and the groundwater aquifer during the monsoon. Figure 2 shows a general settlement pattern in the mountains and their specific water problems. Figure 3 depicts a typical hill 'water tower'. The monsoon rains percolate into the soil contributing to groundwater replenishment and the bursting forth ('mool phutne' in Nepali) of springs at different stages of the monsoon – July springs, August springs etc. The August springs indicate complete recharge of groundwater reserves. These springs and the groundwater table begin to decline until replenished by winter rains or, if these fail, only in the next monsoon. Water stress in the mountains are actually measured by farmers in terms of when or how early particular springs dry out.

Immediately after the monsoon season ends in September, the hills begin to face water shortage. Soil moisture (or 'green water') in all farms and grassland begins to deplete.

FIGURE 3: Rise and fall of groundwater reserve in hill 'Water Tower'



Springs located in the upper areas start to gradually dry out. Those at the lower areas keep flowing, but not for long. As the winter progresses, the discharge reduces in the springs even at lower foothill areas. Many of them dry out during April/May. Water taps connected to the springs at the upper slopes also dry out.

The farm in the picture shows the distribution of soil moisture ('green water') and its availability for plants. It also shows how the depletion of moisture affects plant growth following the monsoon. In this farm, mustard has germinated (seen in patches) where soil has the capacity to hold moisture for longer period. In drier areas primarily caused by poor soil condition, the mustard has not germinated. The farmer has put the same effort throughout this land but he/she gets to harvest only from some patches, which is a partial loss of farmers' effort. If a farmer loses so much on a less sloping land like this, what prospect is there that hill farms and terraces on more steep inclines can produce profitably to reduce poverty?

It must also be emphasised that depletion of 'green water' in areas outside the farms impacts vegetation growth, which causes grass to disappear, which in turn reduces milk and meat production. Women need to go deeper into forests to bring tree fodder to keep their animals from starving. There is now growing appreciation internationally of the value of 'green water' (Chapagain, 2006).

Picture 3.2: Economics of mountain farming

This picture taken in winter shows a heap of manure, some green vegetables, and some mustard on a highly eroded sloping land in front of two houses. Before we analyse each of them, also take note of the fact that the houses have thatch roofs, an indication of the level of poverty. The picture, properly understood, tells us many things about both the helplessness and the wisdom of the farmers.

The farmers seem helpless about reducing erosion from the farms. The big rills seen in the middle of the sloping land indicate that the area receives substantial amount of runoff generated around the farm. It has damaged the terraces. Surface erosion is quite evident from the sloping terraces. The farmer has not been able to do



Picture 3.1: Mustard in this leveled farm is growing partially due to lack of soil moisture at Bhainse village, Bhattedanda, Lalitpur (1991)



Picture 3.2: A sloped farm at Bhainse village, Bhattedanda, Lalitpur (1991)

much to reduce this problem. We will discuss such gully-sized rills and how they destroy the land in subsequent pictures.

Anyone familiar with Nepali mountain villages is well aware of the heap of manure near a cowshed. But very few realise the economics of this heap of manure primarily produced by women of the family (Bhatt *et. al.*, 1994). Women go to forests, and sometimes to their own *Kharbari* (grassland) if they have one, to collect fodder every day. They feed the fodder to their livestock to produce manure, so that they can apply manure in their farms to build soil fertility. Goats are raised for cash income, whereas milk produced by lactating animals, if they have one, provide supplementary source of nutrition. On a day such as the *Teej*, a highly revered festival of fasting for Hindu women, they collect enough fodder the day before so that they can stay home on the fasting day. Considering the minimum wage of the labour involved, this manure heap would cost at least, say, rupees 10,000. The maize produced, however, would not be worth more than rupees 3,000 to 6,000 if sold at prevailing market rates without taking labour and other production costs into account. Since there is very little that this land produces in the winter, economically speaking, hill farming on land such as this is an inherently loss-making enterprise, which explains the structure and nature of hill poverty. It is when such everyday realities are encountered as surprises by well-meaning international donor or national government policies that “poverty alleviation programmes” or MDGs collapse.

The picture also reveals the wisdom of farmers. The manure heap contains a lot of moisture from animal urine and other household uses. Dung itself has lots of moisture. The farmer, usually a woman again, uses every bit of moisture available below the manure heap to grow vegetables for consumption. While the mustard in the rest of the land is barely flowering in absence of moisture, the farmer is utilising what little moisture is available below the manure heap to grow green vegetables. The green leaves are processed to make dried *Gundruk* (fermented leaves), which is consumed when no other vegetables are available in March/April.



Picture 3.3: Reclaiming damaged land in the hills at Dalchoki, Lalitpur (1992)

Picture 3.3: Reclaiming damaged land in the hills

Farmers have traditionally coped with the problems of landslides by slowly recovering damaged land wherever they can. In this picture, a farmer has re-built a terrace at the scarp of the slide after he realised that the slide at this section has stabilised. When certain conditions of moisture, slope angle, running water, and toe support change, parts of the landslide stabilises itself. Farmers use such an opportunity to grow some food, which helps provide some food security for his family.

What is certain is that the catchment above the landslide generates overland flow during rainfall events, which at present is flowing away from this new terrace. Water flow could,

however, change its course due to erosion in channel, small landslide, rodent holes or any other event. If such overland flow comes back to the stabilised landslide, the new terrace will be damaged again.

