Human Dimensions in Sustainable Land Use Management in Degraded Land Areas of Nepal

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A Paper prepared for presentation at the Open Meeting of the Global Environmental Change Research Community, Montreal, Canada, 16-18 October 2003.

Abstract

Nepal is a mountainous country with diverse topography, climate and vegetation. The country's landscape is highly fragile and dissected. With the increased population pressure on the limited agricultural land for food, fiber and shelter even the marginal lands have been encroached for cultivation. The problem of land degradation is severe specially due to soil erosion and traditional human land use activities.. This paper examines the historical trends of population growth and changes in land use patterns in the country. Periodic changes in land use patterns are then correlated with the population growth. An assessment of land fragmentation is made by analyzing the changes in number of households and their average sizes along with the changes of population engaged in agriculture. Also, the system of land tenure over the period is highlighted. The state of the environment at present, with particular emphasis on soil erosion and land degradation is examined. Attempts are made to assess the effects of both the biophysical and human activities on the state of the environment. With the historical background of the existing situation, some outstanding issues are identified and prioritized. During the last few decades, technological interventions for checking land degradation and for vegetation recovery have been implemented through various agencies. Brief reviews of these attempts have been made with a view to identify valid reasons for both successful and unsuccessful attempts. Based on such analysis, some measures have been recommended for sustainable management of land resources by minimizing untoward land degradation and by promoting vegetation recovery. On one side it is recognized that land management options that provide quick returns in the short run may have adverse effects on the environment in the long run. Conversely, the local farm communities without having immediate economic benefits from such activities may not adopt even some well-proven environment-friendly programmes on the other. Hence, it is very important to have a rational look for converging these aspects into the "win-win" interventions by simultaneously improving economically beneficial shorter-term local options in harmony with environmentally sustainable longer-term benefits while recommending appropriate land use management practices for the farmers at large.

1. Background and rationale

The kingdom of Nepal with an area of about 147,500 sq.km. is a mountainous country and it lies at the northern rim of South Asia. On the basis of physiography, geology and geomorphology the country may be divided into five major agro-ecological regions, commonly known as Terai (14%), Siwalik (14%), Middle Mountain (30%), High Mountain (19%) and High Himalayan (23%) regions. Hills and mountains occupy over 70% of the total land area. The middle mountain region has the highest population density per unit cultivated land. Even the marginal areas with steep and very steep slopes have been encroached for cultivation in order to feed the increasing population. Consequently the land resources have been over utilized.

Nepal's land resources are very fragile and prone to degradation both inherently and in response to human activities. Rugged mountainous topography, high intensity rainfall, and active geological processes contribute to a high level of natural process of degradation. A product of geological and climatic conditions, the resource degradation and associated environmental consequences are a part of the natural process of mass wasting in the region (Ives 1987). Notwithstanding the role of natural processes in land degradation, human activities, as a result of increasing population pressure, are helping accelerate the degradation process, in many cases, irreversibly. Jodha (2001) states that at both macro and micro levels, vast differences in comparable environmental parameters, in areas with and without human intervention, would confirm this.
Degradation of natural resources in response to increased human activities manifests itself in many ways. Joshy et. al. (1997) consider land degradation in specific terms as the decline in soil quality caused through its misuse by humans. Other scientists (Lal and Stewart, 1990) refer to it as a decline in soil's productivity through adverse changes in nutrient status and

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soil organic matter, soil structural attributes, and concentration of electrolytes and toxic chemicals. In a wider sense land degradation affects the entire production system based on land and in turn, the very livelihood system of the population. The production potential of the land is reduced, which leads to further encroachment of the forest and marginal lands. The intensification of cropping practices further depletes the fertility of the soils. This again puts pressure on the forest resources both for the maintenance of the fertility of the agricultural land as well as the physical acquisition of more land for cultivation from the forests.

2. Objectives

This paper aims to shed some light in the causes and consequences of land degradation in Nepal, particularly in relation to population growth, and evaluate the attempts made so far to combat them. An attempt is made to observe the temporal changes in the population, land ownership and fragmentation, land utilization, and cropping patterns with a view to relate them with land degradation and ensuing problems such as decline in economic status and increased poverty of people dependent on land. The main objectives of this paper are as follows:

- To synthesize human dimensions in sustainable land use management in degraded land areas.
- To document success and failures of technological interventions and issues related to land degradation.
- To suggest strategies for enhancing public awareness in issues related to environmentally sustainable land use management practices both for the shorter term and the longer term.

3. Bio-physical settings

3.1 Location

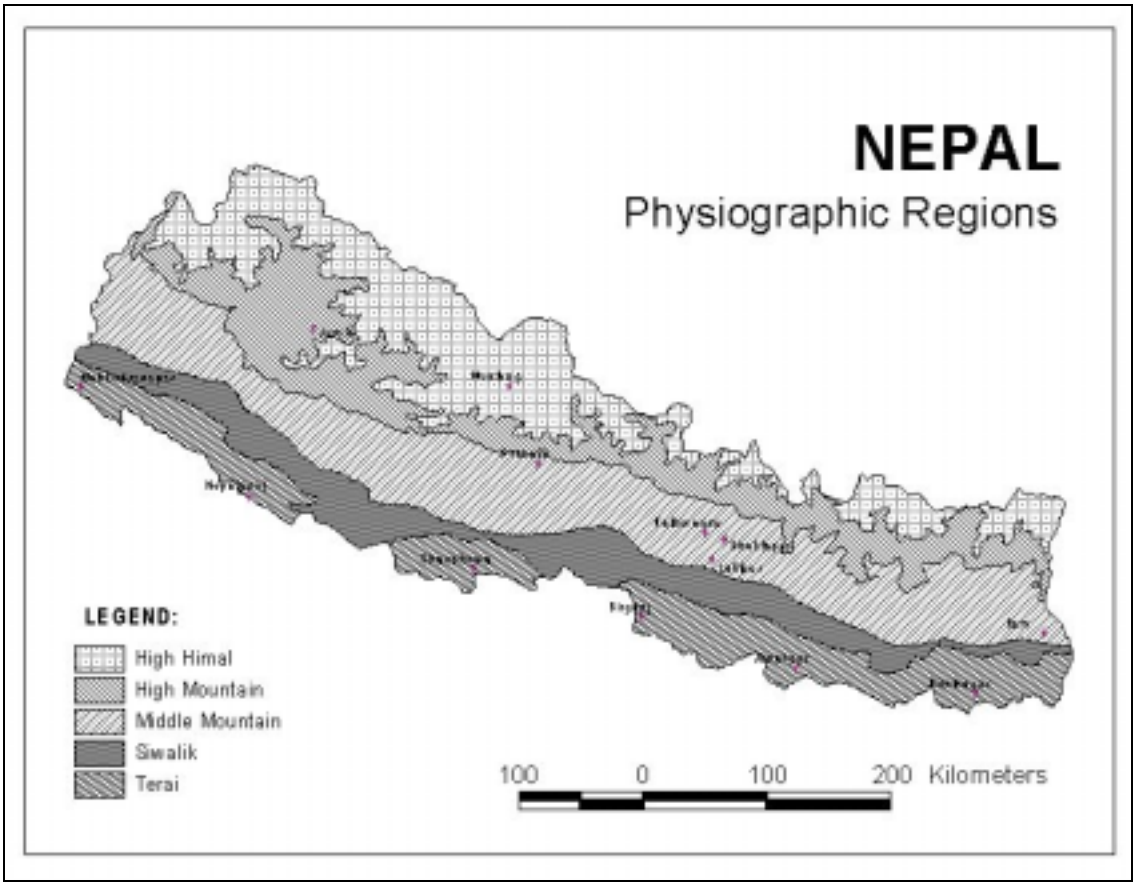
Nepal is located between 80° 04' to 88° 12' East longitudes and 26° 22' to 30° 27' North latitudes. It is a landlocked country bounded in the East, West, and South by India and in the North by the Tibetan autonomous region of the People's Republic of China (Figure 1). Kathmandu is the capital of Nepal. The country is divided into five "Development Regions" and 75 districts.

