A STUDY IN ENVIRONMENTAL DEGRADATION IN THE DARJEELING HILL AREAS

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TO MY PARENTS

PREFACE

Environmental degradation and associated phenomena are the most pervasive of natural problems that undermine the economic and cultural development of the Darjeeling hills. Deforestation along with high intensity rainstorm induced accelerated slope degradation process further complicated the problem.

Implementation of various development programs, construction of human settlement and roads to cater the ever-increasing population, exploitation of forest produce to generate potential, boosting of agriculture growth, tourism, tea plantation, quarrying on the Himalayan immature geology trigger the disaster, huge and complex, never encountered before. The situation was different even 150 years ago. The hills were densely covered by natural vegetation with very thin population and the harmonious relation between the man and nature was well preserved. Extensive heedless deforestation, haphazard construction of roads and settlements, unscientific and illegal quarrying, over grazing, inadequate drainage, in other wards unscientific and unplanned use of fragile hill slopes, has led to the establishment of vicious cycle of degradation. During heavy and concentrated rainfall, catastrophic soil erosion and innumerable landslips are caused to transport huge amount of fertile soil from the Darjeeling hills.

The Darjeeling Himalaya is thus, slowly embracing to the inevitable sterility. The declining carrying capacity of Darjeeling hills is already visible in many sectors i.e., drinking water, transport, housing, etc. In consequence, the environmental quality has also been deteriorated to its all-time low. Climatic change is also visible and significantly demonstrated in rise in temperature, decline in relative humidity and rainy days. The rainfall became more erratic in nature over the past hundred years. It is therefore, becomes imperative to suggest remedial measures and its active implementation. Only then can the geopolitical and ecological stability of this extremely vulnerable region of the country be protected.

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Introduction

i. Scope of work

In the Darjeeling Himalaya, environmental degradation and the consequent deepening crisis has reached such a stage, where it is difficult to maintain the ecological balance – leading consequently to environmental hazards like soil erosion, pollution, landslides and loss of biodiversity. Thus the serious concern is for finding the right way for checking such degradation. Whether, through ignorance or otherwise, the fragile hill ecosystem has often been violated outrageously, impairing its delicate sub-systems which have a long term effects, jeopardizing the life-sustaining process. The growing consciousness about the worsening situation compels the society today, to halt and poder on the grave consequences of such degradation. While, it is admitted that the environment cannot be reverted to its original form, nor can it be intended to, it may not be beyond our conscious efforts to check or control such practices for arresting further deterioration, followed by protective measures for speeding up the restorative processes in the environment.

The Darjeeling hill area is a region with wide variety of renewable and non-renewable resources. Of late, this repository of natural wealth has been subjected to virtual plunder and consequently, the hill ecosystem is fast loosening its resilience and regenerative capacity.

Since the British occupation, the physico-cultural set-up of this region has been seriously disturbed. Extensive heedless deforestation, tea plantation, haphazard construction, huge population influx induced illogical slope cultivation, inadequate drainage, in other words, unscientific and unplanned use of land has led to the establishment of vicious cycle of degradation. As a result, during heavy and concentrated rainfall, catastrophic soil erosion and innumerable landslips are caused, contributing huge sediment load to the rivers which are incapable of transporting the load efficiently under the existing hydrological conditions especially along their lower courses beyond the foothills. The river beds are rising, resulting in lessening of cross sectional area, which being incapable of arresting unusual monsoon discharge and cause devastating floods, endangering the vital line of communication, human habitations, farm lands and forests.

Erosion, transport and deposition are primarily nature's way of adjusting hill slope form and processes. Such an adjustment has been found to be deleteriously disturbed by the

human interferences. Implementation of various development schemes, construction of human settlements and roads to cater to the ever-increasing population, exploitation of forest produce to generate work potential, boosting of agricultural growth, tourism, mining and quarrying on the Himalayan immature geology trigger the disaster, huge and complex, never encountered before.

The fast growing population and the human aspirations for a better standard of living have increased pressure on land situated on delicate and susceptible hill slopes. The felling of trees for timber, fuel, fodder, building construction, road construction, dams and canal construction and the development of sites for tea gardens, arable farming have seriously damaged not only the vegetal cover but also caused irreparable damage to the hill slope hydro-geomorphologic processes operating thereon. The degradation is increasing on account of fast depletion of grazing lands, wild animal, rare plant and natural sources of water i.e., springs etc.

Deforestation has not only seriously affected the output of fodder, fuel and food but also destroyed the homes of numerous tribal communities, birds, reptiles and wild animals. The Social Forestry Programme initially set up to alleviate the fuel and fodder shortage, has in fact become an instrument to provide raw material to the paper, pulp and building industry, thus ignoring the very people it was designed to help.

Increasing number of vehicles along with carrying additional load not only damage the existing road network but also found to be instrumental in causing landslides and related phenomena. Use of age old motor vehicle along with the sub-standard and adulterated fuel by many vehicle operators has contributed pollutants to the already polluted environment of the Darjeeling hill.

The climate of the Darjeeling hill areas is undergoing a rapid change over the past hundred years. The mean annual temperature recorded at Darjeeling and Kalimpong stations has been increased considerably in association with considerable decrease in relative humidity. As a result the net biological demand for water has increased. Consequently, rainfall occurrences during the same period although does not show any clear tendency yet indicates not only erratic nature but also a clear indication of increasing frequency of high intensity short lived rainstorm. The study also reveals decreasing number of rainy days in Darjeeling hills. As a result, the Darjeeling Himalaya has been experiencing acute water shortage especially during non-monsoon months. Innumerable perennial water sources have

dried up. Edaphic drought has become prominent in most part of the hills causing irreparable damage to the flora and fauna of this biodiversity hotspot.

Because of the burgeoning population of human beings and livestock, the forest and grassland resources have been overexploited. This has resulted in multidimensional environmental crisis which in turn have created air pollution, soil pollution and water pollution.

The aforesaid kinds of environmental degradation in the Darjeeling Himalaya are playing havoc not only on human being and animals, but also on the vegetative kingdom. Premature deaths due to respiratory and cardio-vascular diseases like asthma and bronchitis have increased. Lead emitted in the atmosphere from auto exhaust is causing lead poisoning of human body leading to stomach ailments, indigestion, constipation lack of appetite and sleeplessness as dust from quarrying/mining and grinding, stone crushing and other factories leaves trace elements in the atmosphere.

The unplanned construction of high rise buildings in urban areas, a majority of them illegal, has led to deterioration of delicate hill slope stability of the Darjeeling hill areas making the place more vulnerable to landslides and related slope failure processes. Landslide which was a minor natural phenomenon hundred and fifty years before has in recent years become a serious threat not only to the urban area but also to the roads and railway. The glaring example is the fact that the World Heritage title winner, the Darjeeling Himalayan Railway forced to suspend its services for a period of two years.

At this moment, suggestions of restorative and regenerative measures and their active implementation is of vital concern to the region as a whole, as the amelioration of very existence of habitable environment and its sustenance in Darjeeling Himalaya depends on it.

ii. Hypothesis

Environmental degradation in the Darjeeling hill areas has reached an all time high. The Darjeeling hill areas are facing the worst ever crisis even in providing the basic life support input to the inhabitants. The unplanned ecological plunder in the region has been gradually extending to the far distant corner of the hilly area. If such haphazard development programme in Darjeeling Himalaya are not properly reoriented and/or reversed through a viable eco-friendly and sustainablealternative, the situation will assume catastrophic

dimensions. The environmental damage in the Darjeeling Himalaya sounds like the death-knell not only for its inhabitants but also millions living in the surroundings.

iii. Objectives

The main objective of the present study is to (i) assess the causes and consequences of environmental degradation in the Darjeeling hill and (ii) to suggest the remedial and restorative measures. To achieve the above, the following detail objectives have been identified:

1. To examine the historical aspects of development in the Darjeeling hills.
2. To reconstruct the past environment during the different phases of development and comparing its impact during these different periods.
3. To assess the extent of climate change and its impact to the environment, economy and society.
4. To examine and analyse the land use changes over the past hundred years.
5. To assess temporal and spatial aspects of degradation and hazards with special references to landslides and soil erosion.
6. To examine the development of tourism and its impact.
7. To examine the development programme and its impact with special reference to hydroelectric project.
8. To examine the consequences of unplanned development activity.
9. To assess the extent of human encroachment vis-à-vis over use and misuse of environment.
10. To assess the environmental impact of various development programmes.
11. To evolve suitable module for the restorative and regenerative measures.

iv. Study area

The Darjeeling hill areas comprising of the three hill sub-divisions of Darjeeling district of West Bengal is bounded by latitude 26° 31' to 27° 4' N and longitude of 87° 59' to 88° 53' E is endowed with a perfect blend of physical, cultural and aesthetic resources. Of late this repository of natural wealth has been virtually plundered and as a consequence the Darjeeling hill is fast loosening its natural resilience and regenerative capacity.

The area of study comprisesof eight block viz. Darjeeling Pul bazaar, Jorebunglow, Sukhiapokhari, Rangli Rangloit, Mirik, Kurseong, Kalimpong I, Kalimpong II, and

Gorubathan I block. The attempt has been made to study all the hill blocks which are bounded by Nepal in the west, Sikkim in the north, Bhutan in the east, Jalpaiguri district in the southeast and Siliguri sub-division of Darjeeling district in the south (figure 1.0).

The Darjeeling hill started finding mention after the British colonizers took control of it by default as there is hardly any native account of this region. The region was sighted first by G.A. Lloyd and J.W. Grant in 1828. Capt. Lloyd was deputed to negotiate on behalf of the East India Company with the ruler of Sikkim, which was accomplished by 1st February 1835. The Christian Missionaries who started the European system of education around the middle of nineteenth century have recorded most of the information relating to its history and physiographic, flora and fauna people and their practice including culture and politics.

v. Methodology

To fulfill the objectives, rationalistic methodology been adopted by the present investigator, comprising of integration of data collected from both primary and secondary sources and the application of standard methods and techniques to analyse them. The proposed methodological framework for the study comprises of the details outlined as follows:

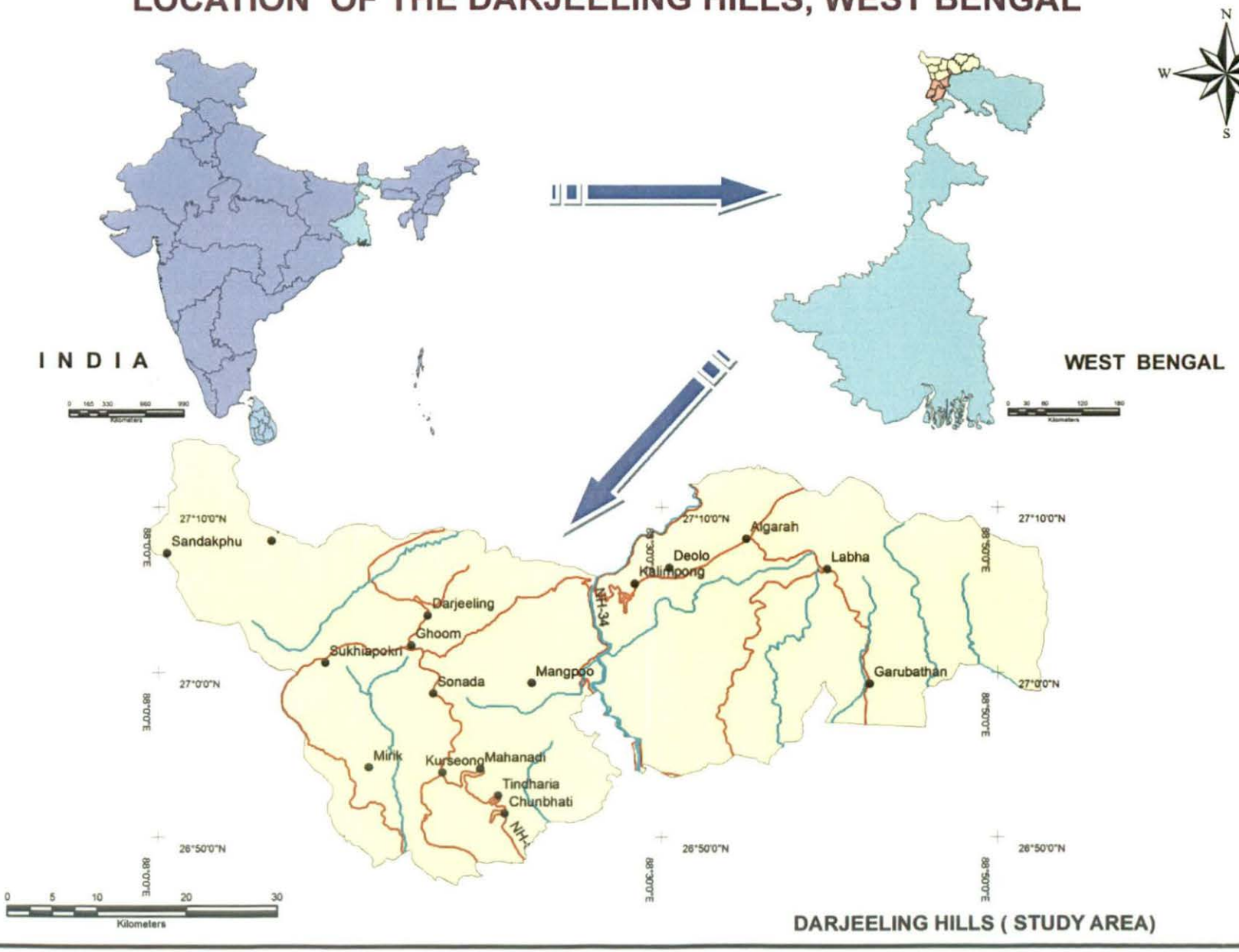
Reconnaissance survey

The investigator has obtained the basic aerial data from different government organizations, from maps published by the Survey of India topographical sheets (1:50000 and 1:63360), US Army topographical maps (1:250000), Satellite imagery (Google), manuscripts and report gazetteers etc. and from the work of individual researcher. These have been used under GIS platform (ArcGIS 9.2) in preparing the detailed programme of the present research work. Significant changes of the environmental characteristics of Darjeeling hills has been followed by comparing the old documents, photograph with the present one.

Scheme for data collection

The scheme for data collection has been carried out in two stages. Firstly, different relevant data has been collected from primary source i.e., by direct measurement at the field based on questionnaire survey. Secondly, relevant data has been collected from different sources like records of Geological Survey of India, records of the Forest Survey of India and Director of Forest, Government of West Bengal and from previously published reports. The reliability of the data collection from secondary sources has been properly scrutinized.

LOCATION OF THE DARJEELING HILLS, WEST BENGAL



The investigator has also obtained data and necessary information from the secondary sources like Census handbook of Darjeeling, District Gazetteer, Statistical Handbooks etc. The data has been also collected from different line departments, NGOs and semi-government organisations.

Primary information has been collected from field surveys mainly by questionnaire method in identified key areas of interest especially to study the perspective on environmental degradation. Extensive field survey has been carried out in vulnerable areas to understand the processes and factors of degradation mechanism and to apprehend its mitigation processes.

As the standard data on various aspects of environmental degradation is not readily available the investigator has used the standard methods of questionnaire, interview, meeting, correspondence with the respondents in Darjeeling hilly area.

Meetings and discussions with the concerned departments, senior citizens and local people were held in the various parts of the hills including forest villages. This has done to incorporate their views and suggestion in formulations of the strategy for protection of forest within broad principles of joint forest management and people participations.

Letters were issued to different organization and senior citizen to get information in order to fill the gaps in the process of reconstructing the past environment in the Darjeeling hills. Information and data have been gathered with the help of interview schedules. Apart from the schedules observations were made and other general information about the extinction and threatened spices have been collected from the elder members of the villages and gram panchayets.

Methods for assessing land use changes and deforestation

Chronological assessment of depletion of the forest cover in the Darjeeling hills has been done under GIS platform using US Army Topographic Maps (1:250000) for the year 1930s, Survey of India topographical maps (1:50000 and 1:63360) during 1960s and 70s, Satellite image available from NRSA (LISS 3) for 2000 and Google image (2010). The time series data thus accessed has been analysed quantitatively to apprehend the nature and extent of land use changes vis-à-vis the extent of degradation in Darjeeling Himalaya.

Methods for assessing of land degradation

Assessment of soil erosion has been done mostly from secondary sources (FAO/UNEP/UNESCO, 1978) and Sarkar (1998). The quantification has been made based diagnostic criteria of (i) climatic erosivity (R), (ii) topographic erosivity (L.S), (iii) soil erodibility (K) and biological erosivity (C.P). Data thus collected from various institutional sources have been followed by field checking by the investigator when have been analyzed and processed to provide logical and sustainable restorative measures.

Assessment of landslides and related phenomena has been based on both primary and secondary source of information. A number of case studies have been performed by the investigator to apprehend the nature and extent of this hazard in Darjeeling hills. The investigator also had applied check list method on 80 sites to study the spatial patterns of landslide degradation in different parts of the Darjeeling hills. An attempt has also been made to identify the landslide prone areas of the Darjeeling Himalaya.

Methods for environmental impact assessment (EIA)

Modified Leopold matrix (1971) has been used to assess the environmental impact of development programs in the Darjeeling hills which involves several development activities under considerable broad headings and number of environmental components under different heads and sub-headings. Environmental impact has been identified under the heading of impact significance and impact magnitude. The matrix has been applied on checklist filled up at 80 different sites across the Darjeeling hills.

Data Processing and Analysis

The investigator has analysed the nature of the terrain, geomorphology of catchment area using standard method. The land use pattern of the watersheds has been assessed from the topographical maps and updated by using satellite imagery under ArcGIS 9.2 platform.

As mentioned earlier that data has been collected from various sources. The reliability of the data collected from secondary sources has been checked statistically. The following methods have been applied to understand the processes and extent of environmental degradation in Darjeeling hills

- correlation analysis
- regression analysis
- linear and log linear analysis

- matrices
- factor analysis

Long term climate data obtained from various sources i.e., India Meteorological Department, SDO, Kalimpong, Planters Club, Darjeeling, Forest Department, Government of West Bengal has been statistically analysed for understanding the trend and the probability using MS excel and SPSS 15.0.

To compile the bibliography as well as reference work, the libraries of North Bengal University, Natural History Museum, Darjeeling, National Library, Kolkata, Planter's Club, Darjeeling, Public library, Kalimpong, District library, Darjeeling has been thoroughly consulted.

Finally, in order to understand the environmental degradation problems of the Darjeeling Himalaya, all the data collected from the field and various institutional and personal sources has been analysed, processed to provide workable suggestions of sustainable nature for restoration and regeneration of the degraded environment of Darjeeling hill areas of West Bengal.

Chapter 1: Geographical Set-up of the Study Area

1.0 Introduction

Darjyu Lyang *or the 'land of God' or 'heaven on earth'* is believed to have given Darjeeling the northern most district of West Bengal its name. It is also believed that the name is a corrupted form of ***Dorjee-ling*** of the Lamaist religion derived from *'Dorjee'* the celestial scepter of double-headed thunderbolt and *'ling'* or the land, it literally means *'theland of the thunderbolt'* after the famous Buddhist monastery, which stands atop the Observatory Hill.

Darjeeling was a part of the sovereign state of Sikkim prior to 1789 A.D. Its creation dates to the 19th century, through the involvement of the British India Government. The signing of the Sugauli Treaty between the two countries saw the return of the *terai* area and part of Darjeeling that was in the possession of Nepal to the British India Government. The signing of the Titleya Treaty on 10th February 1817 ensured that the British restored this region to the King of Sikkim, making it a buffer-zone between Tibet and India.

However, the search for a summer capital and a sanatorium to escape the sweltering summer heat of the Indian plains saw the visit of Captain Lloyd and Mr. Grant to Darjeeling in 1887. On their proposal and persuasion, Lord Bentinck initiated a dialogue with the then King of Sikkim, who handed over this area to the British as a token of friendship on 1st February 1835. Kalimpong on the other hand was ceded to the British Empire by the Sinchula Treaty in 1865 by the Government of Bhutan, and notified as a sub-division of Dooars to be transferred to Darjeeling in 1866. It was finally annexed to the state of West Bengal in 1947. The three hilly subdivisions of the district came under the administrative purview of the Darjeeling Gorkha Autonomous Hill Council that came into effect on 22nd August 1988.

1.1 Geological set-up

Geological investigations in Sikkim and the adjoining Bengal region began in the middle of the 19th Century. Dr. Hooker, in his famous "Himalayan Journals" (1854) reports the geological results of his extensive surveys in the region. He traced the regional domal pictures of gneisses and observed the overlying, bedded sedimentary rocks (Gansser, 1964). The first comprehensive and systematic geological examination of this region was made by F.R. Mallet in 1874. Since then, many observations have been made (Dutta, 1950; Gansser, 1964; Acharya, 1972; Powde and Saha, 1982, etc.). A geological map of the study area

(figure 1.1) has been prepared based on Mallet (1874), Gansser (1964) etc. to show the regional distribution of rocks, while the chronological sequence of the geological series of the study area has been shown in table 1.1.

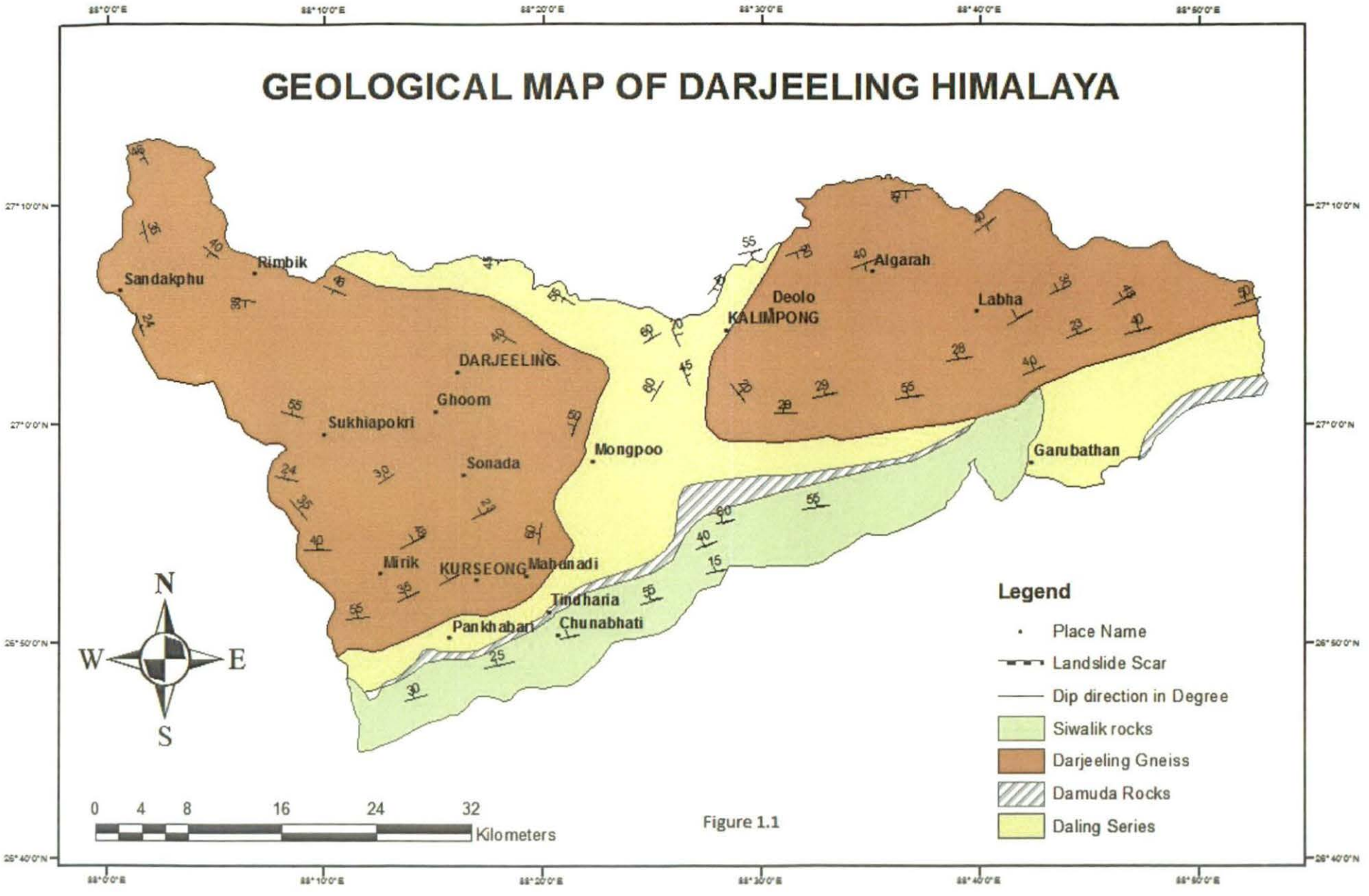
Geological foundations of the Darjeeling hills consist of Precambrian slates, schist, phyllite, quartzite, gneisses, lower Gondwana and Siwalik sandstones and recent to sub-recent alluvium (Gansser A., 1964, Kalvoda, J, 1972). The several tectonic units of the Darjeeling Himalaya overthrusted towards south are built mostly of metamorphic rocks (Darjeeling gneisses, Daling schist and quartzite). The Main Boundary Trust (MBT) separates them from the Siwalik built of sandstones, conglomerates and mudstones, which are overthrusted over the Quaternary fore-deep along the Himalayan Frontal Thrust (HFT). The foreland of the Himalaya is built of Quaternary sediments which show a distinct fractional differentiation starting from boulders and gravels in the root part of piedmont fans and terraces, at distance of 5-10 km from the margin turning to sand and farther downstream to sandy loam and silt (figure 1.1). A brief description of various formation of the Darjeeling Himalaya is given below:

1.1.1 Raised Terraces

A recent to sub recent formation forms a fringe along the hills, especially at the confluences of the rivers. These terraces are composed of gravel, pebbles, and boulders mixed with sand and clay. The formation is semi consolidated, stratified along with the evidences of upheaval at places. This type of high level terraces is also called the *terai*.

1.1.2 Siwalik Series

The foot hill belt comprises of the Siwalik sediments flanking the Quaternary piedmont deposits in the south and is separated in the north from Gondwana group of sediments by the Main Boundary Fault. Though there are some erosional gaps, the Siwalik sediments are quite persistent in the Darjeeling Himalaya. The lower Siwalik comprises of micaceous sandstone, occasionally with pebble beds and bluish grey clay stone. Hard sandstones with pebble beds and subordinate clay form the middle Siwalik. The overlying upper Siwalik is represented by grey micaceous sandstone followed by thick boulder conglomerate with yellowish and carbonaceous lenticular clay beds. Along the Hill Cart Road and the Tista River a few stretches of good exposers of Siwalik are found. The general strike of these rocks in NNE-SSW to NW-SE with dips between 30° to 60°.


GEOLOGICAL MAP OF DARJEELING HIMALAYA
88°0'0"E
88°10'0"E
88°20'0"E
88°30'0"E
88°40'0"E
88°50'0"E
27°10'0"N
27°0'0"N
26°50'0"N
26°40'0"N
Sandakphu
Rimbik
DARJEELING
Ghoom
Sukhiapokri
Sonada
Mongpoo
KALIMPONG
Deolo
Algarah
Labha
Garubathan
Mirik
KURSEONG
Mahanadi
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0 4 8 16 24 32
Kilometers
Legend
Place Name
Landslide Scar
Dip direction in Degree
Siwalik rocks
Darjeeling Gneiss
Damuda Rocks
Daling Series

Figure 1.1

1.1.3 Damuda Series

The Siwaliks are steeply overthrusted by the Damunda formations (Lower Gondwana). The thrust zone is badly exposed dipping at an angle of 60°-70° towards north. The rocks belonging to Damuda series include coarse grained hard sandstone, quartzites, carbonaceous shale and slates. Frequently, the sandstones have been converted to quartzites, the shale into splinter-slates and the carboniferous shale to graphitic shale, while the coal has been altered to anthracite. There is a thin discontinuous band of limestone from Kalijhora to Rongtong. The Damuda series of Darjeeling hills is equivalent to the Gondwanas of Indian Peninsular. The maximum width of Damuda is about 2.5km along the Tista valley. The maximum thickness is about 1000m. The general strike of the bed is from ENE to WSW with a varying dip of 40°to 90°. In this belt coal steams of about 3m in thickness are found near Tindharia, Lish and Gish valley.

1.1.4 Daling Series

Towards north of Gondwana in Darjeeling Himalaya, the Daling groups of rocks tectono- stratigraphically represents the area. These are placed below the high grade gneissic rocks (Darjeeling Gneiss), limited by sheared belt of mylonitic granite gneiss. The Daling series is comprised of chlorite slates, phyllites and schist associated with quartzite, which rest over Damuda series. They border the Damudas with a very sharp thrust contact, dipping steeply towards the north. Well-developed form of Damuda series is found along the Tista river and the stretches along the Tindharia – Paglajhora on the Hill Cart Road. The Rayeng formation (ortho-toproto-quartzite, variegated slates and phyllites), which is a part of Daling group, occurs in tectonic association with the lower unit of Gurubathan. The rocks are occasionally traversed by quartz and feldspar veins. The most important feature of this series is increasing metamorphism upward, where slates from the lowest bed.

1.1.5 Darjeeling Gneiss

In the higher reaches of the Darjeeling hillls, the Daling rocks gradually grade into highly metamorphosed Darjeeling gneiss. The Darjeeling gneiss consists of garnetiferous mica-schists, quartzites, biotite-kyanite and sillimantic gneiss. The dips of the rocks are irregular and vary in between 40° to 70° towards E-W. Darjeeling gneisses are highly foliated due to metamorphism. There are two prominent sets of joints in the Darjeeling gneiss, one running roughly NW- SE and the other MNW – SSE, the general direction of the hill spurs is

in accordance with the joint direction. The Darjeeling gneiss is met with traverses along Sukhiapokhri - Maneybhanjang - Tonglu-Sandhakphu-Phalut Road and also along the Phalut-Rammam-Rimbick-Jhepi-Pulbazar-Darjeeling Road.

Table 1.1 Geological succession of Darjeeling Himalaya

Age	Series	Lithological Characteristics
Recent To Subrecent	Alluvium	Younger flood plain deposits of rivers consisting of sands, pebbles, gravels, boulders etc.
Pleistocene To Lower Pleistocene (Lower Tertiary)	Siwalik	Micaceous sandstone with siltstone, clay, lignite lenticles, etc.
Thrust (Main Boundary Fault)		
Permian	Damuda (Lower Gondwana)	Quartzitic sandstone with slaty bands, seams of graphitic coal, lampophyre silt and minor bands of limestone.
Thrust (Fault Of Nappe Qutlier)		
Pre-Cambrian	Daling Series	Slate, chlorite-sericite schist, chlorite-quartz schist.
	Darjeeling Gneiss	Golden silvery mica-schist, carboniferous mica-schist, coarse grained gneiss.

Based on: Mallet, 1874; Gansser 1964 and Pawde and Saha, 1982

1.2 Physiography

Physiographically, the Darjeeling Himalaya is a region of diverse and complex area, exhibiting a wide variety of landforms. Their genesis, mode of formation and morphological forms are diverse in nature. The hills rise abruptly from the plains (150 m), and the elevation increases north-westwards up to 3636 m at Sandakphu. Two transverse ranges running north-south enclose the Singalila in the west and the Dongkya in the east. Ravines, deep valleys, innumerable springs and jhoras dissect these landscapes, interspersed with a mosaic of micro-topographic units. This complex physical environment is due to different geomorphic processes, each of which has developed its own characteristic assemblage of landforms. The geomorphic configuration of this hilly tract is the joint product of geologic foundation and fluvial processes, although slope-wash, in particular mass-movements and related phenomena play a significant role in the final shaping of the landform. The region is characterized by a myriad of ridges and valleys because of the spurs ramifying into lateral spurs which give off lesser ones, and these in turn cut the terrain into ridges and valleys, creating a mosaic of

micro-topographical units. A detail contour map of the Darjeeling hills has been given in figure 1.2. Physiographically, the Darjeeling hills may be divided into 4 major divisions. Major topographic patterns have been depicted in figure 1.3.

1.2.1 The piedmonts

The piedmont or sub-Himalayan zone is locally known as *terai*. It covers the tilted plains at the base of the foothills. This is formed due to the coalescing of several alluvial fans within the catchment area of the major rivers like Balason, Mahananda, Tista, Jaldhaka, (Sarkar, S. 1990). Rivers and streams which have cut gorges have also given rise to terraces, across the undulating and low plateau like drift deposits thereby, forming a typical landscape, overlooking and often merging with the plain to the south.

1.2.2 Lower hills

This region is bounded by contour heights of approximately 200-800 m and covers most of the central section of the study area. The rivers are mostly south-flowing and cut deep gorges and V-shaped valleys. The landscape is characterized by narrow ridges, deep incisions and numerous mass-movement scars. The average slope in this zone varies between 10° - 30°, with slope length sometimes exceeding 800 m. These lower hills are the most dissected and eroded tract in the Darjeeling Himalaya.

1.2.3 Middle hills

This is a rather narrow zone, sandwiched between the upper and lower hills and bounded by the 800 m and 1400 m contours. Most of the western and north eastern part of the study area fall under this category. These hill slopes are mostly used by tea plantations.

1.2.4 Upper hills

The upper hills lie above the 1400 m contour line and have been identified along the Mahaldiram-Bagora region and above the Ghum-Sonada ridge. It is most prominent along the extreme north-western boundary of the region along the Singalila ridges with peaks like Sandhakphu and Phalut towering over the region. The Singalia the highest range in Darjeeling Himalayaseparates Sikkim from Nepal and extends farther south and enters on

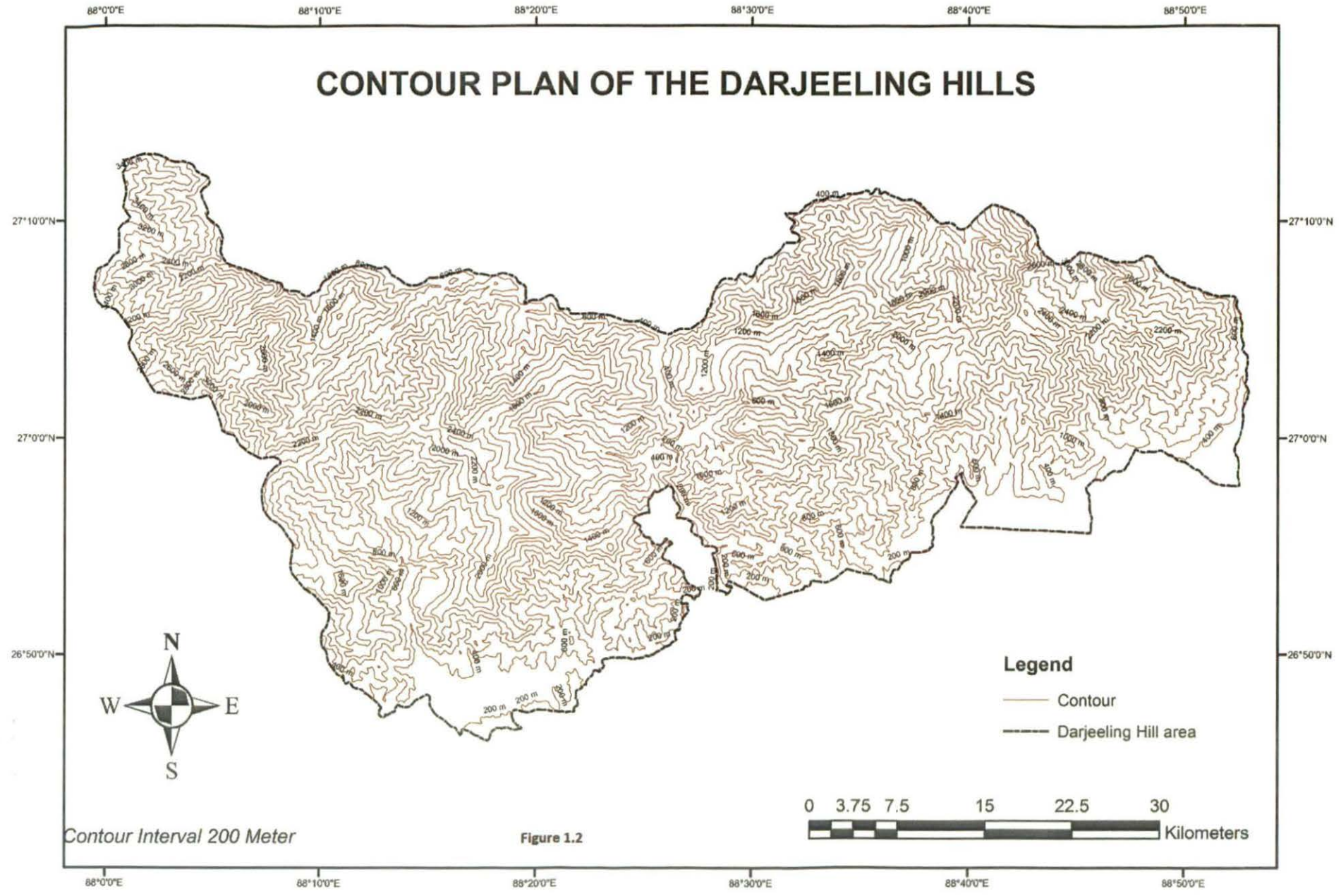

CONTOUR PLAN OF THE DARJEELING HILLS
88°0'0"E
88°10'0"E
88°20'0"E
88°30'0"E
88°40'0"E
88°50'0"E
27°10'0"N
27°0'0"N
26°50'0"N
N
W
E
S
Legend
Contour
Darjeeling Hill area
0 3.75 7.5 15 22.5 30
Kilometers
Contour Interval 200 Meter

Figure 1.2

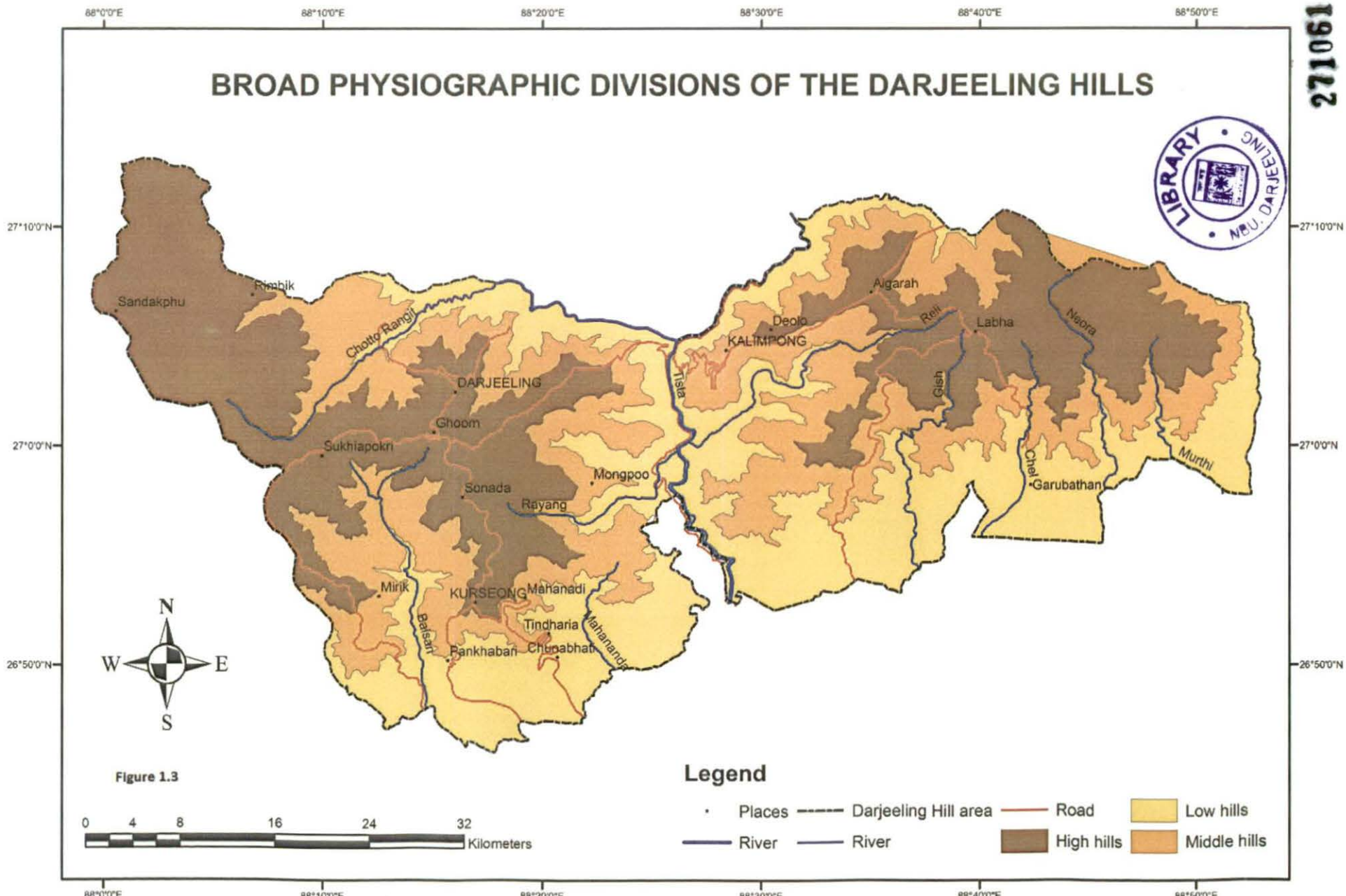


Figure 1.3

the western side. The four major peaks of the Singalia range are Sandakphu (3636m), Phalut (3596m), Sabargam (3543m) and Tanglu (3063m). In between the Balasan and Tista valley stretches the Senchal-Mahaldhiram ridge with prominent peaks of Senchal (2614m) and Tiger hill (2573m). Ridges stretch along three directions from the Tiger hill, (i) Darjeeling-Lebong to the north, (ii) Takdah-Pesok to the northeast and (iii) Bagora-Dowhill to the south. Ghoom (2260m) the highest railway station of India and Darjeeling the famous hill resort situated on Darjeeling-Lebong ridge (figure 1.3).

1.3 Climate

The climate of Darjeeling Himalaya is noteworthy because of its position, the powerful effects of the South Western monsoon against the Himalayan barrier and the peculiar configuration of the ridges and valleys which deflect or allow rain-bearing winds that affect local temperature and rainfall. Darjeeling hills is dominated by two seasons: cold and rainy, however, two more relatively short spanned seasons i.e., spring and autumn are also noticed.

The Darjeeling Himalaya shows its own climatic peculiarities caused by its geographical location, relief and a wide range of altitudinal variations ranging from 300m - 3700m above sea level. It exhibits a typical monsoon climate, with wet summer and dry winter. The condition is brought about by the direct exposure to the moisture laden southwest monsoon flowing upwards during May to October from the Bay of Bengal that lies at close proximity. The climate varies greatly corresponding to the variation in the altitude and the configuration of the neighbouring mountain ranges that greatly affect air movement, rainfall and temperature. Even within very short distances great climatic contrasts occur. Although the latitudinal extent of the region is located within the sub-tropical climatic regime its mountainous configuration has led to varied climates ranging from the subtropical to the temperate and alpine type. Thus, based upon the elevation, the region shows three distinct climatic zones, viz. tropical, temperate and sub-alpine. This variation is responsible for the creation of the various types of vegetal cover, thus bringing about great biological diversity.

1.3.1 Temperature

The temperature of the Darjeeling Himalaya sub divisions shows a great degree of variation with the altitude being the most important factor. Table 1.2 shows the average monthly temperature record of Darjeeling (2150m asl), Kurseong (1480m asl) and Kalimpong (972m asl). January is the coldest month when the temperature at Darjeeling, Sonada and

Lava often go down below 0°C. Considerable local changes in the configuration and aspects influence climate condition which often varies through a wider range. The winter in Darjeeling is extremely cold and extends from December to March. The summer spreads from April to mid-June and during this period Darjeeling is delightfully cool. The rainy months are June to September when most of the rainfall occurs with appreciable amounts in May and October as well. The mean annual temperature is 12°C, monthly mean temperature range from 5-17°C. The highest temperature ever recorded in Darjeeling was 26.7°C on 23rd August 1957. In Kalimpong town, the highest ever recorded temperature was 36°C on the 16th August 2006. The lowest temperature recorded in Darjeeling was -5.0°C on the 11th February 1905 while that of Kalimpong town was 0.6°C on the 8th January 1945.

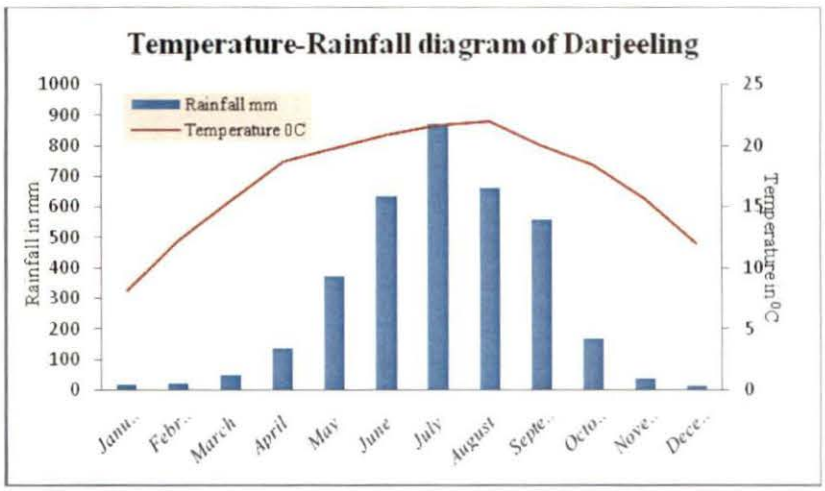


Figure 1.4 Rainfall Temperature diagram of Darjeeling

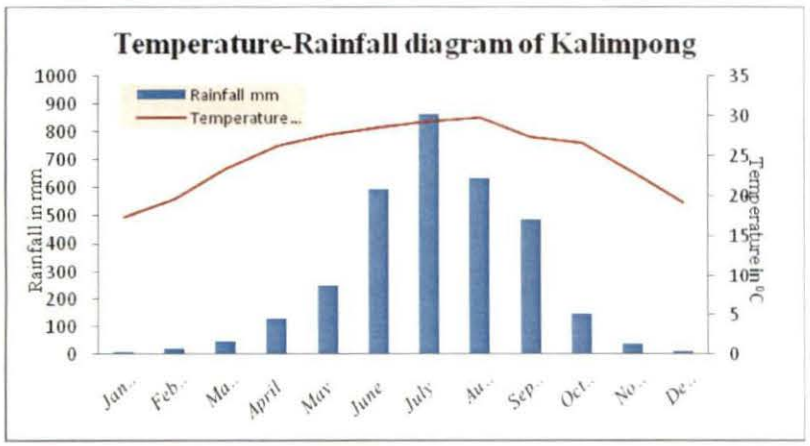


Figure 1.5 Rainfall Temperature diagram of Kalimpong

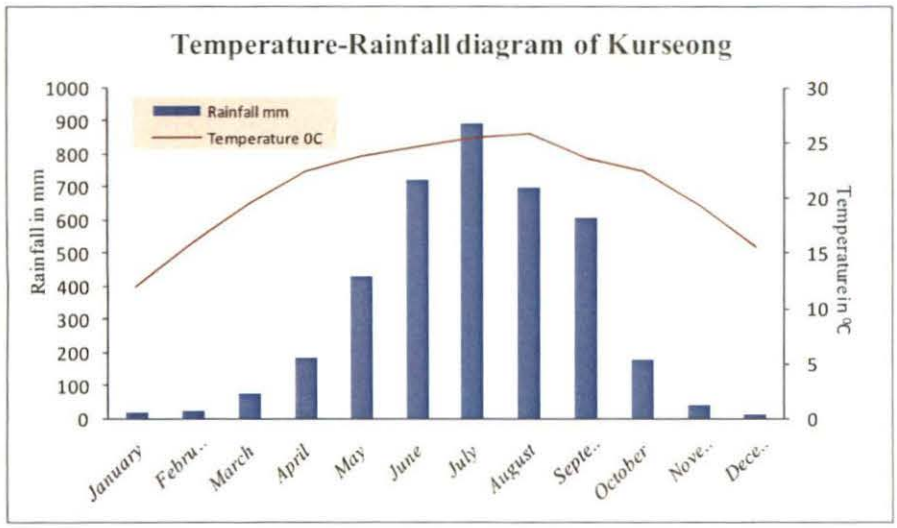


Figure 1.6 Rainfall Temperature diagram of Kurseong

1.3.2 Rainfall

The Darjeeling hills consist of a tangled series of interlacing ridges, rising rangesrising above the foot of the wall of high peaks and passes which marks the 'abode of snow' and its off-shoot (Risley 1884). This configuration coupled with the altitude brings about sharp changes in the rainfall of the region. In general the south facing ridges receive the highest rainfall with the north facing ridges receiving lesser rainfall. The Darjeeling Himalaya is viewed as a stupendous stairway leading from the western border of Tibetan plateau down to plains of Bengal. It is highly humid because its proximity to the Bay of Bengal and direct exposure to the effects of moisture-laden southwest monsoon. Configurations of the ridges and valleys bring sharp changes in the rainfall. Spatial distribution of mean annual rainfall pattern has been depicted in figure 1.7.

Kurseong and its surroundings situated in the Mahananda and Balason catchment along the southern face of the rising Himalayas receives the highest mean annual rainfall of exceeding 4000 mm. Rainfall decreases sharply towards north and the area around Little Rangit valley receives about 2000 mm only. The region experiences the highest rainfall during June to September brought about by the southwest monsoons and the lowest in between November to February with occasional moderate showers during March to May.

There is no distinct relation between mean annual rainfall and altitude. The southern slopes of the ridges get much higher (4000-5000mm) precipitation than leeward sides (2000-2500mm). The next main ridge with Tiger Hill gets 3000mm while to the north the great

Rangit valley receives about 2000mm of rainfall. The mean annual precipitation in Darjeeling hills has been estimated to be 2818 mm, with the monthly highest amount of 753 mm received in July. Spatial distribution of mean annual precipitation has been found very interesting and is depicted in figure 1.7. The Darjeeling hill area thus divided into the following 5 precipitation zones:

I. Very high precipitation area recording above 4000 mm situated in and around Kurseong, Daw hills, Makaibari, Castleton, Ambhootia etc.

II. High precipitation zone receiving 3500 to 4000 mm

III. Moderate precipitation zone recording 3000 to 3400 mm

IV. Low precipitation zone recording less than 3000 mm precipitation.

1.3.3. Relative Humidity

The entire Darjeeling Himalaya experiences a high relative humidity that is spread uniformly. Generally the north facing slopes are colder and remain humid throughout the whole year. The relative humidity is higher towards the higher altitudes (above 2000 m) ranging from 85 - 99% during the monsoons, and the relative humidity generally decreases towards the lower elevations. The drier months of March and April are less humid with the relative humidity ranging between 45 - 60%.

1.3.4. Sunshine and Cloudiness

The Darjeeling Himalaya is a region of high precipitation and humidity with the rainy days as high as 218 days per annum. Thus, this region experiences very few days of sunshine. Not only during monsoon but even during summer and winter, sunshine remains disturbed due to the formation of dense fog that sometimes creates situations of near zero visibility (Chopra 1985). Sunshine is more commonly distributed in the morning and late afternoon. During the monsoon, the rains continue uninterrupted for few days without the sun being visible on those days. The records of sunshine from the middle hill regions shows that, on an average the highest is at Sonada during Novermber (5.84 hr/day) and the lowest at Kurseong in July (0.9hr./day) while that annual average sunshine at Kurseong is 3.49hr/day it is only 1.86 hr./day at Simana Busty.

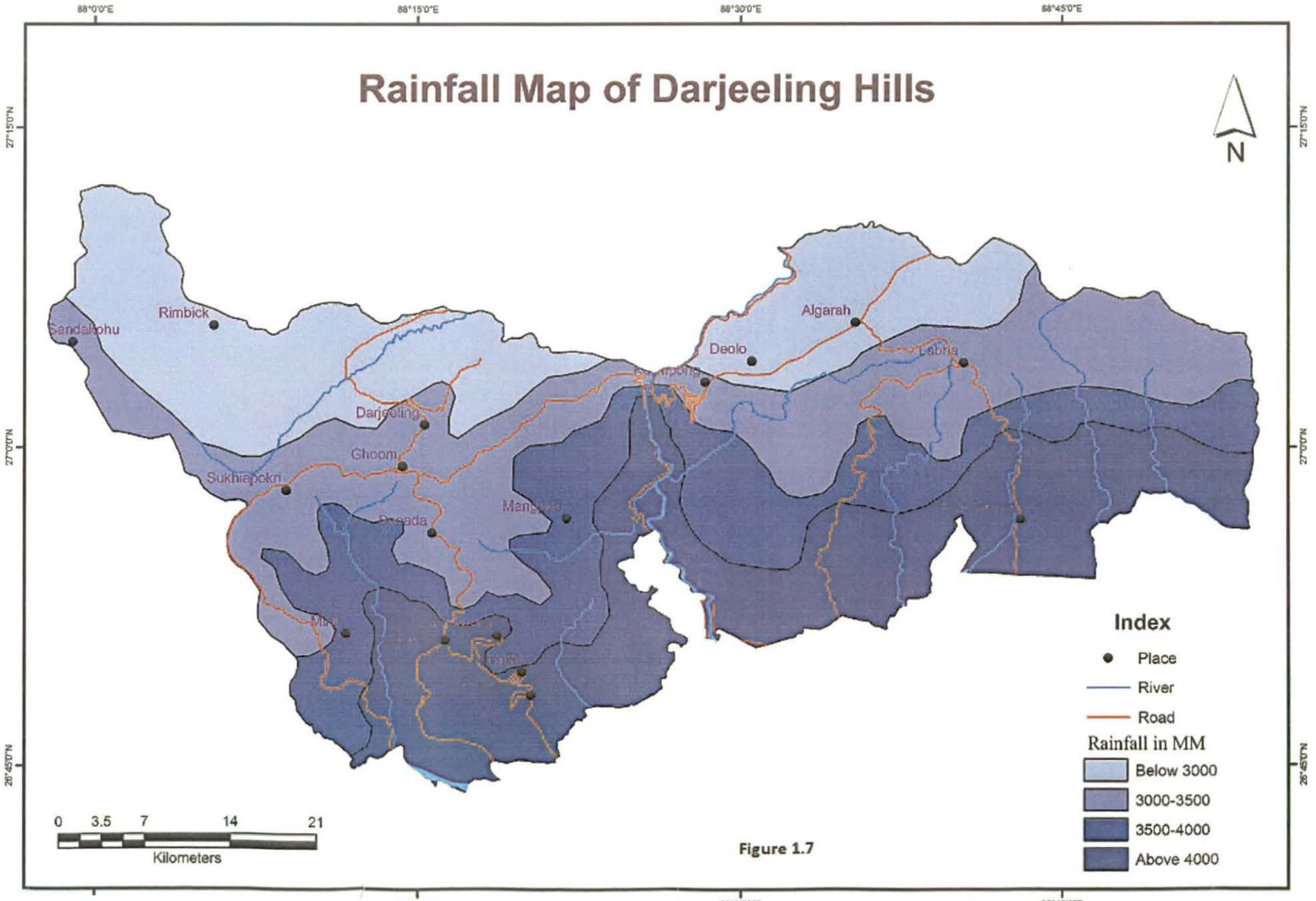

Rainfall Map of Darjeeling Hills
88°0'0"E
88°15'0"E
88°30'0"E
88°45'0"E
27°15'0"N
27°0'0"N
26°45'0"N
N
Rimbick
Sandakphu
Algarah
Deolo
Labha
Darjeeling
Ghoom
Sukhiapokri
Mangpoo
Mirik
Index
Place
River
Road
Rainfall in MM
Below 3000
3000-3500
3500-4000
Above 4000
0 3.5 7 14 21
Kilometers

Figure 1.7

Table 1.2Average rainfall and temperature characteristics of the Darjeeling Himalaya

Months	Darjeeling		Kalimpong		Kurseong	
	Rainfall in mm	Temperature in °C	Rainfall in mm	Temperature in °C	Rainfall in mm	Temperature in °C
January	13.89	8.12	10.16	17.39	17.03	11.97
February	20.16	12.28	20.34	19.67	21.25	15.98
March	47.97	15.55	46.34	23.46	72.17	19.51
April	132.89	18.67	129.82	26.32	181.36	22.5
May	371.67	19.79	248.98	27.77	428.33	23.78
June	631.45	20.85	598.44	28.62	724.95	24.74
July	867.59	21.72	865.26	29.41	896.43	25.57
August	659.89	21.98	634.66	29.82	698.28	25.9
September	556.24	19.99	487.21	27.44	611.73	23.72
October	167.39	18.37	145.99	26.69	176.69	22.53
November	36.96	15.69	38.98	23.03	42.97	19.36
December	10.88	11.98	11.46	19.21	12.67	15.6
Total/average	*3517*	*17.1*	*3238*	*24.9*	*3884*	*20.9*

Source: Tea Planters' Association, Darjeeling, 2009, SDO Office, Kalimpong.

Darjeeling hill experiences sub-tropical to temperate climate and has five distinct seasons: spring, summer, autumn, winter and the monsoons. Summer (May-June) are mild with maximum temperature barely crossing 25°C; the monsoon (July-September) is characterised by cloudiness with frequent torrential rains; winter (December-February) is cold to very cold and unpleasant with temperature falling as low as -5.0°C which is followed by dry and bright sunny spring (March-April). Autumn (October-November) is pleasant in Darjeeling hills as the mean temperature varies between 17.03°C in Darjeeling and 24.8°C in Kalimpong. Darjeeling is often shrouded in mist and fog. High altitude area of Darjeeling hills also experiences occasional snowfall especially in the Singalila, Goom-Simana, Tiger hill-Birch hill-Bagora area.

1.4 Drainage

The Darjeeling hill is endowed with intricate river systems originating from the Himalayas draining across the Himalayas (figure 1.8). The proportion of river length and catchment area between zone of erosion and deposition in various types differ considerably. The drainage system consists part of two major drainage systems namely the Brahmaputra and the Ganga system the two most important drainage basins of the country. The Brahmaputra system is represented in the area by its two major sub-basins i.e., the Tista and

Jaldhaka sub-system and the Ganga system is represented by the Mahananda sub-system. The drainage system of Darjeeling hill area is shown in figure 1.6 and tabulated in table 1.3.

Table 1.3 Rivers and tributaries in Darjeeling hill area

Watershed	Area in Darjeeling	Sub-watershed	Rivers & major tributaries	Length in Darjeeling (km)	Gradient in m/km
Brahmaputra	*1785.1km²*	Tista	Tista	37.00	4.21
			Lish	12.10	136.78
			Gish	30.20	61.23
			Chel	10.46	206.40
			Great Rangit	18.57	5.06
			Little Rangit	23.77	100.42
			Rammam	39.78	77.17
			Neora	27.46	86.23
			Relli	30.64	67.89
			Reyong	18.70	116.09
			Ragnu	16.27	136.01
			Rangpoo Chu	9.66	239.85
			Rishi Chu	17.36	110.25
		Jaldhaka	Jaldhaka	19.47	18.69
			Nichu	14.90	150.67
			Murti	13.82	140.45
			Ruka Chu	8.54	225.99
			Ma Chu	8.79	134.58
Ganga	*494.7 km²*	Mahananda	Mahananda	13.8	136.81
			Balason	33.09	60.53
			Mechi	16.16	99.19

1.4.1 The rivers of Brahmaputra system

The mighty Brahmaputra known as the Tsanpo in Tibet, emanating from the Himalayas near Mansarovar Lake flows through Tibet in an easterly direction. Among the major rivers draining Darjeeling hills, the Tista and Jaldhaka are important.

1.4.1.1 The Tista system

The river Tista, the biggest river in North Bengal originates from the Tista Source Glacier (*Tista Kanyse*) or Pauhurni Glacier near Khangehung Lake (latitude 29° 59' N and longitude 38° 48' E) in North Sikkim at an altitude of 6200 meter. It meets the Brahmaputra (Jamuna) at Kamarganj in Bangladesh at an elevation of 23 meter. The Tista river system, flanked by the Mahananda and the Jaldhaka on either side present a spectacular convergent and divergent drainage pattern. The convergent pattern terminates around 90 meter contour

lines, subsequently to which the character assumed to be one of divergent one fromwhere the rivers are spreading out. While, the 300 meter contour line is curving upward indicating convergence of drainage, the 66 meter line in the extreme south is systematically curved downward indicating large scale fanning out or, divergence of the channels (Mukhopadhyay S.C, 1982).

The combined flow of the Lachung and Lachen, after emerging from Chungthang forming this mightyTista receives a tributary Talung from the north-west, which joins it near Mangan. Below the confluence with the Rangpo River, the Tista river flow is further augmented by inflow through the Rangit from the western direction. The great Rangit is principally the combined flow of three streams, Rangit, Ramam and Chotto Rangit flowing from the north-west, west and south-west respectively. The outfall of the great Rangit into the Tista is near Melli Bazar. In the next, reach below Melli Bazar, the Tista, before it emerges into the sub-Himalayan plains of North Bengal, is joined by two small streams, Rangli and Ranghot from the west and east respectively.

The Tista after flowing for about 25 km passes through Sevoke before it debauches into the plains of North Bengal. In the sub-Himalayan plains it is again joined by a number of tributaries viz. Lish, Ghish, Chel, Neora from the north-eastern end (WAPCOS, 2003). The following are the major tributaries of the Tista in Darjeeling hills.

1.4.1.1.1 River Lish

The Lish Khola has its origin in the Pabringtar Khas Mahal Block and Turung khola has its origin in the Samther Forest which has the highest altitude ranging to 2000m. After the merging of the Lish khola and Turung khola the river flows southwards and meets Nabgang khola on the eastern side and further down Phan khola on the western side. The river then flows into Jalpaiguri district and after another 10 kms meets the Tista near Kalagaity Tea Estate. River Lish has 20 km length and drains a total catchment area of 64 sq.km out of which 48 sq.km is situated in Darjeeling hills. The width of the river in the gorges varies from 60 to 120 m. The bed slope of the river is 24m/km in the hilly region.

1.4.1.1.2 River Gish

The Gitkhola rises from the Lava forest and flows between Gitbeyong on the right and Pankhasari, Samabeyong khasmahal on the left. River Gish receives small streams on its right bank, namely the Reangkhola, Nakhikhola, Desikhola and Chamukhola. Another river

Lethi originating in the forest, south of Pagrambong khasmahal meets the Gish in Jalpaiguri district. The river Gish falls into Tista in Jalpaiguri district. The river runs through deep gorges in the hilly region. The catchment area of the river is 160sq.km and its length is 35km. The bed slope is 22 m/km (Basu S.R. & Ghatowar L., 1986).

1.4.1.1.3 River Chel

The River Chel, a mountain torrent is formed by the amalgamation of two kholas i.e., Chel and Kali khola. The Chel khola originates in the Pankhasari forest. While, the Kali Khala rising from the ridge cutting the Gish and Chel catchments on the western part of the Pankhasari khasmahal flows in between Nim and Pankhasari khasmahal and meets the Chel khola near Ambiok. Ambiok khola, Dalim khola, Sukha khola etc. are the small tributaries of the Chel. South of Mal khasmahal in the Jalpaiguri district it meets Neora and takes the name of Dharala which ultimately falls into Tista above Domohani. The Chel flows for a length of 54 km. The catchment area is 390 sq. km. The longitude slope of the river is 52 m/km.

1.4.1.1.4 River Neora

The river Neora originates from Rechilla Chawk of the Neora National Park in Darjeeling district. The river is joined by Thosum Chhu and flows through the National Park and is augmented by several streams before it finally meets the Santhoke khola and Argara khola on the left. The river enters the Jalpaiguri district and meets Chel further down and then with the Dharala falls into Tista above Domohani. The length of the river is 58km and catchment area 275 sq.km. The valley is mainly on steep hill sides having slopes of 40°to 60°.

1.4.1.1.5 River Relli

The Relli originates in Khempong forest below Lava-Algarah and runs along the southern boundary of Saihur Reserve Forest after where it is joined by the Pala and Lolley khola and southwards it joins the Rani khola.

1.4.1.1.6 River Great Rangit

The river Great Rangit originates from the Pathong glacier of Kabru range, and proceeds southwards till it meets Rammam river coming down from its source near Phalut in Singalia range. It enters the district of Darjeeling at the point on the northern boundary where it receives the Rammam river arising from Singalila and Rangu arising from Senchal in Darjeeling on its right bank. The combined waters after traversing a short distance

receives another tributary the Little Rangit originating from the base of the Tonglu spur in Singalia range and finally meets the mighty river Tista near Tisa bazar.

1.4.1.1.7 River Rammam

The river Rammam demarcates the northern boundary between Sikkim and Darjeeling district. The Rammam originates at an altitude of 3600m at Phalut in the Singalila range. The entire course of the river is interspersed with deep gorges. A very prominent gorge is found at the confluence of the Rammam with its main tributary; the Lodhoma Khola.

