BALASON WATERSHED: ITS MANAGEMENT AND DEVELOPMENT

THESIS SUBMITTED TO THE
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By
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TO WHOM IT MAY CONCERN

I am pleased to certify that Sm. Somali Paul is known to me for the last six years and she worked under me for her Ph. D. Thesis entitled **"Balason Watershed: Its Management and Development"** in the North Bengal University. She prepared the Thesis based on primary and secondary data collected from field survey and other secondary sources. Now, the Thesis is ready for submission for the degree of Ph. D. in Geography & Applied Geography in the Faculty of Science of the University. So far my knowledge goes it is an original work on this topic in this University. She is methodical and sincere in her work. She bears a good moral character.

I wish her success in her future life.

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Somali Paul.

Somali Paul

PREFACE

A watershed or basin is a manageable hydrological unit. Balason is one of the most important rivers of North Bengal. The entire watershed of river Balason includes the highest point of the area (ridge line) to the outlet of the river in the plains where it meets another main river. In this watershed, large tracts of natural forests and grasslands were cleared to establish tea gardens and settlements. Tea gained much importance due to its unique flavour but this sector did not play any major role for the overall development of the area. This drastic change in land use badly affected the Balason basin area. Large number of labour was imported from outside, who were unaware about the area. Traders, middlemen and artisans followed the labour, increasing the population of the Balason basin at a faster rate. Sunnier eastern part of the basin was occupied in no time, and the ever increasing population carried out all sorts of activities in most unplanned and unscientific way. Tea gardens and factories, being the main economic institutions exploited land to such an extent that without proper research and planning the area will face severe problems of resource utilization in near future. Problems like deforestation, overgrazing, soil erosion, landslides, drying of water sources etc. needs proper management and developmental strategies.

The work commences with the *first chapter*, which deals with physical background of the study area, including physiographic divisions, geology, drainage, climate, soil and natural vegetation.

The *second chapter* discusses about the different drainage characteristics of the basin including drainage network and drainage basin morphometric analysis.

Study of human resources in the basin i.e. the distribution of population and their growth, composition, density and occupational pattern are discussed in the *third chapter*.

The *fourth chapter* gives an idea of different types of land uses, found in the basin. Moreover it deals with land tenure systems. The major types of crops grown, the principal cropped areas and their production, also occupies some space in this chapter.

The different socio-economic functions like education, health services, communication, transport, finance, industry, power, drinking water, recreation etc, their distribution and availability are the major areas of discussion in *chapter five.*

The *sixth chapter* deals with the identification of the major problems of the basin. These problems like 1) Physical, 2) Institutional and 3) Socio-economic are discussed in details. Physical problems viz. soil erosion, landslide etc, their causes and impact are discussed. Institutional problems highlight the problems related to land tenure systems. Socio-economic problems have dealt with problems related to socio-economic functions available in the basin.

The *seventh chapter* deals with different types of management of resources needed urgently to protect the study area from further damage. Appropriate management systems which are suitable for mitigating the problems of the basin are also dealt with.

The *eighth chapter* reviews the earlier strategies implemented in the basin and formulates the present strategies. Different types of suggestions for the future development of the Balason watershed are given in the chapter.

And finally the *tenth chapter* comprises of conclusion.

Somali Paul

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GLOSSARY

Term		Description
Amlisho	-	A perennial multipurpose grass.
Basti	-	A rural settlement.
Bathan	-	A cattle station inside a forest.
Dhupi	-	An exotic conifer.
Dhura	-	Quarters
Jhora	-	A small seasonal stream.
Khasmahal	-	Land owned by Government.
Khola	-	A stream or water course
Lahsune	-	A medium size tree of under storey.
Lepchajagat	-	The lepcha toll bar.
Maling	-	A bushy bamboo of lower storey.
Nadi	-	A stream.
Nalla	-	A ravine.
Panisaj	-	A big size tree.
Senchal	-	The damp misty hill.
Sepoydhura	-	The sepoy's lines.
Simana Basti	-	The boundary village.
Tite champ	-	A big size tree.

INTRODUCTION

Since the dawn of civilization, people needed to know about the origin, occurrence, movement, distribution and management of water. This knowledge is the science of water or hydrology. Water found on earth is collectively referred to as hydrosphere. A very large portion of water flowing on the land surface is derived as precipitation. This implies that there is an inextricable link between the geomorphic processes and the cycle of events taking place within the hydrosphere. This link between the earth and the hydrosphere is manifest in the form of hydrological cycle. The area drained by a particular river and its tributaries is known as the watershed or river basin. All the drainage basins receive input in the form of precipitation (P) and the excess input flows through the rivers and out of the basins as output, in the form of the runoff (RO). The river basin, therefore, constitutes an integral part of the hydrological cycle. Rivers occasionally show periods of high flow in response to quick and direct runoff. Often river levels and discharge rise after periods of heavy or prolonged rains. Rivers experience floods when the channel capacity of a receiving stream exceeds by runoff entering the stream and the channel flows fill the entire channel and overtop their banks. Three types of riverine floods are rainfall flood, snowmelt flood and dam failure flood.

Increase in food production can be achieved only when the soil on which all agriculture and all human life depend is conserved. Erosion of soil is part of a vicious cycle, wherein the soils impoverished by erosion, are dislocated from one place to another leading to the deposition of the soil on lands in the lower regions, in reservoirs, in river beds and harbours. This in turn leads to disastrous floods causing loss of property and life. So, management and development of watersheds are carried on to conserve in-situ soil and moisture, to promote agro-forestry and improve arable land through better crop management technologies. The deterioration of natural resources of an area can be contained and the total resources properly developed only

by adopting the watershed approach in which, the basic unit of development is a watershed, a manageable hydrological unit. In this approach, development is done on agricultural lands, the barren hill slopes and the stream beds and all the resources of the area - water, fuel, fodder, livestock, fish and the most important are the human resources, are developed into a harmonious system. This involves the exploration and development of the complex inter-relationships between the watershed resources and its living population.

STUDY AREA

The present study area i.e. the Balason Watershed or Basin falls under Darjeeling district of West Bengal state, which includes the police stations of Kurseong, Mirik, Jorebunglow and Sukhiapokhri. The study area consists of 63 villages spread over four police stations. The numbers of villages are 15 in Kurseong, 12 in Mirik, 19 in Jorebunglow and 17 in Sukhiapokhri (Appendix I). The basin is located between 26° 48' 50"N and 27° 00'27"N latitudes and 88°07'10"E and 88°18'20"E longitudes. Elevation of the Balason catchment varies from 267m (near Dudhia Bridge) to 2355m (at Ghoom Simana). Balason River flows down from north of south. Balason river rises in the Lepcha Jagat near Ghoom Simana range of Darjeeling Himalayas. It is the main river of North Bengal and meets the Mahananda river near Siliguri. Balason river basin is drained by river Balason and its tributaries namely Bhim *khola,* Rangbang *nadi,* Manjwa *jhora* and Dudhia *jhora.* The northern and eastern sides of the Balason catchment are drained by the river Teesta that is a tributary of the river Brahmaputra. The western side of the Balason catchment is drained by the Mechi river. The Balason watershed is delineated on its north side by a ridge emanating from the massive Singalila range and going almost straight to east forming the Maneybhanjang Ghoom ridge. This ridge throws smaller spurs having general direction south to southwest. From Ghoom, a complex system of ridges and spurs emanate, the longest of which is Tiger Hill-Dow Hill and marks the eastern boundary of the study area. From Dow Hill, this

ridge dips down sharply taking a turn towards southwest and looses its altitude from 2000m at Dow Hill to 1400m at Kurseong town within a distance of 4km. On the western side, a huge Nagri spur emanate from the main northern ridge, descends down sharply in the south-east direction from an altitude of 2350m at Simana on the Indo-Nepal border to 900m in the bed of the river Balason. On the south western tip of the area lies a huge colluvial deposit forming a flat terrain. The entire southern most width of this flattish part of the territory has been affected by notorious Ambootia landslide. In the study area, the valley slopes are more flat and open towards the top but attain a steeper gorge like character near the beds of the streams. The study area has spurs, ridges and ranges cut by rills, streams and rivers. General slope of the land is from north to south because the main river flows almost parallel to the 88°15'E longitude. The highest slope (35°) is found on the western side of the basin along the valley of Rinchingtong *khola.* The lowest slope value of below 10° is found in the southern part of the basin. Relative relief is highest in Phulungdung basin and Rinchingtong basin being 700m. The Balason watershed consists of nine micro watersheds. These micro watersheds are the basins of ten tributaries of Balason river. These rivers are Dhudia *jhora,* Manjwa *jhora,* Marina *nadi,* Rangbang *khola,* Phulungdung *khola,* Bhim *khola,* Rangmuk *nadi,* Pachhim *khola* and Rinchingtong *khola.*

Temperature and rainfall within the Balason basin varies from place to place and from time to time. The Terai zone falls under sub-tropical climatic zone whereas the hills fall under temperate climatic zone. The yearly temperature at the Singel Tea Garden, which is situated near Kurseong, average temperature is about 18°C. The mean monthly temperature in January is 11°C and in July 21.6°C. Annual average precipitation is 310.87cm to 390.05cm respectively. Hailstorm is a common phenomenon in Darjeeling hills. Tea and agricultural crops worth several lakhs are destroyed practically every year. Period of occurrence of hailstorm does not have any clear trend. The geological formation of Darjeeling district consists of unaltered sedimentary rocks

confined to the hills on the south and different grades of metamorphic rocks over the rest of the area. The soil in the Terai is composed of alluvium, a light sandy loam being the most common. There are also tracts of sandy or gravely soils unsuitable for cultivation. In general, three types of soil are recognized in hills i.e. black, red and white. The black soil is richest of all while the white ones are the poorest. Red soils occupy intermediate position as far fertility is concerned. Darjeeling hills are rich in vegetation, which may be attributed to physiographic, climatic, edaphic and biotic factors. About 4000 species of lowering plants under 160 families have been estimated by plant scientists. There are 300 ferns; of these 8 species are tree ferns. There are also non-flowering plants like moss, algae, fungi, lichens etc. The important trees are *Acacia catechu, Shorea robusta (Sal), Schima wallichii, Quereus lamellosa, Castanopsis indica, Cryptomeria japonica* etc. Different studies indicate decline in forest areas in the study area during the last 80 years. Physiography of the area is such that agricultural operations are extremely difficult. However, maize, potato, vegetables, millets, soyabean, cardamom, ginger and pulses are being grown in comparatively very small areas. An appreciable increase in agricultural land has been indicated by several studies. Crops are grown on terraces and in valleys of rivers and *jhoras*. Tea gardens occupy appreciable area in Darjeeling district. Balason catchment contains tea gardens well distributed within the area. Phuguri, Marma, Singbulli tea gardens are located on the ridge of Mirik hills or its slopes. A spur emanating from Sukhiapokhri contains 11 tea gardens and rest is located on either Dow hill slopes or spurs emanating from it. Total population of the study area according to 2001 Census Report is 135615 and the total area is 299 km^2. So, population density is 452 persons/ km^2. Population density is low because most of the hill slopes are occupied by tea gardens and thus has fewer settlements.

PURPOSE OF STUDY

The deterioration of natural resources in an area can be contained and the total resource properly developed only by adopting proper management of the watershed. The basic unit of development is a watershed, which is a manageable hydrological unit. In this approach, development is not confined just to agricultural lands alone, but covers the area, starting from the highest point of the area (ridge line) to the outlet of the *nala* or the natural stream. This involves implementation of ameliorative measures on barren hill slopes, marginal, privately owned agricultural lands and badly cut *nala* and river courses. In terms of resource development, it starts from the most important one, that is, water and then extends to the resources of fuel, fodder, livestock and all associate components.

The Balason watershed selected for study draws its importance for the reasons as follows:

i. Weak geological formations in the study area, necessitates a sound combination of engineering and biological measures for soil and water conservation. Traditional soil and water conservation practices are inadequate.
ii. High concentration of rainfall in monsoon months makes the *jhoras* disastrous. They often erode their banks. Landslides occur, if they are not trained properly.
iii. The catchments for supply of water to the entire region are located in the study area. The yield of streams has gone down severely due to deforestation. Overgrazing, forest fires and compaction of ground also impede the infiltration of water into the soil. The study area has chronic shortage of water during dry rain less months. Investigation is necessary in this matter.
iv. Unchecked surface run off leads to soil erosion in the basin which reduces the water holding capacity of the rivers leading to floods.
v. The basin has high concentration of human and cattle population. The demand of fuel by this population had put

limited forest resources under severe strain. Forests owned by Government and tea gardens are degrading fast. Preventive measures are needed immediately.

vi. Most of the Government forest, tea gardens, waste scrub forests and abandoned agricultural lands are being grazed far beyond their carrying capacity. Scrub and sterile cattle are plenty. They are trampling the soil compact. The problem needs immediate attention and investigation.

vii. Agriculture is poorly developed on unscientifically made terraces. Proper channels for safe disposal of excess water are rarely provided. Strip cropping is not practiced.

OBJECTIVES OF STUDY

The main objectives are:

i. To study the physical background of the Balason basin.

ii. To study the different land forms and morphometric analysis of the basin.

iii. To assess the population and the demographic characteristics of the basin.

iv. To study the general land use pattern and their changes during two time periods.

v. To study the distribution of socio-economic functions and their availability.

vi. To identify different problems and their effect on the development.

vii. To discuss conservation and management of resources in the basin.

viii. To formulate strategies for the development of natural and other resources and their management.

METHODOLOGY

Physical aspects of the basin were studied from Survey of India topographical sheets 78B/1 and 78B/5 with scale 1:50,000. A base

map was prepared showing the river Balason and all its tributaries. Morphometric analysis is done by using rotameter. Climate data were collected from Singel Tea Garden and Environmental Research Station, Sukna. Data regarding soil were collected from Soil Conservation Office at Kurseong, Darjeeling. Forest cover and forest resource data were also collected from the Divisional Forest Office, Kurseong. Agricultural offices at Pankhabari Road and Kurseong, provided agricultural data. Population data were collected from Census Report Directory of the Darjeeling District, Government of India. Village wise sample study of socio-economic functions of population was done by preparing questionnaires. Primary and secondary data were collected from field study. Information and literature were collected from the different journals, books and other manuals and libraries.

HYPOTHESIS

The entire Balason basin is divided into nine watershed regions. Land use, soil types, soil erosion, population, environment, transport and communication, trade and commerce are poor with respect to each of the micro watershed of the Balason basin. Land use like forestry, agriculture, and quarrying lead to soil erosion. Soil types are different in composition and soil preservation measures were not implemented properly. Increase in population and livestock exert pressure on land and deforestation lead to environmental degradation. Inadequate irrigation facilities turned agricultural lands into wastelands. Basic amenities like education, medical facilities, drinking water, telecommunication facilities, market and communication are inadequate and the socio-economic standard of the population, can not lead to an overall development of the basin. Deforestation is causing severe soil erosion and landslides. The area is backward due to various other constraints.

LIMITATIONS

The villages included in the basin are on the basis of area covered by them in the study area. If more than 50% area of villages falls in the basin, then they have been taken into consideration, for getting data and information. While doing the research work, it was not be possible to survey all the villages and all the households in the study area, which is vast and major part is remote in communication. Even then, I tried to do justice to my work by sample survey in every part of the study area as far as possible. I tried to collect data in as many aspects as possible, which involves interaction between physical and socio-economic activities of life.

DESIGN OF THE THESIS

CHAPTER I

PHYSICAL BACKGROUND OF THE BALASON WATERSHED

INTRODUCTION

The study area i.e. the Balason river basin, which includes the parts of the police stations of Kurseong, Mirik, Jorebunglow and Sukhiapokhri lies in the Darjeeling district of West Bengal. The basin is located between 26°48'50"N and 27°00'27"N latitudes and 88°07'10"E and 88°18'20"E longitudes. The basin is bordered in the north by the police stations of Pulbazar, Darjeeling, in the east lies by police stations of Jorebunglow and Kurseong along the length of the Hill Cart Road. The southern portion of the basin is bordered by the police stations of Naxalbari and Matigara.The western side of the Balason river basin coincides with the international boundary between India and Nepal. The study area covers an area of 229km^2. (Fig.1.1)

1.1 PHYSICAL BACKGROUND

The study area consists of a portion of the outlying hills of the lower Himalayas and a stretch of territory lying along their base known as the Terai. The hills rise abruptly from the Dudhia and Balason confluence (300m) and the elevation increases northwards and near Ghoom Simana Basti, the elevation is 2350m.Between these two heights, there is mosaic of micro topographic units. The complex physical environment in the region is due to different geomorphic processes, each of which has developed its own characteristic assemblage of landforms.

The physical configuration of the region is partly due to the direction of the main drainage, which is southerly and mainly due to geologic structure, which is the dominant controlling factor in evolution of landforms. The northern portion of the basin consists of hard gneissic rocks capable of resisting denudation to a considerable extent,

LOCATION MAP

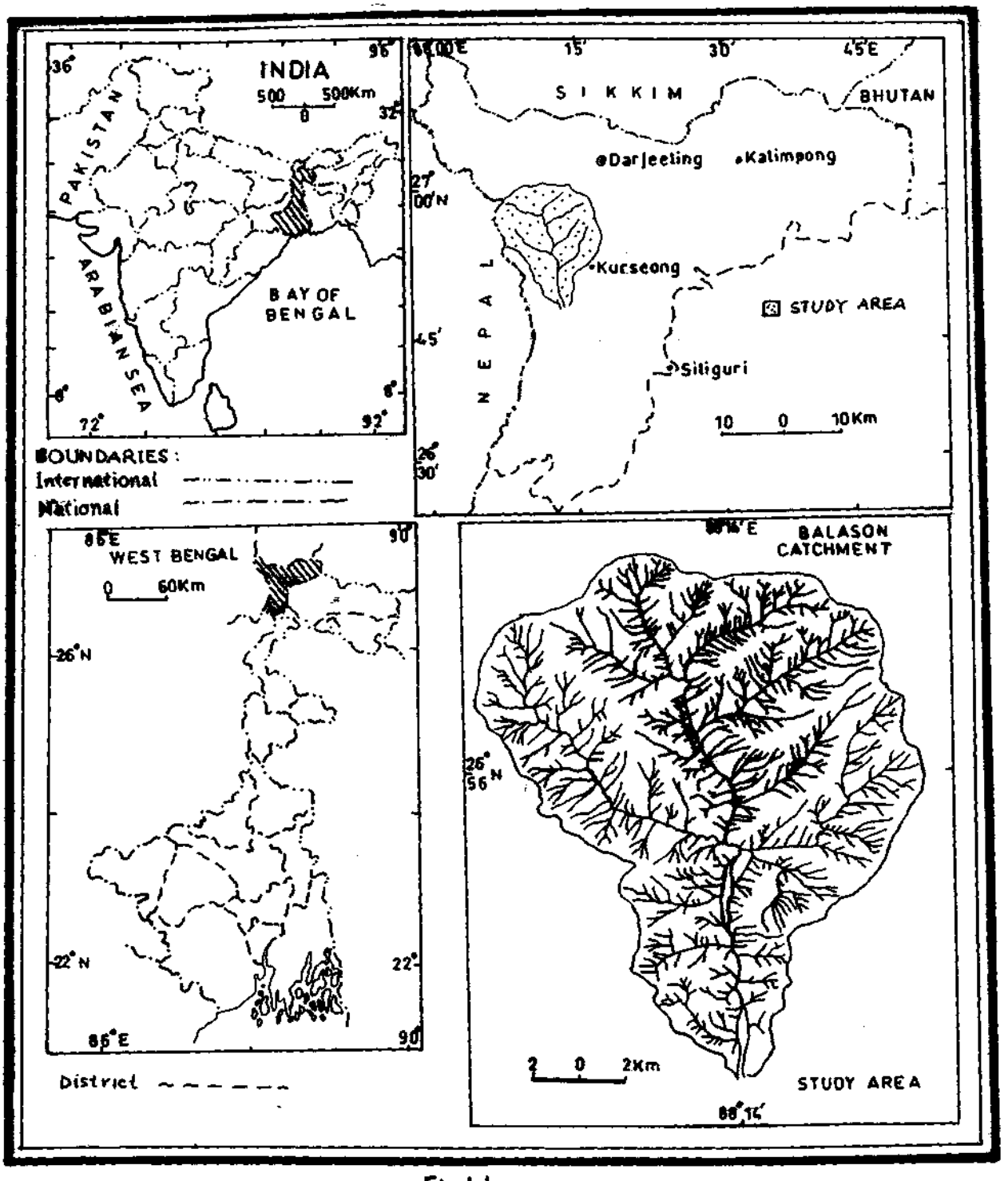


Fig. 1.1

while the southern portion comprises of comparatively soft, thin, salty and half-schistose rock, which are less resistant to erosion. There are no flat valleys, no plains, no sizable lakes, nor any cultured landscape except where virgin forests have yielded place to tea gardens or terraced fields. The main ranges wind and give off spurs of second and third orders in all directions. The valleys thus formed, present a great variety in climate and elevation.

Elevation of the Balason catchment varies from 2355m (at Ghoom Simana) to 267m (near Dudhia Bridge). Balason river flows down from north to south through a funnel shaped basin. The Balason watershed is delineated on its north side by a ridge emanating from the massive Singalila range and going almost straight to the east forming the Maneybhanjeng Ghoom ridge. This ridge throws smaller spurs having general direction south to southwest. From Ghoom, a complex system of ridges and spurs emanate, the longest of which is Tiger Hill – Dow Hill and marks the eastern boundary of the study area. From Dow Hill, this ridge dips down sharply taking a turn towards southwest and decreases its altitude from 2000m at Dow Hill to 1400m at Kurseong town within a distance of 4 kms. On the western side, a huge Nagri spur emanate from the main northern ridge, descends down sharply in the southeast direction from an altitude of 2350 m at Ghoom Simana on the Indo – Nepal border to 900 m in the bed of the river Balason. North of the Terai, the ridges stand out in a succession of bold spurs, the appearance of which has been compared with that of the weather beaten front of mountainous coast. The change from hills to plains is very abrupt and can be appreciated more vividly by observation on a clear day from above. From Kurseong and other view points of the basin, the observer looking southward will see the hills descending steeply below him and suddenly ending and from their foot the plains stretching away without any undulations to the southern horizon. On the southwestern tip of the Balason basin lies a huge colluvial deposit forming a flat terrain. The entire southern most width of this flattish part of the territory has been affected by notorious Ambootia landslide.

Photograph 1.1 Colluvial Deposits on Balason River

In the study area, the valley slopes are more flat and open towards the top but attain a steep gorge like character near the beds of the streams. The study area has spurs, ridges and ranges cut by rills, streams and rivers. For more detailed observations and analysis, the study area has been further divided into four physiographic divisions depending upon their heights. The four physiographic divisions are as follows: -

Table 1.1: Percentages of area under different physiographic units.

Division	Contour line in m	Area in km^2	Percentage of area covered
i) Foothill	Below 500	10	4.37
ii) Rolling land	500 – 1100	65	28.38
iii) Steep slope	1100 – 1900	128	55.90
iv) Highland	Above 1900	26	11.35

1.1. a. Foothill: This region is present in the southern most part of the basin covering 4.35% of the total study area. The Longview T.G., Patong T.G., Jamadar Bhita Khasmahal and Manjha Forest occupy the entire zone. The Balason river flowing through this region has a very gentle gradient. The river flows in a southward direction with severely braided channel. Numerous river borne pebbles, boulders and sand is deposited on the riverbed and banks giving the area a flattish appearance. The colluvial deposits, south of the Dudhia bridge is of great economic importance (Fig.1.2).

