

## **CHAPTER - IV**

### **AGENTS OF ENVIRONMENTAL DEGRADATION IN SIKKIM**

#### **INTRODUCTION**

Environment encompasses wide variety of natural habitat present in the earth at various locations under specific biospheric socio-cultural setup. Before pondering into the environmental problems in Sikkim, it is felt necessary to access the current position on richness of biodiversity and overall environmental scenario of Sikkim. It has already been highlighted in the forgoing chapters that rich flora and fauna in Sikkim has its potential in the higher altitudinal zones marked by severe climatic condition. Further, it is also seen that the rate and degree of degradation is rapid in the high altitudinal belts. An attempt has been made to underline the existing estimates of flora and fauna in the state of Sikkim. The State animal is Red Panda, state tree is Rhododendron Niveum, state Bird is Blood Pheasant and state Flower is Dendrobium nobile or Nobile Orchid.

This region is recognized as one of the ten mega-biodiversity regions of the world. Sikkim falls under diversified biodiversity hotspot of Eastern Himalayas. This region is surrounded by many countries around the Himalayan zone namely China, Bhutan, parts of the eastern Nepal, Chittagong (Bangladesh) and northeastern states of India including the hills of Darjeeling. Sikkim, being located at the foothill of mount Kanchendzonga offers wide scope for the study of Zoology, Botany, Geography, Geology, and so on. Environment of this region is sensitive and prone to fragility due to large number of tourists pouring into the State. It is estimated that the region contributes more than 26% of the flowering plants of India and has been known as a potential phytogeographic reserve of the country. The region is listed among the world's most critical centers for biodiversity and endemism with 150 species of mammals, 550 species of birds, 650 species of butterflies

**TABLE 4.1: PLANT AND ANIMAL KINGDOM IN SIKKIM**

FAUNA				FLORA		
SL. No.	Fauna	No. of species	Name of Principal Endangered Species	Sl. No.	Flora	No. of Species / found in the state
1.	Mammals	144	Bharal, Clouded Leopard, Fishing Cat, Golden Cat, Himalayan Thar, Leopard Cat, Red Panda, Marbled Cat, Musk Deer, Nayan or Great Tibetan Sheep, Pangolin, Serow, Snow Leopard, Spotted Lingsang, Tibetan Antelope, Tibetan Fox, Tibetan Gazelle, Tibetan Wild Ass, Tiger, Tibetan Wolf.	1 2 3 4 5 6	Orchids Rhododendron Flowering Plants Ferns & Allies Conifers Medicinal Plants and Herbs	550(95General) 36(45Varieties) Over 4000 Species 300 9 Plenty (Not enumerated)
2.	Birds	550	Black-Necked Crane (Migratory), Blood Pheasant, Peafowl, Tibetan Snow Cock, Tragopan Pheasant, Snow Partridge, Siberian Crane (Migratory).			
3.	Butterflies & Moths	650	N.A			
4.	Reptiles	33	N.A			
5.	Frogs	16	N.A			

**Source-Statistical Profile, 2004-05**

and moths, 33 species of reptiles, 16 species of amphibians, 48 species of fishes, 4,500 species of flowering plants, 36 species of rhododendrons; 9

species of conifers, 450 species of trees, 480 species of orchids, 362 species of ferns and allies, and 175 species of wild edible plants (Pradhan 1976, 1979; Pradhan and Lachungpa 1990; Tamang 1993; Rai and Rai 1993; Sundriyal and Sharma 1996; Singh and Chauhan 1998; Ganguli-Lachungpa 1998; Sundriyal 1999). In Sikkim, 40.65% of area (Khangchendzonga Biosphere Reserve 2619.92 km<sup>2</sup>; Shingba Rhododendron Sanctuary 43 km<sup>2</sup>; Kyongnosla Alpine Sanctuary 31 km<sup>2</sup>; Fambong Lho Wildlife Sanctuary 51.76 km<sup>2</sup>; Barsey Rhododendron Sanctuary 104 km<sup>2</sup>; and Maenam Wildlife Sanctuary 35.34 km<sup>2</sup>) has been brought into protected area management network. The rich flora and fauna therefore is highly threatened and there are symptoms of extinction.

#### **4.1 RESOURCES - PLANTS AND ANIMALS**

In order to access the natural resource potential in Sikkim, resource map has been prepared where details of resources are placed in the form of tables and diagrams. Firstly, plant and animal diversity has been identified and then environmental aspect is being discussed at length. The five faunal diversity (Table 4.1) with their species available in Sikkim, shows wide range of natural wealth. In total, there are nearly 550 species of birds found in Sikkim.

##### **4.1.2 Floras**

The state is endowed with exclusive variety of natural habitat. An outline of some 29 endemics has been traced out from Sikkim Himalayas. The vegetation cover in Sikkim shows variety of trees and plants located at various heights. Due to variation in climatic condition, plants of unique varieties are found in this region. However, it may be mentioned here that vegetation cover is gradually vanishing from alpine zone due to change in environment and other innumerable factor.

Hooker in his own lines (1906) wrote about the exotics of floral diversity of the Indian subcontinent "to the immigration of plants from widely different

bordering countries, notably Chinese and Malayan on the east and south, of oriental, European and African on the west, and of Tibetan and Siberian on the north". He is the pioneer who gave maiden attempt in studying botanical paradise of Sikkim Himalayas. The Kanchendzonga biosphere has been the house of all such exotic varieties of plant diversity in Sikkim. Most of the species are found in highly elevated regions of Sikkim. Such regions are also the tourist resource of the state. In such a scenario, species are fighting for their survival. The plant varieties listed are not abundant; some species are highly endangered and need immediate conservation. The disturbances and encroachment are very high which led to ecological destruction. Sikkim is a paradise for Orchidaceae and Asteraceae, there are nearabout 450 and 280 species of these families found in this zone.

The rare endangered species of germplasm found in Sikkim are *Aconitum novoluridum* Munz. *Calamus inermis* T. Anders, *Cyathopus sikkimensis* Stapf. *Magnolia globosa* Hook.f. *Soulia vaginata* Franch etc., which are (Singh and Chauhan, 1998) being depleted at an alarming rate in other parts of the country due to severe biotic interferences. Therefore, the area has already been identified as one of the hot spot areas of the country

#### **4.1.2.1 Medicinal plants**

Since time immemorial, the ancient people inhabiting hills and mountains have been known for healing and treating diseases with herbal plant. In Sikkim, practice of such traditional herbal medicine is prevalent almost in all parts of the state. People though uneducated, yet can identify the species and their uses. Sikkim was recognized as the house of medicinal plants only after Hooker's botanical exploration. After a long wait, a work on common medicinal plants of Darjeeling and Sikkim Himalayas by (Bissau, 1956) appeared. According to (Srivastava and Kapaki, 1990) which over 400 plants possessing therapeutic properties have been recorded from the region

In the process of exploring medicinal plants, State Council of Science and Technology in Sikkim created a database on medicinal plants. The Forest

Department of Sikkim under its programme of minor forest produce established 20 trial plots of medicinal plants at different altitudinal zones covering an area of 600 ha (Sharma, 1995). Recently (Gurung, 2002) has brought out a book on the Medicinal Plants of the Sikkim Himalayas. The Sikkim circle of Botanical Survey of India has established extensive herbarium of medicinal plants. The names given in local languages along with the botanical drawings have greatly simplified the identification. Recently a Medicinal Plant Board has been constituted under the Secretary, Forest, wildlife and environment, Government of Sikkim.

There are records of substantial loss of medicinal plants from the mainland of Sikkim. It is reported that in the context of Sikkim Himalayan the situation in herbal plant removal from the wild state was already at a detrimental level as described by (Biswas 1956) " *Chiraita*, *Aconite*, *Ephedra*, *Manjistha*, *Kuth*, *Podophyllum*, *Rheum*, *Lycopodium*, *Chalmogra*, *Ravwolfia* and many others are ruthlessly and crudely collected and sold outside the state." A study by (Rai and Sharma, 1994) highlighted the spots, which were resplendent with jatamasi reported by Gammie in 1894 but so far very few individuals are encountered. A large amount of herbals (jatamasi 26,160 kg, kutki 4,840 kg, aconite 7,880 kg as per Forest Department record, 1990-91) was obtained from Lachen but it remained as a past experienced. The report of a recent survey carried out at Lachen area in April 1999 reveals a less than 80 kg consignment of kutki and the other two species were of negligible amount. The list of restricted and protected medicinal plants; trees are placed at (APPENDIX IV)

#### **4.1.2.2 *Rhododendron***

Sikkim is synonymous to rhododendrons. It was after 1849, Botanist Hooker came up with the pioneer work on 'Rhododendrons of Sikkim-Himalaya' that glimpses of rhododendron of Sikkim was known to all. The American Rhododendron Society carried out the study on Sikkim rhododendrons since 1971 and the then royal family took serious interest in this regard. The continent of Asia is known as the homeland for

rhododendrons and many species of rhododendron had been lifted out of the region during British rule. About 98% of the Indian species are found in the Himalayan region out of which 72% are found in Sikkim. Undoubtedly, Sikkim could rightly be called the '*cradle of Himalayan rhododendrons*'. The major threats to rhododendrons are deforestation and unsustainable extraction for firewood and incense by local people. These alpine plants may be wiped out from the biota in short time if proper conservation measures are not made. It supports a wide range of biodiversity especially birds and butterflies, which attracts a large number of visitors in the region thereby adding to the state and local economy. More than 90% of the World's natural population of rhododendrons is from southeastern Asia stretching from the northwestern Himalaya through Nepal, Sikkim, eastern Tibet, Bhutan, Arunachal Pradesh, upper Burma, western and central China. The genus *Rhododendron*, having about 50 species in India, is mainly distributed in the Himalayan region (1 species in southern India) and is one of the most neglected groups of plants in terms of scientific inquiry so far. There has been no substantial effort on the estimation of total number of species, sub-species and varieties of rhododendrons.

#### **4.1.2.3 Orchids**

Sikkim is the land of orchids. The climatic condition prevailing in Sikkim is best suited for orchid growers. She has about 480 species of which some varieties are domesticated as pot plants or indoor plants as ornamental plants. The orchids like cymbidiums and soft-cane dendrobiums have been placed on top of the world of orchids, it is mainly due to their progenies from Sikkim. Hence, Sikkim can be called as the *storehouse of orchid*.

The Orchids of Sikkim have also been endangered due to deforestation and human exploitation. Many of the species are on the verge of extinction and in case of others the populations have been substantially reduced. This process is in continuation and orchid's natural habitats are being disturbed. Unless timely action is initiated, (Pradhan, *et al*, 2004) the state definitely will lose its orchid wealth at a very fast pace. An ambitious and workable

programme needs to be chalked out to protect, preserve and restore orchids of Sikkim in their habitats. Biotechnological tools can be made good use for rebuilding and replenishing already dwindled numbers of different orchid species.

