Chapter 3

Land Resources and Land Degradation

Land Resources

Land is a nonrenewable (fixed stock) resource, although it has a renewable capacity to support most forms of biological life. Land, on which activities such as agriculture, forestry, and pasture depend, constitutes about 97% of Nepal's total area. But not all land can be used; the country's topography is rugged with over three-quarters of the total area made up of mountains and inter-mountain valleys. The Terai plain makes up less than one-third of the total area but has the largest cultivated area and population. The Hills, which have traditionally had the bulk of the population, constitute the largest area but are geologically fragile; over time this area's relative share of the population has reduced in favor of the Terai.

Nepal is an agrarian country with over 60% of its economically active population dependent on agriculture, so agricultural and forest lands are very important. Forest covers the largest part of the land area (37%) and is a major source of fuelwood as well as an important factor protecting biodiversity, water, and other watershed resources. The Land Resource Mapping Project (LRMP 1986) and Japan Forest Technology Association (JAFTA 2001) are two of the major sources of forest data, although they are not directly comparable in their classification of land uses and survey techniques. The information for the first source was derived from analysis of aerial photographs together with ground truthing, while the latter was derived from the digital analysis of satellite images. These are the best available sources for data on distribution of land resources by district, and for the purposes of this report, their data were made comparable by generating new broad land-use classifications. Data available at district level have been aggregated into the Mountain, Hill and Terai regions. When interpreting these data, it should be remembered that not only were different methodologies used but also the figures do not differentiate in terms of crown cover or other measures of forest health. For example, even a marked level of deforestation would not be apparent, if crown cover remained above 10%.

The people:land ratio is used to examine the pressure of population on land resources available for cultivation; for 2001 it was 5.7 persons per hectare (pph), compared with 5.6 pph in 1981 (CBS 2003)—an insignificant change during the last two decades. The Mountain zone has the lowest ratio with 3.3 pph, followed by Terai (6.0 pph) and Hill (6.2 pph) zones. The people:land ratio ranges from 1.6 pph for Solukhumbu to 383.7 pph for Dolpa (both mountain districts). However, this is a crude method for assessing the population and land resource relationship. It does not consider the quality of land and the ways land resources are used.

Economic (agricultural) density measures the ratio between the share of total population and the share of total agricultural production by weight. Table 3.1 shows that the economic density (ED) is highest for the Mountains and lowest for the Terai.

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Secondary Growth Trees

Land Use and Land Cover Change

The distribution of land according to land use types is shown in Table 3.2. Agricultural land is an important resource, it occupied 23.5% of total land uses in 1986 increasing to 28% in 2000. Expansion of agricultural land is a major problem, as it continues to expand to

Table 3.1: Agricultural Economic Density, 2001

Region	Agricultural Production (tons)[a]	Population[b]	Share of Population (SP)	Share of Agricultural Production (SA)	ED = $100\left(\frac{SP}{SA}\right)$
Mountain	597,290	1,687,859	0.073	0.052	140.7
Hill	3,900,035	10,251,111	0.443	0.338	130.9
Terai	7,033,000	11,212,453	0.484	0.610	79.4
Nepal	**11,530,325**	**23,151,423**			

ED = economic density
Source: [a]MOA (2002), [b]CBS (2002)

Table 3.2: Distribution of Land Uses by Region

Land Use Category	1986[a]		2000[b]		Change 1986–2000	
	Area		Area		Area	
	(ha)	(%)	(ha)	(%)	(ha)	(%)
Agriculture	3,461,069	23.52	4,150,979	28.10	689,910	19.93
Forest (including shrub)	6,211,522	42.20	6,788,292	46.12	576,770	9.29
Other	5,045,509	34.28	3,778,829	25.67	(1,266,680)	(25.11)
Nepal	**14,718,100**	**100**	**14,718,100**	**100**		

ha = hectare
Note: To make the LRMP and JAFTA sources comparable, three broad land use categories were obtained. According to the LRMP definition, shrubland has been included in the forest category; no change was made in the agricultural category in either source; and other land uses such as grazing, water bodies, snow, rocky and barren land, and built -up areas have bee n incl uded under the " other" category.
Source: [a]LRMP (1986); [b]JAFTA (2001)

meet the growing demands of the population. Each year, the increasing population is forced to remain in agriculture because of very limited opportunities in non-farm activities.

