PART III

Assessment of Land Use Changes and Their Impact

An Introduction to Land Use

On the basis of **use intensity** the land in the area can be divided into two types -- *charchit* (used) and protected or inaccessible forest land (Fig. 3.1). *Charchit* land can be divided into three subtypes on the basis of use. They are agricultural land, pastoral land, and accessible degraded forest. These *charchit* lands, apart from *galbari* (fertile alluvial land) *tar* (river terraces), and *gairibari* (gently sloping unirrigated [*pakho*]) are more susceptible to landslide hazards than protected or inaccessible forest lands. Agricultural land can again be divided into two types on the basis of its production potentials or the land system; i.e., (i) marginal and (ii) productive land. Marginal lands can also be divided into three principal types - *bagar*, *dhaden*, and *bhote khorea*. *Bagar* is an active floodplain which is covered mostly by cobbles, pebbles, and sands. Old to recent fans, which are formed by materials brought by debris flow, locally known as *dhaden*, are composed of large boulders, cobbles, and pebbles. Cultivated steep slopes are called *bhote khorea*. Because of the very steep slopes, ploughing with oxen is not possible. All these marginal lands are vulnerable to landslides and flood hazards.

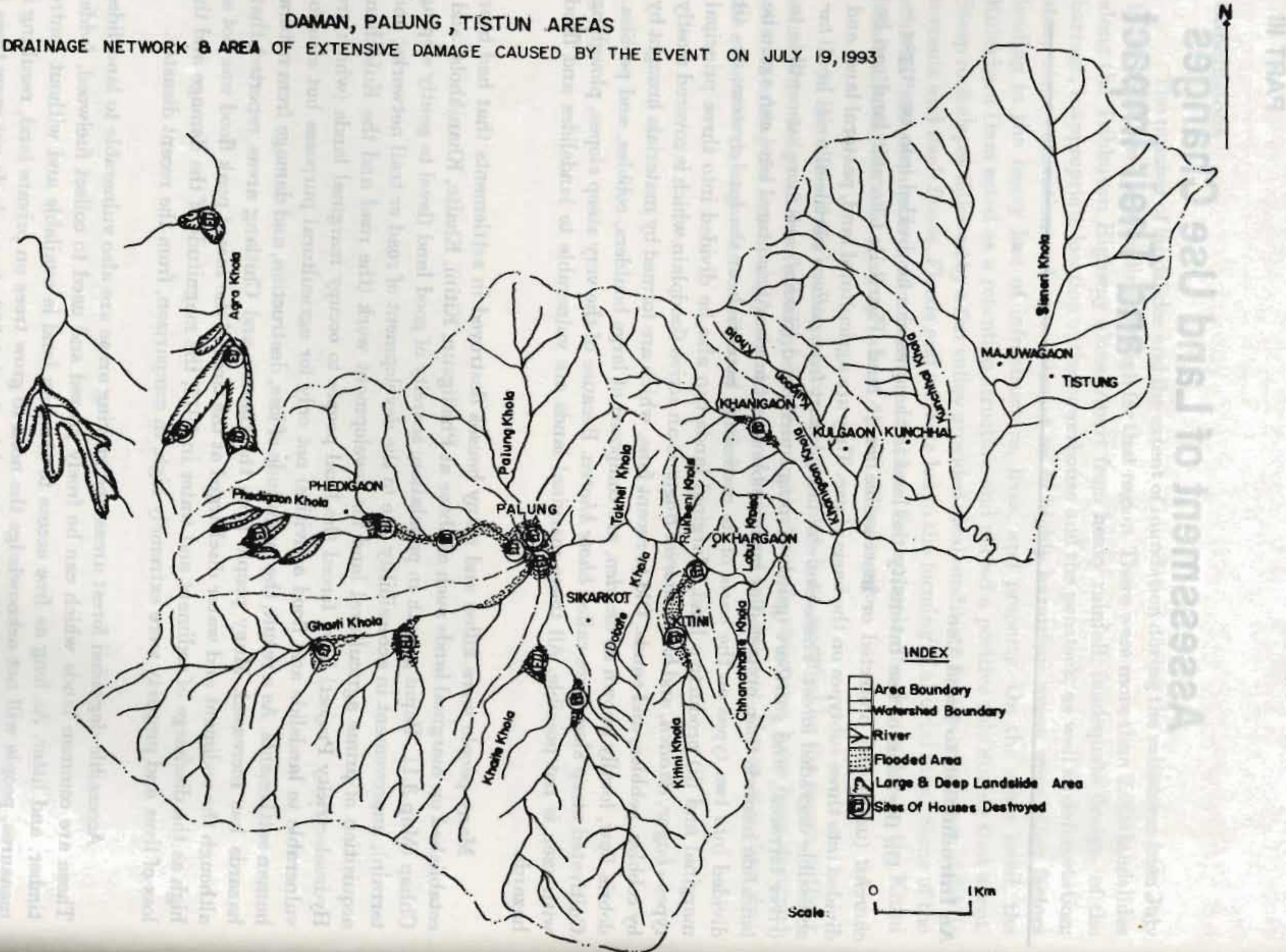
Many people were killed and many houses destroyed in settlements that had been established on marginal lands such as those at Phedigaun, Kitini, Khaite, Khanikhola, and Chhap (Map 3.1). Rapid growth in population; scarcity of good land (level to gently sloping terrain); improvement in accessibility due to the development of road or trail networks; and acquisition of prime agricultural land for development work (the road and the Kulekhani Hydroelectricity Project) have forced the local people to occupy marginal lands (which are vulnerable to landslide and flood activities) not only for agricultural purposes but also for human settlements. As a result, the magnitude of loss, destruction, and damage from natural hazards has increased. Many people from the Daman and Chitlang areas reported that, although the sediment and water discharged at the time of the recent peak flood was not as high as the discharge of sediment and water in 1915, the magnitude of the damage and the loss of lives and property were extremely high, in comparison, from the recent disaster.