1.1. b. Rolling Land: This region covers 28.38% of the total study area and can be further divided into two sub regions.

i) The first one lies between 500m and 800m.This region encompasses the lower segments of Makaibari, Longview, Ambootia, Singel, Moondakotee, Nahori, Dhajea,Marma, Singbulli T.G. and Punkhabari, Dhajea Khasmahal, Manjua Forest,Manjha Forest. This region has huge rock outcrops descending down vertically to the river Balason. The rock outcrops are massive particularly on the points where the river makes changes in the direction of its flow. Major parts of this zone are barren and inaccessible. Open scrubs and mixed jungle are the characteristic vegetation of this region.

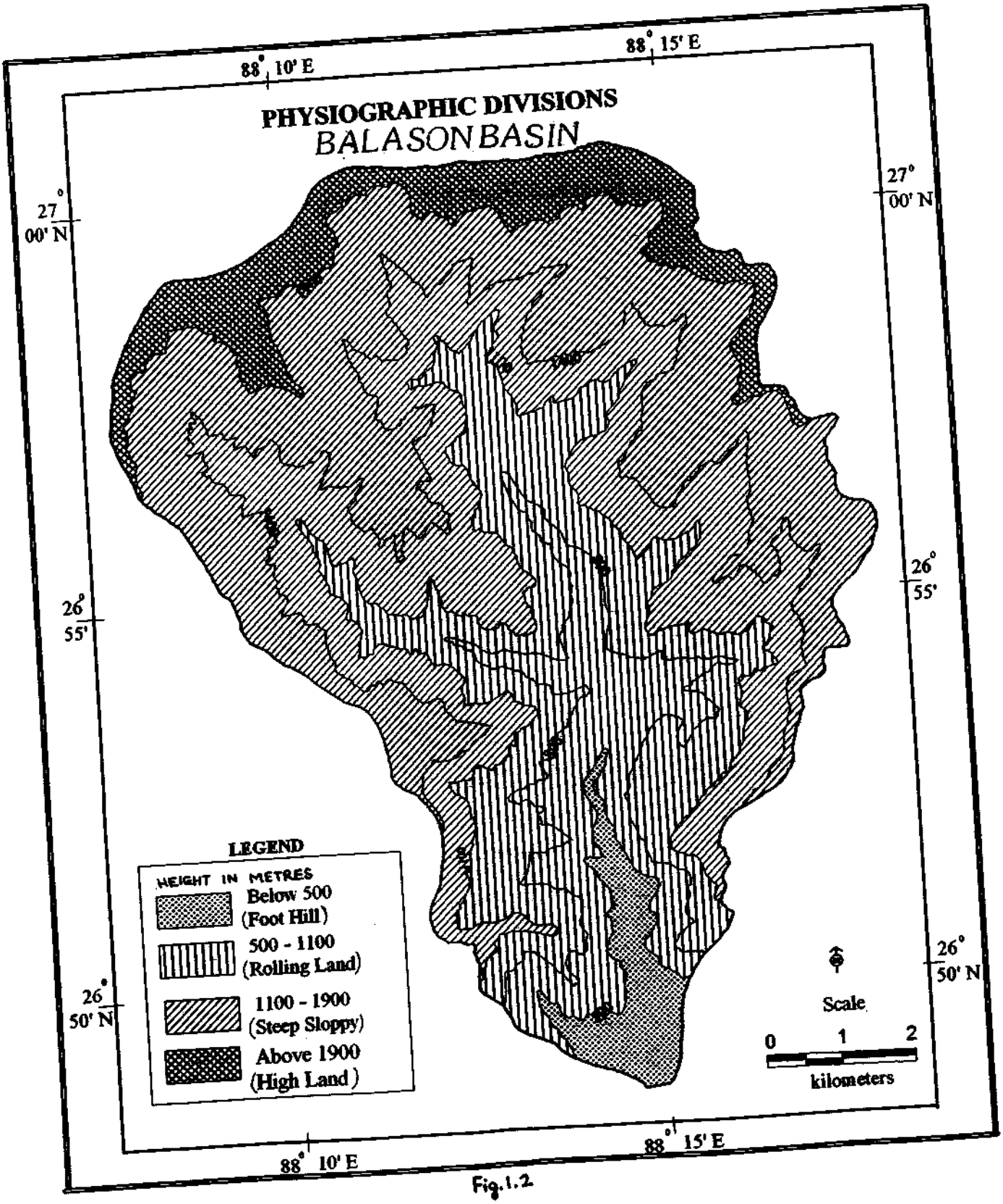

PHYSIOGRAPHIC DIVISIONS
BALASON BASIN
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
LEGEND
HEIGHT IN METRES
Below 500 (Foot Hill)
500 - 1100 (Rolling Land)
1100 - 1900 (Steep Sloppy)
Above 1900 (High Land)
Scale
0 1 2
kilometers

Fig. 1.2

ii) The second sub region lies in between 800m and 1100m. This region has rolling terrain. Because of milder slopes, this part has well developed road networks and the beds of all the tributary rivers are approachable through motorable roads. The rolling slopes are clothed with tea bushes of high density. A number of *jhoras* flow through the tea gardens and have, on the most part, scrubby vegetation and open jungle on their banks. On account of lack of proper distribution of vegetal cover, for protection of steep *jhora* banks, which was not the case earlier, when tea gardens used to maintain such steep *jhora* banks under forests, cutting of stream banks is much in evidence.

1.1. c. Steep Slope: This region lies between the heights of 1100m and 1900m and cover 55.90% of the total study area. This is an area of spurs emerging from the ridge tops. This region has the maximum concentration of settlements. Several hamlets, whose size increases on spurs, like Kurseong, Kharia Basti, Sonada Khasmahal, Tung, Dilaram and Sepoydhura, are located along the Hill Cart Road in the western part of the basin. On the eastern part lies the settlement clusters like Mirik, Mirik Khasmahal, Saurini Basti. To the north lie Phulungdung Khasmahal and Rangbang Basti. Many tea gardens are spread all over the region.

1.1. d. Highland: This region lies above the height of 1900m. The northern part of the study area falls in this category. Steep rugged slopes having a concentric direction towards the center of the basin characterize this region. The terrain is quite rugged and has a complex system of smaller spurs emanating from the Manebhanjang – Ghoom ridge on the northern side and from the Nagri spur on the western and southwestern sides. The terrain being very steep, no tea garden is located in this region. Settlements like SimanaBasti,Sukhiapokhri,Jorebunglow are situated in this region. Most part of the land is occupied by Ghoom Pahari Forest, Mim Nagri Range and Dooteria Forest.

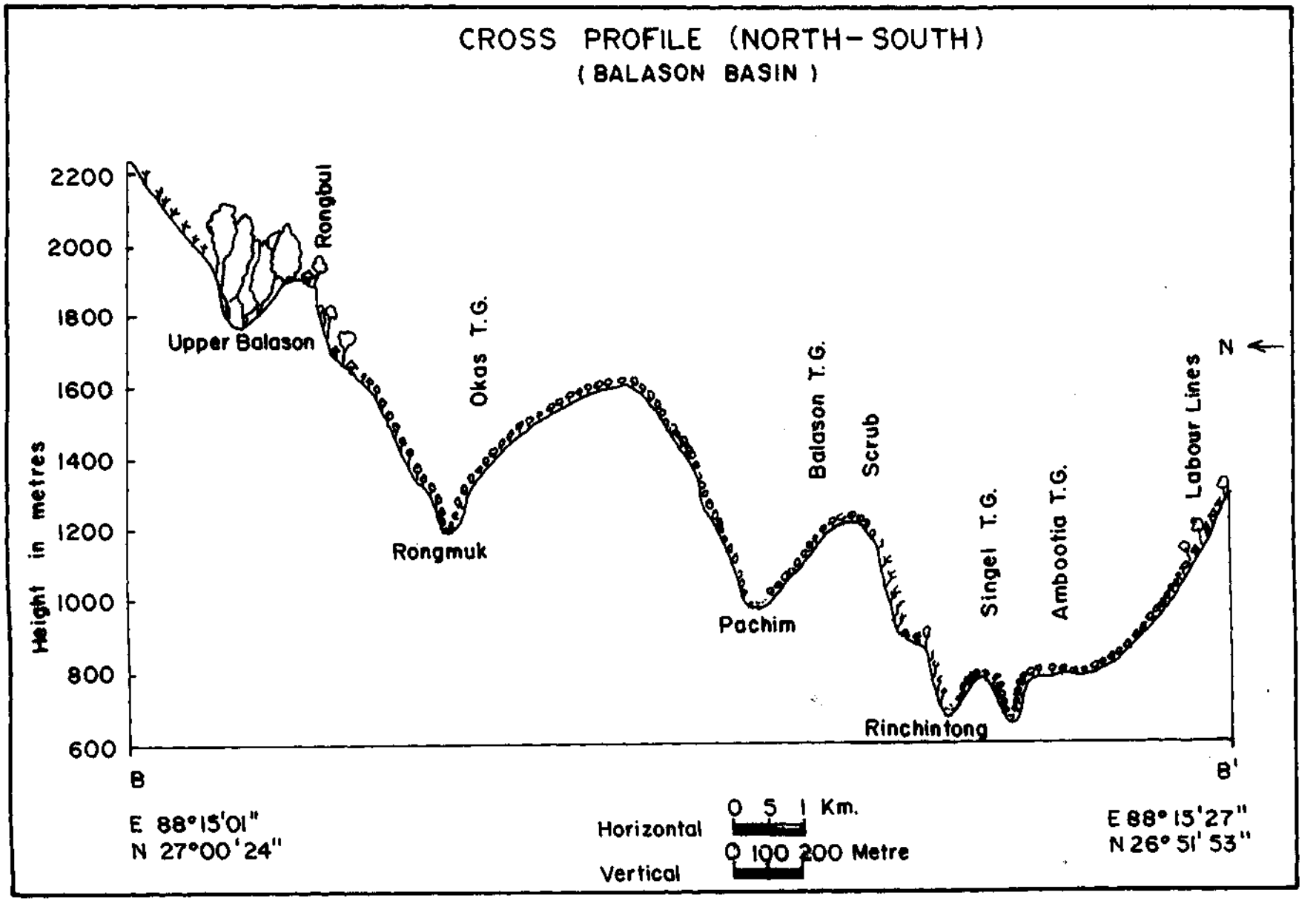

CROSS PROFILE (NORTH-SOUTH)
(BALASON BASIN)
Height in metres
2200
2000
1800
1600
1400
1200
1000
800
600
Upper Balason
Rongbul
Okas T.G.
Rongmuk
Pachim
Balason T.G.
Scrub
Singel T.G.
Ambootia T.G.
Labour Lines
Rinchinfong
N
B
B'
E 88°15'01"
N 27°00'24"
E 88°15'27"
N 26°51'53"
Horizontal
0 5 1 Km.
Vertical
0 100 200 Metre

Fig. 1.3

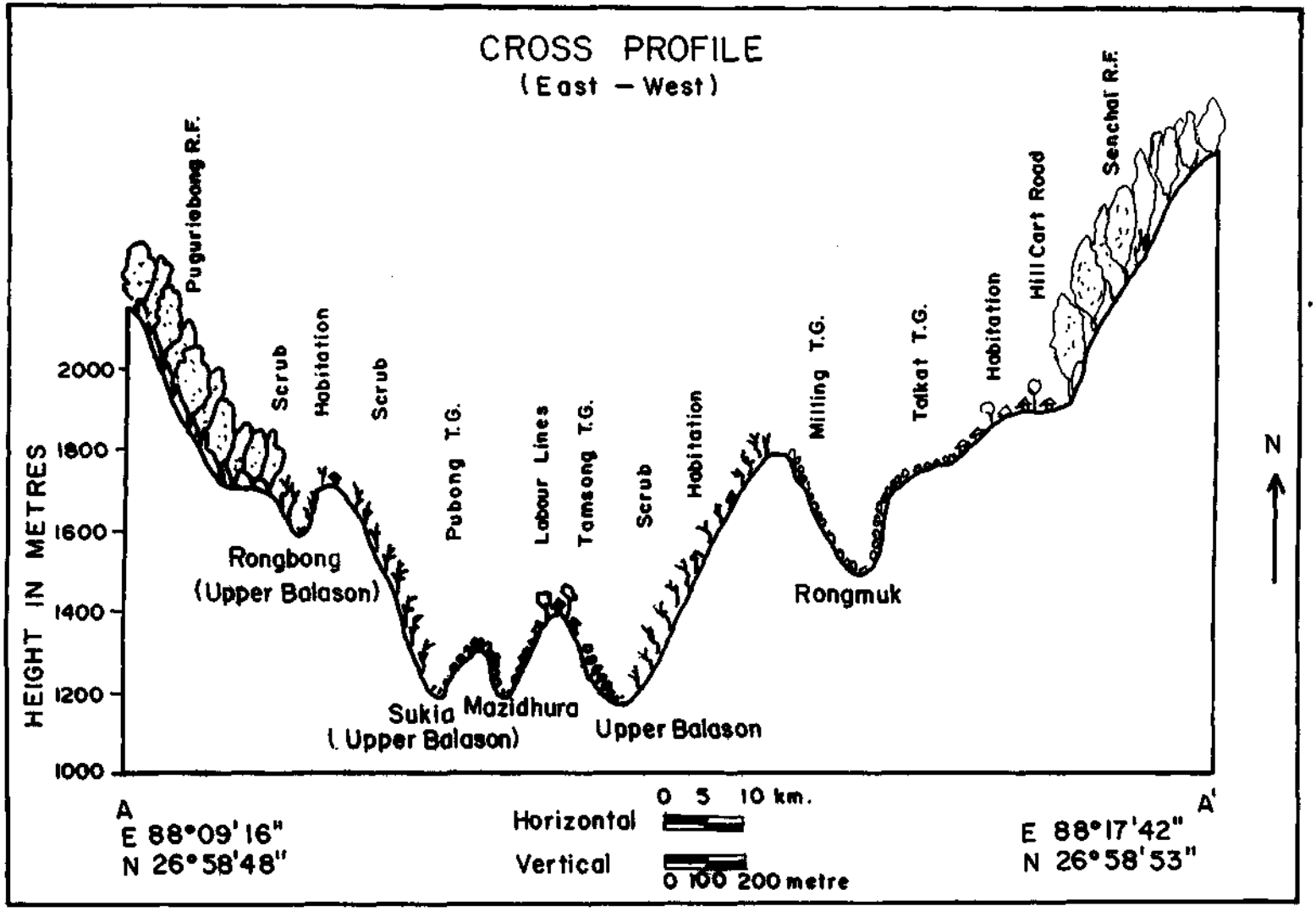

CROSS PROFILE
(East – West)
HEIGHT IN METRES
2000
1800
1600
1400
1200
1000
Pugurisbong R.F.
Scrub
Habitation
Scrub
Pubong T.G.
Labour Lines
Tamsong T.G.
Scrub
Habitation
Milling T.G.
Tolkat T.G.
Habitation
Hill Cart Road
Seachal R.F.
Rongbong
(Upper Balason)
Sukia
(Upper Balason)
Mazidhura
Upper Balason
Rongmuk
N
A
E 88°09'16"
N 26°58'48"
Horizontal
0 5 10 km.
Vertical
0 100 200 metre
A'
E 88°17'42"
N 26°58'53"

Fig. 1.4

1.1.1. Relative Relief

The relative relief in the Balason basin ranges from below 200m to above 700m. Places having relative relief above 500m are regarded to have very high relative relief. These are found to the north of Dudhia *jhora* in Gayabari T.G., along upper Marina *nadi* to lower Rangbang *nadi* in the Marma T.G., upper Rangbang *nadi* and upper Phulugdung *nadi* in Ghum Simana Reserve Forest, upper Balason and middle Bhim *khola* stretching from Pubong T.G. to Tongsong T.G., upper Jore *khola* in Talkat T.G., in Okas T.G., lower Rinchingtong *nadi* north of Kurseong along Singell T.G., south of Ghatta *nadi* in the Makaibari T.G.

Extensive areas are under high relative relief (400 to 500m). On the north it sprawls over Chamong, Simripani, Pubong, Talkat and Cedar T.G. and parts of Ghoom Simana Reserved Forest. Whereas in the south high relative relief in encountered in Singbuli, Manjwa, Springside and Makaibari tea gardens and parts of Phuguri and Manjwa Reserved Forests. In general, the northern part of the study area has more area under high relative relief (400 to 500m) than the south (Fig. 1.5). Thus the former is more erosive and less productive than the latter. Medium relative relief is observed in isolated pockets in the upper Phulungdung basin, upper Manjwa basin, Thurbo T.G., Sangma T.G., Cedar T.G., south of the confluence of Manjwa *jhora* and Balason and to the north of confluence of Dudhia *jhora* and Balason. The low relative relief region is found all over the basin in a haphazard pattern. In general, the upper reaches of the rivers in the northwest are much steeper whereas the middle and lower reaches of the rivers in the eastern and southern part of the basin are steeper and hence the river basin is more eroded in different places.

1.1.2. Slope

One of the geomorphological factors influencing the erosion is the sloping of terrain. The greater is the steepness, the greater is the velocity, and higher are the carrying capacity, greater kinetic energy and erosivity of run off. In natural landscape, before the soils were used, water influenced the soil directly by erosion. Of the four eroding

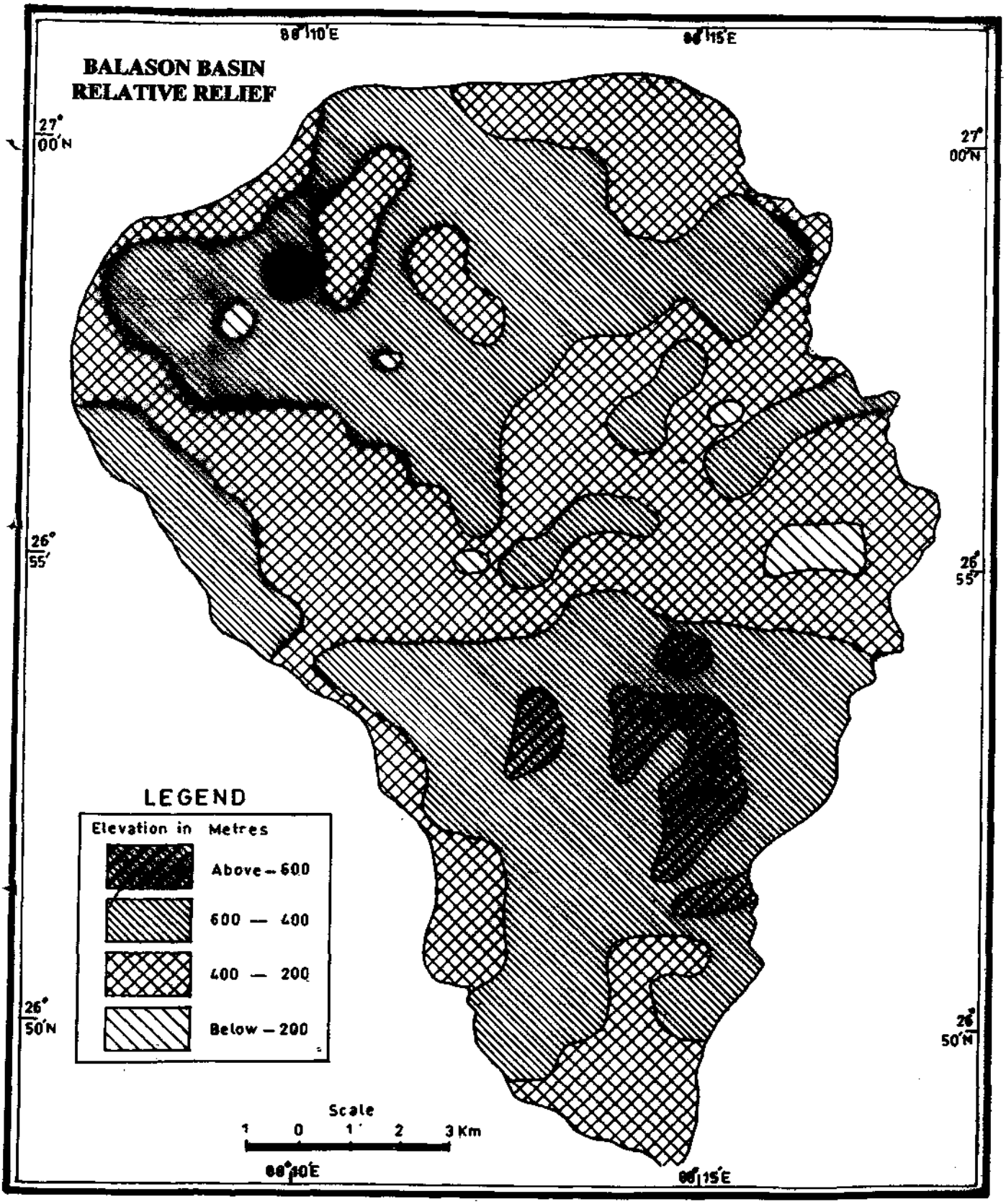

BALASON BASIN
RELATIVE RELIEF
88°10'E
88°15'E
27°
00'N
26°
55'
26°
50'N
LEGEND
Elevation in Metres
Above – 600
600 — 400
400 — 200
Below – 200
Scale
1 0 1 2 3 Km

Fig. 1.5

agents – water, wind, ice and gravity – the first is the most potent one and its erosivity is affected the most by the degree of slope (Smith et al, 1969). Slope, which is conventionally known as the angular inclination between different elevations, is a very important morphometric property since it explains the stages of development of a particular landscape. Various procedures of slope analysis based on contours of topographical maps have been evolved by a number of prominent geomorphologists. The present investigator, however, has chosen Wentworth's (1930) method of slope determination, which is very useful for explaining the spatial distribution of average slope of a particular area. The computation of average slope is based on 2cm grid square area instead of Wentworth's grid based on the British system.

The average slope of the study area varies from 15° to 30°. Slope above 30° is found in small-scattered pockets all over the basin. Slope above 30° is encountered along the left bank of the middle Dudhia *jhora* near Gayabari T.G., right bank of the middle reaches and lower reaches of Rangbang *nadi*, Tomsong T.G., in the middle reaches of Bhim *khola*, upper Jore *khola*, lower Rinchington T.G, interfluve between the Ghatta and southern tributaries of Balason. In the study area, one of the most conspicuous slope assemblages is that comprising a bare rock face followed by a substantial accumulation of talus. Development of talus slope is an interesting phenomenon. Weathering of rocks affects their shear strength, bulk density and permeability it penetrates rapidly when rocks are foliated, jointed or crushed (Gerrard, 1991). Extensive area has medium slope ranging from 25° to 30° (Fig. 1.6). These are also found in isolated pockets but cover more area than the high slope zone. Such pockets occur in north west corner in the upper Rangbang basin and Pussimbing T.G. in the northern part in upper Balason and middle part Bhim *khola* basin, in the north-eastern corner in the Jore *khola* basin in the Talkat T.G in the central part of the basin, a large part along the lower reaches of Ragbang, Pachhim, middle Balason.