Figure 1. Location Map of Nepal

3.2 Physiography, landform, geology and soils:

Of the total terrestrial surface of Nepal, 35 percent is occupied by the mountains in the northern belt 42 percent by the hills in the middle belt and the remaining 23 percent by the Terai and Inner Terai plains in the southern belt. Altitude in general increases from south to north ranging from about 60 m in the Terai to 8848 m in the Himalayas. This great variation of elevations within short and narrow width of the country plays an important role in determining the intensity and distribution of precipitation as well as the variations in temperature all over the country. The country is subdivided into five major physiographic regions including the Terai, Siwaliks, Middle Mountains, High Mountains, and the High Himalayas (Figure 2). These regions have distinct bedrock, geological, climatic, and hydrological characteristics (LRMP, 1986). As a result, the soils and land use within these zones are distinctly different and have different potentials and problems associated with them.

Figure 2. Physiographic Regions



The *Terai* is an extension of the Indo-Gangetic Plain lying along Nepal-India border at altitudes of 60-300 m. It consists of gently sloping Recent alluvium, predominantly loamy and slightly acid. Drainage characteristics vary according to the topographic position. Erosion is generally slight except on some alluvial fans which are subject to severe sheet erosion and gulling when ground cover is removed – increasingly common as agriculture has extended into this region. The *Siwaliks* are the outermost Himalayan foothills with elevation of 300-1800 m. The rocks are interbedded Tertiary mudstones, siltstones, sandstones and conglomerates. Soil textures are most often directly related to the underlying bedrock. The soils are shallow and drought-prone, so cultivation is very limited. The inner valleys (Dun Valleys) were infilled by lacustrine deposits and these areas are intensely cultivated.

The *Middle Mountains* region includes areas within the Mahabharat range characterized by mountains with peaks of 1500 to 2500 m and steep, narrow valleys. The rocks are a complex of phyllites, schists and quartzites of Cambrian to Precambrian age, and granites and limestones of different ages. Soils are extremely variable according to differences in bedrock, geomorphology, microclimate and past land use. The *High Mountains* region is characterized by steep slopes, with narrow valleys at over 2000 m and mountain tops commonly above 4000 m. The bedrock is more highly metamorphosed than in the Middle Mountain region: phyllite, schist, gneiss and quartzite. Besides rocks being more resistant to weathering, the climate is colder and so the soils are shallower and stonier. The *High Himalayan* region includes the areas above the tree line with elevation ranging up to 8848 m (Mt. Everest), largely within the alpine and arctic regimes, with active glaciers. The geology consists of gneiss, schists, limestones and shales of different ages. Physical weathering predominates in this region and so the soils are very shallow and stony.

3.3 Climate

Due to extreme variation in topography and altitude, climate in Nepal varies from the humid subtropical type in the southern Terai to alpine in the north. In general, distinct wet and dry seasons alternate over the year. The wet season lasts from June till September and is caused due to the south-west monsoon. October through May is mostly dry, occasionally interrupted by a few showers in the winter and spring. Thus the main rainy season is confined to the summer monsoon season followed by a cool to cold, dry, post-monsoon season and a hot, dry pre-monsoon season. Annual rainfall varies

from about 250 mm in the rain-shadow areas of north-west Dolpa and Mustang to about 5000 mm in the windward slopes of Kaski district. About 80 percent of the rainfall occurs during the monsoon.

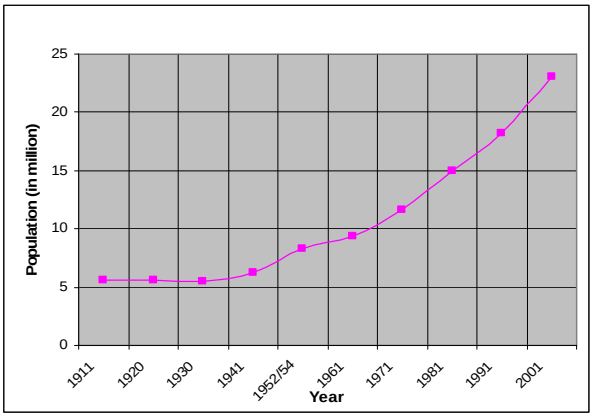
The highest mean monthly temperatures occur in April or May, just before the monsoon breaks. The mean monthly maximum temperatures during this period range from 35 ^{o}C to 40 ^{o}C in the Terai to about 16 ^{o}C at 3000 m. altitudes. December and January are the coldest months, during which period the mean monthly temperatures drop down to between 14 ^{o}C and 16 ^{o}C in the Terai, 6 ^{o}C and 8 ^{o}C at 2000 m altitudes, and about 2 ^{o}C at 3000 m. Above 3000 meters, they fall below zero. Winter temperatures in the Kathmandu valley are lower than would be expected from the altitude, as the valley is a depression surrounded by hills, and cold night air accumulates in it. The mean monthly January temperature at Kathmandu (1300 m) is 9.5 ^{o}C (Jackson, 1987).