Accessible degraded forest areas and grazing areas are also vulnerable to landslides. These are common lands which can be freely grazed and used to collect fuelwood, fodder, timber, and litter. As long as free access to common land is available and without control measures, people will not acknowledge the need to grow trees on private land, resulting in more pressure on common lands. At higher altitudes (>1,500m), people do not grow trees in maize fields. They state that "maize under the trees and a son in debt" are not productive. Because of free access to common lands, the people are not under pressure to change their cropping practices nor to plant trees on private land.

Map 3·1

DAMAN, PALUNG, TISTUN AREAS

DRAINAGE NETWORK & AREA OF EXTENSIVE DAMAGE CAUSED BY THE EVENT ON JULY 19, 1993



In order to reduce the use intensity of common land and eventually to minimise the damage from hazardous events, it is essential to encourage local people to plant permanent tree crops instead of maize crops, particularly on very steep mountain slopes (>30°), on the one hand, and to develop a community forestry programme on common lands on the other.

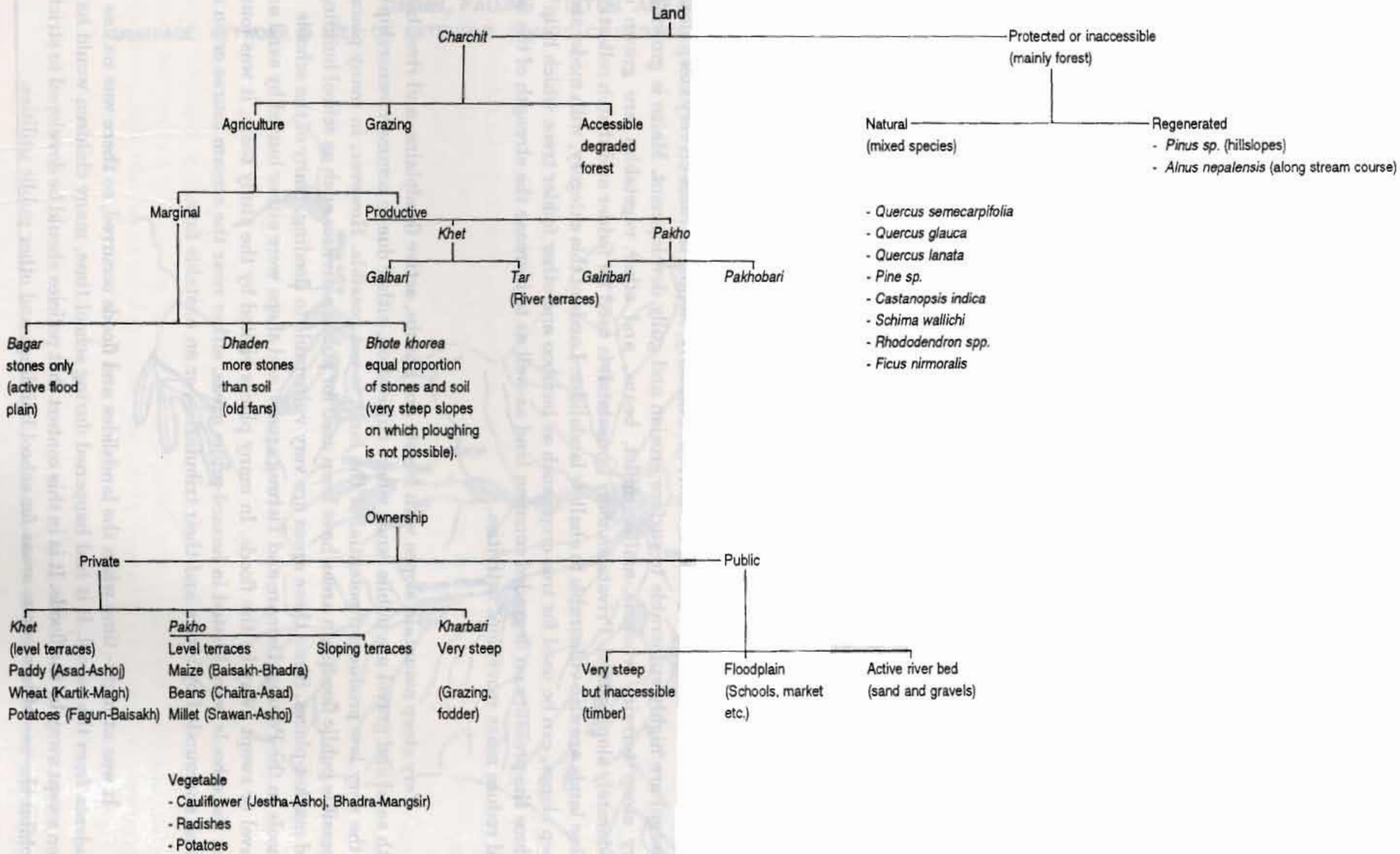
In protected or inaccessible forest areas, it is found that regenerated pine forest (both planted and protected) areas are much more vulnerable to landslide hazards than forests with mixed species, such as *Quercus* sp., *Castanopsis indica*, *Schima wallichi*, *Rhododendron* spp and *Ficus* spp, which have dense and deep root systems and where the undergrowth of other species is high. In pine forests there is no undergrowth, resulting in high surface runoff, gullies, and landslide scars. Tree species, such as pine and *Alnus nepalensis*, need less water and nutrients