1.4.1.1.8 River Little Rangit

The Little Rangit arises at Chitre Pokhri (2380m) and flows north, almost parallel to the Lodhoma Khola. The Little Rangit winds sinuously within a maze of interlocking spurs and valleys. Below the Triveni confluence, the Teesta flows eastwards, where it receives the Little Rangit from Darjeeling where it enters the plains of North Bengal and finally joins the river Brahmaputra in Bangladesh.

1.4.1.1.9 RiverReyang

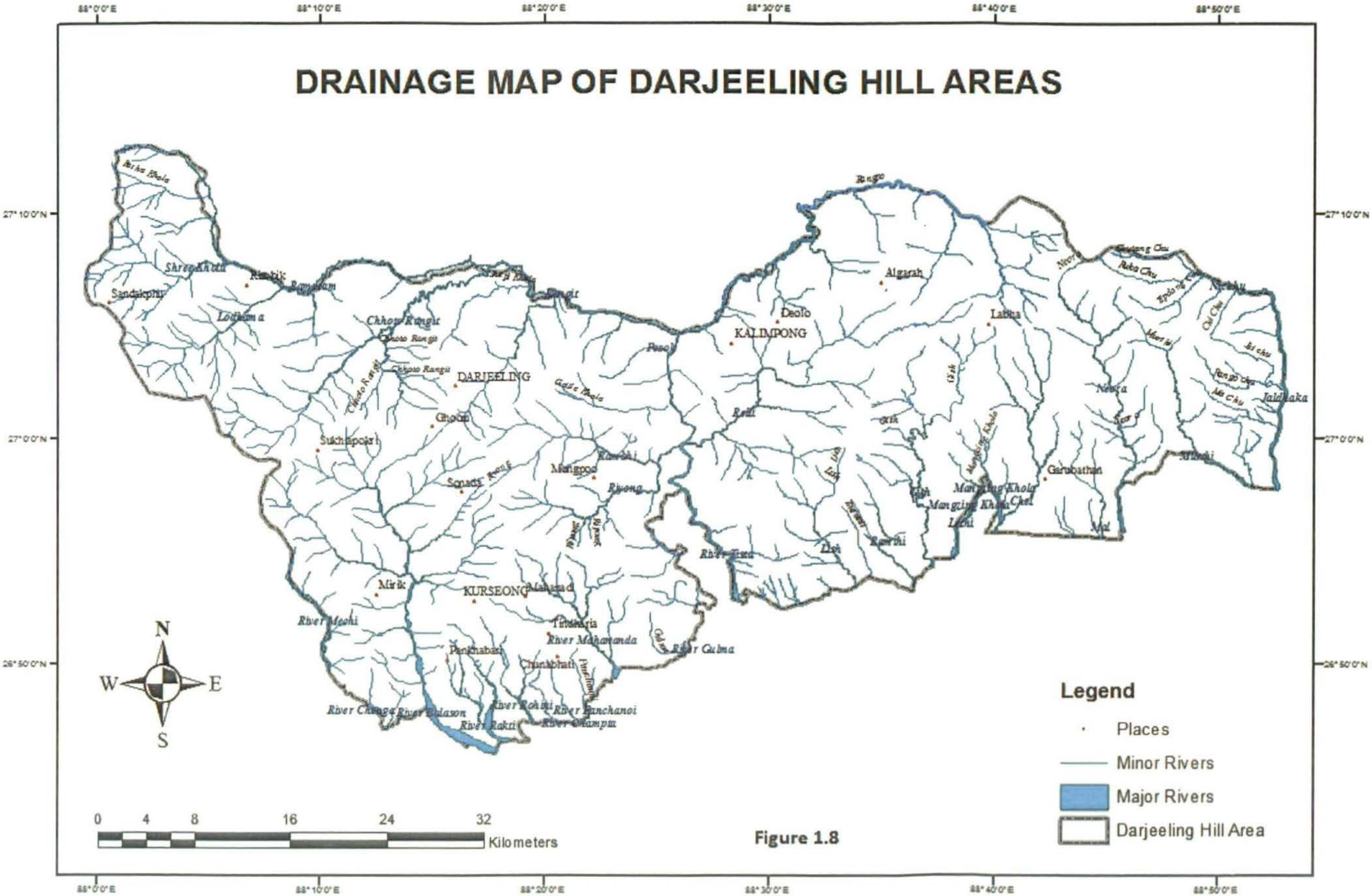
River Reyang originates from the Mahaldiram forest (2438m) and joins the river Tista on its right bank near Rambhi. Rambhi khola is the most important tributary to the river Reyong.

1.4.1.1.10 RiverRangnu

River Rangnu originates from the Senchal forest, flows north wards and empties itself into the right bank of the Great Rangit. It is a mountain torrent which comes tearing down from the Senchal, several thousand feet above its junction with Rangit and though its roar is heard and its course is visible throughout its length.

1.4.1.2 The Jaldhaka system

The river Jaldhaka locally known as Dichu in Bhutan originates from Bidang lake in Sikkim at an altitude of 4250 m to 4550 m. It flows southwards for a length of about 24 km in a straight, steep gradient through mountainous tract up to an elevation of 844 m. At this point, an important tributary Assom khola joins the river Jaldhaka or Dichu on its left bank. Further below, the river meets the river Nichu, a tributary from the right. The river Nichu forms the boundary line between Bhutan and India in this reach.


DRAINAGE MAP OF DARJEELING HILL AREAS
88°0'0"E
88°10'0"E
88°20'0"E
88°30'0"E
88°40'0"E
88°50'0"E
27°10'0"N
27°0'0"N
26°50'0"N
Sandakphu
Rimbik
Shree Khola
Chhoto Rangit
DARJEELING
Ghoom
Sukhiapokri
Sonada
Mangpoo
Mirik
KURSEONG
Tindharia
Panchabari
Chunabhati
KALIMPONG
Deolo
Algarah
Labha
Garubathan
Jaldhaka
River Mechi
River Mahananda
River Gulma
River Tista
River Chenga
River Balason
River Rakti
River Rohini
River Panchanoi
River Champta
N
S
E
W
Legend
Places
Minor Rivers
Major Rivers
Darjeeling Hill Area
0
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8
16
24
32
Kilometers

Figure 1.8

The river Jaldhaka then receives an important tributary Bindu khola from left. From the confluence of Nichu and Jaldhaka, Jaldhaka forms the boundary between Darjeeling hills and Bhutan. From the confluence of Bindu khola, the river flows almost southwardly with few minor bends. The river enters the Indian territory at the confluence of river Jiti which meets the Jaldhaka from the left. No important and major tributary except Jhalong khola joins the river Jaldhaka in the reach between Bindu khola and Jiti. Below the confluence of Jiti, the river Jaldhaka bifurcatesinto two channels and enter Jalpaiguri district.

1.4.1.2.1 River Murti

Murti originates in the Mo block south of Thosum hills flowing through the reserve forest and emerging in the Samsing area and eventually joining the Jaldhaka River.

1.4.2 The rivers of Ganga system

Only 21.7% of the total area under Darjeeling hills is being drained by the rivers belonging to the Ganga system. The river Mahananda, Balason and Mechi along with their tributaries drains the study area.

1.4.2.1 The river Mahananda

The river Mahananda is a major northern tributary of the Ganga system. It is bounded on the north by the Himalayas, the ridges separating it from the Tista river system in the east, the Ganga on the south and the Koshi river system in the west. The Mahananda originates from the Mahalidram hills of the Darjeeling Himalaya near Chimali at an altitude of 2060 meter, 6.4 km northeast of Kurseong town of Darjeeling hill. It is also known as Mahanadi river in the hill. The river flows in a southeast direction receiving a few sizable right side tributaries among which the Siva khola is the most important one. Its left bank tributaries include the Jholi khola, the Jogi khola, Gulma khola, Babu khola and Ghoramara khola. After flowing for 20 km in the hills of Darjeeling, the river enters plains near Siliguri and flows in a southwesterly direction till it is joined by the Balason river on its right bank about 4.0 km downstream of Siliguri. It forms more or less the border between India and Bangladesh between Phansidewa and Tetulia. The river Mahananda is the longest river in North Bengal.

1.4.2.2 The river Balason

The Balason, which arises from Lepchajagat in the Ghum saddle, flows towards the south, scooping out deep gorges in the catchment area, till it reaches the plains and thereby

turns southeast, where its valley is larger than that of the Mahanadi. It receives tributaries like Pulungdung khola, Rangbang khola, the Marma khola, Dudhia khola on the right bank and Rinchingtong khola, Rakti khola, Rohini khola, Jor khola on the left.

1.4.2.3 The river Mechi

The river Mechi, which is the western boundary of the Darjeeling hills also forms the Indo-Nepal boundary. The source of the river is the Rangbang spur of the Singalila range at an altitude of 1905m. It flows through deep gorges in the hilly tracts and widens suddenly when it enters the Terai and the plains. The Mechi eventually joins the Mahananda.

Along with these, numerous small springs occur which meet to form small rivulets at the bottom of valleys. The rivers of the study area drain ultimately into the south .The relief of valley floors and river channels exhibit the youthful stage of evolution characterized by steep ungraded channels, narrow floors and steep valley sides. A number of tributaries of these rivers, along with many jhoras, form a complicated pattern of drainage over the myriad of interlocking spurs and ridges, essentially displaying a dendritic pattern.

1.5 Soil

The soil of upland is usually red and gritty while that of the plains are dark and more fertile. Along the banks of the Tista, silty or silty loam predominates. Red and yellow soils have developed on the gneisses and schists in the higher slopes of the Darjeeling Himalaya. The greater portion of the hill area lies on the Darjeeling gneiss, which most commonly decomposes into a stiff reddish loam but may also produce almost pure sand or stiff red clay. The colour of the red soil, derived as it is by meteoric weathering from gneisses and schists is due to wide diffusion rather than to high proportion of iron content. This type of soil is mainly siliceous and aluminous with free quartz as sand. It is usually poor in lime, magnesia, iron oxide, phosphorus and nitrogen, but fairly rich in potash, some areas being quite rich in potassium derived from the muscovite and feldspar of the gneiss. River alluvium is found in the southernmost part of the district.

The podzolic soils in the hilly area are suitable for cultivation of tea. Parent material variations exert a stronger influence on soil characteristics of Darjeeling Himalayas than climate or vegetation. Very broadly the soil on Siwaliks is pale yellow and coarse in texture, on the Dalings dark gray and porous; on the gneisses a brown clay, sometimes plastic, shallow and sticky. The soil on the Gondwana is generally sandy. Almost everywhere the soil

is residual i.e., derived by the weathering of the underlying rocks. Weathering is selective in Darjeeling gneiss and proceeds along some susceptible bands, i.e., mica rich bands in preference to quartzose bands also along joint and shear planes. As a result blocks of fresh rocks are generally found encircled on all sides by highly weathered rocks of the nature of clay. The impervious clay is found mixed with grains of quartz, feldspar and flakes of mica. This has got an important bearing on the massive landslips.

The NBSSLUP (National Bureau of Soil Survey and Land Use Planning) of the Indian Council of Agricultural Research prepared a map of the soils of West Bengal including the hill zone in a 1:500,000 scale. The relevant portion of the map is presented in (figure 1.9). According to the records, there are five types of soil in the hill areas of Darjeeling, the dominating one is coarse-loamy (Typic Udorthents) followed by loamy skeletal (Typic Haplumbrepts). They recorded the nature of the soil of this eco-region as heterogeneous. The soils developed on steep hill slopes are shallow to very shallow, excessively drained with severe to very severe erosion hazard (table 1.4). The texture varies from gravelly loam to loam. The content of gravel exceeds 89% and organic carbon content ranges from 2% to 7% in the surface soil while pH is 5. The particle size class qualifies these soil families as loamy skeletal. These soils are classified as Lithic and Typic Udorthents. The soils developed on side hill slopes are moderately deep to deep, well drained, loamy in texture with severe to moderate erosion hazards. They show some degree of profile development and are classified as Umbric and Typic Distrochrepts, Lithic Udorthents and Lithic and/or Typic Haplumbrepts. These soils are strongly to moderately acidic in nature, are rich in organic carbon and have moderate to low base saturation.

Table 1.4 Taxonomic soil associations in Darjeeling Himalaya

Sl. No	Soil Types (Taxonomic)	Area in %
1	Loamy Skeletal, Lithic, Udorthents associated with occasional rocky outcrops	9.65
2	Coarse loamy, Typic, Udorthents Associated with loamy skeletal, Typic Dystrochepts	35.94
3	Loamy skeletal, typic Haplumbrepts associated with loamy skeletal, typic Udorthents	1.39
4	Coarse loamy, typic Udorthents associated with fine loamy Fluventic Dystrochepts	53.02

Source: NBSSLUP, Govt. of India

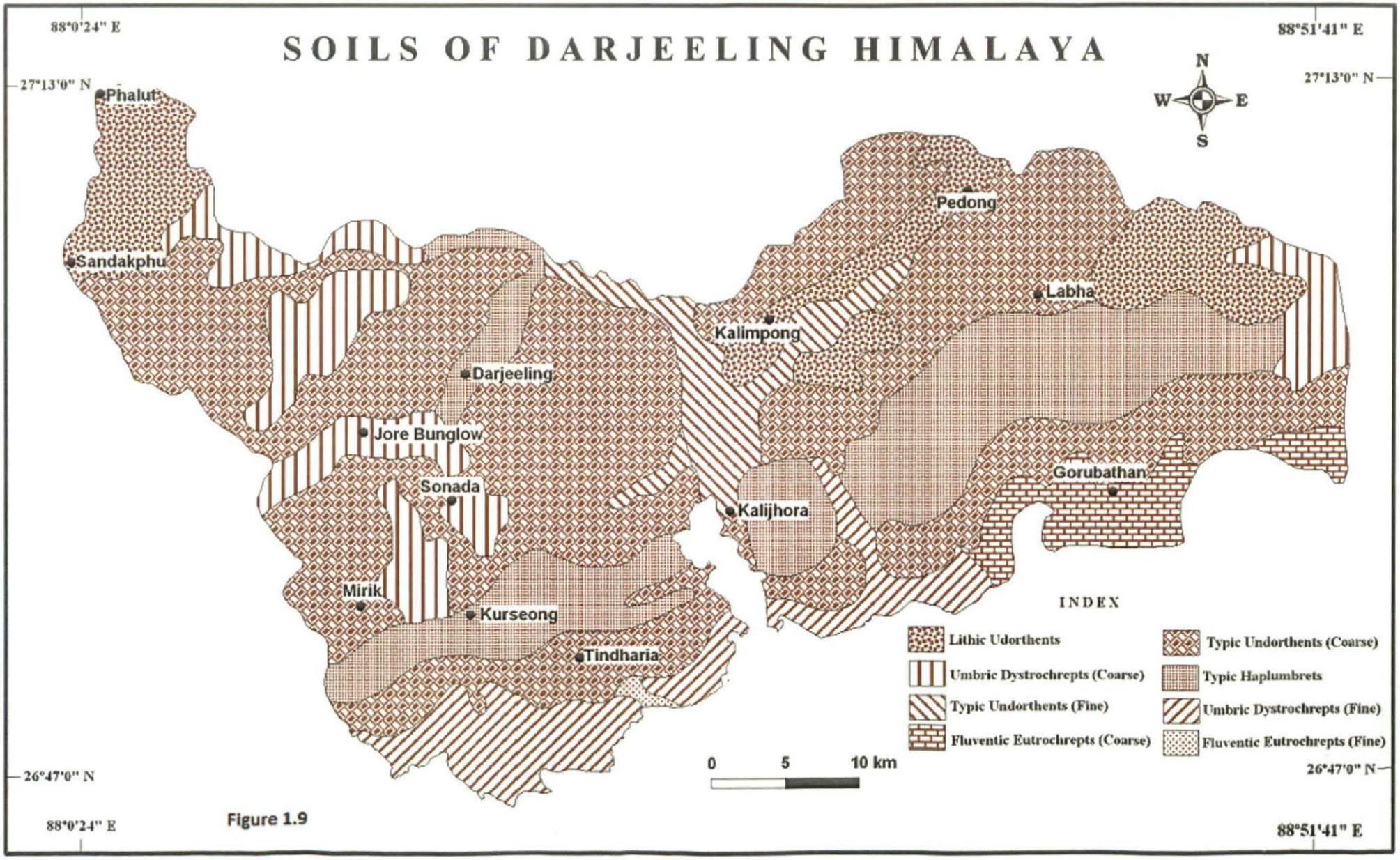
SOILS OF DARJEELING HIMALAYA
88°0'24" E
88°51'41" E
27°13'0" N
26°47'0" N
N
W
E
S
Phalut
Sandakphu
Pedong
Labha
Kalimpong
Darjeeling
Jore Bunglow
Sonada
Gorubathan
Kalijhora
Mirik
Kurseong
Tindharia
INDEX
Lithic Udorthents
Umbric Dystrochrepts (Coarse)
Typic Undorthents (Fine)
Fluventic Eutrochrepts (Coarse)
Typic Undorthents (Coarse)
Typic Haplumbrets
Umbric Dystrochrepts (Fine)
Fluventic Eutrochrepts (Fine)
0
5
10 km

Figure 1.9

All the soils are acidic in nature with the tendency to increase slightly with increasing depth in most cases, indicating the lack of bases from surface and accumulation in the lower horizon. The chemical content of the soil developed over Darjeeling gneiss is characterized by a high proportion of potassium derived from feldspar and muscovite mica. This soil is poor in lime, magnesium, iron oxides, phosphorous and nitrogen. The pH of the soil shows that it is acidic and in few places the pH value recorded even below 5. Organic matter content estimated in the soils varies and fluctuates in between 2 to 5 %. Available nitrogen is deficient in these soils and most soils contain average values of phosphorous and potassium.

However, in vast tract of forest area of Darjeeling hills show a different soil environment conditions. Table 1.5 depicts the major characteristics of soils recorded at different segments of forest covered area in the Darjeeling Himalaya.

Table 1.5 Characteristics of soils in forest areas of Darjeeling hills

Location	Altitude (meter)	Aspect	Drainage condition	Types of vegetation	pH	% of Organic matter in A0 horizon	% of Nitrogen in A0 horizon
Mahananda block Kurseong Range	1807	W	Well-drained	Virgin forest	7.2	22.32	1.14
Mana Block, Kurseong Range	1506	SE	Well-drained	Virgin forest	6.5	19.23	0.97
Mana Block, Sevok Range	1506	SE	Well-drained	Plantation (1919)	6.5	19.48	0.76
Mana Block, Kurseong Range	1204	WNW	Well-drained	Virgin forest	6.5	18.76	0.77
Latpanchar Block Sevoke Range	903	NW	Well-drained	Virgin forest	6.0	24.90	1.05
Berrick Block, Sevoke Range	602	SW	Well-drained	Virgin forest	6.5	10.29	0.35
Kundong Block, Sevoke Range	301	E	Well-drained	Virgin forest	6.5	7.05	0.31
Chamta Block , Sukna Range	151	N	Not well drained	Virgin forest	7.2	7.57	0.36
Kynanuka Block, Sukna Range	151	E	Well drained	Plantation (1940)	6.5	8.04	0.0028

Source: Directorate of Forest, Govt. of West Bengal

1.6 Natural Vegetation

Darjeeling Himalaya is one of the richest regions in the world and is literally considered a *botanist's paradise* and has thus, attracted a large number of plant hunters and botanists during the last three centuries (Don 1821, Das 1995). Phytogeographically, it forms a meeting ground of the Indo-Chinese and Indo-Malaysian tropical lowland flora, the Sino-Himalayan east Asiatic flora and the Western Himalayan flora comprising about 9000 species with a high percentage of endemic plants (Chatterjee 1940, Puri *et al* 1983, Myers 1988, Wilson 1992, Das 1995, Bhujel 1996). This province along with Khasi-Manipur has the richest flora of the Indian subcontinent with the exception of Myanmar (Rao and Murti 1990). A comprehensive travelogue through the dense and magnificent forest and vegetation of this region is rather difficult to conceive due to the nature of Himalayan terrain and intricacy of the plant cover comparable to almost that of the tropical rainforest in some of the river valleys (Bhattacharya 1997).

Although, the Darjeeling hills forms a very small part of this belt covering an area of only 2355 sq. km of a total area of 1,22,802 sq km (Negi, 1990) it shows a remarkable richness and variety in its flora as none other than Sir Joseph Dalton Hooker introduced the beauty and the floristic richness of this region to the outside world for the first time. The occurrences of a variety of physiographic, climatic and edaphic conditions often aided by biotic factors are responsible for such richness and variety. The configuration of the hills and mountains, pattern of rainfall distribution over the lower, middle and upper elevation ranges and high humidity have a great role in the determination of the type of vegetation of the area (figure 1.8). The evenly distributed, highly humid climate is conducive to tree growth and as such the timber line or the upper vegetation in this sector goes up to 4750 m above m.s.l. (Sahni, 1981).

The altitude of the various hill ranges varies markedly and usually there is a distinct correlation between the altitude and vegetation. Thus, altitude is one major factor that determines the range of distribution of different plant species and the associations that they form at different elevation ranges.

Various workers have put forth the classification of the vegetation of this region and it includes workers like Gamble (1875), Hooker (1906), Cowan (1929), Champion (1936), and Kanai (1967), Rao (1974), Sahni (1982), Jain (1982), Bhujel (1996). These authors have essentially classified the 'flora and vegetation' according to altitudinal ranges, although they

differ considerably in detail. Five major types of vegetation which are further subdivided to sub- types can be recognized:

1.6.1 The tropical vegetation

High temperature and heavy rainfall characterize this zone resulting in the propagation of dense vegetation. The tropical vegetation is characterized by the presence of deciduous forests with *Shorea robusta* as a dominant species. Bhujel (1996) further divided it into following four sub types.

1.6.1.1 The riverain forests

It can be observed in small patches along the riverbeds of Tista, Rangit, Balason, Mahanadi, Relli, Chel, Lish, Gish, Jaldhaka, Sevok and Mechi. The forests remain dominated and perennial plants being dominated by shrubs and climbers. The common tree species found in this region include, *Meliosma pinnata, Albizia procera, Albizia lebbeck, Acacia lenticularis, Alstonia scholaris, Lagerostroemia parviflora*with *Acacia catechu* and *Dalbergia sissoo* occurring as distinct patches in planted forests. *Saccharum spontaneum,Mikania micrantha, Clerodendrum japonicum, C. infortunatum, Buddleja asiatica, Oroxylum indicum, Globba macroclada*, cover the forest floor.

1.6.1.2 Sal(Shorea robusta) forest

Shorea robusta is the conspicuous species growing in lower terai sal belt, ridges, spurs and well-drained loamy plains. The main associates of sal in this region include *Terminalia alata, Aglaia lawii, Duabanga grandiflora, Eugenia kurzii, Dillenia pentagynai, Chukrasia tabularis, Meliosma pinnata, Lagerstroemia parviflora, Tetrameles nudiflora, Stereospermum chelonoides, Anthocephalus chinensis* along with *Pavetta indica, Clerodendrum japonicum, Phlogacanthus thyrsiflorus, Barleria cristata, Pinus roxburghii* a normal inhabitant of the temperate to subtropical region can be also be seen associated with species like *Shorea robusta, Ficus oligodon, Pheonix humilis* in some drier valleys. Remnants of the once magnificent sal forests which has given way to the need of agricultural land can be seen along the banks of the River Rangit.

1.6.1.3 The dry mixed forest

This forest is represented by the presence of *Gmelia arborea, Tetrameles nudiflora, Beilschmiedia dalzellii, Erythrina stricta, Bombax ceiba, Alstonia nerifolia, Merremia*

emarginata, M. hederacea, Artocarpus lacucha,Eugenia kurzii etc.

1.6.1.4 Wet mixed forest

Semi-evergreen trees along with a very large number of shrubs, climbers and herbs dominate the Wet Mixed forest. This zone is rich in epiphytes and stem-parasites giving it a distinct characteristic. The major tree species of this sub zone include *Terminalia myriocarpa, Michelia champaca, Sygzygium formosa, Cinnamomum glaucescens, Litsea monopetala, Beilschmiedia roxburghiana, Pterospermum acerifolium.* Climbers include *Beaumontia grandiflora, Bauhinia vahlii, Entada pursaetha,sinohimalensis, Cryptolepis buchananii, Mikania micrantha, Ipomea quamoclit, Boerhavia diffusa, Argyeria roxburghii,* with the lower strata and ground vegetation including *Ageratum conyzoides,Blumea balsamifera, Sonchus asper, Sauropus pubescens* etc.

1.6.2 ***Sub-tropical forests***

The vegetation of this region is affected by a seasonal climate of dry winter and a wet monsoon and thus consists largely of tropical genera and species (Grierson and Long, 1983). The mixed forest is mostly deciduous in nature. Several species tend into this zone from the tropical and plains zone. *Castanopsis indica, Schima wallichii, Gmelia arborea, Adina cordifolia, Duabanga grandiflora, Gynocardia odorata, Bischofia javanica, Callicarpa arborea, Alangium chinensis, Terminalia alata, T. bellirica, Sygzygium ramosissmum,* constitute the dominant trees in this region. In addition *Castanopsis tribuloides, Cinnamomum bejolghota, Magnifera sylvatica, Phoebe lanceolata, Litsea cubeba, Fraxinus floribunda, Helicia nilagirica, Phyllanthus emblica, Mallotus philippensis,Engelhardtia spicata* can be seen in some places. The undergrowths include *Mussaenda roxburghii, Dendrocalamus hamiltonii, Osbeckia nepalensis,Osbeckia stellata, Buddleja asiatica, Embelia floribunda, Croton caudatus, Thysanolaena maxima, Imperata cylindrica, Holmskioldia sanguinea, Woodfordia fruticosa,Boehmeria glomerulifera.* This forest is characterised presence of a good number of climbers such as *Bauhinia vahlii, Tinospora cordifolia, Cissampelos pareira,Mucuna pruriens,Thunbergia fragrans, Vitex negundo.*The common herbs include *Commelina benghalensis,Cyanodon dactylon, Pileahookeriana, P. smilacifolia, Elatostema lineolatum, Ageratum conyzoides, Oxalis corniculala, Urena lobata,Triumfetta rhomboidea.* Exotic weeds like *Euptorium odoratum* and *Mikania micrantha* grow profusely in the disturbed forests, while thickets of the tree fern *Cyathea brunoniana* is found in moist shady places.

1.6.3 Temperate vegetation

The temperate vegetation comprise of dense forest that includes areas extending from Kurseong, Toong, Sonada, Darjeeling, Mirik, Sukhia Pokhri, Maneybhangyang, Rimbick, Lodhama, Kalimpong, Lava, etc. in the Darjeeling Himalaya. The temperate forest occupies most of the region of the Darjeeling Himalaya. The richness of the vegetation is displayed by the presence of the largest number of species and the widest diversity occurring in this region. J. D. Hooker (1907) remarked that the temperate vegetation of this region is roughly divisible into lower non-coniferous and upper coniferous and *Rhododendron* belt, but the line of demarcation between these varies so greatly with the exposure and humidity of the locality that they cannot be dealt apart. Kanai (1966) and Grierson and Long (1983) classified the temperate forest of the region into three subtypes.

1.6.3.1 Temperate Deciduous forest

This forest type is characterized by the presence of trees like *Betula alnoides, Exbucklandia populnea, Eleocarpus lanceifolius, E. sikkimensis, Acer campbellii, A. sikkimensis, Engelhardtia spicata, Lindera neesiana,L. pulcherrima, Prunus napaulensis, Alnus nepalensis, Rhododendron grande,Rhododendron arboreum, Eurya acuminata* etc.

1.6.3.2 Evergreen Oak forest

This forest comprises of trees like *Quercus lamellose, Q. lineata, Q. oxydon, Lithocarpus pachyphylla, L. elegans, Cinnamomum impressinervium, Eriobotrya petiolata, Eurya acuminata, Pentapanax fragrans, Litsea elongata, Litsea sericea, Juglans regia, Leucosceptrum canum, Lithocarpus pachyphyllus, Poplus ciliata.* Shrubs like *Dichroa fabrifuga, Viburnum erubescence, Jasminum dispermum, Nellia thyrsiflora, Arundinaria maling, Hypericum hookeriana, Norysca urala, Notochaete haemosa* with climbers like *Dicentra scandens, Edgaria darjeelingensis, Holboellia latifolia, Sechium edule, Smilax ferox, Codonopsis affinis, Streptolirion voluble, Rubia manjith* etc. and herbs like *Achyranthes bidentata, Anaphalis contorta, A. triplinervis, Artemesia japonica, Bidens pilosa, Potentila fulgens, Plantago erosa, Rumex nepalensis, Clinopodium umbrosa, Gallium asperifolium., Swertia chirayita, S. bimaculata,Impatiens arguta,Lysimachia alternifolia,Poulzolzia hirta, Hypoestes triflora, Hemiphragma heterophylla, Erigeron karwinskianus, Fragaria nubicola,* forming the ground cover.

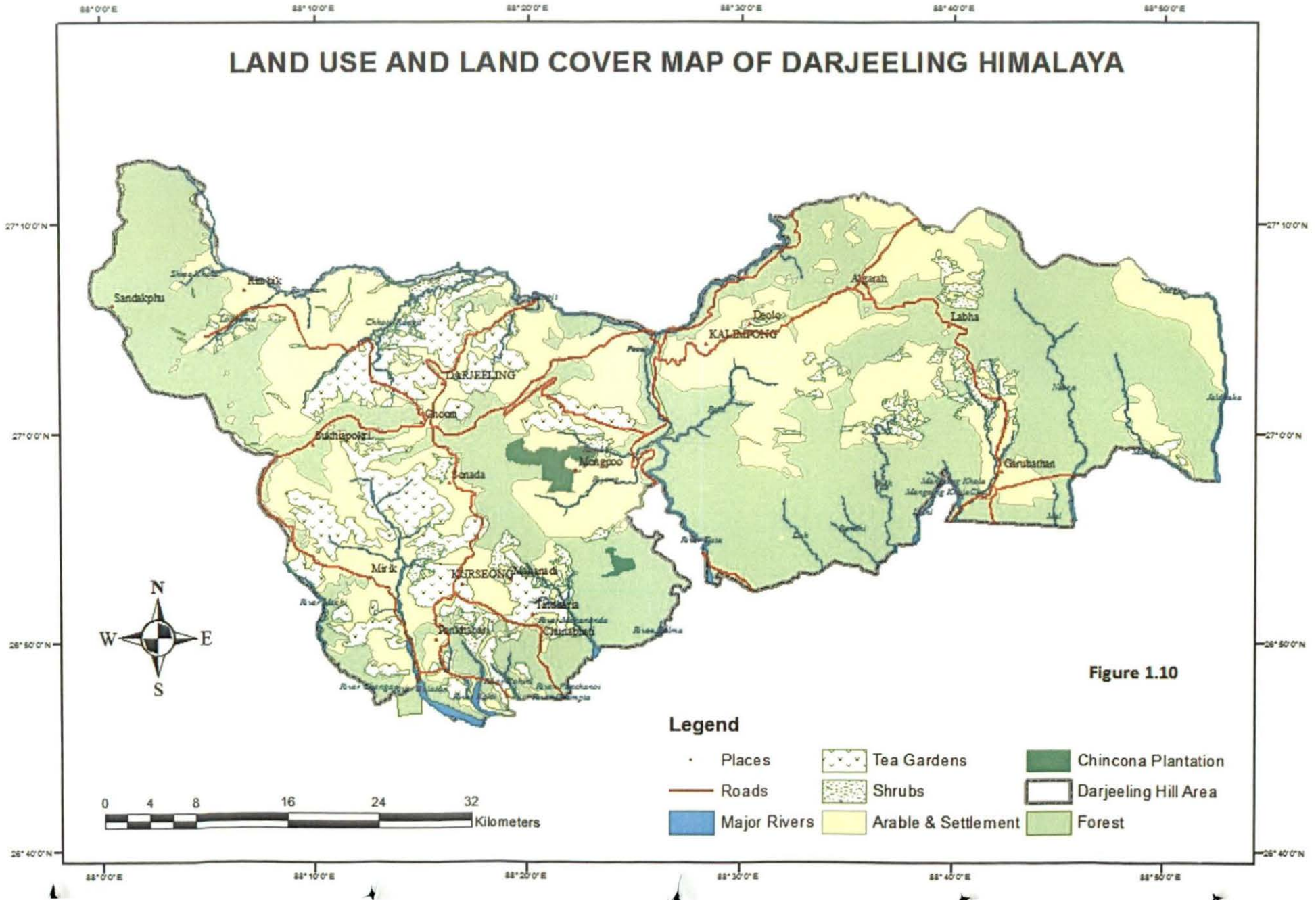
LAND USE AND LAND COVER MAP OF DARJEELING HIMALAYA
88° 0'0"E
88° 10'0"E
88° 20'0"E
88° 30'0"E
88° 40'0"E
88° 50'0"E
27° 10'0"N
27° 0'0"N
26° 50'0"N
26° 40'0"N
Sandakphu
Rimbik
DARJEELING
Ghoom
Bijanbari
Mongpoo
Jorebungalow
Mirik
KURSEONG
Tindharia
Chimtabari
Pankhabari
KALIMPONG
Deolo
Algarah
Labha
Garubathan
N
W
E
S
0 4 8 16 24 32
Kilometers
Legend
Places
Roads
Major Rivers
Tea Gardens
Shrubs
Arable & Settlement
Chincona Plantation
Darjeeling Hill Area
Forest

Figure 1.10

1.6.4. Cold temperate vegetation

Regions lying above 2400m usually receive snowfall and remain covered from a few days to few months (usually 3 - 4 months) during the year. As such there is a decrease in the diversity of the aboreal flora. Numerous herbs, many of which are endemic to the region inhabit this region (Hara 1966; Bhujel 1996). The vegetation of this zone can be broadly classified as being of two types:

1.6.4.1 Mixed temperate forest of the upper hill region

The mixed temperate forest of the upper hill region extends to about 2800m and comprises of trees like *Brassaiopsis mitis* Clarke, *Quercus lamellosa, Magnolia campbellii, Lithocarpus pachyphylla, Sorbus rhamnoides, Ilex fragilis, Prunus undulata* with climbers *Dicentra paucinerva, Clematis buchaniana, Actinidia strigosa, Smilax glaucophylla, Schisandra grandiflora* and shrubs like *Piptanthus nepalensis, Elsholtzia fructioca, Daphne involucrata, Bistorta amplexicauli, Berberis insignis, Aconogonum campanulatum, Rosa serecia* etc. with herbs like *Arisaema speciosum,Fragaria nubicola, Ranunculus diffisus, Viola sikkimensis, Ajuga lobata, Paris polyphylla, Gentiana speciosa, Geranium donianum, Pilea anisophylla,* etc. *Arundinaria maling* is found to invade large open areas in the region.

1.6.4.2 Rhododendron – Hemlock forest

The uppermost tier of the temperate forest is clearly dominated by different species of *Rhododendron* with few patches of other trees. The commonly occurring trees of this sub-region include *Rhododendron arboreum, R. falconeri, R. hodgsonii, R. decipiens, Betula utilis, Abies densa,Tsuga dumosa,Taxus baccata, Acer pectinatum, A. stachyophyllum, Daphnephyllum himalense, Ilex insignis, Larix griffithiana, Picea spinulosa.* Shrubs include *Rosa sericia, Virburnum erubescence, Viburnum nervosum, Ribes* spp. *Mecanopsis napaulensis, Nellia rubiflora, Potentilla fructicosa, Berberis insignis, B. umbellate,Daphne bholua.* Climbers include *Actinidia strigosa, Holboellia latifolia, Aristolochia griffithii, Leptocodon gracilis* etc. and herbs include *Aconitum spicatum, Aconitum Bisma, Fritillaria cirrhosa, Hemiphragma heterophyllum, Valeriana wallichii,Primula capitata, P. denticulata, Gentiana capitata, G. bryoides, G. glabriuscula, Swertia dilatata, S. macrocsperma* etc.

1.6.5 Sub-alpine vegetation

Ranging between 3200m up to around 4000m lies in the sub alpine region. This

region has been categorised by some as alpine region (Biswas 1959, Mitra 1951) while as temperate region by others (Gamble 1875; Kanai 1966). A sharp reduction in the temperature to subzero level during winter with precipitation in form of snow and hail that melts during the summer characterizes the climate of this zone. The common plant species observed in this zone include *Acer acuminatum*, *Acer caudatum*, *Abies spectabilis*, *Cotoneaster frigidus*, *Salix sikkimensis*, *Salix flabellus*, *Sorbus microphylla*,*Viburnum nervosum*, *Rhododendron cinnabarium*, *R. campylocarpum*, *R. campanulatum*, *Juniperus squamata*, *J. communis*, *J. wallichiana* etc. The herbs in the forests and meadows include *Rubus fragarioides*, *Potentilla microphylla*, *P. monanthes*, *Primula glabra*, *P. oblique*, *Ranunculus adoxifolius*, *R. brotherusi*, *Anemone demissa*, *Tithymalus sikkimensis*, *T.stracheyi*, *Saxifraga hispidua*, *S. latifolia*, *Viola biflora*, *V. cameleo*, *Pedicularis mollis*, *P. clarkei*, *Picrorhiza scrophulariaeflora*, *Rheum acuminatum*.

1.7 Land use

At the time of its birth Darjeeling hill areas were totally under forest cover. With the establishment of tea gardens and cinchona plantations, lands started to be used for human activities. More than 50% of the total area was deforested within 1921. Deforestation continued for other uses of land till an apparently stable pattern arose. Current land use pattern is shown in table 1.6.

Table 1.6 Block Wise Land use pattern in Darjeeling Hilly areas

Name of CD Block	Area in km^2	Nos. of Households	Population	Forest in km^2	Arable land in km^2	Cultural waste in km^2	Area not available for cultivation	Others in km^2
Pulbazar	426.55	40880	223034	195.02	194.44	1.03	23.32	12.75
Rangli Rangliot	272.99	13092	64349	104.55	63.22	76.87	28.36	0.00
Kalimpong	369.14	21048	110678	204.43	136.12	1.76	18.15	8.68
Kalimpong Lava	241.26	11501	60263	94.57	71.82	15.61	59.25	0.00
Gorubathan	442.72	10863	54279	182.12	153.14	56.73	50.72	0.00
Jore Bunglow	222.12	22048	100724	55.52	110.76	31.82	24.02	0.00
Mirik	125.68	24053	51378	29.02	61.72	15.32	13.11	6.50
Kurseong	377.35	15050	125886	117.67	158.97	35.28	42.39	23.04
Total	2477.80	158535	790591	982.91	950.17	234.42	259.33	50.97

Source: Census, 2001

The land use pattern of the Darjeeling hills reveals forest, khasmahal area, tea gardens along with settlements. The present land use pattern in Darjeeling Himalayas (figure 1.10)

have however evolved in continuation of the British policies with a very little of the western section of the district coming under agriculture. Settlement density is consequently higher in these areas since no restrictions apply in the regional population that can be supported. Another feature resulting from the settlement vis-à-vis land use patterns that land pressure following the growth of population has highly differential impact on the district. Agricultural development in the western regions blocked by twin constraints on its expansion along the extensive margin by limited access of the population to land since the major part of the area falls either under forests or tea gardens, or by agriculture along the intensive margin being debarred by to geographical difficulty and adverse climatic situations. Highest lease-land commitments to tea and lowest to agricultural usage occur correspondingly. To the east, Kalimpong, with generally lower elevations has greater topographic and climatic suitability for rice-maize-millet cropping, while the lower regions in the southern fringes harbor reserve that are conductive to present and future revenue forestry.

Table 1.7 Cultivated area under different crops in the Darjeeling hill area

Sl No.	Name of Crops	Cultivated area in hectare	Sl No.	Name of crops	Cultivated area in hectare
1	Maize	24778	10	Cardamom	2874
2	Millates	10130	11	Ginger	2278
3	Paddy	9564	12	Turmeric	15
4	Wheat	709	13	Mustered	224
5	Barley	500	14	Kalai	518
6	Buck Wheat	500	15	Soyabean	363
7	Potato	4254	16	Orange	1972
8	Winter Vegetables	1711	17	Pineapple	33
9	Summer Vegetables	3059	18	Other Fruits	341

Out of 950.17 sq. km of land area under agriculture sector 371.01 sq. km (39.04%) has been identified as net cropped area out of which only 82.96 sq. km is irrigated. The cropping intensity was estimated as 171.92% by the Agriculture Department and thus the gross cropped area of Darjeeling hill area has been estimated to be 637.86 sq. km. 184.94 sq.km is under triple crop, 402.52 sq. km is under double crop and only 52.24 sq. km is still under single crop culture (table 1.7). The balance 60.96% of land under agriculture sector has been utilized for tea plantation for which Darjeeling is world's famous.

1.8 Demography

As per the 2001 Census, the total population of Darjeeling hilly area was 790591and the number of total household was 158535. The block-wise distribution of population of population as per 2001 census is shown in figure 1.11.

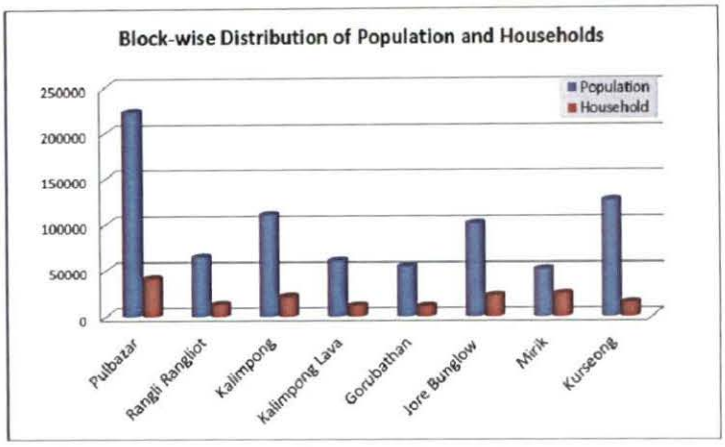

Figure 1. 11 Block-wise distribution of population and households

1.9 Conclusion

The study area thus composed of several tectonic units of the Darjeeling-Sikkim Himalaya overthrusted towards south are built mostly of metamorphic rocks. The foreland of the Himalaya is built of Quaternary sediments which show a distinct fractional differentiation starting from boulders and gravels in the root part of piedmont fans and terraces, at distance of 5-10 km from the margin.

Geomorphologically, the study area is diverse and complex in nature, exhibiting a wide variety of landforms. Their genesis, mode of formation and morphological forms are diverse and have been characterised by successive catastrophic events of slope wash on the hill slope followed by accelerated deposition along the piedmont during the post-Pleistocene period.

Topographically, Darjeeling hill area may be divided into 4 major divisions namely the upper hills, middle hills, lower hills and piedmonts. The hills rise abruptly from the piedmont plain (150 metre) and the elevation increase northwards up to 3636 meter at the Sandakfu massif of Singalila range. Within these, there is a mosaic of micro-topographic units comprising of convex ridges, inter-mountain valleys, high terraces and deep-cut valleys.

The piedmont covers the tilted plains at the base of the Himalaya bounded by the 300 meter contour line to the north and below 100 meter to the south.

The climate of Darjeeling is characterised by extreme diversities in rainfall and temperature pattern between its northern and the southern parts. Mean maximum temperature ranges from 24.2°C in Kalimpong and 18.8°C in Darjeeling in the month of August and mean minimum temperature ranges from 15.4°C in Kalimpong and 1.9°C in Darjeeling during the month of January. Precipitation also exhibits similar kind of diversity that ranges from less than 2000 mm along the northern margin along the Rangit valley to over 5000 mm along the southern face of Mahaldiram range around Kurseong. Extreme diversity in geological set-up, topographic forms along with climatic elements exhibits unique biodiversity in the study area.

Darjeeling Himalaya, with its bracing climate, unrivalled scenic beauty, enhanced further by the majestic view of Kanchendzonga and above all, the exquisite taste exhibited by the British, in building the hill resort, commensurate with its physical setting, has resulted in its emergence as the "Queen of All Hill Stations" – attracting tourists, both from within as well as from outside the country. The location, setting and juxtaposition of these natural features provides a fascinating range of view-scapes. To this complexity of nature, man has added an assortment of his interpretation of aesthetics of landscape.

Under the backdrop of the world's loftiest, youngest and tectonically most active Eastern Himalaya region, the study area exhibits a nature's laboratory for understanding the processes of environmental degradation especially under the strong influences of illogical human interventions into the delicate hill ecosystem.

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Chapter 2: Historical development of Darjeeling hills

2.1 Introduction

The Darjeeling hills wasonce ruled by the Kingdom of Sikkim. Darjeeling region was converted into a hill station by the British East India Company in 1800's and came to be known as the *Queen of the Hills*, and remained a part of West Bengal in independent India. The name of Darjeeling is a composition of two Tibetan words,'Dorjee' means *Thunderbolt* and 'ling' means *place* hence Darjeeling means*Land of the Thunderbolt*. At present Darjeeling district is composed of four sub-divisions i.e., Darjeeling, Kurseong, Kalimpong and Siliguri. The former three sub-divisions are together known as Darjeeling hill area, which is the study area for the present research. The history of Darjeeling is rather complex but interesting. The brief history of Darjeeling district is described in the following sections.

2.2 Pre-British Period

Till the early 19th century, the area around Darjeeling was part of Kingdom of Sikkim. In 1814, the British East India Company intervened in skirmish between Sikkim and Nepal, following which Sikkim became a buffer state between Nepal and Bhutan. In 1828, a dispute occurred between Nepal and Sikkim. British East India Company representatives were sent from Malda to resolve the dispute. They found the Darjeeling very suitable for sanitorium for British troops. The company negotiated with the King of Sikkim to take the area.

On the first day of February 1835, the Maharaja of Sikkim handed over a strip of territory on the Himalaya, 24 miles long and about 5 to 6 miles wide, as a mark of friendship with the then Governor General, Lord William Bentinck, for the establishment of a sanitorium for the convalescent servants of the East India Company. In 1835, Dr. Campbell, a member of the Indian Medical Service and Lieutenant Napier were given the responsibility to develop a hill station there. By 1849, the population grew to 10,000 and following a discord between Sikkim and the Company, the company annexed the Darjeeling region to the British India Empire. The Kalimpong was a part of the kingdom of Bhutan and in 1865, after loosing out to an armed British intervention Bhutan ceded the territory of Kalimpong to British India.

2.3 The British Period

After taking over the Darjeeling area, the Governor General expressed his desire for the possession of the hill of Darjeeling on account of its cool climate, for the purpose of sanitorium for the British government servants suffering from sickness. By 1840 a road had

been made from Pankhabari where there was a staging bungalow. Another staging bunglow was set up at Mahaldiram.The first hotel was started at Kurseong and a second at Darjeeling followed by some 30 private houses which had been erected. Elsewhere, however, the hills was dominated by its virgin forests as the road from Pankhabari was an almost impenetrable forest. The region was still practically uninhabited and one of the most important problem of administration was to attract native settlers.

In 1839, Dr. Campbell became the administrator of newly annexed Darjeeling with sole authority and responsibility of developing the annexed area. Dr. Campbell devoted himself with rare energy to the task of developing the station attracting immigrants to cultivate the mountain slopes, and stimulating trade and commerce. An unnamed British Inspection Officer wrote in 1852 "Darjeeling an inaccessible tract of forests with a very scanty population housed an excellent sanitorium established for troops and others hill corps, no less than 70 European houses with a bazar, jail and buildings for the accommodation, a simple system of administration of justice, maintenance of socio-economic harmony with local tribes, experimental cultivation of tea and coffee and various European fruits and grapes ..... I may in short say of him (Dr. Campbell) that to him is the Government indebted for the formation of the district of Darjeeling".

Between 1839 and 1842 Lord Napier of Magdala, of the Royal Engineers, had been engaged in making a road through the virgin forest from Ghoom to Kurseong via Senchal ridge and Kurseong to Pankhabari. This road was however, both too narrow and too steep for wheeled traffic and it was recognized that in the interest of Darjeeling and for the development of the frontier trade, a road broad enough for carts and with an easy gradient was absolutely necessary. The construction of the Darjeeling Cart Road, a wonderful example of engineering feat, which subsequently made the alignment of a railway so comparatively easy was begun in 1861. By 1866 a broad mettaled road from the Ganges to Siliguri was constructed and thereby established uninterrupted traffic with the plains. From that time the first attempt was made to make the hills the home of European education in India. For some years Bishop Cotton had been advocating the establishment of hill schools for Europeans and his efforts were supported by Lord Canning. As a result, several schools were established in Darjeeling. The first of which was St. Paul's School which was transferred in 1864 from Calcutta to Darjeeling. In 1864, the first large Cinchona plantation was started and successfully developed at Rongbi.

In 1841, Dr. Campbell had started the experimental growth of the tea plant with a few seeds grown in Ruman from China stock. Twenty years later the original plants had grown to a gigantic size, one of them it is said being 15.2m in circumference and 6m high. It was recognized that the soil and climate of Darjeeling were favourable to its cultivation. Large plantations were established and companies were formed and by the year 1866, there were 39 tea gardens covering an area of 4500 hectare. The year 1866 may be taken as marking an epoch in the history of Darjeeling with the addition of Kalimpong within Darjeeling district. With the establishment of peace and progress civilization began. Rapid development of transport and communication of the district became top priority to the British ruler.

The rapid expansion of tea cultivation had however, result in reckless deforestation and it was recognized that it was necessary to provide for the careful conservation of the forests, for their protection from wanton or unscientific destruction and for the proper development of the part of the resources of the region. The Superintendent of the Calcutta Botanic Garden was appointed Conservator of Forests for Bengal with a mission for adopting special measures for protection of forests in Darjeeling where large scale deforestation had taken place due to introduction of tea plantation. To control further degradation all non-accessed lands in the old hill territory above 1850m altitude and all such lands between the *terai* and the elevation of 1000m were declared as Reserve Forest and thereby beginning a new means of Forest Conservancy in Bengal.

In the meantime, however, the development of the industry in the hills had been even more rapid as the suitability of the soil and climate to the growth of tea became apparent. Government offered land to investors on favorable terms and the industry rapidly developed. By the end of 1866, only ten years after the establishment of the industry on a commercial basis, there were no less than 39 gardens with 10,000 acres under cultivation and returns of over 1,96,400 kg of tea. In 1870 there were 56 gardens with 11,000 acres under cultivation, employing 8000 laborers and yielding nearly 7,71,100 kg and in 1874 the number of gardens had increased to 113, the area under cultivation to 18,888 acres, the returns to 17,81,700 kg, and the labour force to 19,000 persons. In other words, between 1866 and 1874 the number of gardens under tea had exactly trebled, the area under cultivation increased by 82%, while the production of tea multiplied nearly 10 times. Since that time the industry has progressed steadily until no less than 50,600 acres or 204.6 km^2 are under tea cultivation. Table 2.1 illustrates the advances which has made during 1874 to 1905.

Table 2.1 Growth of tea industry in Darjeeling during British period

Year	Number of tea gardens	Area under cultivation in hectare	Production of tea in million kilogram
1874	113	7,643.6	1.7817
1885	175	15,579.7	4.1233
1895	186	19,704.6	5.3137
1905	148	20,483.9	5.6462

The fast growing tea industry had tremendous demand for labour for cleaning, planting, construction and other related work. Huge migration, mostly from Nepal ushered a new chapter in the history of Darjeeling, in conjunction with its demographic transition. Simultaneously, the development of transport facilities were on full swing and by 1881, the Darjeeling Himalayan Railway was completed and thereby providing further boost to the already growing tea industry. Another important factor in advancing the general development of the region has been the preservation and development of the forest which supply timber for bridges, buildings, tea boxes, firewood and charcoal.

Native cultivation was practically at the same stage as it was when the British first occupied the country except that the old nomadic wasteful system of cultivation practiced by the Lepchas had been given up, and the use of the plough which they had learnt from the immigrant Nepalese had extended several attempts to introduce better seeds improved ploughs and other implements and those attempts had been met with some success.

The cultivation of coffee was started at about the same time as that of tea on one or two gardens, but did not prove a financial success. Tobacco, again which was indigenous in the hills, and which may might be seen growing around many native homestead had never been successfully cultivated or manufactured on a large scale.

Cinchona plantation had gradually disappeared as the cost of manufacture and transport was found to be prohibitive for private planters after the fall in the price of quinine and a only the Government Cinchona Plantation at Mongpu and its sub-ordinate gardens which produce both quinine and number of alkaloid by-products were then at work.

During British period, they built the basic infrastructure of road, railway line, hotels, tourist lodges. The list of major roads constructed by the British has been tabulated in table 2.2.

Table 2.2 Major roads constructed during the British period

Year	Name of road/bridge	Road length (km)
1839-1842	Siliguri to Darjeeling (with about 300 bridges)	65
1865	Matigara to Kurseong via Pankhabari.	49
1908	Tista valley Road	55
N.A	Tista to Kalimpong	13
N.A	Darjeeling to Teesta Bridge	28
N.A	Naxalbari to Garidhura	18
1879-1881	Darjeeling Himalayan Railway	83
1940-41	Kalimpong to Algarah	15
1915	Siliguri to Giell Khola	31

During the British period the Forest Department had also constructed a number of roads including (i) Old Military Cart road, (ii) Simkona-Lalkuti Cart road, (iii) Sukhiapokhari Cart road, (iv) Manaybhanjan Busti Cart road, (v) Dilaram Road from Bagora to Darjeeling Hill Cart road, (vi) Sukna-Sevok road, (vii) Rissisum-Labha Cart road, (viii) Central Cart road, (ix) South Boundary Cart road and (x) Dalgaon Cart road. In addition to these 39 small village roads, bridle roads and 42 fair weather roads had been constructed during the British period.

Besides the transport network and hotels, 33 Post Offices and 14 Telegraph offices were constructed. During this period Dak bunglows were constructed at Kurseong, Pankhabari, Badamtam, Jorepokhari, Kalijhora, Kalimpong, Mirik, Pashok, Pedong, Phalut, Rangarun, Reyang, Sandakapu, Senchel, Tanglu, Teesta bridge etc. A large number of school buildings, hospitals, hotels, tourist lodges, and government offices were constructed to facilitate administration and basic civil amenities to this newly developed part of the country. Such large scale construction activities by the early developer of Darjeeling also invited environmental degradation as by product.

In 1907, the first ever demand for separate administrative set up for the district of Darjeeling was placed before the Government by the leader of the hill people. This demand was considered to have arisen due to the widespread idea of reforms and the anti-partition wave in Bengal. On November 8, 1917 the representatives of the Darjeeling district submitted a memorandum to the Chief Secretary, Government of Bengal demanding creation

of a separate unit. The copies of that were subsequently submitted to E.S Montagu, the then Secretary of State for India and Lord Chelmsford, the then Viceroy of India.

2.4 Independent Period

After the tea Industry developed to some extent, the number of tea garden increased leading to forest clearings vis-à-vis damage of environment increased. The Cinchona Plantation area increased to 9700 hectare after 1947. After Independence the State Government established eight CD blocks under Darjeeling hills for the development of interior areas. Development works also started in different parts of Darjeeling hills for the establishment of Block Development Offices and other infrastructures. The people slowly began to misuse the environment by cutting down the trees,collecting of stone boulders from forest land for the construction of their dwelling houses and other structures. During the early independent period the following roads were constructed in Darjeeling hills i.e., (i) Sonada to Munda road, (ii) Pulbazar to Kaijalay, (iii) Singmari-Chowrasta-Toongsung, (iv) Rimbik-Manaybhanjang-Phalut, (v) Sukhiapokhari to Nagari via Pokhraybong, (vi) Latpanchar to Shelpu, (vii) Dilaram to Chimney via Bagora, (viii) from 17th Mile to Rangpu via Mongsong, (ix) Kalimpong to 17 th Mile via Dr. Graham's Homes, (x) Relli to Sukrabaray and (xi) Kghunia more to Upper Kumai.

In addition to this several Tourist lodges, Mirik lake, Darjeeling Government College, Kalimpong college, Kurseong college, Darjeeling Polytechnic Institute, I.T.I Toong, HMT Watch factory Toong, PWD Inspection Bunglows at different places, Hydroelectric project of Jaldhaka with barracks and quarters, Ramam hydroelectric project with other structures, Kafaybari Hydroelectric project with other structures in Kurseongb were constructed. During construction of such projects huge number of trees werefelled. Mountain slopes were cut down. As a result many perennial water sources dried up. The level of air pollution, sound pollution, soil pollution, water pollution increased leading to the spread of many diseases among the local people.

In the year 1972 the Government of West Bengal established the Darjeeling Hill Area Development Council, for the overall development of hill areas. Since then some special allocation of fund from the Central and State Government began to flow. In view of its socio economic backwardness, peculiar topographical, physical and cultural features, the Government of West Bengal accorded a very high priority of the socio-economic development of the hill areas of Darjeeling. The development activities in the area were

carried out under the State Plan Budget and a Special Central Assistance additive to the normal expenditure from the State Plan.

Accelerated hill development programmes for the Darjeeling hill areas had been taken up from 1974-75 onwards, from Special Central Assistance. During that period the development works were undertaken in agriculture development, horticulture, agriculture marketing, fisheries, soil conservation, irrigation, animal husbandry, forestry, panchayat and community development, co-operatives, industries, sericulture, cottage and small scale industries, communication, tourism, social and community services, education, DWS schemes, information and cultural affairs etc.

Thus, in the name of development programmes vast areas of this hilly region was destroyed. The construction of roads and other infrastructures were indispensable for efficient transport and communication system for tourism development, but these being done in an unplanned and unscientific manner were mainly responsible for destruction of Darjeeling Himalayan land resource along with its rich vegetation and animal wealth. A careful study shows that the construction of 1km long road in hilly region produced 16.60 million cubic meters of debris and each kilometer of already constructed roads generates 550 cubic meters of debris by landslides and rock falls. Thus, nearly 24 million cubic meters of debris slide down damaging vegetation and chocking the springs etc. These activities accelerate hill slope instability, deforestation, soil erosion, pollution of water and air especially along the road sides and around the most of the tourist resort like Mirik, Lava Pedong, Risap, Lolaygaon, Kaffer etc.

For such development work, the concerned authority had used powerful explosives like dynamite and excavators hence those areas have become weakened and after completion of project especially roads, heavy traffic creates vibrations which cause cracks on rock and earth, which in turn lead to landslides and erosion along with adverse impact on the flora and fauna. The situation has been aggravated further by construction of roads along geologically active zones like at Likuvir, 27th mile under NH-31A, and Paglajhora in NH-55, Paparkheti in Lava-Damdim road. The construction for accommodation facilities like rest houses, tourist bungalows, and seasonal accommodation units, recreation centers, etc. had posed serious menace to the land resources of the region, as it has not only accelerated soil erosion but also caused damage to crops, animals and plants, housing and public properties.

The tourist concentration in the Darjeeling Hill areas started increasing day by day, which went beyond its carrying capacity, while the area under vegetation started decreasing due to accelerated human activities. A considerable area of virgin forest was also being replaced for providing necessary amenities to visitors for tourism promotion. A considerable quantum of forest land had been destroyed only by road construction from 1955 to 1988 in Darjeeling hill areas. Deforestation thus results not only in resource depletion but also in deteriorating fresh and underground water, wildlife and leading to disastrous phenomena like aggravated soil erosion and landslides. The increase in mass tourismhas an adverse impact on the unique hill environment.

On April 5th 1986, a new political party GNLF (Gorkha National Liberation Front) was formed and an agitation for a separate state of Gorkhaland started in Darjeeling hill areas, and disturbance started where the entire local people had to participate in agitation. All development works in hill areas came to a stand still for indefinite period. During agitation period, no government department and agency was in position to control the public property. The agitators indiscriminately destroyed the Reserved and unreserved forest. The labour force of this locality remained idle and unemployed, and they were compelled to go forest for the cutting of trees and to sell it to meet their needs. Some antisocial elements started the cutting big trees and started to sell the variety of wooden planks, battens, etc., and set up their business. There was no law and order in Darjeeling hill areas which continued for the period of 2 years. When agitation s stopped, then entire hill area was like a barren land. There were only burnt remnants of tourist lodges, forest bungalow, government inspection bungalow, rural and urban libraries, school buildings.

2.5 The DGHC Period

When Gorkhaland agitation was over in 1988, a tripartite agreement, between Government of India, West Bengal Government and GNLF Party and an accord was signed on 22nd August 1988 which gave the birth of Darjeeling Gorkha Hill Council (DGHC). Since then a new set up DGHC started for the development of Darjeeling hill area, since then many new roads construction, tourism development works along with other 18 transferred department's work were undertaken. During this period some big projects were undertaken without the approval of concerned authority such as a helipad construction work at Tiger hill, Dooteriah, Mirik, where vast forest area was destroyed but ultimately those projects was cancelled. The damage to the area had already been done.

During DGHC period from 1988 to 2007 139.5 km of new roads in Darjeeling Sadar sub-division, 105.5 km in Kurseong sub-division and 108.8 km in Kalimpong sub-division were constructed. In total 550 km of new roads (including road constructed by DGHC, P.W.D, CD blocks etc. since 1988 till date within 3 hill sub-divisions where approximately 2.2 million m^3 of debris slide down in the valleys resulting in ecological damage. During the road construction large tract of agricultural land as well as tea garden land and some portion of forest land have been damaged. Some portions of virgin forest and government Cinchona plantation have also been damaged due to haphazard construction of new roads, some new landslide have been appeared, and agriculture land of Muddum road, Kagay road, Todey Tangta road have been damaged under Kalimpong sub-division.

The Government of India has introduced Mahatma Gandhi National Rural Employment Guarantee Programme from 2007 in hill area of Darjeeling and about 415 km of village roads have been completed in eight hill blocks, beside the above roads many jhora training works, drains, school buildings and public playground have been constructed resulting in further damage the environment. There are two number of low dam hydroelectric project under construction in Tista river where natural vegetation, the habitat of wild animals and birds have been damaged. Due to construction of those two dams the NH-31A, the life line of Sikkim state and Kalimpong sub-division frequently remained closed during the monsoon months due to landslides. The project area of Stage III of Tista low dam hydroelectric project has declared as the vulnerable area.

Subsequently, development of roads, buildings, hydroelectric power project and urbanization in the hill areas of Darjeeling have pushed degradationfurther. The cumulative effect of development in the Darjeeling hill areas under DGHC period has tremendous affect on forest and grazing lands. Moreover, forest and grazing land are being used for traditional agriculture, asbest agricultural landsare being used for commercial cultivation, pushing cereal cultivation into higher and marginal lands. Land encroachment is taking place even on protected/reserve forests. The increase flow of cash among the indigenous population has brought in a new perspective as they look at land and forest as an instrument of making money not just a means of subsistence as it was a few years back.

Increasing demand for fuel-wood for tourists, towns and local people has to be met locally, and it is still the major source of energy. Fodder and grazing demands have also to be met from dwindling and exhausted lands. All these are leading to a large number of

malpractices, degrading the land and resources. Commercial demand for timber and other forest resources is another source of fast degradation in post DGHC period, both inside and outside the region. There is an insatiable demand for timber and forest product, for construction as well as for numerous wood-based industries. These resources also form the major source of revenue for the Darjeeling hill areas. The mountain people's rights for timber and other produce incorporated in the Forest Act have also brought in several malpractices. The contract system of working these resources is perhaps the most harmful of all.

The ever increasing tourist influx is creating great impact on ecology and environment. The problem of litter, noise pollution and damage to natural assets is causing great anxiety to environmentalists and other educated people. The development and construction of new hotels involves the destruction of vegetation, felling of trees and erosion of the environment under post DGHC period.

Agriculture which was one of the main occupations in post independent period in Darjeeling hill area did not give quick and high economic gains like tourism. During DGHC period in tourist season mainly (March-June) tourism had become the main source of income, as a result of which agricultural system miserably regressed. Vast prime agricultural land was used for development of infrastructure facilities. These activities created dependence system in addition to adverse impact on economy and ecology of the Darjeeling hills.

The farmers who were living in the vicinity of these tourist resorts left their traditional farming for prompt and easy economic benefits. Places around Mirik, Risap, Lolaygaon, Kaffer etc. were the result of this type of tourism impact where agricultural plots were used for tourism purpose. The landslides, droughts, floods, decline in the forest cover, decline in agricultural yield, soil loss, problem of siltation in reservoirs and rivers, extinction of rare species of wild animals, etc. have been found as the major impact of such degradation. The natural springs were rapidly drying, leading to decrease in the the fodder resources and natural forests were fast disappearing in the Darjeeling hills.

To prevent or reduce further degradation of the Darjeeling hill areas scientific and well planned growth of tourism is necessary in which experts of different disciplines along with local people should have close involvement in the whole planning process. There should be correlation between natural resources and tourism development which should be according to the carrying capacity of particular resorts, so that the space action does not affect their eco-system and ecological balance. If these proactive measures are not given due importance in

tourism planning and development, the prosperous heritage and environment of the Darjeeling hills would be damaged beyond the limit of repair/regeneration. The Queen of hills will merely be sweet memory of the glorious past to many visiting tourists.

2.6 Conclusion

The historical records reveal that the land use of Darjeeling hill area was dominated by virgin jungle before 1835. Records from the British travelers also revealed that lush green unspoiled environment of Darjeeling hills. Since the British occupation in 1835, Darjeeling hills have been experiencing various development works. Many roads, bridges, school buildings, hospitals, railway line, public utility structures were constructed. Development of settlements and urban centers took place. Indiscriminate destruction of virgin forest was taken place for the construction of tea gardens, good alignment of roads, railway lines, railway sleepers and other development works.

