

Resource Use and Its Ecological Implications A Case Study of Tinau Watershed

- Vinod Shrestha *

In mountainous areas, particularly in developing countries, there has been a tendency of over exploitation of limited traditional resources to sustain the increasing population. Wasteful and irrational use of the resources, in many instances, has resulted in serious ecological degradation throughout the Nepal Himalaya (Eckholm 1975, 1976, Rana 1976, Bhatt 1981, Moddie 1981, Gurung 1982, Shrestha 1983, Joshi 1984). This paper seeks to analyse the ecological implication of rapid population growth in the Tinau Watershed area which lies within the middle and outer Nepal Himalaya. First, it portrays the present situation of the important natural resources i.e. land, forest and water. Then the implications of ever rising population pressure upon these resources and the environment is analysed.

Geographic Setting

The Tinau Watershed area, which covers about 522 Sq. kms, lies within the hilly region of the western development region of Nepal. It is a part of the Palpa District in the Lumbini Zone. The watershed lies between longitudes 83°, 18' east to 83°, 43' east and latitudes 27°, 42' north to 27°, 52' north (Figure 1). The topographical features of the watershed are characterized by a maze of spur and valleys, rugged topography with steep slopes and deep incised valleys. The Tinau Watershed area consists of three subwatersheds. The Siwalik range which is also known as Churia hills comprises the southern, and the Middle Himalaya, which is known as the Mahabharat Lekh, constitutes the central and northern portion of the watershed. The Siwalik range and the Middle Himalaya run roughly east-west throughout the watershed area. These roughly parallel ranges are alternated by characteristic features of the low and narrow river basins and valleys. The altitude of the watershed area varies from 205m. (Dobhan) to a little over 1900m. above sea level in the Mahabharat Lakh at the north western corner near Khundhara.

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The hydrology of the Tinau watershed, as in other parts of the Himalayas, is controlled by geology, topography and climatological conditions. The rivers and streams within the watershed originate either from the Mahabharat or from the Churia hills. River discharge depends mainly on rainfall. In general sub-tropical climatological conditions prevail. Highly folded, faulted and loosely consolidated rocks have given rise to debris accumulation along the slopes of the hills. Heavy rainfall during the monsoon therefore causes huge land slides and flood hazards along the river course. About 37 percent of the total area of the Tinau Watershed is covered by forests. These can broadly be classified into two categories based on altitude and climate i.e. tropical and sub-tropical forests. The soil types in the watershed vary from sandy loam to sandy clay, loam to clay loam and loamy sand to clay. The soils are heterogeneous in character and the fertility status varies greatly from one location to another.