4. Socio-economic attributes

4.1 Population and demographic characteristics

The population of Nepal, according to the latest census (CBS 2001), is 23.1 million and the growth rate during the last decade was 2.24 percent per year. A historical trend of population growth of Nepal since 1911 is presented in Figure 3. These data clearly show the exponential nature of the population growth. In 1911, the population of Nepal was only 5.6 million and it took 60 years to double to 11.6 million in 1971. The population graph shows a steep rise after the decade of 60s, the trend which is still continuing (Figure 3). As a result, the next doubling of the population took place in only 30 years during which period, it increased from 11.6 million in 1971 to 23.1 million in 2001. At this rate of increase, the population is expected to double again in another 15 years. The population density which was just about 38 persons per square kilometer in 1911 has now more than quadrupled to 157 persons per square kilometer (Annex 1).

Figure 3. Trends of Population Growth



4.2 Economic status

The United Nations Human Development Report (HDR) ranks Nepal as number 129 out of a total of 162 countries of the world. The Human Development Index (HDI) calculated on the bases of life expectancy, education; and GDP per capita was 0.48 on a scale from 0 to 1. The indices of the components of the HDI are as follows: life expectancy index : 0.55, education index: 0.47, and GDP index: 0.42. Nepal ranked third after Pakistan and Togo in the "low human development" category of the HDI (United Nations, 2002).

Economic growth rate during this period was only 3.9 percent per year. The average annual growths in the agricultural and non-agricultural sectors were recorded at 2.9 percent and 4.6 percent, respectively and the per capita income increased by only 1.6 percent. There has been a gradual change in the contribution of agriculture in GDP. The contribution of agricultural sector was 65.1 percent in 1964/65 (NPC, 1992), 40 percent during the Eighth Plan (1992-97), and to 38.6 percent in the Ninth Plan (1998-2002) (NPC, 2002). But unfortunately, this drop in the share of agriculture sector in the economy was not accompanied by a commensurate growth in the industrial sector. The share of the industrial sector was 34.9 percent in 1964/65, which grew to only 39 percent by 1989/90 (NPC, 1992).

4.3 Poverty

Poverty is an important human dimension that directly affects sustainable management of soil and land resources of Nepal. The poor have limited access to land, to knowledge and information about technology and to credit. The land resources they possess is often of the poorest quality and prone to degradation. All these factors lead to unsustainable management of land resources and encroachment into marginal land, which in turn leads to a vicious cycle of further poverty and land degradation. Thus, there exists an urgent need to adopt a suitable policy to break out from this cycle. While a substantial proportion of the population the country is living below poverty line, the incidence of poverty has a very wide spatial variation. It is most widespread in the Mountains and in the rural

Table 1. Extent and spread of poverty in Nepal (%).

Region	Total	Poor	Ultra poor
Mountain	56.0	29.3	26.7
Hills	41.0	21.3	19.7
Terai	42.0	28.7	13.3
Urban Nepal	23.0	13.2	9.8
Rural Nepal	44.0	26.4	17.6
Nepal	42.0	24.9	17.1

Source: Upadhyay-2001

areas. Even in the urban areas, as much as 23 percent of the population is living below the poverty line (Table 1).

The Ninth Plan aimed to reduce population living under poverty level in the country by 10-percentage point and bring it down from 42 percent to 32 percent. According to the mid-term evaluation of the Ninth Plan, however, poverty actually increased by 0.976 percent during the first three years of the Ninth Plan. Due to various reasons, there has been a serious lag in the implementation of poverty alleviation programs of the government. Owing to this, the target of reducing poverty by ten percent during the plan period could not be materialized and thus the level of poverty at present is estimated to be 38 percent.

4.4 Land use

According to the available data (LRMP, 1986), area under cultivation in Nepal amounts to about 2.97 million hectares (20 percent of the total land area of the country). About 0.98 million hectares of the agricultural land (6.7 percent of the total land area) is currently not under cultivation. Nearly 43 percent is under the forest land use and 12 percent under grazing (Table 2). The "other" category of land use occupies 18 percent of the total land area of the country and includes rock outcrops, snow and ice, sand, gravel, and water bodies. The total irrigated area is about 0.92 million ha (30% of the cultivated land) (MOAC, 2000).

Table 2. Land use of Nepal.

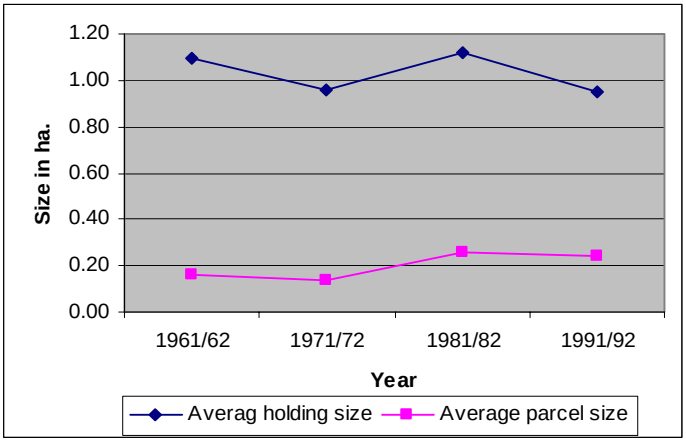
Land use type	Area ('000 ha)	Percent
Total Agriculture	3854	26.8
Cultivated	2968	20.1
Non-cultivated	986	6.7
Grazing	1758	11.9
Forest	6306	42.8
Other	2730	18.5
Total	14748	

Source: LRMP Economics Report, 1986.

4.5 Land holding, distribution, and fragmentation

More than 80 percent of the households of the country are agricultural households, indicating the dominance of agriculture in the country's economy. The National Living Standards Survey (NLSS) found that in 1995/96, agricultural land households represented 83 percent of total households in the country (CBS, 1996). Average size of land holding in 1991/92 was reported to be 0.96 hectares (CBS, 2002). There have been considerable changes in land holding sizes, average number of parcels per holding and average size of the parcels over a period of 30 years (Figure 4).