During independent period the people of Darjeeling hill area misused the environment according to their wish. The DGHC period gave further independence to the people. The people took law and order in their own hands and the law enforcing agencies failed to impose the rule and order framed by the government.

Darjeeling Himalaya is one of the least economically developed hill region in India, and its backwardness can be attributed to environmental/physical constraints like rugged topography, harsh climate, varying altitude with steep slopes, narrow valleys, ethnic complexity and political instability which makes the life painstaking and hazardous. Various development programmes and the implementing agencies lack seriousness and comprehensiveness in approach and hence do not work to the expectations. The agencies like PWD, PHE, Irrigation, Block Panchayat, DGHC and other major public schemes like hydroelectric project, Neora khola drinking water scheme, Balasom water project etc. have had adverse impact on the environment.

In addition to this there had been great impact to the people of hill region as well as environment due to political agitation during 1986 to 1988 and 2007 to 2011 as the economic condition of people has deteriorated rapidly as great environmental damage was caused during those periods. There is an urgent need to work out for a comprehensive regional planning strategy capable of addressing social, economic, political, demographic and

environmental issues in order to bring in sustainable regional development, employment potential, regional income and general improvement in the quality of human life.

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Chapter 3:

Comparative Study of Past and Present Environment

3.1 Introduction

Darjeeling Himalaya is famous for its vegetation besides tea and the panoramic view of the mighty Kanchanjunga. The British botanist Sir J. D. Hooker during his visit in 1848 was overwhelmed by the variety of vegetation that the place offered. He wrote in Himalayan Journal *that no other place that he had visited before could boast of that kind of variety.* The entire Darjeeling hill,*was burning with the flower of Rhododendron species during March-April while October-November gave the impression that the entire district was a single block of ice.* Comparing Hookers description with the present day Darjeeling is enough to create awareness and concern, as what we have today is an altogether different Darjeeling.

The land, water and plant resources are in a state of degradation. Forests are being denuded due to the need and greed of people. The fuel and fodder needs of the increasing human and cattle population with hardly any viable alternatives to plant resources are depleting the forest and green cover at an alarming rate. Hill slopes are getting eroded filling up the streams with silt eventually leading to floods during the monsoon. Springs and streams, the lifeline of the communities are dying especially during non monsoon dry period.

Government and non-government bodies have taken action to repair the degradation of the Darjeeling hills. But these actions are not enough to make a dent into the problem. In spite of development, education and public awareness amongst the people in the Darjeeling hill areas, the help of NGOs and people organization is essential to save the queen of hill station and develop self-reliant Himalayan communities.

Man's desire for a comfortable life has led him to exploit nature's free goods to the extent of reducing its natural capacity for sustenance. As a consequence degradation has started. It is an empirically established fact that there exists a vital link between the environment and life. The history of evolution of life has taught us that through the different ages various forms of life appeared or became extinct in response to the prevailing environmental conditions. Man in his pursuit of ever faster economic growth is upsetting the environmental equilibrium and destroying his life support system. Man's capacity to transform his environment can bring the benefit of economic development and an opportunity

to enhance the quality of life. But this same power, if incorrectly applied can also cause incalculable loss to human life.

3.2 Reconstruction of British period environment

Darjeeling had been aptly described as the *children's paradise*. Its climate was most agreeable as during summer the temperature seldom registers more than 24°C during day or less than 12°C at night. Snow frequently fell, many of the old residents however, affirmed that hundred years ago when the hill sides were clothed with virgin forest, snow covered the landscape for weeks at a time. As snowfalls are now more an exception than a regular feature of the past, this changes in climate condition has been attributed to the gradual denudation of the hillside due to the expansion of the town vis-à-vis environment degradation.

On March 18th 1913, an unprecedented snowfall of 20.3 cm during night covered the entire Darjeeling hills down to the 1700 meter aslfor the whole week and also caused great damage to the forest from Senchal to Takdah. The destruction wasso great as the snow which had broken trees and branches supplied Darjeeling with its wood for the next 18 months. The railwayline from Darjeeling to Sonada was covered by 1 meter deep snow and the DHR had to attach snow-ploughs to the engines to clear the line for traffic. In February 1828, when Lt. General Lloyd visited Darjeeling for the first time, snow fell for three successive days covering the station and the adjacent hills with a white mantle of snow for weeks.

Darjeeling town which covers an area of 10.57 sq km was supplied with pure water from 26 springs in the Senchal catchment area which was collected in the large lake and from thence conveyed through large conducts to the reservoirs established at the St. Paul's School and Rockville, the capacity of the three being 20, 2 and 0.05 million gallons respectively. The water was distributed in the town through pipes of varying size, the total length being 20.8 kms. Provision was made for the supply of pure water at three of the most important stages along the Tista valley road for Kalimpong town. The Minerals Spring which was well known to the indigenous population was situated at a spot called Dabai Pani (medicinal water) to the east of the Mall formally utilized for medical purpose and a convalescent depot was built nearby for the convenience of the troops at Jalapahar. The water however, was not used since 1920, and the depot had been in ruins since then.

During the British period the floras available in Darjeeling hill areas were mostly acacia, aconite, bamboo, champ, chestnut, chillani, cinnamomum, conifers, criptomeria,

ferns, grasses, ironwood, katus, lampati, laurel, magnolia, maple, michelas, mosses, oaks, orchids, palms, panisaj, pipli rhododendron, rubber, vine, sal, silver fir, simul, sissoo, teak, tun and walnut. The criptomeria, which later predominated the hills giving the landscape a stiff appearance was introduced from China and Japan by Mr. Fortune who brought back with him the seed which was passed on to Dr. Anderson and planted out in nurseries in Jalapahar. There were two species of maple and birch. Sisoo grew in the valley of the Balasan, Rangeet, Tista and Rongpu rivers. Tun thrived well but was inferior to the variety which was grown in the plains. The wild mangoes were found in the tract between Kurseong and Pankhabari. Pink variety of rhododendrons flourished from Darjeeling town up to 3600 meter, the white variety were found at lower elevations. The Walnut was then found chiefly in the Tista division. *Champ* a light yellow close grained wood was well adapted for furniture making. Magnolia trees were large and hardy bearing a profusion of white, sweet scented flowers in spring. Wild cherries were grown abundantly at an elevation in between 2000-3500 meter. The barberry was indigenous, while the wood was green and used for dying purposes. Five varieties of raspberries covered the hilly tracts. Strawberry was full flavoured but slightly tartar than that of the European variety. Apples and peaches were grown luxuriantly, but the fruit was bitter and fit only for making jam. A wild grape was found on the lower eastern slopes.

During British period, animal found in Darjeeling hills included antelope (rare), bear, bison, boar, cats (civet, jungle and tiger), deer (barking, hog and spotted), elephant, fox, gaur (goral and serrow), hare, jackal, leopard (ordinary and black), lynx (rare), mongoose, porcupine, rhino (rare), samber, squirrel (flying and ordinary), tiger, wild dog, wolf and snakes of which there were 47 varieties of which 17 were poisonous and chief being the python which often measured 28 feet, cobra, Russell's viper etc. Among the birds duck, pelican, geese, Greek pigeons, imperial-pigeon, jungle fowl, partridges, peacock, snipe, teal and woodcock, green pigeons etc. were available in Darjeeling during summer and autumn. The environment of British period was very much nature dominated. In compare to available natural resources the population was sustainable and thereby the environmental quality was well preserved. As such, degradation was not visible in the Darjeeling hills till the late British period. The law and rules of the civil society was also excellently managed by the British administrator. The buildings were only two storied with G.C.I. sheet roofing.There were numerous springs so water which was sufficient for every person. Almost all people were law abinding. The roads were constructed with proper manner i.e., as per plan and specification.

Prior to the British occupation, the forest were managed by the people according to their own custom and traditions where the relationship between the forest and the people were harmonious. Since the British occupation, the whole relationship was put into jeopardy because the British looked upon forest as valuable goods which needed protection and proper distribution. And in accordance to this they passed forest law. The first forest law was passed in 1865. The early British intervention had profound effect on the lives and especially in the forest because they cleared some portion of forest to set up tea garden and railway lines, and even today the land use pattern has imprints of the British system.

At the time of British acquisition, the Darjeeling hill areas were largely uninhabited and covered with forest. Forest to the east of the Tista were found to be in relatively poor condition due to the greater rural settlement as the indigenous Lepcha people followed *swidden* (shifting) agricultural practices. Extensive forest fires were often reported in the outer hills and along the Tista and Rangit valleys which often originated in the uncontrolled spread of slash and burn fires. The first India Forest Act in 1865 arose out of the need for conservation of timber and also to eliminate the prevalent practice of *swidden* agriculture by virtue of a gazette notification in 1871-72. Thereafter 18,648 sq. km of hill forest were notified as ReservedForest.

Since Indian forestry was a relatively new institution at the time of its inception under Brand's in 1864, the initial methods of working the forests involved the sale of individual trees exceeding a specified girth under the permit system. The impact of the system was decimation of all the best species and consequent accumulation of defective or otherwise poor quality species and specimens in production forest areas, quite the antithesis of sound silvicultural practice. With the establishment of refined forest management under recommendations of Brandis in 1878 as later modified by Schilch, the working practice in hill forest gradually changed over to selective felling at altitudes above 2250 meter and mostly clear felling below these levels. Monoculture gradually entered as the practical solution for improvement of commercial forests quality and spelt the doom of broadleaf stands in many naturally forested areas i.e., monoculture of *cryptomeria japonica* found Darjeeling hill area. The disadvantage of *cryptomeria* monoculture is that it does not allow undergrowth thereby it is not biodiversity friendly nor does it promote soil and water conservation.

At the time of British occupation in 1835, Darjeeling hill area was entirely under forest. Only a small population had been driven out by the oppression of the petty ruler whom they finally replaced. It was in fact estimated that the whole of this tract contained only 100 souls and by the year 1850 the number of inhabitant had increased to 10,000.

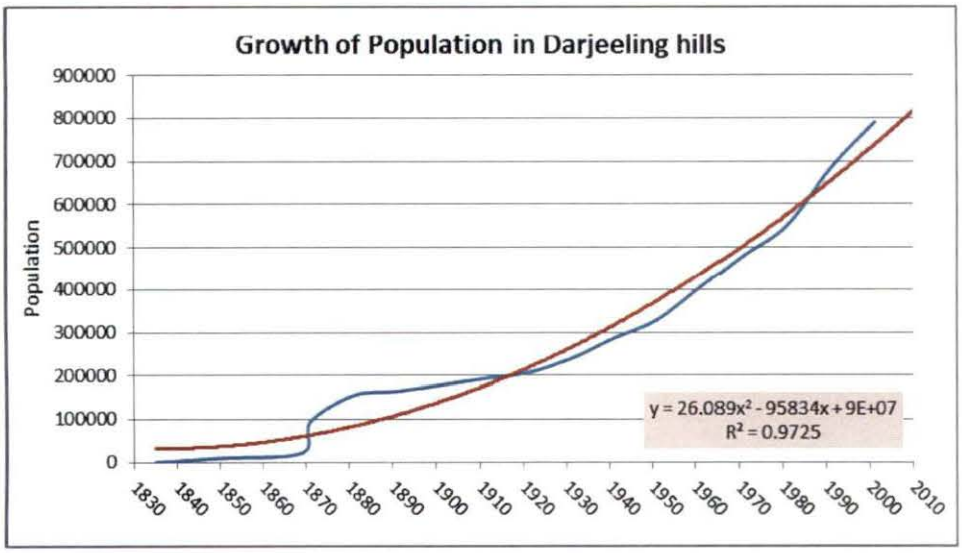


Figure 3.1 Population growth of Darjeeling hills

In 1866, only ten years after the establishment of the first tea garden on a commercial basis there were 39 tea gardens each having an average acreage of 256.50 acres an aggregate yield of 60,325 kg. In 1870, the number of garden rose to 56 covering an area 11,000 acres. Between the years 1866 and 1874 the number of gardens trebled, the area increased by 80 percent while the outturn was multiplied ten times.

3.3 Reconstruction of early Independent period environment

After independence the Darjeeling hill area come to the national main stream economy. The tea industry developed to a large extent and at present this industry is one of the major sources of revenue earning in Darjeeling hill area. The number of tea gardens has also increased at the cost of the forests.

Cinchona is the next important plantation industry in the region as the gross area under cinchona was about 24,000 acres. Government of West Bengal established eight CD blocks in Darjeeling hills along with necessary infrastructure including offices, residential

blocks, roads, water supply etc. Such early development work cost dearly in terms of the environment as large and unregulated deforestation took place for development work.

There was plenty of perennial water sources till this periodthough some virgin reserved forest have been partially destroyed during this period. The Government gave the emphasis to construct the road in different parts of Darjeeling hills to speed up development and implementation of various rural employment generating schemes. Unfortunately, deforestation took place as and when such construction was taken up.

After independence the man-environmentrelationship became more complex where man interferedwith all natural processes leading to large scale degredation. There were two quite distinct processes which needed to be distinguished. Firstly, the mountain served as a source of resources for the population living in other areas. This applied particularly for building construction or other forest products where that commercial exploitation of the mountain environment was carried on excessively. This can beperceived in the development of the urban settlement in Kalimpongwhere the forest cover was totallydecimated or destroyed. However, it was paradoxical as the number of decision makers realized the growing importance of the forests. They worked on sustainable mountain environment practices to help develop the area in future. These were hopeful sign that the concerned authorities had realized their responsibilities for the hill areas.

The second process, which happened to be widespread in Mirik and Kurseong is related to unregulated population influx which was very instrumental in accelerating the processes of degradation and destruction of mountain ecosystem. The water retaining capacity of the natural vegetation was reduced and run off increased both in volume and velocity. Deforestation and the use of inappropriate agricultural techniques on unsuitable land lead to different forms of soil erosion and ultimately to the loss of cultivable land. To survive man neededto depend on the traditional and cultural bound techniques for preserving the environment.

Population growth resulted in pressure to expand the cultivable area by clearing forest lands. The land requirement of a given population depend on the productivity of the soil and this could be considerably enhanced or reduced by the agricultural techniques applied. Increasing population pressure also resulted in marginal land. i.e., less suitable and mostly steeper slopes being brought under cultivation thus, lead to a reduction of overall productivity of the land.

Livestock was usually held in excessive number then in the hill areas, partly for religious reasons, partly on account of the low yield of cattle and partly because of the need of animal manure. Livestock made demand on the forest in two ways. Firstly the forest was used for grazing all the year round and the cattle feed on young plants and the leaves and twigs of small trees and secondly the leaves and twigs were lopped for cattle feed by the population themselves. Such practice was heedless as the whole branches were amputated and the trees were considerably weakened. The destruction of forest by fire was partly for the existence of livestock. Many peasants set fire to dry cover of grass and pine needles in order to improve the growth of fresh grass and to destroy the slippery pine needles which were a threat to livestock grazing on the slopes. In areas where the burning of forest grass was practiced regularly a characteristics open forest of old pines without any young trees resulted.

In addition to this, in the absence of alternative fuel needed for the population in the Darjeeling hilly areas the demand for fuel was met by fire wood and as a result trees were robbed of all their branches except for the top crown. An estimated amount of annual firewood consumption was of the order of 0.6 cum per family or well over about one lakh cum for the whole of hill areas. The forest also had to meet the populations need for constructionin accordance to the climate and local building styles. Timber and fire wood extraction, forest clearance for cultivation, grazing, lopping for fodder, burning of the undergrowth in conjunction with in-efficient timber utilization were causing a general degradation of the forests by thinning, ageing and finally destruction. Since independence the forest department had issued the permit tocollect fire wood once in a day per family and cattle grazing permits also were issued in the respective range by the forest department where the cutting of live trees were prohibited. Many people followed the rule framed by the forest department to some extent but some took advantage which caused further deforestation.

Population pressure in the hills had led to deforestation and erosion from the beginning of independent period and situation was becoming more critical every year. Many had no choice than to look for alternative means of live hood. It was clear that destruction of the forest in the hills, through the destruction of the previously balanced ecology was indirectly resulting in the destruction of the forest in the *terai*where both squatting and legal settlements were dependent on forest clearance while a growing population was placing increasing demands on the dwindling forest for firewood and construction timber. This was not easy to stop since some portion of Darjeeling hill areas depended on the selling of such

timber for the purchasing of essential items to meet the needs of growing population. Deforestation in the *terai* did not have the same destructive effect as in the hills.

3.4 Reconstruction of Pre DGHC period environment

Since the inception of Darjeeling Gorkha Hill Council in 1988, massive changes have been seen in different field of environment including felling of forest trees, sawing of timber and selling them to market without permit. Similarly forest land has been encroached by the people and constructed their dwelling houses. They even started the quarry, which is still seen in several parts of the hill area especially in Kalimpong forest division area and partly in Darjeeling and Kurseong forest divisions. The forest products like cardamom and other cash crops including broom-stick, orange, medicinal plant, house decorative plants etc. have been extracted from forest and are being sold elsewhere. Thus the forest environment have been further damaged. Similarly, the PWD land of various parts of the hills and other public lands have been forcefully occupied by the miscreants.

There was an agitation for Gorkhaland from 1986 to 1988 which involves the arm struggle therefore, most of the youth were familiar with the skill to use gun, have also killed unaccounted number of wild animals including deer, hare, porcupine, birds etc. causing irreparable damage to wild life and biodiversity of Darjeeling hills. The small trees and bushes and *champ* flower bearing trees have been cut down in wide area resulting in the perennial water sources in Thuchuk lake in Lava, Sinchel lake in Darjeeling, Durpin in Chimney being degraded. It is practically seen that the Thuchuk water source which was a major water source for Kalimpong town, since the British period has totally dried up as the entire forest area has been deforested causing water crisis in Kalimpong and adjoining areas.

During this period several new roads have been constructed but many more have been left incomplete as the construction work were given to the activists involved in DGHC agitation to make them happy and financially sound. They were not experienced contractors and their quality of work were very poor. This can be substantiated by the fact thay they cut the treesas well as the hill slopes indiscriminately for road construction leading to destruction of the environment. The village roads were also built unscientifically as such construction havealso damaged crops land, fodder and fruit trees of the area. The poor people did not get compensation even though the roads were not their prior demands.

The people have violated the National Forest Policy of 1952, which was initiated to allow exclusive state control over the forest and its management. The policy aimed to increase Government control over forest resources and develop forest to meet the timber needs of industry and defence. It declared that village communities should not be permitted to exercise their traditional rights over the forests at the expense of national interest. Due to the domination of the local leaders, theNational Forest Policy of 1952 could not be imposed during this period in the Darjeeling hill area.

3.5 Comparison between the different periods

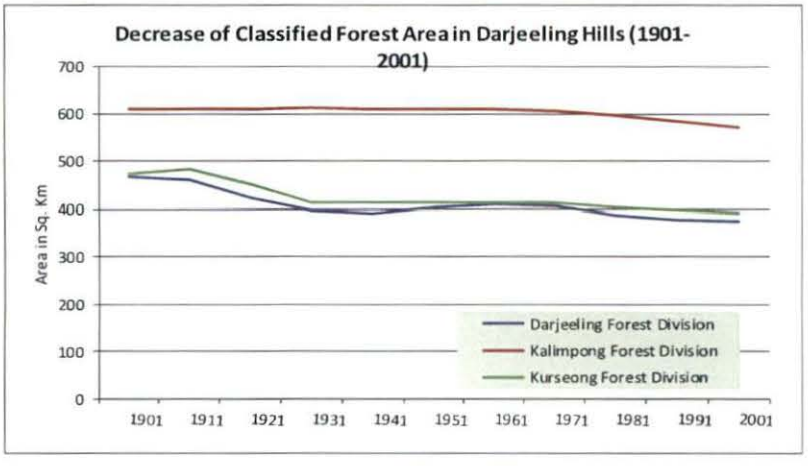
Darjeeling the *queen of the hill stations* was a clean and beautiful town during the British period. The people were law abiding and were law abiding. The present Chowk Bazar (formerly known as *Gundri Bazar*) was the main market place, where the village women used to sell their local produce to the consumers. At present the tall building have over shadowed the breath taking view of Mount Kanchanjunga and the town area is strewn with garbage. The present buildingsin Darjeeling, Kalimpong and Kurseong towns do not follow theMunicipal norm. This difference can beseen when we compare the present building with the old building model constructed in the British regime (photo 3.1 – 3.14).

Earlier the town and *bustys* were establishedonly after a thorough study of mitigation measures for fire havoc, influenza, drought and famine. The houses in the villages were constructed with bamboo, thatch, mud and stone.

Today such houses are only a source of attraction forsustainable tourism. In the early days there were only bullock carts plying in the town as well rural areas of hill areas of Darjeeling. The goods and essential commodities were transported by bullock cartsto their respective destination. In the past there was vast virgin forest in and around Darjeeling and Kalimpong town, but today the towns are covered with *concrete jungle*, where large numbers of multi-storied buildings have been built.

During the British period and during early independence period there were sufficient sources of drinking water in Darjeeling hill areas, but today small springs have dried up and water is being distributed by the tankers of Municipality and P.H.E. Department. The main water source of Darjeeling is Sinchel Lake, Durpin/Chimney in Kurseong and Dhoula in Kalimpong too get much less water in comparision to the yield during the British period.

There has been vast change in forests cover and rhododendron which arethemain attraction for tourists in the past and present are on the verge of extinction. Tea cultivation in the area is confined almost entirely to land transferred on lease from the Darjeeling and Kurseong divisions indicating that substantial felling activity has occurred there in the past and most surviving forest in these two divisions are converted into forests growing conifers at temperate elevation and teak and sal in the terai region.



Source: District Census books of Darjeeling.

Figure 3.2 Decrease of classified forest area in Darjeeling hills

The figure 3.2 reveals long term changes in classified forest covers which have occurred in Darjeeling hills. The most substantive changes over this period seem to have taken place in between 1911to1931, with leasing of considerable tracts of forest land to the tea gardens. Among the three forest divisions, hill forest in Kalimpong have however, consistently accounted for higher forest cover, a feature attributable mainly to the absence of tea garden in that region. Although all forest division show decline in forest cover over the century, the fall has been much sharper in the Darjeeling and Kurseong divisions and moderate in the Kalimpong division

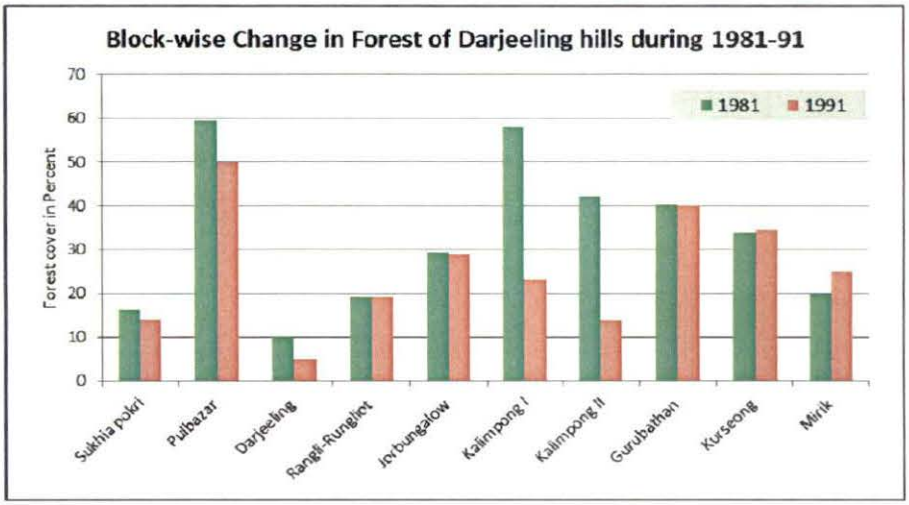


Figure 3.3 CD Block-wise changes in forest cover in Darjeeling hills during 1981-1991

Substantial loss of forest in the district in between 1911-1931 was followed, by marginal recovery of forest cover in between 1941 to 1961, due to large scale forest conversion activity during that period. Lands which had been cleared of mixed forest over earlier period were converted both to tea and to monoculture of coppice, sal and teak in commercial forests. The deforestation trends over the first half of the century thus appear to have been shaped primarily by the revenue motive.

The forests in the region were being felled almost continuously and the losses in classified forest cover represent land transfers outside commercial forestry and tea. The brief recovery in between 1961-71 was followed by another downtrend in forest cover in all three forest divisions in between 1971 to 1991. It is interesting to note that classified forest cover in all three divisions was stationary for nearly five decades beginning 1931 and only after 1971 commenced another decline that appears to be related the growth of settlement.

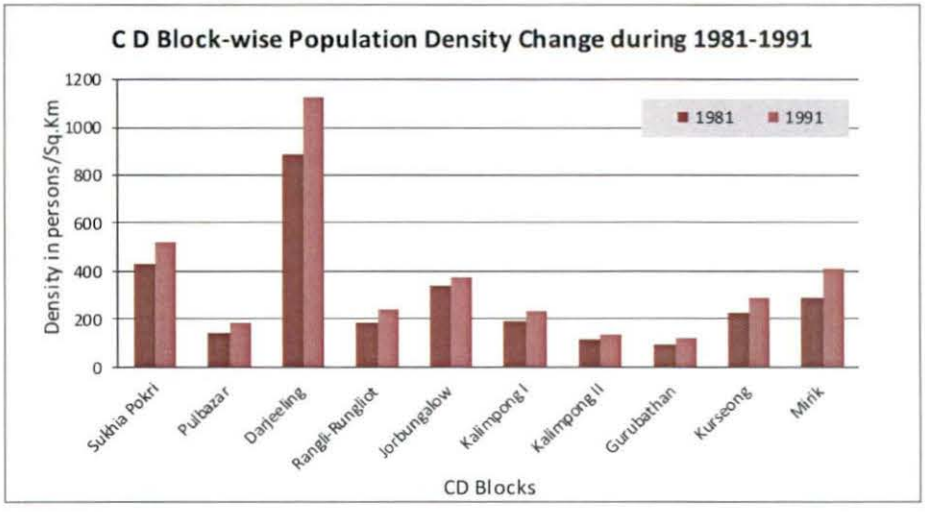


Figure 3.4 CD Block-wise population density changes during 1981-1991

Population density in the Darjeeling hill area stood at 281 persons per sq km in 1991, showing an average increase of 55 persons/km^2 in between 1981 to 1991. The figure 3.4 shows the changes in population density of different blocks of Darjeeling hills. The sharpest increment have occurred in Darjeeling and Mirik both located in predominately tea growing regions where rapid urbanization is also taking place.

Comparison of forest cover to increments population in different blocks during the decade 1981-1991 draws attention to the population forest dynamics of the Darjeeling Himalaya. The growth in population density was estimated to be 66 persons per sq.km during the period 1981-1991, but the settlement is concentrated mostly in and around tea gardens. A sharp contrast is seen in Kalimpong I, where growth of population during the decade has been taken place over dispersed area mostly attracted by agriculture expansion in the absence of tea thus the population increase is absorbed by *khasmahal* leading to a very high rate of forest depletion.

Out of 2355 sq. km of Darjeeling Hill areas the total area of the forest is 1058.08sq km (41.41%), whereas the forest area under the DGHC is 69.50 km^2 which is 2.9% of the total geographical area of Hill Council. The requirement of fuel wood for the population as calculated on the basis of per capita consumption according to Wood Balance Study of West Bengal 1987 comes to 622,000 m^3 obtainable from annual felling of 12.45 km^2 (each hectare producing 500m^3 of firewood). Out of 6.23 lakh m^3 annual demand for firewood, the forest directorate produces annually 25,000m^3 obtainable from 50 ha of clear felled area. Thus the balance which works out to be 11.95 km^2 of forest is plundered annually in Darjeeling hills

for firewood. During the first decade of 1901-1910, the forest department used to produce 82,000m^3 fire woods per year giving 0.32m^3 per capita while during 1951-1960 the firewood production was 84,000m^3 but due to increase in population the per capita firewood available was 0.16 m^3.

The annual average timber production during which 1970 was approximately 1.43 lakh m^3 which in 1980's came to 1.25 lakhs m^3. The timber production further declined and during 1990-2000 the annual timber production in Darjeeling hills was mere 12,500m^3. The total ban of felling of trees following the 1996 Supreme Court order there is practically no legal felling even to meet people's genuine requirement of timber however, this has encouraged timber smuggling resulting in quite extensive degradation of forest. Even as the farmers had raised agro-forestry in their agricultural land the requirement of the landless had to be met from forests. They collect timber and firewood for selling in the market for their subsistence. This is seen to be a major factor for the degradation of forest.

3.6 Reconstruction of DGHC environment of Darjeeling Hill.

Since, the inception of Darjeeling Gorkha Hill Council (DGHC) in 1988, massive changes have been seen in different fields of environment, the forest lands have been cleared and timber was sold without permit. Forest lands wereencroached by the people for constructing their dwelling houses. They have even started the quarrying specially in Kalimpong forest division area. Similarly, the PWDland and Government lands have been forcefully occupied by the miscreants damaging the hill ecology.

The construction of village roadstoo have damaged crops land fodder and fruit trees of the area. Though it was not one of their prime demands the poor people till date has not got compensation for the loss of land. The furniture woods such as champ, panisaj are still available in and around Kalimpong town at a cheap rate mainly due to the total absence of Regularity Authority including Forest Department. In fact, the DGHC period demonstrate all round deterioration of administrative and law enforcing mechanism in Darjeeling hill areas. Thus, environmental degradation reached to a very high level during this period.

The population growth in Darjeeling hill areas during the past 100 years has been high with continuous increment (figure 3.1) putting tremendous stress on the dwindling natural resources. Simultaneously, the growth rate in urban centres has been tremendous as depicted

in figure 3.5. It is revealed, the growth in case Darjeeling town is sharper in comparisiom to other urban centres. Kalimpong shows much sluggish growth (figure 3.5).

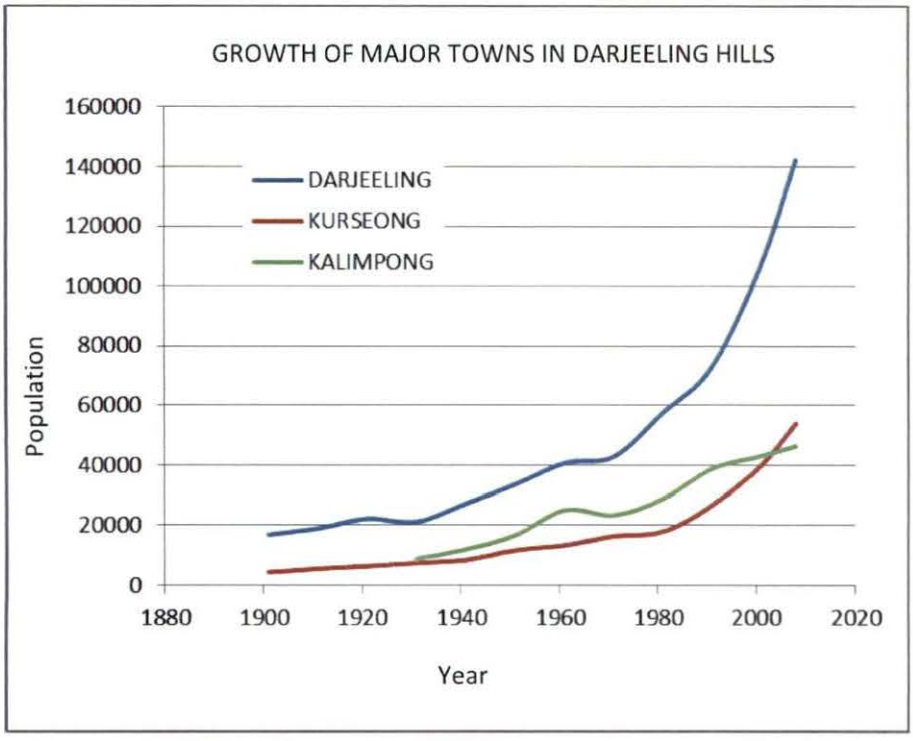


Figure 3.5 Growth of major urban centres in Darjeeling hills

Indiscriminate deforestation and misuse of land within the catchments have caused drying up of many such perennial springs. A conservative estimate put the figure at over 50% during the last century. The rapid land-use transformation has accelerated the decaying processes.During the past hundred years the forest and pasture land has reduced from 77.86% to 38.54%. Consequently net sown area increased from 19.73 to 44.21% (figure 3.6).

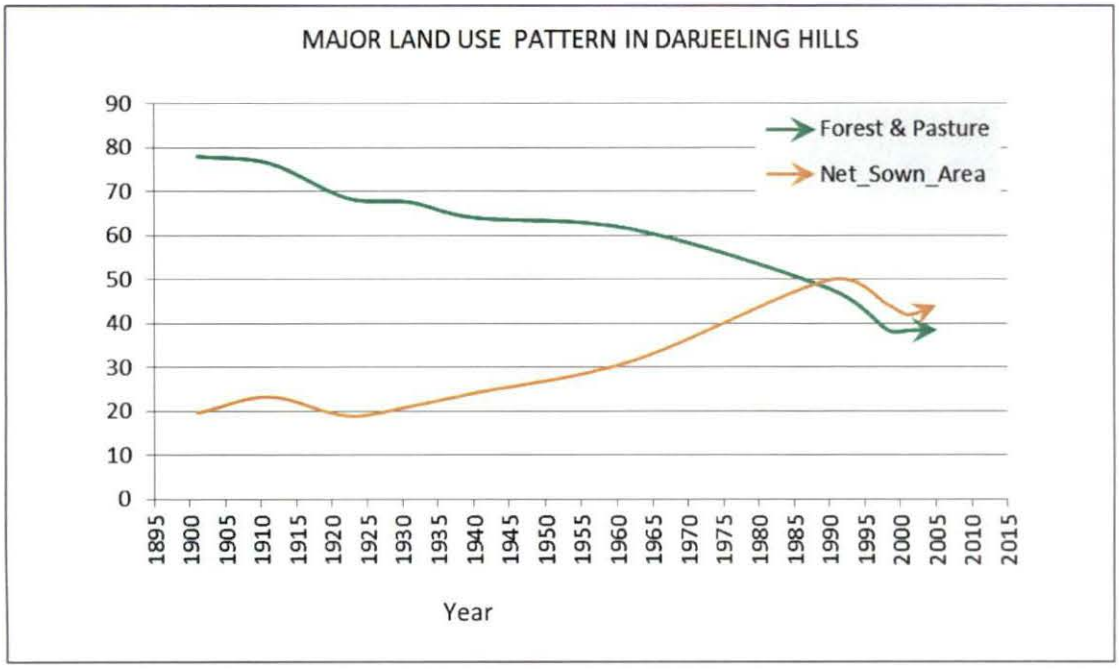


Figure 3.6 Changes in major land use pattern in Darjeeling hills

The hill environment has been damaged badly since the inception of Darjeeling Gorkha hill Council. It is also seen that several tourist spots and community halls have been built in remote villages too, where the approach roads have beenconstructed in such area at the expense of agricultural lands. Forest cover have dwindled, the habitat of animals and birds have been destroyed which is considered as gross destruction of hill environment. Due to construction of various structures especially in urban areas, the temperature has changed due to urban heat island. Further, it is also seen that the very anthropogenic factors such as livestock grazing and fire are responsible for creating many of the grasslands in the hill region.

3.7 Climate change and its impact

Global warming is a phenomenon involving the increase in the average temperature of the earth's near-surface air and oceans since the mid-twentieth century and its projected continuation. The IPCC concludes "most of the observed increase in globally averaged temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations "via the greenhouse effect. IPCC indicates that average global surface temperature will likely rise a further 1.1° to 6.4°C during the twenty-first century. While, climate change includes the long term change in the trend of other climatic elements i.e., humidity, precipitation, wind velocity, sun shine hours etc.

The scenario of global warming vis-à-vis climatic change in the Darjeeling hills perhaps has more implications on the regional life sustaining system than that of its counterpart in the plains. Analysis of long term climatic data reveals some interesting facts regarding the long term trends of temperature, humidity and precipitation pattern. Temperature record (Source: IMD) for the past 116 years reveals the alarming rise of temperature in Darjeeling accounting to 4°C i.e., more than double in comparision to the global figure. Long term projection displays even worse scenario with a possibility of mean maximum and minimum temperature rising to staggering 26°C and 11.5°C respectively with an increase of another 3.5°C by the next century (figure 3.7).

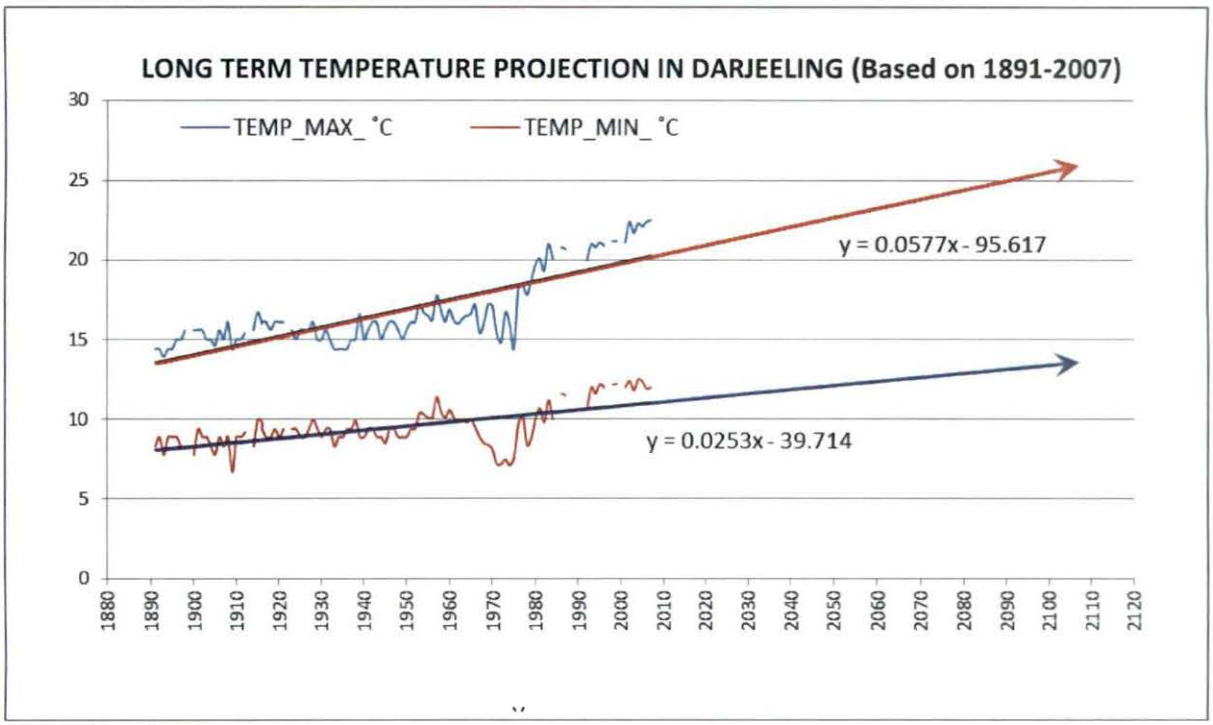


Figure 3.7 Long term temperature projection of Darjeeling

Climate change has also changed the relative humidity level in Darjeeling (figure 3.8) in the past hundred years. A decrease of 7% relative humidity is recorded during the pasthundred years. Projection for the next century reveals a further decrease of another 7% of relative humidity. The decrease will have an adverse effect on the biosphere as when theincreasing biological demand of water cannot be met, it might cause extinction of invaluable biodiversity of the Darjeeling hills. It will also affect agriculture in general and Darjeeling's famous tea production and quality in particular.

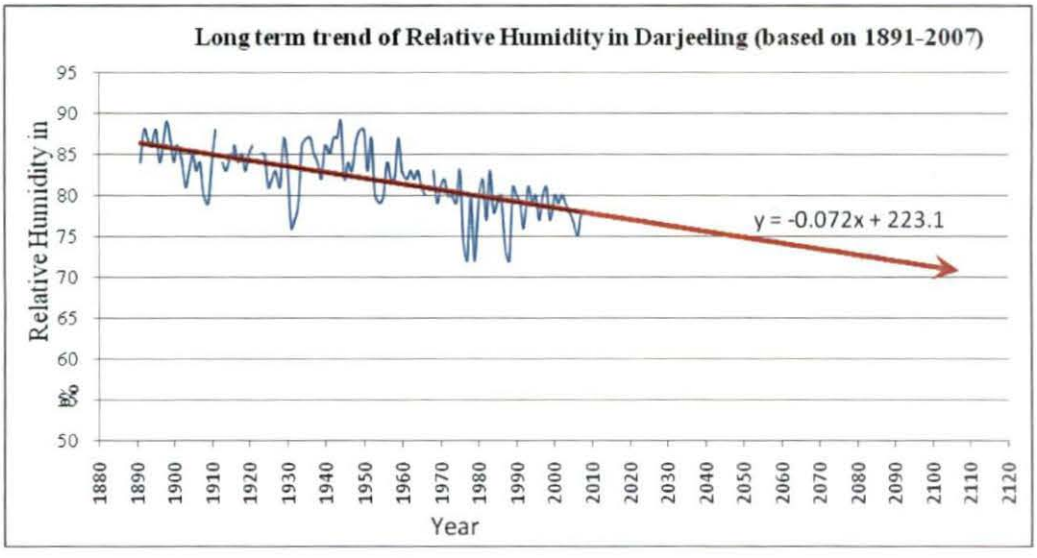


Figure 3.8 Long term relative humidity trend projection of Darjeeling

Effect of global warming is also found visible in precipitation pattern in Darjeeling Himalaya. Precipitation record (Source: IMD) for the past 116 years reveals a clear decreasing trend in precipitation amount at an alarming rate i.e., 300 mm decreased during the past hundred years and another 350 mm is expected to decrease by the next century (figure 3.9). The possible effect of such a drastic change would be disastrous unless the society is prepared with proper mitigation measures.

Darjeeling Himalaya due to its special location against the backdrop of the mighty Himalayan barrier will display massive ramification of the possible effects of global warming phenomena by the next hundred years. These include:

- The Himalayan glaciers have started to melt and the average rate of retreat is almost twice (34 meter) per year as compared to the 1971 levels of 19 meter. Glacial meltdown in North Bengal deserves a special position as it governs the major perennial rivers like Tista, Torsa, Jaldhaka and Sankosh, hence global warming would cause devastating flood followed by prolonged drought.
- As the greenhouse gas emission increases the global warming rate resulting in strange climatologic phenomenon, like altered stratospheric jet stream path that may lead to irregular monsoon. This would be a death blow to agriculture and agro based industry.
- Darjeeling Himalaya is famous for its worthy forests and wild life, a increase in ecological disturbance would result in a very poor flora and fauna percentage in wild,

and this have been proved as a temperature change of mere 5°C degrees can make 30 species extinct.

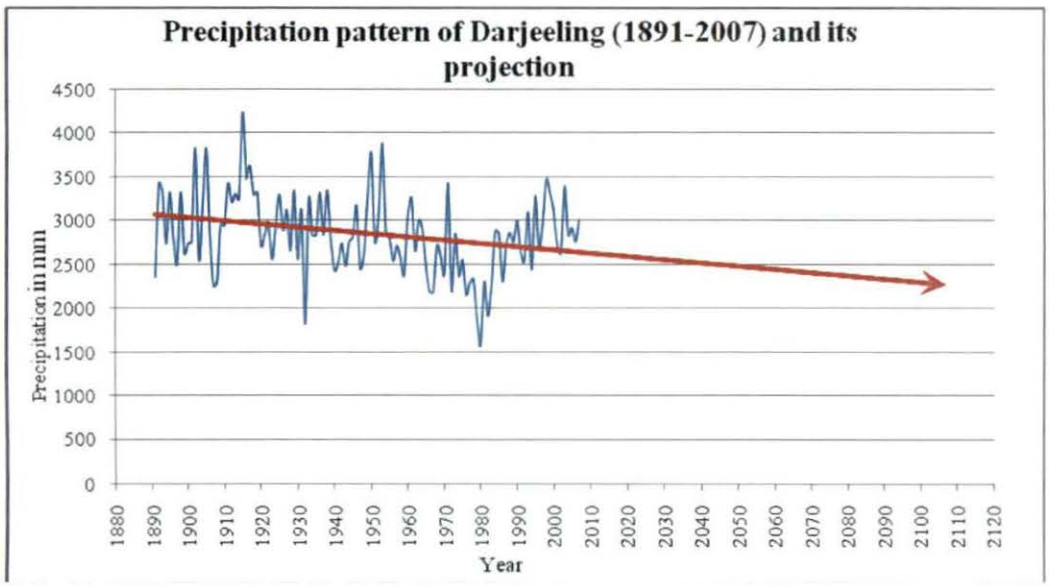


Figure 3.9 Long term precipitation trend projection of Darjeeling

- The global warming manipulates the glacier melting process. Glaciers like Zemu give rise to large rivers of North Bengal (Tista) which holds a place of great economic importance. But an excessive supply of water due to glacial melt down would cause flood so devastating that the riverine trajectory would cause thousands to become landless and homeless. Further, it would hamper the fisheries.
- The land would never get adequate water for cultivation again as the rivers would dry soon after the glacier melt. Many of these rivers might cause premature termination.

Thus it is apparent from the above mentioned facts that the climate change scenario is already visible in Darjeeling hills in quite a significant manner. The course of variability is significant and a wide range of variation takes place in terms of temperature and relative humidity during the past 100 years. These need to be identified in order to sustain the productivity by altering the agronomic management options. The quantity of rainfall and its events have also become more uncertain. In certain places climatic extremes such as drought, floods and snow melt have also increased.

Similarly impact of climate change on soil also has been noticed. The most important process in the soil is the accelerated decomposition of organic matter which releases nutrients

in the shortertime which however may reduce soil fertility in the long run. Soil temperature influences rate of decomposition of organic matteras nutrientswhich are released are taken up by plant's metabolic processes. Soil productivity is influenced by the amount and activity of soil micro-organism which help in degrading the organic carbon in the soil as well as fixing the available nutrients. Climate change may also increase the rate of soil erosion caused by accelerated high intensity small duration rainstorms which will further hamperfood production and a further negative consequence of accelerated erosion will lead to increased sedimentation in streams and reservoirs.

Climate change may influence spatial and temporal agriculture productivity through various influencing factors such as sustainability of crops, stability of crop yields, profitability, trade opportunities, employment and land reforms. The future socio-economic circumstances on which climate change impacts will occur will be very different from today's and therefore one has to be careful in interpreting the present results for future climate change scenario. The future agriculture system is likely to differ not only in size but also in structure from the present system. The pressure of other external drivers and influences such as the WTO also need to be included.What will be a fraction of small marginal and large farmers, how the input application will change due to technological advances and what kind of crops and cropping system will exist also needs to be examined. The land use and land cover change will be strongly influenced by a rapidly growing population, industrial pressure and water availability. The marigold the most common flower cultivated in Darjeeling hills has become threatened due to climate change, cardamom which is the cash crops of hill area of Darjeeling has declined its production significantly. Socio-economic linkage with future agriculture production is relatively complex and also need to be linked through the bio-physical modification associated with climate change. Socio economic aspects can be dealt working out the cost benefit analysis for various climate change scenario by using econometric process models and the other as generating the socio economic scenarios pf the re-cropping system model for further impact analysis.

Agronomic experts can provide guidance on possible strategies and technologies that may be effective, farmers must evaluate and compare these options to find those approximate to their needs and the circumstances of their farm. Identification of the present vulnerabilities of the agricultural system cause of resource degradation and existing system that are resilient and sustainable strategies that are effective in dealing with current climate variability and

resource degradation are also likely to increase resilience and adaptability to future climate change.

Food programmes and other social security programmes need to be introduced to provide insurance against lower production due to extreme events. Infrastructure facilities like transportation distribution and market need to be improved for meeting the growing changes arising due to bio-physical and socio-economic drivers along with the climate change and its variability.

Change in policies such as crop subsidy schemes, land tenure systems, water pricing and allocation could increase the adaptive capability of agriculture. Many of the above strategies will be beneficial to the farmers for climate variability and climate change building the capability to defend change and evaluate possible responses is fundamental to successful adaptation.

The immediate impacts of climate change as already visible includes in early flowering of some species and changes in growing periods of some crops will influence and modify the crop production. The farmers of Darjeeling hills have reported that a disease of black spot on the leaves of potato has developed resulting decline in potato production may be due to the effect of climate change i.e., increase in temperature. Vulnerability to climate change is closely related to poverty as the poor have fewer financial and technical resources available to them to cope with climate related changes they have a great dependence on prevailing climate for agriculture activities.

On the other hand climate change has its impact on health also. There has been growing concern in both climatological and medical communities that climate change is likely to have wide ranging impacts on health. The potential health effects from these consequence are many overall negative health impacts may out weigh the positive ones.

Extreme weather events increase death and pathology rates directly through injuries or indirectly through infectious diseases as well as through social problems that stem from the effects and other stresses indirect health effect include. Increase in vector borne diseases such as malaria and dengue fever because changes in temperature will increase the availability of a suitable habitat for the insects or parasite, the developmental rate of insects that spreads a particular disease there also may be increases in the spread of food poisoning and water borne diseases as aquatic pathogens may get greater chances of survival for a longer period of time.

Table 3.1 Climate change and its impact implication.

Driving factor	Impact and Implication
Increased photosynthesis and water use efficiency as a result of increase in Co^2 concentration.	Forests at lower elevation will respond to a greater degree compared to degraded forest at higher elevation. Evergreen early successional fodder tree will respond to a greater degree compared to deciduous timber tree. However, shortening of life span of leaves, changes in biomass allocation pattern, poor quality litter production may counter balance the Co^2 enrichment effect. Higher Co^2 concentration can induce self compatibility in other wise self compatible species composition will change due to reduced fitness of many species.
Increase in temperature	Warming induced stimulation of growth will increase with increase in elevation. It may result in higher yields of some crops if warming is not coupled with water and nutrient stress, but will not be favourable for alpine species which require chilling for germination and fruiting. Leaf life span reduces with increase in temperature in the north-eastern Himalaya. *Quereus leucotrichophora*, a species with high ecological as well as socio-economic values, shows low production at lower elevation hence is likely to be negatively affected by warming.
Change in precipitation	Ecosystem with clay-loamy and organic soils will affect to higher degree of water stress in Darjeeling Himalaya than sandy soil with low organic matter content. Later successional species with a greater capacity of storing resource in root system will have an advantage in coping with the nutrient stress. If shedding of leaves in a strategy to avoid low temperature and related water stress, increase in rainfall coupled with increase in temperature is likely to increase the life span of leaves.
Change in phenology	Reduction in length of the dry season under higher temperature and rainfall scenario may intensify competition for shared pollinators or may increase the density of some pollinators which may compensate for over lap of flowering. As the proportion of evergreen and deciduous species or winter, summer and spring flowering species and of wind pollinated and insect pollinated species is not uniform across the region the impacts of climate changes on ecosystem properties mediated through phonological changes will vary within the region.
Change in soil carbon stock	Higher rates of removal of leaf litter and dead wood from forest floor with increase in population pressure coupled with higher soil respiration under warmer regimes will reduce downward movement of organic carbon, more so in open environment.
Upward movement of biomass	Upward progression of species in response to warming is almost certain but the rates of ranges expansion are difficult to predict because of interaction of climate and non-climate factors determining species abundance. As responses to temperature differ by species and elevation, new altitudinal belts of vegetation will differ from the present pattern. Alpine vegetation particularly on convex slopes is likely to be the most sensitive's to warming. The proportion of grasses forbs and shrubs are likely to increase and that of sedges to change in economic and ecological functions of

	meadows.
Changes in species composition	Competitive interactions are intensified under elevated Co^2 vines may profit more. A climbing invader niches will under go stress and will have less chances of survival compare to wide niche species. Migration of species to favourable niches will be limited by habitat fragmentation.

There might be nutritional health effects because of changes in agricultural productivity. In the town areas where the health system are not geared up yet to meet the needs of all sections of society, specially the poor are likely to be adversely effected by aforesaid health impact. The most affected even with in the vulnerable areas will be children, senior citizen, physically challenged people, people living in pockets of overcrowded and poorly serviced settlements in urban and rural areas.

There will be massive change in natural vegetation in Darjeeling hills under the influence of climate change. Some of the major impact implications have been tabulated in the following table (table 3.1). While warming will drive biomes upward, changes in ranges of species are also certain. There are several sources of uncertainty to forecast which species are most likely to be threatened or favoured partly because the importance of non-climate factors in influencing vegetation dynamics has not been given due to consideration in the prediction. In the hill areas, moraines exposed as a result of glacial retreat due to warming will drive alpine species upward but colonization may be constrained by erosion and nutrient limitation. The dominance of tree species derives from their physiological adaptation to extremely low temperature. These species with a narrow ecological niche may be exterminated if they fail to complete with the new arrival under warmer regime and/or to expand their ranges.

In alpine areas, Junipers are found to prefer drier limestone area rich in calcium and Rhododendron prefer moist areas in schist area poor in calcium, as altitudinal belts differ in topographic and geological attributes influencing species dominance and distribution. The landscape scale composition of forest and meadows observed at present is going to be different from the future scenario. Low altitude/ foothills forest dominated by *shorea robusta* are not likely to be as sensitive as higher elevation vegetation because this species can withstand much warmer humid/dry climates.

Table 3.2 Common change in vegetation due to climate change

Kind of change	Change driving factors
Conversion of dense to open forest	Population pressure, market forces, erosion of traditional forest management to fulfill local need.
Dense forest converted to scrub	Intensive timber extraction on steep slopes with poor regeneration capacity.
Degraded forest converted to agricultural land	Increase in livestock population, erosion of traditional values of grazing, failure of formal institutions to check illicit grazing, decline in fodder production and policies limiting direct economic benefits from forests.
Conversion of pastures to agriculture/ scrub land/forest	Protection and plantation of multipurpose trees by local communities.
Conversion of grasslands to scrubs	Decline in nomadic grazing due to enforcement and/or cultural change.
Increase in multipurpose trees in farmland	Degradation of natural forest, restriction on access to meadows and forest, policies favouring timber and other industrially important trees, limited indigenous capacity to enhance productivity of community forests.
Conversion of agriculture to agro horticulture	Subsidy on horticultural inputs and marketing.
Increase in forest species richness	Strict enforcement of protection.
Conversion of Oak to pure pine stands	Commercial charcoal making, selective protection of pine to maximize revenue.
Domestication of new crops	Emergency market for medicinal plant product and restriction on extraction from the wild.
Expansion of weeds	Habitat changes together with climate change.
Phonological changes	Shift in flowering time of Rhododendron from March/April to Feb-March due to climate change.

3.8 Conclusion

It is seen from the different records, there has been massive change in environment in the Darjeeling hills for last 100 years, every decade there has been change in human habitation, increase in dwelling houses and urban centres, new roads, developing of tourism centres, along with deforestation, etc. are the main causes of degradation of environment. It can be said that day by day hill environment has been deteriorating to a very great extent. The species which were seen 100 years back has been extinct and threatened. The future will be very bleak if we continue to misuse and over use of hill environment in this way.

The environment degradation in the hill areas are complex and interrelated with many processes i.e., landslide, soil erosion, drought, floods, decline in the forest cover, decline in

agricultural yield, siltation in reservoirs and rivers, extinction of species etc. The natural springs are rapidly dying, domestic animals are less productive or unproductive, the fodder resources are limited and natural forests are fast disappearing in the hill areas. Blasting of the rocks for the construction of roads, tunnels, dams, colonies etc. and haphazard method of mining have greatly affected the ecological balance. Mining operations are old and traditional which have destroyed lush green vegetation cover. The dust particularly emitted from the stone and sand quarries and other similar factories have been contaminating the air and are causing serious air and noise pollution. The forest under growth has been cleared, the sub-surface water has been decreased and the mountain side resembles a gigantic skeleton due to blasting as it is going on the Tista low dam hydroelectricity project.

In higher altitudes, forest edging is an environmental hazard. In areas of moderate relief, water erosion is a serious problem as it makes the bed rock week susceptible to mass movement and landslides. Landslides are very common often blocking the vehicular traffic and sometimes damaging engineering projects. In the low relief of alluvial plains, flush floods, soil erosion and sheet erosion are environmental hazards.

The construction of unimaginatively planned and recklessly executed roads along the fragile hill slopes in the biggest factor of destroying the environment. Constructions of dams on hill rivers to meet the ever increasing demand of irrigation water and power of the plains is yet another environmental hazard. These projects cause destruction of hills, flooding the fertile valleys and create the problem of rehabilitation.

Climate change is a long term process that involves significant change in the average weather of a region. Average weather may include average temperature, precipitation, humidity and wind patterns. The earth's climate has changed many times during the planets history, with events ranging from ice ages to long periods of warmth. It has been proven fact that human activity is the main explanation for the current rapid changes of global climate. Consequently, the stress should be to reduce the human impact. The climate changes are inferred from changes in indicators that reflect climate such as vegetation dendrochronology, ice cores, sea level change, measurement of green house gases and glacial retreat etc.

Aerosols may be of either natural or anthropogenic origin such as collection of airborne solid or liquid particulars residing in the atmosphere for several hours. The physical characteristics of particles and how they combine with other particles are part of the feed back mechanisms of the atmosphere. The atmosphere constituents affect the climate change

directly or indirectly. The effect of climate changes are changes in precipitation patterns changes in wind patterns (storms/high intensity rainstorms), deforestation, urbanization and desertification.

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Photo 3.1 Panoramic view of Darjeeling town in 1913 (Courtesy: Das Studio, Darjeeling)

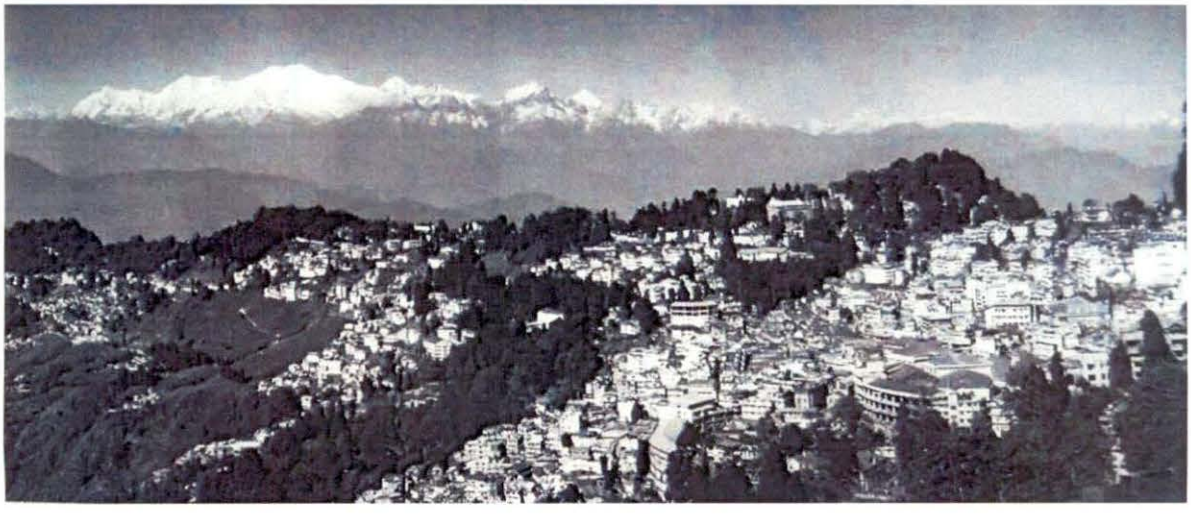

Photo 3.2 *View of Darjeeling Town in 2004 (Courtesy: Das Studio, Darjeeling)*

Photo 3.3 Kalimpong town in 1892 (Courtesy: Kalimpong Public Library)

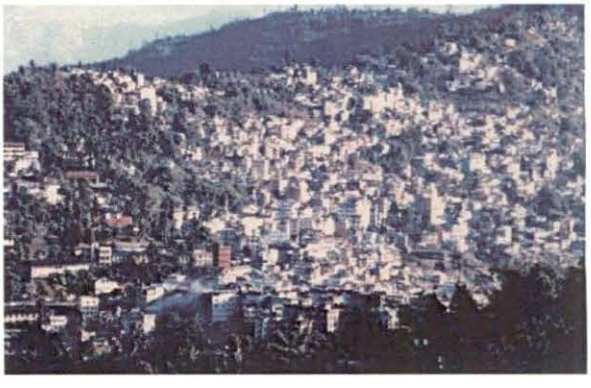

Photo. 3.4 Kalimpong urban sprawl in 2010

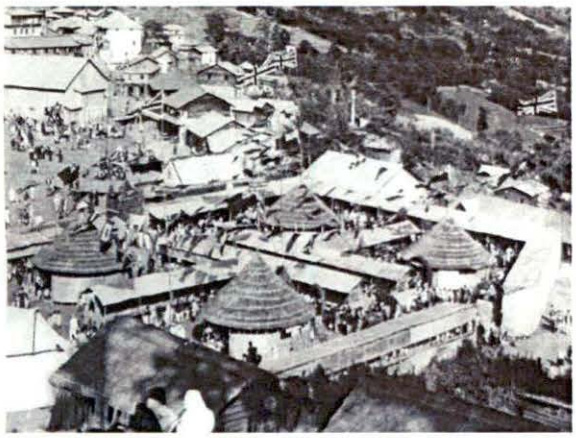

Photo 3.5 Kalimpong Festival at Mela-ground in 1935 (Courtesy: Kalimpong Public Library)

Photo 3.6 Present Kalimpong Mela-ground

Photo 3.7 Riyang Railway Station in 1915

Photo 3.8 Riyang Railway Station at Present

Photo 3.9 Kalimpong Main Road in 1915 (Courtesy: Kalimpong Public Library)

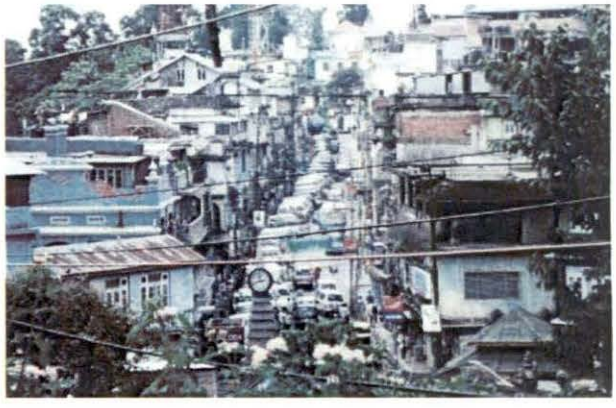

Photo 3.10 Present Kalimpong Main Road

Photo 3.11 Snowfall in Kalimpong in 1920

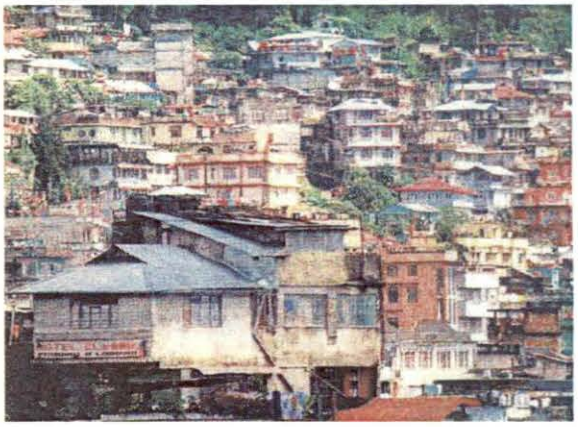

Photo 3.12 Concrete Jungle at the same site as multi-storied buildings coming up in Kalimpong, 2011

Photo 3.13 The TLDP III Project site at Rambhi before implementation, 2000

Photo 3.14 The TLDP III Project site at Rambhi during implementation, 2011

CHAPTER – 4

Nature and Extent of Environmental Degradation in Darjeeling Hills

4:1 Introduction

Environmental degradation and its consequently deepening crisis of sheer magnitude have of late, altered many within this country. Thus, there is a serious concern for finding the right mitigative measures especially in dealing with the hilly environment. Whether, through ignorance or not, the fragile hill ecosystem has often been violated outrageously, impairing its delicate sub-systems which have a long term effects, jeopardizing the life-sustaining processes. The growing consciousness about the worsening situation compels the society today to make a rethinking, for halting the causes of grave injuries to the environment. While, it is admitted that the environment cannot be reverted to its original form, nor can it be intended to, it may not be beyond our conscious efforts to check or control such practices for arresting further deterioration, followed by protective measures for seeding-up the restorative processes in this fragile environment.

The Darjeeling Himalayan region is noteworthy for its wide variety of renewable and non-renewable resources. Of late, this repository of natural wealth has been subjected to virtual plunder. In consequence, the watershed ecosystems are fast loosing their resilience and regenerative capacity.