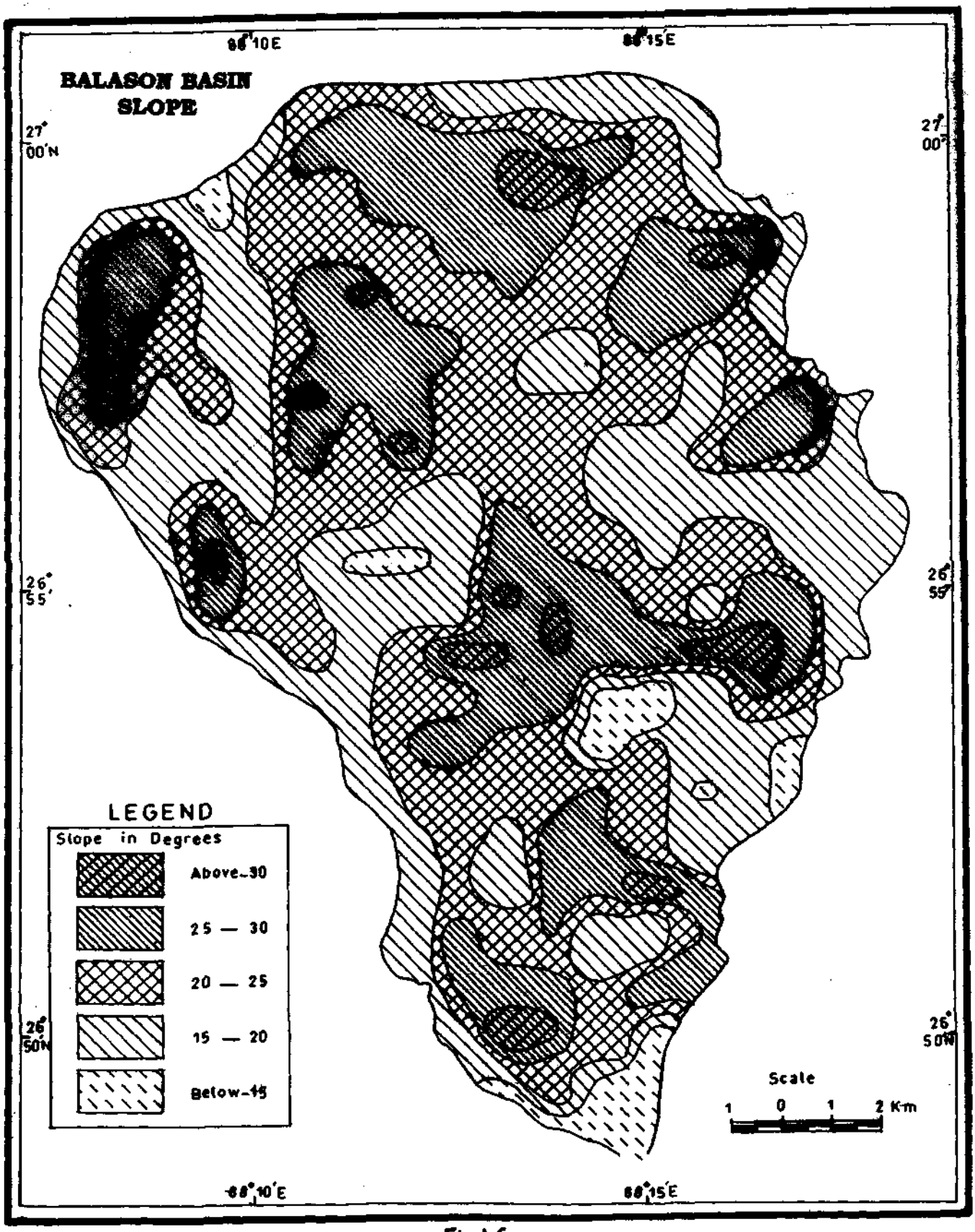

BALASON BASIN
SLOPE
88°10'E
88°15'E
27° 00'N
26° 55'
26° 50'N
LEGEND
Slope in Degrees
Above-30
25 — 30
20 — 25
15 — 20
Below-15
Scale
1 0 1 2 Km

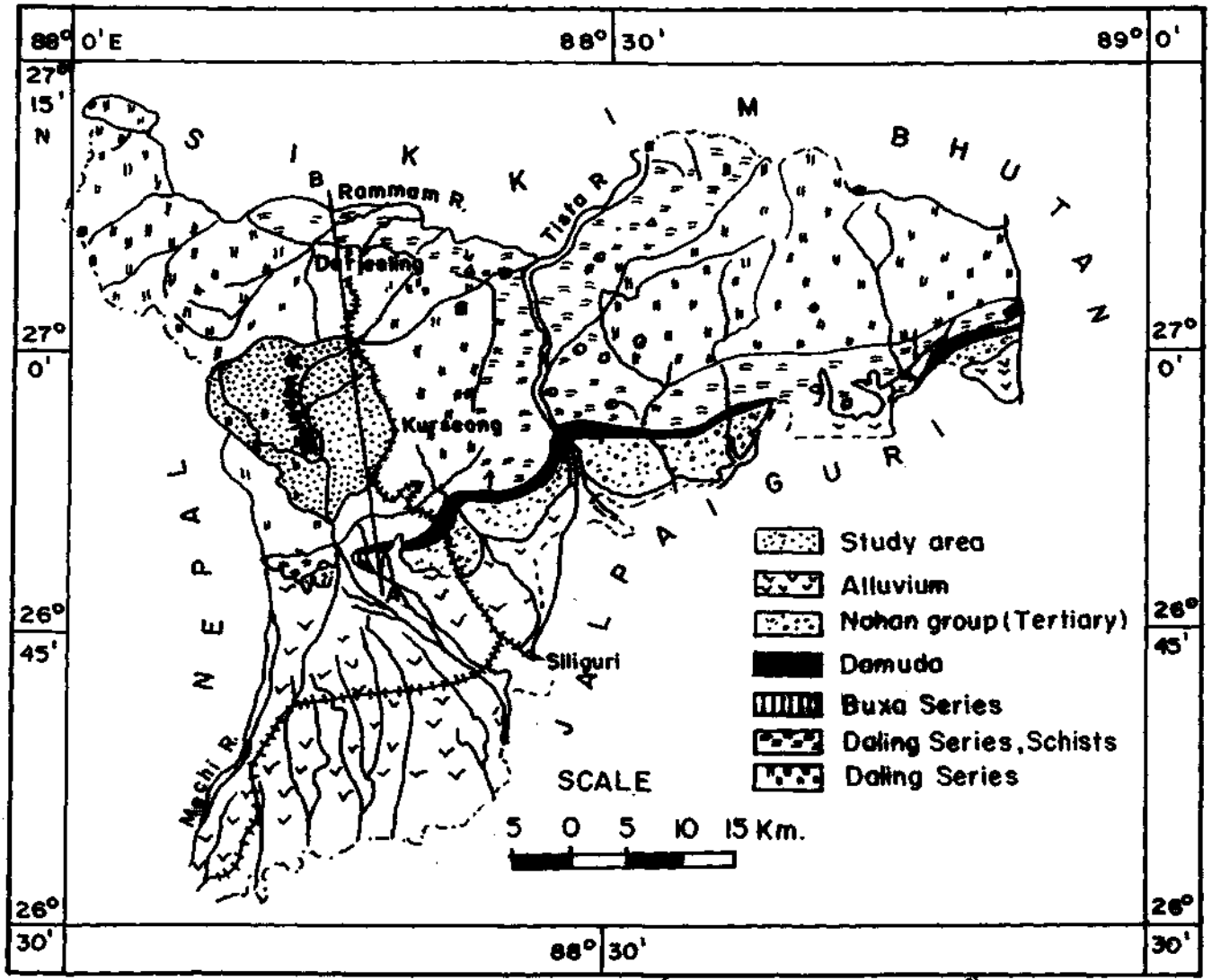
Fig.1.6

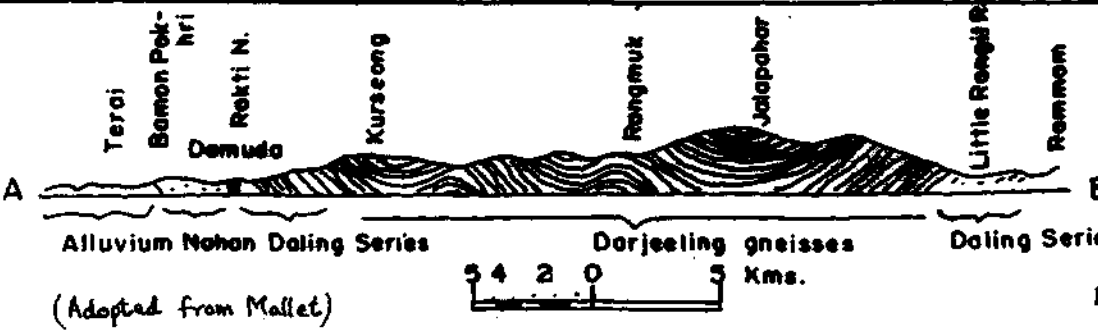
In the northern part of the Balason basin, high relative relief zone is coinciding with high steepness of slope. Wherever relative relief is above 500m, the slope is above 30°. This indicates that the river is in its youthful stage and the erosive power of the river is very high. Thus vertical corrasion is very high and the river is flowing through gorge like features with steep sides. Relative relief of the tributary rivers of Balason is high at the middle of their course probably due to the joining of the maximum number of rills and gullies in that zone. This as a result increases the volume of water, which increases the erosive power of the tributary rivers of Balason. Moderate relative relief with gentle slope is a usual occurrence from where the tributary rivers of Balason are originating. This might be due to the presence of rills, which has less erosive power and is unable to erode the existing hard rocks. The ridges and spurs have less relative relief and moderate to gentle slope, indicating less erosion. As the rivers are flowing down the valley, the steepness of the slope and relative relief is increasing. This is because as more and more rills and gullies are joining, the erosive power of the rivers is increasing. To the south of the Balason basin, the relative relief is gradually decreasing and the slope is either moderate or gentle along its two banks.

1.2. GEOLOGY

The geological formations of Darjeeling district consists of few rock formations varying in age between recent to possibly Archaean age. As one passes from the plain northward to higher elevations, one meets alluvium rocks of Siwalik series, a narrow band of rocks of Damuda series, rocks of Daling series and Darjeeling gneiss and mica schist, each succeeding rock, with possible exception of the last, being older than the one before it (Government of West Bengal, 1959). The Himalayas is geographically a complicated mountain system. The complexity of structure and metamorphism that the rocks have undergone has posed challenging problems for co-relation of the different rock formation on a regional scale. Geological investigations in

GEOLOGICAL MAP OF DARJEELING DISTRICT (BALASON BASIN)





(Adopted from Mallet)

Fig. 1.7

Darjeeling and the adjoining regions began in the middle of the last century. In 1854, J.D. Hooker reported the geological findings of his extensive travels spread over the two years – 1848 and 1849. He traced on the regional domal picture of the gneiss and observed the over line sedimentary bedding but the systematic geological examination of the Darjeeling are first done by C. Mallet in 1874. He classified the metamorphic works of Darjeeling and western Duars into the Daling Series and the Darjeeling gneiss.

Since then, several officers of the Geological Survey of India as well as many scientists have recorded local observation. Among them, Ray (1945) has differentiated progressive zones of metamorphism of Daling series and Darjeeling gneiss. Ghosh (1950) has carried out a detailed geological mapping of parts of the Darjeeling Himalayas. M.B.Pande and S.S.Saha (1982) have also studied the Darjeeling Himalayas extensively. If a section is drawn from the Terai area to Rammam river through Kurseong and Darjeeling, it will be found that the entire succession of rocks has, prima facie, the appearance of a great syncline. In the southern part of the section, namely, in Bamanpokhari, around Rakti river and in and around Kurseong town, all the strata are inclined towards the north at rather higher angles. In the central part of this section, namely, around Hope Town spur (Sonada), Rangmuk river, Ghoom and Jalapahar peak, the dips are rolling and irregular. Towards north, starting from Birch Hill, to Little Rangit and the Rammam rivers, the dip of strata is southerly (Fig. 1.7). This is suggestive of complete inversion of strata due to the synclinal thrust of the Himalayan uplift. Among these rock groups, the relationship between the Daling and the Darjeeling series is quite characteristic. Towards the top of the Daling series metamorphism increases up to the Darjeeling gneiss with share of garnet and sillimanite and this is taken as evidence by many scholars that Daling series and Darjeeling series are not divided by an area of overthrust, but constitute a single vast nappe of inversed strata (Starkel, 1972). The outcrop of these, form a series of bands running more or less

parallel to the general trend of the Himalayas and dipping one beneath the other into the hills (O'Mally, 1907). The great range was elevated during the tertiary period on the site of an ancient sea that had accumulated sediments of different geological ages, the movement resembling the crumpling of the thin sheet of a flexible material held edge on between the jaws of a slow moving vice, one jaw fixed and the other moving up towards it (Raistrick, 1943). The mountains are made of folded rocks, piled one over another by a series of north – south horizontal compression movements and tangential thrust which also folded the strata on the sea floor and caused their upheaval by stages (Govt. of West Bengal, 1970). The present relief of high peaks and deep valleys has been carved by wind, water and snow.

The rock formations in the study area are Darjeeling gneiss most commonly mixed with some pockets of sandstones, siltstones and dark slates commonly referred to as the Darjeeling series. The rocks are micaceous frequently passing into mica schist (Saha et al, 1982). The rock formation of the entire study area can be described as granetiferous mica – schist, quartzite and biotite – kyanite and sillimanite gneiss. Both muscovite and biotite are common. Some common accessory minerals of this area are kyanites, sillimanites, hornblende, garnets, bands of quartzite and aluminous chlorites along with some calcite, the garnet, at places, disseminated through the mica – schist in coarse crystals of considerable size and are prized as a gem (Govt. of West Bengal, 1981). The gneiss is always well foliated and exhibits strongly marked features of disturbances, which is evident from much folding and crumbling. It is highly micaceous and is composed of colourless or grey quartz, white opaque feldspar, muscovite and biotite. It varies in texture from a fine grained to moderately coarse rock, lenticular layers of different degree of coarseness being commonly interbedded (Govt. of West Bengal, 1976). From Kurseong to Ghoom on the eastern side of the study area, the gneiss is continuous. As explained, the dips are uncertain and irregular but are, on the whole, northerly near Kurseong and southerly near

Ghoom and beyond. Gneiss is also met in traverses along Ghoom – Sukhiapokhri road. Typical succession of sillimanite – kyanite – garnet metamorphic zones among this gneiss is well seen in these traverses. At places, numerous veins of quartz pegmatite and aplite traverse gneiss. Thin bands and lenses of carbonaceous matter, usually graphitic in appearance, are also found in the gneiss. Of special interest is lime – silicate inclusions or concretions in Darjeeling gneiss. They seem restricted to gneiss. The inclusions usually form lenticular bodies with curiously bent tail ends. Free lime is rarely present, but a concentric arrangement of a characteristic mineral paragenesis can be observed. From the host rock to the core of the concretion sequence is as follows: quartz, oligoclase – andesine, biotite, garnet, titanite (country rock): quartz, little andesine, little biotite, garnet, titanite (contact): bytownites, green hornblende, garnet, quartz, titanite (contact): bytownite, garnet, diopside, quartz, titanite and bytownite, quartz, fine reticular garnet (titanite) (Govt. of West Bengal, 1981). Introduced quartz usually surrounds garnet and bytownites. Some other concretions have a core of pure red garnet with grains up to 2 cm. The latter show characteristic sieve and drop like inclusion of magnetite and quartz often concentrically arranged. More basic inclusions or concretions have been observed in the form of diopside bearing garnet hornblende. The location of the study area in the gneissose rock formations has a very profound effect on the other parameters having bearing on the soil erosion from the area one of the most important of which is the character of the drainage of the area.

1.3. DRAINAGE

The river Balason is one of the easternmost tributaries of the river Mahananda. The literal moaning of the word 'Balason' is 'the river of golden sand', a Bengali name suggested by the wide bed of yellowish sand as it descends down in the plains. The river Balason rises in the Lepcha Jagat near Ghoom Simana range of Darjeeling Himalayas. The Balason flows south almost parallel to the 88°15'E meridian till it

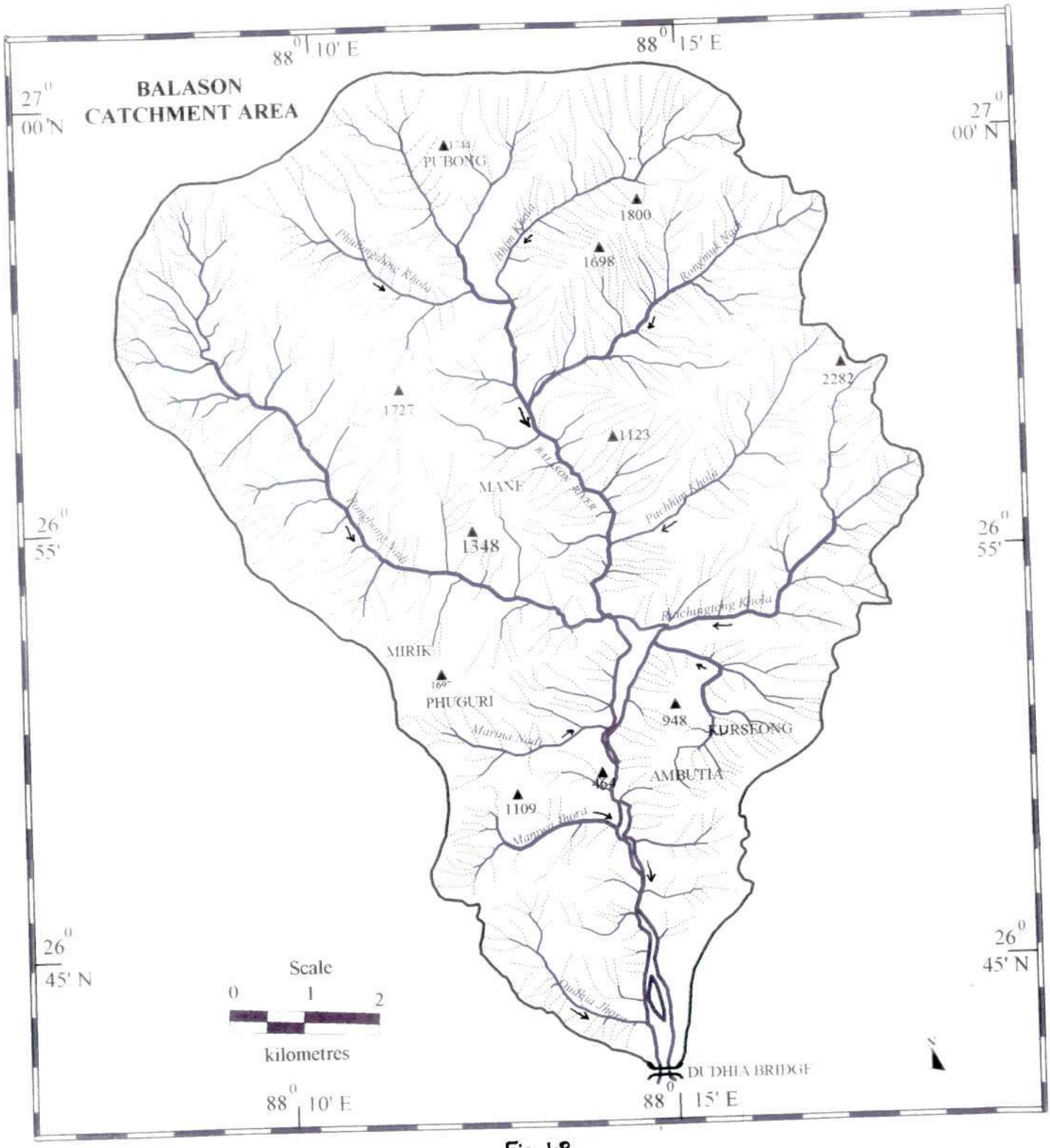

BALASON
CATCHMENT AREA
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 45' N
PUBONG
1744
1800
1698
1727
1423
2282
MANE
1348
MIRIK
PHUGURI
1690
948
KURSEONG
AMBUTIA
1109
DUDHIA BRIDGE
BALASON RIVER
Phuntsholing Khola
Bhim Khola
Pachhim Khola
Kuchuguing Khola
Mansai Nadi
Mansai Jhora
Dudhia Jhora
Scale
0 1 2
kilometres
N

Fig. 1·8

reaches the plains at an altitude of 304.8m and then turns south-east where its valley is larger than that of the Mahanadi, although its catchment basin does not receive so heavy a rainfall as that of the latter. Of its innumerable right-bank tributaries, the chief are Pulungdung *khola* that rises from the southern face of the Ghoom saddle just below the Sukhiapokri- Simanabasti road, flows southeast the Ghoom Pahar Reserved forest, and debouches into the Balason at an altitude of about 912.24m (Fig. 1.8).

The Rangbang *nadi* originating below Simanabasti (2299.38m) on the southern extension of the Singalila range flows south-east through reserved forests and a number of tea gardens and meets to Mirik pass over two bridges, one at 1044.85m (Gopaldhara Tea Garden) and the other at 1356.36m (between Siyok and Selimbong Tea Garden). For its picturesque grandeur the Rangbang gorge is a potential tourist attraction. The Marma *nadi* rising from the south-facing escarpment of the Mirik dome flows east and meets the Balason in a deep gorge. The valleys of the Rangbang and Marma *nadi* very closely resemble hanging valleys. The Manjwa *jhora*, only 0.75km to the south of Marma *nadi*, flows almost parallel to the latter through dense forests. The Dudhia *jhora* descends from 1106.72m (Phuguri T.G.), flows southeast in a concave gradient and debouches into the Balason at an altitude of about 304.8m. For the greater parts of their courses, the south-southeast flowing tributaries, the Chenga and Manjha *nadi*, negotiate the Terai forests and the plains. From north to south the chief left-bank tributaries of the Balason are the Bhim *khola*, the Rangmuk *nadi*, the Jore *khola*, the Pachhim *nadi*. And the Rinchingtong *khola* all of which rise from the Senchal spur south of the Ghum saddle and flow from north-east to south-west through deep and precipitous gorges, a few tea gardens and dense forests. Below Kurseong the main tributaries of the Balason are south flowing. The river Teesta drains the northern and eastern sides of the Balason catchment, which is a tributary of the river Brahmaputra. The Mechi river drains the western side of the Balason catchment.

1.4. CLIMATE

The climate of the study area varies from tropical on lower reaches to temperate on higher reaches closer to the rim of the Balason basin. Darjeeling hills, in general, have a unique climate of their own. The temperature and rainfall data has been collected from Singel T.G., which is located in the vicinity of Kurseong town and is presented in Table 1.2.

Table1.2. Average meteorological data of Singel Tea Garden (2000–05)

Months	Rainfall in mm	No. of rainy	Temperature in °Centigrade		
		days	Maximum	Minimum	Average
Jan	18.5	2.7	15.6	7.8	11.7
Feb	21.0	4.7	16.0	8.8	12.4
Mar	30.7	5.0	20.8	10.8	15.8
Apr	122.2	10.7	21.9	14.3	18.1
May	254.7	14.5	24.5	15.2	19.8
Jun	722.7	21.8	24.9	16.4	20.7
Jul	1098.8	23.0	25.0	17.4	21.2
Aug	834.8	22.0	24.5	18.0	21.2
Sep	434.0	18.2	23.7	16.8	20.2
Oct	181.0	5.5	23.8	14.1	19.0
Nov	9.7	1.2	21.1	10.4	15.7
Dec	5.0	0.7	18.1	8.1	13.1

(Source: Singel T.G., Kurseong.)