Picture 3.4: Reclaiming damaged land in the valley

In the valley, farmers have different ways of coping with the floods. Once the land is buried under the debris, farmers reclaim the land by using their own techniques as far as possible. They make retaining walls and embankments using the boulders deposited by flood along the stream (as seen in the background) to save the land from future floods. Some farmers can compensate for their loss of crop by selling stones if there is market for it. After the big boulders are removed, pits are dug at certain intervals to bury pebbles. If the depth of the debris is less than a meter, the soil from the original land (seen in the pit) under the debris is brought up and spread over the new surface to make the land cultivable. A farmer is seen digging pits in the picture to bury the pebbles and boulders after his land was damaged by floods.

If the debris is more than a meter deep, digging soil from the pit is not possible. Then the farmers use a different technique. The silt-laden floodwater in the following monsoon is allowed to flow through the farm to cover it with silt rich in nutrients. All these activities are time consuming, tedious, labour intensive and back-breaking. Poor farmers have no choice but to somehow make a living from the same piece of land as they own nothing else. Reclaiming land in this way helps them to continue farming on the same piece of land, the only piece over which they have security of tenure.

Picture 3.5: Cost of soil

Sometimes, the thickness of the debris is more than a meter and if the damaged land is on higher grounds, it is not practical to remove the soil from under the debris or allow flood water to flow through. In such cases soil needs to be hauled from elsewhere, usually from upland terraces not affected by floods to cover the debris. In this picture, a farmer is hauling soil from a nearby upland farmland to create land for the first crop after the flood. Farmers put in hard work to keep the land under production despite repeated damages caused by the floods. However, this technique is only possible in limited areas where market exists for cash crops.



Picture 3.4: Damaged farm being reclaimed in the valley at Phedigaun, Makawanpur (1994)



Picture 3.5: Soil being hauled to reclaim damaged farmland at Phedigaun, Makawanpur (1994)



Picture 3.6: Buck wheat growing in sloping terrace at Bhattedanda, Lalitpur (1988)



Picture 3.7: A degraded farm at Saldhara village, Kavre (1992)

In remote areas where market for perishable products are absent, it takes ages for farmers to be able to reclaim the damaged land (see also picture 4.2). Those who cannot reclaim their land become landless squatters and wander away in search of alternate livelihood.

Picture 3.6: Extremely degraded land

It takes a long time for land to form but its degradation could occur quickly if the land is not managed properly. Generally, nutrients are extracted from the soil when crops are harvested. Application of manure and fertiliser replenish the soil nutrients. However, in the hills, the land also degrades due to soil loss (as shown in picture. 2.10), and with it the land's capacity to hold moisture required to support plant growth and maintain soil microbes. As mentioned earlier (picture.1.3), when the slope increases to a degree where no remedy can be applied to stop the loss of soil and nutrients, farmers grow buckwheat as a last measure because other crops can not be grown in such steep terraces.

Picture 3.7: How long can this land feed the family?

The land in the picture is steep and extremely degraded, which has just been prepared to plant maize in the following June. The productivity is low. It is not capable of producing food in cold and dry winter. Water for irrigation is hard to find in the vicinity; the loss of nutrients, soil microbes and organic matter for years has made the land poor; the loss of fine soil has reduced

its capacity to retain moisture. The land does not even support the growth of grass !

When it becomes difficult to feed the family with income from the farm, the farmer has to look for alternate employment. He moves temporarily to cities leaving women and children behind to look after the land. The less a farm produces the less incentive a farmer has to manage it. Gullies start to develop from the middle of the farm. Erosion rate exceeds all tolerable limits. The relationship between livestock and agriculture breaks down because the capacity of a farmer to keep animals for manure diminishes. It is a downward spiral of poverty and fatalism.

Picture 3.8: Master turned servant

The terraces that produced food in the past now appear as grassland. These terraces were abandoned long ago, when the owners could not feed the family with the food

produced even for a few months. The fact is that the degraded land leaves the farmers with only two options: either to continue with the drudgery of hill farming (an occupation that s/he grew with) or look for alternate livelihood. If there are opportunities available elsewhere to make a living with the skill and knowledge that the farmer has, the farmer abandons the land and migrates permanently. This is the story of hill farmers caught between the skewed distribution of too much water during the monsoon that results in erosion, loss of fertility, landslides and gullies, and too little water during the winter that creates water scarcity for domestic use, irrigation, grass production and for raising livestock. The cycle repeats each year.

The land abandoned as a result of this cycle of land degradation and poverty will never be reclaimed. This is a national sacrifice of the area as far as food production is concerned. One must realise that these abandoned terraces were not so steep when they were being managed for cultivation.

Picture 3.9: Widespread abandonment

In this picture one can see how widespread is land abandonment. The families who depended on these lands have migrated to cities. There are hundreds of such terraces abandoned in the past. Numerous gullies running through the middle of the terraces show how runoff, if not managed, can take away the land resources so crucial for a hill farming family's survival. These abandoned terraces, which once produced food, are left to grow trees giving an impression that the area is a forest land. In fact, the scars of the terraces reveal the story of how

unmanaged monsoon runoff and inadequate land management together changed the landscape making it capable of supporting only forest trees. These lands can never be brought back into food production. The scars of old terraces are found under many forest areas around the villages, which indicate that there were more areas under cultivation in the past than there are today. This interpretation of landscape geography is just the opposite of what has been preached since 1970s, i.e. that more marginal land is being cultivated to meet the rising demand of food. One must realise that most of the landslides and gullies are in and around the cultivated terraces. This should warn us that small landslides and gullies in and around hill farms should be taken as what might be the ultimate fate awaiting the landscape if they are not taken seriously today.