Since the British occupation, the physico-cultural set-up of this region has been seriously disturbed. Extensive heedless deforestation, tea plantation, haphazard construction, huge population influx induced illogical slope cultivation, inadequate drainage, in other words, unscientific and unplanned use of land has led to the establishment of vicious cycle of degradation. As a result, during heavy and concentrated rainfall, catastrophic soil erosion and innumerable landslips are caused, contributing huge sediment load to the rivers which are incapable of transporting the load efficiently under the existing hydrological conditions especially along their lower courses beyond the foothills. The river beds are rising, resulting in lessening of cross sectional area, which being incapable of arresting unusual monsoon discharge and cause devastating floods, endangering the vital line of communication, human habitations, farm lands and forests (Sarkar, 1991, 1996).

Implementation of various development schemes, construction of human settlement and road to cater the ever-increasing population, exploitation of forest produce to generate

work potential, boosting of agricultural growth, tourism, mining and quarrying, on the Himalayan immature geology trigger the disaster, huge and complex, never encountered before.

The situation was not so bleak even 100 years back. The hills were densely forested with very thin population and the harmonial relation between the upper and lower parts of the watersheds were well preserved. Extensive heedless deforestation, haphazard construction of roads and settlements, unscientific and illegal mining activities, inadequate drainage, in other words – unscientific and unplanned usage of land, has led to the establishment of vicious cycle of degradation.

During heavy and concentrated rainfall, catastrophic soil erosion and innumerable landslides are caused to transport huge amount of sediments from the upper part of the catchment to the parent river (Froehlich, Soja, & Sarkar, 2000; Patel, & Soja, 995; Starkel et. al., 1998, 2000; Starkel, & Sarkar, 2002). These rivers are incapable of transporting the load efficiently under the existing hydrological conditions, especially along their lower reaches. The river beds are thus elevating at many places at an alarming rate resulting in lessening of cross sectional areas. The reduced cross sections being incapable of arresting the unusual monsoon discharge caused devastating flood, causing heavy damage to the land and properties. It also endangered the priceless forest lands, wild life vis-à-vis bio-diversity and vital line of communication and strategic infrastructure.

Environmental degradation in Darjeeling hill areas has been increasing day by day. The Darjeeling hill areas are facing the worst ever crisis. The degradation damage is gradually extending into the comparative stable areas as well adjacent piedmont areas of North Bengal plains also. If the current illogical and so called development exercise is not arrested and/or be environment friendly the "*dooms day*" is far away for the entire Darjeeling hill area.

Among the major degradation processes active over the Darjeeling hills, deforestation is the single most important and also instrumental in releasing a chain of other kinds of degradation processes. Such as landslides, soil erosion, edaphic drought etc. are basically caused by the massive deforestation that had taken place during the past one and a half century.

4.2 Deforestation

It is already mentioned that the Darjeeling hills has been experiencing massive heedless deforestation since the British occupation. There are different causes of deforestation in Darjeeling hills of different dimensions. Although, the relative importance of such causes are more related to spatio-temporal variations yet all of them are in totality exerted detrimental impact to the once pristine environment of the Darjeeling hills (photo 4.1). The following are the important identifiable causes of deforestation in Darjeeling hills:

i) Deforestation due to establishment of development projects such as construction of dams, construction of roads establishment of railway link (from Sukna to Darjeeling railway line), urbanization, tea plantation and factories, quarry/mines etc. all in fact destroyed forests and disturbed delicate hill-slope hydro-geomorphic balance.
ii) Felling of trees for fuel for fuel wood by villages is a major cause of deforestation.
iii) Clearing of forest for agriculture to supply food for growing population is another reason.
iv) Industrial uses of timber for furniture, raw material, plywood industry etc.
v) Overgrazing by livestock especially introduced by villages inside forests and grasslands cause a great damage through the grazing of seedlings and saplings. This adversely affects the natural regeneration process.
vi) Inception of railway network in Darjeeling hill in the year 1881, steady supply of special variety of timber was needed for sleepers caused massive deforestation along the lower hills and piedmonts.
vii) Man induced forest fires have destroyed considerable forest area in different parts of the hill especially in some parts khashmahal forests of Kalimpong sub-division. Such grave activities have taken place as a result of unholy nexus between politician and timber smugglers. Natural forest fire also causes extensive damage to ground flora every year fire has caused extensive damage to young as well as old plantation in the hilly region of Darjeeling. The damaged of the older plantation was caused in Rimbik, Tonglu, Ghoom-Simana ranges of Darjeeling division. Fire has also caused damaged to the younger plantation especially in Tista valley and Darjeeling range of the division (table 4.1).
viii) Shifting cultivation is also a reason for deforestation in hill areas during early stage of British annexation of Darjeeling hills. This practice still continues as demands on agricultural land increases due to population influx, where more and more land is being brought under cultivation for which forests are cleared, grassland ploughed uneven unstable landslide prone areas are annexed thereby, causing further deforestation. It is

observed that even forest area are distributed among the landless families instead of redistributing un-utilised cultivable land.

ix) Fire wood collection from the forest has been a major occupation to the vast majority of rural population of hill areas not for their own sustenance but also for income generation till today. Fire wood is still today the only source of fuel for cooking and worming during chilly winter to the villagers and people living in small towns. Fire wood collection contributes much to the depletion of forest cover especially in localities which are lightly wooded, denser forest usually produce a lot of combustible material in the form of dead twigs and leaves, hardly any need of cutting down live trees. However, in the case of lightly wooded forest where the pressure of demand is usually higher a slow thinning of woodland occurs due to regular foraging of villagers.

Table 4.1 Forest area affected by fire in Darjeeling division.

Sl no.	Year of occurrence	Area in hectare
1	1991-92 April/ May	500.00
2	1995-1996	37.50
3	1997-1998	38.45
4	1998-1999	46.042
5	1999-2000	27.4
6	2000-2001	231.87
7	2001-2002	180.06
8	2002-2003	54.32
9	2003-2004	21.87
10	2004-2005	34.07
11	2005-2006	98.53
12	2006-2007	594.78
13	2007-2008	567.03
14	2008-2009	671.02

Source: Forest Deptt., Govt. Of West Bengal

x) Lumbering was an important economic activity in Darjeeling hills during the period of British occupation and still it is continuing. As a consequence, vast tracts of high natural forests are being mercilessly exploited. Logging or felling of forest trees for obtaining timber is an important cause of deforestation in this hilly region. Live trees with thick and straight trunks are felled and transported to commercial establishment elsewhere to consumers. The forest department also indulged clear felling in the name afforestation programme. The timber thus collected has been transported in different parts of the country for commercial purpose. Such activities are still in progress in areas under

Kalimpong Forest Corporation and practiced in Rongpu, Tarkhola, Manzang forest area and in Lava range of Kalimpong forest division (table 4.2). Thus large stretches of forest are damaged and the system which could have provided resources worth much more to the local people is disrupted. Profits from timber trade are normally enjoyed by the large companies and/or affluent contractor. Local people get a very small share in the benefits while axing their own resource base.

Table 4.2 Extent of forest degradation in Darjeeling hills

Forest Division	Forest Range	Blocks severely degraded > 40%	Blocks partly degraded 20-40%	% of the degradation as per total range area.
Darjeeling	Tista valley Takdah	Riyang Gayel Takdah west Pamong Lopchu	Pesok Sira	30 30 to 40
Kurseong	Bagdogra	Kalka, Dolka Kadam central Malta Tarabari Tirihana	Bagdogra	40 to 50
	Panighatta	Balasan Kalabari Mechi	Bangkolong Lohagarh	50 to 60
Kalimpong	Chel	Chunabhatti, Noam, Yamakum	Lish, Mangpong	20
	Neora	Mal, Sakam	Ambiok	20-30

4.2.1 Consequences of deforestation

The effects of contemporary forest degradation in the Darjeeling hills have been demonstrated by the ever increasing deterioration in the overall quality of land, air and water of the region concern. As a result, the overall quality of living in the Darjeeling hills is fast deteriorating putting a big question mark on the future of the region. Some of the striking effects are listed below:

- Edaphic drought ness
- Deterioration of surface water both quality and quantity
- Drying up of springs and *jhoras*
- Reduction of ground water recharge
- Deterioration of soil quality
- Increased frequency and magnitude of floods in the lower sections
- Increased frequency and magnitude of accelerated soil erosion and landslides and related slope movements

- River metamorphism vis-à-vis avulsion
- Enlargement of river valley
- Loss of forest resource including biodiversity
- Climate change

It would not be possible here to describe all details of these impacts. However, to visualize the magnitude of the possible threats of watershed degradation as visualized from the rising river beds has been shown in the present case. Increased frequency and magnitude of slope movement vis-à-vis landslides along with accelerated soil erosion in upper hilly section and increased frequency and magnitude of flood occurrences in lower sections of watersheds in the plains has already been demonstrated. Sarkar (2008) has demonstrated the effect of deforestation in upper catchments of Sub-Himalayan rivers as the alarming rate of river bed rising along the piedmont and plains in the following table (4.3).

Table 4.3 River bed rising in the Himalayan foreland

Rivers	Rising of bed level*	Location of measurement	Period of measurement
Tista	1.100	Jalpaiguri town	1985-2005
Jaldhaka	0.900	NH 31 Bridge, Gadhaierkuthi	1986-2005
Torsa	0.900	NH 31 Bridge, Madarihat	1985-2005
Sankosh	0.800	NH 31 Bridge	1987-2003
Balason	1.124	Near Matigara Tea Garden	1984-2006
Mahananda	1.980	NH 31 Bridge, Champasari	1984-2006
Kaljani	1.310	Near Alipurduar	1992-2002
Lish	2.490	Bagrakot	1982-2004
Gish	1.980	Odlabari	1982-2004
Diana	2.012	NH 31 Bridge	1990-2005
Rethi	2.410	Near Chamurchi	1990-2003
Dima	1.800	Near Rajabhatkhowa	1991-2003
Bala	2.145	Near Santalabari	1991-2004
Jainti	3.050	Jainti	1991-2004
Pagli	2.540	Near Makrapara	1993-2003

* *measured by the author.* *Source: Sarkar, S, 2008*

A chain of events is set into motion as the consequences of deforestation such as (a) soil degradation and erosion; (b) changes in climatic condition; (c) destruction of natural habitats and (d) destruction of valuable sink for environmental pollution.

(a) Soil degradation

Plants check rapid movement of air and water. Flowing water stay in the area for a longer duration during which time nutrients are re-absorbed and as water percolates down

ground water table is recharged plant cover keeps the ground surface humid. Trees with the help of deep root system are able to draw water from sub surface water. High humidity prevents excessive water loss and rapid desiccation and thus plants contribute organic matter which upon decomposition adds humus to the soil. Porosity helps in increasing water holding capacity and productivity of the soil. Organic matter binds the soil particles in soil crumbs which make it stable against forces of erosion.

Deforestation leaves the ground surface bare. In humid tropics a large portion of available mineral nutrients is taken away when the biomass is removed. Herbaceous plants and grasses are exposed to the sun, wind and rapidly flowing waters. There is further loss of mineral nutrients. Grazing may remove much of the organic matter with which the further loss of nutrients is even more rapid. All this further reduces the cover of small plants and grasses as well. Adequate plant cover keeps the soil temperature lower. At the depth up to 70 cm a higher temperature is observed in soil devoid of plant cover. Higher temperature speeds up mineralization of organic matter. This reduces the stability of soil crumb structure and the soil becomes easily erodible. It also loses its capacity to hold water, recycle mineral nutrients, nitrogen fixing capacity etc. and turn into a dead mass of silt clay and sand. With plant cover gone the battering action of wind and rain loosen the top soil which is thus carried along with water or air currents and deposited elsewhere.

(b) Change in climatic condition

Forests save natural environment and moderate local climatic condition. They maintain humidity, regulate temperatures, break wind velocities and influence precipitation. The extent up to which forests influence our natural environment is a controversial subject. However, it is almost certain that dense growth of green plants has moderating influences on local climatic condition and the global environment in a number of ways (a) maintenance of humidity (b) regulation of atmosphere temperature (c) moderation of wind velocity (d) enhancing precipitation. Today most scientists believe that perhaps increasing forest cover is the only solution to the ever increasing threat of adverse impact of climate change.

4.3 Edaphic Drought ness of hill slopes

Soil is considered one of the most important ecological factors. Plants depend for their nutrients water supply and anchorage upon the soil. Even for the free floating aquatic plants which derived their nutrients dissolved in the water medium around them, soil (mud) is

important as chief storage of all the nutrients which are made available to the water medium. Edaphic factors include the structure and composition of soil along with its physical and chemical characteristics. Soil system is indeed very complex and dynamic. The increasing edaphic drought condition has brought massive change in the soil of Darjeeling hill areas, and the rate of such changes being influenced by a number of other factors of the environment.

Due to physical and chemical condition of the soil under environmental degradation there have been massive change in plants and animal life in the Darjeeling Himalaya. As the deforestation adversely affect atmospheric humidity and in case of Darjeeling hills it was as high as 7% decrease during the past 100 years (Sarkar, 2012) the apparent soil desiccation is evident. Decreasing atmospheric humidity on the other hand leads to an increase in biological demand for water intake to the living organisms which further desiccate the soil moisture regime. As a result, many plants and animals including micro-organisms fail to survive which ultimately leads to species extinction an irreparable damage to the overall environment. It is seen that due to this reason the common and popular flower Marigold has been almost extinct from the Darjeeling hill area since 2005 and another important cash crops of Darjeeling hill area i.e. cardamom also has been facing serious threat of extinction from various parts of hill areas. Beside that many other less known plants of this hilly region also have been experienced either extinction or facing serious threat of possible extinction.

Perhaps, the increasing edaphic drought ness in the hill slopes of Darjeeling Himalaya has the most serious effect on the growth of shrubs and bushes including grass cover. Edaphic drought ness period now extending for over 7 months in year practically put death blow to many perennial plants and grass particularly along the southern and eastern aspects of the hill slopes. As a results, the forest floor and other hill slopes becomes bare which ultimately threaten the very existence of many small animals and ecologically invaluable microbes and insects. Animal like hare, fox, porcupine have been considered as threatened animal in the Darjeeling hill areas. It is also known that the environmental degradation has increased rate of soil erosion, further hampering food production, increase in rainfall has accelerated the rate of soil loss, reducing farm productivity even more. A further negative consequence of accelerated erosion has been increased sedimentation in stream and reservoir.

4.4 Landslides

Landslide and associated phenomena is the most pervasive of natural problems which has been accelerated by illogical human intervention vis-à-vis environmental degradation,

undermine the socio-economic development of the region. Darjeeling Himalayas occupy the lowest latitude of the entire Himalayan chain and highest permanent snow line. It is situated across the main pathways of the southwest monsoon winds from the Bay of Bengal and thus receives a fair amount of rainfall, which accelerates deep weathering. It occupies the major transverse structure of the Himalayas and exposes all the existing geological belts. Under such a geo-ecological background massive deforestation, unscientific construction, faulty land use pattern along and adjoining areas of the road, stream blocking due to non-disposable garbage dumping have made it unstable.

Earlier studies reveal that each landslide has its own peculiarities and its initiation is not due to any single factor (Bandopadhyay, 1980; Basu, 1969-70; Basu & Sarkar, 1984, 1985, 1987; Dutta, 1966; Ghosh, 1950; Nautiyal, 1951, 1966; Paul, 1973; Roy & Sensharma, 1967, 1986; Sarkar, 1990, 1995, 1999; 2010; Sinha et al, 1966). Of the various factors, water has the most deleterious effect. The toe erosion has admittedly caused some of the landslides. Many recent landslides are caused due to unscientific and unplanned usage of hill slopes and valleys. Every landslide is an individual problem, despite the fact that most of such cases have found to be initiated by common trigger mechanism. The solution to each problem has to be determined for individual site, though it may lie in combination of a few well established methods viz. retaining structure, drainage, afforestation, rock bolt, sheet pile, restriction of settlement and unplanned construction along the vulnerable hill slopes.

Landslide was a minor physical phenomenon in Darjeeling Himalaya a hundred and fifty years ago which has become rampant now-a-days leading to great loss of life and heavy damage to land and property. At present, therefore, suggestion of remedial measures and their active implementation is of vital concern for this extremely sensitive region. Today, in fact, landslide is the most pervasive of natural hazards that undermine the economic and cultural development of Darjeeling Himalaya. The diversity in slope components, geometry, site and situation, micro-regional susceptibility to degradation processes, micro-geology, micro-climate, depth of soil, its physical and chemical properties, vegetation with differential canopy and root system, unplanned growth of settlement, road and sewer systems, have led to recurring landslides.

With rapid modernization, the Darjeeling Himalaya at present is experiencing a phenomenal growth in population (456%) during last 100 years). To cater to such an overwhelming population, pressure on the land is ever increasing. Forests have gradually

been eliminated, steep slopes, generally unsuitable for human habitations and arable use have already been occupied and as a result Darjeeling Himalaya has of late turned into a highly vulnerable region without paying any heed to its ecological imbalance. Curiously, landslide, which was a minor physical phenomenon in Darjeeling a hundred and fifty years ago, has become quite rampant now-a-days leading to great loss of life and heavy damage to land and property. At present, therefore, suggestion of remedial measures and their active implementation is of vital concern for this extremely sensitive region.

4.4.1 The Landslide Occurrences

Historically speaking, a hundred and fifty years ago, land sliding in Darjeeling district was minor physical phenomenon. Ever since, the British occupation, the physio-cultural set up of this region had been seriously disturbed. Tea plantation, extensive and reckless deforestation, haphazard construction works and inadequate drainage, in other words; unscientific and unplanned uses of land have led to the establishment of the vicious cycle of denudation, heavy and concentrated rainfall aggravating soil erosion, landslides and associated phenomena.

From the available records, it may be said that the first disastrous landslip occurred on the 24th of September 1899; on the eastern side of Darjeeling town. The landslips were confined to the soil cap which from the Darjeeling ridge and their immediate causes was to excessive rainfall. This caused the loss of many lives (72 persons killed in Darjeeling town) and widespread destruction of houses, roads and properties. After the disaster, the govt. of Bengal had appointed a committee to enquire the causes of the slip and suggest preventive measures (Griesbach's Report, 1899-1900). The Committee had gone to show that the instability of the hill slides generally increased with the increase of saturation caused by absorption of moisture during a heavy shower and cutting the hill slopes by natural and artificial needs, future increased instability. The second major event of landslips in Darjeeling Himalayas took place on 15th January, 1934 due to Bihar -Nepal earthquake, which was responsible for widespread destruction through not of equal magnitude as was experienced during 1899. On 11th and 12th June 1950, the hill slopes in Darjeeling and Sikkim ware affected by disastrous landslips causing several deaths 'and heavy damage to roads, houses and public works due to heavy shower from 10 - 14 June. Apparent subsidence of Hill Cart Road near Paglajhora stretching for a length of about 500m was first recorded by K. K. Gupta in 1966.

Table 4.4: Incidences of major landslides in Darjeeling Himalaya

Major events and rainfall	Affected areas	Remarks
September 24-25, 1899	Darjeeling (Toongsoong, Singamari, Alubari, Station, Hermitage, Jalapahar); Kurseong, Kalimpong, Ghum, Tindharia, Bloomfield and Tukvor TGs.	72 lives lost in Darjeeling town. Houses along the En. Slope & Observatory hill mostly destroyed.
January 15, 1934; Bihar Earthquake.	Darjeeling town, Sonada, Sukhiapokri, Ghum and in Kurseong.	Little destruction was reported in Darjeeling.
June 11 and 12, 1950; Rainfall: 820.0 mm from June 11 to 13.	Darjeeling town (Jalapahar, Lebong, Katapahar, Bhutia busty, Hermitage), Happy Valley, Kalimpong, Mahanadi Paglajhora, Tindharia, Kurseong, Takdah, Glenburn etc. and the hilld remain cut-off from rest of Bengal for 5 days.	127 lives lost, thousands of people were homeless; slides breached roads and Siliguri Kalimpong. Rly. line lost forever. Paglajhora slump valley activated.
October 3 to 5, 1968. Rainfall: 1121.4 mm	Darjeeling town (Toongsoong, Kotwali, Rajbari, Kagjhora, Butcher busty, Manpari, Lebong, Ambutia, Kalimpong, Tista bazar, Rambi, Algara, Pesoke etc.	Hill Cart Road & NH 31 wiped out heavy loss of life and property. Ambutia landslide re-activated.
September 3 & 4 1980; Rainfall: 299.1mm	Rimbik, Lodhama, Bijanbari, Darjeeling Sukhiapokri, Ghum, Manebhunjang, Sonada, Lebong, Tukvor, Tindharia, Happy Valley, Ambutia etc.	Over 215 lives lost at Rimbik and Lodhama; property amounting Rs. 100 million destroyed.
September 16, 1991; 462.5 mm rainfall recorded from September 15 to 16.	Darjeeling town (North Point Toongsoong, Singamari), Ging, Tukvor, Bennockburn, Bloom- field, Paglajhora, Tindharia Rangtong, Chunbhati etc.	2 people killed. Rail connection between Siliguri and Darjeeling was snapped for five months.
July 13, 1993; Rainfall: 211.3 mm from July 11 to 13	Mongpo, Takdah, Pesoke, Rangtong, Tindharia, Pankhabari, Mahanadi, Gayabari, Ambutia, Darjeeling town etc	15 lives lost at Mongpoo.
April, 7, 2003	Sevoke area	240 mm in 24 hours
July, 8, 2003; 300mm rainfall in 24 hours	Gayabari, Puttung, Dudhia, Tindharia, Boxikhola, Giddhapahar also in NH 31.	17 died in Gayabari, Puttung and Pankhabari.
July, 8, 2005	West Point, Raniban, Krishnagram, Ging TG, Dunga in Darjeeling.	1 died; 8 houses destroyed; 300 people become homeless
July, 17, 2007: 175 mm in 24 hours	Darjeeling,	1 killed, 2 injured, 12 houses were destroyed
August 21, 09; 150 mm rain in 24 hours	Takling in Mirik, Kolbong at Algarah,	3 lives lost in Mirik and Kalimpong
May, 26, 2009; 171 mm rainfall in 24 hours	Aila induced cyclones caused massive landslides in Darjeeling hills between Darjeeling to Kurseong, 14 landslides recorded along the railway tracks.	30 lives lost, massive destruction of animal and property, hills remain cut-off for a long period.

August 16, 2009	Kurseong & Kalimpong: Gaurishankar TG, Sirubari, Nimbong, Paglajhora, Giddapahar area.	7 lives lost in Kurseong & Kalimpong, 500 houses destroyed, HC road & Rohini Road cut off.
June 16, 2010	27th Mile, Paglajhora, 400m road of NH 56 caved in. NH and DHR connection snapped for over a year.	Displaced material transported to the Sivkhola valley and blocked the drainage-way of the head stream of the Mahananda. An artificial lake was formed causing threat of flood further downstream.
September 18, 2011	Kalimpong, Kurseong, Darjeeling along the Roads	Earthquake of M-6.9 caused about 124 landslides of different dimension.

Evidences show that during 1950s, disastrous landslides, huge amount of debris were deposited below Hill Cart Road, along the main Paglajhora. Subsequently, the underground channel drains through joints of the existing bedrocks. Due to enlargement of underground passage through continuous fluvial erosion the basal support of the road is lost and thereby subsiding the Hill Cart road (photo 4.2).

Darjeeling town and its environs, Tista valley, Kalimpong area were again eclipsed with large-scale landslides owing to heavy rainfall that continued between 3 – 5October, 1968. The period between1969 to 1979 was relatively undisturbed. But heavy continuous rain on 27th August and 3rd to 4th September 1980 again triggered of widespread landslide in and around the township. The 1980s witnessed many cases of devastating landslide occurrences in the Darjeeling Himalaya particularly in and around Paglajhora, Tindharia, Darjeeling town, Kalimpong, along the Hill Cart Road and Sevok Gantak Highway. During 1993, there were heavy landslides in Bindu and Garubathan where about 15 persons were killed. During 1995, there was another heavy landslide in Pesok area where about 25 persons lost their lives. In September 2007 a number of landslides occurred in Kalimpong and Darjeeling triggered by high intensity rainstorm. Large scale destruction of land and property was reported in addition to loss of 5 lives in Kalimpong and 1 in Darjeeling. Since 1990 onwards, it has been found that almost every, year parts of Darjeeling Himalayas has been suffering from major or minor landslips, and thus, it has become an integral part of the life of the hill people (Photographs 4.2 - 4.12).

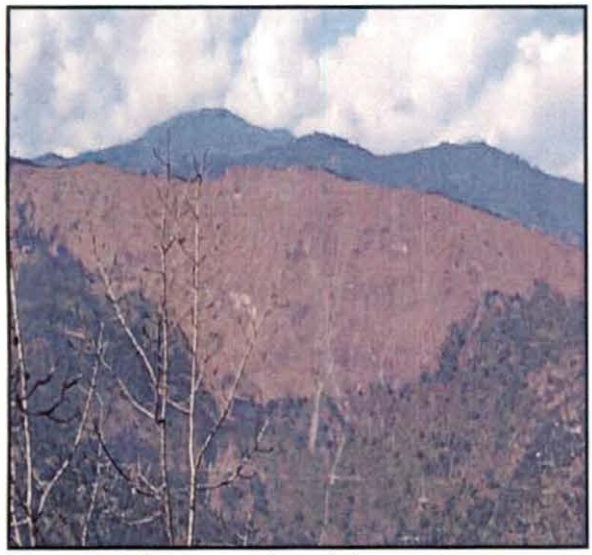

Photo 4.1 Near complete deforestation near Sikkim Darjeeling border.

Photo 4.2. Disruption of traffic: common scenario of roads of Darjeeling hill during monsoon months.

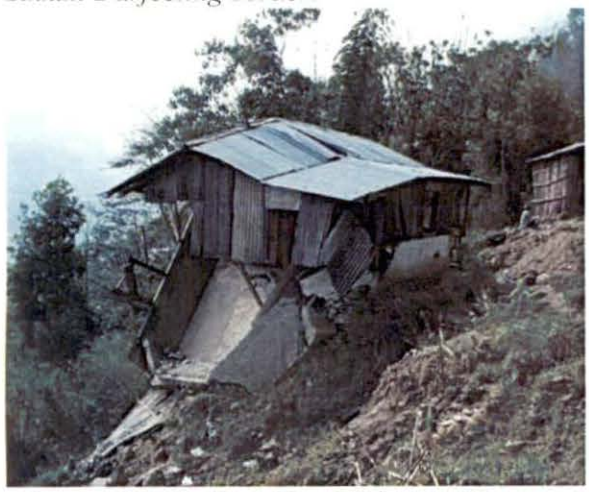

Figure 4.3. Victim of landslide near Kurseong, During the 2009 landslide.

Photo 4.4. Gigantic landslide along southern margin of the Himalaya.

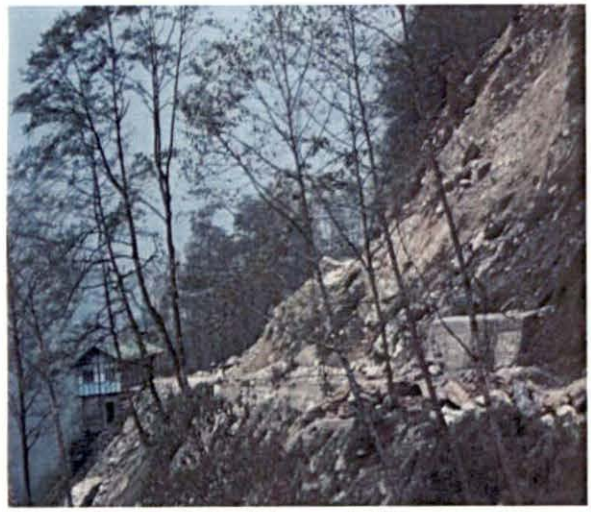

Photo 4.5. Debris slides near Kurseong

Photo 4.6 Slumping in Goomti Tea Garden, Kurseong

Photo 4.7. The Lower Paglajhora Landslide, 2010

Photo 4.8. NH-55 and Railway washed down at 17th Mile, hiking is the only option for local people in 2010

Photo 4.9 Photo 4.1. Debris slide: common form of Landslides in Darjeeling Hills.

Photo 4.10 The Paglajhora slump in 1998

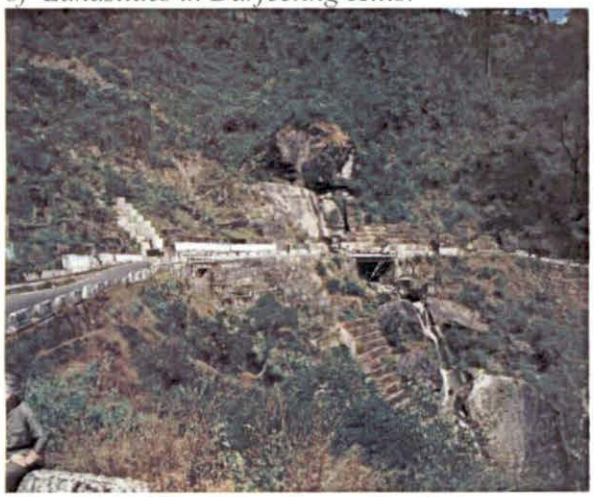

Photo 4.11 Slumping of lower Paglajhora

Photo 4.12. Tea Garden road induced soil erosion, Tindharia

4.4.2 Nature and Processes

Landslides occur in almost all types of slopes composed of various rocks in the Darjeeling Himalaya. Composite slides also take place involving soil or talus and underlying rocks. Slope failure is caused by shearing where the plane-of-shear, taking the form of an arc of a circle; in section leaving a parabolic outline of the slipped portion (Dutta, 1966). The most common occurrence of landslide is found along the spring (locally known as *Jhora*), where rock debris gets detached from their parent body along the slope and form channels. Later, such channels, while carrying drainage water are gradually widened by lateral erosion. Innumerable *nalas* (drainage channels) on hill slopes develop due to slope failure and many landslides in tea gardens and forests look like scars from a distance (Sarkar, 1999).

Landslides on rocky surfaces seem to be primarily influenced by the structural elements of the parent rock. Sliding also occurs in bedding and foliation in rocks with prominent joints and shear planes along the slope. Observations in the soil-covered slopes reveal that slopes having an angle below 30° were not generally affected by slides. The talus materials are formed due to weathering and loosening of rocks along the joints and foliation planes of the parent rocks. Such material, whether dry or in a permanently drained state, are stable at an angle of even 45° and the stability is not necessarily impaired by an occasional wet spell (Sarkar, 2000). Slope failure in such materials, however, occurs by seepage pressure of percolating water during heavy precipitation.

The tea garden slopes are generally formed of talus materials with a thin soil cover. Most of the slides have affected the materials but at some places, slides along the joints of the underlying rocks have also been observed. Generally, the displaced materials scour long channels down the slope, which are visible as scratched scars on hill slopes. The width of these scoured channels originally does not exceed more than 25 m or so but by subsequent erosion, they are further widened. Thus, once the slide has occurred, it generally remains a permanent feature and increases in dimension (Starkel etc.).

4.4.3 Landslide Prone Areas

Identification of landslide-prone areas has been performed with the help of "Check-List" where each separate and discrete slope unit has been classified according to their stability rating. Rating has been done according to a scale from stable through the degrees of potential instability to those slopes, which have already failed. Special attention has been paid

to the old slides, which could become re-activated. The excavation position and depth, drainage diversion across the hill, loading of the upper slope and valley, cutting of basal support, unscientific construction and land-use, deforestation, legacies from the past slope movement, relief, drainage, slope materials, etc. have been accounted for in the "Check-list". Sarkar (1999) has carried out such investigation through collection of direct field data from 65 sample sites as well as from secondary sources, and a map was prepared for identification of landslide-prone areas (figure 4.1).

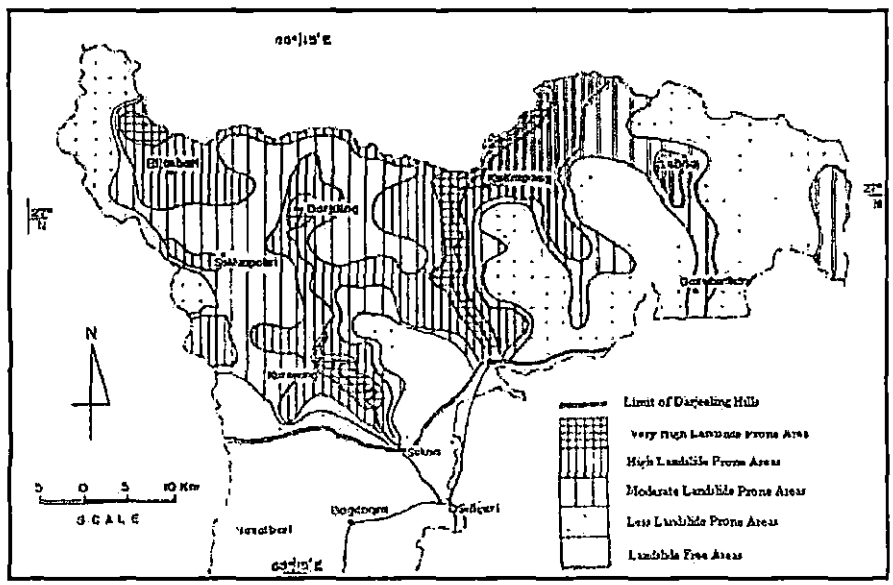

Figure 4.1: Landslide prone areas in Darjeeling hills (Source: Sarkar, 1999).

The map as represented in figure 4.1 shows some striking features such as some tracts of the study area, especially along the Tindharia-Paglajhora, Pankhabari, Rimbik-Lodhama, stretches along the river Tista, Bijanbari, in and around Darjeeling, Kurseong, Mahanadi, Ghum, Sonada, Sukhiapokri, etc., exhibit very high susceptibility. The ridges lower hills and the north facing slopes are showing moderate to moderately low susceptibility (figure 4.1).

Generally, deforested tracts, tea gardens, urban and other settle areas are more susceptible than the natural forested tracts. Geologically, the Daling rocks (phyllites, slates, schists, feldspar, etc.) and Damuda rocks (sandstones, shales etc.) are more susceptible to landslide. Table 2 shows the cases of major landslides, their topographic, geological and land use set-up in the study area.

Table 4.5: Landslides under different environmental set-up

Rocks types	No of Slide	Slope angle & Length	No of Slides	Land-use	No of Slides	Relief	No of Slide
Sandstone	12	> 50°& above 500m	30	Barren & rocky	0	Ridge	2
Shale	7	> 50°& less than 500m	15	Barren & talus	5	Spur (Upper)	27
Phyllite	39	40° – 50°& above 500m	53	Degraded grazing	16	Spur (Middle)	16
Schist	41	40° – 50°& above 500m	22	Grazing land	3	Spur (Lower)	6
Slate	13	30° – 40°& above 500m	3	Tea Garden	25	Valley (Upper)	8
Felspathic	6	30° – 40°& above 500m	15	Arable land	19	Valley (Middle)	19
Granite & Gneiss	24	20° – 30°& above 500m	14	Urban areas	14	Valley (Lower)	26
Complex	76	20° – 30°& above 500m	8	Semi-	16	Along Streams	76
Not Known	27	10° – 20°& above 500m	6	Rural	19	Complex	17
		10° – 20°& above 500m	3	Construction sites	73		
		Below 10°	1				

With the growth of tea and tourism industry in the area, the transport business has escalated tremendously. New roads are being constructed, new settlements are being created opened up and better infrastructural facilities are being provided in the older settlements. The National Highway 55, commonly referred to as the Hill Card Road was built by the British and is the main arterial link of all main hill towns as well as with the rest of the country. The other significant route is NH 31 that connects Siliguri and Kalimpong and the smaller Pankhabari Road (also built by the British) and the most recent route along Rohini built by the DGAHC in 2003. Since these roads have been constructed in the highly compressed and friable lithology prevalent in the region, it results in frequent occurrences of landslides.

Landslides are very common in the Hill Cart Road as well as along NH 31 towards Kalimpong between Likhuvir and 27 Mile. The roads are frequently blocked, sometimes for weeks together and the visitor are stranded and have to face many problems. The Hill Cart Road, connecting Siliguri with Darjeeling spans only 88 km but has been affected by flows,

slumps and slides at about 200 sites, (Basu and Starkel, 2000). This fear of landslips has adversely affected the tourist industry and residents of hill towns like Darjeeling, Mirik and Kalimpong, whose economy mainly rests on tourism, have begun to worry.

Effective insights can be drawn from a detailed study of the road section between Tindharia and Kurseong on the Hill Cart Road (NH 55). This region encompasses the Pagla Jhora environs that are notorious for its slump/ subsidence history that was first initiated in the 1950 landslides that took place in Darjeeling. Thereafter the incidence of slumping is a regular phenomenon and post 1990's, the Paglajhora slumps are causing complete disruption of transport and communication as shown in table 4.6.

Table 4.6: The Rate of Slumping at Lower Paglajhora

Years	Rate of slump (metre)	Years	Rate of slump (metre)
1983-1984	1.10	1987-1993	8.07
1984-1985	0.82	1993-2003	14.54
1985-1986	1.03	2003-2008	2.05
1986-1987	1.51	2008-2010	7.32

Source, S. Sarkar (2010)

4.4.4 Corrective and Preventive Measures

The stabilization on landslide and landslide prone areas must be executed according to a well throughout plan, which lists individual measures according to their urgency. This stabilization is usually difficult and expensive. Before going in for a corrective measure of the susceptible zone, one should have to consider the following points (Zauba & Manel 1982).

- The choice of the particular preventive measure change with the engineering geological conditions of the site.
- The choice of the techniques are to be applied for prevention of the slope movement which is also influenced by several aspects of economic character.
- The local conditions of the site play a dominating role in assuring the stability of potential slide prone areas.
- The importance of the project also influences the measures to be taken to tackle this problem
- It is also the task of designer to draw up a time schedule for implementing the various measures to be taken.

It is important to distinguish between those physical characteristics of a site that make landslide possible and the actual cause, i.e., the trigger mechanism that initiates movement through the increases of pore-water pressure. This is why landslide in the Darjeeling Himalaya almost perfectly correlates with the occasions of high intensity rainstorm. Potentially most unsuitable hill-slopes are also sensitive either to an increase in the load on the top or a decrease in the amount of support that they have at the toe. Recognizing which of these causative factor is in operation, can in itself suggest the cure.

Moreover, a long and often laborious process of investigation, static analysis and planning of the stabilization work should not delay the measures that obviously have to be taken as the treatment of an active landslide is always a context with time: a race against time. All corrective installations must be regularly checked and maintained. If regular maintenance for landslide protection measures has not adhered to, extensive and costly corrective measures may be useless and moreover, within a short period, new movement may start up. Thus the scheduled inspection and the maintenance work should be included in the overall planning of the corrective measures. Thus the principles to be observed in suggesting preventive measures would naturally depend upon the causes that lead to the failure of a slope. The following are the important preventive measures used against slope failures

1. Treatment of slope conformation
2. The drainage of landslides
3. Retaining walls and similar structures
4. Rock bolts and Rock Anchors
5. Stabilization of Landslide by Planting
6. Stabilization of landslides by piles and sheet-piles
7. The hardening of soils.
8. Restriction to settlement

1. Treatment of slope conformation

The slope of the ground surface plays an important role in causing slides of soil and talus material. Hence, theoretically the stability of slope can be increased by the reducing the slope angle, however, which is not possible to reduce the slope angle on natural slopes, except for small portions. This can be done at the cost of another portion, where the slope angle has to be correspondingly increased. The stability of a vulnerable slope may also be

increased either by reducing the volume at the head or by expanding the volume at the toe. Thus, the treatment of susceptible slopes should be done based on the local slope configuration and so it depends on the extent of the slope instability.

2. Drainage of landslides

The drainage plays the most crucial role in producing slope instability in the Darjeeling Himalayas. For the better representation the drainage of landslides may be further sub-divided (a) surface drainage, (b) sub-surface drainage and (c) prevention of percolation and seepage.

The **surface drainage** of any area is affected by landslides is generally uneven, hummocky and transgressed by deep fissures. In the depressions and fissures, water accumulate create wet- ground. Therefore, one of the first remedial measures is the surface drainage of landslide area. Although, surface drainage seldom sufficient to stabilize a slope which is in motion, but it can control landslides by drying ground surface.

First of all streams and temporary water courses are to be diverted from the treated area. Moreover, all springs issuing within the affected area, especially those at its head, must be contained and diverted away from the slide. For an immediate provisional diversion of flowing water and available pipes may be used. After partial stabilization of the landslides, open ditches of adequate dimensions and gradients are to be excavated for discharging rainwater. At the sometime, the ground surface is to be leveled and un-drained depressions filled along with all cracks so that a continuous run-off of surface water is ensured. During their operation, the grass cover must not be disturbed unnecessarily, because grass cover reduced the tendency of water to percolate down into the slope

Sub-surface drainage is one of the major causes of slope instability. Sub-surface drainage of an affected area should be dried up as an effective form of remedial treatment. The disadvantage of sub-surface drainage is that the drainage system cannot be designed until the geological and hydrological investigation has been completed. However, in talus slope, installation of deep drains may ensure protection against slides. For slopes occupied by rocks, drainage by drill holes may be installed as a preventive measure.

The stability of a hill slope can be increased by the prevention of the percolation from direct precipitation and run-off (Roy & Sen Sharma, 1967). Prevention of percolation may be ensured by covering up the portion of the slope to be protected by a layer of impervious

material like clay. However it would not be practicable to put such a layer for large areas of slope. It has been observed that turfed slopes remain stable up to a greater height than bare slopes (Sinha, Verma & Paul, 1975). Thus turfing should be encouraged on every bare soil slope. Afforestation is also beneficial as secretion form plant helps in formation of soil. The big roots, however, parking their way into the underlying material make the surface porous & allow quite a large amount of percolation. Hence, it is not entirely suitable. In fact, small shrubby undergrowth offer better protection against percolation. Rocky slopes with open joints can be made impervious by grunting although, it is an expensive method, but to protect Hill Cart Road near Tindharia, Paglajhora etc., it seems to be reasonable.

3. Retaining walls and similar structures

Retaining walls are sometime erected to bring greater stability to dangerous slopes, or to provide basal support to the existing landslide slopes. The construction of retaining walls requires a great deal of manual and skilled work and which is also highly expensive. Construction of retaining walls become necessary in slopes formed n clayey soil where it is difficult to ensure drainage due to the impermeability of the materials.

4. Rock bolts and rock anchors

The technique of stabilizing rock masses with rock bolts and rock anchors are found widespread in mining and tunneling. They are now also applied to the stabilization of soil slopes in association with other retaining structures (Zaruba & Manel, 1982). However, in the Darjeeling Himalayas, this method is used rarely because it is highly expensive and requires high technical skill.

5. Stabilization of landslides by afforestation

Slope movement generally disturbs the vegetation cover, including both the tree growth and grass cover. Afforestation of the disturbed slope in an important part of any corrective treatment, it is carried out during the latter stages of the work, invariably after at least some degree of stabilization of the landslides has been achieved. The planting of forest trees in landslide affected area should be undertaken after leveling and filling up the cracks. Tree planting, however, is an effective method of prevention only in the case of shallow street slides. Landslide with a deep scar cannot be controlled by development of vegetation, although this has an effect on slide-area by reducing infiltration of surface water. Thus, it is more advantageous to plant deciduous trees than to plant conifers which have a

comparatively low rate of transpiration. Sykora (1961) studies the influence of vegetation on sliding movements and suggested that in selecting suitable trees for sliding slopes, their effects on the structure of the soil should also be taken into consideration.

6. Stabilization of landslides by piles and sheet pile walls

Walls of piles often been used in place of retaining walls. The main advantage of piles is that this can be installed prior to excavation. Little place is needed and therefore, the amount of excavation work required is reduced. Piles decrease the danger of slope movements and also provide and effective means of stabilization. Protection against slope failure by piles and sheet pile wall have been found only a few places.

7. Hardening of soil

The impermeable soil often falls to stabilize the slopes by drainage. In such situation, method borrowed from foundation engineering and known as hardening of soil may be applied such as Electro-osmosis and Thermal Techniques (Litvinov 1955). These methods are expensive and highly technology centric.

8. Restriction to settlement

For a successful management of the susceptible tracts under study, it is wise restricted the existing population to the geologically and topographically more stable part in the hills setting apart the unsuitable areas which have to be carefully demarcated for afforestation by quick growing trees and grasses.

4.5 Soil Erosion

The rapid soil erosion has been a problem since man began cultivating the land. Natural soil erosion is the rate at which the land would normally be eroded without disturbances of human activities. Accelerated soil erosion is the increased rate of erosion that often arises when man alters the natural system by various land use practices. Thus, the problem of soil erosion is essentially the problem of accelerated erosion. Generally speaking, the soil particles are bonded to humus and sesquioxides gels that impart shear strength and resistance to movement. Stability is further aided by trees and shrub roots extending through the soil mantle into crevasses of bedrocks, acting as anchors. Hence in a well stock woodland with forest floor of several centimeter thick, surface erosion is less than 1mm/1000 years (Jenny, 1980), which is even less than that of the rate of soil formation. There are many

standard measures for assessing soil erosion of which sediment yield (Holeman, 1968) and soil loss (Wischmeier and Smith, 1965) are most widely used.

The Darjeeling Himalaya was truly a nature's domain, till the beginning of the nineteenth century. With very scanty population, these hilly tracts were densely covered by natural vegetation and thereby, had no major soil erosion problem. However, with the advent of British occupation, along with tea plantation, extensive heedless deforestation, unscientific terrace cultivation, haphazard construction work, inadequate drainage has led to the establishment of vicious cycle of soil degradation.

Methodology

The soil erosion of Darjeeling Himalaya has been assessed by the quantitative evaluation of the following diagnostic criteria (i) the climatic erosivity (R); (ii) the soil erodibility (K); (iii) the topographic erosivity (L.S) and (iv) the biological erosivity (C.P) based on the existing standard literatures and rating tables (Wischmeier and Smith, 1965; Fournier, 1972; FAO/UNEP, 1978; Arnoldus, 1980; Olson, 1984; Sarkar, 1987). The first three diagnostic criteria involved natural/physical factors and are used in assessing natural vulnerability. The biological factors include vegetation, land use and human interferences which permits the evaluation of actual and/or predicted erosion. The method itself is semi-quantitative in nature as rating value is assigned to each group of these factors in such a way that each group can influence the final result according to its own importance.

A detail assessment of soil loss by water erosion has been appended as "unit area" example from a site near Norbong Tea Garden. The quantitative assessment of the various diagnostic criteria has been described below:

12

i) The Rain erosivity or, $R = \sum_{1} Pr^2 10_{mm}/P$ 4.1

where, Pr_{10mm} is the average monthly rainfall of months having >10mm rainfall i.e., 389.88 mm, P is annual rainfall in mm i.e., 3140.0 mm and R is the rain erosivity i.e., 580.92.

ii) The Soil erodibility (K), has been estimated based on the USLE Nomograph. where, sand is 10.13%, silt and very fine sand content is 61.56%, organic matter content is 2.91%, soil structure has been identified as coarse granular and soil permeability has been identified as moderate to rapid. The K value has been estimated to be 0.28.

iii) The topographic erosivity (L.S) = $\sqrt{L/100(0.136+0.0097.S+0.0139.S^2}$ 4.2

Where, L is length of slope in meter i.e., 332 m, S is slope gradient in percent i.e., 28% and topographic erosivity has been estimated to be 37.533.

iv) The biological factor or C.P has been estimated based on the assigned parametric rating value i.e., 0.28 based on the table (4.6)

The potential soil erosion/loss may be assessed based on the following empirical equation:

Potential loss = RxKxL.S 4.3

Thus the potential soil loss has been estimated to be metric tons/hectare/year

The predicted or actual soil loss from the site may be assessed from the following equation

The Predicted/Actual Soil Loss = RxKxL.SxC.P 4.4

Thus, the actual soil loss from the sample site has been estimated to be 1709.41 ton/h^{-1}/y^{-1}.

4.5.1 Assessment of soil erosion

The assessment of soil loss has been done based on the quantitative estimation of the physical factors like rainfall erosivity (R), the soil erodibility (K), topographic erosivity (L.S) and biological erosivity (C.P) following the equation 4.4. An iso-erodent map has been prepared by interpolating the soil loss value estimated at 62 different sites within Darjeeling Himalaya (figure 4.2). It is evident the south-central part of south facing slopes near Tindharia, Paglajhora and lower Tista valley have been experiencing exceptionally high rate of soil loss estimated to be above 5000 tons/h^{-1}/y^{-1} or, above 300 mm/y^{-1}. Such unprecedented high rate of soil loss is perhaps caused by large scale mass movements that occurred in this area. Unscientific human occupation vis-à-vis land use, slope cuttings following heedless deforestation further aggravates the problem. The south-east and north-western parts of Darjeeling hills recorded low to negligible soil loss rate which is estimated to be less than 5 tons/h^{-1}/y^{-1} or, below 0.3 mm/y^{-1}. These areas in fact, are the least affected by human interferences and are mostly under the cover of natural forest.

In general, it is observed that the area traversed by transport network, settlements, agriculture use, tea garden and degraded pasture and forest yielded higher rate of soil loss. Even the urban areas of Darjeeling, Kalimpong and Kurseong also contribute considerable amount of soil loss. However, for the better understanding of the geographical distribution of soil erosion, the following classes of soil loss have been identified and shown in figure 4.2.

Table 4.7 Rating table for assigning parametric value for C.P factors

No	Major land use type	Coverage (%)	Rating Value
1	Virgin forest with thick vegetal matter on the surface	100	< 0.0005
2	Natural vegetation cover i.e., forest, bush, permanent pasture	100	0.001 - 0.0005
3	Natural vegetation cover i.e., forest, bush, permanent pasture	50 - 100	0.05 - 0.001
4	Tea garden	100	0.05
5	Degraded forests, rough pasture of perennial cover	> 30	0.05 - 0.5
6	Degraded or semi-degraded tea garden	± 50	0.1
7	Row crops, inter-tilled crop	< 30	0.05 - 0.8
8	Terraced cultivated field	20 - 50	0.05 - 0.8
9	Root crops, i.e., ginger, cardamom, potato etc.	± 50	0.9 - 1.0
10	Bare soil, cultivated fallow	0	1.0

Source: Modified from FAO/UNEP, 1978; Sarkar, 1987, 1993

Class I : Exceptionally high soil loss susceptible zone having estimated soil loss of above 5000 tons/h^{-1}/y^{-1} or, above 300 mm/y^{-1}.

Class II : Very high soil loss susceptible zone having estimated soil loss between 2500 to 5000 tons/h^{-1}/y^{-1}.

Class III : High soil loss susceptible zone having estimated soil loss between 500 to 5000 tons/h^{-1}/y^{-1}.

Class IV : Moderate soil loss susceptible zone having estimated soil loss between 50 to 500 tons/h^{-1}/y^{-1}.

Class V : Low soil loss susceptible zone having estimated soil loss between 5 to 50 tons/ h^{-1}/y^{-1}

Class VI : Very low susceptible zone having estimated soil loss between 1 to 5 tons/h^{-1}/y^{-1}

Class VII : None to negligible susceptible zone having estimated soil loss less than 1tons/ h^{-1}/y^{-1}

4.5.2 Strategies for soil conservation

The aim of soil conservation is to maintain soil loss below a threshold level which theoretically, permits the natural rate of soil formation to keep pace with the rate of soil erosion (Morgan, 1979). Of the various soil conservation measures effective for the present purpose may be divided into three major groups: (a) agronomic measures, (b) soil management and (c) mechanical measures.

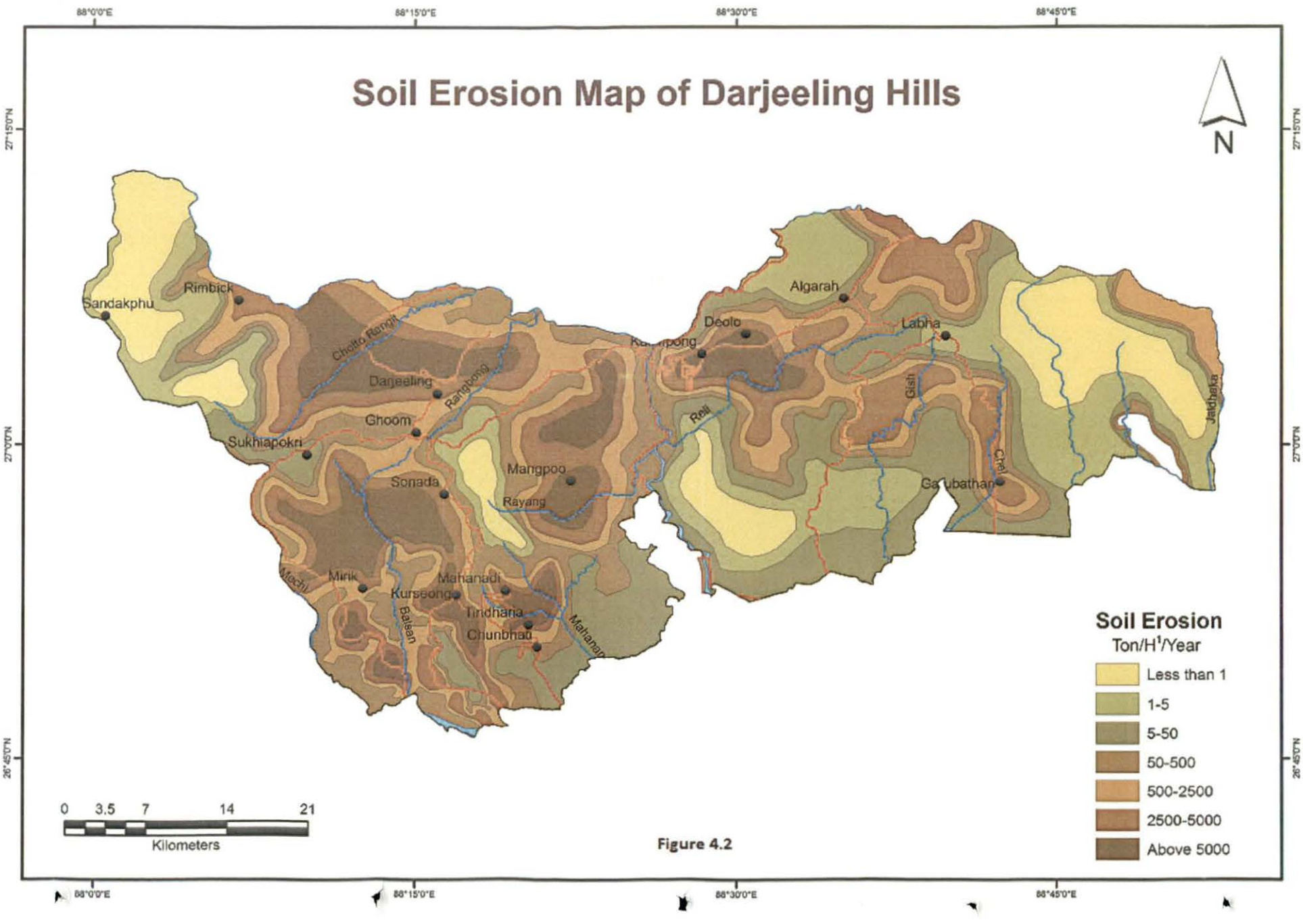
Soil Erosion Map of Darjeeling Hills
N
88°0'0"E
88°15'0"E
88°30'0"E
88°45'0"E
27°15'0"N
27°0'0"N
26°45'0"N
Sandakphu
Rimbick
Chello Rongit
Darjeeling
Rangbong
Ghoom
Sukhiapokri
Sonada
Mangpoo
Rayang
Mirik
Mahanadi
Kurseong
Tindharia
Chunbhati
Balasan
Mahanadi
Algarah
Deolo
Labha
Reli
Gish
Chel
Jaldhaka
Soil Erosion
Ton/H¹/Year
Less than 1
1-5
5-50
50-500
500-2500
2500-5000
Above 5000
0 3.5 7 14 21
Kilometers

Figure 4.2

(a) Agronomic measures

Plants differ in their effectiveness in protecting soil from erosion because of differences in their density and morphology. Generally, row crops are least effective and give rise to the more serious erosion hazards. In designing a conservative strategy based on agronomic measures, row crops must be combined with protection effective cover crops in a logical cropping pattern. Of the various agronomic measures, crop rotation, cover crops, strip cropping, and mulching are important and are recommended as protective measures against soil erosion in the Darjeeling hill area.

(b) Soil management

The aims of soil management are to maintain the fertility and structure of the soil because fertile soil results in high crop yield, good plant cover and therefore, in conditions which minimize the erosive effects of rain drops and run-off. In Darjeeling hilly area, a good fertile soil can be achieved by applying organic matter because, it improves the cohesiveness of the soil, increases its water retention capacity and also promotes a stable aggregate structure.

(c) Mechanical methods

The mechanical methods are used widely to control the movement of water and the decision which is to be adopted, depends on whether the objective is to reduce the velocity of run-off and increase surface water storage capacity or safely dispose off excess water. All mechanical methods should be employed in conjunction with agronomic measures. Of the various mechanical methods of soil conservation contouring, contour bunds, terraces and designed water-ways are recommended for the Darjeeling hills.

4.5.3 Proposed soil conservation plan for the Darjeeling Himalaya

Soil conservation strategies are aimed at reducing erosion to a tolerance level. Theoretically, such level is that at which the rates of soil loss and soil formation are balanced. However, in practice, it is difficult to recognize when this balance state exists and for this reason an alternative definition of an acceptable level is adopted i.e., soil fertility maintenance for a period of 20-25 years (Sarkar, 1993). A mean annual soil loss of 1.3kg/m^{-2} is generally accepted as the maximum permissible level but even lower value of 0.2 to 0.5 kg/m^{-2} are recommended for particularly sensitive areas like Darjeeling hills (Hudson, 1971).

The Darjeeling Himalaya exhibits higher erosion rate due to adverse environmental condition and on the other hand, favourable environmental conditions promote higher rate of soil formation. Keeping these in mind Sarkar in 1993, proposed a target of 0.5 kg/m^{-}2 or, 5 tons/h^{-} ^{1}/y^{-1} of soil loss may be accepted as the uppermost limit.

Table 4.8 Proposed soil conservation plan for Darjeeling hills

No	Erosion Zone	Soil loss (kg/m^{-2}/y^{-1})	Recommended conservation measures
1	Zone I	< 0.5	No conservation measures are to be required
2	Zone II	0.5 - 5.0	Crop rotation, cover crop, strip cropping, contouring, contour bunds along with suitable waterways are recommended.
3	Zone III	5.0 - 50.0	Cover crops, mulching, organic matter application, contouring, retention and bench terraces, diversion channels, terrace channels and grass waterways etc. conservation measures are recommended.
4	Zone IV	50.0 - 250.0	Cover crops, mulching, organic matter application, bench terraces, suitable waterways along with some slope stabilization works.
5	Zone V	> 250.0	All possible agronomic, mechanical and soil management methods should be adopted simultaneously specially, cover crops, mulching, ladder terraces, adequate drainage and slope stabilization methods are recommended.

Although, the entire Darjeeling hilly area possesses high erosivity risk, yet an attempt has been made to categorize them under different classes depending on their degree of vulnerability. Thus with reference to figure 4.2 the proposed level of conservation measures needed to protect soil against degradation has been depicted in table 4.7.

4.6 Conclusion

The forest clad mountain of the Darjeeling Himalaya reveals man's heedless silvicultural activities that triggered mass movements and accelerated soil erosion along the hill slopes and valleys. Deforestation via-a-vis environmental degradation in the Darjeeling hills indeed plays the decisive role in contemporary increased frequency and magnitude of hazards. Vicious cycle of degradation has already been established in the sub-Himalayan watersheds. Perhaps, the only possibility to save the habitable environment lies into the pro-active watershed management. It is thus, our imperative duty to inform the people living in

threshold areas (prohibitive/restrictive zone) categorically about the hard reality of possible hardship during the different stages of watershed management processes.

The analysis of landslide in the Darjeeling Himalaya reveals that each of the slides has its own characteristics and is not induced by any single factor. Of the various factors, water has the most deleterious effect. Some of them have admittedly been caused by toe erosion of the drainage elements and the others due to the effects of unscientific and unplanned human interferences. The choice of remedial measures thus, should be made after careful analysis of the causative factors. The design of the preventive structures should depend on the geomorphologic, geo-hydrological and geo-technical framework of the site.

In view of the ever-increasing problem of landslide in Darjeeling Himalaya, man must be aware of the possible dangers that he is inviting, due to his careless dealing with nature. It is true that one has to make room for the growing population and in this pursuit he has to utilize every piece of land available. But the precautions that have to be adopted should not be neglected. In many places revetments are not maintained properly, the weep-holes are choked, the drains are dumped with garbage, restricting free drainage of water.

Moreover, the present land-use system should be properly evaluated. The construction of high-rise buildings should be stopped immediately. The people should be provided with alternative source of energy, may be through mini-hydel project, tapping the perennial springs, and perhaps this can be the only option to prevent them from cutting down more trees. It is of utmost priority to develop mass awareness among both local people and tourists, so that they become aware of the possible dangers that they are inviting by interfering with the natural laws.

Among the various conservation measures, the agronomic measures should be given preference because they are less expensive and deal directly with the reducing raindrop impact, increasing infiltration, reducing run-off volume and decreasing wind and water velocities. It is also easy to fit them into an existing farming system. The mechanical measures are largely ineffective on their own because they cannot prevent the detachment of soil particles. Their main role is in supplementary to agronomic measures, being used to control the flow of excess water.

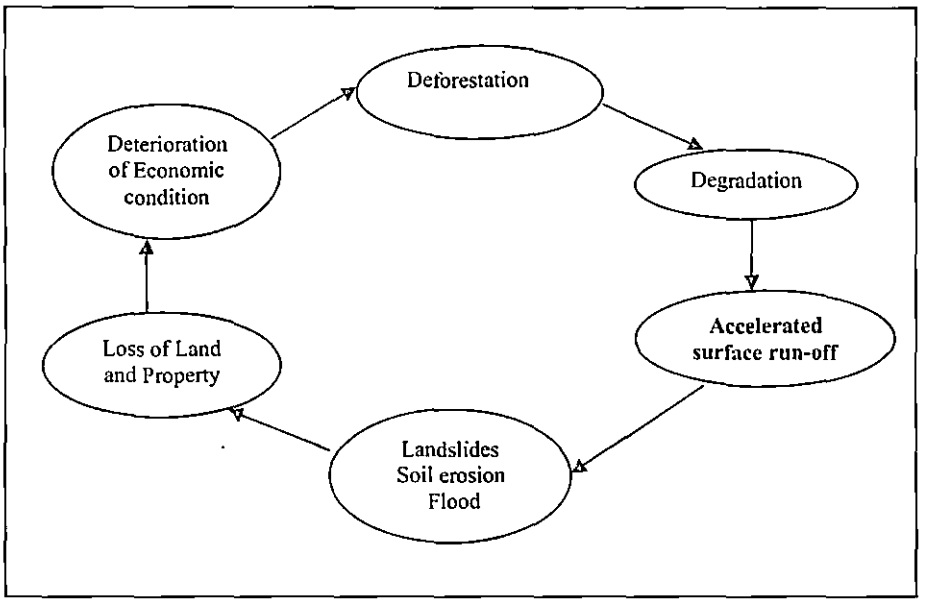

Figure 4.3 Deforestation-Flood Vicious Cycle: A Case of the Darjeeling hills

The conservation schemes must be well designed to reduce soil erosion effectively and their ultimate success depend on how well the measures are implemented. The willingness and the socio-economic background of the farmers and planters to adopt the techniques required by a particular strategy is also very important. Equally important is the strategy proposed should be clearly related to the problems involved. Hence, conservation design must be logically follow a thorough assessment of erosion risk of the area concern.

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CHAPTER V

Causes and Consequences of Environment Degradation

5.1 Introduction

The environmental degradation in Darjeeling hills are caused by many complex and interrelated factors i.e., scarcity of resources, accelerated soil erosion, landslides, droughts, floods, declines of forest cover, decline in agricultural yields, problem siltation, shrinking of bio-diversity etc. The natural springs are rapidly dying up, domestic animals are less productive and/or reproductive. The fodder resources are shrinking and are fast disappearing from the Darjeeling hill areas.

Blasting of rock for construction materials for roads, bridges, culverts, tourist lodge, hydro-electric power projects, residential apartments coupled with unscientific and unplanned mining/quarrying along steep and fragile hill slopes have been greatly effecting the hill slope stability. Unregulated quarrying have also degraded the lush green hill slopes and thereby depriving the nearby cultivated land from the valuable organic matter the storehouse of natural nutrients for plant growth.

In Darjeeling hills soil erosion caused by running water is a serious problem as if make the parent rocks bare and exposed to further degradation by weathering processes and ultimately make susceptible to slope instability. As a result, high intensity rainstorms cause mass wasting including landslides. Landslides are very common often blocking the vehicular traffic and some time damaging engineering structures. While in the foot hills and valleys flash flood induces accumulation of large debris.

The infrastructure development often found highly unplanned and been executed without considering the possible environmental impact of such adjustment within the natural system. Construction of dams/reservoir across the mountain torrents to meet the ever increasing demand of power is yet another factor of environmental degradation. These projects have already caused irreparable damage to the delicate hill ecosystem particularly destruction of fertile flat land of the valleys and also created the problems of rehabilitation of the affected families as well as the immigrants.

The aim of this chapter is to analyse the various causes of environmental degradation in the Darjeeling hills. It also aims to assess the consequences of such degradation in the area.