Temperature in the study area varies depending on altitude. The average temperature for six years has been taken into account. The

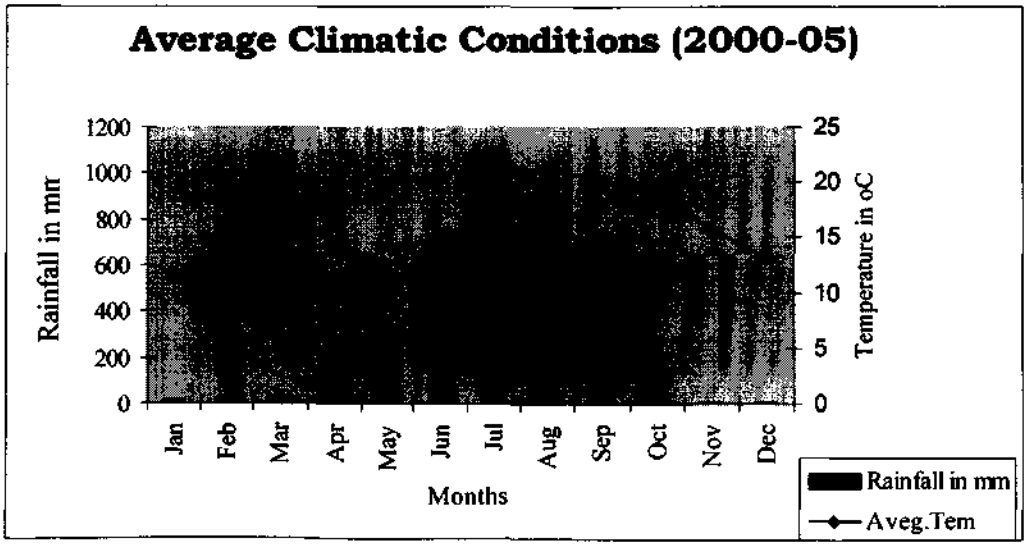


Fig.1.9

extremes of temperatures are felt in areas of high hills (1500m to 2500m) lying along the ridge tops delineating the main basin (Govt. of West Bengal, 1986). As seen from the table1.2, January is the coldest month having average temperature11.7°C and July – August records the average temperature i.e. 21.2°C being the hottest months. The lower altitudes have higher temperatures and higher altitudes have lower temperatures due to altitudinal variations (Mani, 1981). The average annual rainfall in the study area is 3733mm.Most of it is received during the monsoon months between June and September. About 83% of the total rainfall occurs during these four months. The rest of the year is almost dry (Fig.1.1). On account of such heavy concentration of rainfall in a few months, monsoon becomes atrocious during this period (Raghuraman, 1975). Highest average rainfall of 1098.83mm is observed in the month of July, which also has the highest average number of rainy days (23 days). During this monsoon, large sized boulders are reported to flow down through the rivers of the study area. This is one of the reasons for excessive soil erosion and failure of engineering structures, constructed in the river for moderating their flow. The month of December has the lowest average rainfall (5mm) being the driest month with least number of rainy days. In the last few years, 2002 recorded the highest number of rainy days annually (138). Rainfall is higher in the forested areas. During monsoon the weather is generally foggy but from October till April weather is usually dry, clear and fog free. This is the time when people suffer from acute crisis of water. The atmosphere is highly humid throughout the year and relative humidity is highest in summer than in winter.

During the period November-May upper winds over the Himalayan region are predominantly westerly. With the setting in of the monsoon, however, there comes a conspicuous reduction in wind speed persisting until the arrival of winter. Surface winds in Darjeeling district have usually an easterly component. From November and throughout the winter prevailing wind direction is east- northeast. In the spring and upto June there is a tendency for a west or southwest

component to enter and in the monsoon (June to September) prevailing direction is east- southeast.

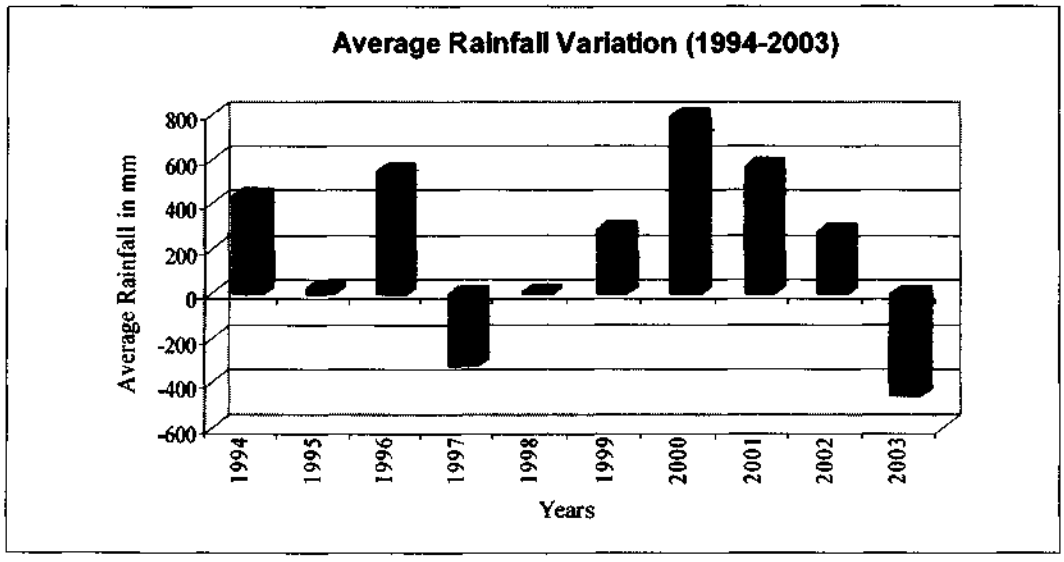


Fig.1.10

1.5. SOIL

Soils are a dynamic part of the earth's geomorphic cycle of surficial weathering, erosion, deposition, sinking, digenesis, metamorphism, upliftment and mountain building (Jackson, 1976). The process of soil formation is quite complex in nature and varies from place to place. The factors, which affect the soil forming processes, are nature of parent material, topography, climate and biosphere. The parent material is fractured, splintered, pried apart and dissolved through the process of solution, freezing, thawing and oxidation – all called together as processes of chemical and physical weathering (Bennett, 1955). Climatic factors have multidimensional effects. These help to develop a wide variety of soils in the study area. The climatic conditions determine the rate of this primary weathering process to a large extent. Apart from physical weathering, the nature, direction and the rate of chemical reactions are affected by the nature of reactants and products, their concentration and amounts, the manner of their supply and subsequent removal of the products from the site as well as temperature, pressure and volume (Barshad, 1976). Soil is a natural body having depth and surface area, existing as a continuous cover on

the land surface, except on very steep slopes and is a product of natural destructive and synthetic forces (Ghildyal, 1981). The physical and chemical weathering of rocks and minerals result in the formation of unconsolidated debris, the regolith, the upper biochemically weathered part of which is the soil.

In the study area, very shallow skeletal to deep soils are found. Red yellow soils, usually gritty, have developed in Darjeeling gneiss and schist occurring in the study area. Darjeeling gneiss commonly decomposes into a stiff reddish loam but may also produce, occasionally, pure sand or stiff red clay. The colour of red soil, derived as it is by meteoric weathering from gneiss and schist, is due more to wide diffusion than to high proportion of iron content (Govt. of West Bengal, 1981). This type of soil occurring in the study area 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 potassium derived from muscovite and feldspar of gneiss. The podzolic soil i.e. the bleached sandy soils poor in humus are good for tea cultivation. The brick red coloured clay loam soils, considered best for tea growing, occur in piedmont slopes. The soils have great variability in their productivity and in combination with climate; the study area produces a wide range of vegetation.

1.6. VEGETATION

Differences in elevations and variable productivity of soil in combination with height variable temperatures in the study area have produced different types of vegetation. The original vegetation of the land hardly exists. Through ages the virgin forests are almost removed and degraded. Experiments through the years have given a new definition to the vegetation types that are found at present. The present vegetation types are as follows:

1.6. a. Humid Temperate Forest Zone: This type of vegetation occurs along the brim of the basin in an approximately 3 to 4 km wide strip except in the southern part. The lower limit of this zone is bounded by

2000m contour line. The species met are Katus (*Castanopsis indica*), Lekh Dabdabe (Meliosma *wallichii*), Tite Champ (*Michaelia cathcartii*), Phalado (*Erythrina indica*), Lapche Kawla (*Machilus edulis*) Musre Katus (*Castanopsis tribuloides*), Lekh Chilauni (*Nyssa sessiliflora*), Walnut (*Juglans regia*), Malata (*Macaranga sp.*) and Arupate (*Prunus nepaulensis*). In several patches plantations of Dhupi (*Cryptomaria japonica*) have been raised.

1.6. b. Moist Scrub Vegetation Zone: To the south of the humid temperate forest lies this zone. This area is more moist and cooler and has characteristic vegetations. The species encountered are Panisaj (*Terminalia myriocarpa*), Lahsune (*Amoora rohituka*) and Lali (*Amoora wallichii*). The species found in the undergrowth are mainly Bepari (*Ostodes paniculatus*), Choya (*Dendrocalamus hamiltonii*), Hatisar (*Alpinia nutans*) and other herbaceous annuals and shrubs.

1.6. c. Dense Scrub With Human Settlements: This region lies between 1500m and 1000m elevation. Settlements and agricultural lands are located in this region. On the steeper slopes and terrace risers perennial grasses like Amlisho (*Thyssanolena maxima*) and Narkat (*Arundodonax sp.*) are planted. Besides being good fodder and only fodder grasses available during winters, these perennial grasses have very good soil binding capability and are a good deterrent against surficial landslide. Among the trees planted by farmers on their fields, fodder trees are of prime importance. The main fodder tree species planted are Gogun (*Saureria nepaulensis*), Nebharo (*Ficus hookerii*), Dudhilo (*Ficus nemoralis*), Utis (*Alnus nepaulensis*) and Weeping Willow (*Calix indica*). Some temperate fruit trees such as plume, peach and oranges are also planted in this zone.

1.6. d. Wasteland with Dry Scrub: This zone lies below 1000m height and consists of wasteland with rock outcrops with occasional skeletal soil. Growth of vegetation is poor on account of poor soil depth and even tree species have stunted growth. Species found are Siris (*Albizzia sp.*), Phaledo (*Ertthrina sp.*), Parari (*Stereospermum chelonoides*) and Malata (*Macaranga sp.*) with undergrowth of Amlisho (*Thysanolena*

maxima), Assamlota (*Eupatorium odoratum*), Tarika (*Pandamus furcatus*) and Choya Bans (*Dendrocalamus hamiltonii*)

1.6. e. Tea Gardens: Tea gardens occupy the largest area in the Balason basin. Shady trees are planted in the tea gardens. Rolling piedmont slopes are occupied by tea bushes whereas *jhora* banks and other steeper areas are kept under permanent vegetation for the purpose of protection. The species met in such patches kept under permanent vegetation are: Chilaune (Schima wallichii), Mauwa (Engelhardtia spicata), Angare (Phoebae attenuata), Strobilanthus sp., Sisnu (Girardinia sp.), Boehmeria sp. and ferns.Bamboo clumps are also seen in some places.

CONCLUSION

Thus it is seen that the study area lies in a geographically complicated mountain system. The basin is balloon shaped which is broad in the north and tapers to the south. The rivers mainly flow from west, north and east of the basin towards the south. The Darjeeling gneiss and Daling series are the main geological formations in the area. The terrain of the areas above 1900m height is quite rugged and mainly forested. The spurs are emerging from the heights ranging from 1100m to 1900m. Below 1100m height, the terrain is rolling and below 800m it is the foothill area with accumulation of numerous colluvial deposits. High relative relief is found in the northern part of the basin, where the slopes are very steep. The average slope of the study area varies from 15° to 30°. Where high relative zone coincides with high steepness of slope, it indicates that the river is in its youthful stage and the erosive power is very high. The climate of the area varies from tropical in the lower reaches to temperate in the higher reaches. Climate of the area is quite interesting with the minimum temperature 7.8°C and maximum temperature is 23.0°C. There is sharp change in between summer and winter temperatures. Places like Jorebunglow and Sonada experiences snowfall during the winter months of December, January and February since the last few years. This might be due to the effect of global

warming and environmental degradation. Rainfall is very high in the basin and continues for four months from June to September. Highest average rainfall of 1098.8mm is recorded in the month of July and lowest average rainfall of 5.0mm is recorded in the month of December. The relative humidity is as high as 94% and never goes below 66% in the study area. High and fog are also quite common. These two are much unpredicted and can happen at any time of the year. Very shallow skeletal to moderately deep soils are found in the study area. Occasionally rock outcrops are also seen. Podzolisation and leaching of soil is very common. Yellowish colour of soil shows washing down of iron and aluminium to a great extent. The soil formation in the study area is not uniform. Soil forming process is slow and soils are relatively young in the steep slopes. In milder slopes soil forming processes are most active forming matured soils. Study area has a wide variety of vegetation. Humid temperate forest vegetation is found along the ridges of the basin. The species grown are Katus (*Castanopsis indica*), Tite Champ (*Michaelia cathcarti*), Musre Katus (*Castanopsis tribuloides*) and its associates. Moist scrub vegetation consists of Panisaj (*Terminalia myriocarpa),* Lahsune *(Amoora rohituka*) and their associates are found in the northern part of the study area. Dense scrub vegetation with human settlement is seen on warmer south western aspect lying all along the eastern side of the study area. Western side has Dhupi (*Cryptomeria japonica*). Tea gardens are mostly concentrated in the middle reaches on all sides of the basin. Wasteland with dry scrub consisting of Siris (*Albizzia sp.*), Parari (*Stereospermum chelonoides*) and associates are encountered in the lowest reaches of the study area.

In view of this discussion it is eminent to study the drainage systems and their network for determining the level of erosion and their impact on agriculture and forestry in the study area. Moreover rivers and springs not only help the agriculture but also generate the hydel power to supply the immediate vicinity.

CHAPTER II

DRAINAGE CHARACTERISTICS IN THE BASIN

INTRODUCTION

The Balason basin is drained by river Balason and its ten major tributaries and numerous minor tributaries. The basin is funnel shaped with rivers draining from north, northeast, northwest, east and west towards the south. The right bank tributaries are Pulungdung *khola*, Rangbang *nadi*, Marma *nadi*, Manjwa *jhora* and Dudhia *jhora*.The left bank tributaries are Bhim *khola*, Rangmuk *nadi*, Pachhim *nadi*, Rinchingtong *khola* and Ghatta–Hussain *nadi*. All these rivers erode the land and set a typical pattern over the land.

2.1 DRAINAGE CHARACTERISTICS

Entire Balason basin shows a dendritic pattern of drainage. All the streams join each other at acute angles. But along the steep slopes in few areas parallel drainage pattern can also be identified. Parallel drainage pattern shows the structures control over drainage.

2.1.1 Long and Cross Profile

Dudhia jhora has a length of 4.75km. It rises along the Nepal border in the south western part of the study area.

Manjwa jhora, which has a length of 4.1km, originates at an elevation of above 1200m and flows eastwards to meet river Balason at an elevation of 450m.The tributaries at the upper course of the river are almost parallely aligned indicating the presence of steep slope. In the lower course the river has fewer tributaries. Along the long profile there are two sudden changes, one at 1000m and again at 800m.The cross profile at 900m is 'V' shaped. The cross profile at 600m elevation shows steep slope on the left bank whereas right bank has gentle slope. The convex slope of the left bank may be due to the presence of more resistant rocks and less tributaries. In the upper part, the slope of the land is 20° but in the lower part the slope is steep, above 25° (Fig. 2.1).

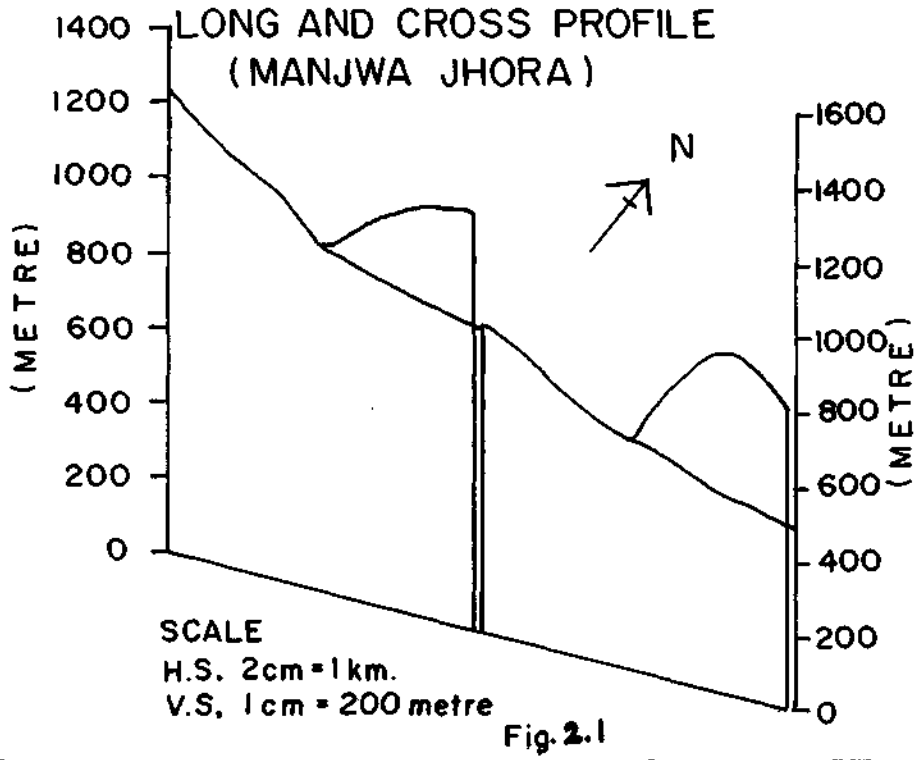

LONG AND CROSS PROFILE
(MANJWA JHORA)
1400
1200
1000
800
600
400
200
0
(METRE)
N
1600
1400
1200
1000
800
600
400
200
0
(METRE)
SCALE
H.S. 2cm = 1 km.
V.S. 1 cm = 200 metre

Fig. 2.1

Marina nadi stretching over a length of 4.25km is slightly longer than Manjwa *jhora*. The course of the river has a typical concave slope. The river rises at an elevation of 1600m, flows eastwards to join river Balason at an elevation of 540m. Under normal circumstances of lithology and structures, weathering and erosion will encourage the formation of concave slope out of a given uniform slope. Gilbert related concavity to water discharge and sediment load. The greater the discharge, the quicker and greater is the transport of load. This would promote concavity. If discharge increased more rapidly down slope than accompanying sediment load, then the whole matter (sediment and load) can be effectively transported even if the slope declined. This would also cause concavity. De la Noe and E. de Margerie(1888) had noted that if weakness of rocks increased upward this would cause the concavity of slopes. Long profile of Marina *nadi* shows the various stages of erosion. At first, the rocks are hard which helps the river to make a convex slope and further down, the river flows through a uniform slope. After flowing 1.5km from the origin, the river flows along a rectilinear slope with declined slope angle. The cross profile at 1000km is peculiar with left bank steeper than the right bank and the right bank is gentle with a sudden break of slope. The cross section at an elevation of 600m shows that the right bank is under continuous erosional process leading to flattish slope. Left bank has harder rock, which is getting eroded at a slower rate than the right bank showing more concavity (Fig. 2.2).

Rangbang nadi extends for a length of 17km. The source lies at a height of 2250m and ends at a height of 525m approximately. Along the long profile of the river, two knick points are visible, one at the height of 1700m and the other further down at an elevation of 900m. The river valley in the upper course that is between the source and 1700m is extremely steep. The angle of steepness or the gradient here is 25°. Between 1700m and 1100m the river has moderate steepness, being 20°- 25°. Between 1100m and 900m the river flows strikingly over a gentle slope making an angle of 20°. At 800m there is a break of slope.

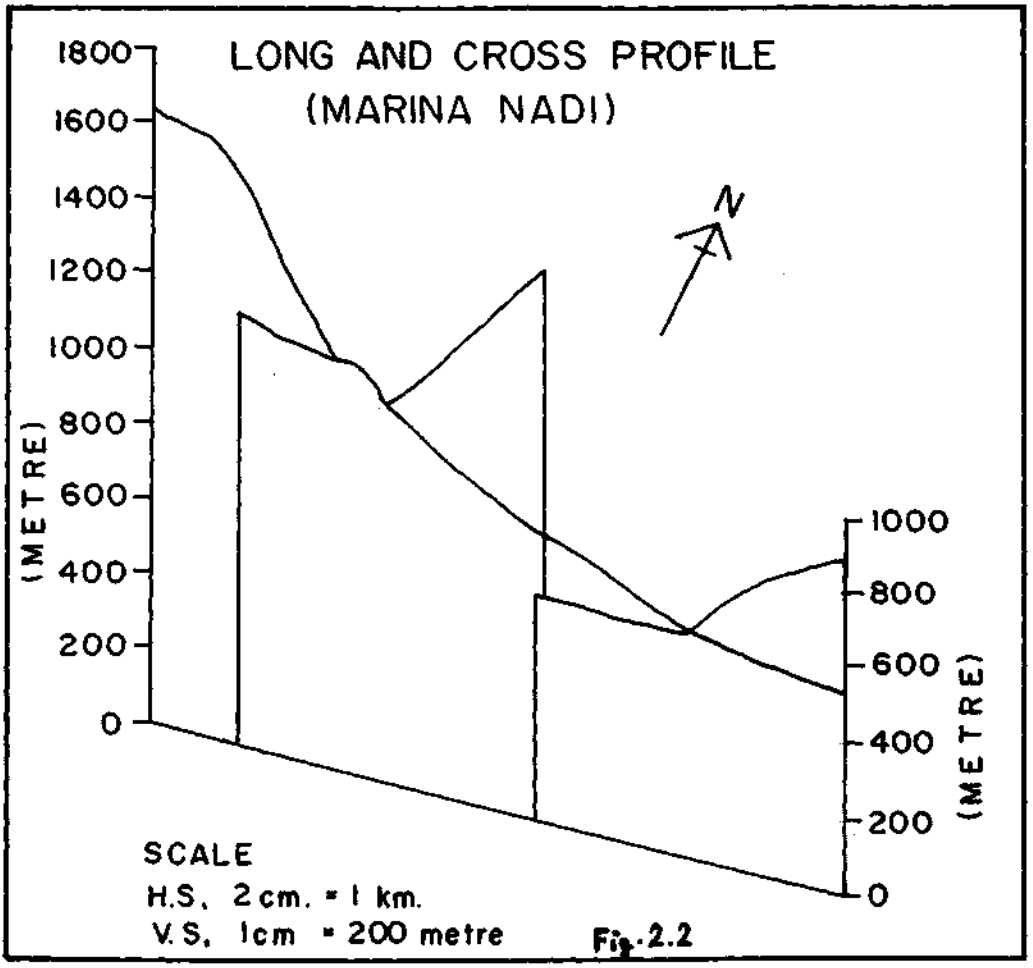

LONG AND CROSS PROFILE
(MARINA NADI)
N
1800
1600
1400
1200
1000
800
600
400
200
0
(METRE)
1000
800
600
400
200
0
(METRE)
SCALE
H.S. 2 cm. = 1 km.
V.S. 1cm = 200 metre

