Land Degradation in Nepal: A Menace to Economy and Ecosystems

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Abstract

Land degradation is one of the greatest challenges facing mankind and Nepal is no exception. Anthropogenic causes such as deforestation, excessive use of chemical fertilizers, overgrazing, construction works and unscientific farming in the hills have resulted in the loss in the flora and fauna, erosion of top soil, occurrence of land slides in the hills and flooding in the plain areas. This has led to severe environmental degradation leading to poor socio-economic condition and disruption of natural ecosystems in Nepal. In this paper the aspects related to land degradation, extent and severity of damages and causes and consequences of land degradation are discussed. Various measures for restoration of degraded lands undergoing in Nepal have also been explained. The empirical study reveals that the rate of degradation outweighs the restoration processes.

Introduction

Land degradation means the loss in the capacity of a given land to support growth of useful plants on a sustained basis. It is a complex phenomenon-driven strongly by interactions among socio-economic and biophysical factors" (Singh 1994) that are quite unique in Nepal. Land degradation has been the greatest challenge facing mankind in recent years, and Nepal is no exception. Natural calamities like landslides in the hills, drought in the most of the areas of the country and flooding in the foothills and the Tarai have frequently occurred. Most of all, flooding has become a major cause of land degradation leading to the poor socio-economic conditions and the deterioration of the natural ecosystems.

Removal of top fertile layer of soil by water is a critical problem in the middle hills region of Nepal. In the past, the perennial streams of clean water trickling from hills supported good agriculture in the plains. In less than 30 years, unrestricted tree felling/cutting, overgrazing, random cultivation on steep slopes without proper terracing has aggravated the soil loss. Apart from the loss of productive top soil, it has further damaged the land and water resources due to siltation of dams and deposition of thick and sandy plains of the Tarai river.

Rivers in Nepal have damaged more than 400,000 hectares of productive agricultural lands (LRMP, 1986). The Shiwalik hills and middle mountainous regions are highly vulnerable to soil erosion. The extent and severity of damage have increased year after year due to frequent changing nature of mountain-rivers. Farmlands near river banks are

washed away by flooding, crops are ruined and widths of rivers widen every year during monsoon. Nepal's rivers carry around 336 millions tons of soil per year to the main river systems entering India (Brown 1981). The bed level of Tarai rivers is rising by 35-45 cm annually (Dent 1984). The productivity of riverside lands has been seriously affected by silting, flooding and deposition of pebbles. Furthermore, the river-damaged areas of middle mountains of Nepal suffer from excessive grazing pressures of domestic animals. Pioneer plants which are indicator species for degraded lands such as *Imperata cylinderica*, *Saccharaum munja* and *Cassia occidentalis* have colonized such areas (Kafle 1995). The natural succession has been inhibited by excessive grazing pressure as well as flash floods during the monsoon.

This paper examines the causes, consequences and processes of land degradation, explains various on-going efforts for land restoration and provides a conceptual model for sustainability of degraded land based on the empirical method.

Physiogrpahic zones and land degradation

Land is a principal natural resource of Nepal that constitutes about 97% of its total area (147181km^2) ranging from 70 meters in Terai to 8848 meters (Mt. Everest) within less than 200 km distance. The country's topography is rugged with over three quarters (76.9%) of the total area made of mountains and hills. The southern narrow plains strip is known as the Terai, it covers only 23.1% but it has the largest proportion of the population (46.7%). The hilly areas are geologically fragile and inherently prone to landslide and soil erosion.

In Nepal, land degradation has been occurred in all the physiographic regions of the country. Indiscriminate felling of trees and clearing forest areas for agriculture has given rise to the scarcity of the essential needs of rural people such as fuel wood, fodder and small timber. These activities, along with population pressure and improper land-use patterns have led to serious environmental degradation (Table 1).