and grow more rapidly than other species. It is in this context that emphasis has been given to planting these species by the forestry development agencies working in this area, in order to achieve good results (to show greenery in the area) within a short period. The present afforestation strategies should be reviewed and emphasis should be given to mixed species rather than pine in order to minimise the damages of rainfall.

On the basis of **ownership**, the land can be divided into two types- private and public (Chart 3.1). Private land can be divided into three major types - *khet*, *pakho*, and *charbari* (grassland). *Khet* is irrigated land on which paddy, wheat, potatoes, and vegetables are grown. Except in places where rivers have shifted their channels, no major damage was found on this land. *Pakho* can be divided into two types - level terraces and sloping terraces. Both level terraces and sloping terraces on very steep natural slopes (>30°) are much more vulnerable to landslides. Many of the landslides occurred on very steep *pakho* where the risers are very high and the widths of the terraces are narrow. Similarly, sloping terraces on very steep slopes (*khorea*) are highly vulnerable to surface erosion and gully development. Maize is grown on very steep terrain, whereas maize, millet, beans, and other vegetables are grown on moderately sloping land. Private *khabari* (grassland) is used for fodder and thatch collection. These lands are also vulnerable to shallow landslides. Lands of this category, with moderately steep slopes, can be used for tree crops such as bamboo and other fodder trees which help to reduce the pressure on degraded common land as well as to increase the strength of the soil and reduce mass movement activities.