#### **4.1.3 Fauna**

The outstanding works in recent memory are on birds by Salim Ali, (1959) who reported as many as 430 bird species. His studies showed that Black necked Crane, Himalayan Griffon, Lammergeyer, Tibetan Snowcock, Snow Partridge, Snow Pigeon, Horned Lark, Snow Finch and Mountain Finch are a few of the many species of resident endangered birds of the trans-Himalayan region. There are also several species of migratory birds which over fly this region and use the high altitude lakes as stopover sites to rest on their journey across continents. Further, inclusion of migrants could round off the number of bird species in Sikkim to about 550 (Lachungpa, 1998). There is also (Chettri, 2000) a compiled list of rare and endangered birds of Sikkim, which fall in different schedules of Wildlife (Protection) Act, 1972. Some of the schedule I species of birds are Blood pheasant, Crimson horned pheasant, Forest eagle owl, Himalayan golden eagle, Lammergeyer, Monal pheasant, Sparrow hawk, Tibetan snowcock and White breasted dipper . As many as 52 species of water birds belonging to 10 families mostly from the Trans Himalayan zone and high altitude river banks of north Sikkim have been reported. Some of these are Ibis bills, Redshanks and Brahminy Ducks. Some of seasonal visitors are Geese, She duck, Widgeon, Gadwall, Teals, Mallard, Pintail, Shoveller, Pochards, Merganser, Black necked Crane, Crakes, Moorhen, Woodcock, Snipe, Redshank, Sandpiper, Stint, Ibis bill, Avocet, Plover, Lapwing, Gull, Grebe, Cormorant, Egret and Heron (Ganguli-Lachungpa 1998 & Pradhan *et al* 2004)

According to Ganguly Lachungpa about 150 species of mammals belonging to 28 families have been recorded from Sikkim. According to Chhetri there are nearly 19 mammals of Sikkim under endangered or rare category, as per the schedule of Wildlife (Protection) Act, 1972 and in the IUCN red

data book. The most important schedule I species of mammals are Bharal, Clouded Leopard, Great Tibetan Sheep, Himalayan Thar, Marbled Cat, Musk Deer, Red Panda, Serow, and Snow Leopard.

Where as Tamang P, 1993 reported 48 types of fishes in Sikkim belonging to hill stream such as 23 genera, known variously as *Balm*, *Asala*, *Bhitti*, *Khasray*, *Challay*, *Chirkey*, *Chepti*, *Gardi*, *Theyr*, *Katlay*, *Sahar*, *Buduna*, *Titay*, *Gadela*, *Jalkapoor*, *Gonch*, *Gona Machha*, *Dhodray*, *Kahray*, *Lulay*, and *Kabray or Hilay*. Further Haribal, 1991 recorded 650 species of butterflies and moths in Sikkim.

#### **4.2 DEFORESTATION AND ENVIRONMENTAL DEGRADATION**

In the long journey from cradle to grave forest is human's first friend. Ecologically, forest changes the course of an eco system. It is often viewed about the economic significance of forest but pondering into the system it reveals that well knitted food chain and food web exist with delicate balance in the eco system. The problem of rain-wash, flashflood, landslide, have caused massive degradation of forest in the recent past. Sikkim being a Himalayan sloppy region, rate of deforestation is exorbitant. The rural people in Sikkim directly or indirectly depend upon forest resources; cooking coal, fodder and fuel are derived from forest resource. The clean air is derived from forest; vegetation determines the type and quality of soil and climate in a given region.

Forest is invaluable property of a nation and also the livelihood of rural mass. Forest resources determine the size of domestic animal. In the present scenario, forest provides raw materials to the modern massive industries. Further, natural habitats including numerous animals and microorganisms, nutrient rich soils having high organic value thrive in the places covered by luxuriant vegetative growth. The forest areas in Sikkim may decrease due to construction of hydro power plants, airports and other constructional activities. There are instances where endangered species of Orchids and Rhododendrons are collected by the local people and trekkers and sell them off in the illigal market to earn their livelihood. The faunal diversity such as



black buck, leopard, cat, golden cat, Himalayan bear fighting battle for their survival.

#### **4.2.1 Deforestation senario in Sikkim**

Deforestation has been a menace, which endangers the fragile ecosystem of Sikkim. Destruction of natural vegetation in the high altitude areas, alpine zones have threatened the flora and fauna. Due to pressure on land, forest areas are often encroached for gaining agricultural development. To fill the belly of large population, forestlands are converted to farming areas. The cardamom growers in Sikkim have been shifting towards high altitude areas. The depletion of forest resource has a wide-ranging impact on ecological balance ranging from the extinction of rare flora and fauna to changes in climatic conditions, desertification and floods. Because of habitat destruction large number of plants and animals are in the endangered list and some of the natural attractions of Sikkim are disappearing. The maintained level of forest cover helps in maintaining water table but encroachment is prominent in the vicinity of forest area. Many private lands in the state share its boundary with the forestland. It is very difficult to monitor the extent of encroachment because of lack of resources, manpower and technology. The rate of encroachment is severe in rural area; it is mainly due to lack of clearly demarcated boundary and lack of knowledge in forest laws.

#### **4.2.2 Land diversion**

The pressure of encroachment on forestland shows notable figure. As per the 1998 estimate, total of 590 hectares forest land of Sikkim was diverted for development related activities. There was an increase in 1998-99 by another 10 hectares of forestland diversion to other activity. Total of 147 hectares of forestlands are proposed to be diverted in future. (Statistical Profile 2004) There are many cases (APPENDIX V) showing diversion of forest in Sikkim.

The concept of compensatory afforestation is found best recorded in Sikkim. It is carried out in the places where deforestation has been carried out

for the purpose of development. Approximately over 1000 hectares of CA has been completed. It clearly indicates that unprecedented forest depletion is taking place in the name of development in Sikkim.

#### **4.2.3 Commercial deforestation**

In 1951, purely commercial deforestation practices prevailed in Sikkim. Under this scheme timber used to be floated through the rivers. There were no urban centers in Sikkim and the entire area was covered by forest wealth. During this time merciless vegetation clearance took place to give way to construction projects. The timbers were cut for house construction and also supplied to meet the demand of industries.

#### **4.2.4 Forest fire**

In Sikkim, forest fire is not a new thing. The forest fire is caused either accidentally or by village community. With a view to add to agriculture land, forest are often put to fire, secondly, unwanted grass cover is wedded through fire so that manuring is not required. People in general and farmers in particular are not aware of the loss of forest cover and its impact on environment. Hence, further depletion is possible to great extend.

### **4.3 ENERGY CONSUMPTION AND ENVIRONMENTAL DEGRADATION**

The energy consumption pattern in Sikkim is different in rural and urban areas. The traditional sources of energy consumption are widely practiced in rural Sikkim whereas modern system is used in the urban centers. Using firewood, animal dung and crop residues fulfill the traditional system of energy needs. Biomass has been a vital part of the state energy source.

#### **4.3.1 Fuel consumption pattern**

Since most biomass fuel is used in domestic cooking, energy wastage from biomass conversion is very high. Fuel wood covers nearly 85% of the total energy consumption, (Table 4.2) which is basically obtained from forest.

The comparative picture of four districts in Sikkim reflects predominance of forest wood as source of fuel for cooking purpose.

TABLE 4.2-DISTRICTWISE TYPE OF FUEL USED FOR COOKING (in percent)

District	Wood		Coal		Kerosene	
	Rural	Urban	Rural	Urban	Rural	Urban
East	82.03	8.44	0.13	0.67	10.63	53.16
West	92.96	61.81	0.01	0.00	2.28	16.75
South	87.37	44.23	0.10	0.14	6.12	16.35
North	92.95	62.42	0.02	0.00	4.91	24.43
Total	87.40	29.35	0.08	0.39	6.60	36.26

Wood is main fuel for cooking purpose even in the urban areas of West and North Districts. Unlike the popular belief that electricity is increasingly replacing conventional sources of energy, (Table 4.3) not even 1 % of urban and rural population use it for cooking. In the North District, LPG consumption is still relatively low which indicate a high degree of dependence on forest resources. It can therefore be well appended that deforestation and environment degradation is unprecedented in Sikkim.

TABLE 4.3: ELECTRICITY AND LPG CONSUMPTION (in percent)

District	Electricity		LPG		Others	
	Rural	Urban	Rural	Urban	Rural	Urban
East	1.00	0.59	5.75	36.73	93.25	62.66
West	0.30	0.84	3.85	20.10	98.86	79.06
South	0.49	0.64	5.54	38.29	93.97	61.07
North	0.42	0.00	1.52	12.73	98.06	87.27
Total	0.61	0.58	4.86	33.02	94.53	66.40

Source: Gyatso and Bagdass, (1998)

TABLE 4.4: MAJOR PROJECTS IN THE PIPELINE

Name of Project	Capacity
Rolep Hydel Project	(2x3) Mw
Lachungchu Stage II	(2 x 1-5) Mw
Lower Kalez Hydel Project	(2 x 1.5) Mw
Rangpochu Hydel Project	(2 x 500) Kw.
Bagachu Hydel Project	( 2 x 2 ) Mw.
Ribdi-Bhareng Micro Hydel Project	( 2 x 50 ) Kw
Kissimey Khola Hydel Project	( 2 x 100 ) Kw
Teesta Hydro Electric Project Stage III	
Teesta Hydro Electric Project Stage V	

*Source-Statistical Profile, 2004-05*

#### 4.3.2 Salient features of Sikkim electricity

Light is an important source of energy, which is required by every household. In Sikkim, power need is fulfilled only by means of hydropower supply. Being a hilly region, hydropower generation is feasible. Hence massive water resource in the state is exploited accordingly. The main river namely Tista and Rangit are the sources of hydropower. Besides huge project, small rivers are also harnessed for generation of power in the state, it include river Rimbi, Kalez, Rothak, Rongnichu etc

#### 4.3.3 Hydel projects under construction and undertaken

The following projects are under construction.

Purey Khola Micro Hydel Scheme (2x100) KW, Rathongchu Hydroelectric Project (3x10) MW (Scrapped in 1997), Diversion of Ralli Khola to Mayongchu, Rabonchu Hydroelectric Project (3x1) MW. Other projects (Table 4.4) in pipeline are also equally contributes to power supply in future.

#### 4.3.4 Environment concern

The rivers harnessed for power generation is located in the high altitude areas characterized by steep slope deep forest with thick vegetative cover. The construction of dams and tunnel results in massive destruction of existing flora, fauna and biodiversity. Sikkim has been identified as rich waterpower generating station; NHPC has taken up various hydropower

projects in the state. Though environmental clearance has been acquired from the Ministry, yet virtual collapse of environment is seen around the power stations in Sikkim. In the Balutar-Singtam-Dikchu power plant area, concretes have replaced the entire landscape. The construction of roads and bridges, buildings and diversion of water through tunnel have killed millions of living organisms. The nearby households complained of crack and sink due to over use of explosives and blasting. Marine life has dried out with the diversion of river Tista. It is found out that water scarcity due to drying up of water sources, have posed serious threat to life and people inhabiting this region having the only alternative to leave the place.