The data collected from various secondary sources i.e., reports, monographs, manuscripts, contribution of earlier authors etc. The investigator has also conducted field study to gather primary data/information from the problem areas. The analysis has mostly been qualitative in nature.

5.2 Causes of environmental degradation

Environment is a union of non-living components which render favourable habitat for the biological development. The elements of environment are always active to protect these biological live sustaining processes in close co-ordination with them. When, the elements of environment are in danger mostly caused by illogical anthropogenic activities the degradation becomes visible. Among such processes deforestation, over population, misuse and over-use of natural resources are common. As a result the elements of environment become unsupportive. It is evident that the human are mainly responsible for the degradation of environment. The ecological balance remains healthy if the mutual activities of human beings and the environmental agents work together in consonance. But, if the human being acts negatively the environment degrades and these happen when anthropogenic activities destroy the essential elements of nature. Such as, the use the chemical fertilizer in order to produce more food to cater the increasing population eventually invites soil degradation that ultimately leads to sterility.

5.2.1 Economic causes of environmental degradation

The natural resource of Darjeeling hill area has been overused by the people. Natural forest has been almost cleared near urban centres and major settlements. As a result, the poor people of hill area are facing severe problem of fuel and fodder. The shortage of cooking gas aggravates the problem further. The rural people are not getting grass for their domestic animals and unable to keep such domestic animals like cow, goat, buffalo etc. to augment supportive economic activities forming a vicious cycle of deteriorating economic condition. Out of desperation many poor villages indulge in illegal and unethical acts like putting forest fire, trapping engendered animals etc. for their survival. Such act has been proved even more detrimental from the point of view of environment and perhaps put the final nail to the once much acclaimed biodiversity of Darjeeling hills.

The poorest of poor villagers of Darjeeling hills for long being depend on forest for gathering various forest produce of food, fibre and fuel for their sustenance. Even the drinking water was also fetched from innumerable springs scattered in and around the forest.

Large scale deforestation in Darjeeling hills in fact, sealed up the very life sustaining processes of this vulnerable section of our society. The following services vis-à-vis economic returns from the hill the forests have lost forever:

a) providing fuel and fodder for the rural people particularly the poor landless and marginal families almost free of cost,
b) providing timber of average quality for rural dwellings, to rural artisans for making tools, implements etc. almost free of cost to support rural vocations and economy,
c) providing to maintain a steady supply of raw materials needed for paper making, plywood and other forest based industries,
d) providing high quality timber and some fuel for the urban population i.e., charcoal, firewood,
e) providing invaluable support in maintaining hill slope hydrological cycle, soil conservation, moderating climate, maintaining aesthetic value of the overall environment and
f) providing shelter and life sustaining module to the biodiversity.

Fire wood constitutes a major shave of the fuel used by rural population of Darjeeling hills for cooking their daily meals. The requirement of fuel of the rural hilly areas has been found tremendous just next to the food and the 60% of Darjeeling's population is still have no other stable source of fuel.

There is a close relation between natural resources and economic development. A country having an abundant supply of natural resources is always at an advantage. It can achieve faster growth than resource-poor countries. However, with economic development more and more resources are consumed. This may lead to depletion of resource base with development. If this happens the performance of rich in resources developing countries would be ever worse. Most resources, the people of Darjeeling use for their subsistence are renewable by nature (water, soil and biotic). They can regenerate themselves, given time. It is possible to exploit renewable resources sustainably if annual harvest not exceeds the annual growth of the stock. The different between the rate of harvest and the rate of growth is called the rate of depletion. The more quickly these resources can be replenished, the faster the economic growth than can be sustained indefinitely.

Sustainability can involve the depletion of natural resources and the eventual decline of farming, fishing, forestry and other sectors depend on natural resources. Since

resources are scarce, they are to be exploited efficiently. The substitution of man-made natural resources may not be productive unless, technology continues to reduce this dependence on raw materials. Furthermore, if population continues to grow and if a society wants to grow by increasing its per capita income, then it must invest more to protect the natural environment as also to continuously increase the supply of renewable resources and conserve non-renewable ones. If a society can do it, it will be able to achieve the sustainable development.

5.2.2 Social Causes

It's a matter of grave concern that large majority of people living in Darjeeling hills shows their grave ignorance and indifferent attitude to the ever deteriorating condition of the over-all environment of the Darjeeling Himalaya. The people are unaware about the environmental problem every year bad days are coming. No body is serious about the environmental damage. The people do not discuss for measures for protection of environment even among themselves.

Of late, only a very small section of people are living in worst affected villages and a number of NGOs have come forward at the village level seriously for the awareness campaign and protection of environment. As a result, the hill society is gradually geared up with the much needed environmental awareness vis-à-vis eco-restoration programme in Darjeeling Himalaya for the sustenance of the unique priceless gift of the nature.

5.2.3 Political Causes

Political instability couple with continuous influx of people in the Darjeeling hills poses serious threat to her delicate environment. Periodic socio-political agitation especially statehood movement in Darjeeling hills often shifted the focus of administrative as well as societal eco-conservation and eco-restoration measures. The situation becomes periodically conducive for the extractors, builders and unscrupulous business man to exploit the priceless environmental resources ruthlessly. Field observation reveals that large scale valuable tree felling had taken place all over the hills including its famous National Parks like Naora and Singalila during the GNLF movement.

The environmental degradation in Darjeeling hills during the agitations reached all-time high. Massive heedless deforestation, ever-increasing landslides, accelerated soil erosion, edaphic drought, dwindle water supply etc. are the major ramification of degradation

of hill environment. Along with these, the possible ramification of climate change over hill environment, economy and society is perhaps would be the major issue in years to come.

Environment has never been considered a political agenda in the Darjeeling hills as no political organization has ever made any environmental issues their agenda. Neither the administration nor the society hasd ever displayedtheir concern over environmental issues and as a result, all environment conservation/protection/safety related acts remain only in books for academic interest. From the beginning ofthis century, a section of the society has finally realized the grave situation and formed NGOs, with an objective to create awareness among the hill people about the ground reality. The civil society thus canameliorate the problem by being the interface between the ravaging of the environment and the perversion of politics on one hand and creating awareness at the grass root level on the other.

It is a fact that day by day environment of Darjeeling hills has been degrading through misuse and overuse of her natural resources. But politically nothing has been done for the protection/conservation. Essentially, there is a lack of political attitude and focus for implementation of various environment friendly lows and guidelines for sustenance. There is urgent need to establish a high power autonomous body in Darjeeling hills to formulate implement and monitor different environmental conservation and protection measures.

5.2.4 Natural Causes

Environmental degradation has also been caused by natural processes. Among them forest fire, high intensity rainstorms, landslides, earthquakes etc. are important. Natural forest fire is common in Darjeeling hills during March-April when hill slopes become very dry and strong wind blows. The coniferous forest of high altitude has been found especially sensitive for such degradation. Large tracts around Singalila National Park affected by natural forest fire during the end of 19^{th} century which still remain visible even after a century.

Landslide and associated phenomena is one of the most pervasive of natural processes that undermine the socio-economic development of Darjeeling hill areas. With rapid modernization, the Darjeeling Himalaya at present is experiencing a phenomenal growth in population (456%) during last 100 years). To cater to such an overwhelming population, pressure on the land is ever increasing. Forests have gradually been eliminated, steep slopes, generally unsuitable for human habitations and arable use have already been occupied and as a result Darjeeling Himalaya has of late turned into a highly vulnerable region without paying

any heed to its ecological imbalance. Curiously, landslide, which was a minor physical phenomenon in Darjeeling a hundred and fifty years ago, has become quite rampant now-a-days leading to great loss of life and heavy damage to land and property. At present, therefore, suggestion of remedial measures and their active implementation is of vital concern for this extremely sensitive region.

Ever since, the British occupation, the physio-cultural set-up of this region has been seriously disturbed. Extensive heedless deforestation, haphazard construction and inadequate drainage, in other words - unscientific and unplanned usage of land, have led to the establishment of the vicious cycle of degradation, heavy and concentrated rainfall aggravating soil erosion; landslide and associated phenomena (Basu & Sarkar, 1987). Since 1980 onwards, it has been found that almost every year some parts of the hill have been suffering from major or minor landslides and thus, it has become an integral part of the life of the hill people (Photographs 1-12).

In addition to forest fire and landslide erratic occurrences of precipitation and earthquakes also caused detrimental effect to the environment of Darjeeling hills. Due to less rain the water table goes down and scarcity of drinking water has been faced by the people. Acid rain and black rain have been appeared in this hilly region. So, the different kinds of plants and vegetables have been destroyed. The marigold of hill area have been lost for last three years, the cash crops of this region is cardamom whose production capacity have been decreased by 80% due to unknown disease. Elderly villagers are in opinion that acid rain and black rain caused irreparable damage to the famous floriculture and horticulture in hill slopes of Darjeeling hills.

5.3 Consequences of Environment Degradation

The basic needs of human are available in the nature like water, air, food, fibre and shelter and exploitation/extraction of such needs begin the front of man-nature interface. Over use and illogical exploitation/extraction leads environment degradation. Due to ever increasing and over exploitation of natural resources, the environment of Darjeeling Himalaya gets degraded and the consequences can be summed up as follows (figure 5.1):

Air the inexhaustible resource for living, is being polluted due to rapid urbanization and industrialization. Air has been polluted because of socio-economic short-term gains. Although air pollution in Darjeeling hills is not noteworthy yet people awareness should be developed immediately to avoid long term adverse consequences.

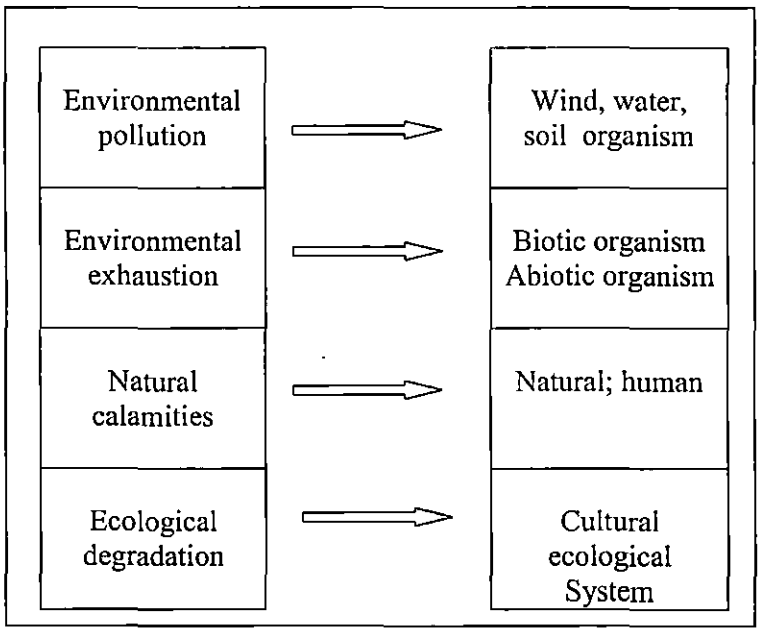

Figure 5.1: Environment degradation and consequences

Like air water is also the basic need for life. The surface as well as ground water resources have greatly been polluted due to urbanization and industrialization. The spring water sources in hill areas have been dried up, due to deforestation and over grazing in catchment area. This can be seen from the decrease in its supply in all the urban areas of the study area. The water supply for Kalimpong town and surrounding area was laid down during the British period. By the beginning of 21st century the virgin forests of Lava, Rachela range where the water source is situated have been cleared. As a result, water yield is declining and if deforestation continues and the remaining small sources of spring water are no longer perennial.

Men have been taking shelter in the lap of nature. The nature is nurturing the entire human race. But the materialistic desire of human being, the urbanization and industrialization has destroyed the beauty of nature. Extraction of building materials and minerals from the hill slopes has also lead to the degradation of environment.

5.3.1 Economic Consequences

The economic consequences of environmental degradation on various products have been assessed for the most likely scenario in Darjeeling, Kurseong as well as Kalimpong sub-

division. The level of dependence of communities on interior village and forest village are quite high and large diversity of products aregathered for household as well as commercial purpose. The diversity and financial value of the gathered products are varied in different forest type. In Darjeeling hill area the most likely scenario, will be the aggregate quantity of non timber product potentially available for extraction is likely to increase in the evergreen and semi evergreen forest areas and decline in area under comparatively low income yielding dry deciduous, dry thorn and montane forest areas.

There will be an increased income from potentially extractable non timber forest products with the income. The economy and livelihood of the people in Darjeeling hill areas are conditioned by the environmental conditions. Topography, climate and soil conditions have influenced human occupancies like agriculture, quarrying, trade and commerce and transportation the major livelihood of the local people.

Plantation economy (tea, cinchona and forest horticulture/floriculture) engages most people while agriculture, quarrying of stones for building and road construction work trade and commercial activities pertaining especially to tourism trade and transport media engage a sizeable proportion of people.

Forestry is an important occupation of the people of Darjeeling hill areas. The forest area in the hill has diminished considerably in recent years. Owing to a high rate of population increased the per capita agricultural and forest areas have shown a sharp decline. Demand for wood as industrial raw materials, fuel would led to indiscriminate cutting of valuable trees unless stringent monitoring is not implemented. Many forest industries have come up and there is huge potential for further development. Cultivation of aromatic medicine and exotic plants and orchid is a source of income in the regional economy. This conclusion is based on the assumption of equilibrium response of vegetation to environmental degradation and climate change.

However, there is uncertainty regarding the transient response of vegetation to climate change and this could lead to loss of vegetation. Conversely fuel wood and timber production may increase due to increase productivity as a result of increased carbon dioxide fertilization and nitrogen deposition.

Table 5.1 List of endangered medicinal plants found in the Darjeeling hills

No	Medicinal plants/ herbs			
	Local name	Botanical name	Parts of plant used	Mode of application
1	Nageswari	Lycopodium spps. Lycopodiaceae	Leaves, stem	Pounded and applied externally
2	NA	Pteridium polypodiaceae	Rhizome, fruits.	Drinking decoction of rhizome and fruits
3	Gopresala	Abies sps. Pineceae	Bark, leaves	Fumigation
4	Bojho	Acorus celamus Araceae	Roots, rhizome.	Pounded roots are administered orally. The rhizome are emetic, antispasmodic carminative, used in remittent fever and bronchitis and to cure cough and cold.
5	Kukurdaini	Smilax sps, Liliaceae	Stem	Brushing
6	NA	Hedychium sps Zinglberaceae	Rhizome	Pounded Rhizome administered orally
7	Chabak	Piper sps Piperaceae	leaves	Pounded Rhizome administered orally
8	Harchun	Viscum album Loranthaceae	Leaves	Leaf powder is applied externally decoction internally.
9	Pinse Jhar	Polygonum sps	Roots, rhizome	Root Juice for cough.
10	Tambarki	Stephania Menispermaceae	Leaves	Paste of leaves of the Plant is used in opening up of boils.
11	Basak	Diohora fabrifuga Sexifugaceae	Leaves, roots, shoots and bark	Decoction of pounded leaves for fever; roots for Malaria; young shoots and bark as febrifuge.
12	Kurakheh	Astilbe rivulara	Roots	Decoction of roots.
13	Asilu	Rubus Elipticas	Roots	Decoction of roots.
14		Prinsopa utilia Araliceae	Leaves	Oil of the plant is used externally
15	Abijalo	Drymaria Cordata Caryophyllaceae	Leaves	Fumigation in case of headache, leaf, juice in case of fever.
16	Taki	Bauhinia Variegata Papilionaceae	Buds, bark, roots, flowers.	Dried buds for cough; bark is tonic, astringent; roots for dyspepsia and flatulence; flowers as mild laxatives.
17		Oxalis Cornicalata Oxalidaceae	Leaves	Leaf curry as appetizer and for treatment of dyspepsia, leaf juice applied on boils.

18	Tezbal	Zanthoxylium alatum Rutaceae	Fruits, branches, seeds bark	Fruits as anti-typhoid, seeds and bark as aromatic tonic in fever, dyspepsia and cholera.
19	Tooni	Cedrela toona Meliaceae	Bark	Decoction of bark as powerful astringent.
20	Bhalavo	Rhus succedanea Ancurdiaceae	leaves, fruits	Leaf used for indigestion and vomiting, fruits are denoted for prosthesis.
21	Bhalubans	Dendrocalamus Sikkimensis	Young shoots	Young shoots boiled and eaten
22	Tamabans Pou	Bambusa poaceae Bambusa arunurnaria Bambusa vulgaris	Buds, Shoots	The tender sprouting bud/shoots can either be eaten raw/fermented. In dried form it can be preserved Tama preparation, young shoots are cut into small pieces and boiled and drained.
23	Nigalo susha	Arundinaria falcota Arundinaria artistata Poaceae	Shoots	These two species are not used in Tama preparation but tender shoots are cooked and eaten.
24	Mailing Puthu	Arundinaria intermedia Poaceae	Stem	Stems are used for making straws for local drinks
25	Betfal Ru	Calamus erectus Arecaceae	Ripe Fruits	Ripe fruits are available in the end of February
26	Kebro	Ficus virens Moraceae	Young Shoots	Young shoots used in pickles
27	Sanulambu Mekrapekung	Morus australia Moraceae	Fruits	Ripe fruits available from April to May
28	Simzoo Surang	Utrica parviflora Utricaceae	leaves and flowering twigs	Leaves and flowering twigs are cooked as vegetable
29	Sishnu, Lekshishnu Surungyong	Utrica ardens Utricaceae Utrica dioca	Tender shoots, leaves	leaves and tender shoots are thoroughly boiled in order to remove stinging effect and cooked as vegetables.
30	Thotne Kandyee Pain	Polygonum molle Polygonaceae	Young shoots	Young shoots are cooked as vegetable
31	Jingaro Jaringle	Phylolacca acinasa Phytolaccaceae	Young leaves, twigs	cooked as Vegetables
32	Dalda sag	Portulaca clearacae Portulacaceae	Young shoots, leaves	cooked as Vegetables
33	Phunchey Phomkung Rajbriksh	Machilus edulis Lauraceae Cassia fistula	Fruits	Fruits are taken by pregnant women
34	Ratokairalo	Bauhinia purpurea	Buds, flowers,	Cooked as vegetables.

	Pangra Kulukprt	Caesal pimiaceae Entada pursaetha Mimosaceae	seeds.	
35	Simrayo	Nasturtium Tropaeolaceae	Young Shoot, leaves	Cooked as vegetables.
36	Nangryn pot Sidipot	Zanthoxylum Aeanthopodium	Fruits	Fruits are used as spice.
37	Lapsi, Silot	Melra dubia	Fruits	fruits are eaten
38	Simul Tarul	Manihot esculentus Euphorbiaceae	Tubers	Tubers, used in Kaza preparation after peeled and boiled.
39	Malinds	Elaeagnus conferts Elacagnaceae	Fruits	Fruits are edible.
40	Gurans	Rhododendron aroboreum	Flowers	Flowers are used in Pickle preparation.
41	Chiwari Yelkung	Aesandra sutyraceae Sapataceae	Fruits	Fruits are edible.
42	Brahmadahoi na	Eryngium foetium Umbelafereae	Leaves	Leaves are used in pickles
43	Ishkush	Sechium edule	Tubers	boiled tubers are eaten
44	Kaferbuk	Canna coccinia	Tubers	Sweet tubers eaten & cooked
45	Pkeebuk (Sikkim Lily)	NA	Tubers	Edible tuber, a rare species in Hee-Gyathang in Dzongu zone.

Many important medicinal plants have already been disappeared even before proper documentation. Thus environmental degradation could have a negative impact on the living standard of communities residing in the hill areas most probably in forest zones as sources of income. Thus there will be an overall decrease in income, although there might be an increase in income from cardamom and groom-stick. However, combined effects of environmental degradation and climate change or biotic pressure will aggravate shortage of timber fuel wood and fodder. The list of extinct/ endangered plants used for food and medicinal purpose in Darjeeling hill areas (used in aliments) are shown in table 5.1.

5.3.2 Social Consequences

The life styles of the people have been changed due to environmental degradation as the people have left the use organic manure. Now, they mostly use inorganic manure, pesticide which is partially poising all living being. Secondly, the transformation of a forest base has far reaching impacts on rural communities and the local economy. The contribution of forest to the local economy in Darjeeling hill area is very small. However, the role of

forest in day to day subsistence needs and some indirect benefit accruing to the agricultural sector is enormous. The factor responsible for social stratification in rural Nepalis of upper class in rural areas of Darjeeling differed drastically in their mobility and status symbols. In past days, the upper class people in Darjeeling were not only political and economic policy makers, but the de-facto rulers (especially in village level).

5.3.3 Political Consequences

Politically, no awareness campaign and other information have so far been organized in Darjeeling hills even though the environmental degradation is increasing day by day. Consequently, the political organizations have not yet been made any manifesto and issue in this regard. They are busy to demand other thing keeping aloof the basic needs of the people. The matter of dried up of water sources extinction of different flora and fauna were already brought to the notice of those political party even then they have not drawn their attention towards these basic problem. It is neglected in this manner the damaged environment cannot be repaired under any circumstances. The medical, physical, social, economic problems are gradually mounting due to environmental degradation. Lack of employment and opportunity among the hill youths has becoming a social issue these days. Consequently, unadeted population growth in the hilly areas has threatening carrying capacity and slowly there shall be problem of shelter, food and clothes also.

5.4 Conclusion

The land of Darjeeling hill areas along with water and plant resources are in a state of massive degradation. Forests are being denuded all over due to the need and greed of the people. The fuel and fodder needs for the increasing human and cattle population with hardly any viable alternatives to plant resources are depleting the forests and green cover at an alarming rate. Hill slopes are getting eroded, filling up the streams with silt eventually leading to floods during the monsoon. Water spring and streams the lifeline of hill communities which are dying especially during the non-monsoon dry periods. Ever increasing landslides are causing serious harms to the economy, society and the environment of the Darjeeling Himalaya. Of late, the very existence of the Hill Cart road the life-line of Darjeeling hill area is under threat and in fact it remains cut-off since August 2010. The condition of the other roads are also equally at stake. The increasing frequency and magnitude of landslides in Darjeeling hills is a matter of grave concern today that needs immediate and all out efforts to ameliorate the problem.

participate in what kind of programs and how to participate and implement the programs such as voluntary coercive participatory etc.

Steps needed for large scale people's participation for development promoters could be: "go to the people" live with them; learn from them; serve them; love them; play with them; start with what they know; build on what they have". These eight principles when applied are likely to give response to the promotion of a good economic development. The above may be considered as basic principles of people's participation. Various ministers and NGOs as well as other voluntary agencies have taken several steps to implement the above principles organization.

- Organizing symposia, workshops, seminars of NGOs at the grassroot level to create awareness among the stakeholders.
- Eco development camps by villagers, students, NGOs etc in various parts of the hill areas normally financed by Government departments.
- Initiating plant nurseries, trees plantation and after care
- Conducting training course in college, schools, training Institutions etc.
- Initiating group action for water harvesting and other soil and water conservation programs.
- Promotion of generation through various types of fencing such as bio- fencing, stone wall fencing, but mainly social fencing.

Though the environment cannot change, it is very much within the reach of man to create a social environment that is conducive to the overall development of people. The various social, cultural and economic conditions that go a great way to improve the quality of life of an individual and the community as a whole.Thus its very much possible to improve the quality of life and living of the socially backward communities by improving their social, cultural and economic conditions where education, health and hygiene must get the top priority on the social agenda as social security is equally important for the backward community.

A right social environment is, therefore what is needed to bring the backward communities in to the mainstream of society, so that all the communities may live in an overall social harmony where the local people will be involved in various environmental and social activities, often in collaboration with well-meaning NGO's.

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CHAPTER- 6

Development of Tourism in Darjeeling Hills and its Impact

6.1 Introduction

Tourism has come to occupy a major slot in the economy of Darjeeling hill areas. Darjeeling the "queen of the hills" where nature has kept her doors wide open have of late become major attraction to tourist worldwide. The hills are abound in a variety of flora and fauna from the alpine to the tropical. Darjeeling and nearby hills offer immense opportunities for trekking, rock climbing, mountain biking, hand gliding and the river Tista flowing the hills attracts the young and brave for white water rafting and canoeing.

Darjeeling popularly known as the "jewel in the crown of the East Himalayas" has been destination for the nature lovers. Dotted with world famous tea gardens the hill town, through dogged by water scarcity is being frequented by tourists for a joy ride on its toy train run by the Darjeeling Himalayas railways that has been awarded with world heritage status by UNESCO. Some call it a paradise for shopping and a kaleidoscope of Indian, Chinese and Tibetan cultures and so no tourist would miss the sunrise over the Mount Everest and the Kanchenjunga.

An attempt has been made to analyse the evolution, growth and development of tourism the second most important economic activities in the Darjeeling hills. Data has been collected from both primary and secondary sources. Various reports, published work, gazetteers, and departmental reports have been thoroughly consulted to get relevant information. Tourist bureau, foreigner registration office, Hotel Association's.transport offices have been visited to gather information of tourist arrival in the Darjeeling hills. Extensive field survey has been carried out involving questionnaire survey among sample respondents from both tourists and local residents to gather primary information on the assessment of impact of tourism under physical, economic, social sectors. Data has been analysed using standard statistical methods under excel platform.

The present chapter aims to study the evolution and growth of Darjeeling as a tourist centre. Moreover, an attempt has also been made to make a comprehensive compilation of a complete inventory of all attractions of tourist significance in the Darjeeling Himalaya. An assessment has also been made of the relative degree of tourist preferences and interest in each tourist spot by using a rating index based on the percentage of tourist footfalls in each

spot. An overall assessment of the availability and distribution of resources related to tourism infrastructure has also been attempted.

6.2 Evolution of Tourism

Tourism in the Darjeeling Himalaya evolved essentially from a high altitude settlement, originally established by the British in India to serve the needs of the civil servants and soldiers of the East India Company. It has subsequently undergone considerable functional evolution so that it now serves an almost entirely Indian clientele. This evolution may be regarded from three vantage points. From the stand point of cultural ecology, the hill station once functioned as part of British colonial ecosystem. Owing to its cool temperatures and its embodiment of an upper class British lifestyle, the British perceived it as a necessity of living in India. Since Independence, however, it has become an integral part of an indigenous ecosystem. Secondly, tourism in the Darjeeling Himalaya can be studied from the viewpoint of settlement geography. From a very small centre with a single purpose function as a health sanitarium, it has developed into a multi-functional type of settlement with a series of inter related activities with overlapping hinterlands. Thirdly, the changing functions of this region also process of Indianisation and the complex process of modernization.

Three factors seem to be of prime importance with regard to the development of Darjeeling as a British hill station, that is, political considerations; height above sea level and the chance factors related to the personal interests of its founders. Travel and tourism developed further with changes in the socio-economic environment. The evolution and growth of tourism in the Darjeeling Himalaya can be analyzed in three distinct phases in terms of colonial and post-colonial episodes:

Stage I: British period (1835 –1947)

Stage II: Post Independence period (1947-1988)

Stage III: Present Scenario (1988 onwards)

6.2.1 Tourism in British Period

The evolution of Darjeeling dates back to 1835 when Captain Lloyd established a sanitorium. The complication of the Calcutta, Darjeeling road in 1838 was the first step towards introducing modern communication. The introduction of narrow gauge railway in 1881 increased the accessibility of Darjeeling in the colonial period and the tea industry was

the pivot of growth and development. An inflow of civil servants, officials, planters and labourers helped the gradual expansion and many civic amenities were gradually appended to this town. This also helped the development of "second homes" around Darjeeling, Kalimpong, and Kurseong of the wealthy landlords from the Bengal.

Initial development of Darjeeling was due to two functions: that of a sanatorium as well as a strategic military station. The establishment of a sanatorium led to urban development and an increase in population. The most important medical institution was the Eden Sanatorium, built in 1882 and it was meant exclusively for the British. The Lewis Jubilee Sanatorium was erected in 1887, on land donated by the Maharaja of Cooch Behar and this was meant for the Indians (O'Malley, 1907).

The major economic activity in Darjeeling was centered on the tea industry. While tea was grown on an experimental basis from 1840, the industry was established as a commercial enterprise in 1856. By 1874, there were 113 tea gardens and by 1905 there were 148 tea gardens (O'Malley 1907). The Darjeeling Planters' Club was established in 1868. The growth of Darjeeling into very popular hill-station was meteoric. Epithets equating the hill station to *"Queen of Hill Stations"* started gaining popularity. Schools like Loreto Convent, St. Paul's, St. Joseph's and Queen's Hill were started by Missionaries for the British children. Today these schools are indices of high status.

The British government also took initiative to develop tourism activities indirectly through offering restricted accommodation for the tourists in Government Bungalow/Dak Bungalow at many places of tourist interest. The Bungalows as shown in table 6.1 were available for the accommodation of travelers and tourists who had obtained passes authorizing them to occupy. The bungalows were constructed in very convenient places. The British had constructed those bungalows without disturbing the environment. In addition to this they had planted different kinds of trees and other valuable plants in and around those spots for the beautification of land and environment so that those places are still considered as very good tourist spots.

The evolution of hotels in Darjeeling began in 1839, when the Darjeeling Family Hotel was established with 12 rooms which was followed by Wilson's Hotel in a two storied house containing 18 rooms. It was followed by Nelson Hotel and thereafter hotels like Woodlands, Drum, Rockville, Bellevue and Mt. Everest followed suit.

Table 6.1 Accommodation facilities for tourists during the British period in Darjeeling hills

No	Nature of accommodation	Place	Distance in km	Altitude in meter	Bed-rooms
1	Dak Bungalow	Kurseong	18 from Kurseong	1482.9	6
2	Dak Bungalow	Pankhabari	24 from Kurseong	548.8	2
3	Govt. Bungalow	Badamtam	7.5 from Darjeeling	792.7	2
4	Govt. Bungalow	Jorepokhari	12.5 from Ghoom	2256.1	2
5	Govt. Bungalow	Kalijhora	32 via Tista Bridge	167.7	3
6	Govt. Bungalow	Kalimpong	28 via Rangit	1219.5	4
7	Govt. Bungalow	Mirik	26 from Sukiapokri	1524.4	2
8	Govt. Bungalow	Peshok	18.5 from Kalimpong	1006.1	4
9	Govt. Bungalow	Pedong	43 from Tista	1451.2	6
10	Govt. Bungalow	Phalut	50 from Darjeeling	3600.9	2
11	Govt. Bungalow	Rangarum	7.5 from Darjeeling	1737.8	2
12	Govt. Bungalow	Reyang	25 from Kalimpong	190.5	4
13	Govt. Bungalow	Sandakphu	37 from Manebhanjan	3636.9	2
14	Govt. Bungalow	Senchal	6 from Goom	2439.0	6
15	Govt. Bungalow	Tanglu	23 from Ghoom	3071.3	2
16	Govt. Bungalow	Tista Bridge	19 via Rangit	216.5	2
17	Forest Bungalow	Battassia	5 from Jorephokhri	2121.3	2
18	Forest Bungalow	Debripani	2.5 south of Jorepokhri	1829.3	3
19	Forest Bungalow	Lepchajagat	5 from Ghum	2134.1	4
20	Forest Bungalow	Paimajua	4 north of Tonglu	1798.8	2
21	Forest Bungalow	Rambhi	5 southeast of Ghum	1905.5	2
22	Forest Bungalow	Ramam	7 southeast of Phalut	2286.6	3
23	Forest Bungalow	Rimbick	6.5 north of Palmajua	2432.9	2
24	Forest Bungalow	Jaisi	2 north of Lopchu	1280.5	2
25	Forest Bungalow	Babukhola	4 east of Toong	1822.6	2
26	Khasmahal Bungalow	Dalapchan	33 via Kalimpong	1380.5	2
27	Khasmahal Bungalow	Gorubathan	77 via Tiger bridge	457.3	4
28	Khasmahal Bungalow	Kumai	82 via Damdim	518.3	2
29	Khasmahal Bungalow	Mongpong	63 via Siliguri	182.9	2
30	Khasmahal Bungalow	Nimbong	68 from Kalimpong	1798.8	2
31	Khasmahal Bungalow	Pagriabong	98 via Tiger bridge	365.9	2
32	Khasmahal Bungalow	Pankhasari	77 via Tiger bridge	411.6	2
33	Khasmahal Bungalow	Patengodak	87 via Damdim	1585.4	2
34	Khasmahal Bungalow	Samthar	68 from Kalimpong	1722.6	2
35	Khasmahal Bungalow	Sinjee	60 from Kalimpong	1204.3	2
36	Khasmahal Bungalow	Siokbir	65 from Kalimpong	975.6	2
37	Khasmahal Bungalow	Targta	92 via Tiger bridge	1722.6	2
38	Khasmahal Bungalow	Tarkhola	26 via Tista	190.5	2
39	Khasmahal Bungalow	Tolo	NA	NA	NA
40	Traveller's Bungalow	Lopchu	15 from Darjeeling	1615.9	2
41	Traveller's Bungalow	Rississum	12 from Kalimpong	1954.3	3
42	Traveller's Bungalow	Tista	23 from Darjeeling	216.5	3
43	Traveller's Bungalow	Birik	10 from Tista bridge	274.4	2

Source: Collectorate, Kutchery, Darjeeling, Divisional Forest Office, Darjeeling & Kalimpong

With the growth of tourist facilities, the number of tourists also went up. Most of the tourists at this stage were British officials and wealthy Indian aristocrats like the Maharajas of Burdwan, Cooch Behar and Digha owned palatial bungalows in Darjeeling. A number of hotels were also established in Kurseong, Goom and Kalimpong during the British period (table 6.2).

Table 6.2 List of Hotels and Boarding houses in Darjeeling hills during the British period.

Sl No.	Name	Place	Location
1	Bellevue	Darjeeling	Commercial row
2	Garrets (Central house)	Darjeeling	Mount Pleasant Road
3	Central hotel	Darjeeling	Post office Road
4	Drum druid	Darjeeling	Commercial row
5	L.J. Vado Ltd	Darjeeling	Commercial row
6	Hotel Mount Everest	Darjeeling	Auckland Road
7	Park Hotel	Darjeeling	Meadow Bank Road
8	Rockville (the Grand)	Darjeeling	Harman's Road
9	Woodlands	Darjeeling	Off Cart Road
10	Add Villa	Darjeeling	Observatory Hill
11	Alice Villa	Darjeeling	Mount Pleasant road
12	Annandale	Darjeeling	Cart Road
13	Beechwood House	Darjeeling	Mackenzie Road
14	Caroline villa	Darjeeling	Kutchery Road
15	EL Esparanza	Darjeeling	Kutchery Road
16	Fern Cottage	Darjeeling	Post office Road
17	Havelock House	Darjeeling	Auckland road
18	La Roche	Darjeeling	Kutchery Road
19	May Cottage	Darjeeling	Lloyd's Road
20	Moss bank	Darjeeling	Cart Road
21	The Labyrinth	Darjeeling	Auckland Road
22	Balaclava Hotel	Ghoom	Old military Road
23	Clarendon Hotel	Kurseong	Cart Road
24	Sorabjee's Hotel	Kurseong	Cart Road
25	Wood Hill	Kurseong	Club Road
26	Rowley Lascelles Ward's Bunglow	Kurseong	Giddapahar

Thus the development of tourism in Darjeeling during the British period represents the phenomenon of expansion of colonialism in the tropics (Mitchell, Nora, 1972). Indeed, they symbolize the growth of modern tourism in the region. This period has certainly provided the initial thrust needed to catapult the Darjeeling Himalaya into modern tourism industry by revolutionizing the present land-use patterns, much to the advantage of tourism in the region.

6.2.2 Tourism in Independent period (1947-1988)

The end of the British Raj in 1947 left behind its footprints in the Darjeeling Himalaya where colonial bungalows on plantations are preserved to this day and the hill schools still retain British traditions. Administration is an important function and Darjeeling still holds the status of the district administrative headquarters. Economic activity is dominated by trade in the 3 T's, that is, tea, timber and tourism. Recreation and commercial tourism have developed phenomenally in the last few decades. New forms of adventure tourism like trekking, rock climbing and rafting have developed. Contemporary urban landscapes have replaced the cottages with massive multi-storied buildings, while numerous hotels, restaurants, plantations and floriculture nurseries have evolved to sustain the region. Thus, the urban landscapes of Darjeeling, Kalimpong, Kurseong and other tourist centres in the region have been considerably altered. Massive constructions catering to the hotel industry have led to the replacement of the verdant forests with concrete jungles. Civil conditions have deteriorated and water shortages and slums have become rampant. Today the hill resorts of Darjeeling Himalaya have become a part of Indian lifestyles. Tourists visit these destinations during their seasons of preference and many infra-structural facilities including varied touristic amenities are being developed.

After 1950, the Indian Government also paid more attention to the growth of tourist industry. Tourism industry in India received a boost when the Indian Tourism Development Corporation (ITDC) was formed in 1965 with the objective of developing accommodation, transportation, entertainment and other tourist facilities. The year 1968 was then declared the 'Year of Indian Tourism' where policies and decisions were adopted to promote tourism throughout the country. Consequently, the influx of tourists has increased and tourism has become a significant part of the economy of the region. With improved transport facilities and expansion of infra-structure, these hill resorts have become more accessible, even to the less affluent middle class. Not surprisingly now tourist destinations like Mirik, Mongpu, Tinchulay, Lava and Lolegaon, Bara Mangwa, Makaibari etc have mushroomed around the three sub divisions of Darjeeling, Kalimpong and Kurseong.

During this period, a notable feature was the establishment of the Tourism Department of the Government of West Bengal in 1958. Subsequently, it has been converted into the West Bengal Tourism Development Corporation, (WBTDC) since November 1975. Prior to 1975, tourism in Darjeeling was managed privately and without much

encouragement or interference of the Government. Since 1975, the WBTDC runs several tourist institutions throughout the region while at the same time serving as an important platform of supplying visitors with basic information about the various destinations in the region and in serving as outlet centers of various handicrafts of the region. The establishment of Darjeeling Gorkha Autonomous Hill Council in 1988 led to tourism activities being transferred to the DGHC. However, the West Bengal Tourism Development Corporation continues to operate in the area.

The picture of tourism in Darjeeling in the post-Independence era however has not always been rosy. A major setback in International tourism occurred when the Darjeeling hill areas were closed to foreign tourists after the Indo-China conflict of 1962. These direct restrictions were lifted in 1985 and the number of foreign tourists to the region increased significantly. Although, even now there are restrictions to foreign tourists in visiting many localities and a visitor can stay in Darjeeling hills for 15 days but only with prior permission from the Indian Missions abroad, the Foreigners' Registration Offices or the Home Department of the West Bengal State Government. Consequently, the number of tourist particularly the foreign tourists visiting Darjeeling increased markedly. When compared with the growth in the resident population, the increase in tourist population is far greater. It has been surmised that the increase in the number of tourists has been so rapid that infrastructures facilities cannot keep pace.

The genesis of the problem in the area can be traced to the haphazard growth and uncontrolled granting of land use rights by the British. Expansion of construction activities along the steeper slopes has exceeded the carrying capacity of the land. Hence, the frequency and intensity of landslides increased. Besides, an expansion of the built-up area at the expenses of forest or open space has resulted in an increased run off accompanied by a reduction in spring discharge. Lower rate of infiltration has resulted in the lowering of the ground water table and hence a reduction in the discharge of yield of springs. This has adversely affected the water supply in the town since the natural springs form the only source of water supply.

The rapid increase in tourist has also resulted in the creation of high density urban areas lacking in aesthetic value as the high rise building obstruct views. In addition, the increase in the built up space to provide for tourist amenities has taken place at the expense of forest areas. Darjeeling has witnessed a sudden growth in the number of vehicles which is

now posing a major threat to the health and environment and safety of the much acclaimed health walkers.

The tourism industry in the Darjeeling hills needs to be re-evaluated which should be followed up by judicious action by all the stakeholders and it is up to the hill people to decide the future of increasingly strong presence of mass tourism.

6.2.3 Present Tourism activities (1988 onwards)

Tourism in the Darjeeling hills was organized and systematized properly after the formation of the WBTDC. New destinations like Mirik and Mongpu have been created in the 80's to serve as satellite townships to ease the burden on the old tourist centers of Darjeeling and Kalimpong. The establishment of the Darjeeling Gorkha Autonomous Hill Council (DGAHC) in 1988 led to the tourism activities being transferred to the DGAHC. However, the WBTDC also continues to operate in the area. After the formation of the DGAHC the region saw an upsurge of unprecedented growth rate in the tourism sector till 2007. In late 2007 political instability resurfaced in the region causing a sharp decline in the total number of tourist arrivals. Consequently, the tourist industry like all other economic sectors in the region plummeted to an all-time low. There is at present an acute need to sustain tourism activities through proper management and administrative intervention.

The overall expansion of tourism in the Darjeeling Himalaya – or the *"pleasure-periphery"* (Turner and Ashis, 1975) of West Bengal, is essentially driven by the lure of awe inspiring scenic beauty, the availability of interesting sightseeing, the liberal tourist incentives and cheap costs that apply to tourism in most third world environments. Tourism development in the Darjeeling Himalaya has witnessed the unprecedented mushrooming of destinations with enormous investments in resorts and hotels, services and other infrastructure. While critics decry mass tourism for its adverse cultural effects and social inequalities from "economic leakage", nonetheless, conventional tourism remains the single most important type of tourism dominating in the Darjeeling Himalaya.

6.2.3.1 The trend of tourism

The Darjeeling Himalaya has been experiencing a substantial tourist inflow during recent years. The growth of tourism can be assessed from the following facts: (i) the number of hotels in Darjeeling hills has increased from 68 in 1980 to 280 in 2010; (ii) bed capacity increased from about 850 in 1980 to 9000 in 2010; (iii) total tourist arrival in the year 2001

was 2,54,086 thereafter it peaked to 4,91,158 in 2006 and in 2010 it was 3,12,741 and (iv) the number of registered vehicles in Darjeeling has multiplied from a mere 10,317 in 1995 to 22,665 in 2009.

Table 6.3 Tourist Arrivals in Darjeeling Hills (2005-2010)

Tourist Arrivals in the Darjeeling Hills						
Years	Foreign	% Variation	Domestic	% Variation	Total	% Variation
2001	11100	-	242986	-	254086	-
2002	12350	11.26	249032	2.49	261382	2.87
2003	18700	51.42	284315	14.17	303015	15.93
2004	18090	-3.26	261596	-7.99	280496	-7.43
2005	27218	50.46	415901	58.99	443119	57.98
2006	30394	10.45	460764	09.73	491158	09.78
2007	29669	-02.44	444253	-03.71	473922	-03.64
2008	26346	-12.61	359258	-23.66	385604	-22.90
2009	23819	-10.61	342813	-04.79	366632	-05.17
2010	27218	12.49	372741	08.03	399959	08.33

Sources: Tourist Bureau, Darjeeling; Foreigners Registration Office, DIB, Darjeeling

These changes clearly indicate tremendous increase in tourist activity. The growth of tourism in the region is further reiterated by the analysis of Tourist traffic (both international and domestic) in the region. Darjeeling Himalaya attracted as many as visitors 1.21 lakh in 1986.

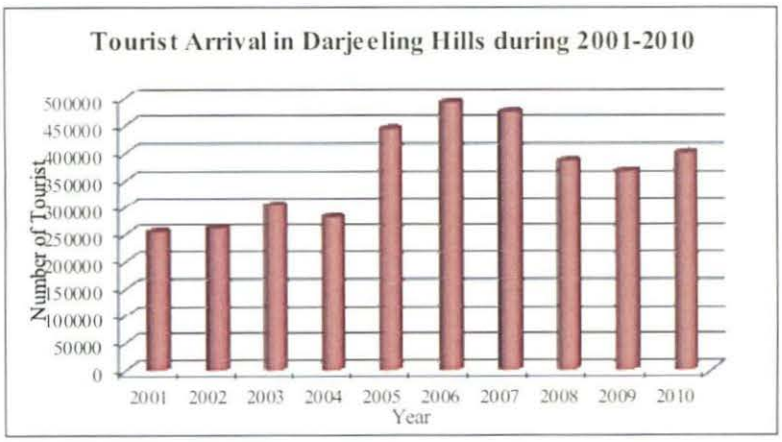

Figure 6.1 Tourist arrival in Darjeeling hills

At present the figure hover around 3.5 to 4 lakh annually. Table 6.3 shows the growth pattern of tourist arrivals in the region. It is evident that there is no continuous increase in the tourist flow, but there is a rise and fall in numbers (figure 6.1). This may be attributed to

factor like the weather conditions or political disturbances in the region. It can be seen from the tourist arrival figures for the year 2008, both foreign and domestic figures have plummeted sharply by almost 21%. This can be attributed to the fresh agitation for a separate Gorkhaland state. To a certain extent the negative role of media was also responsible. Thus, it becomes very obvious that peace and security are as much needed for the tourism.

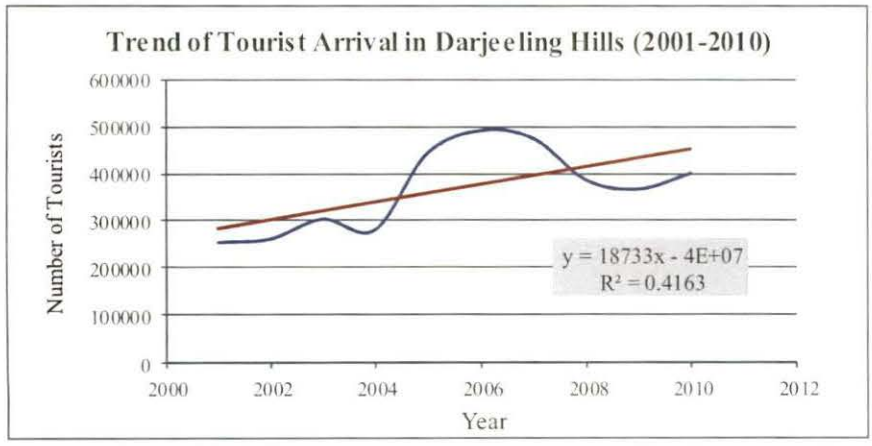

Figure 6.2 Trends of tourist arrival in Darjeeling hills

An attempt has been made to study the trends of tourist traffic (both International and domestic). The time series analysis of tourist arrival in Darjeeling hills (figure 6.3) reveals that both domestic and international is on increase with the time. However, the domestic tourist arrival is increasing trend is more prominent than the foreign tourist. The strong positive correlation as shown in figure 6.3 is a proof of such contention.

6.2.3.2 Spatial distribution of tourist arrival

It is interesting to note that both the domestic as well as the international tourist prefer to visit Darjeeling and its environs among the other hill areas like Kurseong and/or Kalimpong. The subdivision wise distribution of tourist arrival in Darjeeling hills has been given in table 6.4 and diagrammatically represented in figure 6.2. It is reveals that on an average in between 2001-2010, 77% of the total tourist arrived Darjeeling sub-divisions, another 16% arrived Kalimpong and its environs and only 7% preferred to visit Kurseong as their destination. Such preference remains more or less constant over the past decades (figure 6.4 & table 6.4).

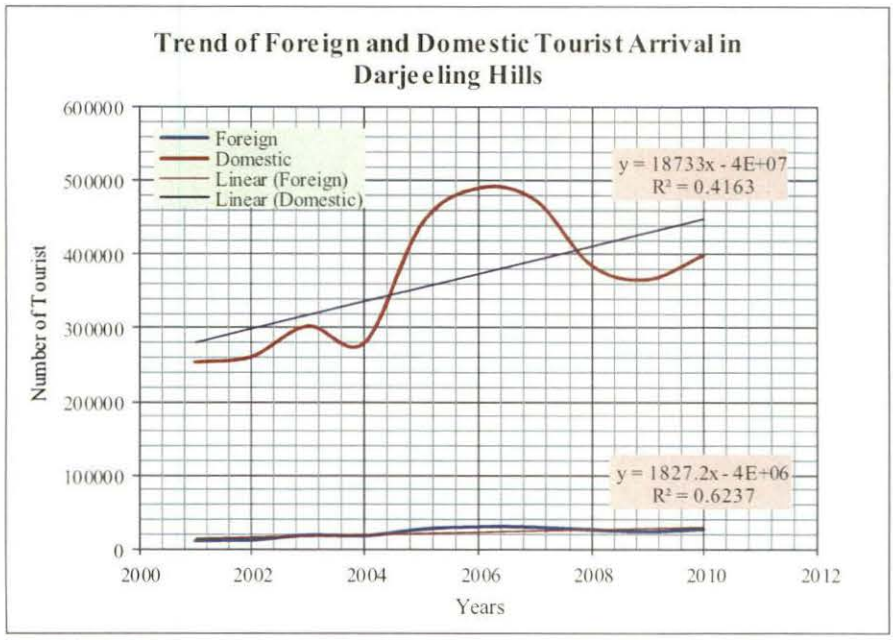

Figure 6.3 Trends of foreign and domestic tourist arrival in Darjeeling hills

It is found that the tourist arrival in Kalimpong has increased considerable while that in Kurseong declined. Perhaps calm and less congested urban environment along with its British infrastructure attract more tourists. On the contrary, overcrowding coupled with trafficcongestion displays its negative role to attract tourist to visit Kurseong. As a result, number of tourist arrival is declining steadily in the recent years (figure 6.5).

Table 6.4 Sub-division wise arrival of tourist in the Darjeeling hills

Year	Sub-divisions			Total
	Darjeeling	Kurseong	Kalimpong	
2001	185000	16424	52662	254086
2002	187925	21168	52289	261382
2003	218301	30324	54390	303015
2004	198342	26880	55274	280496
2005	359832	27856	55431	443119
2006	393321	30556	67281	491158
2007	382403	28976	62543	473922
2008	303967	23853	57784	385604
2009	289675	21745	55212	366632
2010	293912	17212	88835	399959

Sources: Tourist Bureau, Darjeeling; Foreigners Registration *Office, DIB, Darjeeling*

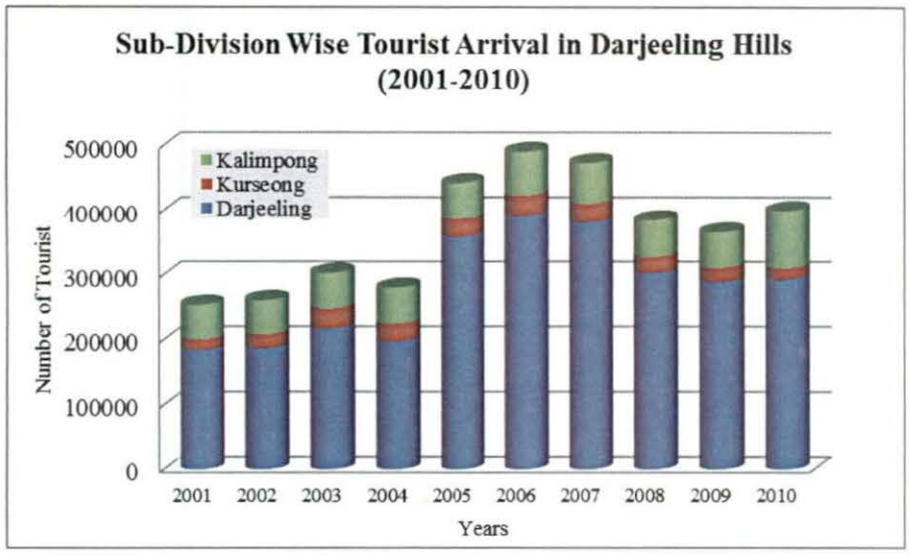

Figure 6.4 Sub-division wise tourist arrival in Darjeeling hills

An attempt has been made to study the trends of tourist traffic in all three sub-divisions in Darjeeling hills. The time series analysis of tourist arrival in Darjeeling, Kurseong and Kalimpong sub-divisions (figure 6.5) reveals that while Darjeeling sub-division shows an impressive growth in tourist arrival, the Kurseong sub-division recorded a virtual stagnation and the Kalimpong sub-division recorded only marginal increase over the last decade. The strong positive correlation as shown in figure 6.5 is a proof of such contention.

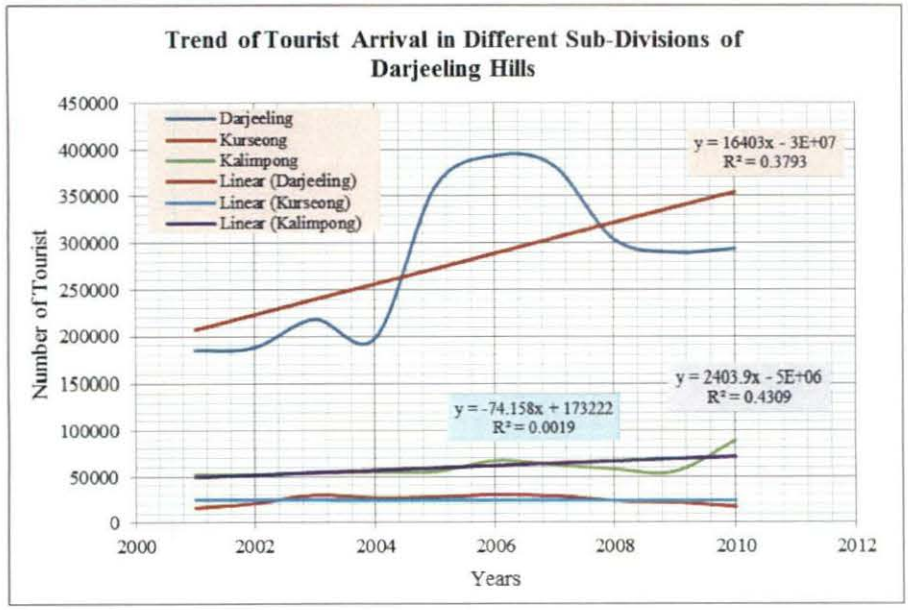

Figure 6.5 Sub-division wise trends of tourist arrival in Darjeeling hills

6.2.3.3 Seasonality of tourism

The seasonal variations reveal that tourism has 2 (two) peak periods in the Darjeeling Himalaya viz March-April and October-November (table 6.5).

Table 6.5 Month-wise foreign tourist arrivals in Darjeeling hills

Months	Years					
	2005	2006	2007	2008	2009	2010
January	1,006	1,938	1,970	1,805	1,676	1,694
February	1,494	2,160	1,780	1,013	2,156	2,193
March	3,272	3,338	3,114	3,362	3,326	3,366
April	1,609	3,109	3,029	3,777	4,397	4,437
May	855	3,116	2,486	2,928	2,142	2,164
June	2,308	1,336	1,219	799	1,533	1,551
July	1,079	1,325	1,345	994	746	756
August	1,614	1,561	1,222	1,814	1,264	1,300
September	3,075	2,140	2,019	1,518	1,522	1,557
October	3,077	4,902	5,519	3,970	2,695	2,720
November	4,863	3,530	3,201	2,704	676	687
December	2,967	1,939	2,765	1,662	1,686	1,700
Total	27,219	30,394	29,669	26,346	23,819	23,143

Source: *Foreigners Registration Office,* DIB, Darjeeling.

Darjeeling town, singularly a unique hill station in terms of its physical setting, attracts the largest number of tourists in comparison to the other centres in Darjeeling Himalaya. The high turnout that is evident in summer is essentially due to the fact that the scorching temperatures in the plains compel tourists to seek cool, exhilarating climates of the hill resorts. In autumn factors like the Dussherra and Diwali vacations in West Bengal and the clear weather skies in the hills giving much clarity to the mountain ranges attract a substantial number of domestic tourists. Furthermore due to climatic preferences, foreigners arrive in more numbers during the autumn and winter seasons (figure 6.6).

The Darjeeling Himalaya has been witnessing a substantial tourist inflow in recent years. An interesting development has been the emergence of 'weekenders' who give rise to short spells of intense tourist activity in the region during the weekends on short term holidays irrespective of the tourist season. As a result, tourism is steadily coming up to be a year-round activity though the bulk of it is still around the twin peaks of pre monsoon-summer and autumn.

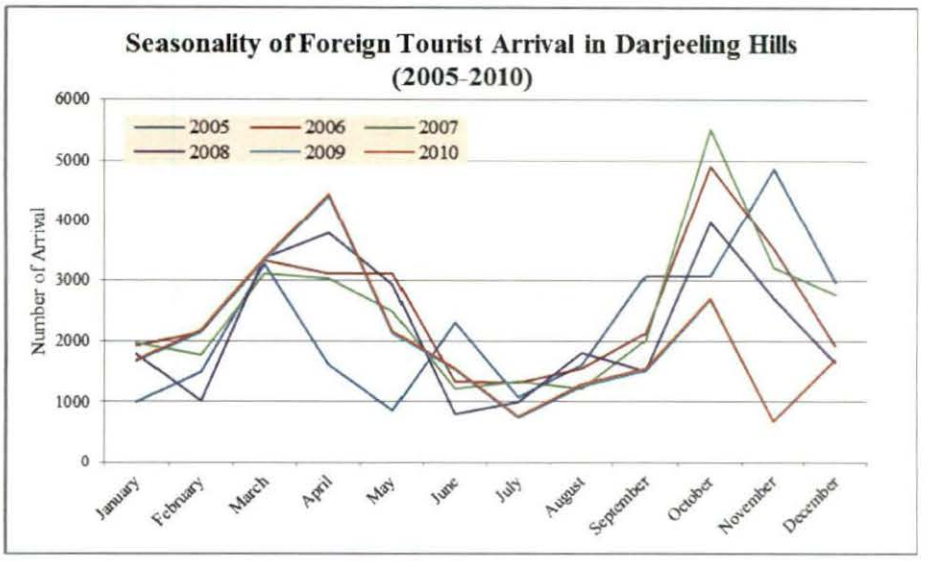

Figure 6.6 Seasonality of foreign tourist arrival in Darjeeling hills

6.2.3.4 Tourism Resources in the Darjeeling hills

Physical environment: Nature has endowed the Darjeeling with splendid scenic beauty in the landforms of tectonic, glacial and fluvial origin. This region is also endowed with the undulating plains of the terai, beautiful lakes and cascading rivers and waterfalls which offer great attractions to the tourists. The Darjeeling Himalaya has natural resources that provide multi-dimensional outdoor tourist activities such as sightseeing, trekking, boating, rock climbing, white water rafting, fishing etc. in addition there are numerous recreation areas such as parks, zoological and botanical gardens, lakes and other related resources.

With the Kanchendzonga range dominating the skyline, the mountain scenery is unsurpassed in the world. A wide panoramic visits profoundly flaunts snowy peaks like Kanchendzonga (8585m), Janno (m), Kabru (m) Lhotse (8501m) and even the world highest peak Mr. Everest (8848 m) is visible in the distance.

The Darjeeling Himalaya stands out distinctly with regard to natural assets. Scenic corridors offer some of the most exquisite scenery and memorable wilderness experience of mountain treks and trails along with the additional benefits of experiencing ethnic and cultural values preserved in these remote pockets. Mountain viewing can be enjoyed from numerous hill tops and vantage points that have now become famous destination points solely for this criterion. The most notable and outstanding vantage points in the Darjeeling Himalaya are spread out throughout the district. A number of these vantage points are off the

usual routes and are accessible only along trekking trails. However, a vast majority of these points are in very easily accessible points.

Mountain landscape around Sandakphu and Phalut in the Singalila environs is the best resource of the Darjeeling Himalaya for treks along trails that provide scenic enjoyment of dramatic land architecture, wilderness of extraordinary solitude, alpine pastures with wild flowers filling up the slopes like carpets and wildlife – which are rare and endemic to the region. The famous *"Rhododendron trail"* along the Indo-Nepal border, starts from Maneybhanjang that culminates in Sandakphu/Phalut at an altitude of 3636 m.

The rivers like Tista and Rangit provide breathe taking views of steep slopes with cascading waterfalls, crystal clear tributaries gushing at the confluence or even wide river terraces laden with golden crops of maize and rice. The Tista provides beautiful tourist destinations like "Triveni", where white-water rafting has become immensely popular form of adventure tourism.

Darjeeling town itself is the premier tourist centre of the region. Developed by the British as a sanatorium, it later became a thriving tourist resort and earned the epithet of the "Queen of Hills." The magnificent architectures of the Raj Bhawan, the St Andrew Church, the Elysee House and innumerable such buildings bear witness to its former grandeur and importance. Kalimpong attracts the maximum number of tourists after Darjeeling. In addition to its scenic grandeur, it has numerous trails for soft treks along Kalimpong town – Relli River – Kaffer – Lolaygaon – Lava – Algarah – Kalimpong via Dr. Graham's Homes and Tirpai hills. The Tibetan Handicrafts of Kalimpong are very famous and much sought after products include carpets, bags, antiques and religions objects like thanka paintings and dorje or the prayer wheel (maney). The lake town of Mirik developed with the intention of serving as a satellite township to ease the burden of excessive tourists on Darjeeling town during the twin peak seasons of summer and autumn – has its own distinct charm and appeal. Kurseong, has perhaps one of the best views of the wild and sloping terrain, surrounded by emerald green forests and tea gardens with a bird's eye view of the plains of Siliguri and Bagdogra.

Climate: The climate of Darjeeling hills by virtue of her elevation, alignments of ranges, windward and leeward locations, proximity to the peaks/snowline, water bodies and natural vegetation display wide differences of climatic conditions especially with regard to temperature and precipitation. Cool temperate climate of Darjeeling even lured the early

British officers to annex the area to develop sanatorium for the British solders and ailing officers.

Flora and fauna: The Darjeeling Himalaya epitomizes a botanist's *"utopia"* due to its species richness. This region supports at least 4000 flowering plant species, including 28 rhododendrons and 322 orchids; of which 53 orchid species are *"endangered"* or *"rare"*. At least 144 of the plant species are endemic to Eastern Himalaya and 29 are restricted to Darjeeling Himalaya alone. The Darjeeling Himalaya is also rich in faunal species. The Singalila National Park, the Senchal Wildlife Sanctuary and the Neora Valley National Park are undoubtedly the most picturesque representatives of the rich and diverse flora and fauna in the entire West Bengal. It shelters many endangered species of the Himalayan region.Of the faunal distribution, 131 species of mammals are recorded in the Darjeeling Himalaya, including endangered species like the Red Panda (ailurus fulgens), the Himalayan pheasant (Satyr tragopan) and the Salamander (Tylototriton verrucosus). It is estimated that there are about 550 bird species in the region along with 125 freshwater fish, 51 reptiles and 25 amphibian species. However, on account of mass tourism some of the most valuable species in this region is being threathened as shown in table 6.6.

Table 6.6: List of Himalayan Species under grave danger on account of destruction by the Tourists for different purposes

Sl No	Species	Supply of fuel	Collection of flower for decoration	Specimens trampled by boots, cylinders boxes etc	Plants parts gathered for medicinal purpose	Preparation of fancy articles	For making walking stick
1	*Abies densa*	+	-	-	-	-	-
2	*Acer pectinatum Gledt.*	+	-	-	-	-	-
3	*Acnitum palmatum*	-	+	-	+	-	-
4	*A.heterophyllum wall.Ex. Royle*	-	+	-	+	-	-
5	*A.violaceum Jacq.Ex.Stapf.*	-	-	+	+	-	-
6	*Allium wallichi.*	-	-	+	+	-	-
11	*Betula alanoides*	+	-	-	-	-	-
12	*B.michrophyla*	+	-	-	-	-	-
13	*Bupleurum raniltonii Balak*	-	-	+	-	-	-
14	*Himalayense Klotz.*	-	-	+	-	-	-
15	*Campanula aristate wall.*	-	+	+	-	-	-
16	*C .colorate wall.*	-	-	+	-	-	-
17	*C himanobambusa falcata (Nees)*	-	-	-	-	+	+
18	*Cicerbita macrorhiza (Royle) Besuv*	-	-	+	-	-	-
19	*Cortia dipressa (Don.) Norman*	-	-	+	+	-	-
20	*Corydalis cashmeriana Royle*	-	+	+	+	-	-
21	*Cyanathus integer wall ex Benth.*	-	+	-	-	-	-
22	*Dactylorihiza hatagirea (D.Don) Soo Nom.*	+	-	+	+	-	-
23	*Gentiana arcentia (D.Don) Cl*	-	-	+	-	-	-

24	*G. contorta Royle*	-	-	+	-	-	-
25	*G. tubiflora (G.Don.) Griseb.*	-	-	-	-	-	-
26	*Gentianella pedunculata (D.Don) H. Som.*	-	-	+	+	-	-
27	*Geranium himalayanse Klotz.*	-	+	+	-	-	-
28	*G.nepalenese. SW*	-	+	+	-	-	-
29	*G. wallichiana D. Don. Ex SA*	-	+	+	-	-	-
30	*Goodyera repens (L) R. Br*	-	-	+	-	-	-
31	*Juniperus commis L. var sexatillis Pallas*	+	-	-	-	-	-
32	*J Indica Bertol*	+	-	-	-	-	-
33	*J. equamata Bunch, Ham*	+	-	-	-	-	-
34	*Leonotopodium himalayanum DC*	-	+	+	-	-	-
35	*Meconopsis aculeate Royloe*	-	+	+	-	-	-
36	*Nardostachys grandiflora DC*	-	+	+	-	-	-
37	*Parnassia nubicole Wall. Ex. Royle*	-	+	-	-	-	-
38	*Pedicularis bifida (Buch.Ham ex D.) Pennel*	-	+	+	-	-	-
39	*P.gracilis Wall. Ex Benth*	-	+	+	-	-	-
40	*P. pactinata Wall. Ex Benth*	-	+	+	-	-	-
41	*Picrorhiza scrophulariflora Pennell*	-	-	+	+	-	-
42	*Pinus wallichiana Jacks*	+	-	-	-	+	-
43	*Polygonum graminifolium Hook*	-	+	+	+	-	-
44	*Potentilla argyrophylla Wall ex Lehm*	-	+	+	+	-	-
45	*P. biflor wild. Ex Schelecht*	-	+	+	-	-	-
46	*P. fruitcosa L. var. Pumila Hook.f*	-	+	+	-	-	-
47	*Primula denticulate Sm.*	-	+	+	-	-	-
48	*P. redidii Duthie*	-	+	+	-	-	-
49	*Rhododendron arboreum Sm*	+	+	-	-	-	-
50	*R. campanulatum D. Don*	-	+	-	-	-	-
51	*R. lepidotum Wall ex G. Don*	-	+	+	-	-	-
52	*Saxifraga asarifolia Stemb.*	-	-	+	-	-	-
53	*S. diversifolia Wall. Ex Saring*	-	-	+	-	-	-
54	*S. parnassifolia D. Don*	-	-	+	-	-	-
55	*Saussurea gossypiphora D. Don*	-	+	-	-	-	-
56	*s. obvallata (DC) Odgew.*	-	+	+	-	-	-
57	*Selilnum elatum (Edgew.) Cl*	-	+	-	+	-	-
58	*S. wallichianum (DC raizada & Saxena)*	-	+	-	A	-	-
59	*Swertia speciosa D. Don*	-	-	+	+	-	-
60	*S. tetragone Edgew*	-	-	+	+	-	-
61	*Tehmnocalamus falconeria Hook f. ex. Munro*	-	-	-	-	+	+
62	*T. spathifloras (Trin.) Munro*	-	-	-	-	+	+
63	*Viola biflora L.*	-	-	+	+	-	-
64	*Zanthoxylum alatum Roxb.*	-	-	-	+	-	+

Socio-cultural: The people of Darjeeling Himalaya are a diverse group with varying customs, costumes and traditions. Among the regions many ethnic groups are the Lepchas, Bhutias, Sherpas and Nepalis consisting of Brahmins, Chettris, Newars, Tamangs, Rais, Limboos, Mangars, gurungs etc. all contributing significantly to the regions heritage. The Buddhist and Hindu inspired traditions and arts, the numerous religious festivals, the thanka paintings, wood carving, the music and dances, the ethnic costumes and the different forms of

architecture create a compelling cultural landscape. This cultural landscape is now subject to new economic appraisals as potential tourist attractions.