Fig. 2.2

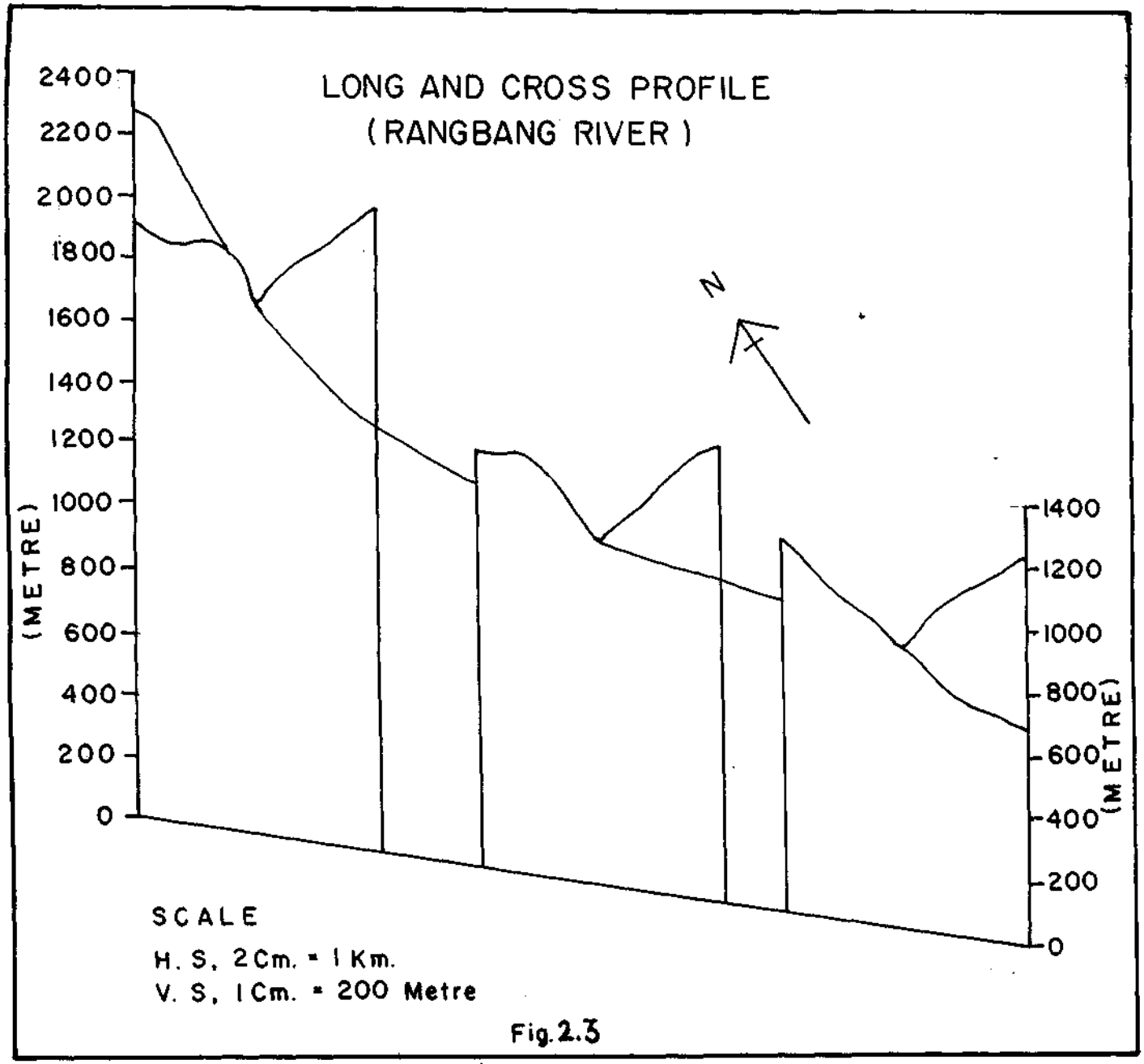

LONG AND CROSS PROFILE
(RANGBANG RIVER)
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
(METRE)
N
1400
1200
1000
800
600
400
200
0
(METRE)
SCALE
H. S, 2Cm. = 1 Km.
V. S, 1Cm. = 200 Metre

Fig. 2.3

Between 800m and the end point of the river where it meets the mighty Balason approximately at a height of 525m, the Rangbang *nadi* forms a moderately steep slope, similar to the slope between1700m and 1100m. Where the slope is steep, the reason might be the presence of resistant rocks whereas the gentle slopes might result due to the presence of comparatively softer rocks. In the steep slopes there might be probability of flash floods during heavy rain. Gentle and moderate slopes are usually prone to soil erosion and landslides. The cross profiles give a clear idea about the change in the shape of the valley. In the higher altitudes the valley is deep forming narrow 'V' shaped valley. Where the river is flowing at an elevation of 1100m, the 'V' shaped valley is comparatively wider. Around 900m elevation the sides of the river are eroded to a great extent due to lateral corrasion and mass wasting. Thus the valley became much wider. In the last cross section at an elevation of 600m again the 'V' shaped valley became narrow might be due to the local variation of rocks. Below the knick point at an elevation of 900m the river again reached its youth and vertical corrasion has increased forming such a valley (Fig. 2.3).

Phulungdung khola extends for a length of 5.55km. Its source lies at a height of 2150m and joins Balason river at a height of 975m. The long profile of the *khola* shows almost gentle slope except between 1900m and 2000m. Here the slope is slightly steep and the angle of steepness is 15° to 20°. Gentle slope all along the course indicates homogeneous rock structure in the area. The cross profile, where the *khola* is at a height of 1800m is a wider 'V' shaped valley than at a height of 1300m where the valley is comparatively narrow. This might be due to the presence of more resistant rock at the lower elevation (Fig. 2.4).

Bhim khola is one of the longest tributaries of river Balason with a length of 7km. Bhim *khola* originates at a height of about 2100m. Along the long profile a knick point can be observed at a height of 2000m. The slope between 1900m and 2000m is comparatively steep. Further down stream the river slope is gentle. In the upper course, the contours are

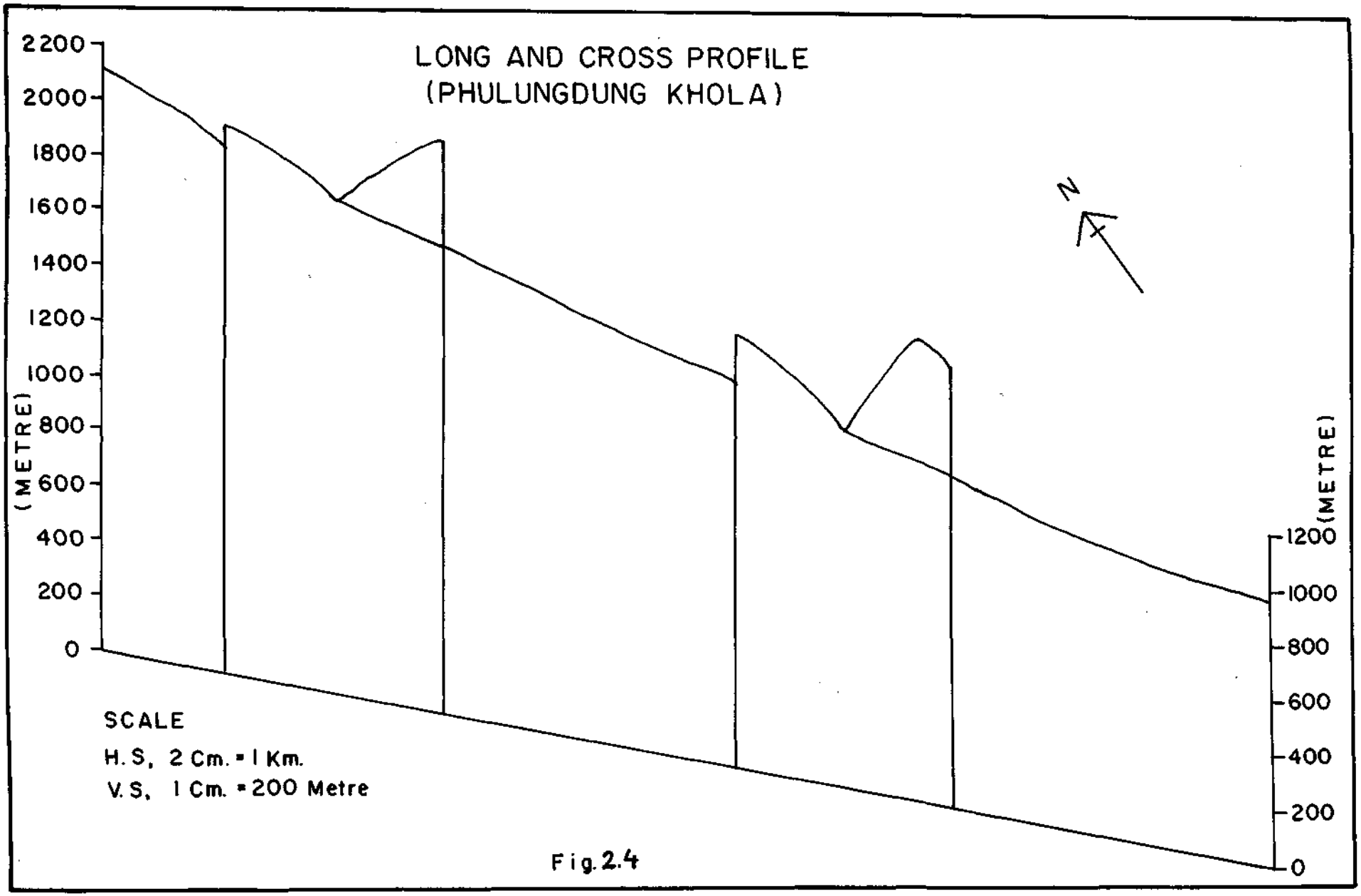

LONG AND CROSS PROFILE
(PHULUNGDUNG KHOLA)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
(METRE)
N
1200
1000
800
600
400
200
0
(METRE)
SCALE
H.S, 2 Cm. = 1 Km.
V.S, 1 Cm. = 200 Metre

Fig. 2.4

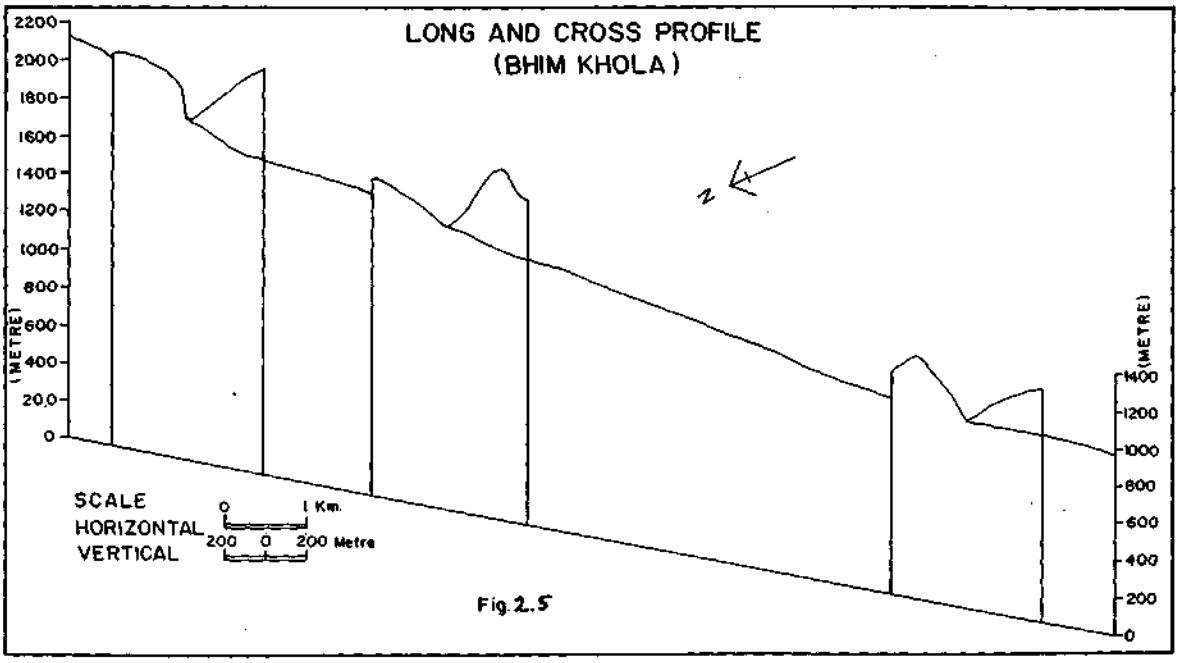

LONG AND CROSS PROFILE
(BHIM KHOLA)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
(METRE)
1400
1200
1000
800
600
400
200
0
(METRE)
SCALE
HORIZONTAL
VERTICAL
0 1 Km.
200 0 200 Metre

Fig. 2.5

closely spaced, middle course contours are moderately spaced and in the lower course contours are sparsely spaced. The slope in the upper, middle and lower part of the river course is 20°, 30° and 25°respectively. The cross profiles give a clear idea about the change in the slope of the valley. Where the river is flowing at a height of 1800m the 'V' shaped valley is extremely steep on the right bank and comparatively gentle on the other side. Further down stream where the river is flowing at a height of 1500m the right bank is extremely eroded may be due to the presence of softer rocks or landslide. The left bank forms a small summit at a height of above 1800m. At about 1000m, the right bank is again steep due to the presence of hard rock and left bank is extremely gentle due to excessive erosion (Fig. 2.5).

Rangmuk nadi rises at a height of 2050m and flows southwards for a distance of 8km, to meet river Balason at an elevation of 800m. Along its course there is sudden break in slope at an elevation of 2000m. From 2000m downwards, the slope is almost vertical. Below the height of 1500m, the slope is quite uniform or rectilinear. Severe down cutting in the upper course of Rangmuk *nadi* leads to the formation of steep slope. The angle of slope is 25°. As we go downstream the angle of steepness decreases. The cross profile at three different heights like 1700m, 1300m and 1000m are 'V' shaped and shows uniformity in the structure of the underlying rocks. Right bank is steeper than the left bank (Fig. 2.6).

Pachhim khola originates at a height of about 1950m and after flowing over a distance of 6.9km meets river Balason at a height of 675m. There are two sudden drops in height, one at an elevation of 1900m and another at 1500m. These two heights might be referred to as knick points. The angle of steepness at 1900m and 1500m are 25° and 20° respectively. Where the river is flowing at a height of 1400m, the valley is narrow 'V' shaped because the *khola* is fast flowing with acute vertical corrasion. At an elevation of 1100m the 'V' shape of the valley has become wider due to lateral erosion. At an elevation of 900m the right bank of the river is completely eroded and lies at a lower

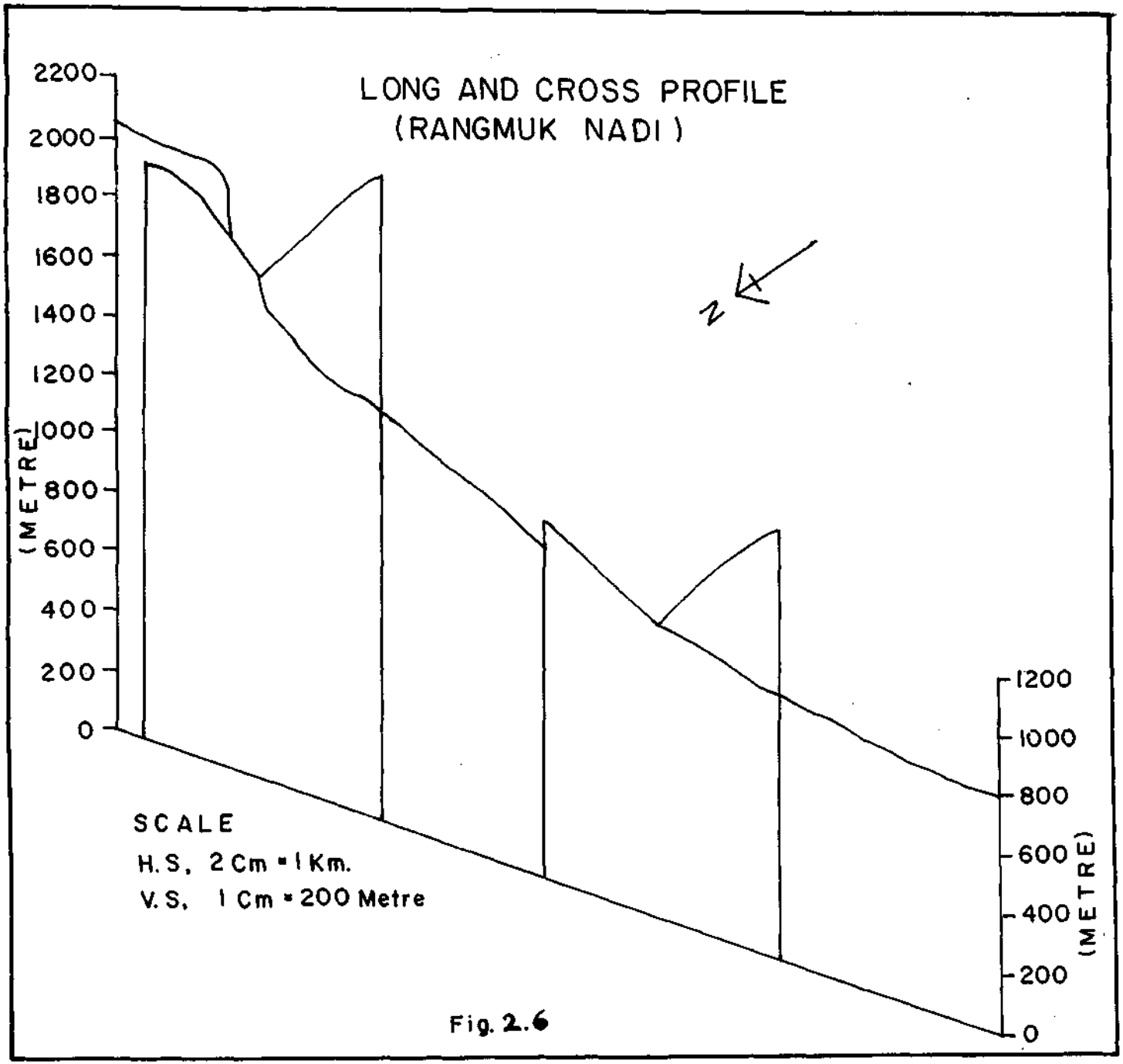

LONG AND CROSS PROFILE
(RANGMUK NADI)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
(METRE)
N
SCALE
H.S. 2 Cm = 1 Km.
V.S. 1 Cm = 200 Metre
1200
1000
800
600
400
200
0
(METRE)

Fig. 2.6

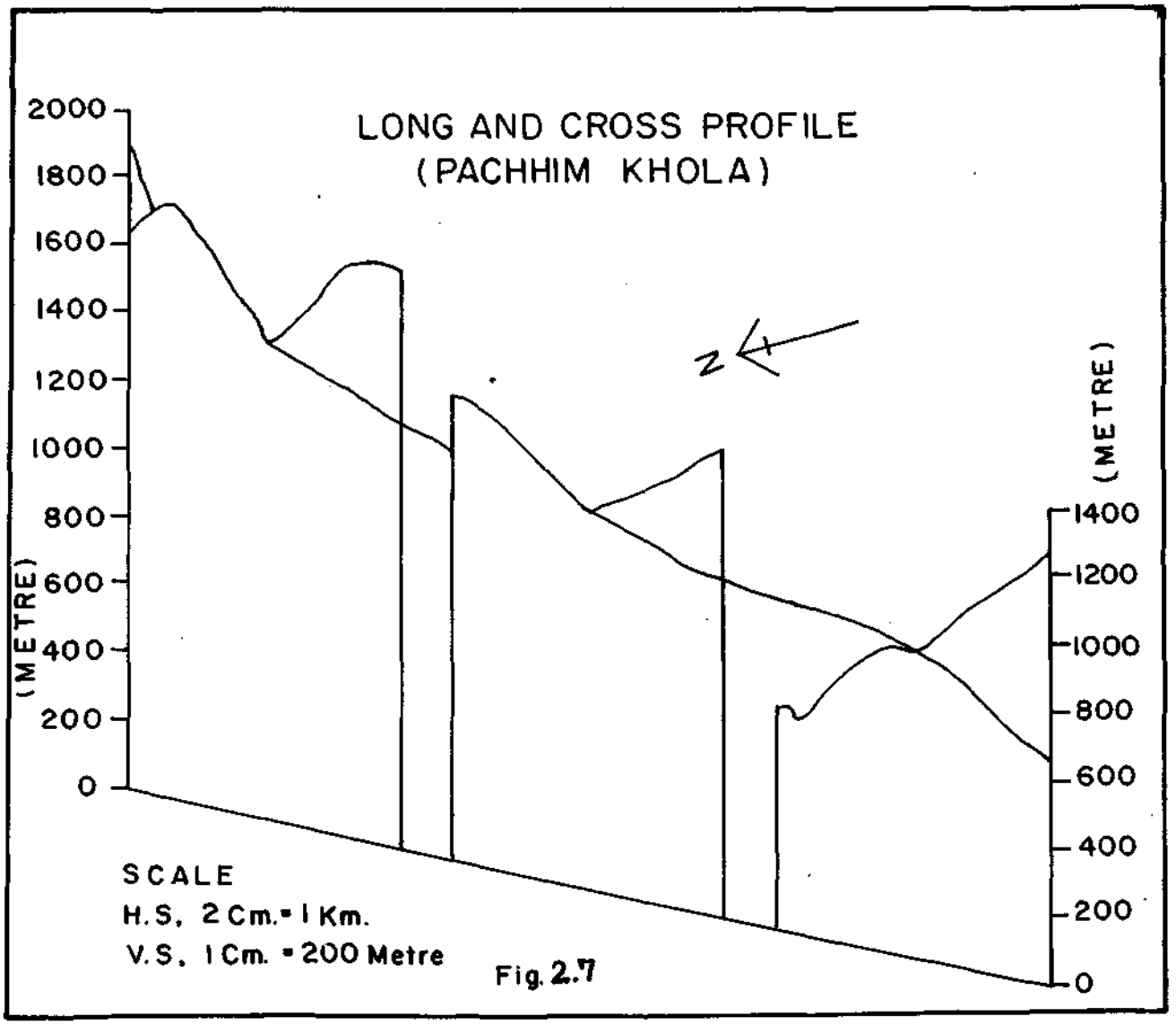

LONG AND CROSS PROFILE
(PACHHIM KHOLA)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
(METRE)
N
1400
1200
1000
800
600
400
200
0
(METRE)
SCALE
H.S. 2 Cm. = 1 Km.
V.S. 1 Cm. = 200 Metre

Fig. 2.7

elevation than the river. On the bank there is an interfluve between the heights of 650m and 900m (Fig. 2.7).

Rinchingtong khola has a length of 7.13km from the source to the point where it meets the Balason river. It rises at an elevation of 1700m and flows southwestwards almost parallel to Rangmuk and Pachhim *khola* in its upper course. Till 1200m elevation, the long profile shows steep slope. Here the slope is also concave and the knick point lies at an elevation of 1200m.Below this, the slope is gentle and at the end it is convex in shape. In the three cross profiles at heights 1500m, 1200m and 700m, the left banks are steeper than the right banks in the upper course (Fig. 2.8).

2.1.2. Stream Ordering

Rivers like Dudhia *jhora*, Marina *nadi*, Phulungdung *khola*, Bhim *khola* and Pachhim *khola* has only till third order streams.Other rivers like Manjwa *jhora*, Rangbang *nadi*, Rangmuk *nadi*, Rinchington *khola* and Ghatta – Hussain *nadi* has till fourth order streams. The three rivers namely Dudhia *jhora*, Manjwa *jhora* and Marina *nadi* which drains almost same area of land, Dudhia has the largest number of first order streams which indicated more erosion. The next four rivers, which drain almost the same area of land, are Phulungdung *khola*, Pachhim *khola*, Rinchington *khola* and Ghatta- Hussain *nadi*. Rinchington has the largest number of first order streams (Fig. 2.9).

Among all the tributaries of Balason river, Rangbang *nadi* has the highest number of first order streams with maximum dissected valleys. Rangbang flows through a valley with slope ranging between 20^0 and 25^0. In the upper reaches the drainage density is high indicating massive erosion of the rock along the hill slopes. So, Rangbang basin is likely to have more flood peaks. In the entire Balason basin, first order streams are almost five times more than the second order streams. This indicates that the entire basin is prone to severe soil erosion.