Picture 3.8: Abandoned farm terraces at Dalchoki, Lalitpur (1997)



Picture 3.9: Scars of abandoned terraces at Dalchoki, Lalitpur (1987)

Picture 3.10: Farm turned into forest

This area was destroyed by the heavy downpour of 1954. Until that year, this slope was used to produce food as indicated by remnants and scars of old terraces below the trees. Note that there are small gullies running down the slope where there is a small forest now. When gullies and rills developed through the then farmland, it became unfit for food production. Obviously, the runoff to make these gullies did not come in a day. The runoff from the catchments above the farm was probably flowing through small depressions for many years until 1954 when a large volume of additional water burst through, damaging the land completely. Such a downpour of high intensity is undoubtedly damaging, but if gully formation is reduced by regulating monsoon runoff, the extent of damages during such events can be minimised. Increasing the threshold of soil retention in the mountains and thus reducing the vulnerability of farming families is key to reducing mountain poverty.



Picture 3.10: Abandoned farm terraces at Ikudol, Lalitpur (1987)



SECTION 4

THE STATE FEELS THE HEAT ONLY WHEN CITIES GET HURT

The debris and high runoff from landslides and gullies continue to create havoc as they flow down the slope and pose threats to vital infrastructures such as roads and bridges in the valleys. When a national highway or a bridge gets damaged, it draws the attention of national media and decision makers because it affects the urban masses and power centers. Funds are quickly made available to repair and maintain the damaged structures as well as to build more complex structures using expensive engineering methods. However, not even a fraction of this fund and attention goes to the mountains where the problems originated, which come in the news only when people are killed by landslides and gullies. An approach by state agencies of looking at water-induced problem as a continuum between mountains and valleys would help strengthen the efforts made by poor farmers struggling to maintain land and water for their own survival. Such a paradigm shift would also have a major positive implication on the protection of the country's vital infrastructures on which its modern sector depends.

Picture 4.1: Debris deposit in the valley

During high flood events, debris and sediment are transported to long distances from their place of origin. Sediment laden water induces toe-cutting of stream banks leading to their intensified erosion and adding more debris and rubble to the floodwater, which wash away or destroy fertile and valuable farmland producing paddy, wheat and vegetables in the river valleys. Sometimes the land is covered by several meters of debris. Even half a meter of debris is enough to turn the precious land into a rubble-filled flood plain. During catastrophic flood events, even terraces on higher grounds may get debris deposits from tributary streams.

Though farmers reclaim damaged land to some extent (as shown in pictures 3.4 and 3.5), the process takes years before production comes back to anywhere near normal. When the amount of debris covering the fields is too large to be worth the effort of reclamation, the land is abandoned increasing food insecurity in the hills.



Picture 4.1a: Farms damaged by cloudburst of 1993 in Palung valley, Makawanpur (1994)



Picture 4.1b: Reclaiming damaged land in Palung Valley, Makawanpur (1994)

Picture 4.2: Farmers' ability to reclaim land

This valley in Bhardeo, inhabited by about 300 households, was flooded in 1981, with its fertile land buried under debris, which in some places was more than two meters deep. The local economy was shattered to such an extent that the farmers lost all hope of being able to reclaim the land to make a living. However, the farmers had some alternative means of livelihood. As part-time labourers, one or two members of some families were already working in brick kilns in a nearby city – a three hour walk from the village – to earn extra cash. After the flood, most of the flood victims began working as full-time bricklayers.

In the meantime government-funded Bagmati Watershed Project helped them to reclaim their land with support as high as 50% of the cost of the reclamation. With government support and the farmers' own efforts since 1987, they could only reclaim about half of the land until 1995 (Upreti, 2002); and even then the productivity of the reclaimed land

remained very low. Although the area is only three hours away from the market centre in Chapagaun, farmers were not encouraged to grow cash crops because all of them had to survive between 1981 and 1986 by doing wage labour outside the village. This imperative disconnected the farmers from their farms, as a result of which, many abandoned their land for good. Though the valley has not been flooded as badly after 1981, the farming economy destroyed in 1981 could not revive. The story of this valley is not an isolated one. Many such valleys, particularly in remote areas have been abandoned following catastrophic flood events and such floods will happen in the future as well. The damaged land resources remain out of production for years. Thousands of hectares of cultivated land along the streams and narrow valleys in the country have been turned into wasteland by such floods in the past. It is believed that such floods sweep these narrow valleys periodically every 30 to 50 years.



Picture 4.2: Partially reclaimed damaged valley farms in Bhardeo, Lalitpur (1998)

Picture 4.3: Damaged Highways

When a part of the major highway is damaged by flood, it becomes national news precisely because it affects those in the cities who make decision about trade, economy, development and so on. A damaged highway affects the national economy in a visible way: supplies to the millions in the cities get obstructed; city dwellers have to stand hours in queue for kerosene and gasoline; and the damaged road sites are visited by ministers and politicians because it is accessible to them and the media. Extraordinary funds are immediately made available to repair the damages.