Table 1: Types of Land Degradation in Physiographic Zones (Joshi et al., 2003)

Physiographic Zones	Types of Land Degradation
High Himal (above 5000 meter from msl)	Rock slides, avalanches, glacial lake outburst
High and Middle Mountains (2100 – 5000 meter)	Mass wasting (slumping, gulling, landslides, rock fall), gully erosion, surface erosion (rill and inter-rill), riverbank cutting
Siwaliks (1200 – 2100 meter)	Erosion
Tarai (70 – 1200 meter)	Flooding, river shifting, river bank cutting, water logging, formation of river-damaged areas

The processes of land degradation

All three types of land degradation exist in Nepal. They include physical, biological and chemical degradation.

Physical degradation

It refers to deterioration in physical properties of soil. It includes compaction and hard setting of soil caused by elimination or reduction of structural pores. Hard setting is a problem of soils of low activity clays and soils that contain low organic matter. Soils prone to compaction and hard setting are susceptible to accelerated run-off and erosion. Erosion of top soil by wind and water exceed soil formation at an alarming rate.
Nepal is a Hindu country and here cows are reared mainly to worship them in some festivals. Almost in every household cows are reared. In the past, the status of people used to measure based on the number of cows and other livestock in his or her family. The method of rearing livestock is unscientific even these days - free grazing in open public land. The 'tragedy of commons' (Hardin 1968, cited from Carter 2001) principle applies here. The heavy grazing pressure on the grazing lands in the mountainous areas caused two effects i.e. compaction of soil and pulverization of top fertile soil. This has helped increase soil erosion and run-off due to the compaction of soil.

Biological degradation

Reduction in soil organic matter, decline in biomass carbon and decrease in activity and diversity of soil fauna are some indicators of biological degradation. It can also be caused by indiscriminate and excessive use of chemicals. In Nepal, unscientific and environmentally unfriendly farming is still prevalent. Use of excessive chemical fertilizers and heavy and intensive farming without rotational tillage and farming in steep slope have been common. It has accelerated the degradation of soil quality which ultimately has resulted in decrease in soil productivity. The biological degradation is generally associated with the decline in micro-biological biomass, decline in quantity and quality of soil organic matter and soil-borne diseases. It increases the rate of mineralization of humus without replenishment of organic matter.

Chemical degradation

Nutrient depletion is the major cause of chemical degradation. Chemical degradation is also caused by the build up of some toxic chemicals and an elemental imbalance that is injurious to plant growth. One of the causes of land degradation in Nepal is the result of use of maximum fertilizer, chemicals, pesticides and insecticides in the land use practices. Due to the application of these chemicals and pesticides, land losses its fertility and capability and destroys the various types of micro-organism like bacteria and fungi in the soil (Singh 1994). In addition to the chemical fertilizers, the soil types have also contributed to the soil erosion and land degradation in Nepal.

Causes and consequences of land degradation

Both the natural conditions and human activities have contributed to the degradation of land in Nepal. Fragile geological structure, forest fire, avalanches and dry landslides are some of the major causes of land degradation whereas deforestation, overgrazing, farming on the steep slope, construction works and excessive use of chemical fertilizers are some major examples of the man-made cause. Increasing population, fragile economy and sometimes farm policies add fuel to it (Lal and Stewart 1990)
In its natural condition, land is covered by forest trees and other natural vegetation. The leaf litters enrich the soil fertility by providing organic matters. Trees leaves control the speed of the raindrops and allow them to go down to the land surface slowly. It helps water to infiltrate into lower part of the soil surface. After the soil is saturated, plants growing on it can utilize the excess water. The excess water is leached to the inner part of soil and supports to originate natural well and streams in the lower areas. It also helps make the water table high. Such natural conditions will be favorable for the growth of plants and micro-organisms in the soil.

On the contrary, when trees are felled and the root mats are destroyed, the soil is subject to soil erosion by the full force of the rains. Heavy rain removes nutrients by washing away the thin top layer of soil and by leaching nutrients deep into the sub-soil thus making it unavailable to plant roots. In the process, it compact the soil and squeezes out the air pockets. Air is as much important to soil quality as mineral nutrients and compacted soil poses serious threat to environment in the form of land degradation (Karpagam, 1991).