#### **4.4 INDUSTRIAL DEVELOPMENT AND ENVIRONMENTAL DEGRADATION**

It is a universal fact that economic development started after industrialization. It is also an established fact that industrialization has its adverse impacts on natural environment. Therefore it is accepted that the rate of industrialization has resulted in rapid rate of exploitation of natural resources, thereby generating several environmental degradation and ecological imbalance. The unlimited resource required for industry has exploited and extinguished natural resources. Firstly, natural resources which maintain ecological balance are used as input for industry and secondly, the left over natural resources are polluted by industrial wastes such as polluted water, toxic gases, chemical precipitates, aerosols, ashes and smokes etc. These effluents further pollute air, water, land and soil leading to uncontrolled environmental degradation. In Sikkim, environmental degradation through industrial activities is found not much problematic, because industrial growth could not take place vigorously in the state. According to the data of 1995-96, industrial sector has shared only 13.65 percent in Sikkim. However, it is a fact that the virgin environs of Sikkim are being polluted by the use of plastics, packets and waste materials.

#### **4.4.1 Status of industries in Sikkim**

After merger in 1975 there has been considerable increase in the industrial activity in Sikkim. Several attempts were made to learn from other Indian states regarding industrial development but due to lack of feasibility all went in vain. The current status of industrialization of Sikkim is standstill. The Government has been promoting industrial setting environment, wherein large chunk of agricultural land has been notified as industrial belt. At present, there are 929 industrial units registered in the small scale sector, but only a small number of units are functioning, remaining have been virtually closed down due to various reasons and only two medium scale units are functioning in Sikkim.

The reasons for the failure of many industrial units are manifold. One of the main reasons is lack of infrastructure building, transportation and market. Secondly it is due to physical inaccessibility and difficult terrain of Sikkim Himalayas. To create employment opportunity industries are coming up but the rate of growth is negligible. The fragile ecology is already overburdened by cementization and concretization of infrastructure development. There is rapid growth of concrete building construction to meet the seasonal demand created by tourists. Every house is in the process of change from mud, thatch to brick and cement concrete. Hence, environment by and large is adversely affected.

The districtwise distribution of industry shows dominance of industries in eastern part of Sikkim. Their number reduces as we go up to higher altitude. In northern Sikkim, number of industrial establishment has sharply reduced to few numbers. This is due to increase in distance and remoteness in location. It is revealed (Table 4.5) that undulating and plain area is progressing towards industrial establishment.

Though Sikkim lacks infrastructural development in setting up of industries, yet the industrial units have been increasing rapidly. Industries ranging from small scale to medium scale are growing up constantly. In the Rangpo- Mining belt, various large-scale industries have come up. These

industrial clusters are characterized by population change, release of effluents, land degradation and ecological threat.

TABLE 4.5: DISTRICT WISE NEW INDUSTRIAL UNITS

East	South	West	North
Rangpo, Majitar, Bardang, Singtam, Topakhani, Martam, 32 Mile, West Namli (Radong), Samlik, Marchak, Ranipool, Tadong, Deorali, Gangtok, Burtuk, Bhojoghari, Pangthang, Penlong, Adampool, Rumtek, Ranipool, Saramsa, Aho, Chota Singtam, Namchey Boong, Lal Turning, Pakyong.	Lower Kitam, Manpur, Mazitar, Jorethang, (along the state highway) Karfektar, Chisopani, Nandugaon, Namchi, Boomtar, Mamring.	Rothak, Piplay, Baiguney, Reshi, Legship, Naya Bazar, Budang, Soreng,	Mangan, Lachen, Lachen.

*Source- Statistical profile, 2004-05.*

#### 4.5 POPULATION AND ENVIRONMENTAL DEGRADATION

The expansion of population in Sikkim has taken place with the corresponding expansion in agricultural cultivation. However, one of the reasons for rapid growth of population can be attributed to Indo-China War of 1962, where large number of Tibetan population flew to Sikkim as refugee. Secondly, in 1975 large number of people migrated to Sikkim to be employed in various institutions of Government and non-Governmental establishments. As a result rapid process of construction of new houses, buildings, industrial complexes, roads and buildings etc. started to give the present form.

In the present scenario, Sikkim is under tremendous pressure of population. It (Table 2.1) shows phenomenal change in population from 1991-2001 with a growth of 24.4 times in Sikkim. The density of population was 8 people in 1901, which creased to 76 persons in 2001. The substantial increase from 57 persons in 1991 to 76 persons per sq. km. is recorded in 2001. It is very conspicuous even to laymen that increase from mere 22,152 population in 1891 to nearly 5,40,551 in 2001 is a red signal of pressure on natural environment, (Table 2.3). At such condition supremacy of men will

prevail over nature and the eco-imbalance may lead to severe damage of eco system.

#### **4.5.1 Environment concern**

At this rate of population explosion there can be no sustainable development. The carrying capacity of a geographic unit cannot support the corresponding increasing in population growth. The over utilization of resource will invite the reduction of millions by natural catastrophe. Environment at this stage will not be able to sustain the starving millions with supply of fresh air for breathing.

### **4.6 POVERTY AND ENVIRONMENTAL DEGRADATION**

Poverty is the free gift of over population. When available resource fails to support the teeming millions, food scarcity is natural. The large section of our people are still deprived of the basic minimum needs. Due to shortage of gainful employment, the poor section of Sikkim's people generally bank upon agriculture, forest, and natural resource. Therefore pressure on natural resource is maximum. The collection of firewood and forest produce is rampant in the rural areas. The downtrodden population has been heavily banking upon the ecology for their livelihood. Therefore, environmental degradation is massively taking place in Sikkim. In such a poverty-ridden economy, collection of firewood and illogical selling of forest produce are common. Hence, poverty also acts as a tool of degrading natural environment. Late Indira Gandhi pointed out once that 'poverty pollutes environment'.

### **4.7 URBANISATION AND ENVIRONMENTAL DEGRADATION**

Tremendous pressure of population in urban centers can be attributed to natural or migratory growth. Further, expansion of new urban centers due to industrial expansion and development activities are responsible for rapid growth of urban population. Therefore, urbanization is a factor for several types of environmental degradation and pollution in Sikkim. The trend of



urban growth in Sikkim is in its progressive pace. Due to the functional disparity between urban and rural in terms of wealth and availability of job opportunities in the urban centers, concentration of population is found in cities and town areas. It can be noticed that there has been gradual increase in the rate of urbanization in Sikkim since its merger in 1975.

The main reason for the shift from rural to urban include

- Availability of amenities facility in Gangtok, Namchi, Jorhang, etc.
- Concentration in Gangtok is mainly due to capital city and access to offices.
- Job opportunity and training availability for human resource development.
- Gangtok is access to college and university and quality schools.
- Seasonal employment during tourist season.

Gangtok has been suffering from traffic congestion, drainage, sewage treatment and solid waste management. As a result, waste generation is high and environmental degradation is resulting in the form of sudden outbreak of waterborne diseases, stress and respiratory diseases.

#### **4.7.1 Population distribution in towns**

There are nine major towns, Mangan in the North, Gangtok, Tadong, Singtam and Rangpo in the East, Namchi and Jorethang in South and Gyalshing and Nayabazaar in the West. There are other small and non-formal bazaars in Sikkim where population is highly concentrated. Though, Sikkim is a rural agrarian society, the size of population in terms of man land ratio is not supportive. But in aggregate about 88 percent of its total population is concentrated in rural area. The distribution of population in these nine major towns (Table 4.6) reflects Gangtok as thickly populated town growing to attain the status of city.

TABLE 4.6: POPULATION OF TOWNS

Gangtok	25024	29162
Singtam	3868	5431
Rangpo	2080	3724
Gyalshing	717	828
Nayabazaar	1045	996
Mangan	803	1248
Namchi	630	978
Jorethang	1939	2968
U.Tadong	NA	14670

*Source: Sikkim Provisional population totals, 2001*

But if we ponder into the size of population in rural and urban areas of Sikkim, it reflects that the percentage of urban population to total population in the year 2001 forms only 11.10% in comparison to rural population which shared a high percentage of 88.9. Increasing urbanization means phenomenal increase in the concentration of human population in limited space, resulting multifarious problems associated with the management of buildings, roads and streets, sewage and storm drains, pucca surface area, vehicles like motor cars, trucks, buses, motor cycles, scooter etc. Number of factories, urban wastes, aerosols, smokes and dusts sewage waters etc. cause several environmental problems.

#### 4.7.2 Site allotment

The allotment of sites for the construction of individual house needs no explanation as the number has increased from 42 in 2001 to 63 in 2003-04 (Table 4.7) All the sites allotted are located mainly in the urban center. As a

TABLE-4.7: SITES ALLOTTED TO SC/ST/OBC/OTHERS

NUMBER OF SITES ALLOTTED					
Year	S/C	S.T	OBC	Others	Total allotments
2001-02	5	11	20	6	42
2002-03	7	19	21	5	52
2003-04	3	19	29	12	63

*Source-Dept. of UDHD & Profile, 2004*

result, various new colonies have been emerging in the periphery of towns. In Gangtok, a new colony has emerged at 5<sup>th</sup> mile, where around twelve houses are erected in the last two years. The barren land located at the vicinity of Gangtok has been virtually filled with jungle of concretes.

When such urban sprawling takes place the space meant for garden and playground are converted into concrete as a result there is bound to have negative impact on environment.

#### **4.7.3 Environment concern**

The gaseous emissions form stacks into the atmosphere, liquid effluents, and solid wastes produces have polluted air, water and land environment. The thick smoke is always seen rising in the atmosphere near mining ground industrial complex. The few industries existing in Sikkim have already made local people feel the deterioration of existing ecology. Continuous release of pollutants into the environment particularly over the years has a cumulative effect on the flora and fauna, domestic animals and man. The disposal of solid wastes in certain industry posing a serious problem due to lack of space, it is noticed in the areas lying between Rangpo-mining belts. Besides direct environmental pollution at the site show glaring examples of resource depletion. Hence, measures must be initiated in time to establish industry in an ecofriendly manner.

#### **4.8 CONSTRUCTION OF ROADS, BUILDINGS, HOUSES AND ENVIRONMENTAL DEGRADATION**

As mentioned earlier, men are active geomorphic agents in terms of inadvertent and planning activities, which finally can affect the morphology of various form of landscape. Modification of terrain by engineering works, quarrying, mining and construction of large number of houses and buildings are prevalent in Sikkim. Such phenomena have always been changing the configuration of the earth's surface mainly by the process of weathering, erosion and mass wasting. Slope land area is the common physiographic

characteristics feature of Sikkim. Human adaptation to such types of land is a success story of human adaptation in the mountain terrain. The humans having been adapted to such environment needs basic amenities. In the process of providing basic amenities, several types of constructional activities such as housing buildings and roads come up. As a result, natural environment eventually fall pray of environmental degradation. Some major impacts of humans' construction activities in hill slopes are landslide, earth flow, mudflow, debris flow and mass movement. Angle of slope determines the rate of all loss and erosion. The steep slopes are readily capable for the occurrence of erosion processes. Different types of erosional agents such as wind, running water, glacier etc. are more active in the area having high degree of slope. The unloading of overlying materials by the construction activities including construction of bridges roads and buildings may expose the underlying rocks and erosion takes place on earth-exposed surface in two main ways. Firstly, it can easily be washed away in bulk under the influence of gravity. Secondly, disintegrated and exposed materials are blown away by means of chemical weathering. Hence, this type of degradation of environment is most common in the rugged areas of Sikkim Himalayas.

#### **4.8.1 Buildings and houses**

The quarters and other buildings are continuously constructed (Table 4.8) by Buildings and Housing Department of Sikkim. Besides, there are other governmental buildings, which are under construction. In Gyalshing, there is a construction of hospital having the capacity of 100 beds on it.