Very steep mountain slopes with forests and shrubs, active floodplains, and river beds with sand and gravel are public lands where cultivation, either due to common ownership or to the very low production potential of the land, is not possible. However, in many places, accessible public floodplain areas have been used for public activities such as school buildings and market-places. Since these areas are very vulnerable to flooding, many of the schools (6 schools in the Palung, Daman, and Tistung areas) and shops were either buried by sand and gravel or swept away by the floods. In many places visited by the study team, it was found that the schools were located in hazard-prone areas, either near the stream course or on an island surrounded by rivers and their tributaries, or on unstable fans.

It was at night- time when the landslides and floods occurred, so there was no loss of students from the school. If it had happened during school time, many children would have been swept away by the floods. It is in this context that policies should be developed to strictly prohibit the use of hazardous areas for school buildings and other public utilities.

CHART 3.1: LAND TYPES AND THEIR USES



Land, Land Use, and Landslide Activities in the Daman-Palung Area

An attempt was made to count the number of landslides by major land-use types, as accurately as possible, in 14 sub-watersheds in the Daman-Palung Area at the time of field work. The basin area of these watersheds and areas, according to principal land use types, was calculated from the toposheet (1:50,000) and Land Utilisation map (1:50,000), prepared by the Land Resources' Mapping Project based upon air photographs taken in 1979 and the changes identified at the time of the current field work. The result is presented in Table 3.1. The frequency of landslides in these watersheds ranges from only 15 per square kilometre in Phedignun *Khola* to 151 per square kilometre in the Takhel *Khola* watershed with an average of 47 landslides per square kilometre. A similar picture of landslide densities was reported from the Lele watershed (46 landslides per square kilometre), triggered by the cloudburst on September 30, 1981 (Manandhar and Khanal 1988). It should be noted that only the frequency of landslides was counted, without keeping in mind their magnitude in terms of length, depth, and width, and this only indicates the extent of the degradation of land by its use type rather than the actual rate of overall degradation of mountain slopes. Landslides located in drainage depressions, seepage hollows, and along major streams were found to be very large and deep, producing a huge volume of materials and destroying large areas on the footslopes and floodplain areas. For example, although the frequency of landslide scars per unit of area is comparatively very low in the Phedignun watershed, the volume of sediment produced by these landslides was much higher. The loss of lives and property in lowland areas was significantly higher than in the Takhel *Khola* watershed where the frequency per unit of area is very high, where most of the landslides are small and shallow, and the loss of lives and property is comparatively very low.

Table 3.1 Frequency of Landslides by Land Use Types

Name of watershed	Total no. of landslides	No. of landslides per km^2	Cultivated land per km^2	Grazing shrub degraded forest (per km^2)	Forest
Phedigaun	85	15	8	80	20
Gharti *Khola*	175	19	4	101	11
Palung *Khola*	95	24	10	63	3
Takhel *Khola*	168	151	126	212	na
Rukbeni *Khola*	35	58	30	82	na
Lobu *Khola*	106	103	53	483	na
Khaite *Khola*	153	23	12	100	19
Dobate *Khola*	23	20	-	105	na
Kitini *Khola*	134	67	28	140	na
Chhanchhane *Khola*	144	127	57	216	na
Khanigaun *Khola*	441	136	137	156	54
Kulgaun *Khola*	148	86	60	200	na
Kunchhal *Khola*	355	102	86	209	na
Sisneri *Khola*	421	37	47	39	11
Average		69+47	47+42	168+102	20+16