As around 77% of the total land area is occupied by mountains and high Himalayas in Nepal, the vegetation cover plays a crucial role for the supply of water source i.e. natural wells and streams. However, the rate of deforestation in Nepal is quite severe i.e. around 1.6% per annum (Joshi et al. 2003). If the ecosystem of the mountain areas is disturbed, people living in both the mountains and the plain areas will be suffered from various natural calamities such as soil erosion, land slides and flooding. "The two major harmful effects of soil erosion are (1) loss of soil fertility and its ability to hold water and (2) runoff of sediment that pollutes water, kills fish and shellfish, and clogs irrigation ditches, boat channels, reservoirs, and lakes" (Miller, 2004).

Forests help to maintain the temperature at a lower level and prevent them from rising. In the absence of forest, the entire heat that is not absorbed by the atmosphere but strike the earth’s surface are reflected by the earth’s surface, leading to a rise in atmospheric temperature. Besides, the repeated pressure of grazing on grasslands beyond its carrying capacity has damaged the ground vegetation and grassland ecosystems. The heavy grazing pressure on grazing lands in the mountain areas has speeded up the soil erosion, which has led to increased run-off and compaction of soil.
Cultivation on steep slope without taking considerations of improved farming such as terracing in steep slope, use of organic manures and so has contributed to the increase in soil erosion which has resulted in high water turbidity, which further leads to the harmful

effects to the aquatic flora and fauna including fish species. Development activities such as construction of roads, buildings, dams and so have further added duel to it.

All these activities have resulted in the poor socioeconomic status and imbalance in the natural ecosystems. Decreased land productivity and wash away of agricultural land due to flooding have given rise to the poor socio-economic status of rural/riparian people in Nepal. As a result, Nepal has the lowest per capita income (US$ 220 per year per person) in south Asia. The productivity of riverine ecosystems has decreased. Natural succession has been inhibited. Pioneers plant species which are indicator species of degraded lands have colonized in most of the river-damaged areas.

Interaction of natural and human factors

Use of resources

In Nepal, land and forest resources have been intensively used to meet the basic requirements of food, fuelwood, fodder and small timber of the people. Hill people cultivate their agriculture field even in the steep slope. As more than 87% people depend on agriculture for the subsistence, agriculture has been a major source of income and living for the people in the country.
Forest is another main source of income and basis for living in Nepal. Rural people in Nepal fully depend on forest to meet their requirements of fuelwood, fodder and timber, and green manures.

Misuse of resources

Cultivation on steep slope without taking into considerations of the scientific farming, extraction of forest resources beyond its renewal capacity, shifting cultivation in the mountains and overgrazing in the open public lands have been some examples of misuse of resources in Nepal. Illegal logging in the south bordering India and construction of highways without following the EIA guidelines have indirectly contributed to the occurring of landslides, flooding and ultimately land degradation in Nepal.

Restoration measures

Land restoration is the process by which an area is returned to its original state prior to degradation of any sort. However, some have argued that it is impossible to restore degraded natural habitats. Gunn (1991) has clearly argued that provided that species have not been made extinct as a result of the degradation, then restoration is possible. Miller (2004) has recommended following measures to maintain the soil fertility of degraded areas:

1. Use of organic fertilizer
    - Animal manure
    - Green manure
    - Compost

- Spores mushrooms, puffballs, and truffles

2. Rotational cropping.
3. Use of commercial inorganic fertilizer, but, he has also warned that commercial inorganic fertilizers have some disadvantages:
    - not adding humus to the soil
    - reducing the soil's content of organic matter
    - lowering the oxygen content of soil
    - releasing nitrous oxide , a greenhouse gas that can enhance global warming, from the soil.