Such is not the case when flood damages happen in remote, generally inaccessible rural hinterlands, even when they destroy the local economy. Soil erosion, landslides, gullies, and subsequent changes in landscape and local hydrology take place in the hills every monsoon. These events takes place over a wider area at varying scales, and affect the natural resource base which sustains the livelihood of hill people. But, unfortunately, the state agencies tend to ignore such silent violence as long as they do not take dramatic human toll. Measures are recommended by central planners living in cities based on symptoms which do not address the underlying fundamental causes. Villagers have tens of other problems to worry about and



Picture 4.3: Damaged Prithivi Highway at Naubise, Dhading (1993)

therefore are preoccupied with other issues of daily livelihood to worry about such recommendations distant from their everyday concerns. If other economic opportunities are available, they tend to ignore the fact that the resources around them need additional attention. Behind this picture lies the uncomfortable truth that the causes behind media blow ups of flood damaged infrastructure are hidden high up in the mountains.

Picture 4.4: Collapse of a bridge

Collapse of a bridge on a highway shuts down the traffic movement for days causing further hardship to the city people. It particularly affects trucks hauling supplies to the cities because a loaded truck cannot cross the swollen river as smaller vehicles seen in the picture can. Unlike a damaged road (picture.4.3), which can be repaired in a short period to open a single-lane for traffic, a bridge takes long time before it can be rebuilt. The longer the supplies are cut off in absence of a bridge, the greater attention such damages get from all quarters of life. Government takes all measures to keep the vehicle moving. Big machines seen in the picture are moved at substantial cost to rescue any vehicle that might get stuck in the river while crossing it (picture 4.4a). But not even a fraction of this cost is spent in the villages from where this flood originated. The best villagers in the hills can get are tents (picture 4.4b), plastic sheets, cooking utensils and some cash if people have been killed or houses damaged.



Picture 4.4a: The bridge at Mahadev Khola along Prithivi Highway was washed away by the 1993 cloudburst (1993)



Picture 4.4b: Tents were distributed to the flood victims of 1993 cloudburst in Phedigaun, Makawanpur (1994)

Picture 4.5: Mountain river training

The techniques of stabilising river banks (or river training works) were introduced in the plains much earlier than in the hills. Expensive modern engineering methods were adopted when rivers started damaging adjoining agricultural fields and inundating villages. But these techniques were not suitable for the mountain rivers, which have tendencies to scour the riverbed and initiate landslides on their banks from toe-cutting. As a response to the specific problems of mountain rivers, sophisticated techniques have been introduced in the country with a reasonable degree of success. The mountain river in the picture scoured its bed by more than ten meters by heavy rains of 1987. A major road passing through the area that connected the area with the capital was seriously

threatened by the deepening river. The options available were either to realign the road at a much higher cost or stabilise the deepening river. Realigning the road would not only take a long time to complete but also would not guarantee its sustainability due to unstable geology of the area. Therefore, the river was treated with heavy 'tetra poles' to keep it from further deepening the bed. Concrete-reinforced gabion walls and checkdams were built to protect side slopes and regulate flow velocity. Drainage channels have been provided to check debris flow. The high cost involved was justified because the road had to be safe and functional. Though the technique is effective, the cost involved forbids using them in nonstrategic hill areas where poor people live.



Picture 4.5: River training works at Charnawati in Dolakha District after it was damaged in 1987 by floods (1994)

Picture 4.6: Stabilising landslides along highways

Similarly, high investments are made in checking erosion and stabilising landslides along the highways. Gabion structures like this one seen in the picture cost hundreds of thousands of rupees for each landslide that cover only a few thousands square meters, but they are effective and the costs are justified to keep the highways safe and open. The question is, can such structures reach the villages and can the villagers replicate them? The problems caused to farms by small as well as large scale erosion, landslides and gullies in the watershed incur significant damages to the livelihood of mountain people. In most cases the landslide and gully problems along the highways and bridges originate in the adjoining watersheds inhabited by poor farmers.

Nationally, the responsibilities of addressing the problems along a road or irrigation canal and those in the watershed areas fall under the jurisdiction of two or more organisations, which use incompatibly different strategies and approaches to tackle the problem. The concerned organisations have almost always failed to realise that any help extended to poor farmers, living within few kilometers away, to solve their degradation problems in the watershed will also help to minimise problems in the downstream areas. Unless these water induced problems in downstream populated or urban areas are looked upon in conjunction with water and land erosion problems in upstream watersheds, there is little prospect that expertise and capability will be developed in the country to deal with problems in the hills effectively.



Picture 4.6: Stabilised landslide at Km 69 in Arniko Highway, Sindhupalchok (1994)

A photograph of a traditional stone-lined pond or reservoir. The pond is built with rough-hewn stones and is filled with water. It is situated in a rural, hilly area with some vegetation and a dirt path visible in the background.

SECTION 5

TRADITIONAL WAYS OF WATER-CENTRIC RESOURCE CONSERVATION

Water not only holds the key to the survival of mountain communities and its environment but also remains at the core of the problems facing them both in wet and dry seasons. When people began settling in the mountains they must have been faced with these challenge of adapting to the problems associated with too much and too little water, which they did by making provisions for managing the monsoon rains. They devised a systematic way of managing runoff from the ridge to the valley with drainage channels and ponds built at strategic points to hold, divert, and delay the flow of runoff. Interestingly, these techniques helped not only in reducing the water induced damages during the monsoon but also building water reserves for the winter.