2.1.3. Drainage Frequency

Balason basin has been divided into five drainage frequency regions. Very low drainage frequency is found in the northern part of

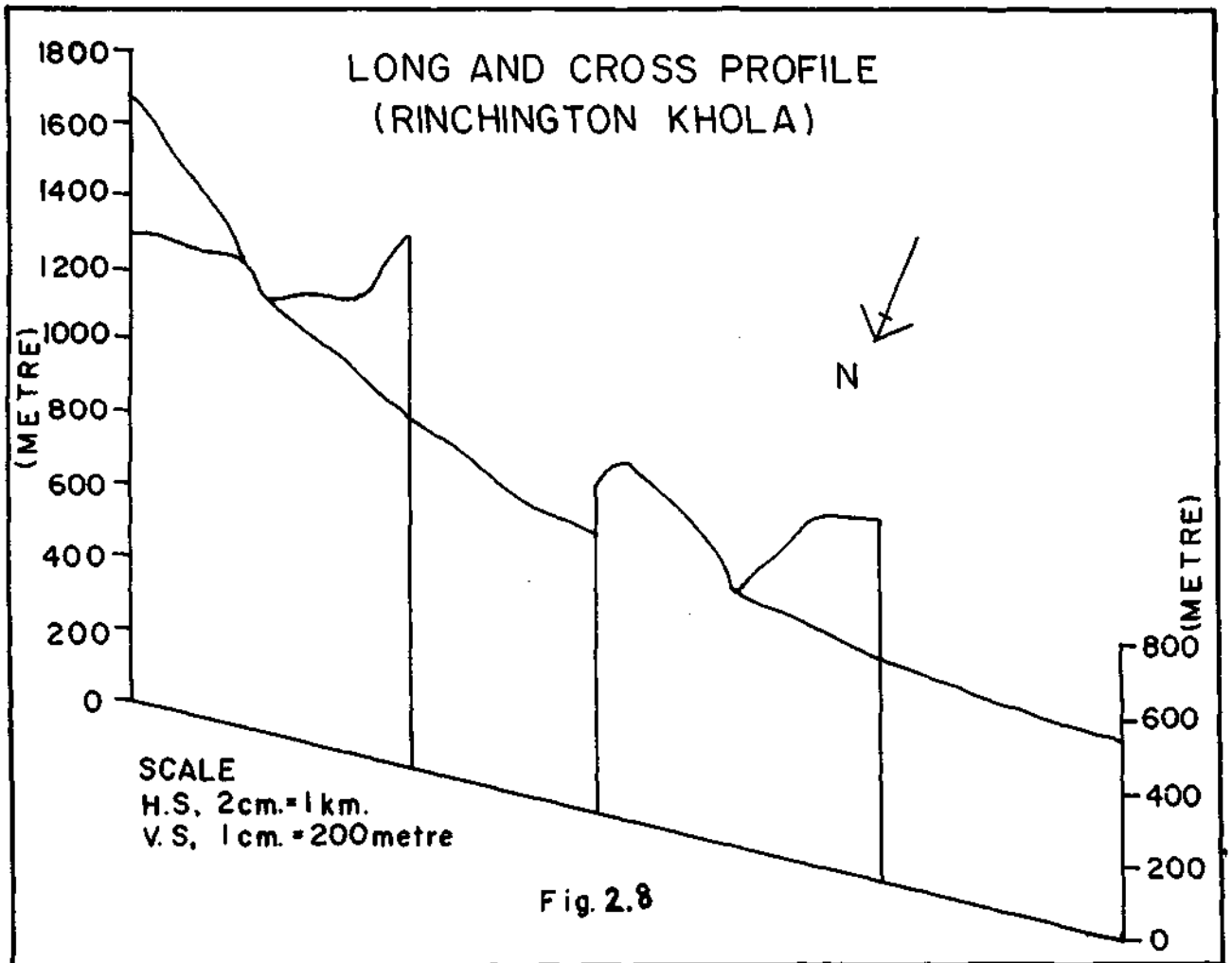

LONG AND CROSS PROFILE
(RINCHINGTON KHOLA)
1800
1600
1400
1200
1000
800
600
400
200
0
(METRE)
N
800
600
400
200
0
(METRE)
SCALE
H.S. 2cm.=1km.
V.S. 1cm.=200metre

Fig. 2.8

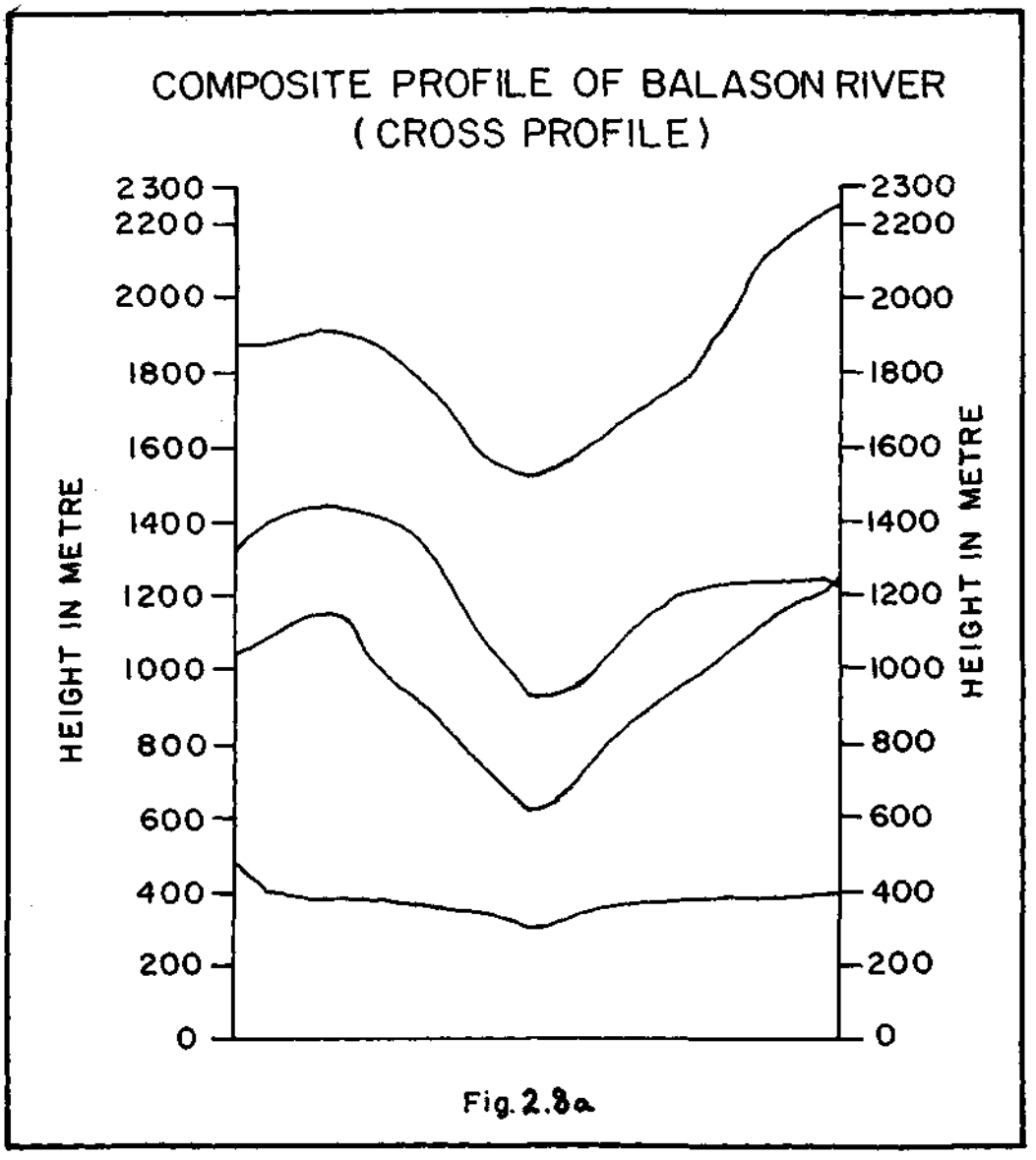
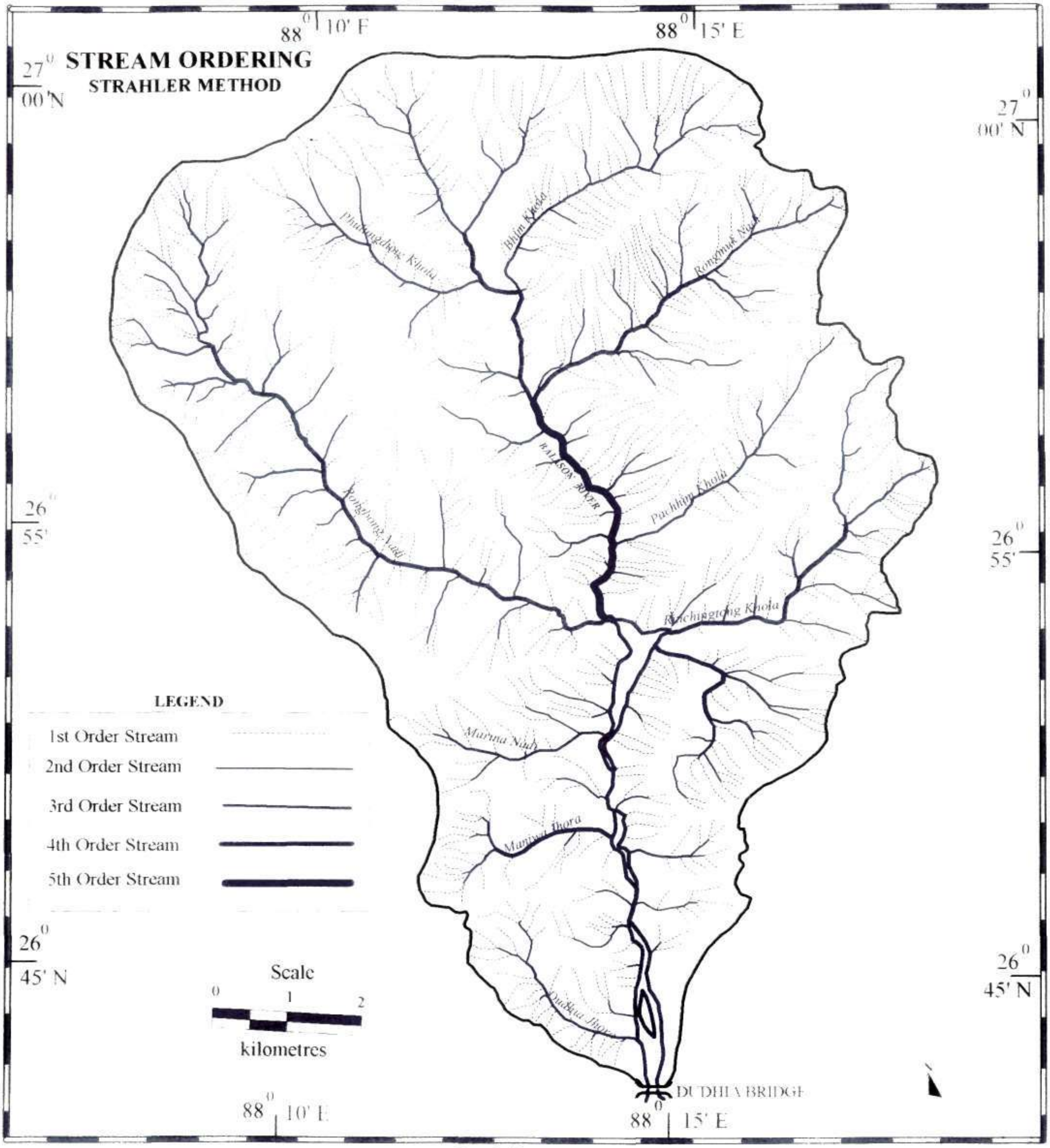

COMPOSITE PROFILE OF BALASON RIVER
(CROSS PROFILE)
HEIGHT IN METRE
2300
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
HEIGHT IN METRE

Fig. 2.8a



STREAM ORDERING
STRAHLER METHOD
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 45' N
Phulungdhong Khola
Bhim Khola
Rongmuk Nadi
BALASON RIVER
Pachhim Khola
Rongbong Nadi
Rachingtong Khola
Marma Nadi
Manjwa Jhora
Dudhia Jhora
DUDHIA BRIDGE
LEGEND
1st Order Stream
2nd Order Stream
3rd Order Stream
4th Order Stream
5th Order Stream
Scale
0
1
2
kilometres

Fig. 2.9

the basin along the Jorebunglow – Sukhiapokhri ridge. Other areas are found as small isolated pockets. Medium drainage frequency i.e. 6 to 8 streams per km^2 dominates maximum area of the Balason basin. High drainage frequency areas are coinciding with high relative relief areas. Very high drainage frequency areas are restricted to certain areas only in the northeastern corner of the map (Fig. 2.10).

2.1.4. Drainage Density

The drainage density of any particular area is a function of geologic structure and climatic factors, specially, rainfall. A drainage network of specific pattern and density develops on account of the fact that streams always seek out and take advantage of weakness in the rock strata over which they flow. They provide useful clues about land stability and in turn, important clues about feasibility of certain land management practices (Hornbeck, 1984). The drainage density could be assessed for the entire basin or can also be assessed for a specified stream order where it will represent length of all channels above the specified stream order, per unit of drainage area (Langbein, 1975). High drainage density affects run off pattern. A high drainage density moves surface water rapidly decreasing the lag time and increasing the peak of hydrograph (Singh et la, 1991). In other words, higher the drainage density, more efficient is the drainage and more flashy is the stream flow and vice versa (Varshney, 1971). The drainage density has an important bearing on transport of eroded material. Higher the drainage density, higher is the sediment delivery ratio (Oyebande, 1981). The values of sediment delivery ratios vary as widely as 5% - 100% (Chow, 1964). The drainage density exhibits a wide range of values in nature and varies from 3 – 4 to as high as 1300 (Chorley, 1971). In areas having comparable rainfall pattern it is a function of permeability of the soil mantle. The sandy soils shall show the least values and the impermeable clays the highest (Fig. 2.11).

The drainage density in the study area varies from 4.0 to 10.0km per km^2. The drainage density is high along the ridge areas where the relative relief is moderate. This may be due to the presence of hard

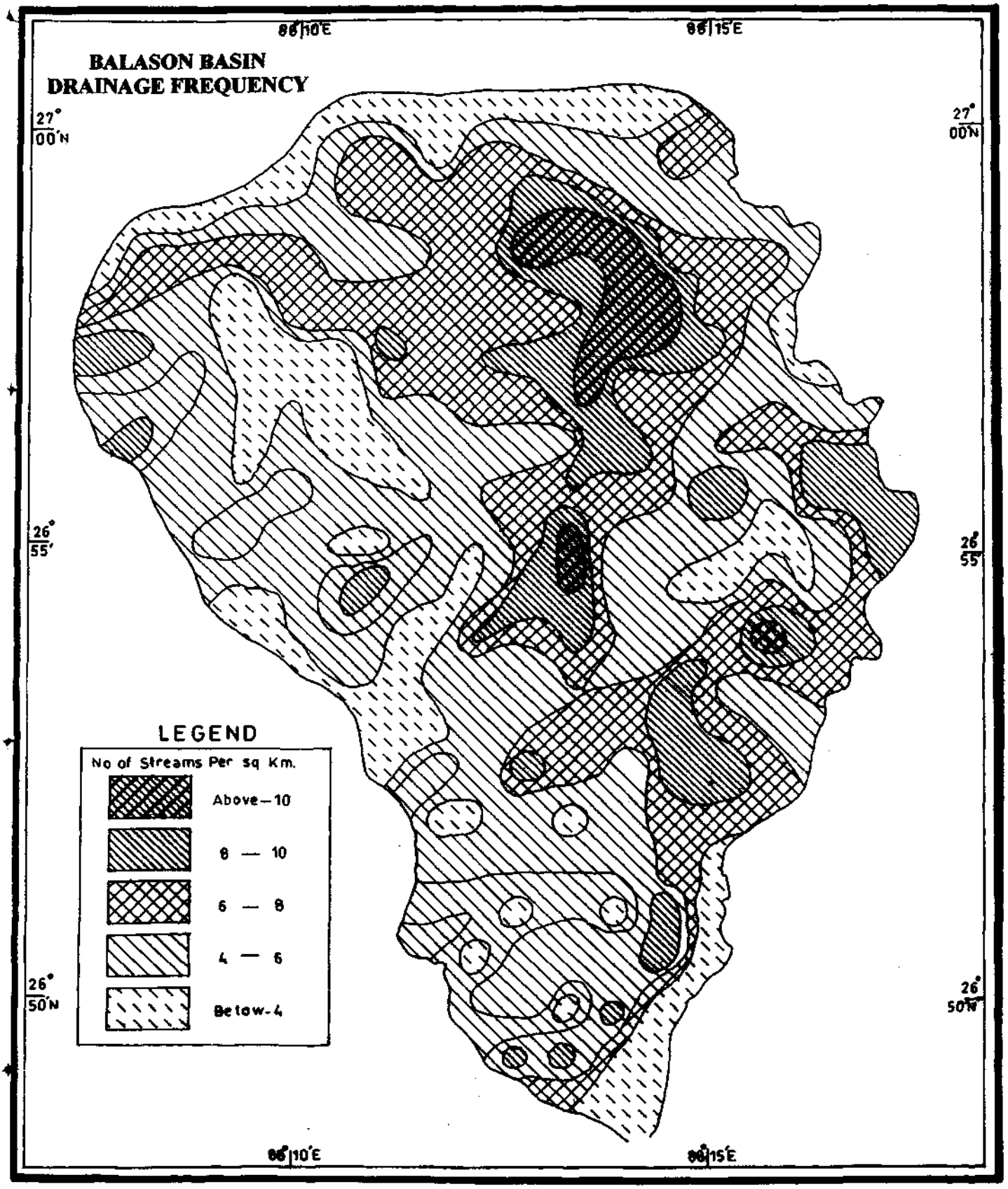

BALASON BASIN
DRAINAGE FREQUENCY
86°10'E
86°15'E
27°00'N
26°55'
26°50'N
LEGEND
No of Streams Per sq Km.
Above—10
8 — 10
6 — 8
4 — 6
Below-4

Fig. 2.10

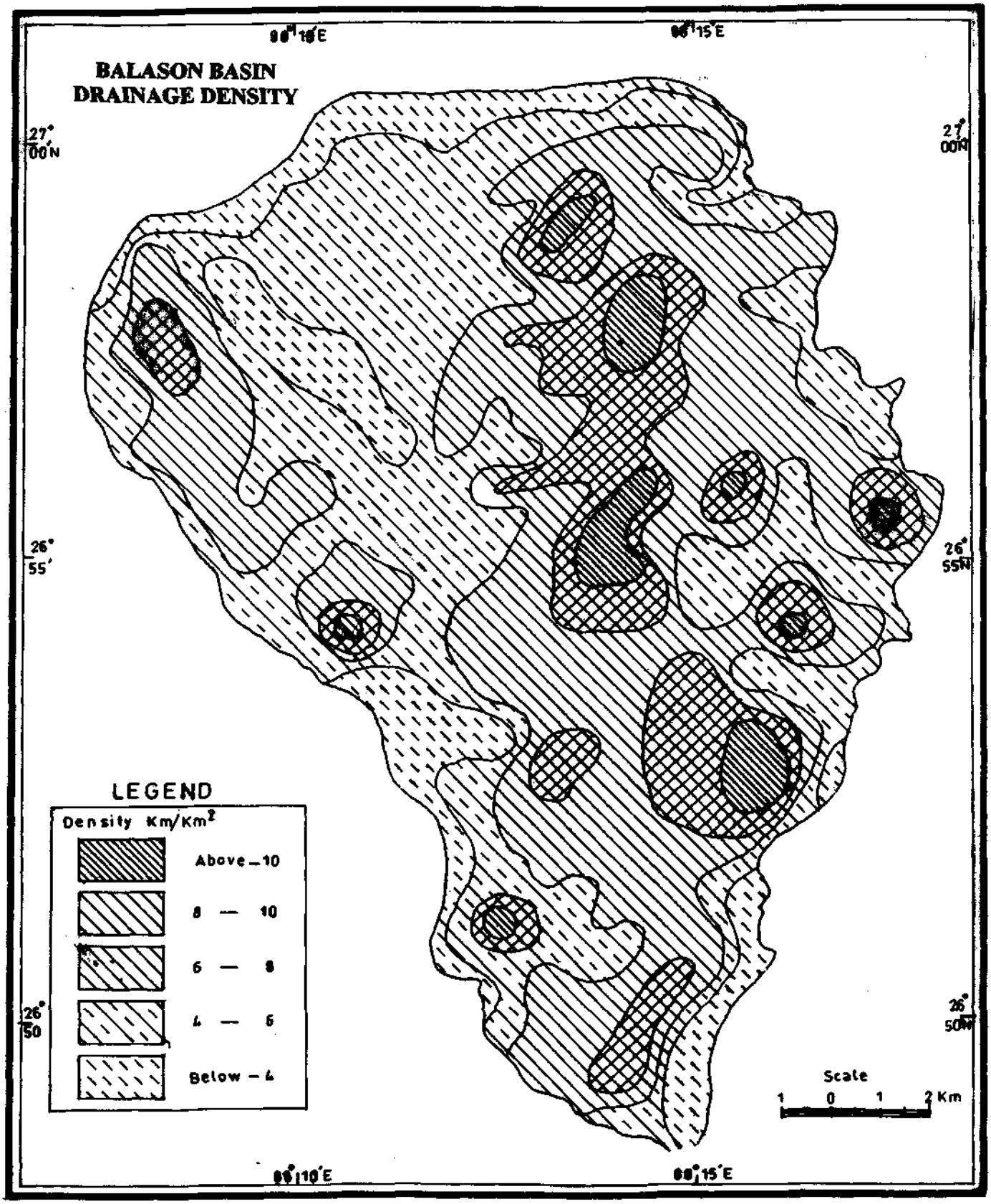

BALASON BASIN
DRAINAGE DENSITY
88°10'E
88°15'E
27°00'N
26°55'
26°50'
LEGEND
Density Km/Km²
Above – 10
8 — 10
6 — 8
4 — 6
Below – 4
Scale
1 0 1 2 Km

Fig. 2.11

rock. The small streams are unable to cut the hard rock. Only rills can be formed. Drainage density is high in the middle and lower part of the rivers and these are the places of moderate to low relative relief. The areas of high drainage density are located in Thurbo T.G. in the west, Tongsong and Rangmuk T.G. in the north, Dilaram, Ringtong and Ambootia T.G. in the east, Mondakoti, Dhajea and Phulbari T.G. in the center and Phuguri T.G. in the south. All these areas have drainage density above 10.0km per km^2 and are found in small isolated pockets. Maximum area of the basin falls under 6.0 to 8.0 km per km^2 drainage density region, which shows moderate density. Along the western part of the basin, tea gardens, which lie in this area, are Chamu, Seyok and Marma. Along the eastern part lie Talkat and Okas T.G. In the water divide between Rangbang and Phlungdung *nadi,* the relative relief is moderate but drainage density is very low. This indicates less down cutting power of the small first order streams. Lowest drainage density is below 4km per km^2, which is also found in the southern most part of the basin.