Table 4.8 NUMBER OF RESIDENTIAL BUILDINGS CONSTRUCTED  
DURING THE LAST 15 YEARS

Residential Building/Govt. Housing	No. of Constructions
Class I Quarters	64
Class II Quarters	256
Class III Quarters	881
Class IV Quarters	1027
VIP Quarters	27

*Source: Building and Housing Department, Govt. of Sikkim, 2003*

This work is under progress and likely to be completed by this financial year 2005. There is a construction of Limbu community center at Tharpu, West Sikkim and construction of infrastructure facilities in trekkers' complex at Yoksum, West Sikkim and work of these both are in progress. There is another construction of tourist information centre at Pemayangtse, West Sikkim. The site has just been handed over to the Tourism Department for utilization purpose. The huge sports complex and Kanchendzonga sports complex at Gangtok have come up in the recent years. Besides, individual, commercial, industrial and institutional buildings are mushrooming across the length and breadth of Sikkim.

#### **4.8.2 Roads and bridges**

Road is the lifeline of Sikkim. Government has prioritize the road connectivity even in the remote corner of the state and construction of roads is the initial process of environmental degradation. The current status of roads in Sikkim (Table 4.9) mentions rapid increase in the length of road from 1997 to 2001.

TABLE 4.9-LENGTH OF ROAD MAINTAINED BY SPWD IN KILOMETRES

LENGTH IN KILOMETERS			
Year	Surface Road	Unsurfaced Road	Total
1997-1998	849.35	926.00	1775.35
1998-1999	837.35	923.00	1760.35
1999-2000	849.35	927.00	1776.35
2000-2001	930.35	927.00	1857.35

*Source: Roads and Bridges Department, Govt. of Sikkim*

In the above-mentioned figure, the length of roads showed negligible declined in the year 1998-99, (TABLE 4.9) it is due to transfer of road construction (around 34 kms) to Border Road Organisation at that time. However, maintenance of all these roads is under the perview of Roads and Bridges Department, Govt. of Sikkim. Besides, there are (Table 4.10) other roads connectivity maintained by Border Road Organization.

#### **4.8.2.1 Roads maintained by Border Road Organisation**

Sikkim being a border state, National Highway 31 runs through the heart of town and cities. Boarder Road Organisation maintains (Table 4.10) National Highways and Sikkim public works department maintains state highways.

TABLE 4.10-Road maintained by BRO as on 31-02-2000

<b>Road Particulars</b>	<b>Length (in km)</b>
National Highway	41.00
Surface Road	577.10
Unsurface Road	53.00
Total Road Length	671.10

*Source: Project Swatik, Gangtok*

Among all types of constructional activities, roads are the need and it is essential too, for building infrastructure and regional development. In Sikkim roads are constructed even in the fragile and rugged topography in order to established linkage between several remote far-flung areas with the hinterland. Hence, human adaptation, responses and interferences into the fragile geological structure of Sikkim are subject of research because it relates to deterioration of environment.

#### **4.8.2.2 Bridges**

Bridges connect the difficult and inaccessible areas in the rugged terrain of Sikkim. The construction of bridges is difficult, as it involves environment loss and public involvement. However, rapid connectivity (Table 4.11) is going on in all parts of Sikkim.

TABLE 4.11: BRIDGES CONSTRUCTED TILL 2003

YEAR	NO. OF BRIDGES CONSTRUCTED			
	North	East	South	West
1995-96	5	2	5	3
1996-97	5	3	5	2
1997-98	8	4	4	6
1998-99	8	5	5	7
1999-00	14	8	9	15
2000-01	3	2	2	3
2001-02	4	2	2	2
2002-03	3	2	2	3
Total	50	28	34	41

*Source-Statistical Profile, 2004*

#### 4.8.3 Environment concern

The roads, bridges, and dwelling houses are the basic necessity for human living and also the symbol of economic development. Sikkim has unique geographical feature where relief sets the limit of development. Construction of roads, bridges and buildings have to be done at the cost of massive eco-degradation. In any construction activity, deforestation, erosion, silting, subsidence followed by drilling, plumbing, blasting takes place at large. Large volume of topsoil eroded by earth cutting, debri from rock clearance are washed away. The biotic wealth is not counted and million of habitats are destroyed during the process of construction. Sustainable development remains a far cry, unless there are movements like Chipko, Narmada Bachao etc. No environmental studies are done prior to construction. Similarly, eco degradation is becoming a usual phenomenon in the process of infrastructure development in Sikkim.

#### 4.9 GROWTH OF VEHICLES AND ENVIRONMENTAL DEGRADATION

Distance in modern times is being progressively reduced with subsequent improvement in transport and communication facilities. So development of cheap and efficient means of transport is necessary for the

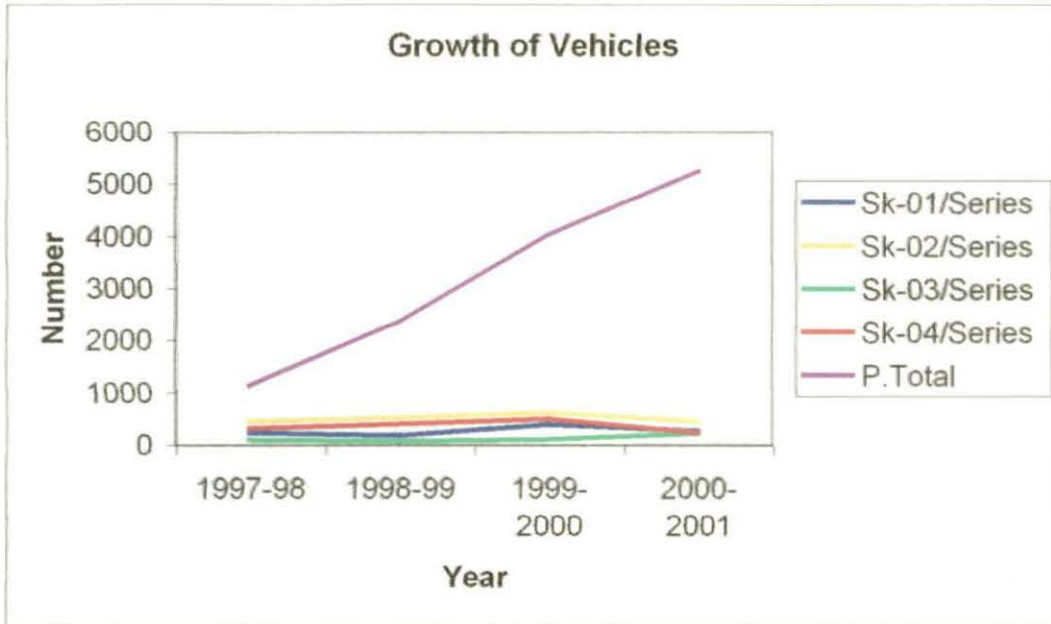
progress of a developing region like Sikkim. There are several mode of transport such as roads, railways, waterways, airways etc. and availability of this entire mode primarily depends upon the economic structure of a region and physical feature governing its location. Sikkim being a Himalayan state, roadway is the main system of transportation. Therefore vehicles as transporting agents are the basic economic arteries of this Himalayan region. For an economist, vehicles are the lifelines of state's economy but for an environmentalist, it is an unnecessary evil. The adverse impact of vehicles in environment have many folds; firstly, number of vehicles are increasing day by day in Sikkim and these rapid increase in number of vehicles have resulted in air pollution. Secondly, the rate of road accident has increased with the increase in road traffic. Thirdly, the heavy vehicles can produce more vibration while running through the fragile zone, which leads to disastrous environment in Sikkim's fragile ecology.

Gangtok, the capital of Sikkim is a loci of a large number of vehicles concentration due to the regional development and functional structure of this area. In Gangtok only, there are approximately 20,879 vehicles, which were registered in the year 2001-2002. Besides, there are number of unregistered vehicles found in Gangtok having the SK-TC number plates and vehicles from other states, especially from West Bengal. The details of total (Fig 4.1) number of registered vehicles found in Sikkim according to its types are as given

#### **4.9.1 Vehicular Growth –a trend**

The position and trend of total number of vehicles registered by its type are recorded for successive years as on 31<sup>st</sup> March 2001. Moreover, there are other registered vehicles too, which are categorized by its series and the number (Fig 4.1 & 2) of such vehicles are represented as SK-01, 02,03,04 etc. The Sk 01 series denotes all motor scooter, motorbike an two wheelers, Sk 02 represents Goverenment and private vehicles, Sk 03 comprises of trucks and goods carriers and Sk 04 means all the taxi permit vehicles.



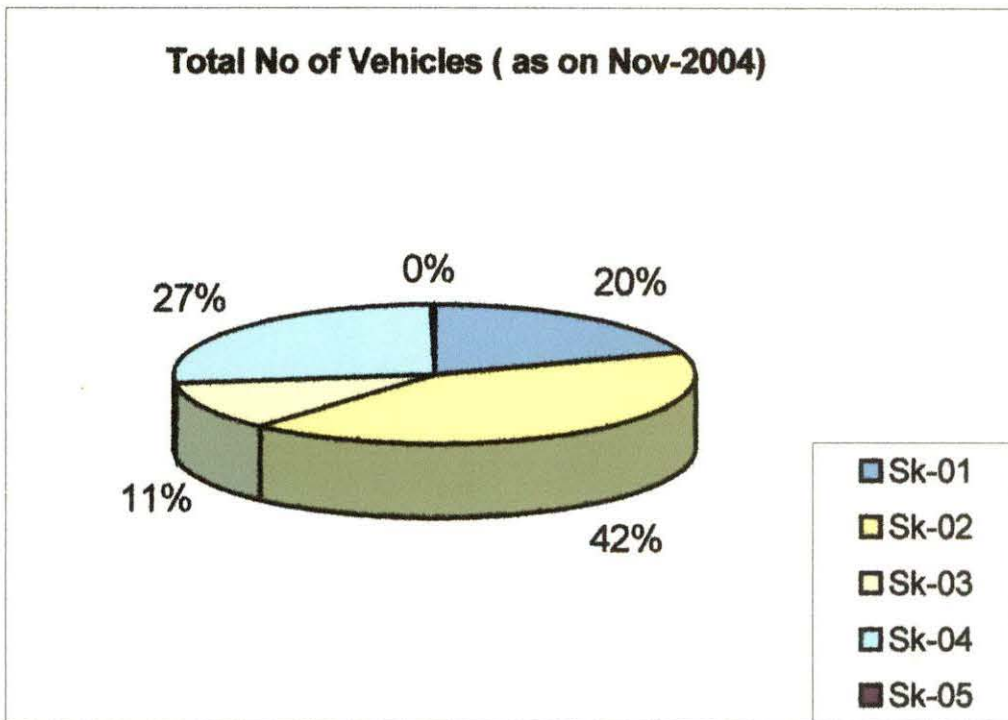


**Fig 4.1 –Trend of Vehicular growth**

Numbers of vehicles determine the rate of pollution in a given place at a given time. Increasing number of vehicles keep the road busy, parking has become a major hurdle and vehicular pollution levels have gone up. Petrol and diesel are major fuel used as an energy source for the locomotion of vehicles. Therefore liberation of these fuels in the form of smoke produces toxic fumes and degrade environment to a greater extent by polluting the air.