Table 3.2 shows that total forest coverage including shrub apparently increased between 1986 and 2000, however this may be the result of the different forest survey methods used rather than reflecting a real change (see above). Although more land is being used for agriculture overall, the most fertile lands are being converted to non-agricultural uses for urban areas, industries, road construction, and biodiversity conservation or buffer zone conservation. Large cities are encroaching upon prime agricultural land. This increment could be

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Intercropping between Trees

causing the decrease in the "other" land use category (Table 3.2).

The overall share of agricultural land apparently increased from 24% in 1986 to 28% in 2000 although it declined in the Hills (Table 3.3). The overall per capita agricultural land declined slightly from 0.19 ha to 0.18 ha, but the main decline was in the Hills while in the Mountain region it increased.

The share of forest land apparently increased from 42% in 1986 to 46% in 2000 as a result of increases in the Mountains and Hills; the Terai forest area declined (Table 3.3). The overall per capita forest area declined from 0.34 hectare (ha) in 1986 to 0.29 ha in 2000, although there was a slight increase in the Hill region.

At the national level, both forest and agricultural land resources have increased, which could be due to a decrease in the area devoted to other land uses, but the per capita area of both resources has decreased, mainly because of population growth.

Land Degradation

Land degradation generally refers to loss of utility or potential utility of land or to the reduction, loss, or change of features of land or organisms that cannot be replaced (Barrow 1991). Land is degraded when it suffers a loss of intrinsic qualities or a decline in its capabilities.

Table 3.3: Change in Agricultural and Forest Lands by Region

Region	Agricultural Land (%)		Per Capita Agricultural Land (ha)		Forest Land (%)		Per Capita Forest Land (ha)	
	1986[a]	2000[b]	1986[a]	2000[b]	1986[a]	2000[b]	1986[a]	2000[b]
Mountain	5.33	10.02	0.19	0.31	27.50	31.03	0.99	0.95
Hill	33.37	28.06	0.24	0.17	50.06	62.89	0.36	0.38
Terai	41.57	56.17	0.16	0.17	50.43	38.88	0.20	0.12
Nepal	**23.52**	**28.20**	**0.19**	**0.18**	**42.20**	**46.12**	**0.34**	**0.29**

ha = hectare

Note: The population for de nsity computation of agricultural and forest resources in 1986 and 2000 is based on the 1991 and 2001 population censuses respectively.

Source: [a]LRMP (1986); [b]JAFTA (2001)

Environments and ecosystems are increasingly more controlled or disrupted and degraded by human activities. Landslides, topsoil erosion, siltation, and salinization are different forms of land degradation. Visible forms of land degradation include dust storms, deep gullies, and landslides.

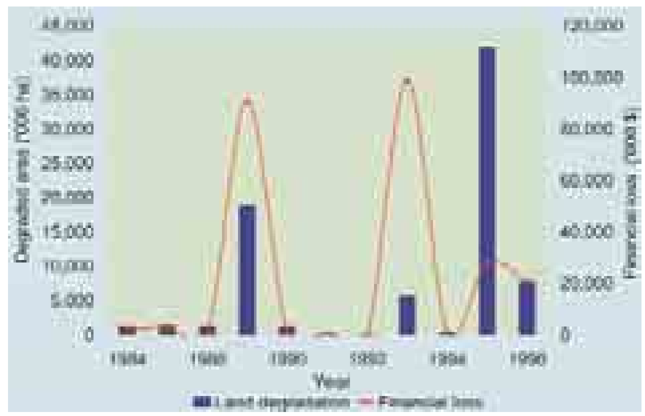
Causes of Land Degradation

The magnitude of land degradation in a place depends on the local geology, land type, landform, land use, rainfall intensity, and human activity. Land degradation results from any causative factor or combination of factors that reduces the physical, chemical, or biological status of land and which may restrict the land's productive capacity. Land degradation is due to (a) natural (biogeophysical) causes, (b) human causes, or (c) a combination of both. Owing to the complex features of the mountain terrain, the nature of land degradation varies greatly in Nepal.