The Darjeeling Himalayan Railway has declared a World Heritage site by the UNESCO. Exhibitions of the region's music, dance and paintings are frequently scheduled exclusively for tourist viewing.

Historical and religious: The Darjeeling Himalaya has a rich cultural heritage which comprises historical and religious interest. The famous Mahakal Temple on the top of the Observatory Hill; the Senchal Devi Dham atop Tiger Hill; the holy Devi Dham at Giddapahar (Kurseong); the Thakurbari; the Mangal Dham at Kalimpong are a few of the very sacred hindu temples which constitutes noteworthy attractions for both Hindu and non-Hindu tourists. There are about eighty monasteries in Darjeeling Himalaya belonging to various sects of Buddhism like the Ghum monastery, Dali Gompa; The Bhutia Busty Gompa, the Tamang Gompas at Darjeeling, Mirik, Kalimpong and many others dot the entire region. These monuments point to the assimilation of the Tibetan culture in the region.

Festivals and fairs: The festivals of Darjeeling Himalaya belong essentially to two main cultural streams based on religion: the Nepali culture, based on Hinduism and the Bhutia - Lepcha culture, based on Buddhist traditions. The two major festivals of the Nepalese, the Dasain and Tihar are known as Dussehra and Diwali respectively in the rest of India.

Folklore and folk dances: Folklores are important aspect of the rich cultural heritage in the Darjeeling Himalaya. From times immemorial, shamanism, spirit possession and mystical rites are performed openly and with festive ardour, especially on "Guru Puja" or mid *shravan* (i.e., August) the day all "jhakris" gather to pay obeisance to the deity at Mahakal Temple.

Arts and crafts: Arts and crafts are a part of the cultural development of a society. The one sector that has benefitted from Tourism is the local art and craft sector. In order to satisfy the demands of tourists in the form of gifts and souvenirs the local products are handicraft in the region. Some of the notable handicraft products include: thanka paintings; carpets and woolen garments produced by the Tibetan Refugee Centre and Hayden Hall; wood carvings, candles and bamboo items are very popular among tourists.

Infrastructure: The tourist industry has always been greatly assisted by the development of its infrastructure notably a good transport network, accommodation, civic amenities and recreational facilities. Keeping in view this fact, an attempt has been made to analyze the

civic amenities and important public utility services which have provided better amenities and comforts to both the tourists as well as the inhabitants of the region.

Over the years the number of hotels and other accommodations for the visitors has increased considerable not only in urban centres but also in semi-urban and at vintage locations for attracting tourists. Consequently, the number of registered hotel has also increased. In Darjeeling town there exist 150 registered hotels with 9000 beds, Kalimpong has 50 registered hotels with 3000 beds, Kurseong has 16 registered hotels with 960 beds, Mirik has 18 hotels with 1080 beds. It is interesting to note that the number of Star category hotels has also increased to 10 mostly situated in Darjeeling town. Number of hotels in rural environment and vintage points has also increased to 20 with 1200 beds. Number of tourist lodges owned by the government tourist departments has increased to 15 by the year 2010 with a total bed capacity of 900 in Darjeeling hill areas.

The West Bengal Forest Development Corporation (WBFDC) has also promoted eco-tourism in Darjeeling hill areas. Nine number of "nature resort" with clusters of eco-friendly cottages have been developed in Lolaygaon (17 cottages), Lava (18 cottages), Kalimpong (4 cottages), Suntalay khola (6 cottages), Rangpo (2 cottages), Mongpong (4 cottages), Jaldhaka (2 cottages), Samsing (6 cottages) and Lepchajagat (6 cottages).

While the temporal analysis shows the different phases of growth of tourism in the Darjeeling Himalaya – there seems to be a marked spatial imbalance in the development of tourism in the region. It is clear that the marked spatial imbalance is the greatest with respect to resource based facilities, comprising of outstanding physical features. Certainly, not all areas of Darjeeling Himalaya are equally endowed with spectacular visual landscapes.

The identification of the types and distribution of recreation resources in the Darjeeling Himalaya in terms of its natural, socio cultural and infrastructural aspect, reveals that there is an excessive spatial imbalance of tourism in the region. The growth is not uniform and it has mostly been concentrated in and around the town of Darjeeling, while Kalimpong and Kurseong sub-divisions are woefully neglected.

6.3 Environmental Impact of Tourism

Rapid expansion of tourism as one of the largest and fastest growing industry in the world and as an economic activity of immense importance has caused numerous changes in almost every sphere of life of the host societies and the destinations.Considerable debate

exists today over the nature and extent of the impact which tourist development may have on host societies and localities (UNESCO, 1976). Tourism, which was once regarded as unreservedly beneficial, is no longer seen in that light, (Young, 1973; Bryden, 1973). Tourism, by its nature, involves contact and interaction between the residents of and the visitors to the destination. And this contact inevitably creates considerable positive and negative impacts. This development of tourism affects not only the tourists and the developers, but also other sectors of the economy, the society in general and the environment as a whole. Consequences of this interaction are commonly referred to as the "impacts of tourism" and can be categorized into three main types: economic, socio-cultural and ecological.

Table 6.7 Impact of tourism in Darjeeling hills

Types	Positive impact of tourism	Negative impact of tourism
Physical	*Preserves:* • Environment • Flora and fauna • Parks and nature reserves *Encourages:* • Ecological preservation • Improves waste management • Awareness for the environment	*Changes:* • Physical environment and ecosystem • Habitats flora and fauna • Negative change in physical integrity of area
Economic	*Creates:* • Job opportunities for skilled and unskilled • Foreign exchange • Diversification *Improves:* • Infrastructure • Regional development • Standard of living	*Increases:* • Price of land housing and essential commodities • Excessive demands on health care and police services during peak season • Seasonality of income
Socio-cultural	*Preserves:* • Folk traditions • Culture • Art and history *Encourages:* • Education/ training of human resource • Contact with outside world • Expands knowledge • Rediscovery of lost traditions	*Leads to:* • Excessive demands on local amenities and institutions • Overcrowding and traffic congestion • Disruption of traditional life • Demographic change • Erosion of cultural values • Vandalism of historic sites

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The Darjeeling Himalaya, where wanton encroachment by man has led to the degradation of the eco-system. In many parts, the biomass, the flora and fauna, the water resources have suffered greatly due to heavy and unplanned encroachment. In many cases, the failure to provide drainage, disposal of garbage, supply of waterpower, transport and communication in respect to the corresponding tourist demand has been the cause of environmental degradation.

Economic transformation through tourism is widely accepted and tourism has been recognized as an industry. It increases employment and income potential in almost every sector of economy at the national, regional and local levels. The social and cultural aspects of tourism, though less perceptible, have far reaching consequences than other factors. The perception of social change is intimately related to human values. Socio-cultural transformation through tourism is rather gradual and its evaluation involves a considerable span of time. The impact of tourism in Darjeeling may be positive that have nurtured the growth and development of the regional economy or negative that bring about unwanted constraints in the region. Thus, an attempt has been made by the present investigator to analyze the manifold impacts of tourism under the headings (i) environmental impact, (ii) economic impact and (iii) socio-cultural impact.

6.3.1 Physical Impacts

The development of tourism in the study area clearly shows that the environment of various places has largely contributed to the growth of tourism. Scenic sites, pleasant climates, attractive landscapes have been a major influence in drawing people to specific tourist destinations. However, most literature on the impacts of tourism has viewed the relationship between tourism and environmental conservations as one of conflict. Numerous examples have been cited, the world over, of negative or detrimental impacts of tourism on environment which include degradation of natural resources by deforestation and erosion, destruction of landscapes and congestion as well as negative effects on cultural heritage and social customs.

Tourism, on the other hand, is also perceived as having beneficial aspects, both social and physical: the conservation of natural resources; attempts of achieving sustainable tourism development; improving welfare through recreation; creating employment; restoring ancient monuments and heritages etc. Thus, whilst there may be different perceptions of the issue, achieving the correct balance of positive and negative impacts, i.e. minimizing and avoiding

negative effects should be the goal of any tourism development strategy. Further, where environmental degradation has been caused in the past, policies can be directed towards corrective action to enhance environmental quality. Instead of a conflicting relationship, tourism and environmental conservation, therefore, need to be a supportive or symbiotic relationship, whereby each supports and benefits from the other, within the total context of development.

6.3.1.1 Positive physical impact

The existing knowledge about tourism impacts of the tourism industry in the region is highly fragmented. Emphasis is laid on the negative impacts only. While, here is ample evidence of the negative impacts of tourism on the environment of the study area, tourism has been responsible for inculcating environmental appreciation. The tourist industry has discovered made known and rendered accessible specific regions and aspects of nature: the pristine mountain ranges, the turbulent rivers, the verdant forests of Darjeeling Himalaya all form the very basis of the tourism industry in the region. While new destinations are continuously been discovered and marketed, it is the simultaneous conservation of the scenic areas, along with the historical and cultural heritage – that is gaining ground and is of utmost significance today. Slowly but inevitably, there is growing realization that the economic potential of tourism is inextricably linked to the conservation of the prime tourist destinations, which is today being considered an essential investment.

Tourism in the Darjeeling Himalayas has not only promoted conservation, but in some cases, it is also providing the economic means by which such measures can be taken. For e.g. the maintenance and repairs of the world famous DHR and institutions like the HMI and the Lloyd's Botanical Garden and Rock Garden at Gangamaya and Batasia Loop are from the funds generated from tourism earnings. Tourism has also provided the incentive to conserve the endangered DHR by incorporating the UNESCO to confer the "World Heritage" status. In the context of tourism development in the Darjeeling Himalaya conservation of the environment has been mainly of four types:

1. Firstly, tourism has provided the incentive and stimulus for the conservation of natural resources i.e., the establishment of the Singalila National Park; the Neora National Park, the Senchal Wild Life Sanctuary have succeeded to some extent, in protecting diverse species of flora and fauna in the region, that were otherwise, endangered or threatened with destruction. Such efforts are not without the

contribution of tourism that provides the thrust for the preservation of the natural environment and its enjoyment by the tourist. The establishment of these reserves and sanctuaries has resulted in other benefits like the creation of employment with the park ad in auxiliary tourist services, provision of infrastructural facilities etc. which are the secondary effects of conservation.

2. Tourism has led to the restoration and regeneration of several sites of historical and cultural interest. The DHR; the cottage of Netaji Subhas Chandra Bose at Kurseong and Mayapuri Complex in Darjeeling are some of the places with great historical significance that have been restored and rejuvenated mainly because of the stimulus provided by tourism.
3. Tourism has been solely responsible for the transformation of old buildings and sites, by retaining their original features and putting them to better use for tourism facilities. Most notable example of this would be the old world colonial charm of the "sick–and-on-the-verge-of-collapse" tea gardens of Darjeeling. The utilization of these gardens as 'tea-tourism destinations' as in Makaibari, Glenburn, Bannockburn etc has not only benefited the entire garden community, but has also been immensely helpful in relieving pressure of the tourists on the congested hill resorts of Darjeeling as well as on other crowded circuits, by providing an alternative form of tourism.
4. Finally, visitors can also credit tourism in the Darjeeling Himalaya with the introduction of administrative and planning measures at many places to prevent further physical deterioration of tourist attractions due to their excessive and uncontrolled use i.e., Mirik, Labha and Lolaygoan were planned and developed as satellite tourist destinations with sole intention of diverting tourists to reduce the stress capacity on the crowded hill station towns of Darjeeling and Kalimpong. Tourism may be the means of enhancing the tourist's sense of environmental appreciation; it can also serve as the means of preserving areas of scenic beauty or centers of historical interest by providing an economic or social rationale to enforce purely environmental considerations. (Pearce, 2006.).

6.3.1.2 Negative physical impact

It is well documented that the tourism activities have had many fold far reaching adverse consequences on the regional environment (OECD, Paris 1980). Expansion of tourism has identified four major sources of environmental stress due to tourism-generated activities. Such as:

i) Restructuring of the environment brought about by a variety of construction activities. "The replacement of a natural has a variety of far-reaching and long-lasting consequences in terms of existing biological species and physical conditions in the area. It may be also cause significant changes in visual amenity.

ii) Environmental stress results from the generation of new or increased waste residuals. In resort communities, it creates water pollution through the discharge of inadequately treated effluents and sewage into water bodies; it may seriously impair human health and destroy flora and fauna.

iii) Recreation activities have had adverse environmental impact including soil erosion and landslides, change in plant cover and species diversity, habitat changes that subsequently affect wild-life and this leads to a further series of impacts.

iv) Stress generated from seasonal population increases and densities. It results in congestion in these areas. Thus, seasonal influx increases the demand on natural resources.

The ever increasing population and escalating tourist influxes into the region are causing changes in land use patterns in Darjeeling; which, over the years have resulted in a situation that has put a tremendous pressure on the environment. The process of land use change brought about by the development of tourism in the area through the passage of time has gradually increased the environmental hazards that we are now exposed to. Man's activities, in the area has escalated the pressures of an increasing population on the ecologically fragile environment leading to wide spread deforestation, soil erosion, landslips and landslides in the region.

The various steps that were taken to bring about the changes in the land use and the direct and indirect results that emanated should be taken as important lessons and warnings. Signs of environmental breakdown began to manifest by the turn of the century itself, when the landslides of 1899, which took the toll of many lives and the loss of a lot of property in the area, following unprecedented rainfall, came as a warning to planners. The report of the committee, which was appointed to inspect the condition of buildings, roads and drains; to find remedies for preventing the occurrence of such landslide narrowed down not only to the natural phenomena of heavy amount of rainfall that was received during the particular period, but also, and more so, to man's own indifference and ignorance. The report revealed defective draining of sites, excessive lead of drains, imperfect or badly constructed revetments, neglect to reduce or protect steep slopes, defective supervision of building sites

and quarrying in unsafe localities. These findings led to the promulgation of an act, which ensured immediate protection work to be carried out in the district. The fact that an act could come into force and lead to extensive protection works which were considered necessary as far as preventive measures were concerned, stands as one good example of the "will" which needs to be emulated when we have all the advantages of modern technology today.

6.3.2 Economic Impact

Since 2000 AD, tourism is already being slotted and projected as the "numero uno" or the "first among service industries". Today, tourism is the world's largest employer, generating nearly 200 million jobs, directly or indirectly that accounts for nearly 10 % of jobs globally (Honey and Roove, 2000). Tourism is the principal "export" (foreign exchange earner) for 83% of developing countries and the leading export of $^{1}/_{3}^{rd}$ of the poorest nations. International tourism in developing nations is increasing by 9.5% annually, compared to a 4.6% growth worldwide. Porter (1978) reiterates that tourism reinforces developing economies as a positive force by improving infrastructure and dispersing economic activities. Thus, tourism invites foreign exchange earnings, generates employment and income and accelerates infrastructural development.

In Darjeeling hills tourism is the second largest export industry after tea providing direct and indirect employment to nearly 38% of her population. The emergence of tourism as an important source of foreign exchange earnings is also of crucial importance its economy. However, domestic tourism is the source of wider tourist movements and has significant importance as an economic activity.

Tourism is thus instrumental in increasing the sustainable income in the local economy of Darjeeling hills where economic development has remained sluggish. The difficult terrain and frequent occurrences of natural disasters delimit the sphere of economic growth. In this region, the scope for industrialization is limited – in the absence of raw materials and skilled labour. Under such circumstances, the best, or rather, the only viable option for Darjeeling is to recharge the sluggish economy by utilization of the "tourism potential" that is explicit in her natural splendour and cultural heritage. Limited access to other resources in the region has made tourism a prerogative and an obvious choice to develop a sustainable economy. Today, the significance of tourism as a revenue earner in the Darjeeling Himalaya has become very evident. At the turn of the new millennium, the

increase in tourist arrivals has been remarkable, wielding tremendous social impact in the region, while at the same time hauling up its sagging regional economy.

Table 6.8 Economic impact of tourism in Darjeeling hill areas.

	Positive economic impact		Negative economic impact
1	Tourism generates local employment, directly in the tourism sector and in support and resource management sectors.	1	Higher demand created by tourism activity may increase the price of land, housing and a range of commodities necessary for daily life.
2	Tourism stimulates profitable domestic industries, hotels and other lodging facilities, restaurants and food services, transportation systems, handicrafts and guide.	2	Demands on health service provision and police services can increase during the tourist seasons at the expense of the local tax base
3	Tourism generates foreign exchange for the country and injects capital and money into the local economy	3	Undesirable opportunity costs including transfer of found from health and education
4	Tourism helps to diversify the local economy.	4	Increase in administrative costs and capital out flows
5	Improved road systems and infrastructure that contributes to the entire destination can be justified and supported by the benefits from tourism development.	5	Acquisition of a poor reputation as a result of inadequate facilities improper practices or inflated prices.
6	Often the jobs created through tourism can be low paying and unskilled but they constitute an important step for the poor to improve their economic condition.	6	Negative reaction from existing enterprises due to the possibility of new competition for local manpower and government assistance
7	Increased tax revenues from tourism.	7	Better alternative investment and real estate speculation.
8	Increased knowledge concerning the potential for investment and commercial activity in the region.	8	Inadequate estimation of costs of tourism infrastructure development.

Source: United Nations (2003) Poverty Alleviation through Sustainable Tourism Development, New York.

Tourism is an important activity in the Darjeeling Himalaya – generating incomes and employment for the local residents. Tourists every year spend to the tune of 32.54 crores. Apart from an increase in the income and the demand for local products, tourism also results in a multiplier effect. Everybody right from the hotel owner to a porter benefits from tourism. The multiplier effect refers to the way in which tourist expenditures filter through the economy and generate other economic activities. The multiplier is expressed as a ration of change in the host's economic level of output, income, employment, revenue earnings and foreign exchange to the change in tourist spending that brought it about. In addition to the

contribution of tourism to economic growth, the labour intensive nature of tourism and tourism related industries results in a significant impact upon the level of employment.

An official release by the Joint Director of Tourism, West Bengal in 2009 taking the annual flow of both foreign and domestic arrivals in the Darjeeling and Dooars the quantum of revenue has been calculated, based on the presumption that the minimum average daily expenditure of a foreign tourist is Rs.1000 per day and a domestic tourist spends Rs.800 per day. Tourism may be viewed as an economic activity and thus as an industry. Tourism has been identified as one of the fastest growing industries in the world. It has grown from the pursuits of a privileged few to a mass movement of people with an urge to discover the unknown, to explore new and strange places, to seek changes in environment and to undergo new experience. The major economic impacts of tourism activities in Darjeeling hills are tabulated in the following table (No. 6.7) to apprehend the impacts.

6.3.3 Socio-cultural impacts

The qualitative changes which tourism causes to the socio-cultural structures of host areas are difficult to measure. While assessing an overall view of the regional impact of tourism, it becomes necessary to consider these parameters. Thus, the development of tourism should not be based on the sole criteria of the quantifiable positive economic advantages but must also take into account the socio-cultural consequences and other non-tangible impacts, which are not readily quantifiable in exact figures (Tewari, 1981).

In the Darjeeling hills, it has been seen that in addition to its economic potential, tourism introduces new interactions between the local residents and the visitors. It has been instrumental in fostering acculturation, diffusion of ideas, exposure to new innovations and technologies that are prompting new lifestyles and aspirations. Consequently, the potential of socio-cultural impacts is great. Thus, in any integrated approach to the study of tourism cannot, and should not, be restricted to evident economic advantages to be gained from it, but should take into account its social and cultural impacts as well.

In recent years there has been considerable debate on the social and cultural impact of tourism. While the economic impact can be quantified, measured and evaluated, the same cannot be applied in the case of socio-cultural impacts. Pearce (2008) asserts that *the social impacts of tourism will vary according to the differences between the visitor and visited, chiefly in terms of numbers, race, culture or social outlook.* Critics of tourism argue that the

long-term consequences for the local people may be negative while supporters of tourism view local customs and traditions as colourful assets to be exploited by the tourism industry. Proponents of tourism however argue that in order to overcome the backward economy, the dynamic tourism industry should be vigorously pursued without sentimentality over its potential cultural impacts (Gurung, 1984).

Table 6.9 Socio-economic impacts of tourism in Darjeeling hills

A	**Positive Social impact**		**Negative Social impact**
1	The quality of life of a community can be enhanced by economic diversification through tourist.	1	Rapid tourism growth can result in the inability of local amenities and institutions to meet service demands.
2	Local communities as well as domestic/international visitors can use recreational and cultural facilities created for tourism.	2	Without proper planning and management, litter vandalism and come often accompany tourism development.
3	Public spaces may be developed and enhanced through tourism activity.	3	Tourism can bring overcrowding and traffic congestion.
4	Tourism enhances local community's esteem and provides an opportunity for greater understanding and communication among peoples of diverse backgrounds.	4	Young members of the host community are susceptible to the economic expectations these tourists bring and can result in disruption of traditional community ways of life.
		5	The community structure may change, e.g. community bonds, demographics and institutions.
B	**Positive Cultural impact**		**Negative Cultural impact**
1	Tourism can enhance local cultural awareness.	1	Youth in the community begin to emulate the speech & attire of tourist
2	Tourism can generate revenue to help pay for the preservation of archaeological sites, historic buildings and districts.	2	Historic sites can be damaged through tourism development and pressures.
3	Despite criticism about the alteration of cultures to unacceptable levels, the sharing of cultural knowledge and experience can be beneficial for hosts and guests and can result in the revival of local traditions and crafts	3	There can be long term damage to cultural traditions and the erosion of cultural values, resulting in cultural change beyond a level acceptable to the host destination.
4	Increased in level of local interest and participation in types of activity associated with event.	4	Commercialization of activities which may be of a personal or private nature.
5	Strengthening of regional values and traditions.	5	Modification of nature of event or activity to accommodate tourism
6	Increased local prides & community sprit	6	Potential increase in crime.
	Increased awareness non-local perceptions.		Tendency toward defensive attitude concerning host regions.

Source: United Nations (2003) &Modified based on Getz (1977) Matheson and Wall 1982.

Thus, it is obvious that there are both positive and negative socio cultural impacts of tourism. Any policy for the growth and development of tourism must, therefore, aim at maximizing the positive effects and minimizing the negative effects of this "necessary evil." A prime consideration in examining the social and cultural impact of tourism is the nature and composition of the various groups involved and the interactions and relationships between them. The major identifiable positive and negative impacts of tourism activities in Darjeeling hills are summarized in table 6.8.

It is not difficult to argue that tourism is damaging the environment including the wildlife of Darjeeling hill areas. It is not possible to develop tourism without incurring environmental impacts but it is possible with correct planning to manage tourism development in order to minimize the negative impacts while encouraging the positive impact. The trek route to Sandakaphu and Phalut as well as other tourist spot of Lava and Lolaygaon has so well established or tourist path for a long time a special expedition was under taken to clear up the litter that lay around halting camp. To obtain hot water to meet the needs of tourists for a wash after the day's trek, wood is cut down and thereby aggravating deforestation. There is evidence that tourism threatens the wildlife that tourists come to see. The wild animals of different wild life century and national park of the hill areas may have their feeding and breeding activities interrupted as tourist vehicles surround them so that tourists can take photographs.

The construction of roads and other infrastructure are indispensible for efficient transport and communication system for tourism development but these unavoidable activities are mainly responsible for destruction of hill areas land resource along its vegetation and animal wealth. The construction for accommodation facilities like rest houses, tourist bungalow, resorts, building and seasonal accommodation units, recreation centre etc. have posed the most serious menace to the land resources of the region not only does it accelerate slope degradation but it also causes damage to crops, animals and plants, housing and public properties. The beauty of hill areas forest, alpine meadows and peak is the main sources of tourist attraction. The continual flow of tourists, mountaineers, trekkers etc. is likely to have almost negative impacts on these natural resources to a certain extent.

A considerable area of virgin forest is also being replaced for providing necessary amenities to visitors for tourism promotion. It has been seen that a huge forest area has been destroyed only by road construction from 1980 to 2006 in the Darjeeling Hill area.

Deforestation not only result into resource depletion but also deteriorated fresh and underground water, wildlife and other related resources along with acceleration of disastrous phenomena like heavy soil erosion and landslides. Many flora are threatened and extinct due to increasing rate of tourism traffic and direct and indirect activities of tourists. Many important and charming species of flowers like orchid *primulas*, *Anthorium* etc. are now found in reduced abundance along the treks, roads sides and other easily accessible areas. This degradation will definitely occur in the entire area with increasing number of tourists.

Tourist activities like invasion in wildlife habitat close view watching and photography hunting poaching and other disturbances etc. have created a problem for wild animal, mammals and birds an affected in large extent more than reptiles insects and other small animal. These activities further affect the feeding and breeding habits and ultimately the entire life cycle. The small animals die due to heavy and frequent traffic which affect the food chain in wild system. The increasing tourist craze for the Himalayan wildlife and their products is also responsible for its destruction as it increases the demand of stuffed animals, ivory ornaments, furs, tails, quills, feathers, horns, skins, musk and wildlife souvenirs, etc. Such demand provokes the curio trade resulting into poaching and slaughtering of animals. The deer, black bear, hare, leopard etc. are few well known animal species which are in great danger due to poaching in Darjeeling hill areas. To prevent and reduce degradation of Darjeeling hills natural resources, there should be scientific and well planned growth of tourism in which experts of different disciplines along with local people should have close involvement in planning.

6.4. Environmental Impact

The most important direct impact that the tourism industry brings on the environment is increased pressure on the carrying capacity of the ecosystem in each tourist locality. Increased transport and construction activities lead to large scale deforestation and destabilization of natural landforms, while increased tourists flow leads to increased in solid waste dumping as well as depletion of water and fuel resources. Tourist movement to ecologically sensitive area lead to destruction of rare and endangered species due to trampling, killing, disturbance of breeding habitats. Noise pollution from vehicles and public address systems, water pollution, vehicular emissions, untreated sewage, etc. also have direct effects on bio- diversity, ambient environment and general profile of tourist spots.

6.4.1. Statistical analysis

The study adopts a multivariate data analysis technique to assess the impacts of tourism in the four dimensions. It is suggested that a minimum sample size should be at least 200 (or more) to minimise the chance of getting exaggerated goodness-of-fit indices due to small sample size (Anderson and garbing, 1988). Thus, the sample size for the present study was 250 respondents comprising of senior citizens, government servants and people engaged in tourism either as guests or host were. The impact of tourism on the environmental aspect in Darjeeling hill area was considered. Items for each dimension were selected to measure the residents' perception of tourism impacts. A survey using questionnaires was used to collect data. A five point Likert scale (strongly disagree = 1 to strongly agree = 5) was used to measure the items.

Factor Analysis was conducted using SPSS 15.0. First of all, to determine the appropriateness of factor analysis the Kaiser-Meyer-Olkin measure of sampling adequacy and the Bartlett's Test of Sphericity were examined. A value of 0.60 or above from the Kaiser-Meyer-Olkin measure of sampling adequacy test indicates that the data are adequate for factor analysis and that a significant Bartlett's Test of Sphericity ($p < 0.001$) is required (Tabachnick and Fidel, 1989). In order to ensure that each factor identified by the factor analysis has only one dimension and that each attribute loads on only one factor, attributes that had factor loadings of lower than 0.4 were eliminated from the analysis (Kim, 2002).

6.4.1.1 Environmental impact variables

The items used to measure environmental impacts of tourism can be categorized into three different sub dimensions;

i. Pollution,
ii. Solid waste and
iii. Wildlife and ecology.

These three environmental sub-dimensions of tourist impacts were measured. Items that are used to measure each sub-dimension were summated and the summated scales were used to assess environmental impacts of tourism. Three items for pollution, three items for solid waste and three items for wildlife and ecology were used to measure residents' perception of each sub-dimensions of environmental impact of tourism. A 5 point Likert scale (strongly disagree=1 and strongly =15) was used to measure these items.

i. Pollution

- Tourism brings environmental pollution;

b. Tourism produces noise, congestion and littering

c. Tourism activities like boating and rafting produce serious water pollution in rivers.

ii. Solid waste

a. Tourism produces large quantities of waste products;

b. Tourism related business produce huge quantity of garbage – solid and liquid;

c. Littering by tourists destroys the beauty of the landscape.

Table 6.10. Factor Analysis result of the environmental impact of tourism

Constructs and Scales	Loadings	Eigen values	Variance explained
Pollution	.860*	2.283	76.10 %
• Tourism produces noise, littering and congestion	.905		
• Tourism brings environmental pollution;	.917		
• Tourism activities like boating and rafting produce serious water pollution in lakes and rivers.	.766		
Kaiser-Meyer-Olkin MSA	.742		
Bartlett's Test of Sphericity	.000		
Solid waste	.890*	1.863	62.12 %
• Tourism related businesses produce a large amount of garbage	.992		
• Littering by tourists destroys the beauty of the landscape	.953		
• Tourism produces large quantities of waste products	.775		
Kaiser-Meyer-Olkin MSA	.728		
Bartlett's Test of Sphericity	.000		
Preservation of wildlife and ecology	.880*	1.871	74.53 %
• Tourism contributes to the preservation of the natural environment and protection of the wildlife in the community;	.957		
• Tourism contributes to loss of forest cover and green space	.960		
• Tourism has improved the ecological environment in the community in many ways.	.743		
Kaiser-Meyer-Olkin MSA .811	.794		
Bartlett's Test of Sphericity	.000		

*Reliability coefficient (Cronbach's Alpha)

iii. Preservation of wildlife and ecology

- Tourism has contributed to the preservation of the natural environment and protection of the wildlife;

- Tourism has improved the ecological environment in the community
- Tourism contributes to loss of forest cover and green space

6.4.1.2 Environmental impact of tourism variable

The environmental impact of tourism was measured with three dimensions:

i. Pollution

Three items were used to measure the pollution. From a principal component factor analysis, results of the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (.661) and the Bartlett's Test of Sphericity ($p<0.001$) indicated that the data were acceptable for factor analysis (table). All factor loadings were greater than 0.70 and loaded only on one factor. Cronbach's Reliability Estimate was .85 and the factor explained 76.10 % of the variance.

ii. Solid waste

Three items were used to measure the solid waste. From a principal component factor analysis, results of the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (.628) and the Bartlett's Test of Sphericity ($p<0.001$) indicated that the data were acceptable for factor analysis (table). All factor loadings were greater than .70 and loaded only on one factor. Cronbach's Alpha Reliability was .88 and the factor explained 62.12 % of the variance.

iii. Preservation of wildlife and ecology

Three items were used to measure the preservation of wildlife and ecology. From a principal component factor analysis, results of the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (.704) and the Bartlett's Test of Sphericity ($p<0.001$) indicated that the data were acceptable for factor analysis (table). All three items had factor loadings greater than .70 and loaded only on one factor. Cronbach's Reliability Estimate was .89 and the factor explained 74.53 % of the variance. Hence all three items were used to measure preservation of wild life and ecology.

From the table 6.9, it is apparent that residents perceive marked environmental threats as tourism activities increase in the locality. The primary area of concern is in the amount of and types of environmental pollution, solid waste and garbage that are increasing in these communities as a result of the growth of tourism in their areas. The local populace also view tourism as being instrumental in the loss of green spaces and forest cover in their localities.

On a more positive note however, residents are also of the opinion that certain tourism activities like ecotourism, tea tourism and flori-tourism contribute to the preservation of the natural environment and that tourism has also contributed in many ways, to the conservation and protection of the local flora and fauna within the communities.

6.5 Conclusion

In Darjeeling hills, at the time, when it is not only the erosion of the soil that should concern us – but the erosion of our value systems, the very exquisite scenic grandeur and invigorating climate that earned the epithet of "*The Queen of Hill Stations*" for Darjeeling has taken the form of a one way ticket to Doomsland. The fragile and susceptible ecosystem can hardly withstand such unprecedented exploitation. There is, as the Mahatma had once put it, "enough for every man's need, but not enough for man's greed!"

Granted, that development of tourism in the hills areas is of fundamental importance, but it should not proceed at the cost of ecological and societal degradation. Therefore, to be really effective 'development without destruction' is the only way forward for a long, lasting and sustainable solution to the manifold problems that hound the region. Findings of this study are consistent with the assumptions that the economic, social, cultural and environmental impacts of tourism do exhibit sub-dimensions. Moreover, it can be observed that each tourism impact dimension has both positive and negative impacts. The results from this study are indicative of the fact that when residents of the community were asked to reveal the impacts of tourism on the community, they assessed the perception of tourism impact in both positive as well as negative ways.

The present study also indicates a positive relationship between the economic impact of tourism in the sense that the residents' sense of satisfaction of material wellbeing increases with better economic conditions attributed to tourism, which in turn seems to influence their overall life satisfaction. Thus, it would be quite pertinent to note that tourism in a community should be developed, not simply on the analysis of costs and benefits in the short term, but also from a long term perspective of resident's quality of life and sustainable tourism.

There is no denying that tourists do influence the host population's culture. The places in the mountains have remained relatively isolated from the mainstream and therefore, the

value system and traditions of mountain people are vulnerable. Cultural tourism is one of the instruments to fight tourism's adverse socio-cultural impact.

This huge yearly influx of tourists far exceeds the carrying capacity of the city, almost paralyzing the socio-economic life due to near breakdown of the basic amenities and community services. Unplanned urbanization, which is a direct result of increase in tourism activities, is the root cause of this ecological devastation. Increased transport and construction activities lead to large scale deforestation and destabilization of natural land form while increased tourist flow leads to increase in solid waste dumping as well as depletion of water and fuel resources. Flow of tourist to ecologically sensitive areas lead to destruction of rare and endangered species due to trampling, killing, disturbance of breeding habitat. Noise pollution from vehicular emissions, untreated sewage etc. also has direct effects on bio-diversity, environment and general ambient of tourist spots.

Large scale deforestation to realize tourism related development has led to severe environmental hazards like soil erosion, landslides, river siltation droughts, floods etc. Dumping of wastes and garbage by campers and tourists, inadequate sanitation system, unplanned abstraction of water, building of dams and bridges, have all contributed in the metamorphosis and town plan rules are openly flouted.

In the Darjeeling Himalaya, tourism has conventionally been portrayed as an agent of change within the tourist-visited areas. However, for any assessment of the overall impact, it becomes very essential to look beyond the purely economic benefits and focus on the net result of the welfare of the local community, comprising the sum of the desirable as well as the undesirable effects over the full range of social conditions. Any concept of development that embraces increases in economic output and accompanying material standards of living must also include social well-being.

While, the role of tourism as a major economic activity in Darjeeling hills cannot be denied, the necessity of regulating it in a manner compatible with environment conservation can not be over-emphasized. Against this back ground, perspective planning integrating environmental and ecological factors is of utmost importance in Darjeeling hills as they are ecologically fragile and sensitive. Beside long term perspective planning, immediate measures are necessary to contain the adverse impacts. A number of schemes for improvement of tourism infrastructure in Darjeeling hill area have been launched by the DGHC for sustainable development of the tourism industry. These include:

(a) Diversion of tourist traffic from overcrowded Darjeeling-Kalimpong areas to the newly discovered places of tourist interest in regulated manner.

(b) Introduction of entry tax on outsiders to generate revenue to be spent on maintenance and development of tourism infrastructure.

(c) Provisions for providing planned and properly maintained basic amenities like water supply, health, public transport and communication.

(d) Modernization/Introduction of solid and liquid waste disposal system in areas of tourist interest.

(e) Regular monitoring including checking of tourist inflow by regulating entry point for different tourist hot-spots in Darjeeling hills.

(f) Spreading of environmental awareness amongst tourist as well as local population.

(g) Imposition of penalties for deliberate destruction of forests, bio-diversity and heritage sites and littering and causing noise pollution etc.

(h) A comprehensive plan for arresting further environmental degradation of the hill areas needs to be formulated along with the tourism development activities.

The development of tourism in the hills areas is of fundamental importance, but it should not proceed at the cost of ecological and societal degradation. Therefore, to be really effective 'development without destruction' is the only way forward for a long, lasting and sustainable solution to the manifold problems.

6.5 References

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Chapter 7

Land Use Change and its Impact on Environment

7.1 Introduction

Before 1835, Darjeeling hill area was covered by natural forest, in 1835 there were about 20 huts with a population of 100 souls. The entire land was covered by natural vegetation, the most remarkable features of the forest of Darjeeling was the wonderful variety of species that they contained; there were in fact, probably few places in the world in which so many different types of forest exist within so small area. At the highest altitude from the elevation of 8000 to 12000 feet forest of silver fir were found interested with grassy slopes which were dotted here and there, with the whitened stems of dead trees.

With the introduction of tea plantation, the transformation of land use was started in Darjeeling hill areas in real sense. General Llyod was appointed local agent to deal with application for land which began to pour in from residents of Calcutta. Progress was rapid and further boosted by the early development infrastructure particularly with the completion of vital transport networks i.e., the Cart road and the Darjeeling Himalayan Railways.

7.2 Nature and extent of land use transformation

The history of land use transformation in Darjeeling district is necessarily linked with the settlement of the hill tracts by immigrants and the development of the region following the cession of certain tract by Sikkim Raja to the East India Company. The basic features of the land system in Darjeeling are different from those prevailing elsewhere in West Bengal. The cultivated lands are divided into tea and non-tea areas. Most of the non-tea areas fall under the category of *Khasmahal* and prior to the coming into force of the estates.

The tea plantation in the district goes back to the year 1834 when Lord William Bentinck appointed a committee to advice on the introduction of tea cultivation in India. Tea lease are granted and renewed under the provision of the Bengal waste land manual. Some of the important provisions governing these lessees include:

- ❖ that the leases would pay the rents in time,
- ❖ that the lessee or his manager would reside on or near the land,
- ❖ that the lessee would not divert the flow of any stream or spring with in the land without the previous sanction of the Deputy Commissioner,
- ❖ that the lessee would not set up any new market or hat without the permission of the Deputy commissioner,
- ❖ that the Lessee would erect and maintain boundary marks and lines,
- ❖ that the lessee would furnish to the Deputy commissioner full information about birth and death within his area,
- ❖ that the lessee would not subject the land,
- ❖ that the right conferred by the lease was heritable and transferable with the previous approval of the Deputy Commissioner and
- ❖ there was also a provision that in special circumstances a summary renewal for a period of one year would be granted.

The bulk of the revenue paying non-tea estates in the district were grouped under the following categories, (i) the Sadar and Kurseong *Khasmahal,* (ii) the Kalimpong Development area and Kalimpong Government estates and (iii) The Terai *Khasmahal.*

Table 7.1. Hilly area of Darjeeling district

Sub division	Tea Estates	Non Tea Estates Including Khasmahal & district improvement fund land	Total
Sadar	106.72	81.66	188.38
Kurseong	75.62	18.00	93.62
Kalimpong	11.55	171.61	183.16
Total	*193.89*	*271.27*	*465.16*

Under the then Revisional Settlement survey (1954-1955) the entire area of Darjeeling district excepting reserved forest was recorded as 202.37 sq. miles according to the *Touzi* Register. Three small blocks from the Duars area of the Jalpaiguri district covering an area of 0.09 sq miles were added to the district in 1944 and in 1959, 57 sq. miles transferred from the Purnea district, Bihar to Darjeeling. About 435 sq. miles of the district were accounted for by reserved forest and approximately 63 sq. miles were covered by the Mungpu Cinchona

plantation and Ranpo Medicinal plantation. The total hilly area area of Darjeeling district is shown in table 7.1.

7.2.1 Land use transformation in British Period

During British period the Darjeeling District was divided as (a) Government estates in the hills, (b) those in the Terai, (c) the strip of land lying to the North West of the Little Rangit and (d) the land granted for the cultivation of tea. Besides these four tracts however, there were reserved forest occupying an area of 415sq. miles and land reserved for Cinchona cultivation which was extended over 59 sq. miles.

The Kalimpong Government estate including the Government reserved forest and the few tea plantation interspersed in it comprised an area of 401 sq. miles to the east of the Tista. The reserved forest in that area comprised cover 200 sq. miles and the tea garden 10 sq. miles, and the actual area occupied by the tract managed direct by Government as a Government estate was 178 sq, miles. That tract was taken from Bhutan after the war of 1884 at the conclusion of which it was formed in to a sub-division called Dalingkot and finally transferred to the Darjeeling district in 1866.

For short time after the cession of the Darjeeling territory in 1835, there appeared to have been but little demand for land and the application which were made were dealt with by the superintendent at his direction, but by the year 1838 large number of applications for land for building sites led the then British Government to set rules for the grant of land. These rules provided that the condition of any grant made previously by the Superintendent would be binding on Government but that in future land would be given only as follows:

- land suited for building location for which purpose a space of 200 yards broad on either side of the principal road from Kurseong to Darjeeling was especially reserved.
- cleared spaces of undefined size to be reserved for Bazaars at Pankhabari, Kurseong, Maldhiram and Darjeeling and
- land not required for either of the above purposes, but available for farming leases.

There were also certain small areas held for special purposes since 1866 a strip of land on either side of the Cart road from siliguri to Darjeeling had been set aside for road purposes,

though in common places settlers had been allowed to build houses, a small revenue was derived from these persons who were more tenants-at-will. At Jalapahar, Katapahar and Lebong certain areas had been made over to the military department, an area of 116 acres below Darjeeling had been set apart for the jail and 622 acres, originally intended for grazing grounds had been retained by the Darjeeling Municipality. A return prepared in 1903 had given the following synopsis of the land tenures of the district and shown in table 7.2.

Table 7.2 Land Tenure system in Darjeeling during British period (1903)

Type of Land	Description	Area in Km^2
Revenue Paying Tenures	Location held in perpetuity under the building location rules of 1839	0.57
	Location for 99 years held under the above rules as modified by the court of Directorate in 1840	1.48
	Farming leases under the rule of 1859	6.30
	Cultivation leases for 30 years under the rules of 1864	211.01
	Chebu Lama's grant as then held by his heirs	128.06
	Tea cultivation leases under the waste land rules of 1882	25.78
	Other recent leases from 10 to 50 years	42.10
	Government Khas Mahal under direct management	894.80
	Total	*1310.07*
Free Hold Tenures	Location commuted into fee simple under rule 10 the rules of 1859	2.12
	Land brought under rule 1 of the above rules	196.22
	Land commuted under rules 9 of the above rules	122.15
	Lands brought under fee simple rules of 1862	45.18
	Total	*365.68*
Government Land	Land held by the forest department forest reserves	1126.95
	Land held by the military department	1.63
	Lands held by Government for Cinchona cultivation	152.62
	Lands held by Jail Deptt	0.47
	Municipal grazing land	2.51
	Other land (i.e waste lands Bazaar lands etc)	55.65
	Total	1339.83
	Grand Total	***6031.18***

7.2.2 Land use transformation in Independent Period

The Darjeeling district has been broadly divided into two parts the hilly areas to the north forming its greater part and the alluvial plain to the south known as the terai. Altitude vary from 100 meter above sea level in the plains to about 3500 meter in the hill while the terai contains stretches of alluvial soil admirably suited for rice cultivation, there were also poor sandy tracts which could not be brought under the plough, nothing except scrub jungle grow on the stony soils, but the land was of good fertility on the gentler slopes and in the upper valleys. No part of the district laid above tree level, but no crops were grown beyond 3000 meter above sea level owing to the cold. The following table indicates the land use pattern existed in Darjeeling district during the beginning of Independence period (table 7.3).

Table 7.3 Land utilization pattern in Darjeeling district in the early independence period.

Type of land use	*1960-1961*	*1961-1962*	*1962-1963*
Area under forest	292400	292400	292400
Area not available for cultivation	180100	180100	180100
Cultivable wastes excluding current fallow	41700	38400	39500
Current fallow	11400	5700	9000
Net area shown	42200	251200	246700
Area shown more than once	38700	39500	38100
Total cropped area	280900	290700	284800
Total area of the District	767800	767800	767800

The area of cultivable wastes has remained more or less constant during the period of review. They are scattered throughout the district in hill blocks of various sizes. There has not been any appreciable change during the decades that have followed. In fact, expansion of cultivation in the district was rapid in the middle of the last century and since then there are few areas where land could be cultivated economically owing to adverse physical conditions such as steep slopes, heavy landslide and soil erosion etc. In fact, cultivation is carried out under great difficulties and at considerable input of manual labour. Some portions of such waste like land located in Rungli-Rungliot (2800 acres) and Gorubathan (1692 acres) could however be brought under cultivation.

Forest covers an appreciable areas of the district however, there is hardly any swamps which could be profitable utilized for agricultural purposes after recovery. The forests of the district were almost invariably reserved by the forest department except a few square miles in Kalimpong sub-division, which were controlled by the Deputy Commissioner. There were also large areas under tea and cinchona cultivation. The distribution of land for forest, cinchona, tea and other cultivation varies at different parts of the district and while the forest area under the *Khasmahal* administration was diminishing since 1907. Considerable area under tea estate has been utilized by lease holder for cultivation of various non-plantation crops.

The nature of the land has been changed due to major landslip in Darjeeling and surrounding areas. Major landslides have taken place in 1950, 1955, 1958 and 1968 caused massive destruction to all sphere of socio-economic fabric of Darjeeling hill areas. It is estimated that about 25% of land had been converted into waste land. The people could not bring back those lands in their original position till this date. Since then people have change their agricultural land to forest land under their physical possession. Most of the forest areas of the district were administered as reserved or protected forest by the directorate of forests Government of West Bengal. The following table (7.4) indicates the different categories of forest and their respective acreages in 1966.

Table 7.4 Classification forest area (in Acre) of the Darjeeling hills in 1963

Forest Division	*Reserved forest*	*Protected forest*	*Unclassified forests*	*Private/corporate Forest*	*Total*
Darjeeling	72,936	3,297	470	10,958	87,661
Kurseong	71,815	593	2,051	10,475	84,934
Kalimpong	143,957	285	1,870	-	146,112
Total	288,708	4,175	4,391	21,433	318,707

Previously many forest areas formed parts of tea estates. Such land as well as the *Khasmhal* forest vested in Government in 1953 under the estate acquisition Act and were subsequently notified as protected forest under the Indian Forest Act XVI of 1927. Forest demarcation and reservation proceeded fast after the inauguration of forest conservancy work in 1879, the total area of reserved forest in Darjeeling division was 27143 in Kurseong division 60,994 in Kalimpong division 27079 Acres.

Table 7.5 Tea gardens and total area occupied by the tea gardens in Darjeeling districts.

Year	Number of tea gardens	Total area in hectares under tea gardens
1861	22	1317
1871	56	6162
1881	155	11489
1891	177	18462
1901	170	20948
1911	156	20853
1921	168	23897
1931	169	24777
1941	136	25858
1951	138	25345
1961	145	27709
1966	144	28121

Besides that the position of land has been found change due to increase of tea garden in Darjeeling hill area. The table 7.5 shows the number of tea gardens and area occupied from 1861 to 1966. While the table 7.6 depicts the total area under tea cultivation in 1965 in three Darjeeling hill sub-divisions.

Table 7.6 Area occupied by the tea gardens in three hill sub-divisions.

Name of sub division	Area of the tea estate (hectares)	Area under tea including fallow (hectares)	No. of Estates	
			With tea factories	Without tea factories
Darjeeling Sadar	23770.94	11325.81	50	3
Kalimpong	2869.04	1,143.59	6	-
Kurseong	15943.41	6370.05	31	3
Small grower	21.44	19.74	-	-
Total	4,2604.83	18859.19	87	6

Due to rapid growth of population large tracts of agricultural land as well as barren lands have been converted into homesteads. Fragmentation of land over generations further

transformed arable and other land into homesteads. In spite of adverse physical set-up, the Darjeeling hills has been experiencing rapid and unplanned growth population along with residential use of land in the independence period. Darjeeling has been witnessing haphazard growth with high rise concrete structures which not only spoiled the aesthetic and picturesque view but posed risk with increased probability of landslides. The unplanned and rapid growth of town has further strained the already crippled infrastructural facilities and at present the system is on the verge of collapse.

The overriding priorities and the human activities modify the landscape to suit their own needs. The man's uses of land in post British period have been found much illogical that dramatically alter the character of the environment of Darjeeling hills. The proximate and underlying drivers of human transformation of earth face affecting ecosystem organization and function are given in table 7.7. Deforestation is responsible for large scale species extinction that affects biological diversity in three ways i.e., habitat destruction, fragmentation of formerly contiguous forest and adverse physical and biological consequences in terms of buffer effects within a boundary zone between forest and deforested areas.

Table 7.7 Proximate and underlying drives for land use transformation

Nature of transformation	Proximate drive	Underlying drive
Land	Clearing, cutting & burning for agriculture, abandoning and subsequent degradation.	Demand for foods, goods and services, fragmentation leading to isolation of habitat and ecosystem
Piedmonts	Land cover conversion and water exploitation.	Decline in environmental quality followed by livelihood support.
Wetland	Land use alternation, modified drainage leads desiccation and eutrophication	Change in hydrological regimes, ground water depletion, alteration in food chain.
Biodiversity	Clearing of forest / natural ecosystem, introduction of alien species.	Risk to environmental and food security, landscape amenity and disappearance of habitats.

Darjeeling Himalayas has the forest cover 38%, 18% under tea cultivation 2% Cinchona. The rest i.e. 42% of the land is called *Khasmahal* area, which is the area left for the use of the people. This set up i.e. the land use pattern plays an important role in the concept of forest, management because the major portion of the land is allotted to tea and forest have left

little space for the expansion/ settlement of the people the forest area of Darjeeling hill are under different administration authorities (table 7.8).

Table 7.8 Administrative set-up of the forest area in Darjeeling hills

No	*Administrative set-up*	*Area in km2*
1	Forest Directorate	268.00 sq km
2	West Bengal forest dev. Corporate	457.38sq km
3	Wild life division	332.70 sq km
4	Darjeeling Gorkha Hill Council	69.50 sq km
	Total	1127.58

7.3 Nature and extent of human encroachment

The nature of man's encroachment over the natural ecosystem in Darjeeling hills is controlled by the growth of population, infrastructural development and commercial activities as well as demand for forest produce and forest lands. Subsequently, development like roads, buildings, hydroelectric power projects and urbanization in the semi-urban area were pushed further encroachment. A number of roads were constructed through the forest to connect remote villages.

The cumulative effect is the tremendous demand for land and at such land is no more available. The option left virtually only the grabbing of forest and grazing lands. Land is require for living space, for construction of roads, hydroelectric power projects, industrial estates etc. In fact, agriculture has been pushing into what was earlier forest and grazing land primarily because good agricultural land is being consumed for commercial use including high value crops pushing cereal etc. into higher and marginal land. Land encroachment even in protected/reserve forests is on the increase. Flow of cash among the indigenous population has brought in a new perspective they look at land and forest as a goldmine rather a means of subsistence earlier.

Increasing demand for fuel wood has to be met locally and it is still the major source of energy. Fodder and grazing demands have also to be met from dwindling exhausted lands. Thus over exploitation of renewable natural resources leads irreparable damage to the delicate hill ecosystem of Darjeeling. Commercial demand for timber and other forest resources is another source of fast encroachment both inside and outside the region. There is tremendous demand for

timber and forest products for construction as well as for numerous wood based industries. These resources also form the major source of revenue for the hill areas. The hill people's rights for timber and other produce incorporated in the forest Act have brought in several malpractices. The "contract" system of working these resources is perhaps the most harmful of all. The forest has been woefully thinned by the axes and saw of the local people who has been cutting timber for building. The migrated people have encroached the forest land and constructed the dwelling houses in Algarah, Lava road, 14th mile Dalapchan area and Gumpa dara area in Kalimpong sub division.

7.3.1 Human encroachment in British period

The human encroachment in British period consists the following factors:-

7.3.1.1 Tea industry

The establishment of tea industry in Darjeeling due to the enterprise of Dr. Campbell who was appointed superintendent of Darjeeling at a time when attention was being attracted to the possibility of starting and developing the cultivation and manufacture of tea in the territories under the East India Company. In 1834, the Governor General Lord William Bentinck had appointed a committee for the purpose of submitting a plan for the introduction of tea culture in India. In 1840, Dr. Campbell started the experimental growth of tea since 1840 and soon found that the plant throve readily at this altitude and other began to fallow Dr. Campbell's example seed being distributed by Government to those who desired to cultivate the plant.

The tea industry actually began in 1856 on an extensive scale in Darjeeling till then Darjeeling was dense forest and nobody was encroached there. In the year 1858, the Alubari tea garden was opened by the Kurseong and Darjeeling Tea Company and another on the Lebong spur by the Darjeeling Land Mortgage Bank. In 1859 the Dhutaria garden was established and between 1860 and 1864 four gardens at Ging, Ambutia, Takdah and Phubsering were established by the Darjeeling Tea Company and two gardens at Takvar and Badamtam by the Lebong Tea Company. Other gardens which were started at the early period include Makaibari, Singel and Pandam situated in the hills and Champta in the Terai.

The development of the industry in the hills had been rapid as the suitability of the soil and climate to the growth of tea bush. Also Government offered land to investors on favourable terms and the industry rapidly developed. By the end of 1866 i.e., only ten years after the establishment of the industry on commercial basis there were no less than 39 gardens with 10000 acres under cultivation. In 1870, there were 56 gardens with 11000 acres under cultivation employing 8000 workers and by 1874, the number of garden had increased to 113 the area under cultivation to 18888 acres and the work force to 19000 souls. Thus between 1866 and 1874, the number of garden under tea was almost exactly trebled the area under cultivation increased by 82%. Since the time the Industry had progressed steadily and by the year 1905 the total number of tea gardens reach to 148 covering an area of 50600 acres or 79 square miles. In addition to the 50600 acres actually under tea which in themselves constituted one third of the total area under cultivation the tea estate in the district included 49300 acres which had been taken up by planters but had not been planted with tea.

7.3.1.2 Cinchona Industry

The cultivation of Cinchona in Darjeeling was commenced in 1861-1862 in Rangpo and Reyang valleys. It proved too small for the number of trees which were required to keep place with the increasing demand for febrifuge and Quinine. In 1883, the first out laying plantation of 300 acres was situated in the Ranjung valley in Kalimpong and in 1899 a fresh extension of about 900 acres and further extended to about 7000 acres in the Damsang forest situated about 15 km North east of Kalimpong known as Munsong division.

In the year 1906, the Government Cinchona Plantation comprised the following (i) the Rangpu valley block consisting of the Rangbi and Mangpu division which together measured about 900 acres containing nearly over 2 million plants; (ii) the Reyang valley block consisting the Sitong and Labdah division which together comprised an area of about 600 acres with over 200000 plants and (iii) the Rangpu valley block comprising the Munsong division. All these lands were occupied by dense jungle that was felled and burnt a year before planting operation were to be carried out. While clearing the forest and burnt the number of valuable trees bushes and plants were destroyed along with the precious wild animals in that locality. The British Government has also undertaken timber trading. A short account is given below of each division and the following table shows the average annual outturn revenue and expenditure during the year 1897 to 1907 (table 7.9).

Table 7.9 Timber trading and revenue expenditure of Forest divisions (1897-1907)

Division	Timber Cubic feet	Fuel Cubic feet	Minor produce (Rs.)	Revenue (Rs.)	Expenditure (Rs.)
Darjeeling	177330	986650	8100	91560	72860
Kurseong	203770	371480	2820	55900	38300
Tista	128630	630900	7800	34980	36600
Total	509730	1989030	18720	182440	147760

When the forest department took change of the hill forest they had to allow felling of Sal trees in order to meet the demand of the railway for sleepers. When this ceased the feeling remained unregulated except to a certain extent in the Baman Pokhari block and the Sukna forest until the introduction of Mr. Hatt's working plan in 1904. Unregulated felling were confined to the more accessible areas.

The railways were the market for wooden sleepers and the tea garden for fire wood. Box planking for the tea garden was converted by the agency of the managers. A certain amount of timber and fuel from the neighbouring hill forests was sold in Kurseong for local consumption and a little charcoal was made there. Grazing was regulated by the rules laid down for Darjeeling in 1884, by which about half of the forest was open to grazing not more than one heard of cattle was being allowed for every ten acres of the open area.

Almost the whole of the yearly yield of Sal timber was extracted in the form of meter gauge railway sleepers for which the Eastern Bengal State Railway provided a practically unlimited demand also for the Darjeeling Himalayan Railway. In addition to this the British people emphasized to construct the wooden structure in hilly regions so that many matured trees were destroyed for the construction of houses. There was no question that large stretches of forest had been cleared away since the British first came into possession of the Darjeeling hills. As, all the early travelers were unanimous in describing the district as entirely covered by forest.

7.3.2 Human encroachment in Independent Period

During independent period, the construction of road and other infrastructure were indispensable for efficient transport and communication system for tourism development but

those unavoidable activities were mainly responsible for destruction of hill areas land resource along its vegetation and animal wealth. The use of powerful explosives and frequent heavy traffic creative vibrations which caused crakes on rocks and earth, which in turned lead to landslides and erosion along with adverse impact on the flora and fauna. The construction of roads along geologically active zone like at Sukhia-Simana-Manaybhanjyang, Tanglu, Sandakapu, Mirik road, Lava-Damdim road, Pedong-Rishi road, Bhalumarg road, Darjeeling-Singla road etc. caused major transformation of land use pattern in hill areas of Darjeeling. The construction for accommodation facilities like rest houses, tourist bungalows, buildings, tourist rest shed, private lodges and seasonal accommodation units, recreation centre etc. had posed the serious threat to the land resources and also accelerate soil erosion and caused to damage to crops, animals and plants. It was also contributory factors in causing landslides with heavy damaged of properties and lives.

The beautiful forest of Darjeeling hill areas and peaks was the main source of tourist attraction. The continual flow of tourists, mountaineers, trekkers etc. was likely to have positive as well as negative impact on those natural resources. To a certain extent mythological beliefs and tradition which were also prevalent in the hill region were also responsible for adverse effects on the flora, especially in those localities adjoining the shrines. Religious tourists collect flowers and colourful herbs to offer to temples as a results, many species became endangered.

The increasing influx of tourists exerted an adverse impact on the unique hill areas wild life. Tourist activities like invasion in wildlife habitat, close view watching and photography, hunting, poaching and other disturbances etc. had created problems for wild animal and birds were affected in large extent. Owing to the large interference of man in the habitat and life style of animals, especially in national park, wild life sanctuaries etc. the ferocity of animals was being lost. The habit of tourists to provide ready made food to wild animal was also responsible for loss of ferocity. For last 3 decades the monkeys of NH-31A from Sevok to Tista bazar has become domestic owing to the availability of ready-made foods i.e., bread, biscuits, fruits from tourists and also from other travelers.

During independent period a number of hydroelectric project were constructed with large land use transformation, The Jaldhaka hydroelectric project stage I and stage II caused transformation of large paddy field and forests. The project also caused the heavy landslide and flood almost in every monsoon. The Ramam hydroelectric project in Bijanbari also invited

heavy landslide in addition to large deforestation and damage to wild life and biodiversity. Similar story has been notice in the Tista hydroelectric projects. The hill area development council was set up in 1972-1973 and development works were taken up with the help of about 35 Government departments. The various developmental works were initiated in Darjeeling hills including construction of roads in remote village area, bridge, culvert, school building, playground etc. In fact, such developmental works ushered further degradation vis-à-vis land use transformation in Darjeeling hills.

7.3.3 Human encroachment since 1980s

It is matter of fact that large scale human encroachment vis-à-vis land use transformation was actually been started since 1980 especially with the beginning of GNLF movement in Darjeeling hills. The complete devastation of forest in the several ranges have lead to the crisis of drinking water as the perennial sources of water have been dried up since 1980. The temperate forest mainly of Oak, Uttish, Champ and Panisaj appear to have disappeared. The valley slopes and soil are naked and this has greatly affected the water regime of the region.

During Gorkhaland agitation in 1980's the road side trees were cut down to blockade the road for paramilitary forces who use to patrol in different parts of the hill area, where massive quantities of trees were cut down, it was estimated that 40% of forest cover had been destroyed in that agitation. The hill people deprived economically and they entered the forest of every range and began to start deforestation, most of the local youth as well as anti-social elements started sawing the timber and began to sell it in a usual way. The Government offices, forest department, police could do nothing for it. This practice is still continuing the forest department could not control it. The forest protection committees have been set up in hill areas to control illegal falling of trees but no effect is noticed till now.

In addition to this most of the Government land such as PWD land, municipal land, forest land, khasmahal land have been forcefully occupied by anti-social elements and miscreants. Many beautiful spaces of hill areas were destroyed by them, in some portion of forest area have settled the illegal village also. The DGHC itself started to construct heliport one at Sinchal forest area and another at Dhoteria, without getting clearance from the civil aviation as well forest and environment department. Large forest damaged and beautiful hill environment were destroyed for nothing.

The trend of encroachment unfortunately continued in the DGHC period, accentuated by indiscriminate quarrying of stone, sand, stone chips etc. The low dam construction over Tista river in two places with other activities which disturbed badly the land, water and vegetation of these areas. As a result a threat to the life and livelihood of people emerged in a significant number of hill villages. This led to considerable re-thinking among social workers and other concerned people about the way in which protection should be sought. Several lines of thought and action emerged, prominent one of which is an ecological movement seen more prominently in the hills of Darjeeling district but of course existing in other area also.

During 1980, the agitation of separate state was started by the Pranta Parishad and GNLF the agitation was reached in climax in 1986-1987, the Government was least bother about damaged of environment, the forest was badly destroyed. The un-employed youth of the hills became timber and firewood contractors and they used to sell all kinds of timber plank, battens and firewood without permit in a very illegal manner. The drastic environmental damage done since 1980 continued to till this date. During Gorkhaland agitation, the tree shed land i.e. both sides of the roads have been encroached by anti-social elements and also constructed house cum shops and other structures. Often they used to sell such lands and houses to outsiders though they don't have their documents of land and property and gradually transforming the very land use of Darjeeling hills.

During Gorkhaland agitation large scale destruction of public properties have been taken place including Kalimpong handicraft centre, BDO offices of Jorebungalow, Sukhiapokhri, Takdah, Kalimpong II, Gorubathan, BLRO Office Kalimpong II, Pedong, Libraies situated at Birch Hill Darjeeling, Forest Bunglow of Lepcha Jagat, Sukhiapokri, Rikisum, Dapalpchan, Janta College Kalimpong, many GP Offices, Red Cross building Darjeeling, Dalapchan Beat Office, Khasmahal Bungalow etc. were burnt by the anti-social elements. All such acts in fact, lead to further degradation and transformation.

7.4 Spatial and temporal extent

Due to unabated migration population of Darjeeling hills have been increased very rapidly since the independence. People from Nepal, Bhutan, Tibet and Sikkim have been migrated by large number. The virgin forest, pasture and agriculture land have been converted in settlement as a result, green areas are fast disappearing. The migrated people have been given

the facilities of electrification, water supply, transportation, sanitation so that tremendous stress put on the existing infrastructure. Due to settlement of migrated people there has been hardly left any space. The road has been congested due to encroachment of road side, drainage have been blocked, the rain water use to flow every where in road surface causing landslide in municipal area too.