Figure 4. Trends of changes in land holding and parcel sizes



Fragmentation of land is a dominant characteristics of the land ownership in Nepal. Almost all owners tend to have their plots scattered over many places. As the population grows, even such small plots get further subdivided and fragmented due to inheritance, sales and other forms of transaction. At present, the average parcel size for the country is reported to be 0.24 ha and the number of parcels per holding is nearly 4. The seemingly improved situation since the decades of 60s and 70s corresponds with massive forest clearance and encroachment into the marginal land. Due to the continuing population pressure, however, the level of fragmentation will definitely increase in the future unless this issue is addressed consciously.

There is a wide variation in land holding sizes across the regions and ecological belts of the country. The NLSS (CBS, 1997), for instance, found that the average sizes of holdings were 1.22 hectares in the

Table 3. Holdings (in percent of total holdings)

Size of holding (ha)	1991		1996	
	Number of households	Area of agricultural land	Number of households	Area of agricultural land
0.1 – 0.2	9.8	1.5	9.87	1.26
0.2 – 0.5	27.0	9.4	23.59	7.10
0.5 – 1.0	26.3	19.2	26.24	16.96
1.0 – 2.0	19.6	27.6	20.98	26.56
2.0 – 3.0	6.2	15.4	6.67	14.76
3.0 – 4.0	2.2	7.8	2.38	7.34
4.0 – 5.0	1.1	4.8	1.67	6.57
5.0 – 10.0	1.2	8.1	1.16	10.14
> 10	0.3	5.8	0.55	8.84

Mountains, 0.89 hectares in the Hills, and 1.29 hectares in the Terai. An outstanding characteristics of land holding of Nepal is that there are a great majority of small holders (Table 3).

4.6 Crops and cropping patterns

Rice, wheat, maize, millet, and barley are the principal cereal crops cultivated in Nepal. Pulses, potato, vegetables, some cash crops and fruits of different varieties are also grown in large quantities. Rice is the most preferred crop where conditions are suitable for its cultivation. It is mainly cultivated in the Terai plains, low lying valleys in the hills and mountains, and in level terraces in the gently sloping hill sides where temperature is suitable for its cultivation and where at least partial irrigation is available. Thus, in such areas, the cropping pattern is basically rice based. In the hill slopes where the slopes are too steep to build level terraces or where irrigation is not available, the cropping pattern is dominantly maize based. In higher altitudes, generally above 2000 m, choices of crops are severely limited by temperature. In many places in such areas it is possible to grow only one crop per year or at the most three crops in two years. In such high altitude areas, potato is the main crop and temperate fruits such as apples and walnuts are also cultivated to a certain extent. In the recent years, cultivation of vegetables on a commercial scale is becoming successful and is gaining popularity, especially near the urban centers and where there is easy access to the markets. This phenomenon is observed in all ecological belts in the country.

Over the years, there have been slight increases in area under paddy, maize, and wheat. The area under barley actually declined and that under millet remained more or less the same (Table 4). Despite the considerable amount of resources used for research and extension during this period and concerted efforts of the government, increase in production still depends on area expansion and favorable climatic condition, particularly the monsoon rainfall. Unfortunately, no significant increase in yields have been achieved.

Table 4. Area, production, and yields of principal crops
(area in '000 ha, production in '000 MT, yields in MT/ha)

	Fiscal Years						
Crops	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/01	2001/02
Paddy							
Area	1497	1505	1506	1514	1551	1560	1517
Production	3579	3699	3641	3710	4030	4216	4165
Yield	2.39	2.46	2.42	2.45	2.59	2.70	2.74
Maize							
Area	792	793	799	802	819	824	826
Production	1331	1312	1367	1346	1445	1484	1511
Yield	1.68	1.65	1.71	1.68	1.76	1.80	1.83
Wheat							
Area	654	665	647	641	660	641	667
Production	1013	1056	1001	1086	1184	1158	1258
Yield	1.5**5**	1.59	1.55	1.69	1.79	1.80	1.88
Barley							
Area	39	39	37	32	28	28	28
Production	41	39	37	32	31	30	31
Yield	0.95	1.00	1.00	1.00	1.10	1.10	1.11
Millet							
Area	260	260	262	264	263	260	258
Production	282	289	285	291	295	283	282
Yield	1.09	1.11	1.09	1.10	1.12	1.09	1.10
Total Area	**3242**	**3262**	**3251**	**3253**	**331**	**3313**	**3296**
Total Production	**6246**	**6395**	**6331**	**6465**	**6985**	**7171**	**7247**

Source : Central Bureau of Statistics & Ministry of Agriculture and Co-operative, Agriculture Statistics Division

5. Land degradation

5.1 Status of land degradation

Much of the country's land base is environmentally fragile and susceptible to erosion and degradation. Cultivation on sloping land is a common feature of the Nepalese hill agriculture. Over the centuries, farmers have been adopting a system of land use compatible with their environment such as shifting cultivation. But such traditional farming system has not been

able to cope with the rapid growth of both human and livestock population. Over the recent decades, land degradation and degradation of mountain ecosystems are becoming increasingly widespread. The traditional farming system and cultivation in steep hill slopes have accelerated the rate of erosion and degradation. Agricultural productivity specially in the hills and mountains is at a decline due to erosion of fertile surface soils every year. It is, in general, reported that almost 240 million cubic meters of fertile soils are eroded away annually out of the country. In addition to soil erosion there are also various other factors like acidification, alkalinity, siltation, flooding and so on that are responsible for land degradation at different scales. Therefore, there is an urgent need to develop suitable land and crop management system for sustainable agricultural production and environmental protection.

5.2 Mountain agriculture and sustainability

In a country like Nepal where majority of the population have to depend upon mountain agriculture for their livelihood the country is, over time, to bear the burden of increasing population. The present thrust of farming system is the key concern to maintain production system in proportion to population growth. The declining trend of farm productivity in the hills and mountains is much attributed to the decline in soil fertility due to erosion of fertile surface soils every year and partly due to the non-availability of or inadequate access of mountain farmers to appropriate low cost technologies and other key farm inputs. Moreover, the basic issues facing mountain agriculture in the country may be summarized and listed as follows:

- Low productivity of land due to continuous soil erosion and land degradation
- Inadequate access to appropriate and low cost technology and other external farm inputs
- Lack of marketing facilities
- Inadequate credit facilities
- Poor community organizations
- Small land holding of the farm-family
- Frequent natural calamities
- Over utilization and mismanagement of natural resources, etc.