Landslides are the most important factor in land degradation in Nepal. Landslides occur almost every year, particularly in the sloping areas of high mountains and low hills during the monsoon season. The consequences of landslides include topsoil erosion; damaged and destroyed roads, trails, and bridges; loss of land, lives, and property; and siltation in low-lying areas resulting in unproductive land (Figure 3.1). About 1.8 million ha (13%) of the land in the Mountains is estimated to be severely degraded by landslides (CBS 1998).

Table 3.4 provides information on soil erosion rates for different land uses, rock types, and slope levels in the country. The soil erosion rate is higher in the unmanaged land use category and on steep slopes than in the managed land use category. Similarly, intensity of soil loss is found less in cultivated lowlands than in rain-fed sloping terraces, ranging from as low as 7.8 tons/ha/year in the forested Siwalik hills to as much as 570 tons/ha/year in the unforested midhills (CBS 2004). In the middle Hills of Nepal the rate of soil loss in grassland is 0.7-

Figure 3.1: Land Degradation and Financial Loss Due to Floods and Landslides



Source: CBS (1998)

Bare Land Exposed to Erosion, Mustang

Table 3.4: Estimated Soil Erosion Rates at Selected Sites in Nepal

	Location and Characteristics	Land Use	Erosion Rate (tons/ha/year)
Siwalik Range	Eastern Nepal: south aspect, sandstone foot hills	Forest to grazing	7.8–36.8
	Far West Nepal: south aspect , sandstone, foot hills of Surkhet	Degraded forest	20.0
		Gully land	40.0
		Degraded, heavily grazed gully land	200.0
Middle Mountain	Central Nepal: Mahabharat Lek, steep slope, metamorphic and sedimentary rocks	Degraded forest and agricultural land	31.5–40.0
		Gully land	63.0–420.0
		Degraded forest and shrub land	27.0–45.0
	Kathmandu Valley: northern foothills	Overgrazed shrub land	43.0
		Severe gully land	125.0–570.0
	Kathmandu Valley: south	Dense forest (75%)	8.0
	Pokhara Valley: Phewa Tal wate rshed	Protected pasture	9.2
		Overgrazed grass land	22.0–347.0
		Gully, overgrazed grass land	29.0

ha = hectare
Source: CBS (2004) Table 4.36.

8.7 tons/ha/year, which is less than the 2.5–16.4 tons/ha/year over cultivated terraces. Likewise the rate of land loss in open degraded areas is 25–40 tons/ha/year compared with 3–25 tons/ha/year from cultivated outward sloping terraces (ICIMOD 1998). However, erosion rates in excess of 200 tons/ha/year are common in grazing lands below 1,000 masl where there is overgrazing, which causes gully erosion (Carson 1992).

Owing to weak geological formations such as shallow and coarse lands and loosely compacted rocks, the Churia hills are more vulnerable to rainfall than the mountain areas. As a result, the bare slopes of the Churia hills are readily exposed to degradation every rainy season. The meteorological data show that the Churia hills receive much more intense rainfall than the northern high mountains. Intense soil loss from the Churia hills takes place during the pre-monsoon season when there is less vegetative cover. About 60–80% of all annual soil loss occurs during the pre-monsoon season (DSCWM 1999).

The mountain terrain is rugged and characterized by unstable, steep slopes, making it vulnerable to exogenous factors. The torrential monsoon rainfall that occurs within a short span of time is an important cause of soil erosion. Different forms of mass wasting such as landslides, slumps, rock falls, and river cuttings also contribute to sedimentation in the valleys, plains, and river basins and cause degradation of soil fertility.