#### **4.9.2 Environment concern**

The growth of vehicle is directly associated with level of pollution. As defined by WHO, air pollution is substances put into air by the activity of mankind into concentrations sufficient to cause harmful effects to his health, vegetables, property or to interfere with the enjoyment of his property. Hence, the internal combustion engines that need a mix of air and fuel to burn and produce energy to move the vehicle cause vehicular or automobile pollution and these burnt gases that come out of the exhaust have the potential to cause pollution.



**Fig-4.2 Total number of vehicles registered**

Hence, internal combustion engines that need a mix of air and fuel to burn and produce energy to move the vehicle cause vehicular or automobile pollution and these burnt gases that come out of the exhaust have the potential to cause pollution. Therefore vehicles are considerably accounted for one of the active agent of environmental degradation. Besides registered vehicles, there are uncounted number vehicles entering from Siliguri, Darjeeling, Kalimpong and neighbouring states and countries. Trucks are found in large number for carrying essential commodities, goods and services, vegetables and raw materials such as rod, cement, sand, stone chips etc. Private vehicles from Bhutan, Nepal and West Bengal are found in great number during the tourist season. All these constitute greater degree and level of environment degradation in Sikkim. Air, noise and atmospheric pollution has replaced fresh atmospheric condition in the state of Sikkim. Initiation for the cultivation of Jetropa plant for bio-diesel is yet to introduce.

#### **4.10 TOURISM DEVELOPMENT AND ENVIRONMENTAL DEGRADATION**

Tourism is the only smokeless industry in the world which creates millions of employment opportunities in various service sector across the globe. Tendency of human beings to visit different places to perceive the scenic beauty of any environmental setup is a matter of fashion in present day scenario. Hence, exploitation of natural environment by human beings is a key factor in deteriorating environment. It is most essential to examine the physical environment before assessing the impact of tourism. Therefore, it is essential here to describe about physiographic features in one hand and natural parameter on the other. Sikkim is the loci of tourism attraction. There are several conditions which are contributing for this phenomenon.

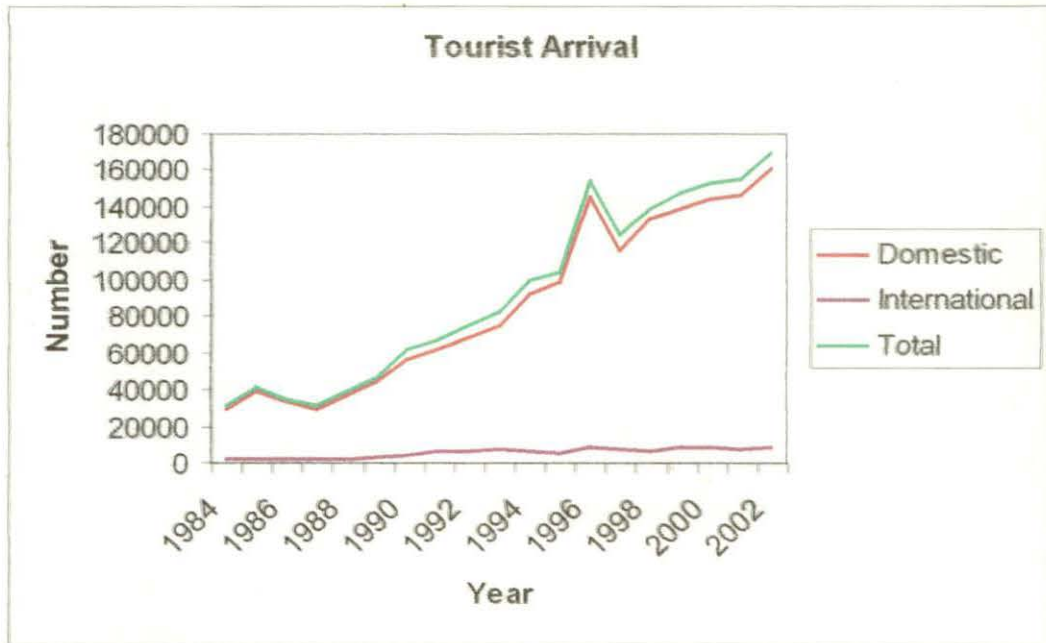
Firstly, the snow-capped mountain has provided a unique face that gives a fanatic moment to the passion of nature while perceiving its appeal. Secondly, the climatic conditions of this Himalayan region play a predominant role in attracting tourist from extremely hot regions.

Thirdly, Indian plains experience hot weather and plain people search colder regions for leisure. Fourthly, culture and adventure attract tourists from all over the globe.

Hence, Sikkim has become an abode of tourism environment and hence tourism development is taking place at a very high cost. The Sikkim Himalayas as a whole is a tourist's paradise. The snow-clad mountains, crystal lakes, greenery, wilderness and alluring flora and fauna are the major attractions for the tourists. The main objectives of this paper lies on tracing out the current pattern of tourist flow and impact of tourism trade on environment. Inflow of tourist over Sikkim can be classified into (i) Domestic and (ii) Foreign. Most of the tourist flow is observed from mid March to mid June and September to November. Indian tourists mostly pour in the months of April-May and October-November during the time of festival holidays. This season offer them a good opportunity to enjoy the scenic views of mountain and the invigorating climate of Sikkim.

#### 4.10.1 Tourist profile

Tourist traffic is increasing annually in Sikkim. In the year 1980 only



**Fig-4.3-Tourist arrival in Sikkim**

15,434 tourist-visited Sikkim, out of which about 83% were Indians and 17% foreigners. Since 1984 there has been a steady increase in the tourists flow. In 1989 about 46,416 tourists arrived Sikkim in which 96% were domestic and 4% from abroad. As depicted (Fig-4.3), there seems no decline in the rate of tourist population. In the year 1995, tourist flow crossed the mark of one lakh and reached 1,52,997 in the year 2000. Further in 2002, total of 18,35,267 tourists visited Sikkim.

Tourism business has become a seasonal affair, the concentration of tourists is seen during two seasons in a year. There are several factors controlling movement of tourists in Sikkim, namely, adverse climatic condition in January and heavy rainfall and landslide during monsoon season. Both domestic and international flow has declined during the month of July, August and January. The months of April and May show heavy rush. (Fig 4.4 & 4.5) This could be attributed to summer heat in Indian plains and vacation period of students in the Border States.





Fig-4.4 Peak season estimate of international tourists

#### 4.10.2 Projection

The estimate on arrival of domestic and foreign tourist for the period of 15 years have been taken into account. The projection (Table 4.12) shows tourist traffic forecasted by TES, Master plan shows massive possible increase in influx of tourism from 1,18,000 in 1996 to 3,71,700 in 2011. The estimate if reflects true then Sikkim will have no accommodation for tourist. The destinations will be congested and there will be shortage of basic amenities and supply of food grains.

TABLE 4.12: PROJECTION TILL 2011

NUMBER OF TOURISTS			
Year	Domestic	Foreign	Total
1996	110500	7500	118000
2001	163900	13800	177700
2006	236400	23600	260000
2011	333300	38400	371700

Source-TEC, DOT, GOS

According to quantitative assessment (Table 4.12) based on present flow of tourist, available infrastructure and tourist destination; it is revealed that East District will outnumber other districts in tourist population.

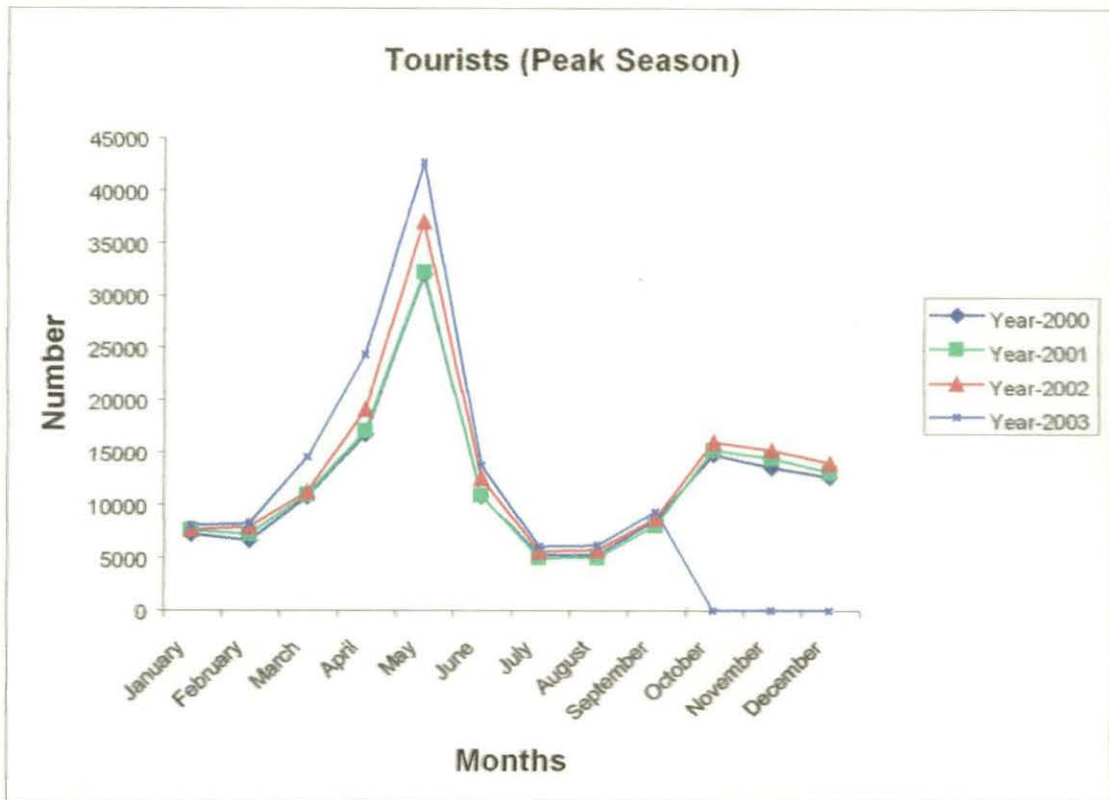


Fig-4.5 Peak season estimate of domestic tourists

In the year 2011, East Sikkim shall have nearly 2,78,800 tourists, (Table 4.12) where as North District shares only 16,300 tourists. International tourists prefer natural and cultural products. So, sight -seeing tourist segment is developing in Sikkim along with trek and trial tourism. However, scale of mount Kanchendzonga has been banned to preserve the sanctity and belief of local people. As a result, Nepal still maintains equal growth despite of several insurgency problems.

#### 4.10.3 Environment concern

The fragile zone of mountainous Sikkim is sensitive and prone to degradation. Among all, tourism is one of the most significant activities, which led to degradation of environment. The lack of ecological balance due of expansion of tourists over an environment has given rise to the following major negative feedback.

**a. *Pollution***

Several types of pollution takes place due to tremendous increase of tourists' pressure. Spillages of oil may produce water pollution and air is polluted mainly by vehicular emission. Noise pollution is caused due to transportation and entertainment. Moreover soil pollution takes place due to improper waste disposal management and regular use of plastics. Due to the expansion of vehicular traffic, rate of pollution has tremendously increased, causing various diseases such as bronchitis, lungs related diseases, respiratory and pulmonary problems, headache, heart problems etc.