There is a strong interdependence between mountain agriculture, forest and animal husbandry. The central issue of soil fertility management without adversely affecting the natural resources needs to be considered and clearly addressed. For the sustainability of the mountain agriculture and production system this should involve the integrated use of soil, water, forest base and external inputs necessary. Because of the population pressure and exhaustion of the forest base resources, land system is approaching to more of degraded condition resulting in the decline of farm productivity. These all require bringing together biophysical processes with socioeconomic issues in an integrated manner, which should become environmentally and economically sustainable.

5.3 Causes of Land Degradation

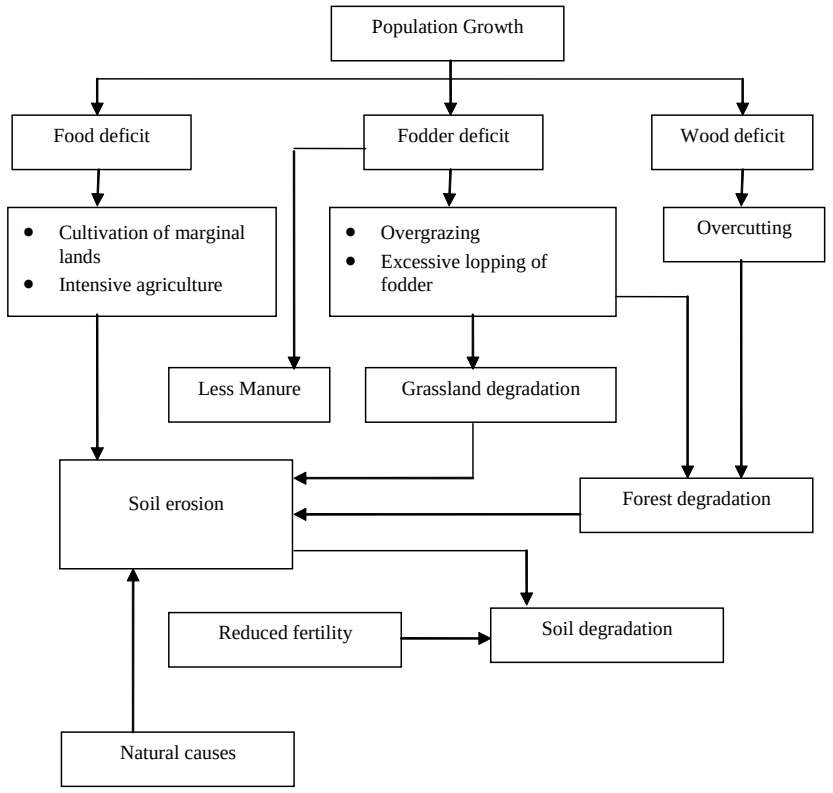
In a wider sense, land degradation in Nepal is almost synonymous with soil degradation, for the quality of land and its carrying capacity on which the ever increasing population depends on its very survival and well being is determined by the properties of the soil. There are several factors, both internal and external, that contribute to the degradation of the soil and land. Figure 5 illustrates a conceptual model of the causes and relationships of soil and land degradation in Nepal. As the population grows, demands for food, fodder, and shelter (wood) increase. These demands put pressure on agricultural land and forest and hence encourage marginal land cultivation, intensification of agriculture, overgrazing, and overcutting. These in turn degrade the agricultural land as well as the forests and grazing land. This in turn, leads to soil degradation and reduces the carrying capacity of the land.

Joshi et. al. (1997) site the following five causative factors for land degradation, relevant in the context of Nepal: i) deforestation, ii) overgrazing, iii) agricultural activities, iv) overexploitation of natural resources, and v) bio-industrial and industrial activities.

Available data suggests no significant change in agricultural land since 1985, but area under forests has decreased considerably. The forest land use is reported to have declined from about 43 percent in 1978 to 29 percent of the land area of the country at present (UNEP, 2001). The decrease in forest land appears to be associated with the increase in shrub land (Table 5). This gives an indication of the level of degradation of the forest in the country which is caused by increasing population pressure for fuel wood collection as well as due to overgrazing by the increasing livestock population. The annual rate of reduction in forest area between 1978/79 and 1994 was 1.7 percent; the annual reduction rate in forest and shrub combined was 0.5 percent (UNEP, 2001). Citing the data from the Forestry Survey Division (1993), Wagley (1997) reports negative changes in area under forest in almost all the 20 Terai districts (except Dhanusha and Siraha) of the country. Total forest area in these 20 districts decreased from 654 thousand hectares in 1978/79 to 545 thousand hectares in 1990/91, resulting in total loss of 99 thousand hectares of good forest land in just over a decade.

The livestock population of Nepal, which is already high, is increasing steadily. UNEP (2001) concludes that the population of livestock (number of cattle, pigs, goats, and sheep) increased by about 20 percent between 1985 and 1998. Meanwhile, the grazing area remained the same. It means that the increased demand must be met by the forests. Raut (1997/98) estimates that about 10 percent of the livestock feed comes from the forest.

Figure 5. Causes of land degradation in Nepal



Adapted from UNEP, 2001.

Inappropriate agricultural activities in the face of the population pressure contribute heavily to land degradation. Although, the official records show no change in agricultural land since around 1985, it is widely reported and readily observed that encroachment into the forests and shrubs are occurring and increasingly more marginal lands such as steep slopes and shallow soils in the hills and mountains are being brought into cultivation. Maskey (1995) observes that in Nepal we can see slopes greater than 40 degrees (nearly 100 percent slopes) being cultivated. Newly cleared forest land is quite fertile but the fertility declines very quickly as the organic matter depletes after just a few years of crop cultivation. This necessitates addition of heavy doses of chemical fertilizers to obtain satisfactory yields. This heavy application of fertilizers hastens the degradation of the land, quite often in an irreversible way.

Land based products such as fuelwood, timbers, fencing material, non-timber forest products, as well as construction materials like sand, gravels, stones, etc. are being collected regularly for household uses and for trade, including export. This is causing heavy exploitation of natural resources, which in turn, contributes to land degradation.