Natural Resources : Prospects and Use

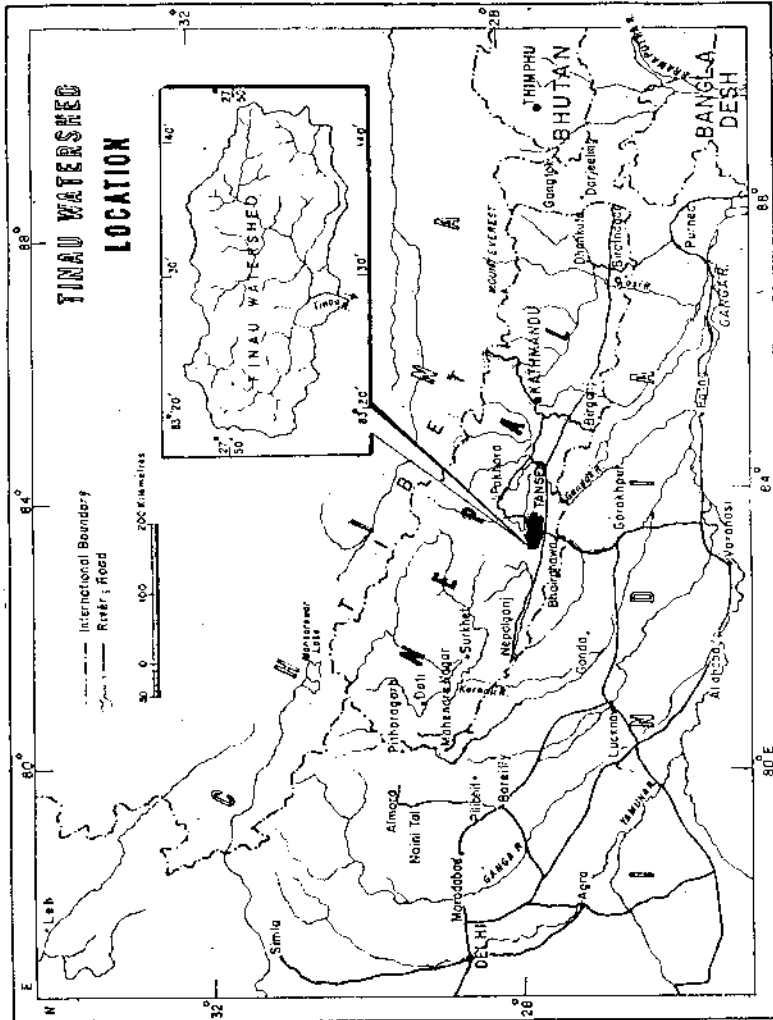
Resources, it is said do not exist but are made. The very concept of resource implies the desire and need of man to make a specific resource useful (Joshi 1983:386) in a given geographic environment. It is through a geographic interpretation that one can assess the potentialities and pattern of resource use of a particular region. It is quite common to distinguish two broad classes of resources—renewable and non-renewable. The renewable one can further be divided into two sub groups - flow resources and biologically generated resources. The flow resources typified by solar energy, are virtually indepletable because the flow may be tapped without affecting future availability. The biologically generated resources (fisheries and natural forests) are renewed through biological growth, but depletion will occur if output exceeds natural growth. Non renewable resources are fossil fuels and minerals which are usually depleted by use because the rate of renewal is too slow. It requires a long geological period for their formation.

A detailed inventory of natural resources in the Tinau Watershed area is lacking. A preliminary survey conducted in the 1960s showed the watershed to have some minerals like iron ore, and limestone (Ministry of Home and Panchayat, 1969:6). It is believed that these mineral resources are not good in quality and cannot be commercially exploited. Besides the mineral resources land, forest and water constitute the principal resource base of the watershed.

Land Resource

Land in the Tinau Watershed is a basic and important resource on which more than 95 percent of the total population depend for their livelihood. Land that can potentially be used for cultivation without any mechanical or biological treatment is very limited in the watershed area. The only potential and good farm lands are found in the river basins and valleys which are flat and have relatively deep soils. Lowland terraces are rain fed and the soils are moderately deep. Upland terraces occupy most of the areas in the rugged hill slopes. Per capita land in the watershed is 0.64 ha. and the per capita cultivated land is a meager

Fig. 14



0.21 hectare on the average. Land for agricultural use is extremely limited and most of the land brought under cultivation is not suitable for agriculture. Small and scattered holdings with limited irrigational facilities are typical. Table 1 presents a general picture of land use pattern in the Tinau Watershed.

Table 1 : Land-use Pattern in the Tinau Watershed

	Area in Hectare	Percent to Total
1. Forests	19.716	37.75
2. Agriculture	16.817	32.19
3. Scrub and Bush	12.747	24.40
4. Grass	1.679	3.21
5. Others*	1.278	2.45
Total	52.239	100

* Others include erosion, land slides, rivers, ponds, debris and built up areas.

Source: (Tinau Watershed Management Plan, 1980:32)

Of the total area, 97.65 percent constitutes of cultivated land, grass, scrub and bushes and forests, only 2.45 percent of the total land area is not usable for production purposes:

Forests

In the Tinau Watershed area, forest still constitutes the largest land use category. According to the land use map prepared by Tinau Watershed Project based on 1972 aerial photographs and compiled and updated in 1979, some 1,971 ha. or 37.75 percent of the total land area of the watershed is covered by forests. Dense forests, mainly sal, is still reserved along the southern belt of the watershed (Siwalik Zone) where as in the northern portion of the Middle Himalaya (Mahabharat Zone), scattered patches of forests are found mainly along the non-cultivable and mostly inaccessible higher slopes. Because of increasing demand for fuel, fire wood, timber, grazing and agricultural land, these scattered forests are being gradually depleted. At present the original forest area has been reduced to a large extent and these deforested areas are dominated by scrub and bushes.