**b. *Erosion***

The land degradation, landslides, subsidence, citation are common phenomena at the construction site, the infrastructure development and growth of tourism is taking place at the cost of ecological disaster. Tourism is related to construction of hotels and amusement parks, which in turn pollute the ecological mileau. In Sikkim, construction of airports and five star hotels are coming up at high speed. Therefore further erosion is expected at large scale.

**c. *Change of habitat***

The floral and faunal diversity is at stake along the trekking route, the luxuriant vegetation and rhododendrons are uprooted by growing number of trekkers. The deforestation has resulted in extinction of plant and animal species.

**d. *Piracy and plastics***

In the parks and wildlife sanctuaries, trekkers even pluck the flowering plants for their personal gain. Proachers and guides often collect fuel and firewood from adjoining places and virtually destroy the existing eco-system. There have been many incidents of bio- piracy in Sikkim.

#### **4.11 MINING ACTIVITY AND ENVIRONMENTAL DEGRADATION**

Owing to its Geological and Geographical setting, Sikkim is not feseable for industrial establishment but mineral resources are found in many places in Sikkim. The Department of Mines and Geology has been exploring

the sites for mineral excavation from time to time. At present, the potentials of minerals in Sikkim are coal, dolomite/limestone, marble, base metals, quartz/quartzite, talc, sillimanite/kyanite, graphite etc. The distribution of each mineral and their environmental consideration has been drawn.

#### **4.11.1 Mineral resources**

According to Mines and Geology estimates, following are the distribution of mineral found in different parts of Sikkim Himalayas. The listings and their environmental consideration has been drawn accordingly.

##### **1 Coal**

The coalfields in Sikkim are widespread in the 'Rangit Valley Tectonic Window'. Geological Survey of India (GSI) carried out detailed studies of coal around Namchi Public School. After drilling, a reserve of 1.4 lakh tones was estimated in the area. Lately, the State Department of Mines, Minerals & Geology have been carrying out investigation of coal and areas of coal occurrences have been identified. Latest study at Reshi indicated a reserve of 70,000 tones. In Reshi area, coal deposits if exploited may cause severe problems causing environmental degradation

##### **2 Graphite**

Graphite is versatile mineral chiefly used in foundry facing, lead pencils, lubricants, paints, polished, cubicles, electrodes, dry batteries and others. Graphite in Sikkim occurs over parts of West and North Districts. Workable deposits are located at Chitre-Dariely and Dentam-Uttarey areas of West Sikkim. This graphite on an average contains 40-60% fixed carbon. For commercial purposes beneficiation is necessary. There is ample scope for development of this mineral. Uttary belt of graphite is in the extreme western region of the state with delicate natural vegetation. Hence, ecological threat must not be undermined.

##### **3 Sillimanite**

The industries making spark plugs, insulators, cement, ceramics, glass making, metal smelting and so on require it as raw material.



Investigation of sillimanite in the State shows occurrence of the mineral in the form of boulders and in situ lensoidal bodies at the headwaters of Rothak Khola (West Sikkim). The boulders alone show a tentative reserve of 1000 tonnes. The 50m thick sillimanite/kyanite bearing band is reported to extend along the strike of the country rock over 25m from Changey Khola to Sardung (Pelling-Dentam road section).

#### **4 Quartzite**

Occurrence of high-grade quartzite with over 92% silica, suitable for ceramics, glass, refractory industries and others are found in East, West, and South Districts of the State. At present quartzite occurrence of Rani Khola-Manasari area of West Sikkim are being mined by M/s Sikkim minerals Pvt. Ltd. The total estimated reserve in the area is 681,250 tonnes. But the reserves are found in fragile ecological condition. Therefore ecological disturbances are very much associated with it.

#### **5 Talc**

Talc in Sikkim is reported from Rani Khola-Mansari area of West Sikkim as intercalation in quartzite deposit. As estimated, reserve of 80,000 tonnes of this mineral is in the leased area of M/s. Sikkim Mineral Pvt. Ltd. There is scope of further development of mineral in the adjoining areas

#### **6 Limestone and dolomite**

Sikkim has extensive deposits of dolomite with bands of limestone in the Rangit Valley tectonic window. Exploratory work was formerly carried out by GSI. The State Department of Mines, Minerals & Geology continued it and the work is in progress around Reshi-Mangalbary and Namgaon area of West Sikkim.

#### **7 Marble**

The term marble is derived from the Greek word 'marmors' meaning a shining stone. Generally defined, marble is a metamorphosed rock formed by recrystallization of milestone. Marble is widely distributed in India but the occurrences of economic importance are limited to only few States. Marble is chiefly used for building construction as walls and floors.

Sikkim is endowed with sizable deposits of marble around Chungthang and Tsangu. Much attention was paid to this mineral for viable commercial exploitation.

### **8 Base Metals**

As regards to the poly metalliferous deposits in the state, copper-lead-zinc deposit at Bhothang Rangpo is being exploited by Sikkim Ining Corporation. The corporation has been in operation for the past 30 years. Other base metal deposit under consideration of the Government is the Dikchu Copper-Zinc Project. The techno-feasibility study of the Dikchu project was carried out by the mineral exploration corporation (MEC) of India.

### **9 Thermal Water**

According to GSI record, there are over 300 hot springs in India. Suraj Kund in the Hazaribagh District of Bihar measured the highest temperature of 87 degree centigrade. From the chemical composition point of view, the Indian waters fall under four main classes. The majority of the springs occur in broad belt following the regional tectonic trends. Sikkim has a long tradition of faith and belief on hot spring as medicinal value. Every winter people take a dip in the hot spring to get rid from various skin diseases. There are at least 8 known springs in Sikkim. Of them, Phurtsa Chu (Khandu Sangphur), Borong and Polot of South Sikkim and Yumthang, Tarun and Tolung of North Sikkim are the well known ones. There are also a large number of uncharted cold springs in the State. Investigation of few hot springs in the state were conducted in the field on the geology of the area around the springs, the flow of the springs, their temperature, pH and dissolved gases such as CO<sub>2</sub> and H<sub>2</sub>S.

The geological environments play an important role in influencing mineral composition and radioactive characteristic of the waters. Thermal spring such as Yumthang, Tarun and Phurtsa Chu are locally enjoyed for their therapeutic values. Among them, Phurtsa Chu is the most popular and enjoys religious sanctity. There is ample scope to develop the mineral spring resources of Sikkim. The hot springs of the state are also capable of developing into tourist resources.

#### **4.11.2 Environmental impact analysis in mining and quarry areas**

The environmental impact analysis has been done in the mining centers located in the fragile ecological condition of Sikkim. According to Negi (1982 and 1985), the mining activity involves blasting, earth digging, quarrying, excavation and extraction. As a result, following impact on mother earth is noticed.

- The environmental problems caused during the extraction of the mineral from the quarry face various problems as discussed. Due to removal of the topsoil and vegetative cover, the quantity of water seeping into the earth's surface is considerably reduced, thus lowering the water table. Loss of vegetative and topsoil cover also leads to erosion. Open cast mining methods means the loss of valuable land, which could have been put to other uses such as forestry, wildlife protection or agriculture. Explosives like dynamite are used in quarrying operations. Explosions cause shock waves to pass through the country rocks. Prolonged use of dynamic weakens the country rocks over a large area and may lead to frequent landslides.
- The excavation debris is allowed to roll down the hill slopes from the quarry face. This results in the formation of scree like features. The sliding mass of debris covers valuable arable land, forests roads and canals, which lie in its path. It even encroaches open human settlements.
- The dust generated during quarrying and other operations is causing health problems for the labourers. Aesthetically speaking, these white scars give an ugly look to the lush green hills.
- The above illustration shows that the potential mineral reserve is found in extreme ecologically fragile zones of Sikkim. Exploration in this area not only create problem of displacement of habitat but also led to massive loss of existing environment. The entire area gets affected by pollution and rise in temperature. The paragraph showed that places like Dentam, Bul, Damthang, Namchi are in ecologically delicate

position. Hence mining activity at such places would be no less than adding fuel to fire.

#### **4.12 WASTE ACCUMULATION AND ENVIRONMENTAL DEGRADATION**

Environmental pollution is one of the major problems the world is facing and pollutants are byproducts of man's own action. In developed countries, lakes and rivers are polluted with wastes from industries, pesticides, herbicides, fertilizer and chemicals and with exhaust gases of automobiles and industries etc. In the under developed countries, pollution is mainly caused by population explosion. The rapid growth of urbanization has encouraged the migration of population from village to urban areas. This in turn has given way to environmental problems like waste water generation and their disposal, garbage generation and their disposal, air pollution due to increase in vehicular traffic and industrialization, which result in contamination of water bodies. Unplanned dumping of wastes, sewage has resulted in unhygienic and poor living condition.

##### **4.12.1 Solid waste**

Rapid rate of urbanization has posed a serious threat to the urban environment in many countries and Sikkim is no exception. Solid wastes constitute all solid discarded material derived from industry, agriculture, commercial and other trade practices. With the rapid improvement in technology and growing consumerism, sophistication has increased manifold. As a result, products designed for consumer satisfaction is highly attractive and use of plastics and synthetic items are growing day by day. As a result, no dumping space is available. Therefore improper disposal has caused severe environmental problems.

The World Bank (1998) has reported that urban areas of Asia produce about 760,000 tones of municipal solid waste per day, or approximately 2.71 cubic meters per day. In 2025, it is expected that quantities will increase to 1.8 million tones of waste per day or 5.21 cubic meters per day. It also reported that India generated 0.46 kg/capita/day producing 114,576 tones /day in 1995 and is expected to generate 0.70 kg/capita/day producing 440,460 tones/ day

by 2025. As per the report of UDHD, Sikkim generates 0.45kg/capita wastes. The total quantity of municipal waste generated at Gangtok is approximately around 42 tones per day. The only study carried out by the State Pollution control Board reveals the following findings on the state of solid waste management in Gangtok.

#### **4.12.1.1 Sources of solid waste**

It may be mentioned that, Gangtok is the only major town in Sikkim from where large-scale solid waste is generated. The solid waste comprises of domestic waste 34.19%, commercial and institutional waste with 28.1% and 19.2% respectively. Waste from agricultural activities is 3.17%, industrial and other waste 0.12% and 15.22% respectively. The total municipal waste generated in Gangtok town is approximately 27,000 kg/day. The per capita generation of solid waste is approximately 0.385 kg/day as per the report of Urban Development and Housing Department, Government of Sikkim. The constituents of solid waste in urban area reflects Commercial 28.10, domestic 34.19, institutional 19.20, agriculture 3.17, industrial 1.12 and rest 15.22 do not fall under any category.

Domestic waste are derived mainly from households, it includes kitchen waste, papers and cartoons, plastics, glass, textiles, leather, metals, ashes and garbage. Major producers of institutional wastes are schools, colleges, offices, banks, hospitals and religious places. It comprises of articles like paper and cartoons, food waste, glass, plastics, hazardous and pathological wastes. Commercial waste are produced at large scale by markets, tea stalls, restaurants, hotels motor repair shops, and factories. Such centers produce polythene case, strings, foam, bags, disintegrated metals, nail, glass waste, paper cases and spoiled and discarded goods. The natural waste consist of leaves, tree branches and carcasses of animals also form considerable part of solid waste in Sikkim.