With the increasing interest in cultivating vegetables, fruit, and cash crops, especially near the urban centers of the country, uses of insecticides, pesticides, and chemical fertilizers are on the increase. Excessive uses of such chemicals and lack of adequate regulatory mechanism contribute to the soil and water pollution and eventually cause land degradation in the long run. Although not yet noticed on a large scale in Nepal, such practices must be watched and monitored carefully.

Table 5. Changes in area under forest and shrub land uses (1978 - 1994)

Type	Area occupied (in percent land area of the country)		
	1978 – 79 [1]	1985 – 86 [2]	1994 [3]
Forest	38.0	37.4	29.0
Shrub	4.7	4.8	10.6
Total	42.7	42.2	39.36

Sources: 1. LRMP (1986); 2, 3. DFRS (1999)

5.4 Manifestations of land degradation

Joshy et. al. (1997) summarizing the findings of several studies conclude that the effects of soil or land degradation results in the following visible effects:

- Greater soil erosion and gullying
- Frequent floods and landslides
- Greater damage to aquatic life through increased sedimentation and siltation in rivers, lakes, water reservoirs and hyro-electricity dams

- Reduced crop yields
- Soil fertility deterioration
- Soil and water acidification
- Increased pollution

In addition to this, other workers (Wagley, 1997 and Yogacharya, 1997) have reported desertification extended as a result of land degradation in some districts of the country.

7. Measures taken for combating land degradation

In spite of the dismal picture that emerges as regards the situation of land degradation in the country, there are several bright spots as well. Most important of all, there has been a renewed awareness and understanding of the problem and efforts are already underway to ameliorate the situation. Some of the efforts have been highly successful and lessons have been learnt. In the following sections are given a brief overview of some of the soil conservation practices and interventions made so far under three basic categories: a) the indigenous practices (traditional), b) the technological innovations, and c) the policy level interventions.

7.1 Indigenous soil and land conservation practices

Local farmers have long realized the need to conserve their soils, and have discovered and used a number of practices to combat the problem in a very successful manner. Some of the practices followed by Nepalese peasants for soil conservation and fertility maintenance are as follows:

- Terracing
  Use of level terraces for rice cultivation and sloping terraces for maize based cropping patterns
- Fallowing in combination with shifting cultivation
  Shifting cultivation is one way of maintaining soil fertility and is still practiced in many hill areas, particularly in the Makwanpur area and some high mountain districts in Eastern Nepal. Due to the population pressure, however, the fallow period is shortening now.
- Use of sediment laden runoff from rivers and streams
  Mainly practiced in the rice fields by taking advantage of local surface runoffs.
- In situ manuring
  Cattle and buffalos left to graze and housed on fallow land where they fertilize the soil by leaving behind their manure and urine.
- Use of nitrogen fixing plants
  Inclusion of legumes in crop rotation, e.g., soybeans and lentils planted in association with grain crops and use of azolla in the rice fields.
- Terrace riser slicing
  Slicing the terrace risers to get rid of weeds and insects as well as to fertilize the terraces.
- Use of compost and farmyard manure
  Compost is by far the most important soil additive used by Nepalese farmers to manage fertility. It is made up of animal manures, forest litter, agricultural and household waste, including ash from cooking fires. Reported rates of compost use are 0 to 58 tons per hectare but are most commonly 0 and 23 tons per hectare for rice and 20 to 28 tons per hectare for maize crops.

7.2 Technological innovations

Several technological advances have been made through a long experience in the management of sloping land with a view to minimize soil and land degradation. These efforts are based either on the concept of conservation farming, watershed management, or some other technological bases.

A. Conservation farming

1. SALT farming system: The innovations derived on the basis of conservation farming have been embodied in the concept of the Sloping Agriculture Land Technology (SALT) farming system. The main objective of this farming system is to facilitate soil conservation (through the use of nitrogen fixing hedgerows) and to improve soil fertility (through bio-nitrogen fixation and by the application of biomass after pruning of hedgerows). Several models of SALT farming system have been developed and tested successfully in Nepal. These are described briefly as follows:

- SALT 1 – Crop-based model: Various cereal and horticultural crops are planted within the alleys between hedgerows. Preliminary study results show that the local farmers are interested in this model because soils are well conserved and fertility is maintained.

- SALT 2 – Animal husbandry-based model: The difference between this model and SALT 1 is that fodder plants instead of crops are planted in the alleys between hedgerows. Hedgerows consist of fodder species also. This model will require more time to prove its benefits to the local people because animals, especially goats, cattle and buffaloes are presently free grazing under local practices.
- SALT 3 – Agroforestry-based model: This model is a combination of small forests and SALT 1. In this model, the upper part of a hill or sloping land is used to plant timber trees while the lower part adopts the normal SALT 1.
- SALT 4 – Horticulture (or cash crop)-based model: This model differs from SALT 1 in that fruit trees, or other cash crops (plants) instead of cereal crops, are planted in the alleys between hedgerows. Preliminary study results indicate that this model is more acceptable to the local farmers because people can get quick economic returns from cash crops.

2. **Hill side ditch farming system**
3. **Alley cropping**
4. **Strip cropping system**
5. **Minimum tillage farming system**

B. Watershed management

- Land management technologies

  Major land management technologies promoted by the government and NGOs for the control of land degradation include the different models of SALT as described above, agro-forestry, bio-fertilizers like compost and green manures, soil testing services and recommendations for balanced use of chemical fertilizers, inclusion of legumes in the cropping system, plantation of soil conserving crops like tea and cardamom in the marginal and degraded lands, including the public lands..

- Water management technologies

  Water harvesting has been promoted by many NGOs an INGOs as well as some government agencies as an appropriate and effective technology for sustainable land management in the hills and mountains of Nepal. The current policy of the government regarding irrigation in the sloping lands emphasizes rehabilitation of the existing surface water schemes instead of constructing new ones, and promotion of alternative forms of irrigation like sprinkler and drip irrigation.

- Land use managements

  Programs related to land management include the designation and protection of National Parks for the conservation of wild life and biodiversity and encouragement for public participation in the management of forest resources through community and leasehold forestry schemes. On the other hand, there has so far been no serious effort in identifying and promoting appropriate land management practices in the agricultural sector.