Source: Field Survey

The density of landslides on cultivated land ranges from less than four per square kilometre in Dobate *Khola* and Gharti *Khola* watershed, where valley cultivation and footslope cultivation are comparatively intensive, to 127 per square kilometre in Takhel and 137 per square kilometre in Khanigaun *Khola* where the proportion of sloping terraces on steep slopes is very high. The number of landslides per unit of grazing land, including shrubland and degraded forests (with crown densities of less than 40%), is significantly high, ranging from 80 landslides per square kilometre in Phedigaun to more than 200 in Lobu *Khola*, Takhel *Khola*, Chhanchhane *Khola*, Kulgaun *Khola*, and Kunchhal *Khola* watersheds. The number of landslides per square kilometre of forest area (crown densities >40%) ranges from three in Palung *Khola* watershed to 54 in Khanigaun *Khola* watershed. On an average, the number of landslides per square kilometre of land ranges from 47 with a standard deviation of 42 on cultivated land to 168 with a standard deviation of 102 on grazing land, including shrubland and degraded forest areas, and 20, with a standard deviation of 16, in dense forest areas. Overgrazed areas, including grazing land, shrubland, and accessible degraded forest areas are much more vulnerable to shallow landslides than inaccessible, dense forests with mixed tree species and cultivated land. However, the number of landslide scars, even on cultivated land on steep hillslopes, and particularly on sloping agricultural fields, is very high.

A detailed study was carried out on four hectares of maize fields in the Kunchhal area and the results are presented in Table 3.2.

Table 3.2: Landslides in a *Pakho Bari* (maize field) near Kunchhal Village

1. Total area of the study plot : 3,9732 square metres (3.9732 ha)

2. Size of the Landslides:
   Range: 1.25-787 square metres
   Mean : 109 square metres

Size class:	Size	No. of landslides	Percentage
	$<20m^2$	23	47
	20-59	8	16
	60-99	2	4
	>100	6	33
	Total	49	100

3. Total area occupied by landslides: 5325.37 square metres
4. Percentage of area covered by landslides: 13.4
5. Total volume of materials eroded: 7676.19 cubic metres
6. Average volume of materials eroded from one landslide: 156.7 cubic metres
7. Total volume of materials transported from the area: 4771.29 cubic metres
8. Soil loss from the study plot: $0.12m^3/m^2$ or $1201m^3/ha$

9. Natural slope of the landslide area: >30°

Slope category	No. of Landslides
30-35°	24
36-40°	23
>40°	2

Source: Field Survey

There was a total of 49 landslides with sizes ranging from 1.25 square metres to 787 square metres. The average size of these landslides was 109 square metres. Out of these 49 landslides, the average size of 23 landslides was less than 20 square metres, whereas the average size of 16 landslides was more than 100 square metres. The natural slope of these landslides was more than 30°. Hillslopes of more than 40° have been brought under cultivation, and these lands were found to be much more vulnerable to landslides. Nearly 13 per cent of the total maize field is occupied by landslides. Nearly 7,676 cubic metres of soil was removed from the terraces of which 4,771 cubic metres (62%) was transported from this area. In this way nearly 1,201 cubic metres of soil were eroded from one hectare of maize field because of this single event. The heights of the risers of such maize fields ranged from 1.3m to 4.5m, with an average of 2.5m, and the widths of the terraces ranged from 1.9m to 5.7m, with an average of 3.2m.

The area occupied by landslide scars was found to be slightly higher, i.e., 18 per cent on agricultural and grazing land in Lobu *Khola* watershed near Okhar *Bazaar*.

An attempt was also made to examine whether there is a relationship between the density of landslides and geology and land use types. As mentioned earlier, the study area consists of two major geological units - one of more resistant granite in the south west of Palung *Khola* and another of less resistant rocks of slate, quartzite, phyllites, and marble. The number of landslides observed and the area of different rock types are presented in Table 3.3. The number of landslides per square kilometre of land as a whole is 47, whereas it is only 31 in the granite area and 57 in areas with comparatively less resistant rocks such as slates, quartzite, phyllites, and marble. Although the frequency of landslides per unit of land is comparatively very low in the granite area, the size of boulders in the river bed in this area is comparatively very large compared to the size of boulders in the area of slates, quartzite, phyllites, and marble, and most of them have round shapes.

Table 3.3: Frequency of Landslides and Geology

Geology	Total no.of landslides	Area km^2	No of landslides per km^2
Granite	629	20.26	31
Slate,quartzite, phyllites, and marble	1854	32.27	57
Total	2483	52.53	47

x2 value: 4.71

Source: Field Survey

The percentage of grazing, shrub, and degraded forest on the total land area; percentage of hillslope cultivation on the total cultivated land area; percentage of sloping terraces on cultivated hillslopes; percentage of degraded forests in total forest land; percentage of shrubland and pine forests in total forest and shrubland, which are thought to be much more vulnerable to landslide scars, its average score by watersheds; and the frequency of landslides per square kilometre are presented in Table 3.4. It indicates that there is a close relationship (with a correlation coefficient of 0.77) between the average score of these land use parameters and the frequency of landslides. It is in this context that, if the land is managed properly, the magnitude of damage can be minimised.