The Himalayas (covering 15% of Nepal's area) are also susceptible to land degradation from glacial lake outburst floods (GLOF). Since the second half of the 20th century, the high mountains have been experiencing melting of their large glaciers, resulting in the formation of a large number of glacial lakes behind the unstable "dams" formed from the now exposed end moraines. A slight disturbance can break the balance of the dam, resulting in an abrupt release of a great amount of water and generating floods that can cause serious damage to infrastructure, houses, and the environment downstream. A recent study identified 27 potentially dangerous lakes in the Nepal Himalayas, and found that GLOF events had occurred in 10 of them in past years (Mool et al. 2001). Nepal experienced its most catastrophic glacial lake outburst from the Dig Tsho in 1985.

Anthropogenic activity is equally significant for land degradation. Deforestation, overgrazing, inappropriate use of agro-chemicals, production intensification, shifting cultivation with a shortened cycle, development work, maldistribution of landholdings, industrial waste, and others are all important causes of land degradation.

Glacial Lake Outburst Flood Events

The periodic or occasional release of large amounts of stored water in a catastrophic outburst flood is referred to as a glacial lake outburst flood (GLOF). GLOF events are severe geomorphological hazards and their floodwaters can wreak havoc on all human structures located in their path. Much of the damage created during GLOF events is associated with the large amount of debris that accompanies the floodwaters. Damage to settlements and farmland can take place at very great distances from the outburst source. In Nepal, GLOFs have caused extensive damage to major infrastructure like roads, bridges, trekking trials, and villages, as well as incurring loss of human life (WECS 1996). The government has undertaken some mitigation steps to minimise the risk from one lake by establishing a telemetric early warning system in Tsho Rolpa and lower areas that could be affected. The open canal constructed to lower the lake level of Tsho Rolpa Glacial Lake has been operating since June 2000.

Source: Mool et al. (2001)

Clearing forests for cultivation to meet the food requirements of the growing population, particularly over the sloping areas of the middle Hills, has resulted in accelerated soil erosion, declining productivity, and sedimentation in downstream areas and the Terai plains (Zimsky 1999). Forest resources have also been pressured by increasing numbers of livestock, from 14.9 million head (equivalent to 9,790 thousand livestock units (LU) in 1984 to 17.6 million head (11,226 thousand LU) in 1998. The increasing livestock population has increased the demand for fodder and leaf litter from the forest, causing land erosion especially in the mid Hill region.

Land degradation due to desertification has been seen over about 10,000 ha of dry and cold land in the western Himalayan districts such as Dolpa and Mustang. This is mainly due to scanty vegetation on marginal land grazed by an excessive number of livestock.

Agricultural land is subject to ever-greater intensification of use through double and multiple cropping to produce more food for the increasing population. Soil micronutrients are depleting due to overuse, inadequate supplements, and imbalanced application of fertilizers. For instance, the most recent data available (DOA 2000) show low or medium nitrogen content in 48% and 40% of of 9,827 farmland samples analyzed; 64% of 7,520 farmland samples had low organic matter and high to medium potassium content and 35% had low phosphorous content and overall deficiency in micronutrients such as zinc, manganese, molybdenum, copper, iron, and boron.

These results indicate the highly nutrient deficient status of farmland. As a result, productivity of crops has declined. The impact appears to be much more serious among poor farmers who mostly cultivate marginal lands on steeper slopes. The yields of maize and millet declined by more than 4% per annum between 1977 and 1997, while those of paddy and wheat increased by 16–37% per annum, due mainly to increased use of agro-chemicals (MOA 1999). The use of high yielding seeds has increased the yield of crops per unit of land, but has resulted in less production of crop residues and greater uptake of soil nutrients. This has forced farmers to depend more on fertilizers than on manure, as well as to use different types of insecticides and pesticides. Consumption of fertilizers (nitrogen, phosphate, and potassium) increased from 7 kg/ha per year in 1980 to 25 kg/ha per year in 1993.

Average use of fertilizer by district ranges from less than 10 kg/ha to more than 100 kg/ha. The fertilizer use by Nepalese farmers is lowest among the South Asian countries. The use of pesticides is on the increase. In 1998, the most recent year for which reliable data are available, about 250 types of pesticide, 40 types of herbicide, and various different fungicides were used to minimize the loss of agricultural production to pests and insects (MOF 1999). However, despite the use of pesticides, crop yields have not increased significantly even though the land ecology has been degraded. In commercial farming, the national average consumption rate of pesticides was estimated at 650 g/ha. In 1997, the Pesticides Registration Office at the Department of Agriculture estimated that about 60 tons of different pesticides were imported into Nepal.