C. Other appropriate technologies

Other technological innovations that have been proved to be appropriate for the management of degraded land in Nepal include: water harvesting technologies, plastic film technology (for water storage), bio-engineering technologies for controlling gullies, and improved compost making technologies (including IPNS) for the maintenance of soil fertility.

7.3 Policy level interventions

Control of land degradation is accorded high priority in the government's plan and policy. Several initiatives have been taken by various line agencies like the Ministry of Agriculture and Cooperative, Ministry of Forestry, Department of Soil Conservation, etc to address this issue through programs on leasehold forestry, private forestry, community forestry, sustainable soil management programme, and integrated plant nutrient management system (IPNMS).

8. Technology generation and initiatives for adoption

8.1 Technology generation

In the country there is a strong need of need- and problem-based research on sustainable land use. Before embarking on a research program it must be made mandatory to carefully assess its adoptability in the local agro-ecological and socio-economic conditions, and to examine whether it can raise farmers' income sufficiently from the existing production systems to provide an exit from rural poverty. Since the supply of arable land in the country is very limited, research should focus on increasing labor productivity. The potentiality of high value crops across different climatic regimes may prove a boon to the poor farmers, but integrated efforts of government and non-governmental agencies and developmental institutions are essential for this to be successful. In this regard the government needs to substantially increase annual budget expenditures on agricultural research programmes. Expenditure for research at present stands at the level of about 0.25 percent of the average gross domestic product. The researchers need to be highly motivated both morally and

financially to carry out the quality research work based on country's problems and needs, and to generate low cost and appropriate technologies for sustainable land management and farm productivity.

8.2 Initiatives for technology adoption

The adoption of new technologies generated from the on-station research is far below the expected levels of adoption. Rural poverty and illiteracy could be the major obstacles in motivating the local farm communities for adopting the technologies. Moreover, the poor farmers need guarantees that their livelihood will not be adversely affected by the adoption of the new technologies and they want quick return from such adoption. They cannot wait for a long time to enjoy the benefits from the adopted of technologies due to their small holdings of land on which they depend exclusively for survival. They cannot take the risk of losing their only means of livelihood for the promise of a high level of profit in a long term. It is, therefore, very difficult to motivate the poor farmers to adopt new technologies without some incentives either in cash or in kind. The reasons for uneven, low or non-adoption of new technologies can be explained by the following facts:

1. Poor farmers generally have weak access to information about new technology. Development agencies generally reach better off farmers close to the highways where access and dealings are easier.
2. Risk bearing capacity of such farmers is low. Since income is barely adequate, or in many cases inadequate, they need a regular and reliable source of income to meet the requirement of non-food items. They take external invasion as a risky game and would rather believe on their own traditional system of farming using their own inputs.
3. Production credit does not reach poor farmers. Burrowing from informal sources is 80 percent of the total credit in Nepal, which is the main source of credit for resource poor farmers. Rate of interest in such loan is generally very high.
4. Though poor farmers possess sufficient experiences of farming (as being a regular farm worker), they have little chance of applying their skills for their own benefits due to the lack of enough land holding power.
5. Women farmers are socially least encouraged by community to come forward that contribute substantially to agricultural production.
6. The poor are socially docile, they hesitate to come forward and share experiences and other innovative ideas with development agents.
7. Low or no development of markets for agricultural inputs and outputs.
8. Technologies not suitable to farmers' socioeconomic setup: food habit, market demand. culture, etc.
9. Low level of education and exposure to outer world: if the people are unaware of relative economic standing, they may not be motivated to improve their standard of living. In a poor locality, the individuals may not fully realize that they are poor and deprived and take their situation as a way of living.
10. Vicious circle of poverty-poverty, the reason of poverty.
11. Farming, the responsibility of rural olds.
12. Socio-cultural conditions.

9. Capacity building, networking and dissemination of information

Networking and dissemination of information among researchers and technology users play a vital role in both the capacity building and increasing efficiency of all the actors involved in generating and utilizing the technologies for sustainable land use management. Collaboration and networking among researchers from different countries and regions will provide an opportunity for sharing and exchanging of knowledge and experiences not only with each other but also with other stake holders including the farmers. Periodic training is another component that is necessary to increase the efficiency of both the researchers and farmers. This will also contribute to the capacity building of the researchers and the institution both in national and regional levels.

10. Government policy, strategies and programmes:

There are different Government and Non-government agencies working towards rehabilitation of degraded lands and sustainable land use in the country, such as Ministry of Agriculture and Cooperatives (MOAC), Ministry of Forest and Soil Conservation (MOFSC), Ministry of Water Resources (MOWR), Nepal Agricultural Research Council (NARC) and several NGOs and INGOs. Agriculture, forestry and water resources are the priority sectors of the government.

10.1 Agriculture

Agriculture is the priority sector of the government to attain the national goals of poverty alleviation. Government's role in agriculture development is catalytic and provides support services, technical know-how and credits through banks. MOAC, through its different agencies, encourages farmers to adopt suitable farming system technologies for sustainable agricultural production and for soil and water conservation and rehabilitation of degraded lands. NARC is the national agency with the overall mandate for agricultural research and development in the country. It is responsible for carrying out research and developing necessary technological packages for sustainable land management and crop production. For the last few years NARC is also carrying out, with farmers participation, on-farm research on soil-conserving farming systems and pasture

development in collaboration with several NGOs and INGOs. Some of the technologies developed from this effort could be effective and be suitable for adoption for the rehabilitation and productive use of degraded and marginal lands as well.

10.2 Forestry

The Government has adopted a policy of promoting the development of forestry sector through public participation and implemented programmes of community forestry, private forestry and leasehold forestry. Prevention and control of soil erosion is the main forestry policy of the government and its role in the management of forest and degraded lands is more of catalytic and technical advisory nature. The strategic policy to manage forest and rehabilitate degraded lands is to produce basic needs for forest products with due consideration of soil conservation measures and promote alternative energy resources and energy efficient devices. The aims of community and private forestry are to develop and manage forest resources through active participation of individuals and communities to meet their basic needs for fuel wood, timber and fodder. The purpose of national and leasehold forestry is to develop and manage the national forests through government agencies and private sector leases that will complement community and private forestry as a means to increase the supply of forest products. For the last few years, the MOFSC has also implemented "soil conservation and watershed management" and "conservation of ecosystems and genetic resources" programmes in the country.