Table 3.4: Frequency of Landslides and Land-use Characteristics

Watersheds	1	2	3	4	5	6	7	8	9	10
Phedigaun	5.71	15	84	9	7	66	100	55	0	46
Gharti *Khola*	9.42	19	36	11	53	62	11	17	11	22
Palung *Khola*	3.94	24	49	29	22	81	100	57	54	64
Takhel *Khola*	1.11	151	70	30	0	94	100	100	100	85
Rukbeni *Khola*	0.60	58	45	55	0	28	100	100	100	77
Lobu *Khola*	1.03	103	88	12	0	74	100	100	100	77
Khaite *Khola*	6.56	23	23	8	70	87	0	10	100	41
Dobate *Khola*	1.15	20	81	19	0	58	0	100	100	55
Kitini *Khola*	2.0	67	65	35	0	71	0	100	100	61
Chhanchhane	1.13	127	55	45	0	79	0	100	100	65
Khanigaun *Khola*	3.19	138	53	40	7	100	100	84	84	82
Kulgaun *Khola*	1.72	86	81	19	0	100	100	100	21	68
Kunchhal *Khola*	3.47	102	80	14	0	81	100	100	100	79
Sisneri *Khola*	11.5	37	50	27	23	66	100	54	59	61

1. Basin area in square kilometres
2. No of landslides per km²
3. Percentage of cultivated land
4. Percentage of grazing land including shrub and degraded forest (crown densities of less than 40%)
5. Percentage of dense forest (crown densities of more than 40%)
6. Percentage of hillslope cultivation in total cultivated land
7. Percentage of sloping terraces in total hillslope cultivation
8. Percentage of degraded forest in total forest area
9. Percentage of pine forest, including shrubland, in total forest area
10. Average score of 4,6,7,8, and 9.

Correlation coefficient between the frequency of landslides (2) and use type (10): 0.77

Source: Field Survey and Land Utilisation Map prepared by LRMP

History of Land-use Change

Increasing demands for fuelwood, fodder, and timber, as well as for land for agricultural use and housing as a result of population growth have been leading to encroachment on to forest and marginal lands such as very steep hillslopes, active floodplains, and unstable fans. In addition, development works, such as the construction of the Tribhuvan Highway and the Kulekhani dam, and the establishment of a horticultural farm in the area, have also led to encroachment on to very steep slopes for cultivation and on forest land for timber, firewood, and fodder. It was reported that deforestation, as well as degradation of, natural forests, commenced in 1952 when the feasibility study for the Tribhuvan Highway was carried out. Before then, there was a dense religious forest of mixed species, known as the forest of Mahadev-Parbati, in the Chhanchhane *Khola* watershed. It was protected by the local people. No one was allowed to cut green trees from this forest. At the time of the feasibility survey, when the army entered the forest to collect firewood, the local people could not protect it. As a result, the traditional system of protection broke down and the forest was open to all the local people and was converted into shrubland. Similarly, many forest areas along the highway began to deteriorate from this time.

The horticultural farm was established at Daman in 1960. Nearly 72 ha of previously forested land (before 1960) was cleared for horticultural activities. It led to an increase in pressure on the remaining forest land for fuelwood, fodder, and timber.

Quite a large area of fertile agricultural land was inundated after the construction of the Kulekhani Hydroelectricity project. Although the project had provided land compensation to local people, these people could not migrate to other places with the money they had received. They were forced to settle and encroach on very steep slopes and forest land in nearby areas.