Darjeeling had rich and unique vegetation, comprising of *cryptogwns* (Non flowering plant) and *phanerogains* (flowering plant). In the surrounding areas of Darjeeling town a few species of rhododendron grown in plenty but in Kalimpong sub-division it was scattered. The most common species of this genus is Rhododendron arborcum locally known as *Lali Gurash* but nowadays it has been threatened. Many more species which were found in the hilly region of Darjeeling but the flowering plants are fast disappearing because of being ruthlessly felled for fuel and construction of houses. Prior to 1863, very little attention was paid to the conservation of forest. Since independence, due to rapid urbanization, the upper belt of the forest was taken for commercial use. Much of the natural forests in the Senchal, Ghoom Simana and Takdah ranges have been converted. Some patches of natural forest are still found in Reshop, Bara Senchal, Lopchu, Rongbong and Mirik and still a few natural forest patches are found in and around difficult terrains.

The growing pressure of population during the last two decades has left clear mark on the forest resources of the region. Marked decline in forest cover were observed in Takdah, Ghoom-Simana area of Darjeeling Sadar, Sukna, Pankhabari region of Kurseong and Chel-Jaldhaka catchment of Kalimpong. The forest cover of Darjeeling hill areas is decreasing at an alarming rate. Per capita forest area was 0.62 hectares in 1941 but now the situation has drastically changed to 0.02 hectares per persons.

Darjeeling was once considered as a health sanatorium for the tired British people working in the plains, Darjeeling has now turned in to a glorified slum with crumbling infrastructure because of population explosion. There are no provisions for the local people to take a stroll around the town and it is virtually impossible to drive around thanks to lack of parking space and narrow roads most of which have been further narrowed down by encroachment. Darjeeling today is one of the most densely populated hill-town at global scale.

The Darjeeling Himalaya constitutes a fragile and unique ecological system. The region is frequently plagued by environmental catastrophes. Among such catastrophes events landslide is perhaps the most rampant threatening the Darjeeling town itself. With the successful implementation of tea gardens in the Darjeeling hills, labourers poured in and phenomenal growth of population resulted. A considerable bulk in this growing population was contributed by the immigrants. In a desperate attempt to acquire as much arable land as possible extensive areas under forest cover were being gradually encroached upon. The ever increasing number of people haphazardly settled in every bit of land available. It was perhaps the rapid denudation of the forest cover, which aggravated the problem of landslip coupled with the geological, rainfall and slope characteristics.

During the British period, it was made a rule that forest at the upper part of the hills should not be brought under ordinary commercial forest management. But after independence, the demand for timber increased at an unprecedented scale and even the upper layer of the forest was not spared there was a desperate attempt to cut trees, without considering soil erosion, water supply and landslip even after mass afforestation programme have been implanted, a big gap remains between felling and replanting. It has been estimated that 70% of the cooking energy needs of the rural population is still being met by fire wood. This practice is likely to continue if they are not provided with some alternate source of fuel. Needless and reckless obliteration of forests, faulty agricultural method, unscientific use of slopes especially in construction works have change the scenario. The forest covers acted as blankets for tapping rain water and maintaining the perennial character of the springs.

The tea plantation has also contributed its share in bringing about ecological imbalance in the region. Nearly 80% of the tea bushes are over 50 years old and young bushes cover only 4% of the area. The tea bushes after 50 years are generally fail to protect soil from erosion. This is because of the fact that the old bushes tend to loosen the cohesive bond between the soil particles and fail to bind the soil against soil erosion. The bushes when young are allowed to spread horizontally so that all the bushes can touch each other forming a thick canopy, giving adequate protection against direct rain impact.

7.5 Misuse and overuse of fragile hill environment

Steady influx of population in the Darjeeling Himalaya under the back drop of severe topographic constraints, harsh climates, dense undergrowth infested with deadly animals and

incurable diseases, lack of easy movement, poor condition of agricultural operations etc. have restricted initial growth and development in some restricted sites. In fact, such a condition leads to over exploitation of natural resources. Excessive concentration of people around the towns like Darjeeling, Kurseong, Kalimpong and Mirik and major settlements like Tindharia, Mahanadi, Sukiapokri, Bijanbari, Manebhanjan, Goom, Sonada, Dilaram, Gurubathan etc. has caused indiscriminate deforestation along with the expansion of tea gardens, roads, buildings, agriculture field and other cultural landscapes have eaten up a considerable portion of the hills. Misuse and overuse of the steep slopes at the cost of environmental damages caused incalculable miseries to humanity.

The hill environment has been badly misused during construction of roads, community centres, development of settlements urban centres, development of public utility structures etc. especially rural roads have been constructed haphazardly without considering the environmental impact. The motive was only construction of roads from starting point to a particular destination through the ecologically vulnerable situation. As a result, wild animals and birds have been fled or died along with irreparable damage caused to the biodiversity. Mining and quarrying also caused environmental problem such as loss of valuable vegetation, loss of productive top soil, wild life and biodiversity in the hill areas. It has also been identified that such activities also caused water and air pollution, solid wastes leading to health hazards.

Large scale blasting weaken the rock and fine minerals and dust released during the process mixed in the atmosphere and pollute the air and have adverse impact on health. The toxic and harmful metals and minerals dissolved in the rain water percolate down to the aquifer in the mining area and also in the adjoining areas thereby deteriorating the ground water quality. Intense grazing has also accelerated the processes of soil erosion and this has made the slopes bare and barren and prone to sheet erosion and gully erosion. Enormous quantities of silt and sediments filled the river valleys and resulted in flash floods. The catastrophe of floods causes great loss of life and property.

7.6 Conclusion

Land use in Darjeeling hills still remained highly dynamic around large settlements and urban centres while, in the vast tracts of rural areas such charges are not prominently visible. Such changes can be attributed to the influence of human being. The land management process

often determines land use need and the complexity of such processes and their consequences at the local and regional levels indicates towards the diverse issues that are associated with agricultural land use. The study of agricultural land use and productivity limits to agricultural growth brings out food security issues. Combined with tremendous demographic pressure the questions of cropping intensity, physical and economic access to food and maintaining the productivity of land have gathered greater attention. Some of the other issues which have remained in the periphery of debate and discussion include impact of human resources on agricultural development consequences of local and regional conflicts on agricultural land use.

The land use transformations in Darjeeling hill areas faced the growing problem of haphazard growth, loss of land cover, decline in arable land and also decline in wildlife habitat vis-à-vis biodiversity. Most of the problems are attributed to increasing population pressure. The understanding of land use change in urban areas is the key to urban development programme. The temporal analysis provides in any given context the spatial patterns of land use. The emerged dynamism helps planners to delineate urban growth boundaries, land use zoning plans and infrastructure requirements. Socio economic development is inextricably linked with the current as well as past land use pattern and access to land determine the socio-economic development of vast stretches of rural areas. Village development is often connected to land use and type and intensity of agricultural practices.

Demographic trends become important features to understand the land use transformation at its present context. The details of demographic trends are useful in assessment of the impact of population growth on land use directly or indirectly, population growth is a powerful force to bring about a change in traditional methods and to transform the economy into rather advanced and productive stages.

Tremendous population concentration within a short span of few decades have created manifold problems including political, economic, social, cultural and ecological in this region. Accelerated population growth in limited available land has led to indiscriminate exploitation and ruthless destruction of natural resources. This has led to serious ecological damages of far reaching consequences, visible through bare hill slopes, stony and gravelly riverbeds, erratic river courses, changes in climate and hydrological regimes, landslip, loss of top soil, disappearance of rich flora and fauna etc.

At present the agriculture in Darjeeling hills is not sustainable. It is more of land and water mining than agriculture, similarly we are not using out water and energy resources in a sustainable manner. Utilization of land resources has never paid proper attention to sustainability. As a result, transformation of land has taken place rapidly and has been deteriorating rapidly, due to overgrazing, non-availability of irrigation, improper crop rotation, deforestation and extractive activities.

7.7 References

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CHAPTER- 8

Development Programmes and its Environmental Impact

8.1 Introduction

The early developer of Darjeeling identified appropriately that developing communication with rest of the country is the key to develop the newly annexed hitherto inaccessible terrain. The then Darjeeling hill area was mostly uninhabited only dotted with few settlements of Lepcha community. The means of communication in Darjeeling hills up to 1835 were very rudimentary. A few narrow rough tracks through forests and occasional cane bridges over torrents were all that existed at the time of Grants memorandum of 1830 that mentioned only two routes then existing northward from the plains into Sikkim. One was the *Nagree Pass* and the other by the *Sabbook Golah*. A third route by the Mahananda was mentioned as having been deserted and over grown with jungle.

The pioneers who came to poem up Darjeeling after it had been ceded in 1835 were confronted with an arduous journey from Calcutta before they reached the hills. The first step to introduce modern communication in the district was taken in Journey 1838 when the trace of the Calcutta road to the east of the hill on which Jalapahar Cantonment stands now was completed by Lt. George Lloyd in 1839, Lt. Napier of the Royal Engineers was deputed to prepare a lay out of Darjeeling town and to construct a road from Siliguri to Darjeeling. The project was carried out between 1839 and 1842, at an expenditure of rupees eight lakh and the road, latter known as the old military road. It is still seen winding its way from Pankhabari to Kurseong and then on to Dow Hill, Senchal and Ghum having 300 bridges and culverts. This road was not suitable for wheeled traffic and the development of Darjeeling and transportation of heavy military stores led to the construction of Cart Road to Darjeeling from Siliguri. The work was begun in 1860 the section from Kurseong to Darjeeling was opened to traffic in 1864 and the whole road completed in 1869.

The British construction engineers also understood the hazard potentials of such construction activities on the steep slope of the Himalayan immature geology. Moreover, transportation of bulky and heavy consignment became increasingly difficult by the existing narrow and serpentine road. The opportunity came in 1878 when Siliguri became connected with Kolkata by railway. Mr. Franklin Prestage, Agent of the Eastern Bengal Railway, foresaw the utility of a rail link between the hills of Darjeeling and the plains. He submitted a

scheme for the construction of a two feet gauge railway line from Siliguri to Darjeeling. His scheme was mainly driven by hard economic considerations viz. the huge difference in the cost of essential commodities between Darjeeling and Siliguri, the need to carry out tea for export and the inability of the existing road to handle the growing traffic. Prestage received the final sanction for his project on 8th April, 1879 and formed the Darjeeling Steam Tramway Co. The idea of operating the line as a steam tramway was soon abandoned and on 15th September and in the year 1881 the company adopted the designation of Darjeeling Himalayan Railway Co. (DHR), which remained effective till today. The line between Siliguri and Kurseong opens to the public in August 1880 and by June 1885 the railway line extended to Darjeeling bazar. By the year 1915, another branch opened from Siliguri to Kalimpong Road (Gielle Khola) i.e., the Teesta Valley Line.

The genesis of the DHR is significant both economically and in engineering terms, the DHR broke new grounds in India in both domains. It was the first railway in India built exclusively with Indian capital, the immense reduction in transport costs to and from Darjeeling guaranteed plenty of traffic and hence a good return on the investment thus facilitating its financing, which ran to Rs. 28 lakhs. Moreover, the journey time from Calcutta to Darjeeling was reduced from 5-6 days to less than 24 hours. This was a crucial factor in enabling the development of Darjeeling as a hill station and a bustling holiday destination.

Thus, it is not surprising that the DHR has achieved worldwide fame for a number of reasons. It serves as a gateway to the Himalaya, the world's loftiest mountains and a land of mystery and imagination. The spectacular landscape unfolds as this 2 feet gauge railway labours uphill at about 10 mph, criss crossing the Hill Cart Road. Darjeeling is an old hill station and has attracted visitors and writers from all over the world. It is famous for Darjeeling tea. Perhaps the UNESCO inscription on DHR (5th December 1999) is the fittest adjective to *the Darjeeling Himalayan Railway is the first example of a hill passenger railway. Opened in 1881, it applied bold and ingenious engineering solutions to the problem of establishing an effective rail link across a mountainous terrain of great beauty. Kit is still fully operational and retains most of its original features intact.*

The Darjeeling hill was experienced massive development activities during the following years. Development of infrastructure facilities followed by life supporting activities attracts huge migration mostly from Nepal and other parts of the country. With the early

success of tea cultivation, large scale tea estates established. Thus, the topography and land use of Darjeeling hills transformed significantly.

The aim of this chapter is to assess the different development programme that have undertaken in Darjeeling hill areas under their true chronological perspective with a view to find out their respective environmental impact. Data for the study has been obtained from both primary and secondary sources. The growth of population during the past one hundred year has been accessed from the census of India reports. District gazetteer, statistical hand books, reports from various line departments have been consulted to gather information relating to the development programme and to find out their respective impact.

8.2 Development Road Network and its Impact

When the British annexed Darjeeling hill there was no proper road and bridge, however there were small paths, trails and kutcha roads existed where the bullock carts use to ply carrying the goods beside pack-ponies or human carriers were consequently most generally used for transport.

Table 8.1 Major roads network in Darjeeling hills during the British period

No.	Road from	To	Length in km
1	Siliguri	Sevoke	19.3
2	Sukna	Adalpur	4.9
3	Matigara	Darjeeling Hill Cart Road	3.3
4	Matigara	Kurseong via Pankhabari	21.7
5	Panighatta	Dhudiajhora	3.9
6	Siliguri	Darjeeling	77
7	Siliguri	Rhenok	79
8	Sivok	Tipprapara	16
9	Tista Bridge	Rangpu	21
10	Jore bunglow	Riyang/ Rambi	19.3
11	Bagdogra	Ghum	74.2
12	Algarah	Minglass	38.6
13	Mitabari	Kurseong	25.8
14	Kurseong	Mirik	25.7
15	Darjeeling	Tista bridge	35.4
16	Manibhanjan	Jhepi	25.6

Source: Collect orate, Darjeeling, Govt. of West Bengal

During British period the most important road in the district was the cart road winding through the hills from Siliguri to Darjeeling. This road was 79 km long, which is one of the best mountain road in India, the road belongs an average breath of 7.5 meter and a ruling

gradient of 1:31. The construction of the road was begun in 1861, in order to replace the old military road which was too narrow and steep for carts. By the year1865, the upper section from Darjeeling to Kurseong a length of 31.2 km containing 300 bridges had been completed in 1869, the road from Pankhabari to Kurseong also was fully completed which was about 9 km long.

Table 8.2 Roads constructed by PWD Darjeeling construction Division during third Plan.

No.	Name of roads and location	Length
1	Approach road to Tista bridge	0.44 km
2	Road from 6th Mile of Ghum Peshok road to Tista valley Via Takdah and Rungli Rungliot	19.3 km
3	Darjeeling Pulbazar Bijanbari road	
	(a) Bijanbari Pulbazar section (b) Darjeeling Pulbazar section (c) 4 Miles section in Chonton area	1.7 km 19.3 km 4.1km
4	Matali Rongo road - Gairibas Rongo section	10.2 km
5	Mirik Panighatta road Balasan bridge – Mirik section	25.6 km
6	Extension of Peshok – Mangpu road to Surrel Bunglow	5.2 km
7	Jorebunglow- Sukhiapokhri (Village road)	12 km
8	Mirik - Panighatta road including Balasan bridge	5.7 km
9	Peshok Mangpu road	8 km
10	Kumani - Naxal khola road	5.5km
11	Naxal khola Gairibas road	3.3 km
12	Khunia to Rangpo Cinchona plantation	13.5 km

Source: PWD Darjeeling construction Division

Next in importance came the Tista valley road, which was the highway for travelers and merchants going to Sikkim and Tibet, the total distance of road is 55.5 km from Sivok to Rangpu on the boarders of Sikkim. Road was constructed from Darjeeling to Tista bridge which was 27.2 km long, latter road constructed from Tista to Kalimpong and Kalimpong to Algarah. Another important road was that leading from Ghum to Simana busti on the north west of the Darjeeling hill. This was a good cart road 16 km long leading along the Ghum range through the dense forest clothing its southern slopes. It passes through Sukhia pokhari (12 km from Ghum) and 5 km further on terminates at Simana busti on the Nepal frontier. Other important roads of British period were from Kurseong to Matigara via Pankhabari (18.5 km) and Naxalbari to Garidhura (65.6 km) and in the east of the district from Rikisum via Minglass and Gorubathan. The table 8.1 shows the important road network in Darjeeling hills during the end of British rule. The railway line from Siliguri to Darjeeling 82 km started in 1879 and on 3 July 1881 the Railway line was officially opened to Darjeeling. In 1915

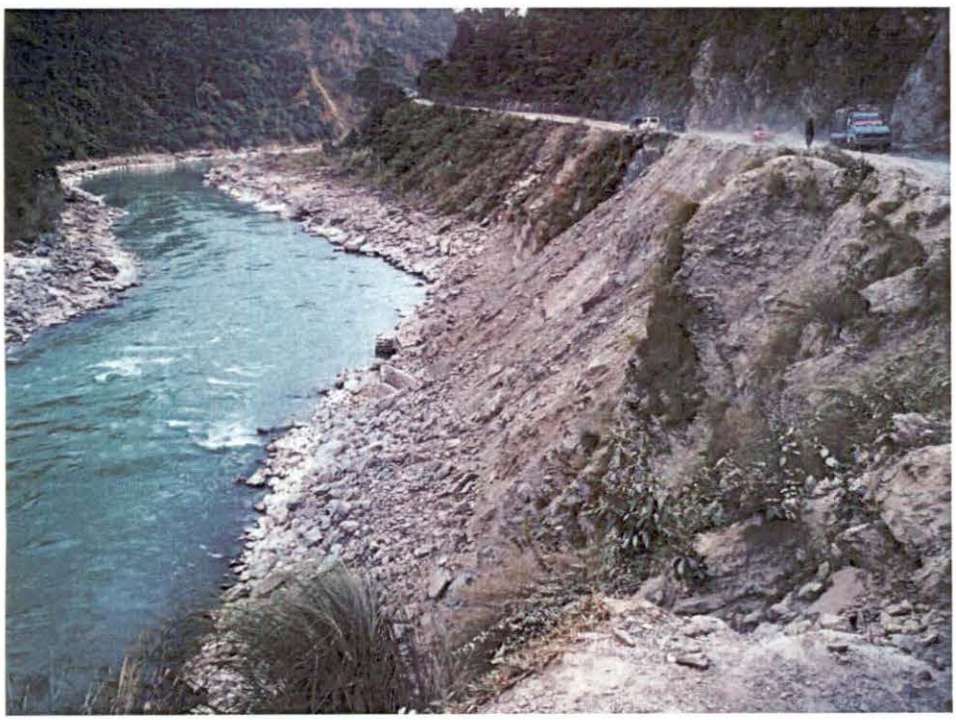
another branch the Tista valley line was opened from Siliguri to Kalimpong road last station was Giel Khola.

Darjeeling construction division of PWD initiated need based road construction in Darjeeling hill area and during the 3rd Plan period 133.84 km long road was constructed across the hills. During this period in addition to connect strategic locations large rural settlements were also connected. The table 8.2 depicted the details of the newly constructed roads during the 3rd Plan period.

In the year 1972, the Darjeeling hill area Development Council was established for the overall development of Darjeeling hill area, since then some development works were started all over the district. The development of communication in all the hill areas of Darjeeling includes the construction of arterial roads rural link roads in order to provide adequate marketing outlets for rural surpluses and to open up the rural hinterland for developmental activity. The constructions of the arterial roads were taken up mainly by Darjeeling Highway Division of the P.W. Roads department. During the period 1980-84 this department had completed the construction of around 60 km of arterial roads while major works over a length of around 60 km had also been taken up under the state plan which included Bijanbari-Jhepi- Lodhoma road (30 km), Rangpu-Rambi Bazar road (12 km) and up gradation of Sukhiapokhari- Manrybhanjyang road (8km). The major schemes that had been taken up from central assistance were Sukhoapokhari-Nagari road (14 km) Gairibas-Sandakphu- Phalut road (7km), Mirik-Simanabusti road (21km), Nagari-Dhajia road (7km). Improvement of Maneybhanjyang-Rimbik Road (21km), Mirik bypass (3 km) and Baggora-upper Mamring road (6.0 km), the P.W.D Darjeeling Division during the same period had taken up work on the road from Murdhahattta to Hill cart road at Naya Busty, Kurseong and the up gradation of Rangit road from Lebong to Majitar. During the period 1980-84 an amount of Rs.486.54 lakh had been provided for the development of arterial road communication in the hill areas of Darjeeling.

While constructing the above roads several kinds of trees and bushes were destroyed along with some valuable medicinal plant. During construction of such roads nobody care about the destruction of forest wild animal insects and environment.

Photograph 8.1 The Hill Cart road the life line of Darjeeling near Lower Paglajhora is under threat of existence



Photograph 8.2 The NH 31A the life line of Sikkim along the Tista valley become highly vulnerable

8.2.1 Forest road

In the tea gardens, the roads were kept up by the tea estates concerned and in the reserved forests which occupied over one third of the total area of the hills they were maintained by the forest department. Many roads were constructed and maintained by the forest department i.e., Sukhiapokhri to Maneybhanjayang, cart road from Simkona to Lalkhoti in the Darjeeling forest division; the old military cart road from Ghum to Kurseong in Darjeeling and Kurseong forest divisions, Sukuna-Sivok road in the Kurseong forest division, Rissibum- Labha cart road and Dalgaon Tar cart road in the Kalimpong forest division. In 1961 the Kalimpong forest division was alone maintaining 316 km of roads and pathways which in 1967 increased to 439 km comprising 152.3 km of motor able and cart roads, 247.1 km of bridle tracks and 39.6 km of footpaths and trails.

Table 8.3 Roads constructed during the DGHC Period in Darjeeling hill

No	Darjeeling Sub-division	Length (km)	No	Kalimpong Sub-division	Length (km)
1	Pokriabong- Pulungdong	5.0	1	Delo – Tourist view point	2.50
2	Sukhiapokhri to Ramji	2.5	2	Bhupalay to Today	12.0
3	Lingay Fatak to Tamsang	4.5	3	Pedong to Muddum khola	7.0
4	Kashingdara to Rangbhang	3.0	4	Muddum khola to Kagay	4.0
5	Rimbik to Srikhola	3.0	5	Pedong to Keshyone	3.0
6	Kaijalay to Relling	5.5	6	Samather to Mungpong	3.0
7	Dhajia to Marma	4.0	7	Lava to Ladam	6.0
8	Gopaldhara T.E.	5.0	8	Bong Church to Devithan	1.0
9	Kolbong to Goak	3.0	9	14th Mile to Ramlal School	1.0
10	Rangbhang Busty	4.0	10	Suntalay to Neem	2.0
	Total	*39.5*	11	Sakyong to Tendrabong	1.0
Roads in Kueseong Sub-division			12	H.L.Dikshit road- Samalbong	4.0
1	Mahanadi to Sivitar	5.0	13	Kagay to Maria	2.5
2	Koila Godam to Turuk	6.0	14	Furun to Kamzer	3.0
3	Deorali to Mazwa	5.0	15	Kagay to Ladam	5.0
4	Singel T.E. to Kafaubari	7.0	16	Ghattaytar to Samdung	3.5
5	Munda T.E.	2.0	17	Upper Fagu to Nim	6.3
6	Kurseong to Pandu Busty	1.5	18	Relli to Deorali	7.2
7	Mid Kharay to Lower Kharay	1.5	19	Relli to Charkhol via Singi	22.0
8	Dhuday to Mirik	6.0	20	Sangsey to Tarkhola	12.8
9	Turuk Busty	3.0		*Total*	*108.80*
	Total	*37.0*			

A total length of 60.8 km of hill motor roads and cart roads was constructed in this Division under various development schemes between 1955-56 and 1967-68 (table 8.3). Another 118.9 km road was constructed within Kalimpong forest division between 1967-68 and 1980-81 i.e., Chunabhatti-Lolaygaon road via Nimbong (40 km) to link up to with the

existing Labha Lolaygaon road, extension of Samsing motor able road to Tempola (4.8 km), Labha- Paktham road via Kolbong and Khampong (9.7 km), Dalimkot- Pastin road via Ambyok and Pankhasari (32.2 km), Paren-Tangta road via Chi chu valley (32.2 km). Construction of roads in the other two forest division has also been taken up in order to reach more and more untapped forest wealth. Some of these roads are Labha-Rishila, Samsing hill, Batasia- Palmajua road etc.

8.2.1 Impact of road construction

There have been constructed about 200 km of road since 1988 to till this date with in 3 hill Sub- division where approximately 800000 m^3 of debris dumped down the slopes and valleys resulting to irreparable environmental damage inclusive of destroying habitat of wildlife and creating sound, soil, water, and air pollution.

In these road construction maximum agricultural land as well as tea garden have been damaged as per report there have been damaged the some area of virgin forest land and Cinchona plantation area also. The maximum road gradient varies from 1:8 to 1:12 and in some places in Darjeeling hill roads are very steep. Due to construction of road some places like Todaytangta, Muddum, Kagay where the loose areas have not been projected properly. So that rain water had damaged the nearby agricultural lands during monsoon. The emphasis has not given for the protection of land and reforestation works have not been taken as the last of forest area have been deforested.

The most of the roads are made up to consolidation stage some are left in soling stage some are left after earth cutting, the further maintenance of road such as surface repairing drain clearance works have not done in most cases. Such man-induced disturb slopes often yielded during the monsoon months and thereby aggravating the hill slope degradation (Photograph 8.1 & 8.2).

Roads are serious threat for biotic environment of Darjeeling hill areas. The rapid and unscientific haphazard development of roads in Darjeeling hill areas are affecting endangered species of flora and fauna. Road construction in hills generates a huge amount of debris which is one of the major cause of environment degradation. It is estimated that one kilometer road construction in Darjeeling hills on and average yielded 4000 to 8000 m^3 of debris from the excavation. The direct impact of road construction occurs in the form of forest cutting and damage of many species of small plant. The effect of the construction work

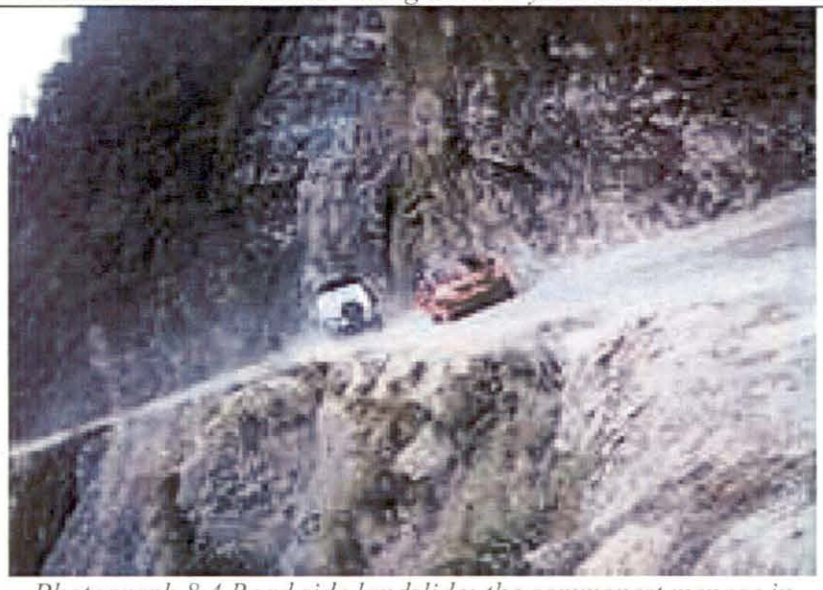
can be seen in the form of landslides, boulder falls and damage and cutting of land. Thus construction of road induced landslide destroyed the natural beauty and vegetative cover in many areas. In Darjeeling hill areas most of the interior village area shows the excavated land for road construction and huge amount of debris slide down in the valleys resulting in overall environmental degradation (Photograph 8.3 & 8.4).

With the introduction the NREGY scheme in 2007 in hill area of Darjeeling about 415 km of village roads have constructed in all the 8 CD blocks (Table 8.2). Field observations reveal that the construction of village roads done without having scientific and engineering investigation and planning. As a result, irreparable damage caused to the already degraded environment of rural Darjeeling hills causing further deforestation and innumerable landslides caused in hitherto unaffected areas. In addition to roads many Jhora training work, drains, play-grounds have also been constructed without proper consideration of the possible environmental consequences as a result jhora expansion, drying up of water sources in addition to landslides. It is also observed that several natural habitats of animals and birds are also experiencing the shortage of drinking water in hilly region. It is estimated that during the process of road construction under NREGY scheme alone produced 2.905 million m3 of debris. It is also interesting to mention that on and average all the blocks in Darjeeling hill area are affected considerably which ultimately acted as instrumental in horizontal expansion of degradation in all over the Darjeeling hills.

Table 8.4 Construction of village roads under NREGY scheme since 2007

No	Name of CD Blocks	Road length (km)	Debris produced (m^3)
1	Darjeeling Pulbazar	62	434000
2	Jore Bunglow-Sukhia Pokhari	53	371000
3	Rongli- Rongliot	46	322000
4	Kalimpong I	65	455000
5	KalimpongII	63	441000
6	Gorubathan	41	287000
7	Kurseong	59	413000
8	Mirik	24	168000
	Total	415	2905000

Photograph 8.3 Construction of motorable road near Rimbik caused innumerable landslides along the newly constructed road.



Photograph 8.4 Road side landslide: the commonest menace in Darjeeling hills during Monsoon.

During field survey it was seen that several perennial water sources had been dried up, especially it was so happened due to up gradation and degradation of road surface, and some where existing water sources were buried due to covering the waterway by debris. This had been noticed in Dokan dara to Sangsey road, Pedong to Kagay road and along Paren to TodhayTangta road. It was also noticed in Darjeeling Sadar where the construction of road from Kaijalay to Kolbong and 6th Mile to Takdah where several plants have been destroyed during construction of such roads as the above roads falls under forest area. It is also seen that

in the name of development of Tourism industry in the Darjeeling hills, transport business has grown enormously. Many new roads are being constructed as the new tourist spots are being connected with better facilities and services.

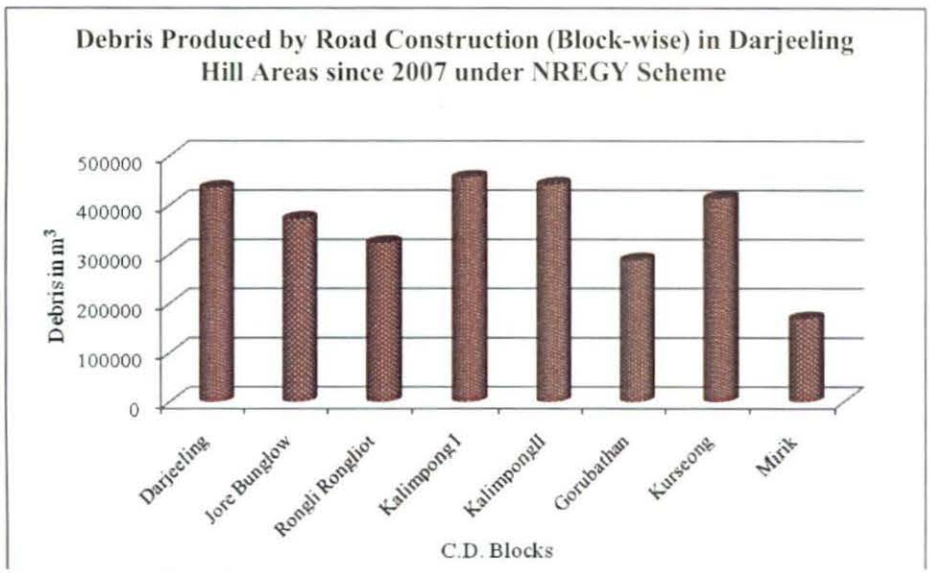


Figure 8.1 Debris produced by road construction in different blocks of Darjeeling hills

The figure 8.1 shows block-wise distribution of debris production due to new road construction in rural area under NREGY scheme since 2007 vis-à-vis environmental impact of so called implementation of development programme in most casual manner. It is found that such impacts are found more prominent in Kalimpong I & II, Darjeeling-Pulbazar and Kurseong blocks while least in Mirik block.

The people of Darjeeling, Kurseong, Kalimpong, Mirik, Gorubathan, Tindharia, Sukuna etc. has caused indiscriminate deforestation along with the construction, extension of road leading to tourist centres, tea garden, Cinchona plantation, agriculture fields and other cultural activities which in terms have eaten up a considerable portion of the hills in order to accommodate ever expanding and varied occupancies. Mis-use of the steep slopes at the cost of environment damages had brought incalculable miseries to humanity. Natural calamities in the form of landslides, occasional droughts which were not so widespread before have become a regular occurrence.

8.3 Development of Settlement and Urban centres and its Impact

Development of settlement and urban centers vis-à-vis concentration of population with diversified economic activities in Darjeeling hill areas have been taken place since the

second half of the last century. The so called prosperity of Darjeeling has also invites deadly impact of environmental degradation, traffic congestion and the problem associated with public goods and services. Unregulated migration from the rural areas for employment, services and better livelihood put tremendous pressure on the existing urban infrastructure particularly space for construction of dwelling houses, toilets, scarcity of drinking water, air passage, light etc. As a result marginal and unsuitable land hitherto kept as natural buffer zone since the time of British annexation has been occupied in most cases illegally for residential and commercial purposes. Thus already dwindling greenery of the hills has been further declined inviting accelerated landslide and associated problems. It is also interesting to note that many pieces of cultivated land in rural Darjeeling hills have been converted to waste land due to migration. The agricultural production has also been affected in addition to livestock rearing.

Table 8.5: The growth of population in major urban centers in Darjeeling hill area

Year	Census population					
	Darjeeling Municipality	Decadal growth	Kalimpong Municipality	Decadal growth	Kurseong Municipality	Decadal growth
1901	16924	-	1069	-	4469	-
1911	19005	12.3	7880	29.84	5574	24.73
1921	22258	17.12	7944	0.81	6445	15.63
1931	21185	-4.82	8776	10.47	7451	15.61
1941	27224	28.51	11958	36.26	8495	14.01
1951	33605	23.44	16677	39.46	11791	37.95
1961	40651	20.97	25105	50.54	13410	14.43
1971	42873	5.466	23430	-6.67	16425	22.48
1981	57603	34.36	28885	23.28	18008	9.64
1991	73062	26.84	38832	34.44	26758	48.59
2001	107197	46.72	42998	10.73	40998	49.56

Source: Census Report, 2001

Three major urban centres in the Darjeeling hills namely Darjeeling, Kalimpong and Kurseong have been experiencing phenomenal growth during the past 100 years (table 8.5). Population of Darjeeling municipality has been increased from 16,924 persons in 1901 to 107,530 persons in 2001, Kalimpong municipality recorded an increase of population from 1069 in 1901 to 42,998 in the year 2001. The population of Kurseong municipality was 4469 persons in 1901 and increases to 40998 persons in 2001. In fact, the population growth in Kurseong is the least among the urban centres in Darjeeling hills (figure 8.2).

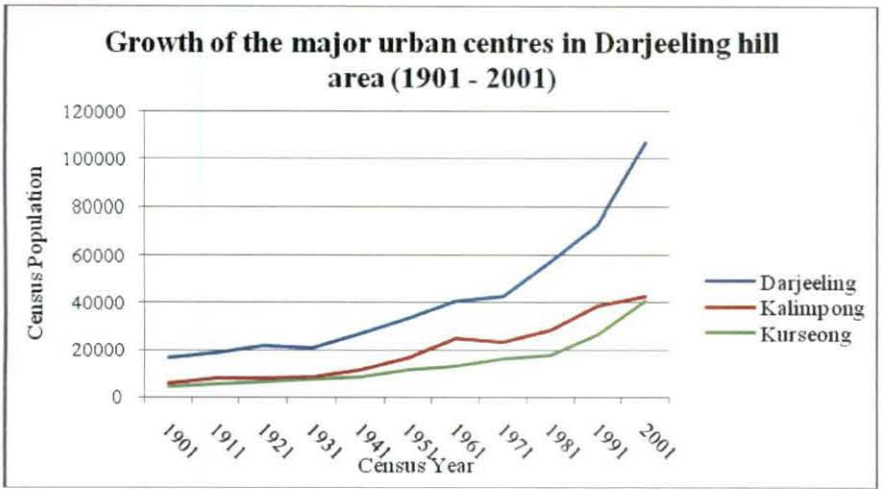


Figure 8.2 Growth of major towns in Darjeeling hills

The decadal growth of population in urban centres of Darjeeling hill areas is rather interesting and depicted in figure 8.3. It is observed that Darjeeling and Kalimpong towns have been experienced negative growth during 1921-1931 and 1961-1971 respectively. It is also observed that all the urban centers have experienced two phases of massive growth i.e., 1931 to 1951 and again 1971 to 2001.

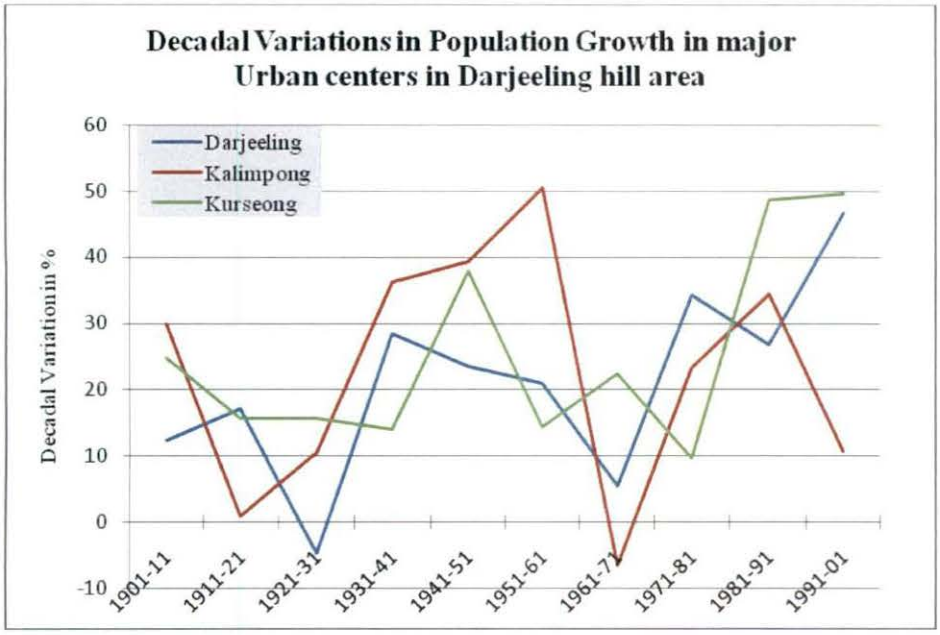


Figure 8.3 Decadal variations in population growth in major hill urban centers

The growth of Darjeeling town is most spectacular among the urban centers in Darjeeling hills which recorded an increase of 633% during the past 100 years (1901-2001). In this context, it is important to note that the early developer of Darjeeling town planned to

develop the urban attendant infrastructure for the town for an estimated residential population of 25000-30000 persons. By the end of the century with 4 times more residential population in Darjeeling town exerting tremendous pressure to her existing urban infrastructure. Every sector of basic urban facilities has been found collapsed and thereby putting tremendous stress to the delicate environment system of Darjeeling town and its environs. Among the worst affected sectors, water supply in Darjeeling town is noteworthy. An attempt has been made in the following section to apprehend the impact of unregulated population growth in Darjeeling town on its water supply system.

8.3.1 Water supply system in Darjeeling town

Water supply in the Darjeeling hills is entirely depend surface water i.e., spring/jhora. Long pipelines were laid down across the hills connecting many settlements for the supply of water during the lean months. With the drying up of sources, over one half of such pipelines in fact fail to supply water during the most crucial period of Mach-May.

The Darjeeling town is supplied with drinking water from twin Senchal lakes (South lake with capacity of 13 million gallons built in 1910 & North lake with capacity of 20 million gallons built in 1932) having its source from 26 nos. of perennial springs in the Senchal catchments area. The total capacity of these two lakes is 33 million gallons. Water filtration is done through gravity pressure filters situated at Jorebungalow filter house and from there water is further supplied through large conduits to the reservoirs built at St. Paul having capacity of 2,35,812 gallons and at Rockville having capacity of 1,14,000 gallons. The whole distribution network is run by operating over 90 valves, not only near the main tank at St. Paul and Rockville but also at many places in town. The third lake with capacity of 15 million gallons was constructed in the year 1978 at Singdhap. Considerable volume of water also supplied from the Rambi line and local jhora/spring like Bakshi Jhora, Laldighi Jhora, Bhagyakul Jhora, Bhotay, Giri Jhora etc.

8.3.1.1 Genesis of Problems

The early developer of Darjeeling town understood the importance of water supply in proper perspective and develop Senchal watershed cum reservoir for the purpose hundred years back which till today considered as the backbone of the urban water supply in Darjeeling. Over the years, increase in population (figure 8.2) induced increase in demand and only after half a century another serious effort was initiated at Singdhap reservoir which

found partially crippled thanks to poor quality of work. The hundred years old distribution system was never revamped rather manipulated, repaired and extended at the expanse of its efficiency. As a result, even conservative estimates showed over 20% precious water wasted or misused.

Sources of water in the Darjeeling hills are available mostly in the form of spring/jhora; these springs directly depend upon the natural preserves in respective watershed and rainfall. It is very much essential to preserve the catchments area, which feeds such springs. Indiscriminate deforestation and misuse of land within the catchments caused drying up of many such perennial springs a conservative estimate put the figure of over 50% of the during the last century. The rapid land-use transformation accelerates the decaying processes.

8.3.1.2 Present Status of Water Supply

The drinking water supply system in Darjeeling town consists of 26 nos. of springs from the catchment of Senchal Wildlife Sanctuary 15 km away from the town. The water is arrested in an arrester tank and fed to the masonry conduit line (8 km in length) brings water by gravity in twin Senchal lakes with a capacity of 33 million gallon. From these lakes water filtration is done through pressure filters situated at Jorebunglow filter house from where water is conveyed through large water mains to reservoirs at St. Pauls' tank (capacity 235812 gallons) and two tanks at Rockville (capacity 114663 gallons). Drinking water is distributed from these reservoirs over the town through subsidiary tanks located at various places and also directly through 19 nos. of distribution mains of different diameters.

The existing water supply installation of Darjeeling town was designed to cater a population of 20000 only. Since then, several new water installations like Khong Khola station, Rambi water line, Sindhap lake, Bakshi jhora, Bangla Jhora etc. were added but this could not cope up with the rapid in population as a result, water scarcity becomes the rule of the day since the last three decades during December-May. Situation became even more complicated during the last decade due primarily the drastic fall in the volume of water in the watershed. The estimated water availability from different sources at present, during the dry period may be as follows:

The estimated water demand for 202,255 persons (inclusive of 60,000 floating population) is 2730,442 gallon per day keeping in mind a minimum requirement of 10 gallons/head/day. The total storage capacity is just enough for supplying 15 days of water

requirement leaving 75 days in lean season dry.Thus, the present storage capacity of drinking water for Darjeeling town could cover only 13.5% of her total requirement. Besides these the century old water distribution network of Darjeeling town is run by manually operated valves which are liable to the problem of perennial leakage and misuse. Illegal tapping and unscientific connections have further aggravates the already problematic distribution system. The age old Senchal reservoirs show numerous micro-cracks and fissures allowing seepage of water. While, the newly constructed Sindhap lake has been found to be partially crippled due to sub-standard construction.

8.3.1.3 Future Requirement

The present population (2008) of Darjeeling municipal area as estimated to be 142,255 (based on projection) and another 60,000 floating population, a total of about 2.02 lakhs of population for whom water has to be provided especially for crucial dry season i.e., February to mid-June. In view of rapid growth of Darjeeling town a population projection is attempted (figure 8.4).

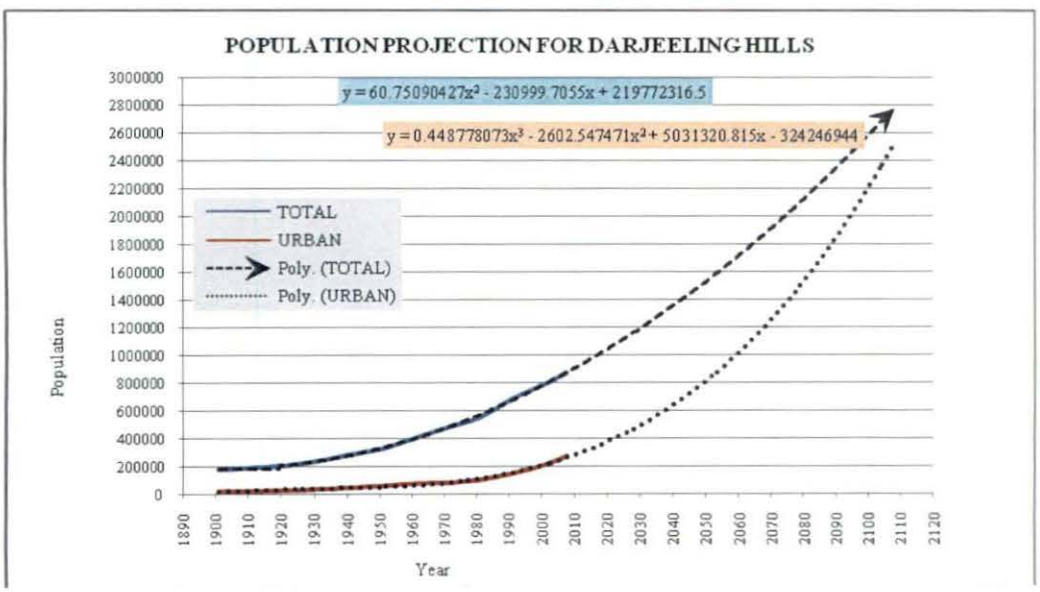


Figure 8.4 Population projection for Darjeeling hills

Only 11.58% of the actual water demand is being met through the Municipal Water supply system of Darjeeling town at present. Without having any other alternative source for drinking water (except bottle water), the citizen of Darjeeling have had to face the ever

increasing severity in fetching a bucket of water (non-potable) at the cost as high as Rs.100/- during the time of crisis.

The projected demand vs. supply of drinking water curve has been depicted in figure 8.5 and table 8.6. It reveals that the drinking water demand only in Darjeeling town has increased from 1.35 million gallon/day in 1991 to estimated 4.0 million gallon/day by the year 2021. Total increase of 196% has been registered between the periods 1991 to 2021 i.e., an annual increase of 6.5%.

To keep pace with the increasing demand and to ensuring gradual improvement of situation it is suggested (based on mathematical model) an annual increase of 11.6% in storage and supply of drinking water in Darjeeling town.

Table 8.6 Projected water demand and supply in Darjeeling town

Year	2008	2011	2021	**Water Supply in Gallon/day**	2009-10
Population*	202,255	227,279	320,000		
Water Demand in Gallon/Day				Conduit @6000 gallon x 24hours	144,000
Domestic demand @10 gallon/day/head	2022,550	2272,790	3200,000	Khong Khola Pumping Station @5000gallon x12h	60,000
Industrial/Commercial demand @10% of total	202,255	227,279	320,000	Sindhap lake @1000 gallon x 10hours	100,000
Public Utility demand @5% of the total	101,127	113,640	160,000	Rambi line @1500 gallon x 24 hours	36,000
Fire demand	Not available	Not available	Not available	Bakshi Jhora, Laldighi Jhora, Bhagyakul Jhora, Bhotay, Giri Jhora	32,000
Loss/waste/leakage etc @20% of the total	404,510	340,919	320,000*	Loss en-route @15%	55,800
Total (gallon/day)	2730,442	2954,628	4000,000	Total	316,200

* Inclusive of estimated floating population

It would be a herculean task for the concern authority to keep pace with the ever increasing demand and to arrest the increasing gap between the supply and demand in Darjeeling hills in general and in Darjeeling town in particular. It requires not only to augments source of water supply but also revamping of the existing distribution and supply system and imparting maximum possible transparency into the entire system. GIS based drinking water supply system (DWSS) armed with necessary database would be of extremely helpful not only in need based distribution and monitoring but also to keep necessary

surveillance in technical, financial and administrative management of the water supply system in Darjeeling hills.

Rapid urbanization is thus continuously disturbing the natural state of equilibrium of the region, semi urban nodes are in a state of continuous influx and the rural setup has undergone drastic changes. In spite of greater congestion the delicate balance of man- nature interface could have been maintained, had the people been more conscious about the vulnerability of the less stable Darjeeling Himalaya. Landslides became most rampant and regular causing tremendous stress to the day to day activities of urban life and livelihood.

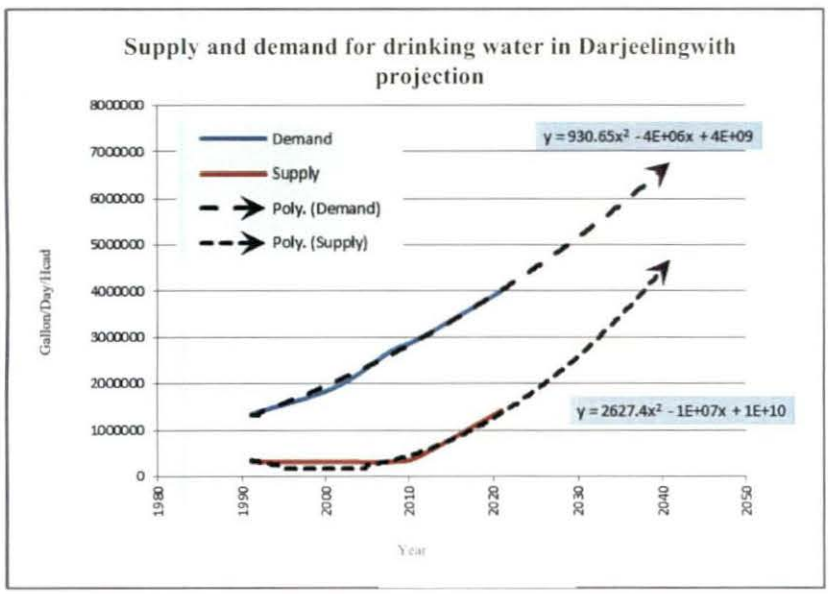


Figure 8.5 Demand and supply of drinking water in Darjeeling

Even through the town suffer great economic loss due to landslide every year. There has been complete lack of perception of the problem among the local people and also to the tourists. It is a common practice to dump debris an adjacent slopes during construction and clearing of roads. These unconsolidated extra burdens are virtually unstable. They obstruct easy flow of surface run off. Water passes through the regolith and increases pore-water pressure resulting into landslips. The something happens when the sewage lines are chocked with garbage.

The problem reaches dangerous proportions when the residing population almost doubles itself during the tourist season. Darjeeling itself is a major tourist centre of global scale, multiplying tourist inflow without adequate infrastructure is rapidly leading to the point of urban collapse.

8.4 Development of Public Utility Structures and its impact

When the British took over the Darjeeling in 1835 and Kalimpong in 1865, public utility structures was practically unknown. Darjeeling in 1835 had a collection of 20 huts with a population of 100 persons. In 1840, town consisted of the Kutchery and 30 others buildings i.e., Mount Pleasant, One Tree House/Beechwood , Bryanstone etc. all residence cum office of the British officials. Perhaps St. Andrew's Church constructed in 1843 was the first public utility building in Darjeeling town. This was followed by Loreto Convent (1847); Jalapahar Convalescent Depot (1848); Hindu Mandir (1851); Jumma Masjid (1852-62); St. Paul's School (1864); Old Cemetery and Jail (1865); Jalapahar and Katapahar Cantonments (1867); Planter's Club (1868); Union Chapel (1869); Bhutia Boarding School (1874); Ghoom Monastery (1876); Lloyed Botanical Garden (1878); Victoria Boy's School, Kurseong (1879); Brahma Mandir (1880); Eden Sanatorium (1883); Lowis Jubilee Sanatorium (1887); St. Josheph College (1888); Lebong Cantonment (1888); St. Mary's Training College, Kurseong (1889); St. Helen's Convent, Kurseong (1890); Railway Station (1891) etc.

8.4.1 Education Infrastructure

The early British developer of Darjeeling indeed tried to develop the modern education infrastructure of Darjeeling at global standard and accordingly number missionaries boarding schools and convents were constructed. In Kalimpong, Dr. Graham's Homes School was established in 1900, which was occupied more than 500 acre of land. It is seen that the missionary's schools had occupied more or less 20 acre of land by each school during that period. Similarly Loreto School, St. Robert's School, Bethany School, Mount Hermon School in Darjeeling Sadar and Goethel's Memorial School, St. Helen's School, St Alphons's School, St. Joseph's Girls School in Kurseong and St Augustine's School, S.U.M.I. Institution, Kalimpong Girls' High School, St Joseph's Convent in Kalimpong were established and constructed during British period.

Table 8.7 Education Infrastructure in Darjeeling hill sub-divisions in 2006-2007

Sub-division	Pry. School	Middle school	High School	H.S. School	General College	Professional & Tech. College	Non formal education
Darjeeling	564	28	37	23	6	5	890
Kalimpong	333	19	25	12	2	3	431
Kurseong	268	6	34	09	2	4	388
Total	1185	53	96	44	10	12	1709

During Independent period there had been constructed a number of government schools, municipal board schools, government aided schools, private schools were established in Darjeeling hill areas. In 1966, there were altogether 420 primary Junior Basic School in the rural areas of the hill region of Darjeeling district under different management. Table 8.7 shows the status of different educational infrastructure as it was during 2006-2007.

Among the other public utility infrastructure in Darjeeling public library, hospital and health centres, family welfare centers, agri-marketing centres are more important. During the year 2008-2007, Darjeeling hills housed 100 public libraries with free reading rooms and 984 mass literacy centres under continuing education programme. The health infrastructure available in Darjeeling hills has been tabulated in table 8.8

Table 8.8: The health infrastructure in hill sub-divisions of Darjeeling district in 2006-07

Name of Sub-Divisions	Hospital	Rural Hospital	Block Pry. Health Centre	Pry. Health Centre	NGO/Private Nursing Home	Total	Total Bed
Sadar	2	1	2	6	4	15	487
Kalimpong	1	0	3	6	6	16	484
Kurseong	2	-	2	10	-	14	595
Total	5	1	7	22	10	45	1566

For The agriculture department had taken up a programme for marketing the agricultural surpluses through the regulated market and sub-market yards from the state plan budget. This programe was consists of infrastructure development and provision of transport facilities, under the former principal market yards were being developed at Kalimpong, Darjeeling and Bijanbari and Sub-market yards were constructed and developed in the rural areas of Kalimpong and Darjeeling. Rural transport facilities have been augmented each of the eight hill blocks of Darjeeling district through providing with a truck to facilitate the transport of farmer's product from village to market.

8.4.2 Pisiculture

Successful implementation of Mirik lake fishery project particularly the rate of fish growth encouraged the Fishery department, Government of West Bengal to introduce the scheme of Jhora fisheries in the hill areas. The project involves an area of 1500 sq ft. in hill terrace along streams where small water body thus created be utilized for fish rearing. A modest beginning was made in 1980-81 with establishment of 9 units in Kalimpong increased

to 339 units in the hill areas of Darjeeling by the year 1990-91. Out of which 82 were in Bijanbari block, 23 in Sukhiapokhri block, 2 in Rongli-Rongliot block, 75 in Mirik block, 65 in Kalimpong I block, 73 in Kalimpong II block and 19 in Gorubathan block. By the beginning of 1990s it was gradually understood that the initial success has not been thoroughly scrutinized and negative impact becomes more and more prominent. It is now ascertained that all most all jhora fisheries scheme had been leakage and thereby damaging nearby arable land and households in the hill areas.

8.4.3 Rural development programme

The different programme for rural development in hill areas of Darjeeling were being executed through the Panchayati Raj Institutions (PRI's) as in the rest of the state. Centrally sponsored programme like National Rural Employment Programme, Integrated Rural Development Programme, Rural Housing and Rural Water Supply, SGRY, NREGY etc. The PRIs and line departments in the hill areas of Darjeeling during 1980-84 have completed 348 small irrigation and channel construction schemes, 483 flood control and anti-waterlogging schemes and 272 schemes for land reclamation and soil conservation. The Panchayat bodies under the NREP had executed 13 schemes, under RLEGP, 628 schemes for construction and repair of village roads had had been taken up, 8 panchayat buildings had been constructed, 357 schemes for repair and construction of Primary schools and 269 schemes under welfare of schedule caste and schedule tribe had also been completed.

Under the Rural Housing Programme, 290 huts had been constructed for landless indigent persons, during the same period financial assistance from central assistance had been utilized for rural link road development in order to provide sufficient marketing outlets to the rural surplus. The zilla parishad had taken up the construction of seven bridges and twenty one roads during 1980- 84 and BDOs have completed 84 pony roads, 33 bridges and 30 culverts during the period of 1980-84. Several other public utility structures in tourism, public health engineering, social and community services have been executed during the period. After panchayat election of 1995, the panchayat and rural development department constructed 112 nos. of new gram panchayat buildings in 3 hill sub-divisions. Approach roads leading to gram panchayat office also had been constructed.

8.4.4 Environmental Inpact

For the development of public utility structures it can be said here that the construction of school, colleges, community halls, hospital, dispensaries, road construction, water reservoirs are the essential and indispensable things for the people. But the authority concerned did not take any care for the misuse and overuse of environment. The forest and land have been destroyed more than its actual requirement and inhumanly they destroyed the forest as well as habitat of animals and birds. They never thought for reforestation and habitat of wild animals.

The deep-rooted poverty and ignorance have become chronic over the period of time. Besides, the people are living under a state of acute infrastructure deficiency. The socio-economic distress has not been reflected in the day to day living among the hill people of Darjeeling, perhaps an in-depth house-to-house survey in the rural villages will reveal the real picture as to how people are struggling for their livelihood. The remote villages are still traveling a daylong walk for shopping in the towns. The farmers have to walk day long to sell their produce in the nearest town. The situation becomes worse during the rainy season when frequent large scale landslides and other forms of mass wasting take place in the hills. During this period a large number of villagers lose their lives. Safe drinking water, educational institution, primary health centres, power supply etc. face similar fate in the rural hills.

8.5 Development of Hydroelectric Project and its impact

The turbulent river system of Darjeeling hills has long being acclaimed as major potential source for hydroelectric power. Sidrapong located a few kilometer from the Darjeeling town hosted the first hydroelectric power generating station in the country established in the year 1897 and proud enough to declare still operational.

Although, most of small and medium size rivers in Darjeeling hills are rain fed and do not have enough perennial and constant supply of water needed for generating hydroelectric power yet, they are capable to host mini and micro-hydroelectric power generating station. There were 5 mini/micro hydroelectric power generating stations in the district with a total installed capacity of 9.778 MW another two major hydroelectric power generating stations is not under operation stage (table 8.9). With a view to exploiting the immense potentiality of the water power of the Jaldhaka river medium sized hydroelectric generating station was set up at Paren in Bhutan boarder, and it started supplying electricity since March 1967. Under the first phase of the scheme about 27 MW had been generated, which was increased to 36 MW under the second phase which was completed in 1983.

Table 8.9 Hydroelectric Power Generating Stations in Darjeeling hills

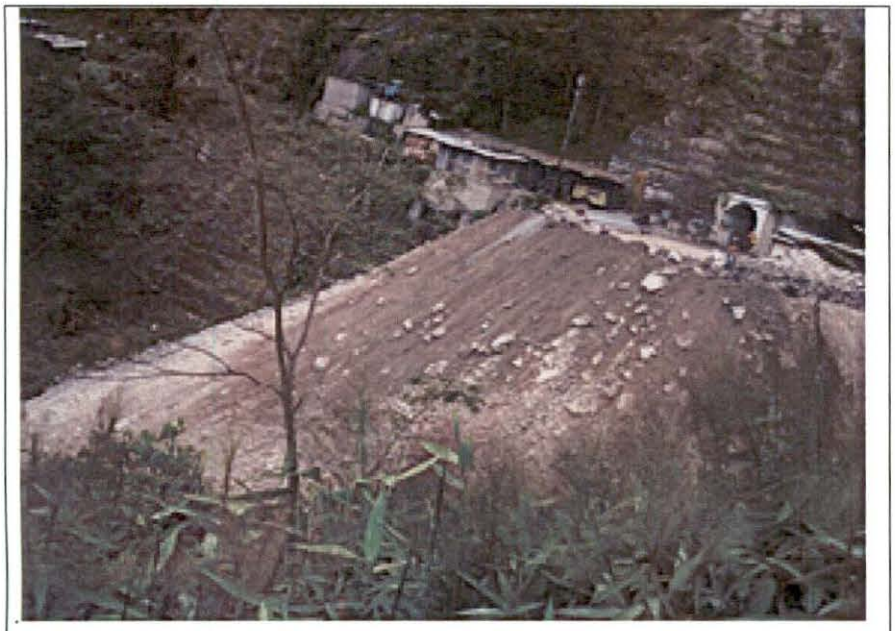
No	Hydroelectric Projects	Installed capacity in MW	Planned capacity in MW
A	**Mini/Micro-Hydroelectric power generating stations**		
1	Rinchington	2x1 = 2.0 MW	
2	Little Rangit	2x1 = 2.0 MW	
3	Mungpoo Kalikhola	3x1 = 3.0 MW	
4	Sidrapong	3x0.11= 0.33 MW	
5	Fazi Hydel	3x0.81= 2.448 MW	
B	**Medium size hydroelectric power generating stations**		
1	Jaldhaka Stage - I	3x9 = 27.0 MW	
2	Jaldhaka Stage -II		2x4 = 8.0 MW
3	Rammam Stage - I	3x12 = 36.0 MW	
4	Rammam Stage -II	-	3x17 = 51.0 MW
5	Rammam Stage -III	-	3x30 = 90.0 MW
6	Rammam Stage - IV	-	3x10 = 30.0 MW
C	**Major Hydroelectric power generating stations**		
1	TLDP - III	-	4x33 = 132.0 MW
2	TLDP - IV	-	4x40 = 160.0 MW
	Total	72.778 MW	471.0 MW

The Rammam hydroelectric project with a total installed capacity of 207.0 MW was an ambitious aspiration of West Bengal State Electricity Board (WBSEB), Government of West Bengal to harness the mountain torrents was proposed to be set up in four stages of 36MW, 51MW, 90MW and 30MW. The first phase of the project was envisaged to be a 36 MW hydroelectric plant (3 x 12 MW), followed by a 3x30MW project in its second stage. The third phase was envisaged as a 90 MW project (3 x 30 MW). This was to be followed by a 30 MW Rammam ultimate hydroelectric project as the last phase. The first stage was commissioned during 1980s and running well. The WBSEB initiated the construction work for Stage II in 1982 but progress was severely affected over the years owing to political unrest in Darjeeling hills. Only one phase has been commissioned. The other three phases of the projects are yet to see the light of the day.

8.5.1 Impact of mini/micro and medium hydroelectricity projects

The mini/micro hydroelectric projects are normally very small and utilize natural water flow over steep gradient. The land required for developing necessary infrastructure is very limited and as such no reallocation of habitation is needed. As such, the mini/micro

hydroelectric project seldom invites large scale environmental degradation. The local people are also considered such projects as eco-friendly and sustainable. The historical Siderbong micro hydroelectric project is classical example of such kind.



Photograph 8.5 Dumping of Tunnel wastes along the hill slope near Linsebong, Rammam project invite site for future landslide.

Photograph 8.6 Deforestation along with massive cut & fill of hill slope materials is characteristics of a hydro-electricity project

The construction of medium size Jaldhaka and Rammam hydroelectric projects and its attendant infrastructure caused irreparable damage to the delicate physical and biological environment of the project sites and their environs. Large amount of public lands were damaged, people had to shift from project area to other places, the existing forest area were

damaged, large number of flora and fauna were found lost and killed due to construction of project road and construction of building, staff quarter, community hall and other infrastructure. Heavy landslide took place in Rammam hydroelectric project site during 1980-81 threatening the overall stability of pen structure and power house. Jaldhaka project site was also affected by large scale landslide occurrences along the hill slopes along the realigned road to the project sites. Dumping of excavated materials for tunneling in Rammam project along the hill slopes has been found near Linsebong is a real threat (photo 8.5). No mechanism of environment protection has been adopted to check such illogical act of the project authority. Construction of new road to make accessible to the different project related infrastructure sites under Rammam project leads to innumerable number of landslides along the road (photo 8.6) and thereby posing serious threat to the environment.

The socio-economic impact of such medium size hydroelectric projects in Darjeeling hills has been found highly negative. The residential people finds very limited benefit out of rather they are gradually facing more and more hardship in their day to day livelihood activities i.e., loss of arable land, increasing edaphic drought, decline in irrigation water supply, drying up of springs and jhoras along hill slopes etc.

8.5.2 The Tista Hydroelectric Projects

The biggest source of hydroelectric power potential lies with the mighty glacier fed river Tista. The potential was long been understood and the first serious attempt was made during 1940s. However, technical capability couple with economic feasibility became formidable barrier in the way of its implementation. It was only in 2002 the National Hydroelectric Power Corporation (NHPC) a government of India enterprise started to implement two major hydroelectric power generation stations to be located in Darjeeling hill areas. The Tista Low Dam Project Stage III (TLDP-III) at Reyang (Rambhi) and Tista Low Dam Project Stage IV (TLDP-IV) at Kalijhora.