#### **4.12.1.2 Composition of solid waste**

The composition of solid waste varies from place to place and time to time. There are food wastes 51.50% paper (10.80%) grass (13.80%), metal (0.60%), glass (0.40%), miscellaneous degradable (10.80%), miscellaneous non-degradable (10.00%) inorganic substances (1.60%). Waste generated in Gangtok town give an alarming result where, food waste constitutes 51.50%, glass 13.80%, paper 10.80%, plastic 0.50%, glass 40%, metal 0.60% and other degradable and non degradable (Pradhan *et al*, 2004) constitute 30.80% respectively. Western eating habit such as packet food, canned cold drinks, milk in sachets, chips in pouches, plastic ropes and carry bags, dry fruits in tin is responsible for rapid increase in the volume and content of solid waste

#### **4.12.1.3 Waste collection in Gangtok town**

In Gangtok, the responsibility of waste management lies with the Urban Development and Housing Department (UD and HD), Govt. of Sikkim. As stated by UDHD, there are two types of waste collection.

*i* -Commercial complex collection- In this, bins are placed at specific points depending upon the population and distance. In the main bazaar site and road site, wastes are collected every morning by the municipal vehicles.

*ii*-House collection- Every morning municipal vehicle collects waste from individual household.

The commercial establishments have been made mandatory to keep dustbins in front of their establishment. According to the interim report of the Supreme Court, every 130 persons should have a bin for the collection of waste materials. (Down to Earth 2000). In Gangtok town, dumping of waste into the jhora and streams are traditional habit that die-hard. The jhora, nalla and backside of the tall buildings are filled with solid waste in Gangtok and surrounding area. As a result these produce odour and bad smell frequently around the town.

#### **4.12.1.4 Transportation and disposal**

The department of Urban Development and Housing Department is the nodal agency of waste management. Wastes are being collected from the disposal bins and are transported by trucks to the disposal site on a daily basis. The disposal site is located at Marchak at a distance of around 15 kilometers from the main town. During transportation, truck full of open stinking garbage gets scattered along the roadside as well. The timing has been set for the movement of vehicle collecting garbage from different corners. As per the report received from UDHD, there are 7 trucks specified for the collection of waste. During the collection process obnoxious odor is produced causing nauseating and vomiting tendencies. The wastes are many times scattered along the road while transportation which poses serious threat to environmental and health.

#### **4.12.1.5 Plastic waste**

Though the state government has put a ban on use of plastic since 1997 yet there seems amply available plastic packed eatables in the town. However, strict rules are enforced in the state regarding plastics and polythene bags etc. With a view to make Sikkim free from non-degradable waste, a fine worth Rs. 5000/- is charged for contravening the law. But the eatables packed in plastics are commonly found in all the places as tourists snacks such as mineral water, pepsi, namkeens are packed in plastics.

### **4.13 NOISE POLLUTION**

With the constant increase in vehicular population and entertainment units of Sikkim, there is a rapid rise in noise level. Noise pollution is directly associated with human health and surrounding environment. The quantitative measurement of noise is done on a logarithmic scale called "decibel" (dB). According to The World Health Organization (WHO ) standard level of 45 dB is considered to be safe noise level for a city. By international standard a

noise level upto 65 dB can be taken as tolerable. In this context noise level of various places around Gangtok has been studied.

The main source of noise pollution are vehicular, commercial activities, construction activities, loud speakers at ritual centers, schools, generators, music centers etc. The residential area of college valley, Tadong, Deorali Govt. quarters and development area and commercial area showed sharp variation. In the market areas high sound level is due to vehicle horn. However, during Durga, Laxmi, Diwali, Biswakarma, Saraswati puja time, temples generate sound pollution.

The report of State Pollution Control Board shows that, noise level is fairly high in all the areas in Gangtok. However, through the launching of public awareness campaigns and enforcement of traffic guidelines and rules, noise level can definitely be brought down and stabilized at a non-pollutant level.

#### **4.14 AIR POLLUTION AND ENVIRONMENTAL DEGRADATION**

Air is an important constituent of atmosphere. There would be no life without air in the atmosphere. Various life forms in the earth are supported by air quality. Health of a human being and animals are controlled by quality of air prevalent in the atmosphere. The whole universe will come to and standstill if the flow of air stops for a minute. When air is polluted, there are health hazards. Pollution of air is caused by emission of CO, NOX; HC etc. According to WHO, air pollution may be defined as follows: "Substances put into air by the activity of mankind into concentration sufficient to cause harmful effect to his health, vegetables, property or to interfere with the enjoyment of his property." However definition may vary from time to time. It may be mentioned that Gangtok the capital town of Sikkim is most polluted than other parts of the State. Theoretical source of air pollution include matter, which gets released by the burning of fossil fuel such as coal, petroleum and emission include-

- (a) Fine particles which include carbon particles, metallic dusts, tars, resins, aerosols, solid oxide, nitrate, and sulphates.



- (b) Carbon particles largely carbon particles and heavy dust that is quickly removed by gravity from air;
- (c) Sulfur, oxygen and nitrogen compounds
- (d) Halogens and Radioactive substances.
- (e) Dust and atmospheric suspended particles.

In the context of Gangtok, automobile including diesel and petrol motors are the prime polluter. It is estimated that nearly three-fourth of the carbon monoxide and two-third of the hydrocarbons and nitrous oxide are emitted by vehicle population in Gangtok. Besides, other pollutants include, pesticides used in agriculture, dust from agriculture practices and fields burning, construction industry, dust from road and building construction, industrial emission from Rangpo, mining areas. Along the roadside, pollution has caused is massive destruction of existing flora and fauna. Vibration due to heavy vehicles is giving sleepless nights to the people inhabiting NH31. The number of registered vehicles in Gangtok has been increasing day by day. (Fig 4.1) In Gangtok average 30,000 liters petrol and 15000 diesels is consumed per day and this figure has steadily increasing (SPCB, Pradhan *et al* 2004). The high pollution level is also attributed to steep gradient and the narrow streets of Gangtok. In general, low temperature prevailing in the hill regions trap poisonous gases in the ambient atmosphere. This phenomenon causes health hazards to pedestrian and roadside inhabitants.

#### **4.15 WATER POLLUTION AND ENVIRONMENTAL DEGRADATION**

It is a widely accepted generalized fact that water will be the cause for third world war. Needless to mention that cold war has already begun between the individuals, states and nations. The bone of contention in the city like Kathmandu, Darjeeling has been on water. As per the data, it is stated that, seventy percent of the earth's surface is covered by water. Of which 2.5 percent fresh water is available for human consumption in day-to-day life. An accounts of fresh water resources of world shows that, nearly 75% is

perpetually remains frozen under ice sheets and glaciers, around 24.5% contributes to ground water and remaining 0.3% and 0.06% are found in rivers and in the atmosphere.

With the increase in human heads, demand of water has increased manifold. On the contrary resource depletion is exorbitant and water sources are drying up day by day. As a result tempering, human interference and pollution are prevalent in the important water source areas. Due to all such problems, fresh water is being polluted. In the context of Sikkim, important water sources are lying in the high altitude belt, where there is massive environmental degradation. The water bodies in the lower belt is characterized by dumping of garbage, animal and human encroachment and this is defined as: "water pollution, which changes the quality of our surface and subsoil water to such a degree that its suitability either for human consumption or for the support of man's natural life process will decrease or cease."

#### **4.15.1 Drinking water quality**

The report based on the study conducted by SPCB for Gangtok and surrounding area has been placed herewith for accessing the level of pollution. Drinking water is supplied to Gangtok town by the Public Health and Engineering Department. The source of drinking water is at Tamzey at an altitude of 4200 m above mean sea level. An army base camp is also situated besides this stream.

The water from Tamzey is stored at 10<sup>th</sup> mile and 4<sup>th</sup> mile Rateychu tanks and before distribution it is stored at Selep tank (1800 m) where chlorination takes place after which the water is supplied through pipeline network to different parts of the capital town Gangtok.

The analysis shows that there is microbial contamination at all the study zones and microbial density is highest during the monsoon period and lowest during the winter or dry period. The findings further revealed that the water is contaminated when the run-off rainwater gets mixed with the source of drinking water along the open canal through which water passes before

reaching the point of chlorination and distribution. In view of unrestricted cattle grazing and also the presence of an army camp at Tamzey, the source of drinking water, it is feared that the microbial contamination may also be due to open defecation by the cattle (Pradhan *et al*, 2004) and the humans.

#### **4.15.2 Environment concern**

With the rapid increase in population of humans, vehicle, houses, due to heavy influx of tourists and migration, short supply of amenities have been felt in Gangtok in particular and Sikkim on the whole. The environmental pollution by soil, water, and air has been discussed at length and highlighted that ecology is in threat. The menace of solid waste and bio non-degradable waste are piling up in the state. Activity like road sweeping and drainage inadequacy are some glaring happening in Sikkim.

#### **4.16 NATURAL CALAMITIES and ENVIRONMENTAL DEGRADATION**

Physiographically, Sikkim is being hemmed in between the impassable Himalayas gifted with frequent landslide and natural calamities. The major landslide belts across the four districts of Sikkim are: Bhusuk, Barapathig, Changey Senti, Namcheybong, Parakha, Bordang, Lueing, Kumrela, Tadong, Phadamchen and Sirwani in the East, Lingi Payong, Kateng, Turung, Kewzing, Heingdam (Legship), Shyampari and Soda in the South district, Mangnam-Kurchey, Sakyong, Chewrey Boley, singhshhore (Uttarey), Reshi, Daramdin, Rumbuk and Beyong-Tikpur in West district and rang-Rang, meyong, Lanthey Khola and Ritchum (Lama, 2001) in the North district. Nature takes its own course and form in stabilising striking balance between man and biosphere. The natural calamities are the manifestation of maladjustment of isostatic balance in the form of catastrophes. Calamities could be in the form of earthquakes, landslides, forest fires, floods, flashfloods, avalanches, mass wasting, subsidence, drought etc. The event of landslide, falling of rocks and trees, floods, drought is commonly prevalent in hilly state like Sikkim. The horizontal and vertical tectonic movements of Himalayas result in development of various faults. As a result, earth

movement is disturbed and led to devastation of crust and its formation. In such condition, endogenetic and exogenetic geo-tectonic forces are responsible in bringing about catastrophes on the surface earth.

Calamities such as earthquakes, landslides and flash floods are taking place in Sikkim and massive devastation of life and property is experienced. The natural calamities are harmful not only to human being but also to plants, animals and overall ecosystem. The loss of several endangered plants and living organisms are due to radioactivity and terrestrial activities. Some of the natural disasters prone to Sikkim Himalayas are dealt with in depth.