2.1.5. Bifurcation Ratio

The bifurcation ratio of the ten sub – basins of river Balason, ranges from 2.9 to 7.3. The higher the bifurcation ratio, the younger is the drainage. So Bhim *khola* (rb = 7.3) is younger compared to Manjwa *jhora* (rb = 2.9). Bifurcation ratio above 3 usually indicates that the river is prone to floods. The hydrograph of Manjwa basin is therefore, the most acute and that for Bhim is flattest of all. The bifurcation ratio of the entire Balason basin is 5.2, which shows that the area is prone to floods. The determination of bifurcation ratio of basins has been done following standard techniques (Chorley, 1971).

2.1.6. Circularity Ratio

In circularity ratio, value ranges from 0 to 1. Values above 0.5 indicate maturity of the river basin in its evolutionary cycle. Circularity ratio of Rangbang *nadi* and Phulungdung *khola* is high ranging from 0.5 to 0.6 whereas that of Manjwa jhora, Bhim khola, Rangmuk nadi and Ghatta – Hussain *nadi* ranges from 0.6 to 0.7. Basins of

Rinchington *khola*, Dudhia *jhora*, Marina *nadi* and Pachhim *khola* have circularity ratio below 0.5 which indicates that the rivers are in their youthful stage, eroding more by vertical corrasion.

Table: 2.1 Morphometric characteristics of the major rivers in the basin.

Name of sub-watershade	Bifurcation Ratio	Circularity Ratio+	Elongation Ratio#	Form Factor*	Compactness Co-efficient
Dudhia *Jhora*	4.9	0.48	0.61	0.75	1.44
Manjwa *Jhora*	2.9	0.68	0.70	0.73	1.22
Marina *Nadi*	4.3	0.48	0.63	0.81	1.44
Rangbang *Nadi*	5.4	0.57	0.61	0.30	1.32
Phulungdung *Khola*	5.8	0.55	0.71	0.46	1.34
Bhim *Khola*	7.3	0.66	0.73	0.47	1.23
Ramgmuk *Nadi*	4.4	0.66	0.65	0.40	1.23
Pachhim *Khola*	5.7	0.49	0.54	0.70	1.43
Rinchingtong *Khola*	4.3	0.37	0.54	0.65	1.64

*(*Horton1932, +Miller1953, #Schumm1956)*

2.1.7. Elongation Ratio

Lower the value of elongation ratio, the basin is more elongated which means that the basin is structurally controlled and relatively in a youthful stage and hence more prone to erosion (Mithra & Rao, 1993). In the Balason basin in case of both Pachhim and Rinchingtong *khola*, elongation ratio is 0.54, which is less compared to 9.2 of Ghatta – Hussain *nadi*. So soil erosion caused by Ghatta – Hussain *nadi* is less since it's in its mature stage. Both Pachhim and Rinchingtong are in their youth and so these rivers more effectively do soil removal.

2.1.8. Form Factor

This is the shape index of the basin. Form factor is highest (0.81) in Marina *nadi* and lowest (0.30) in Rangbang *nadi*. So the shape of the Rangbang basin is more elongated than the Marina basin.

2.1.9. Compactness Co-efficient

Compactness co-efficient is highest (1.64) in Rinchingtong Khola and lowest (1.22) in Manjwa jhora. If this value is greater than one, it indicates that the basin in compact in nature. All the tributaries of river

Balason flows through compact basins.

CONCLUSION

River Balason flows from north (Lepcha Jagat) to south. Among the ten major tributaries, which spread over the basin, Marina, Rangbang and Rangmuk are perennial. Rivers like Rangbang, Phulungdung and Rangmuk rises at an elevation of above 2000m. All the rivers flow through deep and precipitous gorges in their upper course. Long profile of the rivers show concave and rectilinear pattern of slopes. The cross profiles are different in case of different rivers. In Marina *nadi* and Rinchingtong *khola*, the left banks are steeper whereas in Bhim and Rangmuk *nadi*, the right banks are steeper. The rivers through gentle slope indicating homogenous rock structure in the area. The study area has mainly dendritic drainage pattern accompanied by parallel drainage pattern wherever the land is very steep and this indicates structural control over drainage. In the entire basin, as usual, the number of first order streams is more than the other ordered streams. Rangbang *nadi* has the largest number of first order streams with maximum dissected valleys. The study area is dominated by medium frequency (6 to 8 streams per km^2). High drainage frequency areas have high relative relief. The drainage density in the study area varies from 4 to10km per km^2. The drainage density is high along the ridge areas where the relative relief is moderate. Maximum part of the basin has medium drainage density (6 to 8 km per km^2). Lowest drainage density, below 4km per km^2 is found in the southern part of the study area. Bifurcation ratio of the entire basin is 5.2, which indicates high flood peak. Circularity ratio of six tributary rivers is above 0.5, whereas rest tributary rivers have circularity ratio below 0.5. Elongation ratio and form factor both confirm the elongated shape of majority of the tributary basins. All the tributary drainage systems are compact in the study area. The settlements depend on the availability of water so generally population lives on the bank of river or valley of the river. Availability of water has greatly influenced the

spread and growth of population. The study area is mountainous with fast flowing rivers. So distribution of settlements and growth of population with their demographic characteristics can be discussed in the next chapter.

CHAPTER III

HUMAN RESOURCE IN THE BASIN

INTRODUCTION

Human resource study has its focus on the rates and trends of various population characteristics such as distribution, growth, density, composition etc. Population growth in itself helps in planning human needs like food, clothing, shelter etc. Any comprehensive geographical analysis of a region should take into account the differential growth of population. Number, densities, distributions and qualities of the population provide the essential background for all geography (Trewortha, 1972). Population is the central element around which all other elements revolve and derive geographical significance. Thus, the study of population is the single most important approach to geography and in which the regional concept has its broadest application (Ghosh, 1985).

The Balason basin is situated in the eastern Himalayas. The mountainous physiography provides very little flat land for the easy spread of population and naturally population is less. The steep slopes of the mountains, scarcity of water storage facilities, thin layer of rocky soil and severe climatic conditions discourage people to settle down in the hills. Population is very unevenly distributed all over the basin. Despite the pressures of population explosion, vast areas remain inaccessible to mankind. Distribution of population gives an understanding of the geo-economic prospects and potential of an area. The growth and distribution of population vary widely because of topography, social, cultural and economic factors in the basin. Forests in the basin are mostly uninhabited and tea gardens support the population of the labourers who work in the respective gardens. So population is only concentrated in the khasmahals, which are, Government vested lands.

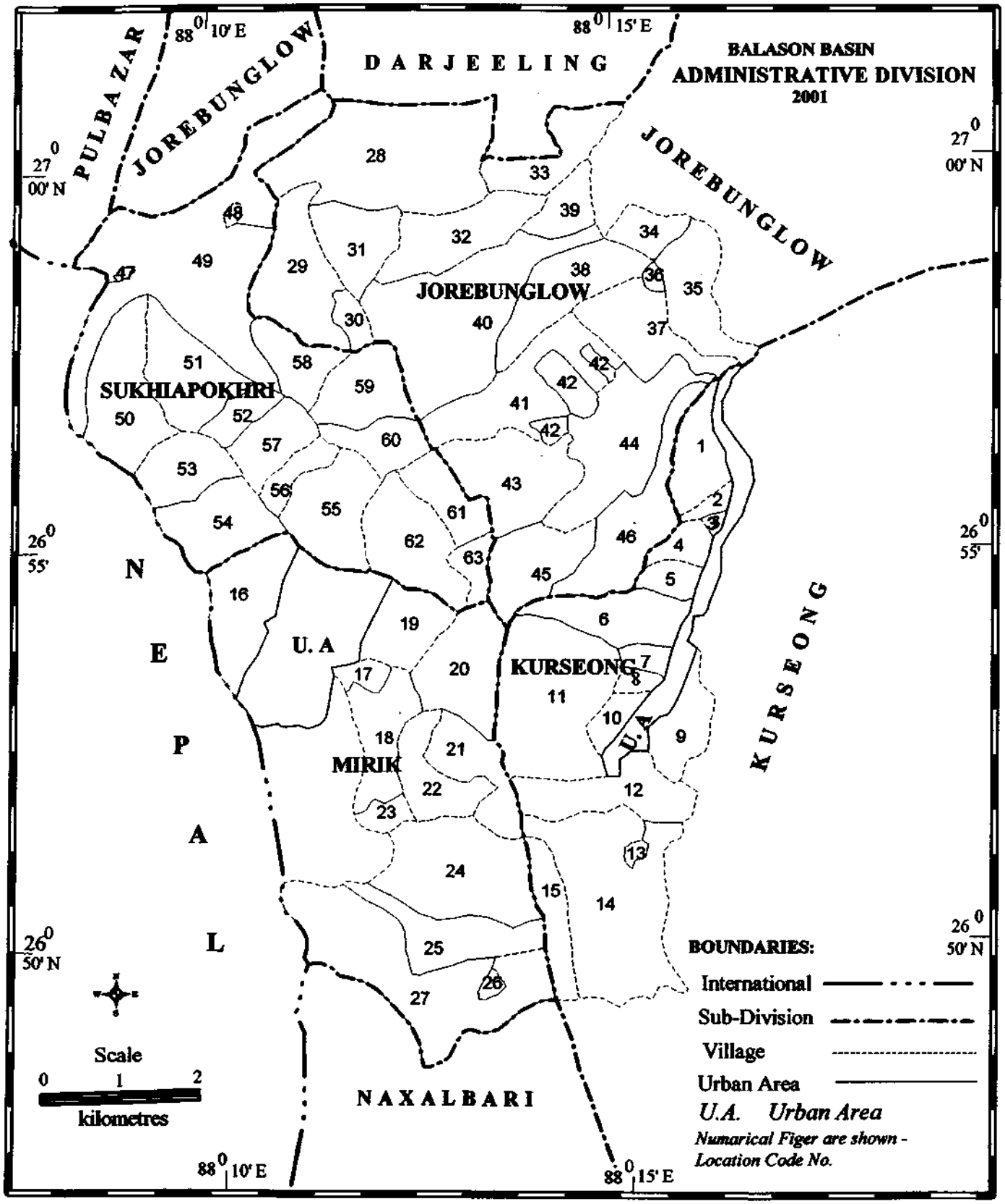


Fig.3.1

Appendix - I

3.1 DISTRIBUTION OF POPULATION

Distribution of population refers to the way people are spaced over the surface of the earth (Ghosh, 1985). In fact, the distributional pattern of population is an eloquent expression of the synthesis of all geographical phenomena operating in the area (Singh, 1985). The interpretation of population distribution in terms of area and population quality etc. gives an idea about the pattern of people, regional contrast and disparities including the degree of concentration in different areas. It has been estimated that about 80 percent of the world's total population is concentrated only over 20 percent of the world's total land area. Not only the social and economic systems but also the behavioural system is to a certain extent found to be a product of the pattern of distribution of various components of both static and dynamic nature (Hasanuz Zaman, 1998).

The population distribution has continuously changed in space and time, with migration and varying rates of population growth. In the study area, the population distribution is uneven due to hilly terrain, severe climate, non-availability of agricultural land and paucity of water.

Table:3.1: Classification of the villages according to area.

Area in Km^2	Category	No. of villages	Percentage to total area
> 8	Very Large	9	14.29
8 – 6	Large	10	15.87
6 – 4	Medium	14	22.22
4 – 2	Small	14	22.22
< 2	Very Small	16	25.40
Total		63	100.00

Source: Census of India, 2001.

Villages were demarcated in the past as revenue villages. The settlements in the villages grew up in and around the water resources and available agricultural land. Villages are very small in size in the study area. Moderate to very small villages account for 69.84% of the total area of the Balason basin. To access the limited resources available, the villages are small. Large villages are mostly tea gardens. Two forests namely Manjha and Ghoom Pahar are very large in size. In

the last three decades, the village size almost remained unaltered due to restriction to encroach forests. Among the tea gardens, Longview is the largest and Edenvale is the smallest. Among the khasmahals, Mim Nagri Range has the largest area whereas Simana Basti has the smallest. Among the forested areas, Manjha forest occupies the largest area and Phuguri Forest occupies the largest area (Fig. 3.2)

Relationship between population and resources has the great significance mainly due to the relation that continued population growth was a barrier, which obstructed further development and kept the world in a state of perpetual crisis. Population growth becomes vital element in assessing population resource of an area. Population is an important and valuable resource if it can be utilized properly. Proper utilization depends on different factors like availability of educational facilities, employment opportunities, sex ratio etc.

Table: 3.2: Classification of villages according to population size.

Ranges of population	Category	No. of villages	Percentage to total population
> 4000	Very High	10	15.88
4000 – 3000	High	7	11.11
3000 – 2000	Moderate	14	22.22
2000 - 1000	Low	14	22.22
< 1000	Very Low	18	28.57
Total		63	100.00

Source: Census of India, 2001.

Since Balason basin is situated in hilly area, settlements are isolated in nature but concentrated in areas where agricultural land and water supply is abundant. Population size is small in majority of the villages, compared to the mean of the basin. According to 2001 census, population ranges from 9030 in Sonada Khasmahal to 29 in Manjha Fst. (Pan.F.Rly.). The villages with population less than 1000 are mostly forest areas. Few villages on the western side of the Hill Cart Road, also has less population due to rugged steep terrain of the hill slope. But, in general, if compared to the plains, population is higher here. Among the tea gardens, Rongmook Ceder has the highest population i.e. 4908 and Edenvale has the lowest population i.e. 169.It is evident from the table 3.2, that 28.57% of the villages has population

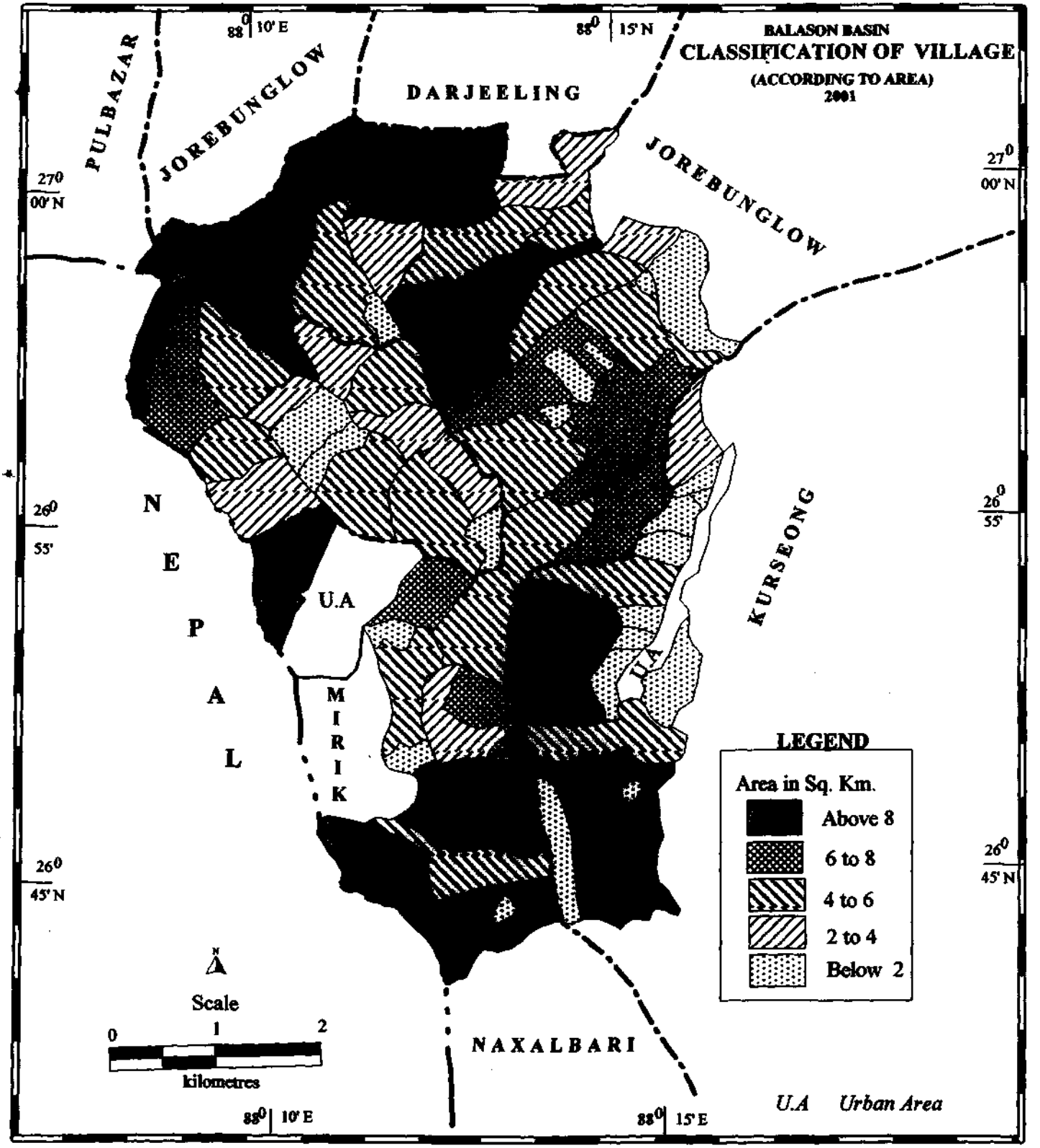

BALASON BASIN
CLASSIFICATION OF VILLAGE
(ACCORDING TO AREA)
2001
PULBAZAR
JOREBUNGLOW
DARJEELING
JOREBUNGLOW
KURSEONG
NEPAL
U.A
U.A
MIRIK
NAXALBARI
88° 10' E
88° 15' N
27° 00' N
26° 55'
26° 45' N
LEGEND
Area in Sq. Km.
Above 8
6 to 8
4 to 6
2 to 4
Below 2
N
Scale
0 1 2
kilometres
U.A Urban Area

Fig.3.2

less than 1000. According to 1991 census it was 15.87% and 1981 census it was 9.52%. So there is a gradual population increase in the villages during the last three decades. Twenty-eight out of 63 (44.44%) villages have population less than 3000 and 26.99% villages have population greater than 3000.Percentage of villages having medium range of population gradually decreases during the last three decades, which is evident from 66.66% in 1981, 47.62% in 1991 and 44.44% in 2001. Percentage of villages having high population increased from 1981 to1991 but remained same in between 1991 and 2001(Fig. 3.3)

3.2. COMPOSITION OF POPULATION

Composition of population is an important determinant of human resources. Each family comprises of both male and female members, further differentiated as children and old age people, who are generally called dependants. It is also differentiated on the basis of literates and illiterates.

3.2.1. Sex Ratio

Sex ratio influences the form and tempo of life and population structure. Sex ratio is important as it affects the labour supply. Moreover, it influences age of marriage, fertility and population growth, determination of birth and death rates and status of women. At the same time sex ratio is influenced by birth, death, migration etc.

Table: 3.3. Classification of villages according to sex ratio (female/1000male).

Range of sex ratio	Category	No. of villages	Percentage
> 1100	Very High	5	7.94
1100 – 1050	High	9	14.29
1050 – 1000	Moderate	22	34.92
1000 – 950	Low	20	31.75
< 950	Very Low	7	11.11
Total		63	100.00

Source: Census of India, 2001.

Majority of the villages have high sex ratio. Percentage of villages having sex ratio of above 950 females per 1000 males have increased from 57.14% (1981) to 60.325(1991) to 88.88% (2001) in the last three

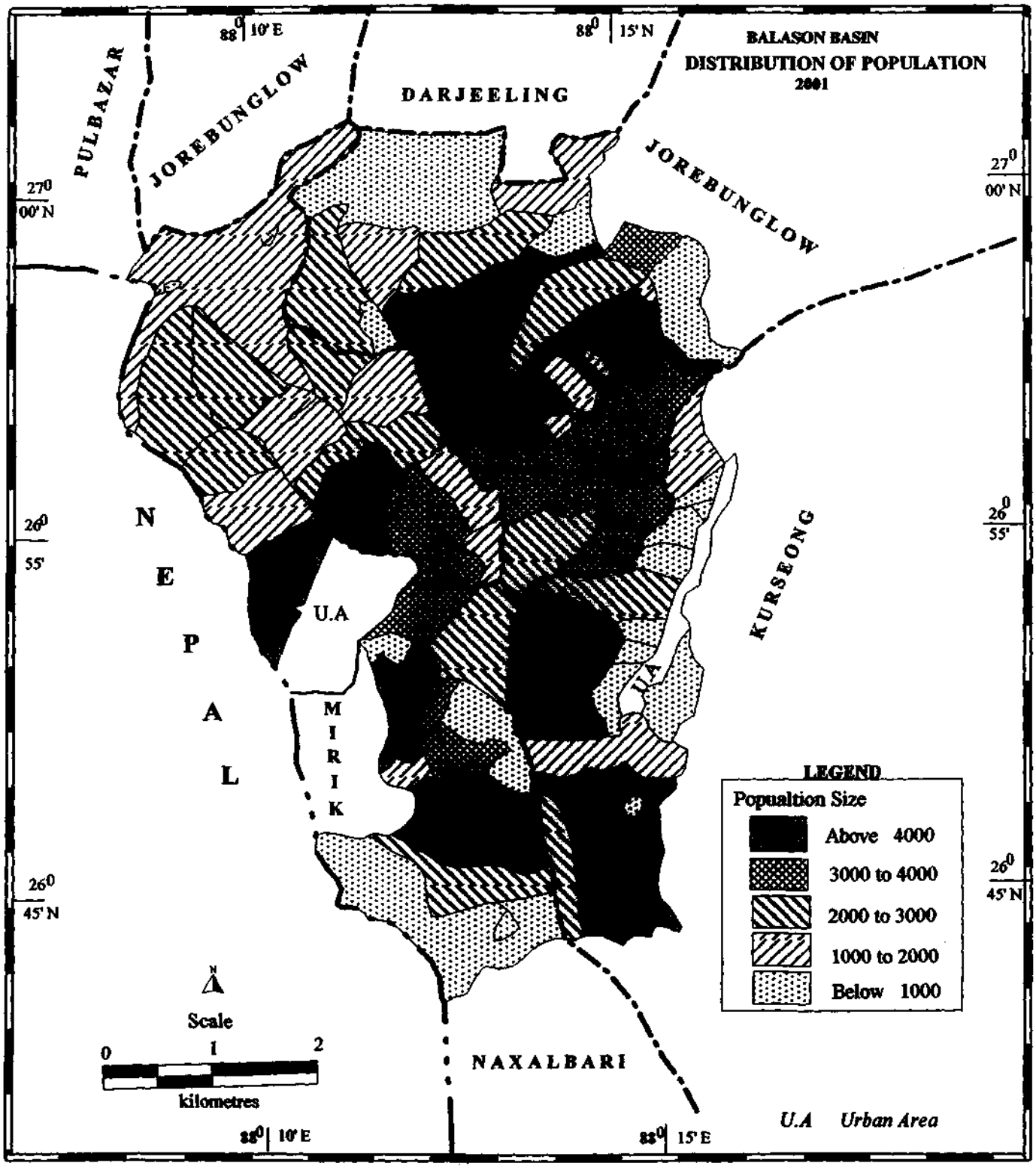

BALASON BASIN
DISTRIBUTION OF POPULATION
2001
88° 10' E
88° 15' N
DARJEELING
PULBAZAR
JOREBUNGLOW
JOREBUNGLOW
27° 00' N
26° 55'
N E P A L
U.A
MIRIK
KURSEONG
U.A
26° 45' N
LEGEND
Popualtion Size
Above 4000
3000 to 4000
2000 to 3000
1000 to 2000
Below 1000
N
Scale
0 1 2
kilometres
NAXALBARI
U.A Urban Area

Fig. 3.3

decades (Fig. 3.4). Sex ratio is visibly high in the tea gardens because female workers are much in demand in such areas. As a result, their number is more. Men usually go out to work in the nearest towns as labourers. Male members of the family also join the army and stay away from home. Low sex ratio indicates high cost of living, scarcity of accommodation and many other demographic problems.