Agricultural Land

The cultivated area of the watershed is 16,817 hectares which amounts to 32.19 percent of the total land area. The northern part of the watershed (Mahabharat Zone) is more intensively cultivated. Most of the fertile lands are concentrated along the river valleys and lacustrine

basins like Red: (Jhadewa Valley), Madi (Tinau valley), Nayapati (Hulangdi Valley), Dobhan Valley and Kachal Valley.

The cultivated land in the watershed can be divided into two broad categories - Khet and Bari. About 6 percent of the total area is irrigated by different means mostly by monsoon rain. The cropping intensity in the Khet and Bari land is estimated to be around 120 and 155 percent respectively (Tinau Watershed Project 1980:39). To a certain extent, factors like soil depth and fertility, slope and irrigational facilities affect the cropping potential in the area. In the irrigated fields along the valleys, lake beds and low terraces, cereals like paddy and wheat are grown. In the upland Bari lands (non irrigated) particularly along the middle and higher slopes of the Mahabharat range (generally along the south facing slopes) maize is the main crop in summer followed by millet, buck wheat and wheat. Mixed cropping and relay cropping is usually practiced along with the main crop (maize). Khet land constitutes 19.82 percent of the total agricultural land where as Bari land constitutes 80.82 percent. However, major portion of the Khet land remains fallow because of socio-economic and ecological constraints (New Era 1982).

Because of the ever increasing population, farmers have encroached upon the forests wherever possible for the expansion of agricultural land. The land resource particularly in the northern portion of the watershed area (in the Mahabharat Zone) has been intensively used because of high concentration of animal and human population. Along the southern part of the Siwalik (Churia) belt, however, the original forest is still intact. The dense sal forest of this zone is now being gradually encroached upon particularly in Laudapani, Jhangla, Dadegaon, Nuwakot, Kadambas, Chidiya, Basantapur and Dansing Kot area. Though the potential cultivable land area constitute some 0.5 percent of the total land area in the Tinau Watershed (APROSC 1979:19) there has been a growing tendency of extending agricultural land beyond the potential area. This tendency of over-exploitation of land resource will certainly have serious ecological consequences.

Scrub and Bush

Land under scrub and bush covers an area of 12,447 hectares or 24.4 percent of the total area of the watershed. Scrub and bush dominate the south facing slopes of the Mahabharat range. Erosion scars also are mostly concentrated in this area. The original dense vegetation cover has been reduced to scrub and bush through the combined action of over-grazing, shifting cultivation and indiscriminate cutting of the trees. The area under scrub and bush has increased due to indiscriminate cutting of trees. The practice of slash and burn agriculture (locally known as Khorja) which is mostly practiced by the Magars (majority of the population in the watershed) in a cycle of about 3 to 5 years has led to further deterioration of the land. Further, the land is being gradually converted into semidesert like landscape due to over grazing and land mismanagement.

Grass

Grassland covers an area of 1,679 hectares which amounts to 3.2

percent of the total land area. Grass-lands are mostly found along the northern portion of the watershed near human settlements. These are primarily public lands left for common grazing and have low grade grass. Existing grass or pasture lands are heavily over-grazed resulting in denudation of the soil and reduction in the carrying capacity of the pasture land (Shrestha 1983:6). Further intensive grazing in these lands would have a negative impact on the land resource.

Others

Land under this category includes land slides, debris, rivers, ponds and built up areas (Roads, Trails and Settlements). The area occupied by this category is 1278 hectares which amounts to 2.45 percent of the total land area of the Tinau Watershed. Land slides and soil erosion along roads and trails are common. Along the Siddhartha highway (which passes through the Tinau Watershed area) debris deposition is mainly concentrated along the river course and valley bottoms particularly in the Madi, Redi, Marmera and Dobhan Valleys.

Forest Resource

The forest is a community or an ecosystem of biotic and non-biotic components consisting predominantly of trees or other woody vegetation growing more or less closely together (FAO 1980:19). Forest resource in the Tinau Watershed constitutes a major resource base. Forests play an important role in protecting top soils against erosion and land slides, in producing regular flow of clear water, reducing danger of flooding and in protecting crops and human settlements against destructive winds or excessive temperature.