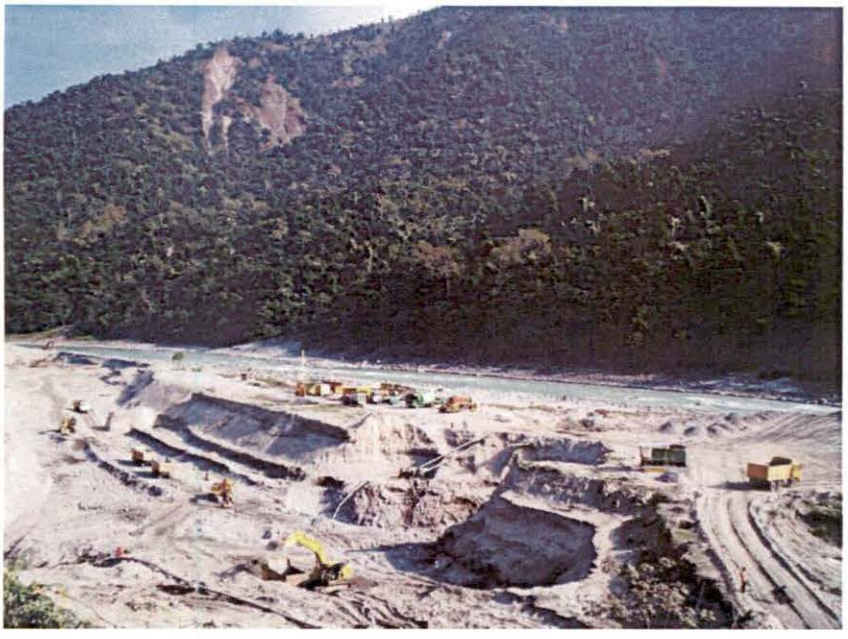
The Tista Hydroelectric projects have been considered as the biggest developmental programme Darjeeling hill ever experienced an estimated investment of Rs.19470.6 million (at 2001 price level). On completion the TLDP –III & IV shall produce electricity at the tune of 132 MW and 200 MW respectively. The project shall bring prosperity in development starve Darjeeling hill in particular and the North Bengal as a whole on one side and the apprehension of the local people and environmentalists/civil society about its large scale and unpredictable adverse environmental impact. Lot of debates on apprehensions and

demonstrations has been taken place particularly on EIA (Environmental Impact Assessment) and EMP (Environmental Impact Assessment) of both the TLDP-III and TLDP-IV. However, the NHPC authority could able to go through with project and its contact is now expected to commission by 2012 after undergoing through rigorous public hearings and mass contact.

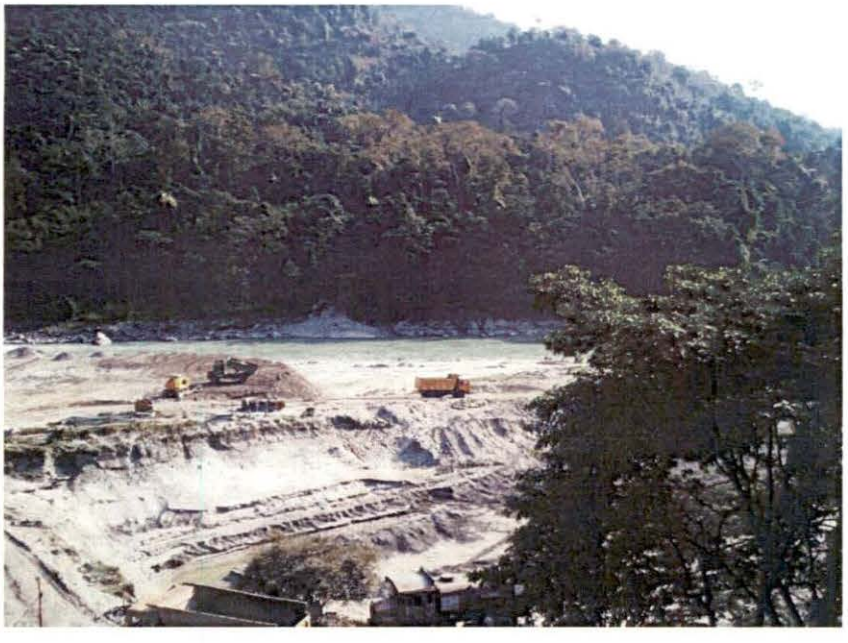
In pursuance of the provision of the Electricity (supply) Act 1948, the NHPC shall exercise all powers vested in a generating company under said Act for the purpose of the aforesaid scheme. Power Grid Corporation of India would provide suitable integrated power evacuation system matching with the commissioning schedule of power plants. This shall be done in consultation with CEA/ WBSEB.

The TLDP - III submerges residence of nine families and that in the TLDP – IV shall be ten families. The NHPC will provide compensation based on the EIA and EMP plan. The water will also submerge forest land and also sections of National Highway 31A leading to Sikkim. The forest submerged will be compensated by compensatory afforestation. The submerged section of NH 31A would be realigned through the Mahananda wild life Sanctuary.

Being situated in on the lap of the highest, youngest and tectonically most active Himalayas, the river Tista is notorious in its erratic behavior especially the devastating flood occurrence that triggered by high intensity rainstorm in October 1968. Moreover the location of TLDP-IV near Kalijhora only a few kilometers from the most active Main Boundary fault (MBF) separating the Indian plate and Tibetan plate makes the project site highly vulnerable. Frequent earthquake in this region (zone IV) and particularly under the light of recent Sikkim earthquake (September, 2011), the environmentalists and civil society members are highly apprehensive. The question arise that in case of dam brake/ dam bursting two important urban centres along with million people along the riverine tract would perished. It was naturally a justified demand from the civil society keeping in mind safety and security of millions to have detail and scientific EIA and EMP to not only safe guard the interest of the people but also to the stability and sustainability of the Tista hydroelectric projects the largest of this kind in North Bengal.



Photograph 8.7 Construction of TLDP Stage III under progress



Photograph 8.8 Construction of TLDP Stage IV under progress

8.5.3. Case study of Helipad at Mirik dome to showcase unscientific planning

The Mirik landslide has been selected as the most suitable case study to high light the issue. The methodology employed by the investigator is a rationalistic one, comprising of the examination of the geomorphologic processes involved in sculpturing the land surface along with the study of the nature and extent of anthropogenic interferences that can either cause or

aid natural hazards. The data for this study has been collected mainly from field survey as well as from compilation of secondary references.

The disposal of talus materials, resulting from the excavation of hill slopes and hill tops for so called development purposes, and in many cases into jhoras and kholas is a common practice in the study area. This particular case exemplifies how such an action has initiated a series of landslides that have affected the road communication, agricultural fields and threatened the fluvial environment of the river Marma, an important tributary to the river Balason.

The Darjeeling Gorkha Autonomous Hill Council in 1995 undertook an ambitious project of constructing a helipad in Mirik area to boost tourism. The Mirik dome was selected for the purpose and operations to cut the dome and level the area started in a war footing by engaging heavy bulldozers and hundreds of labourers. (Bhutia, 2000). The excavated materials were thrown downhill into the area, which formed the source of Marma Khola ignoring the consequence of such heedless action. The project was abandoned in 1996 due to its unfeasibility, but the damage was already done, as landslides occurred immediately during the following monsoons resulting in the disruption of communication and loss of agricultural areas along the banks of the jhora.

The follow up study as shown in table 8.10 reveals how unscientific and irrational activities of man can cause irrevocable damage to the environment. The dumping of excavated materials into the source of Marma khola has initiated landslides along the entire tract of the khola, causing a series of chain reaction leading ultimately into deterioration of the hydrological regime of the river Balason. In Mirik unscientific developmental activities, without taking into consideration the fragile nature of the Himalayan ecosystem has lead to serious environmental degradation. The impacts of such activities have been adverse and if not heeded, could lead to extensive damage to both human life and environment.

It is thus necessary that extensive studies are carried out and analysis of the impact of development activities be made, before undertaking any such activities in this region. Under the prevailing conditions of environmental degradation in the study area, it has become absolutely necessary to have a comprehensive plan to offer every remedial measure, for each and every kind of adverse environmental effect of development projects. This would also help to adopt precautionary measures that are pertinent and need to be followed, before undertaking any development activity. These have to be taken up seriously and followed

carefully if the development activity is to have the minimal adverse effect on the ecology of the region.

Table 8.10: Morphology of Mirik landslide

Pre slide conditions	Post slide conditions (1997)*	Post slide conditions (2009)** post Aila	Remarks
1.Rocks: Moderate to highly decomposed jointed granite, gneiss interbedded felspathic veins. The rocks are dipping at an angle of 20 to 60 towards NE – SW, NNE-SSW and EES and WWN. A number of joints have been identified.	1.Length of Scar: 270m 2.Width of scar: Max: 95 m Min: 10 m Ave: 52.5m 3.Depth of scar: Max: 5.1 m Min: 0.3 m Ave: 2.7 m	1.Length of Scar: 340m 2.Width of scar: Max: 105 m Min: 12 m Ave: 63.5m 3.Depth of scar: Max: 7.2 m Min: 0.3 m Ave: 3.75 m	Within a short period the link between Mirik and the hospital will be affected. Immediate proper storm water draining system and protective walls are recommended
2.Altitude 1620 to 1690 m	4.Shape: Triangular	4.Shape: Triangular	
3.Slope Convex (25 to 30)	5.Total area affected: 14,175 sq.m 6.Total volume of materials displaced: 38272.5 m3	5.Total area affected: 21,510 sq.m 6.Total volume of materials displaced: 80962.5 m3	
4.Natural Vegetation: Scattered shrubs. Landuse: Tea garden is situated just below the threatened area. Mirik to hospital Road passes through this affected area.	7.Process responsible for the landslide: Removal of basal support by toe cutting makes the stage ready for the slide. Spontaneous liquefaction due to heavy rainfall and cutting of ridge tops for the helipad has actually provided the so called trigger mechanism.	7.Process responsible for the landslide: Removal of basal support by toe cutting makes the stage ready for the slide. Spontaneous liquefaction due to heavy rainfall and cutting of ridge tops for the helipad has actually provided the so called trigger mechanism.	Ridge top cutting materials were thrown along these natural streams downslope. These unconsolidated materials have undergone massive gully erosion during the monsoon months. Such stream actions along with continuous toe cutting has actually invited disastrous landslide along the upper valley of river Marma, a tributary of the Balason.
5.Soil Colour: Top: 10YR 4/4 (Dusky red) Mid: 2.5YR 4/4 (Reddish Brown) Base: 5YR 4/3 (Reddish Brown)	8.Modified slope: Concave and irregular (12 to 60) 9.Type of slide: Debris flow 10.Special features: a number of gullies have developed, incisions have also been noticed.	8.Modified slope: Concave and irregular (12 to 65) 9.Type of slide: Debris flow 10.Special features: a number of gullies have developed, incisions have also been noticed.	

*Based on P.T. Bhutia, ** Field observation by the investigator

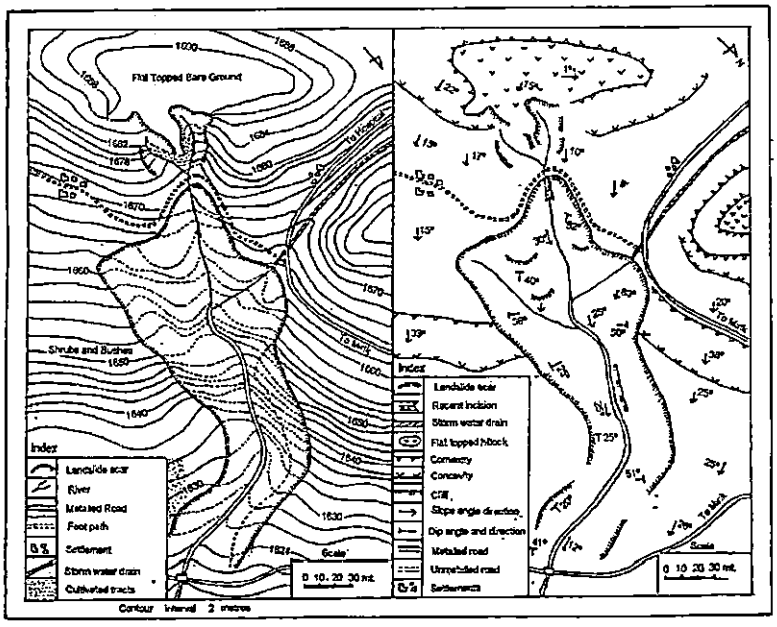


Figure 8.6: Geomorphological map of Mirik landslide (Based on P.T. Bhutia, 1998)

In the case of the Mirik landslide it becomes imperative to plan the land uses scientifically – not just in terms of socio-economic importance but also for strategic planning. This calls for the compilation of all relevant information and building up of a comprehensive database for landuse planning purpose in order to prevent half-baked faux pas in the name of planning new infrastructure for tourism. With decentralized decision- making being one of the major tools for successful planning, local level participation is highly necessary. Thus a whole hearted effort has to be initiated by involving local residents in the field of data generation, data preservation and data utilization for all future land use planning. Arbitrary and baseless plans should be avoided at all costs. The faux pas at Mirik also points to the fact that certain legal changes are also needed in the area of resource management covering the land and water resources, which are both scarce commodities in the hills. More specifically, changes in building rules in municipal area, slope ordinances controlling allowable activities in different slope areas and controlled drainage of the region should be considered a priority for legal intervention. Intense rainfall and cloudbursts as has been seen so often in recent years, can and has had devastating impact in the hills. It is of utmost urgency that watershed and catchment management have to be adopted for regulation of drainage and effective utilization of extra water resources in the Darjeeling Himalaya.

8.5.3.1 Environment Impact

Keeping in mind the above mention aspects of the Tisa hydroelectricity project the NHPC initiated independent implementation of Environmental Impact Assessment (EIA) and Environmental Impact Management (EMP) individually for both the TLDP-III and TLDP-IV. An attempt has been made in the following sections to assess various environmental impact of the Tista hydroelectric project in Darjeeling hills in particular and the sub-Himalayan North Bengal as a whole.

The significant and visible increase in landslide occurrences along the NH 31A the life line for Darjeeling and Sikkim from Sevoke to Tista Bazar during the past few years may be considered as one of the worst negative impact of Tista hydroelectric projects. Movement of frequent heavy vehicle for construction purpose is primarily responsible for such an unusual increase of slope failure. Gigantic cut and fill processes has been undertaken at both project sites along with diversion of the mighty river Tista for the construction of Dam and powerhouse shall be responsible for serious disturbances of hill slope hydro-geomorphic stability (Photograph 8.7 & 8.8). In fact, the mammoth project activities caused irreparable damage to the pristine landscape of the lower Tista valley. Ever increasing scars starting right from the foothills of Sivok to Tista Bazar in fact bear mute testimony of the true environmental impact of the much publicized Tista hydroelectric project in Darjeeling hill area.

The river Tista carries huge amount of bed and suspended load, perhaps one of the highest at global scale. During the construction stages there is every possibility to increase such load movement manifold and thereby may indulges unpredictable fluvial adjustment. Couple with this ever increasing landslide occurrence shall also produce large amount additional silt load to the river which ultimately affect the proposed dams in terms of reducing their life span and/or caused catastrophic dam brake. Special attention shall be given to the catchment area treatment with an aim to reduce silt production to be transported to the parent river.

Among the major identified impact management to be adopted to ease out the adverse environmental impact of the Tista hydroelectric projects are summarized below:

i) Catchment area treatment plan shall be of high priority to check soil erosion and slope failure within watershed shall have the following objectives:

a) to treat the severe and very severely degraded area as identified in EIA,
b) to stabilize various unstable areas using several engineering and bio-engineering measures and
c) to increase the life span of the project by reducing sitation in the reservoir.

ii) Rehabilitation and resettlement plan for the identified and would be affected families/establishment as identified in EIA document.
iii) Compensatory afforestation
iv) Reservoir rim treatment plan shall be executed to identify potential weak/slide zone followed by RRT work to offer stability of reservoir side
v) Fisheries development plan including installation of fish ladder to facilitate fish migration
vi) Bio-diversity conservation plan
vii) Wild-life management plan
viii) Free fuel provision for the local/affected households/labourer
ix) Saftety and health management plan
x) Eco-tourism development plan.

8.6 Conclusion

Since the independent the development of various projects such as transport and communication, irrigation and agricultural, water supply, sericulture, fishery etc. were taken place in the Darjeeling hill area. Local inhabitants are also receiving opportunity to exploit benefit out of such development projects. It is only during the last few decades the man has begun to exploit the vast and varied natural resources like flowing water through the rivers like Tista, Rangit, Rammam, Balasan and the Jaldhaka. At several places these rivers have been tapped and plugged to generate hydroelectric power, to construct dams to generate power and to irrigate the agricultural land to benefit the inhabitants. As a result, rapid urbanization has been taken place in Darjeeling hill areas. The rural Darjeeling has also been experiencing rapid population growth during the past couple of decades. The Darjeeling hill has been considered as environmentally sensitive and susceptible and thereby has limited carrying capacity. Thus, the unregulated developmental activities couple with uncontrolled population growth invites the most unfortunate story of premature degradation in almost every sphere of her environment.

The problems of environment management are diverse in nature that requires special attention. The development of urban centers and settlement in Darjeeling hill also invited large scale landslide occurrences. It is clearly understood that acceleration of landslide occurrences since the beginning of the last century was essentially due to human encroachment in the form of illogical and unregulated growth of settlement, infrastructure and livelihood activities. The construction of railway track, road, bridges, culvert and other development works took place at cost of slope cutting often accelerated the processes of soil erosion and mass movement. Extensive landslide damages was reported in 1899, 1910, 1932, 1942, 1943, 1944, 1950, 1954, 1968, 1980, 1991, 1993, 1996, 1998, 2004, 2009, 2010 and 2011.

The land use of Darjeeling hill during the time of the British annexation was dominated by rich temperate forest in the high altitude, dense mixed jungle in the middle hills and gregarious tropical forest in the lower hills dotted with grassland and shrubs and bushes. Massive land use transformation has been taken place since the British annexation. Vast clear felling was reported at the early stage especially during the establishment of tea plantation. This was followed by selective deforestation that was taken place during the implementation of almost every developmental programmes.

The Darjeeling hill is endowed with a wide range of plants and in fact one of the centers of origin of certain important agricultural and economic plants. Exotic plants like rhododendron, wild rose, conifers, rare herbs and food crops should be genetically upgraded to meet the requirement of food. The temperate Himalayan belt offer great potentials for forage grasses and legumes, as such the natural grasslands of low productivity can be replaced with highly productive by farming systems. These untapped grasslands resources of the hill region can perhaps make large contribution to its economic development. As the prosperity of a nation is determined by its capacity to utilize and conserve its resources it is therefore, necessary to undertake suitable steps based on the physical and biological environment to formulate plan for sustainable development of biological resources of Darjeeling hill areas.

The varieties of wild animals and birds have threatened and some are extinct due to implementation of different development projects, such as construction of roads, construction of hydroelectric projects, township, community halls, tourism projects etc. The concerned animal resources department as well as forest department should take necessary steps

regarding conservation of such threatened species. The maintenance and development of roads, irrigation, schemes, water reservoirs and various rural employment generating and income generating programmes in the hilly terrains should be implemented under close supervision and monitoring mechanism considering environmental impact assessment of each of them.

Darjeeling Himalaya suffers from a vicious cycle of development process along with burgeoning population. There has been a constant increase on the area under subsistence crops followed by an increased dependency on livestock farming. Such sequence intensifies the demand on the fragile mountain land resources. Excessive encroachment of forest land to meet the mushrooming demand for fodder, fuel wood, and other requirements has led to unprecedented damage to forests, livestock grazing more often in this fragile environment has led to overgrazing leading to create barren land. Tourism in the area is another factor that has its share in the degradation and polluting the environment. Besides, the physical isolation, economic backwardness, social heterogeneity and unstable politics have a bearing on the social life of the hill folk which is often ventilated through disbelief, frustration and demand for linguistic and political autonomy.

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CHAPTER 9

Environmental Impact Assessment

9.1 Introduction

Environmental impact assessment is an assessment of the possible positive or negative impact that a proposed project may have on the environment, together consisting of the environmental, social and economic aspects. The purpose of the assessment is to ensure that decision makers consider the ensuing environmental impacts when deciding whether to proceed with a project. The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made." EIAs are unique in that they do not require adherence to a predetermined environmental outcome, but rather they require decision makers to account for environmental values in their decisions and to justify those decisions in light of detailed environmental studies and public comments on the potential environmental impacts of the proposal.

EIAs began to be used in the 1960s as part of a rational decision making process. It involved a technical evaluation that would lead to objective decision making. EIA was made legislation in the US in the National Environmental Policy Act (NEPA) 1969. It has since evolved as it has been used increasingly in many countries around the world. As per Jay *et al.*(2006), EIA as it is practiced today, is being used as a decision aiding tool rather than decision making tool. There is growing dissent on the use of EIA as its influence on development decisions is limited and there is a view it is falling short of its full potential. There is a need for stronger foundation of EIA practice through training for practitioners, guidance on EIA practice and continuing research.

The Darjeeling hill areas have been passing through the processes of development of different degrees and magnitudes since the British occupation since 1830s. The early phase was characterized by massive deforestation, cleaning of forest, shrubs and grassland followed by leveling of ground surface to get sites for construction and development of different kinds. Such a massive interferences into the delicate hill slopes hydro-geomorphic processes was demonstrated the major and devastating landslide occurrences in 1899 which caused massive

destructions of land and property in addition to the loss of nearly 100 people. The following phases of development processes also caused degradation of different magnitude. The post-Independence scenario was dominated by massive influx of population i.e., over 500% increase during the past century which is much higher than the physical carrying capacity of Darjeeling hills. Darjeeling town as for example, the original developer of the town designed its infrastructure to cater 25000 to 30000 people which is now accommodation a few hundred thousand. Thus, the contemporary developmental activities are more need based as people need land to cultivate and for land forest must be cleared some kind of vicious cycle of degradation has been established in Darjeeling hills.

It is true that development activities irrespective to its magnitude and nature have has some kind of effects on the natural environmental system, as they are inseparably linked to each other. However, costs of such developments, not in terms of money but equally or rather more valuable in term of its impacts on the environment must be assessed before initiating such a programme. The concept of environmental impact assessment (EIA) and environmental impact management (EMP) today stand very strong in all most everywhere in the present world.

Any development process is bound to have its impact on the environment. If we trace the history of human being it should be clear that there had been tremendous environmental impacts of industrialization, mining and development of hydroelectric projects had very harmful impact on our environment. Such impact led to degradation of our lands, forests water, air and biological diversity by release of noxious chemical and other factors.

Developments programme and industrialization had been a mixed blessing in Darjeeling hill areas. There was limited economic growth and increase overall standard of living. However, such development activities had been undertaken at tremendous environmental cost. Man has virtually reached a stage where natural resources could not be exploited further and development will have to be achieved without destruction of environment.

In Darjeeling hill areas, in the post independent period, the development activities like construction of roads, water supply project, hydro-electric projects etc. have been undertaken without proper investigation on environmental impact and possible impact management especially to the natural drainage system and flora and fauna of the affected area. It would be

desirable to have such environmental survey of the area before the projects are launched and thus avoid many of the unfortunate environmental maladies.

The objective of environmental impact assessment (EIA) is to ensure that developmental is sustained with minimal environmental impact assessment of developmental projects in various sectors such as heavy road construction, public building, tourist lodges, hydro-electric projects, industries mining and irrigation projects. In order to ascertain the impact of various development projects both on the society as well as on the environment. It is seen that the soil, water vegetation andman in the region have led to drastic changes in the environment thus the main objectives of the environmental impact assessment is to extrapolate the possible impact in years to come.

The overall impact of developmental activities in Darjeeling Himalaya, on the environment becomes evident from the process of degradation that has taken place over the years. Degradation of land and soil through soil erosion and landslides, where water has been the main agent and the degradation of biological conditions through changes in species diversity have resulted from the natural and more so unnatural interactions between man and environment. The direct impact of developmental activities is best understood through impact assessment involving impact identification and case studies. The objective of the impact assessment is to understand the development related factors that have led to the environmental degradation in the region. An attempt has been made to assess the magnitude and the significance of the environmental impact of various development programmes in Darjeeling hill areas in the following sections.

9.1.1 Methodology

A wide range of method has been development (Stover 1972, Munn, 1979, Wood & Lee 1987), Soresen and Mess (1973) are of the view that the present diversity should be considered as a healthy condition in a newly formed and growing discipline. The methods are divided into the following categories:

- Check list
- Matrixes
- Quantitative method
- Network and overlay maps.

The method that has been used is based on the quantified matrix i.e. the Leopold Matrix, developed for the U.S. Geological Survey based by Leopold et al (1971) with relevant modifications. The matrix is based on a horizontal list of 39 developmental activities under 9 broad headings and a vertical list of 58 environmental components under 4 broad and 12 sub-headings. The scope of possible interactions between the developmental activities and the environmental components is wide, as the overall impact is being considered from the time started until date, and therefore the assessment could aid in future planning. In each appropriate cell, two numbers are recorded. The number on the left of the back slash represents the impact's magnitude, from + 10 (very positive) to –10 (very negative). The figure on the right represents the impact's significance, from 10 (very significant) to 1 (insignificant).

9.2 Impact identification

Impact identification brings together various developmental project characteristics and base line environmental characterstics with the aim of ensuring that all potentially significant impact (adverse and favourable) are identified and taken in to account in the environmental impact assessment (EIA) process. Among the different states of EIA process i.e. impact identification, impact prediction, impact evaluation, impact communication, impact mitigation, impact presentation , impact monitoring and impact auditing, the investigator of the present study has performed impact identification as it will be possible to locate the places of impact magnitude of various degree with in the Darjeeling hill areas.

Impact identification brings together the developmental characteristics and base line environmental characteristics with the aim of ensuring that all potential environmental impacts are identified and taken into account in the impact assessment. The modified Leopold matrix as mentioned above has been applied for the said purpose and is represented with a "unit example" of **Phuguri** in table 9.1.

To have quantitative value of such impact from the matrix, the present investigator has applied a simple calculation as follows:

$$\text{Impact Magnitude} = \frac{\sum P - \sum N \times 100}{TP} \quad \ldots\ldots 9.1$$

$$\text{Impact Significance} = \frac{\sum S \times 100}{TP} \quad \ldots\ldots 9.2$$

Where P= positive impact; N=negative impact; TP = total parameters and S=significance. The matrix has been applied as "check list" in forty different tourism sites within the study area to have an idea about spatial distribution of the environmental impact of developmental activities in the Darjeeling Himalaya. This ultimately helps in producing two different maps: i) impact magnitude (figure 9.1) and ii) impact significance (figure 9.2).

9.3 The Impact Magnitude

Figure 9.1 depicts the different zones of the magnitude of environmental impact of developmental activities. It is found that such impact magnitude vary from highly positive (300) to highly negative (-300). Positive impacts of different magnitude have been noticed along the north western extremity of the study area, while negative impacts have been noticed along the most inhabited areas. However, for a better understanding of the geographical distribution of different impacts magnitude, the following classes are put forward:

Class I: High Positive Impact: is very evident in two broad zones viz. the north western periphery covering the Singalila Wild Life Sanctuary of the Darjeeling subdivision and the eastern section encompassing the Neora valley of the Kalimpong subdivision. Two much smaller zones exhibiting a high positive impact can also be seen in the southern section along the Sukna/Baikunthapur and Choklong khola regions. A narrow strip in the centre flanks the left bank of the river Teesta from Sevoke to Kalijhora. These zones falling under Class I exhibit a high positive impact chiefly because these areas are still under virgin forest cover and have not been affected by any adverse developmental impact on the natural environment.

Class II: Moderate Positive Impact: In the Darjeeling and Kalimpong subdivisions, this Class II zone of moderate positive impact can be observed mostly bordering the Class I zone in a narrow belt in the north western and eastern sections of the study area. This zone is much more pronounced in the southern sections, especially along the foothills flanking the Terai and Dooars areas. In Kurseong subdivision, this zone is very prominent in the central part, along the Mahananda river, Rangtong khola, Manjha jhora and Marma catchments and along the riverine tract of the lower Balason river – extending chiefly through Pubong, arching further east and culmination just above Kalej valley. Towards the south, a wedge like protuberance extends eastwards winding in and around Panighatta. These tracts are still under natural forest cover of different species. A distinct and notable positive impact of silviculture activities can also be observed.

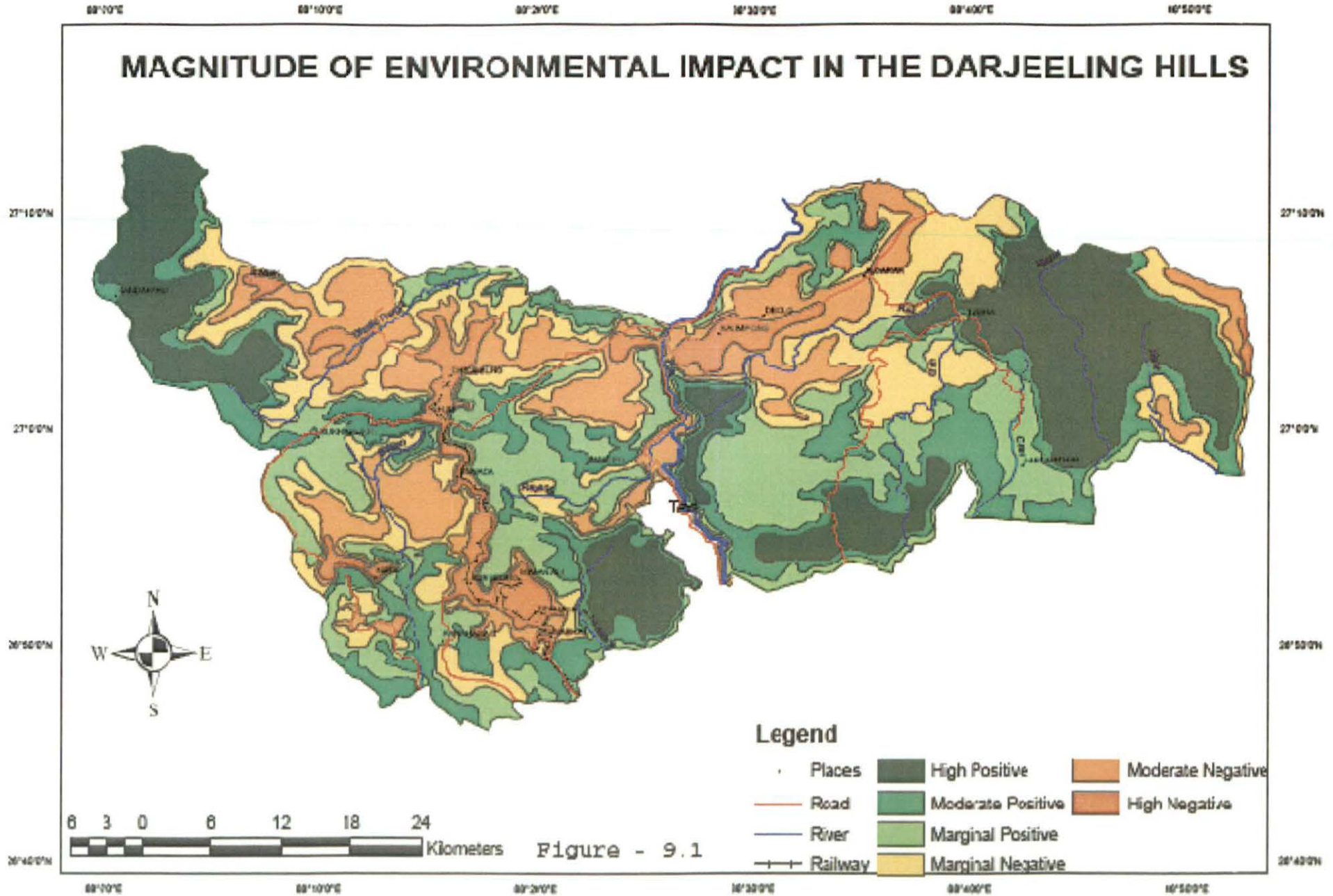
MAGNITUDE OF ENVIRONMENTAL IMPACT IN THE DARJEELING HILLS
N
W
E
S
Legend
Places
Road
River
Railway
High Positive
Moderate Positive
Marginal Positive
Marginal Negative
Moderate Negative
High Negative
6 3 0 6 12 18 24
Kilometers

Figure - 9.1

Class III: Marginal Positive Impact: predominates along the Mahaldiram range, the Latpanchar cinchona areas in Kurseong subdivision and in the southern and eastern sections of Gorubathan in Kalimpong subdivision. In the Darjeeling subdivision, this zone extends from Tumsong in Kalej Valley to Sonada and Dilaram, and proceeds as an elongated narrow wedge along the Mungpoo and the Nagri Farm environs. The field survey showed these tracts to be mostly under dense vegetative cover of exotic species like *Cryptomeria japonica*, cinchona and *Tectona grandis* etc. The hill and Dooars regions are also dominated by tea plantations, although the large scale plantations show evidence of detrimental effects on biodiversity, these plantations have also shown a beneficial impact on landscape and soil water management since they play a significant role in checking soil erosion and in recharging ground water aquifers. Consequently a marginal degree of positive impact is attained.

Class IV: Marginal Negative Impact: covers a large area in the northeastern section of Kalimpong subdivision in and around Algarah and Relli khola. In Darjeeling subdivision, this zone can be traced in a narrow zone south of Jorebunglow and Simana area as it proceeds into the Kurseong subdivision from Mirik through Ambootia and then to Singbulli, Makaibari and Selim Hill. The Khaprail region also exhibits a low negative impact. The catchment areas of Rohini khola, Rakti khola and Rangbang khola also exhibit a low negative impact. In this zone, large scale deforestation for the growth of human settlements and widespread arable farming along with the introduction of tea gardens have destroyed the regional biodiversity, thereby exerting a negative impact on the environment.

Class V: Moderate Negative Impact: can be found spread across the study area. In the northern sections this zone extends from Lodhama in the northwest to Dooteriah, Cedar, Seeyok and Margaret's Hope tea gardens in Kurseong. This zone is significant especially in the Mechi-Mahananda interfluve section. A narrow strip extends from the north of Thurbo eastwards into Marma tea garden. The southern section is prominent in the Simulbari-Longview areas, which are mostly tea gardens.

In this zone, it is apparent that in the northern hilly areas, large-scale deforestation of forests in the steep slopes has induced many unfortunate environmental repercussions like landslides and soil erosion. In the plains, the presence of neglected tea gardens and dense

human settlements, with associated detrimental human activities like rock quarrying and road blasting, unscientific arable farming have had a negative impact on this region.

Class VI: High Negative Impact: The most prominent zone of high negative impact has been identified along the Hill Cart road, NH 55 starting from Siliguri, through Rangtong, Chunabhati, Tindharia, Paglajhora, Kurseong, Sonada, Ghum and culminating in the town of Darjeeling. A second prominent zone can be encountered in and around the town of Kalimpong. Smaller pockets can also be identified around Mirik, Soureni Phuguri area as well as the Bijanbari-Pulbazar areas in the north and Pankhabari, Malatar and Lizzipur areas in the south. This zone is characterized by the highest degree of deforestation, excessive human settlements and built up areas. Consequently, haphazard constructions, inadequate drainage, random road cutting and blasting coupled with unsystematic and unscientific landuse have established a vicious cycle of degradation leading to a high to a very high negative impact of 'developmental activities' on the environment

9.4 The Impact Significance

The spatial distribution of environmental impact significance has been identified based on the check list (table 9.1). Semi quantitative rating value has been obtained from forty sites chosen and plotted on the map. The impact significance map has been prepared based on interpolation method (figure 9.2). It has been found that the impact significance varies from very high (8) to insignificant (1). The following impact significant classes have been identified:

Class I: Highly Significant Environmental Impact: has been identified chiefly along the NH and Hill Cart Road, in an elongated tract from Chunabhati - Rongtong, through Kurseong, Sonada, Ghum to Darjeeling a narrow belt along NH 55, flanking the Tista river widens into a prominent zone around the town of Kalimpong. Smaller zones can be seen along Dilaram-Jorebunglow-Rangli Rangliot area as well as to the southwest in and around the Mirik – Tingling – Phuguri – Thurbo - Soureni and Singbulli area. The Nagari Farm, Ambootia, Makaibari, Selim Hill regions also fall under this zone. These areas have experienced the most devastating impact of developmental activities o n the environment. Ever increasing population growth, unplanned developmental activities and the maximum concentration and growth of destinations of mass tourism in thee regions are responsible for such a high significance of environmental impact.

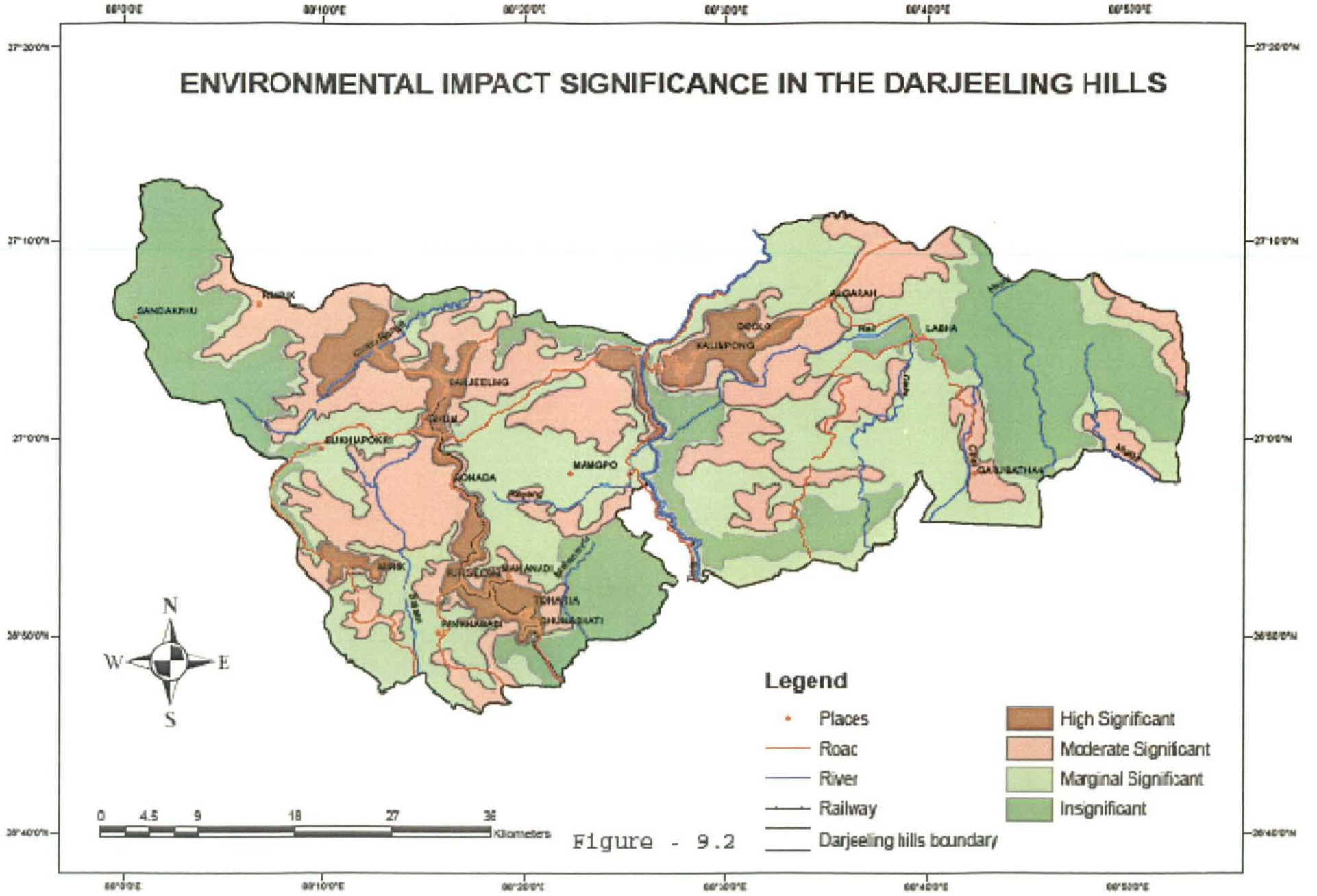
ENVIRONMENTAL IMPACT SIGNIFICANCE IN THE DARJEELING HILLS
GANGAKHU
DARJEELING
SUKHIAPOKHRI
MANGPO
KALIMPONG
LABHA
GARUBATHAN
N
W
E
S
0 4.5 9 18 27 36
Kilometers
Legend
Places
Road
River
Railway
Darjeeling hills boundary
High Significant
Moderate Significant
Marginal Significant
Insignificant

Figure - 9.2

Class II: Moderately Significant Environmental Impact: is the most widely spread zoned and has been identified in most of the tea garden dominated areas. Large-scale deforestation along hill slopes to set up tea plantations has exerted tremendous stress on the biodiversity of the region and played havoc with the delicate hill ecosystem. The rampant and indiscriminate use of fertilizers, pesticides and herbicides to augment tea production also has had detrimental effects on the quality of land, water and atmospheres of the area. Innumerable unprotected roads, footpaths and trails both for the use of locals as well as infrastructure – built up for opening up destinations of rural and tea tourism cause heavy loss of surface soil and often invite landslides.

Class III: Marginally Significant Environmental Impact: is evident in the degraded forest areas and in plantation tracts throughout the study area. It is apparent that in this zone, the reduction of biodiversity coupled with marginal development activities such as minor roads, trails and setting up of rural tourism destinations like Relli, Rishap, Bara Mangwa etc have exerted an adverse impact. However, the natural regeneration of the forest habitats has to a certain extent checked the negative impacts.

Class IV: Insignificant Environmental Impact: has been observed prominently in the north western part of the study area around Singalila Wild Life Sanctuary, the Neora Wild Life Sanctuary in the east, the Baikunthapur-Sukna forest areas of Mahananda Wild Life Sanctuary and in a narrow elongated zone of the left bank of Teesta River and in the extreme north a small zone flanking the right bank of Ramman river. Field observations revealed that these areas are still free from any significant development and/or modification impact and are largely covered by dense natural forests. An overview of the matrix suggests high interactions between the components under modification of regime with those of flora, fauna and landuse. The modification of regime brought about by the introduction of tea species and associated management practices along with the impact of tourism that has certain negative impacts on the environmental components, particularly flora and fauna is quite significant.

The development activity having high interaction is land transformation and construction, which has influenced geo hazards like soil erosion and landslides with high magnitude – the impact of which is very significant. This has been clearly revealed in case of landslide caused by construction of roads and other infrastructure.

9.5. Conclusion

Environmental impact assessment is an assessment of the possible positive or negative impact that a proposed project may have on the environment, together consisting of the environmental, social and economic aspects. The purpose of the assessment is to ensure that decision makers consider the ensuing environmental impacts when deciding whether to proceed with a project. The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made." EIAs are unique in that they do not require adherence to a predetermined environmental outcome, but rather they require decision makers to account for environmental values in their decisions and to justify those decisions in light of detailed studies and public comments on the potential environmental impacts.

EIAs began to be used in the 1960s as part of a rational decision making process. It involved a technical evaluation that would lead to objective decision making. EIA was made legislation in the US in the National Environmental Policy Act (NEPA) 1969. It has since evolved as it has been used increasingly in many countries around the world. As per Jay *et al.*(2006), EIA as it is practiced today, is being used as a decision aiding tool rather than decision making tool. There is growing dissent on the use of EIA as its influence on development decisions is limited and there is a view it is falling short of its full potential. There is a need for stronger foundation of EIA practice through training for practitioners, guidance on EIA practice and continuing research.

The EIA experience in India indicates that the lack of timely availability of reliable and authentic environmental data has been a major bottle neck in achieving the full benefits of it. The environment being a multi-disciplinary subject, a multitude of agencies is involved in collection of environmental data. However, there is no single organization in India which tracks the data available amongst these agencies and makes it available in one place, in a form and manner required by practitioners in the field of environmental impact assessment

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Table 9.1 Environmental Impact Identification

		I. Modification of Regime								
		Exotic Fauna/Flora Introduction	*Modification of Habitat*	*Alteration of Ground*	*Alteration of Ground water Hydrology*	*Alteration of Drainage*	*Irrigation*	*Weathering Modification*	*Burning*	*Surface of Paving*
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**
A	***1. Earth***									
	Mineral Res									
	Soils	-3/4	-3/4	-2/3		-2/3		-1/1	-3/4	-3/3
	Landform								-2/3	-3/4
	2. Water									
	Surface	-3/3	-2/3					-3/4	-2/3	-3/4
	Groundwater	-3/3	-2/3	-2/3	-2/3			-3/3	-1/2	-2/3
	Quality							-3/4	-1/2	
	Recharge									
	3. Atmosphere									
	Quality								-1/1	-3/4
	Rainfall									
	Temperature									
	4. Process									
B	Flood				-3/3					
	Erosion				-2/2					
	Deposition			-2/2	-2/2					
	Compaction									
	Stability									
	Earthquakes									
	1. Flora									
	Trees	-3/3	-3/3	-3/3						
	Shrubs	-3/3	-3/3	-3/3						
	Grass	-4/5	-3/3	-4/4						
	Crops									
	Micro-flora	-2/2	-2/2	-2/2						
	Aquatic									
	Rare Species	-3/2	-3/2	-3/2						
	2. Fauna									
	Birds	-2/2	-2/2	-2/2						
	Mammals	-3/3	-3/3	-3/3					-3/3	
	Fish				-2/2					
	Insects	-3/3	-3/3	-3/3					-3/3	
	Micro-fauna	-3/3	-3/3	-3/3					-3/3	
	Rare Species	-2/2	-2/2	-2/2					-2/2	

		I. Modification of Regime								
		Exotic Fauna/Flora Introduction	*Modification of Habitat*	*Alteration of Ground*	*Alteration of Ground water Hydrology*	*Alteration of Drainage*	*Irrigation*	*Weathering Modification*	*Burning*	*Surface of Paving*
		a	b	c	d	e	f	g	h	i
C	***1. Land use***									
	Open Space	-2/3	-3/3	-3/3						
	Wet Lands		-2/2	-2/2	-3/3	-2/2				
	Forestry	-4/5	-3/3	-3/3						
	Agriculture	-3/3								
	Grazing	-3/3	-3/3	-3/3						
	Residential									
	Commercial									
	Mining									
	Quarrying									
	2. Recreation									
	Camping	2/2								
	Picnicking	2/2								
	3. Aesthetic									
	Scenery	3/3								
	Wilderness									
	Landscape									
	Reserves	-3/3	-3/3	-3/3						
	4. Cultural									
	Statue									
	Health									
	Employment	4/4								
	Population									
	Density	5/5								
	5. Man made									
	Structures									
	Transport									
	Utility									
	Wastes									
D	***1.Diseases***									
	Food chain	-2/2	-3/3	-2/2					-3/3	
	Others									

A: Physical and Chemical Conditions; B: Biological Conditions; C: Cultural Conditions: D: Biological Relations

Table 9.1 Environmental Impact Identification ..... Cont.

		II. Land Transformation and Construction								
		Urbanization	*Industrial Sites and Buildings*	*Highways, Bridges, Roads and Rails*	*Transmission and Pipelines*	*Barriers including Fencing*	*Channel Revetments*	*Recreational Structures*	*Blasting and Drilling*	*Cut and Fill*
		a	b	c	d	e	f	g	h	i
A	***1. Earth***									
	Mineral Res	-1/2								
	Soils	-1/2		-1/2	-1/1		1/2	-2/1	-5/6	-2/3
	Landform							-1/1	-5/3	-3/3
	2. Water									
	Surface									
	Groundwater									-3/3
	Quality									
	Recharge									
	3. Atmosphere									
	Quality	-1/1								
	Rainfall									
	Temperature									
	4. Natural Processes									
B	Flood			-4/4			2/2			
	Erosion			-5/4			2/2			-3/3
	Deposition		-2/2	-3/3			1/2			-2/2
	Compaction	-3/3	-2/2	-2/1						
	Stability	-3/3		-5/4			1/1		-3/2	-3/2
	Earthquakes			-1/1						
	1. Flora									
	Trees	-3/3	-1/1	-2/2						
	Shrubs	-3/3	-1/1	-2/2						
	Grass	-2/3	-1/1	-2/2						
	Crops									
	Micro-flora									
	Aquatic									
	Rare Species	-1/1								
	2. Fauna									
	Birds	-3/4								
	Mammals	-4/4	-2/2							
	Fish									
	Insects									
	Micro-fauna									
	Rare Species	-2/2	-1/1	-3/3						

		II. Land Transformation and Construction								
		Urbanization	*Industrial Sites and Buildings*	*Highways, Bridges, Roads and Rails*	*Transmission and Pipelines*	*Barriers including Fencing*	*Channel Revetments*	*Recreational Structures*	*Blasting and Drilling*	*Cut and Fill*
		a	b	c	d	e	f	g	h	i
C	***1. Land use***									
	Open Space	-2/3	-1/1	-3/3						
	Wet Lands	-2/2	-1/1	-2/2	-1/1					-2/3
	Forestry	-3/4	-1/1	-3/3				-1/1		
	Agriculture	-3/3	-1/1							
	Grazing	-3/3	-1/1	-3/3		1/1				
	Residential									
	Commercial									
	Mining									
	Quarrying									
	2. Recreation									
	Camping									
	Picnicking							4/4		
	3. Aesthetic									
	Scenery	-4/4	-1/1	-2/2						
	Wilderness									
	Landscape									
	Reserves	-3/3	-1/1	-4/5	-1/1			-1/1		
	4. Cultural Status									
	Health									
	Employment	4/5	3/3	4/4						
	Population	6/6	2/2	3/3						
	5. Man made									
	Structures									
	Transport									
	Utility				4/4					
	Wastes		-5/5	-2/2						
D	***1. Diseases***									
	Food chain	-2/2	-3/3	-1/1	-2/2					
	Others		-3/3							

Table 9.1 Environmental Impact Identification ..... Cont.

		II. IExternal		IV. Processing			V. Alteration		VI. Renewal		
		Surface Excavation	*Clear Felling and Lumbering*	*Farming*	*Hunting and Grazing*	*Lumbering*	*Erosion Control/ Terracing*	*Landscaping*	*Reforestation. Wildlife, Stocking and*	*Fertilizer Application*	*Waste Disposal*
		a	b	a	b	c	a	b	a	b	c
A	***1. Earth***										
	Mineral Res										
	Soils	-5/6	-1/2	-4/5	-1/2	-4/5	3/3	-1/1	4/5	-3/4	-3/3
	Landform	-5/3	-2/3				-5/6	-1/2			
	2. Water										
	Surface	-3/3	-4/5	-2/2		-3/3	-3/3	-1/1	4/5		
	Groundwater		-2/3	-2/3		-3/3			5/5		
	Quality			-2/2					2/3	-2/2	-2/2
	Recharge		-4/4						3/3		
	3. Atmosphere										
	Quality										
	Rainfall										
	Temperature										
	4. Natural Processes										
B	Flood		-4/4			-4/4					
	Erosion		-5/5			-3/4	4/4				
	Deposition		-3/3								
	Compaction										
	Stability		-4/4	-4/4	-1/1	-3/3	5/5				
	Earthquakes										
	1. Flora										
	Trees		-3/3			-4/4			4/4		
	Shrubs		-3/3			-3/4			4/4		
	Grass		-2/2			-2/2			-4/4		
	Crops										
	Micro-flora								2/2		
	Aquatic										
	Rare Species		-2/2						3/3		
	2. Fauna										
	Birds		-4/4		-3/3						
	Mammals		-4/4		-3/4						
	Fish										
	Insects		-3/3						3/3		
	Micro-fauna		-2/2						3/3		
	Rare Species		-2/2		-4/4				3/3		

		III. External		**IV.** Processing			V. Alteration		VI. Renewal		
		Surface Excavation	***Clear Felling and Lumbering***	***Farming***	***Hunting and Grazing***	***Lumbering***	***Erosion Control/ Terracing***	***Landscaping***	***Reforestation. Wildlife, Stocking and Management***	***Fertilizer Application***	***Waste Disposal***
		a	**b**	**a**	**b**	**c**	**a**	**b**	**a**	**b**	**c**
C	***1. Land use***										
	Open Space			-2/2							
	Wet Lands		-3/3		-4/4	-3/3	3/3		2/2		
	Forestry		-4/4	-1/1			4/4		6/6		
	Agriculture		-3/3	1/1					4/4		
	Grazing								-3/3		
	Residential										
	Commercial										
	Mining										
	Quarrying										
	2. Recreation										
	Camping								3/3		
	Picnicking								3/3		
	3. Aesthetic										
	Scenery										
	Wilderness										
	Landscape										
	Reserves		-4/4				3/3		5/5		
	4. Cultural Status										
	Health										
	Employment			4/4		3/3					
	Population			3/3							
	5. Man made										
	Structures										
	Transport										
	Utility										
	Wastes										
D	***1. Diseases***										
	Food chain				-3/3					-4/4	
	Others										

Table 9.1 Environmental Impact Identification ..... Cont.

		VII. Traffic			VIII. Waste Disposal						IXChemical	
		Railway. Automobile and Trucking	*Trails*	*Communication*	*Pipeline*	*Emplacement of Spoils*	*Municipal Waste and Junk disposal*	*Septic Tank*	*Smoke and Exhaust Emission*	*Spent Lubricants*	*Fertilizer*	*Weed and Insect Control*
		a	b	c	a	b	c	d	e	f	a	b
A	***1. Earth***											
	Mineral Res											
	Soils	-2/2	-3/2	-4/5	-1/1	-3/4	-2/3	-2/2	-1/1	-1/1	-2/3	-3/4
	Landform					-1/1						
	2. Water											
	Surface		-1/2	-4/4		-4/4	-4/4					
	Groundwater											
	Quality					-1/2	-4/4	-3/3		-2/3	-3/3	-4/5
	Recharge											
	3. Atmosphere											
	Quality	-4/5										
	Rainfall											
	Temperature											
	4. Process											
B	Flood					-1/1						
	Erosion					-4/5						
	Deposition					-4/4						
	Compaction											
	Stability					-3/3						
	Earthquakes											
	1. Flora											
	Trees											
	Shrubs											
	Grass											
	Crops											
	Micro-flora											-3/3
	Aquatic											
	Rare Species											-2/2
	2. Fauna											
	Birds											
	Mammals											
	Fish											
	Insects											-4/4
	Micro-fauna											-4/4
	Rare Species											-3/3

		VII. Traffic			VIII. Waste Disposal						IXChemical	
		Railway. Automobile and Trucking	*Trails*	*Communication*	*Pipeline*	*Emplacement of Spoils /Overburden*	*Municipal Waste and Junk disposal*	*Septic Tank*	*Smoke and Exhaust Emission*	*Spent Lubricants*	*Fertilizer*	*Weed and Insect Control*
		a	**b**	**c**	**a**	**b**	**c**	**d**	**e**	**f**	**a**	**b**
C	***1. Land use***											
	Open Space											
	Wet Lands											
	Forestry											
	Agriculture					-3/3						
	Grazing											
	Residential											
	Commercial											
	Mining											
	Quarrying											
	2. Recreation											
	Camping		3/3									
	Picnicking		3/3									
	3. Aesthetic											
	Scenery											
	Wilderness											
	Landscape											
	Reserves											
	4. Cultural Status											
	Health										-4/4	-3/3
	Employment		5/5									
	Population											
	5. Man made											
	Structures											
	Transport											
	Utility											
	Wastes											
D	***1. Diseases***											
	Food chain											-3/3
	Others						-3/3	-3/3	-2/2			-4/4

CHAPTER 10

Summary and conclusions

The Darjeeling hill situated in the northern part of Darjeeling district in the state of West Bengal has its own peculiar historical background. Cool bracing climate of Darjeeling allured the British officials to acquire this land from the Raja of Sikkim in 1835, and made it a safe home including sanatorium for the British civil servants. With the introduction of tea plantation several ethnic races like Lepchas, Bhutias and Nepalese settled as migrant from the nearby hilly areas as worker. Life was quite hard to begin with in this newly opened hill station where these three different ethnic groups had to live together. They had to begin a fresh lease of life under an alien rules and regulations. They were forced to live a kind of life different from what they were leading before.

The environmental degradation in the Darjeeling hills has been demonstrated significantly in terms of contemporary deforestation, soil erosion and landslides leading to the drying up of water sources, flash floods and decline in yields of food and cash crops, fodder, fuel and other minor forest produces. Poverty in the hills in directly related to shortages of resources for basic subsistence particularly in area under the traditional land and water management system and the carrying capacity of land to support the population has already been exceeded.

In the study area human and livestock pressure along with indiscriminate felling of trees for commercial purpose have already led to loss of soil and rapid depletion and destruction of forest cover. Beside, water retention capacity and productivity of land have been adversely affected. These factors have impaired the ecology significantly and also resulted in deterioration in the economic condition for the hill people. Traditional agriculture practices, specially shifting cultivation have also contributed to destruction of forest and soil erosion. Seemingly harmless activity as prolonged grazing by livestock, especially goats and sheep has further exposed many hill areas to serious ecological degradation. Development activities like construction of building, roads, dams, large and medium industries and mining etc. have aggravated environmental problems. Consequently, perennial sources of water like springs and shall streams have dried up in many areas.

The major challenge, therefore, is to devise suitable location specific solution, so as to reverse the process and ensure sustainable development of the growing population and environment of the hill areas. In addition, frequently occurred landslides, edaphic drought, floods, decline in the forest cover, decline in agriculture yield, soil loss, loss of biodiversity etc. have to be addressed in proper perspective to ensure further deterioration of natural resources base in the hill areas. Using dynamite and other explosives for blasting of the rocks for the construction of hydroelectric projects, roads and other infrastructure facilities have had adverse effects on the regional geo-environmental set-up of the Darjeeling hills. The prevailing mining and quarry operators have been destroying vegetative cover and also disturbing delicate hill-slope hydro-geomorphic processes. Construction of tourism infrastructures including tourist sheds, lodges, roads etc. even in potential vulnerable areas during the DGHC period have caused irreparable damage to the environment and responsible for destruction of land resource and biodiversity.

Agriculture is one of the main occupations in rural Darjeeling hills, but it does not give quick and sizeable return like tourism. During tourist season, tourism has become the main source of income as a result, agricultural system has neglected. Prime arable land is being converted for tourism infrastructure facilities. Such activities create dependence system in addition to adverse impact on economy, society and environment. The farmers who are living in the vicinity of these tourist resorts leave their traditional farming and livestock rearing occupation and are carrying out different types of business for prompt and easy economic benefits. In many such developing tourist places tourism has almost overlapped agriculture i.e., Lolegaon, Mirik, Lava, Kaffer, Rishap etc.

The Darjeeling hill area provides a variety of natural resources which have been threatened largely by human negligence and activities. In order to improve and regenerate degraded Darjeeling hill environment, scientific approach involving hazard zone mapping and banning of engineered development activities in such zone, drainage management, protection of slopes through vegetation, application of technology and improved agronomic practices should be carried on priority basis.

The ecological balance can be maintained and improved in Darjeeling hills by reforestation and checking the illegal felling of trees. Law should be enacted to stop indiscriminate timber trade, installation of new cement factories, stone crushers which is turn

cause air water and noise pollution. The mining operation should be allowed only using appropriate technology and essentially after carrying out mandatory environmental impact analysis (EIA) and environmental impact management (EMP) in order to minimize the pollution of atmosphere and to avoid further degradation. Soil and land use inventories need to be taken up on priority basis. To prevent and/or reduce such degradation there should be scientific and well planned growth of tourism in which experts of different disciplines along with local stakeholders should have close involvement in planning. There magnitude of such tourism development should be done keeping in mind the carrying capacity of particulars resorts to avoid negative impact of such activities to the ecosystem.

Application of scientific inputs to agriculture and allied sectors including identification of crops suitable for the agro-climate zones, multipurpose species of trees and bushes to meet requirements of the people from a well-developed small land area is of special importance. This approach is expected to space considerable areas for permanent greening programme like social forestry or horticultural and serves the long-term objectives of enhancing production on sustainable basis. Appropriate technologies to bring about localized self sufficiency and generate alternative means of livelihood as opposed to heavy dependence on forest and livestock rearing can be encouraged.

Use of appropriate technologies to upgrade the traditional productive system like agricultural operations, livestock rearing, arts and crafts, households and cottage industries etc. needs to be encouraged on priority basis. The technologies have to be need based more productive, efficient, low cost and ecologically sustainable.

Extension services should be encouraged to enlighten and educate people on how to enhance productivity of both arable and community land on a sustainable basis in the context of increasing human and livestock pressures. Consolidation of small and scattered land holding would help in improving water and land management and ultimately, productivity of the limited land resource of the hills.

In many hill areas of Darjeeling district land resource are held as common or community property. In such areas people do not make permanent investment and several other problems also originate from this. To overcome those, local communities have to

evolve suitable models of land management that would invite permanent investment and ensure both optimal returns at sustainable manner.

The government agencies may take a fresh look at their plan and non-plan schemes under the backdrop of forest policies, land tenure system, land and water use policies and religious customs to eradicate practices destructive to the environment.

In order to reduce pressure on land, quality of livestock including goats, sheep, pigs and poultry birds has to be improved and their numbers be reduced. There is an urgent need for assessing the bearing capacity of available land for livestock population. The livestock and cattle improvement programmes need to be integrated with fodder and cattle feed development. The land and livestock management system have to improve rapidly for achieving the overall livelihood security.

The productivity of pastures and grazing area needs to be restored and enhanced. The effort should be to meet the requirements of food, fuel-wood, timber and fodder through scientific utilization of scarce hill resources on sustainable basis. Development of non-conventional energy and use of non-wood based sources of energy should be encouraged.

Development of horticulture, sericulture, plantations, especially cash crops having low volume, light weight, high value and long life cycle could play an important role in generating employment opportunities, higher incomes and ecologically sound sustainable development in Darjeeling hills.

Tourism can be organized as an industry with due care taken to avoid exploitative use of scare local resources especially, water and fuel-wood. Location specific suitable code of conduct for tourist may be evolved so as to maintain the surrounding clean and disease free and to protect environment and respect to local tradition, culture and heritage.

Special care needs to be taken to ensure that hill roads are constructed as per traffic needs, scientific design and specification suited to Darjeeling hills. In such hill areas where the population density is low and the villages are small and scattered over long distances, pony tracks may be promoted instead of metal road to avoid destruction of virgin forest and rich biodiversity.

The hill people have to be made aware of the far reaching implication of environmental degradation and their active participation has to be sought for its restoration. Environmental aspects can be suitably wooden into the curriculum of primary and high school classes. The role of NGOs and civil society is also very important in propagation the knowledge and insights of different aspects of contemporary environmental degradation in the Darjeeling Himalaya. Both electronic and print media may also take-up appropriate step to transfer the insights of this peril to the common people. In the recent past some voluntary organizations have been doing commendable work in the hills which may be encouraged, especially those engaged in improving the ecological system besides economic and social condition of the people.

Regeneration and development of the Darjeeling hill environment cannot be achieved without the pro-active and all out co-operation of the people. It will be forthcoming, only if the benefits from improved land, water and forest resources reach directly and equitably to the people themselves.

The Darjeeling hill areas is prone to tectonic and seismic activities, need to be identified under the light of activities like construction of heavy structures, multi-storied buildings, hydroelectric projects and creation of artificial large water bodies. Large projects might endanger the ecological balance and displace large number of people thus need to be very carefully considered before investment decisions are taken. The EIA and EMP must not be done in casual manner what it was done in most cases in the past.

Some corrective steps may be taken-up immediately in order to arrest further environmental degradation in the Darjeeling hills are recommended:

1. Effective population control and distribution planning, however, difficult in the light of present realities it may be implemented in order to relieve pressure in vulnerable and fragile areas around big settlement centers.

2. Natural forces that are at work in Darjeeling hills though cannot be stopped but there are marginal possibility of reducing the run off volume and velocity of the streams through afforestation, bio-engineering measures and man-made structures like check

dams, retention basins and designed drainage way. Thus arresting of land degradation by soil loss and landslide would be possible.

3. Alternative employment through value addition services, emphasis on high value produce including crops, horticulture, floriculture and orchid culture may reduce the growing demand for more land controlled occupations.

4. Development of fuel forestry, non-conventional energy, eco-friendly tourism industry and small scale or cottage based industries should be promoted.

5. Appropriate land use planning, creation of aesthetic biomes and national parks, trekking area, biodiversity core as a repository of natural resources, restrict demographic and technological threats in the fragile catchments area at the cost of deforestation. Exploration of conservation oriented development techniques and spread of environmental awareness are absolutely needed.

6. Implementation of pilot projects with integrated approach may be experimented at micro-level and their results should be monitored for exploration of future projects in such other areas.

7. It may also be recommended that research and development on to the functioning and dynamics of the hill ecosystem should be initiated for an everlasting and sound environment management in the hill areas of Darjeeling district.

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