A number of activities have been launched to restore the degraded farm lands in Nepal. Some of them include:

- Agro-forestry practices to reclaim degraded lands and meet the basic requirements of local people such as fuelwood, fodder and small timber.
- Initiation of community forestry and private plantation schemes to protect natural forest and increase plantation forest in rural areas.
- Amendment in forest law to institutionalize forest users group.
- Government policies for agricultural, forest and land such as per family land holding ceiling, land categorization and taxation based on the land types and so.
- Stall feeding system has been emphasized/adopted by farmers.
- Terrace farming in the hills has been emphasized to reduce the soil loss.
- Community forestry, private plantation and leasehold forestry concepts have been introduced and effectively implemented in order to reduce the human pressure on natural forests.
- Initiation of Integrated Pest Management (IPM) system
- EIA emphasized in development construction
- Initiation of non formal education on environment.

In addition, various alternative methods have also been adopted such as terracing, contour farming, strip and alley cropping, and gully improvement activities.

However, due to ineffective implementation of the methods and government rules, the pace of land restoration has not been satisfactorily improved. Government rules and policies have not been effectively implemented and followed. The following activities are recommended to effectively implement the abovementioned measures to counter the land degradation in Nepal:

1. Expansion of successful agro-forestry model to reclaim degraded lands of the river-affected areas through out the country.
2. Empower and enhance management capacities of community forestry user groups.
3. Provide subsidies and technical support for private plantation and forest leasehold schemes.
4. More emphasis on the environmental education-both formal and non-formal.

Although several innovative measures to counter the land degradation have been adopted, the balance between the rate of degradation and restoration is not equal. In order to restore the degraded lands more efforts are urgently required yet. The political commitment and sincerity in the beaurocracy are a must for the successful implementation of all land restoration measures.

Land Degradation in Nepal: A Conceptual Model

Based on the earlier discussion, a conceptual model of the land degradation and rehabilitation has been made. Both the causes and consequences of the land degradation along with the rehabilitation measures have been mentioned. The model based on empirical study reveals the fact that the land degradation rate outweighs the restoration processes (Annex1).

Conclusion

It is clear that due to the lack of effective implementation of counter measures, the land degradation problem is increasingly becoming a challenge for the economy and natural ecosystems in Nepal. It is realized that the balance between the land degradation and restoration rates should be maintained so as not to further degrade the land. The effective implementation of land restoration measures with full fledged political and beaurocratic commitments and sound technology are urgently required.