The need of forest products is ever increasing mainly due to the demands of a growing population. Available land for growing trees is shrinking due to expansion in agricultural lands, settlements and construction of roads and high power transmission lines. The fast rate of denudation of vital forest cover, which should be 60 percent of the total land area in the hills for ecological stability (Moddie 1981:344), has had disastrous consequences like land slides, soil erosion and gully formations specially in the northern zone (Mahabharat Zone) of the Tinau Watershed area where the forest area is found to be only 18 percent. At present the demographic pressure on the forest for fuel wood and timber has outstripped natural regeneration and plantation. The forests along the hill slopes within the vicinity of Tansen (Urban centre and district head quarters of Palpa) have already been exploited to a large extent because of high demand for fuel wood and timber in the urban centre. In recent years, the process of deforestation has been further aggravated by an increasing demand and consequent high prices for fuel wood in Tansen and Butwal.

The destruction of forest resources will continue so long as alternative fuel for cooking is not freely available to the rural poor. It is very difficult to assess the resource status on a quantitative basis, because the data base at the village level in Nepal is very weak and there is virtually no time series data at the micro level. The carrying capacity of the forests of the northern portion of the watershed has

been gradually reduced due to continuous deforestation to fulfill the basic needs of the people. Only in the southern portion, particularly along the Siwalik range, the forest resource is still intact. Here forests account for about 68 percent of the total area of the southern zone and is about 71 percent of the total forest area of the Tinau Watershed (Tinau Watershed Project 1980:31). The extensive virgin secondary tropical forest area of the south is a potential resource, which should be preserved and better managed in the changing and precarious ecological situation of the watershed.

Water Resources

Water in the Tinau Watershed area is derived from different sources like precipitation, springs, rivers and streams. However, these sources are unevenly distributed in both time and space. The primary source of water resource is precipitation. The supply of water to different sources is derived from rainfall. Table 2 shows the rainfall pattern in the watershed area.

Table 2: Tinau Watershed (Rainfall in mm)

Month	Dobhan Valley ¹ Altitude 300m. Siwalik Zone	Tansen ² Altitude 1240m. Mahabharat Zone.
Jan.	25.5	36.7
Feb.	4.0	16.6
Mar.	20.5	14.0
Apr.	2.2	33.8
May.	242.7	57.8
Jun.	109.3	239.6
Jul.	612.3	466.3
Aug.	623.3	423.7
Sept.	437.6	201.2
Oct.	170.0	73.8
Nov.	-	1.0
Dec.	56.2	9.8

1. Mean 1983

2. Mean 1972-74

There are two main sources for water in the watershed - surface and ground water resource. Most of the streams and rivers in the Tinau watershed originate from the Middle Himalaya and few streams (which are mostly seasonal) originate from the Siwalik range. None of these ranges are snow covered. Thus the water flow and discharge depends on intensity, amount and duration of rainfall. The heavy seasonal rainfall and river discharge channels act as a recharge for ground water aquifer.

In the remote hills particularly in the far western portion of the

watershed in Palung, Phek and Juthapauwa Panchayats, drinking water poses several problems. Except for Tansen, the supply of pure water for drinking purposes in the rural villages is almost non-existent. Villagers usually collect their drinking water at open springs, shallow ponds or from irrigation channels. Most of these collection places are heavily contaminated posing health hazard for the rural people (Tinau Watershed Project 1980:102). The water resource in the Tinau Watershed for irrigation has not yet been adequately utilized. In the watershed area, it has been estimated that only 500 to 600 hectares of agricultural land has been brought under permanent irrigation (Rieger et. al. 1976:71) which accounts for 3.5 percent of the total agricultural land. The agricultural lands which can be irrigated are scattered and most of the potential area is limited. Large and continuous plain tracts are rare except in the Kachal, Madi and Redi valleys. Due to topographical constraints, there is practically no scope for major irrigation schemes except in the Madi Valley.