With the understanding of the usefulness of the trails and ponds, the BWP attempted to revive this old technique in degraded hills of Kavre and southern Lalitpur districts in central Nepal, which were severely damaged by heavy downpours of 1981. The damage propelled the implementation of BWP with financial assistance from the European Union in 1986. Between 1987 and 1996, BWP worked with about 1000 farmers within an area of about 630 square kilometers of the Bagmati Watershed building networks of diversion channels to divert water from around the houses and from around the farms on the entire slope of the sub-watersheds. Water thus diverted was collected in ponds built at strategic locations. Some sloping terraces were leveled in front of the houses to encourage infiltration. The following pictures show some examples of BWP's efforts of reviving this traditional ways of managing runoff.

Picture 5.1: Point of runoff management

Ever since people settled in the hills, they faced problem of 'too much water' during the monsoon and 'too little water' after the monsoon until the beginning of the following monsoon. The relatively small amount of precipitation brought by winter westerlies helped preserve 'green' soil and groundwater; but when the monsoon was delayed, or the winter rains failed, even little water they had in springs and streams dried up, burdening their life with severe water stress. People had thus developed ways of storing monsoon rainwater so that problems arising from too much water would be reduced and at the same time additional water supply could be ensured in the dry period. They started managing runoff from the point of origin such as this seen in the picture. Runoff in the mountains starts to generate from micro-catchments in the ridge area. The runoff volume increases when it flows down with more runoff from the other areas joining the main channel.



Picture 5.1: Farms generating runoff at mountain ridge top, Bhattedanda, Lalitpur (1993)

Picture 5.2: Trails used as drainage channels

To reduce the problem arising from increased volume of runoff, people used village trails to divert runoff to suitable places before they became hazards. They paved the steep parts of the trail with stones to reduce scouring. They made steps with the paved stones to help walking on the trail. Unlike modern-day trails, which have uniform steps, they used steps of varying size to facilitate walking for their livestock. Trails are common property, and they also serve as water diversion sections.



Picture 5.2: Main trail diverting runoff at Dalchoki village, Lalitpur (1991)

Picture 5.3: Channels within farms

People built diversion channel to divert runoff from farms and around their houses. Small channels were built in the terraces. Such channels are more pronounced in areas having sandy soil than in areas having loamy soils, because concentrated runoff in sandy soil can erode lots of soil in a short period, and hence need to be diffused as much as possible. The channels collected fine soil washed from the terraces above. It was one way of minimising soil erosion and keeping it to a tolerable limit. Such channels had to be maintained every year while preparing the land before the monsoon. Water from such channels also was diverted to common trails



Picture 5.3: Farms with channels to divert runoff at Dalchoki, Lalitpur (1990)

or drainage such as a natural gully. It must be noted that letting concentrated runoff from one's field to someone else's field below is still considered a crime and can create serious conflicts in the villages.



Picture 5.4: Revived pond to catch runoff at Dalchoki, Lalitpur (1990)

Picture 5.4: Ponds to hold water

Diverted water was collected at suitable locations using simple dug out ponds about a meter or a meter-and-a-half deep and of varying sizes. Large community ponds were built in the middle of the villages, which were used to store monsoon rainwater to be used for washing, cleaning and for livestock. Ponds retained water for a few to several months depending upon the size, the age and the location of the pond. Ponds were cleaned periodically especially before the monsoon, to keep it from filling with sediment and debris. In Kathmandu Valley, a certain day on the lunar calendar around May just before the onset of the monsoon is celebrated as 'Sithi na kha', a day of cleaning canals and wells. People scraped the fine sediment deposited in the pond and used it as manure in the kitchen gardens. Though primarily meant for wallowing buffaloes, the community ponds are also used by other livestock such

as pigs, ducks, and cows. As the ponds are called *ahals* meaning a place for wallowing buffaloes, it is not clear whether people knew that ponds also helped in recharging the ground water as no reference is available to indicate use as such. In reality, the ponds helped to feed the ground water long after the rainy season, thus making more water available to the springs in the dry months. Perhaps the early settlers dug ponds to recharge groundwater and the aforesaid uses were only a bonus for few months. Bigger ponds were built in drier areas of western Nepal, much more so than by their fellow farmers in moister areas of eastern Nepal.



Picture 5.5a: A community pond at Bhattedanda, Lalitpur (1991)

Picture 5.5: Types of ponds

Ponds were of different shapes and sizes depending upon the space available. The important thing was not the size and shape of the ponds but their locations. Some ponds were located strategically to hold potentially trouble-creating runoff (picture 5.5a) while others were built to increase soil moisture for grass or dry land crops. The idea of making such ponds was to lower the peak discharge in the runoff channel. Ponds built with this purpose around the head of the landslides or gullies (picture 5.5b) helped stabilise active landslide and gullies. The early settlers understood the simple fact that if the high discharge occurring during high intensity rain is allowed to run down the hill slope unchecked,

they cause considerable damages. The same discharge, if held for few minutes in ponds, reduces the intensity of scouring and hence potential damages. High intensity rains last only for short bursts of time, often no more than 15 or 20 minutes, and such ponds have only to lop off this peak flow.

In areas where the land is more porous, big ponds may create trouble. Over topping of the pond during high rainfall can wash the sides and cause the water to flow in a gush. Therefore, in such areas, they built several small ponds rather than few big ones. Small but many ponds were usually built in grazing areas. The advantage with these small ponds is that they kept a large area moist for a little longer period to support grass growth. The important point is to understand how ponds can be built to minimise flooding and scouring risks and still meet the objective of maintaining soil moisture for a longer period in the dry post- and pre-monsoon seasons.