Local people used to collect medicinal plants and herbs and export them to India. According to them, nearly 50 full trucks of these medicinal plants were exported to India annually. The principal plant species include *majhito* (*Rubia cardifolia*), *chiraito* (*Swertia chiraito*), *pakhanbed* (*Bergenia Pigulata*), *jeewanti* (*Demotrichum tibritum*), *kutki* (*Picrorhiza kurroa*), *archuro*, *panisaro*, *kurilo*, *thunke*, and *jhyau* (*Lichenes* spp). The principal species on which lichens grow are *Quercus* spp., *Castanopsis indica*, and *Lithocarpus grandifolia*. In order to collect lichens one has to climb the tree and rather than doing that people would cut down the branches as well as the trees. Thus, uncontrolled collection of these medicinal plants and herbs has led to the degradation of natural forests in the area. It was reported that forest fires are frequent in the Mahabharat Range, causing degradation to forest resources. It was also reported that a large forest fire last year caused the accelerated decay of tree roots, decreasing the cohesive strength of the soil and hence leading to many landslides at the time of high precipitation.

Summing Up

Mountain precipitation is very complex and varies a great deal with time and space. Landslides and flood hazards associated with high intensity precipitation are not uncommon, although their impact is confined to small areas. There were two different, very high intensity precipitation events with recurrence intervals of from 80 to 150 years. The area coverage of such high intensity rainfall ranges from 500 to 800 square kilometres. Damage by landslides and flood hazards generated by high intensity precipitation was not confined to the upper catchment area where the high intensity precipitation occurred. It caused damage at least 60km downstream. The natural and man-made causes that triggered the recent hazards and damages are summarised in Chart 3.2.

It is evident that apart from high intensity precipitation, geological and tectonic activities; climatic factors, such as a wide temperature range as well as the drainage pattern network (sharp bends in channels and the merging of tributaries with the main river more or less at right angles); and the steep channel profile are other natural factors still responsible for triggering the hazards and the magnitude of the damage.

Chart 3.2: FACTORS WHICH ARE RESPONSIBLE FOR TRIGGERING THE DISASTER OF JULY 19 AND 20, 1993

Main Cause: Climatic (high intensity rain with recurrence intervals from 80 to 150 years).

Other Causes

Natural

Geologic:-
- Tectonically very active mountain systems (the mountains are rising, resulting in very steep slopes and intensifying down-cutting activities as well as reworking previously deposited materials along the streams. Most of the large, deep landslides are located along the stream and recently formed fans are more vulnerable).
- Structure (jointing systems of rocks caused to produce large boulders).

Climatic:- High range in seasonal temp. (very cold winters with frost and snow and hot summers).

Drainage Network:-
- Sharp bend in the river course, cause of partial damming and deposition of bed materials resulting in flooding.
- Areas where tributaries are merging in more or less at right angle are much more vulnerable to the flood.

Cumulative Effect of Past Events:- Earthquakes, precipitation and landslide activities in the past (reinitiation of landslides).

Others

- Encroachment on marginal and forest land due to rapid growth in population (cultivation on very steep slopes up to 45° and maize-based, subsistence agriculture).
- Free access to common lands (no need to grow trees on farmland).
- Deforestation and frequent forest fires.
- Lack of long-term experiences about the environment in recently habitated areas, particularly in *Churia*, *Bhabar*, and the inner *terai* region.
- Emphasis on result-oriented programmes in forestry (*Pinus* spp and *Alnus nepalensis*).
- Construction of private and public buildings on unstable land, particularly in accessible areas without keeping in mind the possible risk of hazards that could be occur frequently.
- Abstraction of sand and gravel along streams.
- Development activities such as -
- Horticultural farms (previously forested area).
- Kulekhani hydro project (forced people to encroach marginal land).
- Road construction (pressure on forests).
- Quarrying on steep slopes and on steep river banks along the stream (rise in bed level causing lateral erosion).
- Lack of records about such information and lack of their application in designing major construction works (Bagmati barrage, penstock, checkdam on the Rapti and many bridges).
- Lack of communication systems (information exchange and warning).
- Lack of scientific investigation of such events in the past.