#### **4.16.1 Earthquakes**

Sikkim falls under Zone IV of the Earthquake Vulnerability Mapping; therefore earthquake in this belt will not be an astonishing fact. The sudden movement of earth crust is the result of either volcanic eruption or by faulting and displacement of rocks. Three classes of earthquakes are recognizable; (a) tectonic, (b) volcanic, and (c) artificially produced. Compared to the last two classes, the tectonic type is by far the most devastating and frequently occurring in the Himalayas (Gaur, 1998). For the hilly tract of Sikkim earthquake is a major threat to its people. The measures to predict earthquake and to measure its intensity are the broad task before the planner and decision makers. However a humble beginning has been initiated by Department of Science and Technology in installing seismographs at various locations in Sikkim. However, earthquake remains as a major threat in destroying and degrading the existing environment.

#### **4.16.2 Landslides and flashfloods**

Landslides are seen in every hillslope in Sikkim. The mass of earth and rock charged with water from rain and melting of snow when percolates through the crack and joints, results in causing slides. The steepness of slope and degree of saturation are the factors controlling landslide in Sikkim. The main causes of landslides are cloudburst, sudden high rainfall and

temperature, perpetual waterlogging and removal of vegetation on the slope. The sedimentary and metamorphosis rock predominates this area with the composition of dolomite, sandstone, shale, mica schist quartzite etc. The fragile geological structure of the terrain due to faulty rock formation is the main cause of landslides in Sikkim. Incidents of landslides are lower where the rocks are in anticline faults, i.e. the direction of layers embedded in the slopes is away from the direction of the slope. Lack of vegetal cover is certainly another cause of landslides. The excess run off causes the formation of gullies and scouring of the banks of the streams also cause landslide. Building of houses, roads, water supply schemes and hydropower projects, and biotic interference in the form of indiscriminate felling of trees overloads the carrying capacity of the soil and thus causes (Lama, 2001) landslides. Case histories of three major landslides during the early 1960 in 7<sup>th</sup> mile on Gangtok- Kupup highway, Rangrang and New Vong on North Sikkim highway suggest that these landslides occur mostly due to hydrological reasons. In recent times the landslide in Sikkim has been triggered by high intensity of rainfall. The worst damage due to rain was during 1968 when there were heavy and continuous rains for almost 72 hours. The damages was extensive and spread over almost all parts of the state when the entire lifeline was disrupted due to washing away of roads, bridges, power and water supply lines etc. It took several years to restore the damages and bring back the life to normalcy. The recent damage caused by high intensity rainfall was on the night of 8<sup>th</sup> June 1997, when rainfall measuring 233 mm, working out to be 20 times more than average of the same period of the previous years causing heavy damages in Gangtok and surrounding areas. (Lama ,2001) The rainfall of 24<sup>th</sup> September 2005 has taken nearly 15 lives and more than 100 houses in Mangzing and Rakdong Tintek. The cases of roadblock and broken bridges are numerous. (Personal visit, 2005)

Landslides, rock fall and debri fall causes massive damages to life and property in the state. During the monsoon rain, roads are blocked due to falling of tree and landslide activity. The National Highway linking Siliguri with Gangtok and beyond are highly vulnerable to massive landslides.

#### **4.16.3 Glaciers, glacial lake outburst floods (GLOF) and avalanches**

In the northern Sikkim, glacial activities are common phenomena that occur in high mountain ranges. The movement of glaciers such as Rathong and Zemu have caused in uprooting natural vegetation of the region. The debris and barren land is seen in the higher altitudes. The soil and natural vegetation are washed away every year in glacially active regions. In the glaciated tract, glacial lake outburst floods (GLOF) are a common hazard. Sikkim also has had glacial lake outburst floods in the past. Frequency of GLOF has increased because of global climatic change, global warming and acid rain. The Onglokthang glacier also feeds the Tista. A detailed study conducted by scientists and environmentalists of the Khangchendzonga Biosphere Reserve in 1995; found that the Onglokthang and Rathong Chu glaciers are receding rapidly. This could spell disaster for Sikkim's fragile ecology. With the threat of global warming looming large, it is of paramount concern to study the status of glaciers and the impact of global warming on Sikkim. A study team reported that since the Little Ice Age, the Onglokthang glacier had retreated by about 500 m and the Rathong Chu glacier by 600 m. Sikkim's largest glacier, Zemu, had also retreated by 3-4 km. If the glaciers continue to recede, it could spell disaster for Sikkim's sensitive economy and may even lead to devastating floods and ultimate dryness in river Tista (Lama, 2001). Sikkim is no exception to glacial outburst and loss of natural environment. In the North Sikkim such geomorphic features are noticed in the higher climatic belts. Recently, such activity was seen at Lachung valley that washed away vital installations and habitat including yak and yeti of this region. In the cold deserts region of Gurudongmar and Cholamu, avalanches cause widespread loss to natural environment. The loss of vegetation; grassland, trees and bushes are some of the most happening activity in north Sikkim. Nurseries and fresh saplings are virtually destroyed every year. As a result there is a disturbance in overall biosphere.

The Glacial Lake Outburst and avalanche claim four lives of mountaineers on 26<sup>th</sup> September 2005. The mountaineers, while attempting to

scale Chomo Yummo peak in North Sikkim (Sikkim Express, 28 sept 2005) died at the height of 6768.42m above the MSL.

#### **4.16.4 Drought**

Drought is a condition where there is scarcity of rain and water for a long spell of time. Lack of precipitation causes hydrological imbalance thereby reducing the water table. In Sikkim, west and southern regions are adversely affected by drought hit. The most affected crops are rabi crops and cash crops like cardamom, ginger and orange, drought also caused scarcity of drinking water in acute conditions. As per the report of Agriculture Department, the total rainfall recorded in between October 1998 and 31<sup>st</sup> March 1999 was 93.34 percent, which is less than the rainfall in the last 25 years. The drought is characterized by loss of crop yields and gain in unproductively. During drought period farmers of Kitam, Gom and rain fed areas shift sowing of seeds for few months. The drying of land leads to failure of cardamom cultivation. The estimated loss of large cardamom plantations was about 60% in the unprecedented dry spell. The north district in Sikkim alone produces large cardamom worth of Rs. 200 million annually (Lama, 2001). The above facts reveal the danger of drought in causing massive environment and economic loss.

#### **4.16.5 Hailstorm, frosts and strong wind**

The hailstorm, frost and strong wind are commonly prevailing natural activities in Sikkim. The loss of crops, soil, and vegetation are common characteristics. In the year 2002, repeated hailstorm received at various places in the state damaged crops including cardamom, maize etc. With the marginal land Sikkim devotes for cultivation, each year's natural calamities take away nearly half of its produce.

#### **4.16.6 Forest fires**

Forest fire is caused by natural and human ways. People knowingly set the forest on fire with a view to add nutrition to soil and clear the jungle for cultivation. Secondly, in bamboo dominated areas, when two bamboo trees strike against each other, firing takes place. There are instances that some grazers and farmers light fire in the forest for the reason mentioned in above paragraph. Such fires not only damage forest but also the entire ecology and habitat. Ground vegetation and small faunal components are totally burnt disrupting the ecological balance. The animal and living organisms are disturbed and they tend to migrate to other places. Topsoil is washed away and the nutrient balances are disrupted to large extent. During the field survey it was found out that there was a great forest fire in upper Lingi and Upper Borung, Famtam during 1997-98. (Personal interview, 2005)

#### **4.16.7 Environment concern**

The natural calamities are expected to occur at any point of time. The lower altitudinal valleys like Kitam, Jorethang belt are affected by flood and drought where as higher altitudes like North Sikkim are affected by glacial activities. On top of that landslide, debri fall, soil erosion, tree fall are ubiquitous during rainy season. During monsoon rain, hailstorm and snow fall in winter cause severe loss of biodiversity. The people have become blind in amassing wealth and have given up their noble thought towards mother nature. It is felt that the carrying capacity of the crust is overburdened by the by rigorous use. Therefore, environment health of the state is suffering from multi-ferious ecological challenges.

#### **CONCLUSION**

In bio diverse natural region of Sikkim the remote areas are being networked with roads and bridges, knowing that construction of road is directly related to environment displacement. Transportation is done through unsurfaced narrow road passing through delicate habitat natural zone. In such zones the following problems relating to environment are studied.



The new road construction is extremely dusty and whenever a vehicle passes by, a large quantity of dust is blown high into the air. During winter, atmosphere is polluted and dust settles on the trees, grass, nursery and shrubs growing along the road. Besides being a health hazard for the inhabitants of the nearby villages, labourers and truck drivers, this dust has resulted in the clogging of the leaves, blocking of the stomata and several other loss to plants.

Such scenario is noticed during winter season in almost all over Sikkim. All roads are not metalled hence, dust powder adds to air pollution. The roads around the hydropower projects at Balutar and Dikchu display such exhibition.

The vehicles used for transporting the mineral are usually diesel powered. They emit toxic fumes that have blackened the roadside flora. This is more marked on steep climbs. Cracks have developed on the leaves of the affected plants and many of them have begun to shrivel up. At some points along the tract affected by fumes, higher forms of plant life have vanished. During rainy season, the road at Namli, Rangpo, Sirwani, B2 remains virtually closed. Around 5<sup>th</sup> mile area of Gangtok, sinking and subsidence are normal along the roads.

Since orchid itself is a tourism product, orchids in the wild, along with the rhododendrons and primulas, could become major tourist-products in this belt. It has been suggested to open the trial route followed by J.D. Hooker and promote as a hooker's trial of 1848-50. Such trek and trial may further lead to environmental damage and bio piracy as the trial covers all the botanical garden of Sikkim.

The environments of orchid in Sikkim are in poor state, because of massive biotic interference due to deforestation and human exploitation. It is estimated that many of the species are on the verge of extinction and their population have been substantially reduced. Steps must be taken to protect it from tourist influx.

The various faunal species in Sikkim have very important role in maintaining ecological balance of the region as they represent different tropical levels in the ecological food web. The conservation values of these

faunal species are of importance not only to the state, but also for the region, the country and for universe. The present study highlights that there are danger of disturbance on food web and food chain system due to rapid endangering of living organisms.

Environmental degradation vis a vis extinction of endangered species must be further studied, so that assessment is made and preservation methods are applied. The main threats include-population influx in such regions, land use transformation, human interference, habitat degradation, forest cut and fires, constructional activities, landscape fragmentation, continuous grazing and hunting, unplanned tourism, lake pollution, loss of soil nutrients and lack of conservation knowledge amongst local people. As discussed, nearly 65 plant species have been identified as threatened in the Sikkim Himalaya that includes many valuable medicinal plants (Maiti and Chauhan, 2000). As many species as 19 mammals and 11 birds are also threatened that includes animals like snow leopard, musk deer, red panda, Himalayan thar etc., and birds like blood pheasant, monal pheasant, sparrow hawk, forest eagle owl etc. A study (Chettri, 2002) shows that, important trek and trail route of Yuksum and Dzongri belt in the West Sikkim showed immense pressure on its natural resource, mainly due to massive tourist influx in these regions during past two decades. The grazers lack knowledge on valuable medicinal herbs and they take no step for conservation. However it is needless to mention that some farmers in Sikkim are expert in practicing herbal treatment; therefore poachers of this type pluck the plants ruthlessly.

It may be mentioned that inclusion of barren areas under protected management network will not enhance biodiversity conservation. The local populace must be trained to be aware in the process of conservation.

This chapter highlighted vividly on various agents that are responsible for degrading surrounding environment. The next chapter further focuses on impact of tourism on nature, culture and economy.