Picture 5.6: Private ponds

Farmers built private pond in their cultivated land in front of their houses. Water from around the house and from the front yard was collected in these ponds. Water from tap water supplies, if available, was also collected in the same pond and the water thus collected was used for irrigating vegetables. Even the sides of the ponds were used to grow plants such as cardamom. Farms, which would have looked bone dry otherwise have become lush green with winter vegetables due to ponds.

The pond shown in picture 5.6 is located in the village shown in picture 1.1, which has helped the owner to grow winter vegetables as well as stabilise the gullies in his farm.

Picture 5.7: Leveled terraces

Two or three sloping terraces in front of every house were leveled as seen in the picture. The runoff generated from the homeyard was then diverted safely to the ponds nearby. Leveled terraces help increase infiltration without adversely impacting the crop productivity while increasing the stability of terraces below. Increased infiltration sustains soil moisture for a little longer encouraging farmers to grow winter vegetables or other dry land crops.



Picture 5.5b: A pond built to stabilise gullies at Bishwaroop, Pashupati, Kathmandu (1991)



Picture 5.6: A private pond in a hill farm, Bhattedanda, Lalitpur (1988)



Picture 5.7: Leveled terraces of Bhardeo village, Lalitpur (1989)



SECTION 6

RESULTS OF PILOT ACTIVITIES

The results of BWP's work showed surprising results. Active landslides and gullies were stabilised without having to use other types of far more expensive structures. The usefulness of this technique has been acknowledged by an international soil scientist in the following words:

"Recent work of the Bagmati Watershed Project has emphasised the importance of surface water control to overall slope stability. By the simple diversion channels, they have been able to stabilise previously active landslide areas and whole terrace systems"
(Carson, 1992).

Besides land stabilisation, the other benefits to accrue from the technique has been recorded by an evaluation mission (EFGDC, 1993) of the BWP conducted by the Commission of the European Communities. The evaluation mission acknowledged that the technique consisting of terrace improvement, catchment ponds, gully and landslide control through water management and afforestation etc. effectively prevent further deterioration of resources as well as improve productivity where implemented. The mission also noted that gullies and landslides are closely associated with poorly constructed terraces and the lack of proper water management. Stabilisation of landslides and prevention of gully formation is, therefore, an essential precondition for sustainable land management. The policy of concentrating near houses enables waste water and manure to be used and provides the basis for more intense vegetable growing. The technique is simple and easy to adopt and requires no inputs not available locally (EFGDC, 1993). The examples of some of the key results are as follows.

Picture 6.1: Landslide stabilisation

This landslide at Bhainse – a mountain village in Lalitpur, was very active in 1987, seriously threatening the farms and houses in the village. Local efforts of planting grass and trees had proved futile. Retaining walls could not be built due to the steepness and the length of the slope. More complex anchored or masonry retaining walls would cost more money than could be justified for spending on a slide that endangered so few hectares of land and only some houses. However, the use of pond and drainage works stabilised the landslide. The pictures show the ‘before’ and ‘after’ situations of the landslide, which would have cost two million rupees (about USD 30,000) to stabilise using conventional technique of retaining structures.

It was stabilised with less than rupees 30,000 (USD 500) in 1990 by manipulating runoff. The landslide has experienced several heavy monsoons since then, but it has not re-activated. The entire area is expected to become more stable by the year as vegetation takes root.



Picture 6.1: Before and after pictures of a landslide that was stabilised by managing runoff at Bhainse village, Bhattedanda, Lalitpur

Picture 6.2: Gully stabilisation

Similarly, a gully had become a threat to few houses in the village of Bhardeo in 1987. Six checkdams were built to stabilise the gully but failed in the monsoon of 1988. In 1989, in an attempt to try out the pond technique, drainage channels were made above the gully to divert all water coming to the gully. Water thus collected was stored in a pond built right above the gully head. The approach helped to stabilise the gully for a nominal cost. The picture shows the ‘before’ and ‘after’ conditions of the gully.



Picture 6.2: Before and after pictures of a gully stabilised by managing runoff at Bhardeo village, Lalitpur



Picture 6.3a: T-shirt with news of floods, landslides and water scarcity (1996). See also inside back cover .

with news clippings of floods and landslides on one side and of drought and water scarcity on the other.

At the field level, however, it was a combination of techniques – leveling the terraces, building drainage channel, and ponds to store runoff water – helped to reduce nutrient loss from the terraces. This was clearly indicated by the increase in maize yield (picture 6.3b). In fact, maize yield in Lalitpur district increased gradually after 1987 and reached one of the highest among the 36 hilly districts in the country in 1992. Every farmer that

participated in runoff management reported increase in maize yield of up to 50 percent. Leveled terraces in front of the house encouraged farmers to grow vegetables. Water in the pond also helps to maintain higher level of moisture in its surrounding area which help grass for cattle to grow even in late winter. The important thing in this type of water management was that the farmer could see for him/herself the advantage of increased maize production as well as additional grass and vegetables. The farmers, however, were indifferent to increase in groundwater by their action of water management; but their fellow villagers at lower elevations could see the benefit from the action of water management above. Revival of this technique also convinced them that they have the ability and necessary skills to manage rainwater and improve their livelihood.