Over the past few years various projects on soil and water conservation were implemented. Under these projects much attention was given to planting trees, terrace improvement and construction of engineering structures like check dams, but farmers' welfare was mostly overlooked. The agricultural lands specially those under upland cultivation are prone to soil erosion and land degradation with negative effects in agricultural productivity. Similarly, less attention given to livestock husbandry which is an integral part of the Nepalese agriculture and has direct impact on land degradation and farm productivity. Due to these reasons there is poor response from the farm community in adopting land management technologies. Considering this, NARC has recently initiated work on developing sustainable land and water management technologies to be used for integrated watershed development and management practices with the participation of all stakeholders including the local farming community and in collaboration with various International Agencies, local NGOs and CBOs.

10.3 Water Resources

The government agencies under MOWR carry out regular river training programmes to check the damages to land and settlements from riverbank erosion and floods and to mitigate the land degradation due to flooding and river shifting. Government’s role is mainly to provide materials and technical inputs and the works are carried out with the people’s participation.

11. Constraints and opportunities

There are various constraints and opportunities in the rehabilitation and sustainable management of degraded land areas in the country like Nepal where much of the land area are hilly and mountainous and majority of the population live in the subsistence level and where the problem of land degradation due to soil erosion is very severe. The various constraints and opportunities may be grouped as follows.

11.1 Institutional

There are many Governmental and Non-governmental agencies currently working in the rehabilitation of degraded lands in the country, but there is lack of clear demarcation of responsibilities among them. Clear policy, strategies and programmes to tackle the problem in a coordinated manner is still lacking. Scientific land use planning policy has never been formulated which is restricting the mitigation of the problems of land degradation due to misuse and over exploitation of natural resources. There is an urgent need to strengthen the Government agencies and machineries to make them capable to take up the challenge and for this there lies an immense opportunity for international collaboration.

11.2 Technical

Land degradation problem in the country is vast and complicated. There is heavy encroachment in the marginal lands with steep slopes for cultivation arising out of the necessity to feed the increasing population. Cultivation on steep slopes without terracing has further aggravated the problem of soil erosion and land degradation. In the Nepalese condition soil erosion from the steep slopes under upland cultivation is very severe. There is not enough systematic research work carried out in the country to tackle this problem. Thus, there is now a strong need to carry out systematic research which can lead to the development of low cost technologies for integrated watershed development and management with particular emphasis on agro-forestry and soil conservation farming system technologies. The research and development work must ensure the participation of all stakeholders including the local farm community in order to get wider acceptance and adoption by the farmers. Also, there is a need to strengthen the national institutions and to enhance the capacity of their human resources. Therefore, there is ample scope for the international collaboration in these fields.

11.3 Socio-economic

Most of the land area being hilly and mountainous and majority of the population being subsistent farmers it is very difficult for the country to sustain the huge population of about 23 million with very limited arable land. Population growth control measures are not much effective in spite of the Government's efforts on family planning for decades. There is very limited alternative job opportunity other than the farming. Population control and diversification of economy have become very essential without which the problem of land degradation will be even more serious in the years to come since increased population will exert more pressure on limited land resources for their daily needs. Hence, these socioeconomic aspects also need careful attention in order to lessen the problem of land degradation in the country.

11.4 Financial

Nepal is a poor and landlocked country with very limited financial resources and it is very difficult for her to allocate sufficient funds for programmes to combat the problems of land degradation that require huge investment both in research and development. Moreover, the problem like this can only be tackled with an integrated approach taking into consideration all the sectors and components related to it. Therefore, the country is in need of both financial and technical assistance from outside.

12. Conclusion

Nepal is highly vulnerable to degradation due to the extremely fragile nature of the landscape. The process of irreversible losses of soils through the natural causes is further aggravated by inappropriate land use and management resulting from the ever increasing population pressure. Encroachment on the marginal land for agriculture and further degradation of the land resource is highly correlated with the rampant poverty that infests the country. High population pressure on fragile land leads to severe degradation of the land resources, which leads to further impoverishment of the population. Thus, it is necessary to break out the vicious circle of poverty by sustaining agricultural production in the hill and mountain ecosystems of the country. To reverse the natural processes of degradation, the problems arising out of the human dimension in sustainable land management must be addressed both adequately and judiciously. The major issues concerning mountain agriculture and its sustainability can be summarized in relation to: 1) low productivity of the land due to continuous soil erosion and land degradation, 2) inadequate access to appropriate and low cost technology and other external farm inputs, 3) poor marketing facilities, 4) inadequate credit facilities, 5) poor community organizations, 6) small land holding of the farm family, 7) frequent natural calamities, and 8) over utilization and mismanagement of natural resources.

The paper examines some of the intervention measures that could be taken into consideration and some others that have already been initiated by various governmental and nongovernmental agencies for ameliorating the problems of land degradation. Several indigenous practices that have proved successful could be explored further and disseminated widely. These measures were successful in the past but no more viable to the current situations of continuous increase in population pressure. There are some promising technological innovations that must be developed further and included in the mainstream research programme. Most of all, appropriate policy intervention can go a long way in mitigating the problem effectively. Research must look into these aspects as well. While examining the human dimension of land degradation in Nepal, poverty emerges as a critical problem that must be tackled immediately, without which there can be no sustainable land management in the mountain ecosystem. Some of the constraints against sustainable land management have been categorized into institutional, technical, socio-economic, and financial types and some appropriate means to tackle them are necessary. In the institutional front it is necessary to pursue a strong scientifically based land use management policy and full coordination among all agencies and stakeholders that are affected by land degradation, whereas in the technical side, it is necessary to carry out systematic research work to develop low cost technologies with participation of all the stakeholders including the local farm community to ensure wider acceptance and adoption of such technologies. Reducing the rate pf population growth in conjunction with creation of job opportunities outside the farm through diversification in the economy is equally a vital socio-economic front to be considered. Availability of funds for research and development of the technology will have to be increased considerably.

Acknowledgement

The authors would like to express their sincere gratitude to the International Scientific Planning Committee of the Open Meeting of the Human Dimensions of Global Environmental Change Research for accepting our paper and for inviting the senior author to participate in the Meeting. Also, Asia-Pacific Network for Global Change Research (APN) is duly acknowledged for its funding through Centre for International Earth Science Information Network (CIESIN), Columbia University, without which it was almost impossible for the senior author to participate in the Meeting.

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