Minor irrigation schemes can be initiated in different small river basins and valleys specially in Kachal, Dobhan, Nayapati, Madi and Redi. Though a detailed hydrographic survey of different rivers in the watershed area has not yet been conducted, the potential surface flow of the water resource can be utilized for generating hydro-electric power at different stages of the rivers. There is a hydro power station constructed by Butwal Power Company and has been in operation since 1971. It is located near the outlet of the Tinau river which is very close to Dobhan. The technology applied to construct the hydro-electric project is new and the first in Nepal. The water from the Tinau river is diverted through a two kilometre long tunnel along the Siwalik range. It generates 1000 kw. of hydro-electricity. The hydro power has been distributed in Butwal-Khasauli town area since December 1971 when the first phase of the work was completed.

As far as lakes are concerned, there is only one lake popularly known as 'Satyawati Tal' in the watershed area which is situated at the top of a hill along the Mahabharat range (Shrestha 1974:6) at an altitude of 1250 meters above sea level near the Satyawati village in the Koldanda Panchayat. The lake is about half a square kilometre in area and is surrounded by thick forests. This has made the lake a spot of scenic beauty. The source of water in the lake is spring and monsoon rain. There are a few other shallow lakes and ponds of which 'Suke Tal' or Dry lake (Ministry of Home and Panchayat 1969), and few shallow and swampy ponds (Purin Dhap, Buduwa Dhap, Kalpu Dhap and Budh Dhap) are notable. A small seasonal lake called 'Pravas Tal' (situated at an altitude of about 800 metres above sea level in the Nayapati valley which is very close to the Siddhartha highway and is about 8 kilometres south of Tansen) was converted into a fish farm in 1975 by the Palpa District Panchayat. At present, the Tinau watershed Project is trying to improve the fish farm in the Pravas lake.

Population Pressure on Resource

In recent years, increasing population pressure (both human and animal) in the Nepal Himalaya has become a matter of serious concern

from ecological viewpoints. At present, the country has relatively high density (102 persons per sq. kilometre in 1981) of population among the mountainous countries of the world (UNESCO MAB 1973:55). According to 1971 census, the total population in the Tinau Watershed was 61,224 whereas the population figure for the same area in 1981 was 80,664. The 1981 census reports that the population growth in the watershed area was 2.79 percent per annum which was higher in comparison to that of the Palpa District (1.83%). Moreover, the population figure calculated from the 1981 census report on Tinau Watershed area reveals the average density of population to be 155 persons per square kilometre which was substantially higher than the national density of 102 persons per square kilometre. Population pressure in the Tinau Watershed area is therefore quite high.

Increasing pressure of population on land and forest resources of the area under study has become a matter of grave concern from the viewpoint of ecological balance. Every year, the ecological balance in the study area is found to be seriously disturbed by indiscriminate exploitation of resources. The high intensity of deforestation and quarrying for construction purposes are found in some ecologically precarious and sensitive areas along the northern portion of the watershed* which have created irreversible changes in the environment. Because of higher rate of population growth, basic necessities for survival have been placing increasing demands on natural resources, to the extent that the ever increasing demand for food, fuel, fodder timber and other basic necessities cannot be fulfilled by deteriorating resources. Thus, there is no option for the people: they must either face hunger or migrate seasonally or permanently to the neighbouring Tarai or into the plains of India or they must exist by further exploiting the already deteriorating resources.

Increasing pressure on the land resource has led to the extension of crop farming into more and more marginal areas which for reasons of topography and soil quality are not suitable for agriculture. In the Tinau Watershed area, as in other mountain and hilly parts of Nepal, there is a considerable pressure of population on the limited agricultural land resource where the agricultural density is about two times that of the Tarai region, though the fertility status of the soil is very low in comparison to the fertile alluvial soil of the Tarai plain. Khet land in the watershed is very limited and accounts for only 19.21 percent of the total agricultural land. Since there seem to be no possibilities to expand the Khet land, the increasing population pressure necessitates the expansion of Bari land in an increasing proportion. In more densely populated areas of the northern part of the Tinau Watershed, the ratio of Bari to Khet is 3.6:1 (Tinau Watershed Project 1980:55). However rapid population growth has now already led to such pressure on land resource that per capita availability of agricultural land (0.21 hectare per capita) is already lower in the watershed. In view of the present trend of population growth, it is clear that the increasing population pressure will impinge on the southern part of the Siwalik Zone where the forest is still intact. All the Panchayats which lie within the watershed, with the exception of Chidipani (which produces a surplus of

food grains) claim to have a food grain shortage varying from two months per year to as much as eight months (Palung Panchayat) or even ten months a year (Chhahara Panchayat) (Tinau Watershed Project 1980:55). This extent of food grain deficit in the Tinau watershed shows that the carrying capacity of the agricultural land resource has already been far exceeded.