Picture 6.3b: The full-bodied maize cobs on the left are from water managed terraces and the stunted ones on the right are from drier, sloping terraces in Ikudol, Lalitpur (1991)





SECTION 7

WAY FORWARD

This technique of making small ponds to collect rainwater and diversion channel to divert runoff water to a desirable location is less expensive because farmers can dig them without outside assistance. Local tools and materials are used in their construction. Because there is no set limit to the size of the pond, any size that suits their need and area availability is feasible. In case the pond caves in at some point farmers can immediately repair it. BWP's effort of reviving this technique of water management showed that unlike the case with other high expertise dependent, expensive technologies, this one rather than deplete, enhances a hill farmer's resilience to disasters. It is less expensive, easy to implement, and requires neither sophisticated tools and equipment nor expertise.

However, things have changed in the last five decades, and not always for the better. This traditional technique of water harvesting and runoff management is gradually vanishing from mountains and valleys. It is sad that such a valuable and cost-effective resource management system is disappearing when we needed it most, particularly when we look at its adaptability and cost effectiveness in the context of impending food crisis. There are some obvious reasons as to why this technique is disappearing. Information given by farmers and observation in the field suggests that after piped water supply became popular among development workers and the villagers, water from far away distances was brought to the doorsteps of farmers. The official figures suggest that more than 80 per cent of the people have been provided with potable water supplies in the last four decades. With newly built systems farmers need not take buffaloes to the *ahal*, the buffalo wallowing mud pond, but could use a small pipe and bathe their buffaloes. Similarly, they could irrigate their kitchen garden with the tap water.

Additionally, malaria eradication programme was launched in the low-lying areas of Nepal during the late 1960s. One of the aims of this programme was to convince the villagers to cover all ponds that served as a breeding ground for mosquitoes. Gradually ponds were taken as a negative thing by the communities. The well-intended message did not differentiate between the ponds in the hills and the ponds in the valleys, nor did it distinguish between a pond and a pool of sewer. Piped water on one side and strong

messages from the government officials to cover the water pools on the other were enough reasons for villagers to abandon the ponds established by their forefathers for multiple purposes.

In the hills, ponds get filled with sediments, requiring voluntary community labour for its seasonal clean up. But when the farmers did not need the ponds, many of them got filled with sediments, and no one was interested in spending time and labour for what they came to believe as totally useless ends.

About the same time, education in the country was just being promoted with assistance from the US government, whose primary function was to make school buildings with playground for children. So the land occupied by the silted up ponds were flat and big enough to make school buildings with a playground in front. Then came the Panchayat system of governance guided by the king. The lower rung of the system was the Village Panchayat, which needed buildings for itself in the villages. Areas occupied at one time by ponds were used to build Panchayat buildings. In fact, many government buildings in Kathmandu Valley have been built in old ponds (Amatya, 2006). The police headquarters in Tangal, Kathmandu and the office of Lalitpur Municipality in Pulchok, Patan are glaring examples of how ponds were destroyed to build buildings. Since ponds were centrally located many small ponds have also been turned into residential areas in the valley. Encroached upon by schools, Panchayat buildings and playgrounds, ponds in the hills stood no chance of survival. And with the disappearance of ponds, all the benefits that the ponds provided too disappeared, including soil moisture retention, maintaining soil fertility and protection from erosion.

No one needed to scrape the pond floor to collect valuable silt because chemical fertilisers arrived, which were promoted in all its possible ways to modernise Nepalese agriculture. Farmers who just had started to see the light of modern development after 1950s had no choice but to believe what the new development workers had to preach. But it all came with high financial and environmental costs.

Now, we are entering into a new environmental phase of unaccustomed concerns driven by global climate change. Growing evidences indicate that global climate change is happening faster than predicted, with more unexpected extreme events like floods and droughts. In the Himalayas, glaciers are retreating and glacial lakes are expanding in size with increased threats of GLOFs (Mool *et al.*, 2002). Studies at lower elevations show that rainfall patterns at local level have changed significantly over the last decade affecting traditional farming. Livelihood of farmers have been affected due to reduced crop yield, water shortages, and increased hardships. Increased temperature has altered the environmental limits for plant distribution in the hills. Tropical plants are gradually migrating uphill (DST, 2008). There are increased incidences of plant diseases, where

they were absent in the past. Farmers' capacity to maintain food production with conventional farming is increasingly undermined by these climate anomalies.

There is an increasing consensus that the impacts of climate change will have serious consequences and hence extensive adaptation to the changes must be promoted in order to deal with emerging stresses (IPCC, 2007). But there is little understanding about how the farmers can be enabled to adapt to the changed context, especially in the hills where the impacts can be more damaging. What is clear is that the change in temperature and precipitation will lead to increased incidences of erosion, floods, and drought. In other words, the problem of 'too much' and 'too little' water as explained earlier is expected to be exacerbated with changing climate.

The story portrayed here about traditional ways of water harvesting shows that, to sustain livelihood in the hills, using dug out ponds is effective in maintaining a balance between too much and too little water. While the science behind this has been established (see pages 4, 15 and 30), it has yet to find any serious expression in the policy regarding watershed management. Promoting ponds at a larger scale will provide that space where poor farmers can start taking steps towards adaptation to the 'as yet unknown' but 'inevitable' impacts of climate change.