Land ownership patterns are another cause of land degradation. The agricultural statistics (CBS 2004) indicate that the marginalized and small farmers with landholdings below one hectare account for 69% of all farmers, but these farms cover only 31% of the total landholding area. As described earlier, there has been an increase in the number of farmland holdings, while the average holding size has decreased.

The land system in and around major urban areas is affected by solid waste disposal. Production of municipal waste increased from 0.144 million tons in 1984 to 0.330 million tons in 1997 (CBS 1998; more recent statistics are not available). Production of toxic and hazardous waste increased from 270 to 512 tons over the same time interval (Tuladhar 1999). This waste is disposed on land surrounding towns or in water bodies without any treatment.

Land degradation is often seen as a side-effect of development work such as construction of roads and irrigation canals along hill slopes, which have contributed to landslides and land erosion. Laban (1979) estimated that 5% of all landslides in Nepal are associated with roads and trails. The construction of roads is on the rise, and after roads are built they are usually ravaged by recurrent landslides and rock falls during the monsoon season.

Stone quarrying can also lead to landslides and soil erosion; however, no hard data are available.

Impacts of Land Degradation

One of the direct impacts of land degradation is the loss of topsoil, which together with organic matter and plant nutrients influences soil fertility. Loss of soil at the rate of 5 tons/ha is equivalent to a loss of 75 kg/ha of organic matter, 3.8 kg/ha of nitrogen, 10 kg/ha of potassium, and 5 kg/ha of phosphorous in the middle hills of Nepal (Carson 1992). The country's major rivers carry away thousands of tons of sediment annually, but a large part of this occurs naturally and a significant part is composed of riverbed load, embankment erosion, and similar components.

Impacts of land degradation like landslides and land erosion are the most pressing problems in Nepal. These occur every year during the rainy season. While landslides and land erosion mostly occur in the Hills and Mountains, floods occur in the valleys and the Terai plains. Floods wash away land or deposit debris, but in some situations flooding adds alluvium which is good for soil fertility.

The loss of life and property as a result of floods and other natural disasters is discussed below.

Land Degradation Control Measures

Land degradation is an important factor hindering agricultural production in Nepal. Government measures to conserve the land resource and its proper planning and development include establishing the Department of Soil Conservation and Watershed Management in 1974, and formulation of the Soil and Watershed Conservation Act (1982) and its Regulations (1985) to protect watersheds. But these legal instruments are very restrictive and therefore have not been implemented. At present DSCWM is introducing a process to amend these laws.

B. Pradhan

Human Pressure on Land—Terraced Fields used for Crops

Community forestry has been a successful policy initiative in controlling land degradation. Its aims are to manage forest resources and use of forest products by involving local communities. According to the Department of Forest, by February 2000 more than 650,000 ha of public forests had been given to local forest user groups to be managed as community forests. Local control of community-managed forests has led to increases in productivity and biomass because of strict protection from fires, free grazing, and uncontrolled cutting. These protection activities have encouraged natural regeneration of forest cover and helped stabilize gentle slopes. Because of the increased forest cover, the water regime (both yield and quality) has improved at the micro-watershed level (Mathema et al. 1998).

The Agricultural Perspective Plan has identified fertilizer input as a major contributing factor to accelerating agricultural growth. The Ninth Plan (NPC 1999) recognized that there is now a need to have sound land management programs to maintain land quality and fertility. The Plan also envisaged formulation of a Fertilizer Act and the establishment of a Fertilizer Unit at the Ministry of Agriculture, though these have not yet come to pass.

Nepal has signed various international conventions and treaties related to conservation of land. The UN Convention to Combat Desertification (June 1994) was signed by Nepal on October 12, 1995, and obliges Nepal to combat desertification and to prepare a national action plan including programs for poverty reduction, which is closely related to land degradation.