Due to lack of alternative employment opportunities outside agriculture, the rapidly increasing population is increasingly bound to depend on subsistence agriculture or migrate. Due to continuous pressure on the limited available land, more and more people in the watershed have tended to see the forest land in terms of its potential for crop farming. Consequently this tendency has led to the expansion of cropland on steep unsuitable slopes, over grazing of animals in the forests, and reckless cutting down of trees from the dwindling forests for fuel, fodder, timber and agricultural land (Bajracharya 1983, Shrestha 1983:97).

Initially the wood lands are cleared for dry crops and then are subsequently converted to irrigated land. This dimension of the land use problem has serious implications for the stability of population-resource relationships in the Tinau Watershed. The extension of cropland in the marginal land creates a chain reaction: area of grazing land decreases, forests are over-grazed leading to soil erosion and land slides.

Due to mismanagement of land, environmental deterioration is severe in the northern part of the watershed. The Madi Valley which has the largest proportion of agricultural land in the watershed can be taken as an example. Here the rim of the valley shows signs of desertification. The process of ecological degradation has resulted in loss of top soils and land slides along the surrounding hill slopes on the one hand and the loss of agricultural land, fertility of soil, debris deposition and siltation problems in the fertile valleys on the other. The incident of flood hazards by swollen rivers flowing from the surrounding hill slopes is increasing every year. In 1978 some 30 households in the Madi Valley had to re-transplant their paddy seedlings six times in one season due to flooding (APROSC 1979:107). The rivers which once flowed below the level of Khet land now flow above the level of the Khet land between vulnerable banks (New Era 1982:11).

The silt and debris which are brought and deposited by the rivers and streams have damaged not only fertile agricultural lands but also the irrigation channels as well. The Chekuwa Kulo in the eastern part of the Madi Valley has been damaged by flood and debris (Shrestha 1978-2035 BS). At present, such deposits along the banks of the rivers and streams (Tinau, Sukjor, Naubise, Tansing, Andheri and Dondra) are found throughout the valley. If the present deposition process continues, the areas of debris deposition will gradually expand, converting the whole Madi valley into an agriculturally useless landscape. The heavy rainfall (more than 250 millimetres within 14 hours of September 29, 1981) in the valley seriously damaged the standing paddy crops and serious deposition problem caused by Sukjor (Khahare) Khola, Tinau, Maraha and Andheri Khola completely washed away more than 150 Ropanies of agricultural land near Dohara (New Era 1979:11).

The heavy deposition of debris by the rivers along the beds have

resulted in raising the level of the rivers even during normal rains. The rivers often change their courses converting fertile agricultural land by depositing debris into unproductive land on the one hand and damaging the standing crops on the other. According to one inch to one mile (1:63360) toposheet of 1959, the total area under debris deposit was only 9 hectares but the area had increased to about 140 hectares in 1981. Thus within a short period of about 22 years, the area under wasteland has increased more than 16 times (Shrestha 1982:69).

Over exploitation of forest resources and mismanagement of the land resource along the hill slopes have set in the process of environmental deterioration and ecological degradation in the fertile valleys of the Tinau watershed area. Loss of fertile agricultural land in the valleys leads to decrease in total agricultural land thus resulting in the decrease in agricultural production. The people are thus bound to occupy the marginal and ecologically sensitive steep hill slopes for cultivation. The process of land slides and soil erosion along the hill slopes and its repercussion on the fertile agricultural land in the valleys generates more demand for cultivable land. The forest areas are further reduced. Clearly a vicious cycle has been set in motion. This cycle is accelerated by ever increasing population and greater aggregate demand for arable land (Blaikie 1982:214).