These mountains are rising, resulting in very steep slopes and intensifying the down-cutting activities, as well as reworking the previously deposited materials along the streams. It should be noted that high intensity precipitation, although small in magnitude, and the size of the area covered are common before such disasters. Cracks and landslides occur on the mountain slopes and, in such situations, mass movement activities are inevitable. These natural factors cannot be controlled or improved through human efforts. However, there are other factors that are responsible for triggering the hazards. These include deforestation; encroachment on marginal lands (very steep slopes, active floodplains, and fans), even for housing; unmanaged quarrying; and extraction of sand and gravel from the river bed. It should be noted that many of the settlements and houses that were destroyed by the recent event in the mountain areas (both in the Churia and Mahabharat areas) were new (within 40 years) and were located in hazard-prone areas (fans or floodplains, or near drainage depression areas, or on very steep mountain slopes). Although agricultural fields were also damaged substantially by this event, most of these fields can be repaired or reconstructed within a two- to three-year period, which is not the case for the other damage incurred.

There is little information on the environmental consequences of natural hazards (both geologic and climatic), and there is no government agency responsible for monitoring the watershed conditions and identifying potential hazard areas and warning systems. Flood-warning systems have not yet been developed. It took two to four hours for the peak flood to arrive from Bhimphedi (the high intensity precipitation area) to Bhandara and Kumroj (Chitwan) in the downstream area. If information about the flood had been communicated more speedily, the loss of life and property would have been minimised. People living in the downstream reaches from the Kulekhani dam site are concerned about the timings of the opening and closing of the dam gates, since there is no system by which this information is communicated to them.

It was also found that development projects, such as road and dam construction, and activities which are confined to forest areas, such as the horticultural farm at Daman, had neglected the environmental consequences of their activities in the past. Efforts of the forestry as well as of the agricultural development projects in the area to improve watershed conditions were found to be ineffective in minimising the impact of the event, because of their result-oriented (rather than sustainable) development programmes.

Construction of infrastructure without proper understanding of the geohydrological processes, particularly the discharge of water and sediment and discharge types, has also led to hazardous activities. For example, if the designer of the Bagmati barrage had known the size and the volume of logs that could be brought down by the river, there would have been no damming and floods would not have been so big in the downstream reaches. Similarly, if the engineer had known the size of the boulders, that could be brought down by the Jurikhet *Khola*, he would have constructed a tunnel to protect the penstock pipe from debris flow instead of constructing two checkdams in the upper reaches.

There is no scientific investigation into the magnitude and consequences of the big events occurring in the past in other areas of the country. Exchange of information among the development agencies, as well as among independent researchers, is poor. It is still difficult for interested independent researchers to find the hydrometeorological records of a particular event.

It should be noted that the discussion presented earlier is based on a relatively short field visit and consequently some of the conclusions are tentative, to be confirmed by further research in the future. However, in spite of various limitations, a number of issues can be identified for future action.

Because of the inherently unstable nature of mountain areas, the probability of hazardous events is very great. Reports by local people also suggest that hazard events of varying intensity have occurred quite frequently. These events will also definitely continue to occur in the future because of the nature of the environment. The present level of understanding and analysis of these natural events are very poor. No database exists. No monitoring activities are carried out on a regular basis, even in cases where such monitoring can be of direct benefit to project-related management activities.

Not all natural hazards necessarily become natural disasters. A natural hazard turns into a natural disaster when these naturally occurring hazards result in heavy loss to human lives, property, and other economic assets. This happens when human activities, on account of limitations of knowledge, resources, capacities, and alternatives, take place in natural hazard zones. Different types of natural hazards have different types of spatial manifestations, and once these are occupied by human activities, these naturally become subject to such events. The fact that a natural hazard area has been occupied increases the probability of a natural hazard becoming a natural disaster, depending upon the extent to which precautionary measures are affordable and are actually taken.

In the present case of the natural events of July 19 and 20 in the southern parts of the Central Development Region, the fact that different types of natural hazards occurred was not surprising nor unknown. Recent histories of such events are still quite vivid in people's memories. The fact that they turned quickly into a natural disaster of catastrophic proportions has a lot to do with human decisions and activities in and along the natural hazard zones in the area. Ironically, while some interventions undertaken to provide protection from such events failed and resulted in even greater damage, because of a number of critical oversights in technical decisions, other losses of economic assets were the result of technical incompetence in coping with fairly predictable and recurring natural events. No specific examples are provided because these initial indications need to be validated by a thorough technical enquiry of all the major physical assets that were damaged and destroyed during the recent natural events of July 19 and 20.