However, even though the farmers have the capacity to manage monsoon runoff at the farm level, they are not in a position to cover the entire watershed with required integration of hydrological details such as information about catchment area, geology, contour details, rainfall data, river discharge, hazard mapping, and inter-village water relations. This is where the role of the government becomes important. The government has the means and the capacity to collect such details, important for understanding the larger picture, by making use of high-science tools including aerial photos, contour maps, climate and hydrological information, and so on. In fact, the government's irrigation policy of 2003 (HMG, 2003) emphasises the need to promote the use of ponds. What is required is the merger of the two – the farmers' indigenous knowledge and local capacity with the government's ability to introduce high science– to achieve a powerful synergy in Himalayan water management. This is best done by public-community partnership where the government can provide technical as well as financial support to help farmers extend the use of ponds. For example, it has been suggested (Dixit and Gyawali, 1997) that village communities in 4,000 VDCs of Nepal, can all collect rainfall, temperature, and soil moisture data through a school science programme, while the government can supplement this powerful database with satellite, Doppler and other high science techniques to better understand mountain climate and changes therein. Ponds deserve to be resurrected and the technique for their massive implementation in the Himalaya must see a renaissance. Only then will poor hill farmers be part of the solution, rather than being castigated unfairly as being part of the problem.

REFERENCES

- Amatya S., 2006: *Water and Culture*, Jalsrot Vikash Sansthan (JVS) Nepal. Kathmandu, Nepal.
- Bhatt N., Shrestha L., Thomas-Styler B., 1994: *Managing Resources in a Nepalese Village: Changing dynamics of gender, caste and ethnicity*. Ecogen Case Study Series. Massachusetts, USA, Clark University.
- Carson B., 1985: *Erosion and Sedimentation Processes in the Nepalese Himalaya*, ICIMOD Occasional Paper No. 1, ICIMOD, Kathmandu, Nepal.
- Carson B., 1992: *The Land, The Farmer, and The Future: A soil fertility management strategy for Nepal*, ICIMOD Occasional Paper No. 21, ICIMOD, Kathmandu.
- Chapagain A.K., 2006: *Globalisation of Water: Opportunity and threats of virtual water trade*. Dissertation, Delft University of Technology, UNESCO-IHE, Delft, The Netherlands. Published by A. A. Balkema Publishers, a Member of Taylor and Francis Group Plc.
- Dixit A., and Gyawali D., 1997: *Dakshin Asiama Paniko Artha Rajniti: Nitigat samasya ra prastavharu* (Political Economy of Water in South Asia, Policy Issues and Proposals in Nepali), Nepal Water Conservation Foundation, Kathmandu.
- DST 2008: *Re-imagining the Rural-Urban Continuum: Understanding the role ecosystem services play in the livelihoods of the poor in desakota regions undergoing rapid change*, Research Gap Analysis prepared by the Desakota Study Team (DST) for the Ecosystem Services for Poverty Alleviation (ESPA) programme of Natural Environment Research Council (NERC), Department for International Development (DfID) and Economic and Social Research Council (ESRC) of the United Kingdom. Published by Institute for Social and Environmental Transition - Nepal (ISET-N), Kathmandu.
- EFGDC 1993: *Project Review/Evaluation Mission (CC/A/EFG/B7-3000/92/95)* Final Report by European Framework Group Development Consultant for the Commission of the European Communities, Bagmati Watershed Project, Nepal.
- FAO 2008: *Forest and Water*, FAO Forestry Paper 155. A thematic study prepared in the formulation of the Global Forest Resource Assessment 2005. Food and Agriculture Organisation of United Nations, Rome.
- HMG 1958: *Krishi Sammelan Report 2015* (Agriculture Conference Report, 2015 in Nepali), Ministry of Agriculture, Nepal.
- HMG 2003: *Sinchai Niti 2060*, (Irrigation Policy 2003 in Nepali), Department of Irrigation, Ministry of Water Resources, His Majesty's Government, Kathmandu, Nepal.
- IPCC 2007: *Climate Change 2007: Climate change impacts, adaptation and vulnerability*, Working Group II Contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report. Summary for Policy Makers.
- Ives J. D., 2004: *Himalayan Perceptions: Environmental change and the well-being of mountain people*. Routledge, Oxon, UK.
- Kantipur 2009: *Displacement of Villages due to Landslides*, News reported by Rajendra Nath in Kantipur Nepali National Daily, April 3, 2009, Kathmandu.
- Mool P.K., Bajracharya S.R., Joshi S.P., 2001: *Inventory of Glaciers, Glacial Lakes, and Glacial Lake Outburst Flood Monitoring and Early Warning Systems in the Hindu Kush- Himalayan Region - Nepal*. ICIMOD, Kathmandu.
- Thompson M., 2008: *Organising and Disorganising: A dynamic and non-linear theory of institutional emergence and its implications*. Triarchy Press, UK.
- Thompson M., Warburton M., Hatley T., 2007: *Uncertainty on a Himalayan Scale: An institutional theory of environmental perception and a strategic framework for the sustainable development of the Himalayas*. With a new introduction by Michael Thompson and Dipak Gyawali. Himal Books, IIASA, James Martin Institute for Science and Civilisation.
- Upadhya M., 2004: *Bhattedanda Milkway: Making markets accessible to marginalised farmers in Ropeways in Nepal*, Context, Constraints, and Co-evolution, (eds.) Dipak Gyawali, Ajaya Dixit and Madhukar Upadhya, Nepal Water Conservation Foundation and Kathmandu Electric Vehicle Alliance, Kathmandu.
- Uprety O.B., 2002: *Impact of Floods in Sustainable Development of Middle Mountain Communities: A case of 1981 floods in Bhardeo VDC*. Masters Thesis, Nepal Engineering College, Kathmandu.