Natural Disasters and Vulnerability

Physical changes are a part of nature, and humans have learned to cope with these changes quite well. However, time and again these events turn very violent and then tragedy strikes resulting in huge suffering and loss of lives and assets. If the Himalayas are a part of these natural events, the floods in the southern plains are also an integral part of this cycle of change.

As human activities increase significantly even in environmentally sensitive areas, people become vulnerable to all sorts of natural events. What yesterday was seen as a normal natural event is today poised to be a natural disaster because of the impact on humans as steep slopes and flood plains are settled, as heavy construction is undertaken in highly seismic zones without adequate safeguards, and as natural systems are altered by construction, pollution, and excessive harvesting of resources.

Clearly natural processes will not stop or alter to suit human needs, although many "natural" changes are also now understood to be anthropogenic. We have only one planet and our survival depends on all the life support systems being able to function adequately. Natural events are an integral part of this process, and it is humans who should change their behavior and make the necessary adaptations. The challenge for poor countries like Nepal is to develop the capability first to understand the ongoing changes and then to be able to alter activities as needed both in the short and long term.

Tables 3.5 and 3.6 show examples of losses of lives and property by type of disaster and year. In

Table 3.5: Loss of Lives and Property by Different Types of Disasters in Nepal in 2002

Type of Disaster	People			Affected Families	Livestock Loss	Houses Destroyed	Cattle Shed Destroyed	Estimated Loss (NRs '000)
	Deaths	Missing	Injured					
Floods and Landslides	441	21	265	39,309	2,024	18,181	775	418,915
Fire	11	0	6	1,387	100	1,604	37	94,739
Epidemics	0	0		0		0	0	0
Windstorm	3	0		227		70	45	4,847
Hailstorm	0	0		0		0	0	7,000
Lightning	3	0	16	12	2	1	0	63
Earthquake	0	0		0		0	0	0
Total	**458**	**21**	**287**	**40,935**	**2,126**	**19,856**	**857**	**525,564**

Source: CBS (2004) Tables 5.19–5.20.

Table 3.6: Disaster Casualties 1995 -2002

Year	People		Livestock Loss	Homes Destroyed	Affected Families	Land Affected (ha)	Estimated Loss (million NRs)
	Deaths	Injured					
1995	873	1,937	2,053	10,275	134,210	41,870	1,933
1996	895	1,523	2,480	30,014	58,320	6,060	1,579
1997	1,160	1,120	1,191	4,825	46,050	6,060	410
1998	1,190	117	1,179	15,082	36,980	320	1,230
1999	1,466	146	65	4,304	17,840	180	509
2000	377	162	1,017	6,886	24,900	880	1,141
2001	415	132	665	6,103	15,900	—	526
2002	458	287	2,126	19,856	40,930	10,070	525

— = not available, ha = hectare
Source: CBS (2004) Tables 5.19–5.20.

2002, 458 deaths were attributed to different natural calamities with financial losses amounting to some $7 million (Table 3.5). The impacts are greater when people have no opportunity to choose alternative livelihoods or dwelling sites. In two earlier episodes in 1984 and 1993, 363 and 1,336 deaths of people were caused by landslides and floods and financial losses were incurred amounting to $1.9 million and $99.1 million (DPTC 1997).

Nepal is highly vulnerable to droughts, floods, earthquakes, landslides, forest fires, storms and hailstorms, avalanches, glacial lake outburst floods, and the effects of global warming. Of the 75 districts in the country, 49 are prone to floods and/or landslides, 23 to fire, and one to wind storms. A total of 64 out of 75 districts are prone to disasters of some type according to the Department of Narcotics and Disaster Management. Many of these natural disasters cannot be stopped. However, to minimize the human and other losses that are incurred, better understanding of traditional coping mechanisms and their modification to suit present reality has become an urgent necessity at the local, district, and national levels. The threats to very costly infrastructure are very real and every known precaution is necessary. Even the practice of environmental impact assessment is quite recent and has a long way to go. Settlement and building guidelines should be properly developed and enforced to improve preparedness against earthquakes and floods. There is still no close monitoring of the different natural disasters, and without a proper understanding responses will be limited in scope and content.

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