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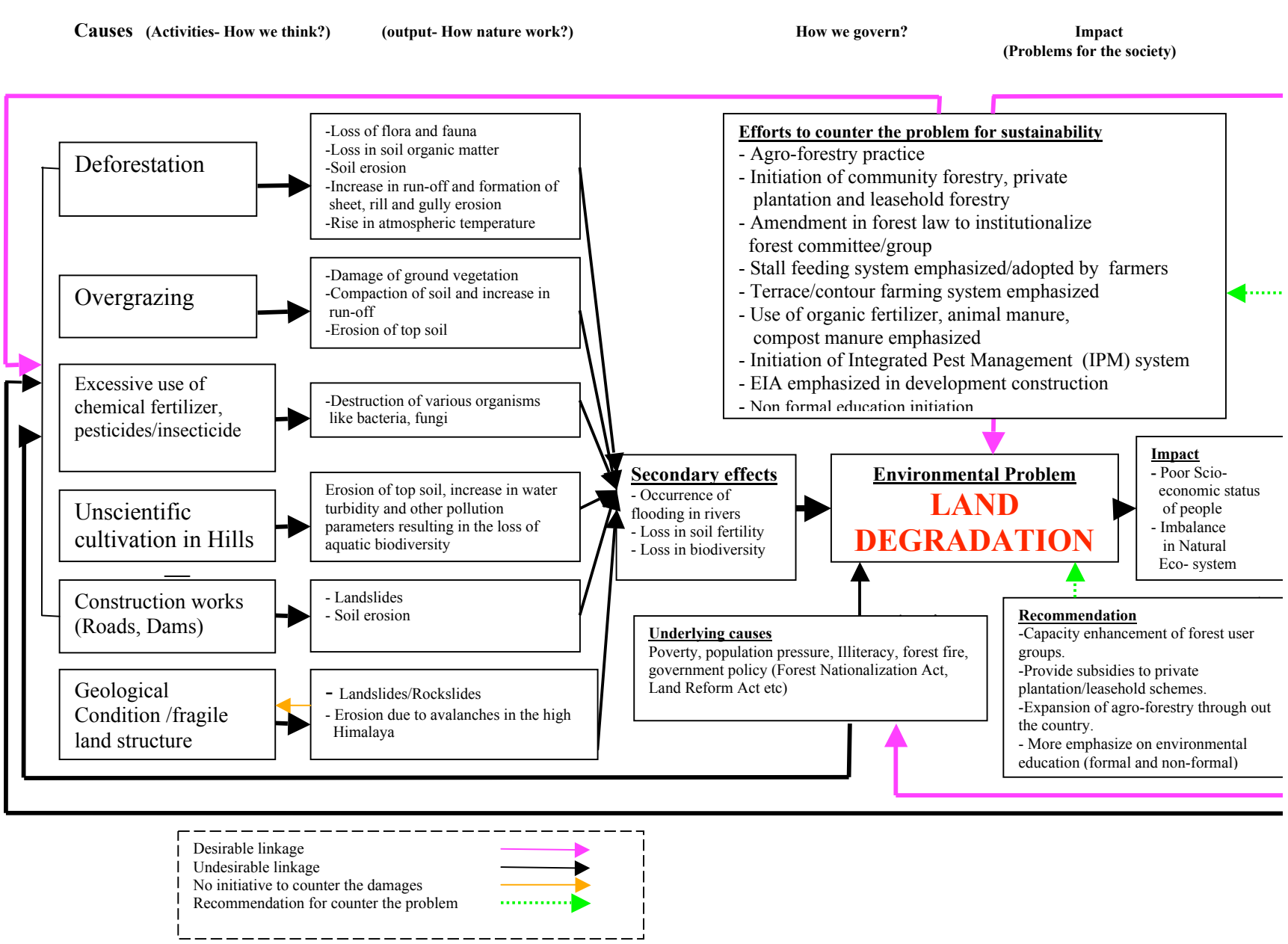
Causes (Activities- How we think?)
(output- How nature work?)
How we govern?
Impact
(Problems for the society)
Deforestation
-Loss of flora and fauna
-Loss in soil organic matter
-Soil erosion
-Increase in run-off and formation of sheet, rill and gully erosion
-Rise in atmospheric temperature
Overgrazing
-Damage of ground vegetation
-Compaction of soil and increase in run-off
-Erosion of top soil
Excessive use of chemical fertilizer, pesticides/insecticide
-Destruction of various organisms like bacteria, fungi
Unscientific cultivation in Hills
Erosion of top soil, increase in water turbidity and other pollution parameters resulting in the loss of aquatic biodiversity
Construction works (Roads, Dams)
- Landslides
- Soil erosion
Geological Condition /fragile land structure
- Landslides/Rockslides
- Erosion due to avalanches in the high Himalaya
Efforts to counter the problem for sustainability
- Agro-forestry practice
- Initiation of community forestry, private plantation and leasehold forestry
- Amendment in forest law to institutionalize forest committee/group
- Stall feeding system emphasized/adopted by farmers
- Terrace/contour farming system emphasized
- Use of organic fertilizer, animal manure, compost manure emphasized
- Initiation of Integrated Pest Management (IPM) system
- EIA emphasized in development construction
- Non formal education initiation
Secondary effects
- Occurrence of flooding in rivers
- Loss in soil fertility
- Loss in biodiversity
Environmental Problem
LAND DEGRADATION
Impact
- Poor Scio-economic status of people
- Imbalance in Natural Eco- system
Underlying causes
Poverty, population pressure, Illiteracy, forest fire, government policy (Forest Nationalization Act, Land Reform Act etc)
Recommendation
-Capacity enhancement of forest user groups.
-Provide subsidies to private plantation/leasehold schemes.
-Expansion of agro-forestry through out the country.
- More emphasize on environmental education (formal and non-formal)
Desirable linkage
Undesirable linkage
No initiative to counter the damages
Recommendation for counter the problem