Due to rapid growth of population and animals, the forest area particularly in the northern area is being depleted both in terms of area as well as in density. When one questions the old people in the villages about the forest coverage, they say that there was extensive and dense forests near their villages a few decades ago. Only scrub and medium sized trees are found in these previously forested areas particularly in the vicinity of Tansen. It is amazing how fast such forests are being used up. There is virtually no replantation system in the villages taken by the villager's own initiation in the watershed and no real efforts are being made for conserving the dwindling forests. The fuel wood crisis is now acute in the northern part of the watershed. The present rise in the price of fuel wood in urban centres is two and half times higher than it was a decade ago. If the present population in the watershed area doubles within the next 25 to 30 years, (which in all likelihood it will) the ecological situation will further deteriorate and lead to an acute shortage of fodder, fuel wood and food. This will ultimately lead to untold misery.

Animal Population Pressure

The number of livestock in the Tinau watershed is increasing more or less in the same way as human population. This is because the additional land brought under cultivation requires more manure to maintain the fertility of the land and extra income to keep pace with increasing demands for basic necessities. Huge quantities of vegetation is consumed by the livestock, either roaming in the forests or by being stall-fed, in the villages. Goats, Cows and Oxen are usually herded throughout the year over the slopes of the barren hills and the animals consume whatever they can find. Uncontrolled grazing decreases both regeneration and productivity. There are as many cattle and buffaloes as people in the watershed area (Table 3)

Table 3: Estimated Livestock Population in Tinau Watershed (1978)

Animals	Estimated number	Percentage to Total
Cows	25.000	22.40
Oxen	13.600	12.19
Buffaloes	20.000	17.92
Goats	28.000	28.09
Pigs	25.000	22.40
Total	1,11,600	100

(Source: Tinau Watershed Project 1980:40)

It is estimated that in the Nepal Himalaya, cattle graze in the land nine times more than it can take, tearing up the grass crippling trees and eating seedlings before they can grow (Lean 1983). Thus soil erosion and gully formation is widespread in the watershed due to over grazing of animals. During the dry seasons (May to June) burning of forests and grasslands is a common feature (Bajracharya 1983:237). It is to stimulate early growth of grass for animals to graze. This is a devastating practice, because it removes most of the mulch and exposes the soil to erosion.

Mostly buffaloes in the Tinau watershed area are stall-fed. Cutting of such fodder occupies much of the time of the female members of the household. Two to three bundles of such fodder are brought to each household every day, each bundle weighing about 16 kg on the average. The only alternative to overcome the problem is either to improve the quality of the animals and grazing lands, or lower the number of livestock. At present it would be unrealistic if not impossible to reduce drastically the number of livestock, for reduction in number would mean a drastic cut in protein, manure, productivity and extra income. In such a situation, increasing deforestation and over grazing process may ultimately affect not only the supply of timber and firewood, but also extra income and consumption of protein and calories as well.

Concluding Remarks

There is a close relationship between population and resources. In fact, the relationships between the level of national development and nature of human and natural resources is more direct than other relationships. The development of a country and the well being of the people therefore depends upon proper and balanced relationships between these two components: There has been a steady pressure on the resources due to high rate of population growth in the Tinau Watershed. This has placed a greater demand for land and forest resources to provide the basic necessities like food, fuel, fodder timber etc. But the productive

capacity of the resources of the watershed to provide such commodities is fast decreasing. Under these precarious circumstances, every possible piece of land has been cultivated and forests are being irrationally encroached upon for timber, food, fertilizer, fodder and fuel. Improper land use practices and cultivation of more and more marginal lands without adopting soil conservation and water management techniques, over exploitation of community lands such as forests and grass lands, have resulted in loss of top soils, gully formation and land slides. This has led to serious consequences upon the delicately balanced ecosystem of the Tinau Watershed area.

For restoration and preservation of the resources and thereby the environment, the long term goals should be to stop further degradation of the watershed and reduce population pressure on the land and forest resources on the one hand, and preserve and scientifically manage the existing resources on the other. A scientific land use system can be introduced in the watershed by conducting scientific soil surveys and preparing soil and land use inventories. To derive relief from the demographic pressure on the deteriorating resources, the present trend in population growth should be checked and opportunities for off - farm employment created. At the same time, land use measures based on land capabilities should be adopted by discouraging wasteful exploitation of the resources. Effective resource management policies should be implemented for speedily arresting the process of ecosystem degradation in the Tinau Watershed.

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