3.2.2. Caste Composition

Two fundamental and primary strata within the Hindu society are the ritually higher caste and the untouchables, officially called scheduled castes (S.C.) (Bhardwaj, 1975). Another constituent of the population is the tribal people (S.T.) recognized by the constitution. As per the S.C. and S.T. Orders (Amendment Act, 1976) there are altogether 59 communities as S.C. and 38 as S.T. in West Bengal (Census, 1991).

In the study area, people from different places came to work in the tea gardens. The tea plantations created a big demand for plantation labour in the basin. Large-scale immigration took place. Since the inception of immigration, people belonging to various castes and tribes, speaking over a dozen Indo- Aryan and Tibeto- Burman tongues and hailing from Nepal, have always been a majority (Gazetteer, 1980). People immigrated from Nepal, Bhutan, Tibet and Sikkim. The scheduled castes include Kamis, Damais and Sarkis in the study area.

Table: 3.4 Classification of villages on the basis of percentage of S.C.population to total population.

Ranges	Category	No. of villages	Percentage of villages
> 12	Very High	4	6.35
12 – 9	High	11	17.46
9 – 6	Moderate	16	25.40
6 – 3	Low	17	26.98
< 3	Very Low	9	14.29
Nil		6	9.52
Total		63	100.00

Source: Census of India, 2001.

The total population of the basin contains a small segment of scheduled caste population. The highest percentage of S.C. population

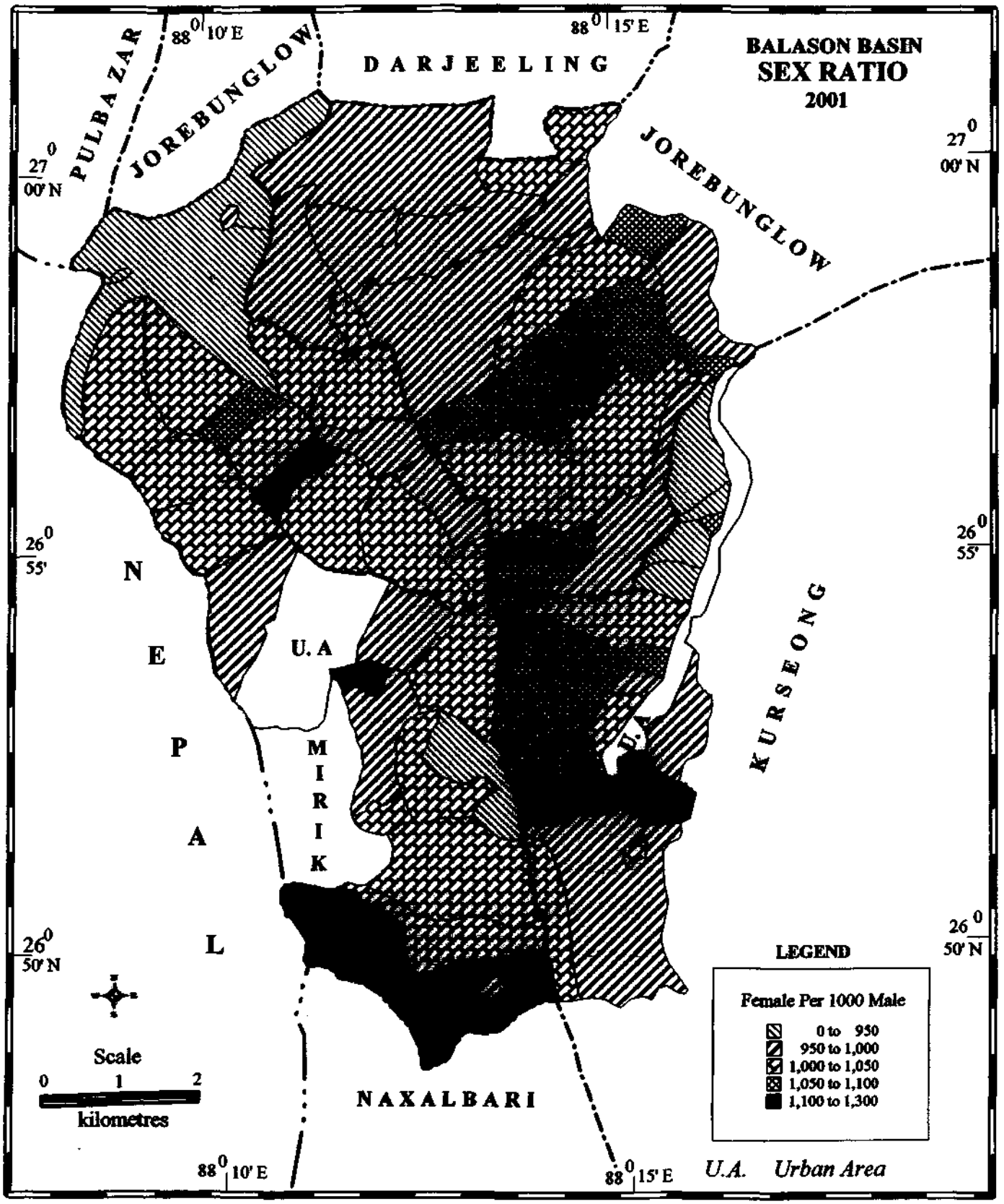

BALASON BASIN
SEX RATIO
2001
DARJEELING
PULBA ZAR
JOREBUNGLOW
JOREBUNGLOW
KURSEONG
NEPAL
U. A
MIRIK
NAXALBARI
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
LEGEND
Female Per 1000 Male
0 to 950
950 to 1,000
1,000 to 1,050
1,050 to 1,100
1,100 to 1,300
Scale
0 1 2
kilometres
U.A. Urban Area

Fig. 3.4

i.e. 16.67, is found in Montiviot T.G. and lowest is 0.15, found in Dhajea T.G. Majority of the villages have high percentage of S.C. population Out of these, 25% alone is found in sixteen villages. Six villages have no S.C. population. These villages may have S.T. and general caste population. Areas under high percentages of S.C. population are fluctuating through the last three decades i.e. 60.32% (1981), 42.86% (1991) and 49.21% (2001) in the study area (Fig. 3.5).

Table: 3.5. Classification of villages on the basis of percentage of S.T. population to total population.

Ranges	Category	No. of villages	Percentage
> 6	High	12	19.04
6 – 4	Moderate	1	1.59
4 – 2	Low	9	14.29
< 2	Very Low	22	34.92
Nil		19	30.16
Total		63	100.00

Source: Census of India, 2001.

The percentage of S.T. population is low in the study area compared to the S.C. population. This is because Nepalese don't want to consider themselves as S.T.'s. Tribal people are less in the basin because people are mainly immigrants who are S.C.'s and not S.T.'s. About 41 out of 63 villages, have less than 2 percent S.T. population. This is quite an exception. Surprisingly, all the khasmahals have the highest percentage of their population as S.T. population. Jorebunglow has 41.95 % of its population as S.T. population, which is also the highest in the entire Balason basin(Fig. 3.6). Other villages having high percentage of S.T. population are Simana Basti, Sonada Khasmahal, Sukhiapokhri, Pulungdung Khasmahal, Mim Nagri Range and Rongbong Basti. Number of villages, which has above 10% of its population as S.T., decreased from 15(23.81%) to 9(14.29%), in between 1981 and 1991 respectively. The S.T.'s include Lepchas, Bhutias, Dukpas, Sherpas, Yolmos etc.

3.2.3. Literacy

In population geography, literacy is considered as a reliable index of socio – cultural and economic advancement of an area. Literacy is essential for eradicating poverty and mental isolation for cultivating

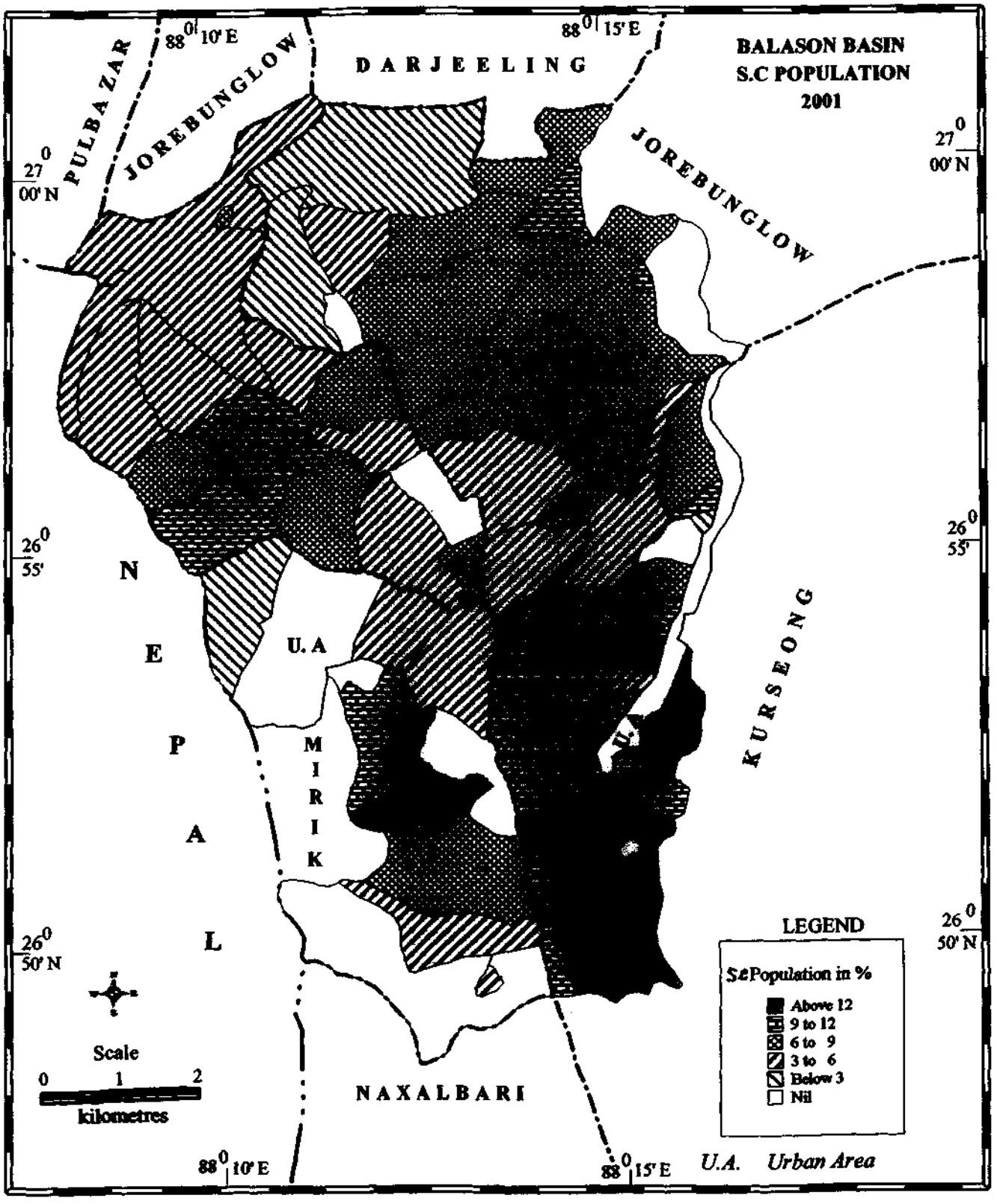

BALASON BASIN
S.C POPULATION
2001
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
PULBAZAR
JOREBUNGLOW
DARJEELING
JOREBUNGLOW
KURSEONG
N
E
P
A
L
U. A
MIRIK
NAXALBARI
LEGEND
Population in %
Above 12
9 to 12
6 to 9
3 to 6
Below 3
Nil
Scale
0 1 2
kilometres
U.A. Urban Area

Fig. 3.5

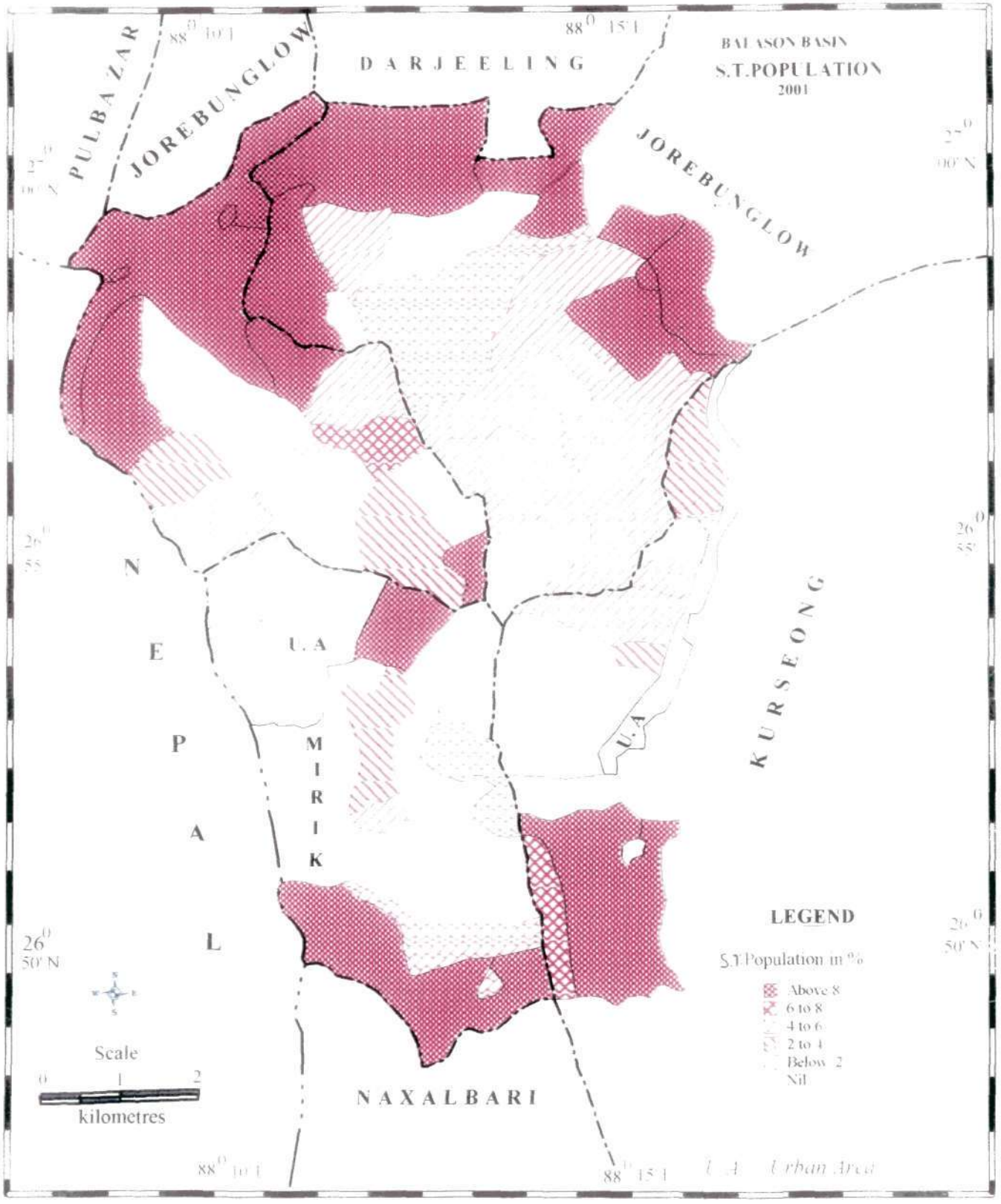

BALASON BASIN
S.T. POPULATION
2001
DARJEELING
JOREBUNGLOW
PULBAZAR
JOREBUNGLOW
KURSEONG
NEPAL
MIRIK
NAXALBARI
U.A
U.A
88° 10' E
88° 15' E
26° 55' N
26° 50' N
LEGEND
S.T. Population in %
Above 8
6 to 8
4 to 6
2 to 4
Below 2
Nil
Scale
0 1 2
kilometres
U.A Urban Area

Fig. 3.6

peaceful and friendly international relations and for permitting the free plays of demographic process (Chanda et. al., 1980). The trend of literacy is the index of socio – economic development of the society. Education affects demographic behavior concerning marriage, fertility, mortality as well as labour force. A very low degree of literacy is an obstacle to economic growth. The basic minimum measurement of educational status is the degree of literacy. But it is very difficult to measure the degree of literacy in accurate terms (Ghosh, 1985).

Table: 3.6. Classification of villages on the basis of percentage of literates to total population.

Ranges	Category	No. of villages	Percentages
> 75	Very High	9	14.29
75 – 70	High	22	34.92
70 – 65	Moderate	14	22.22
65 – 60	Low	8	12.70
< 60	Very Low	10	15.87
Total		63	100.00

Source: Census of India, 2001.

Majority of the villages have high literacy rate. Rate of literacy increased by leaps and bounds in the study area in the last three decades. This is evident from the fact that out of 63 villages, number of villages having more than 50% literacy, has increased from 12(19.05%) to 31 (49.21%) to 61 (96.83%) in the year 1981, 1991 and 2001 respectively (Fig.3.7). Free and compulsory education along with mid-day meal encourages the children to go to school. Mainly villages in and

Table: 3.7. Classification of villages on the basis of percentage of male literacy to total male population.

Ranges	Category	No. of villages	Percentages
> 85	Very High	7	11.11
85 – 80	High	16	25.40
80 – 75	Moderate	20	31.75
75 – 70	Low	12	19.04
< 70	Very Low	8	12.70
Total		63	100.00

Source: Census of India, 2001.

around Kurseong town have high literacy rate because number of schools in such locations is more and economic condition of the people is high. Transport and communication is better along the Hill Cart

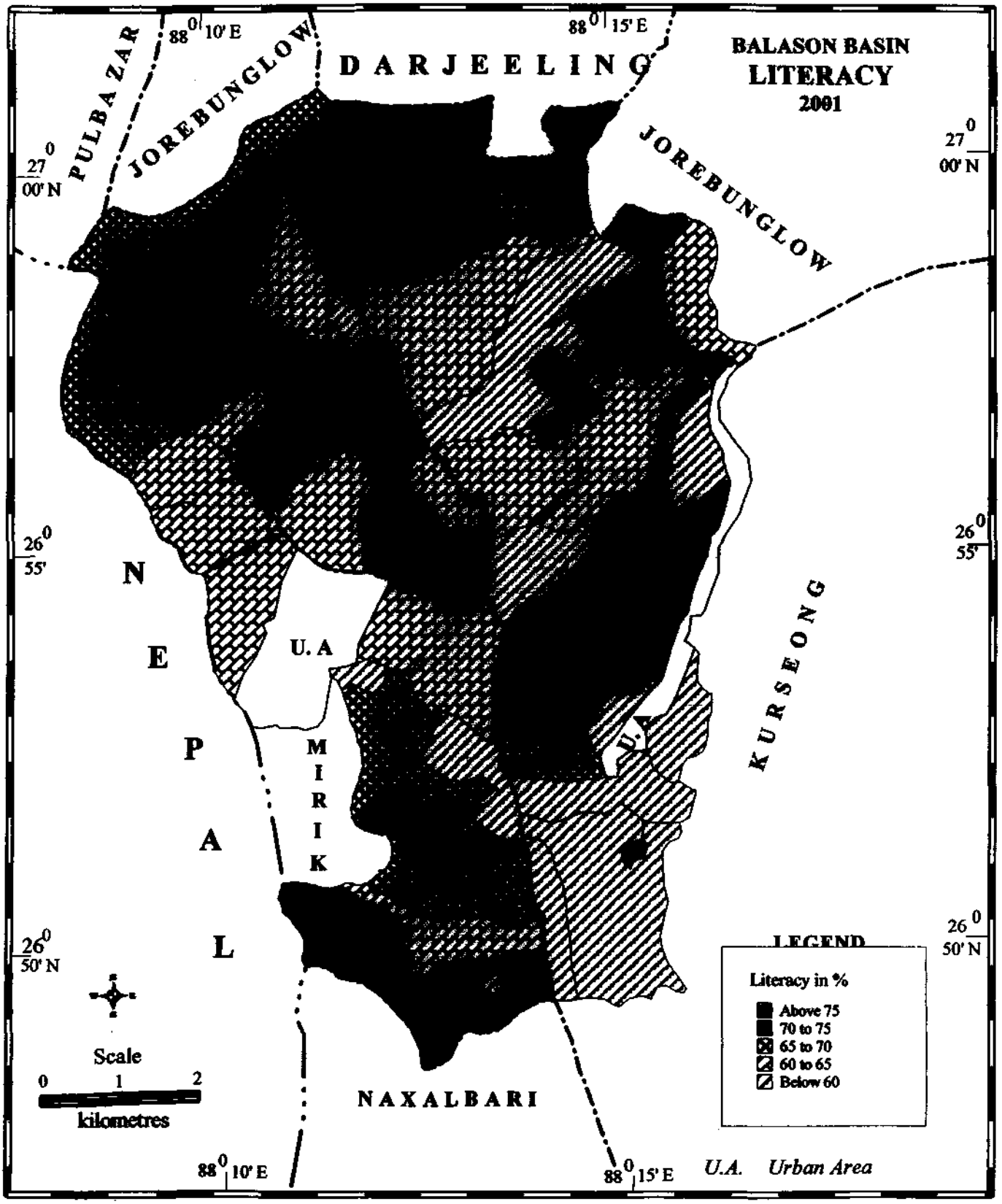

BALASON BASIN
LITERACY
2001
DARJEELING
PULBA ZAR
JOREBUNGLOW
JOREBUNGLOW
KURSEONG
NEPAL
U. A
MIRIK
NAXALBARI
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
LEGEND
Literacy in %
Above 75
70 to 75
65 to 70
60 to 65
Below 60
Scale
0 1 2
kilometres
U.A. Urban Area

Fig. 3.7

Road, than other areas which improve accessibility. Usually tea gardens show low literacy rate because of their remote location.

Male literacy is high in the study area. If observed carefully, there was a sudden fluctuation in the pattern of growth of male literacy rate in the last three decades. Percentage of villages having above 50% literacy changed from 96.83% to 49.21% to 100% in the year 1981, 1991 and 2001 respectively. Literacy rate among males are higher than the females because they are the main bread earners of the family. Manjha Fst. records the highest male literacy rate because it has the lowest male population in the study area. Actually, Ragbul has the highest literacy rate (87.39%) in the basin. Other than forest areas, Pulungdung T.E. has the lowest male literacy (57.87%)(Fig. 3.8).

Table: 3.8. Classification of villages according to the percentage of female literacy to total female population.

Ranges	Category	No. of Villages	Percentages
> 65	Very High	12	19.05
65 – 60	High	18	28.57
60 – 55	Moderate	15	23.81
55 – 50	Low	6	9.52
< 50	Very Low	12	19.05
Total		63	100.00

Source: Census of India, 2001.

Female literacy rate is extremely low in the study area. According to 1981 Census, there were no such villages with literacy rate above 50%. Female population is backward as well as neglected. Early marriage, household work, working in the tea gardens, going to the forest for collecting fuel wood and fodder, bringing water from far are the main activities, which keep them away from the schools. Out of 63 villages, number of villages having above 50% literacy was 12 (19.05%) in 1991 and 51 (80.95%) in 2001, which is a major improvement. Female literacy in the study area should be given more importance in future because it is still far below the male literacy rate. Highest female literacy (77.37%) is observed in Jorebunglow and lowest (35.83%) in Pulungdung T.E (Fig. 3.9).

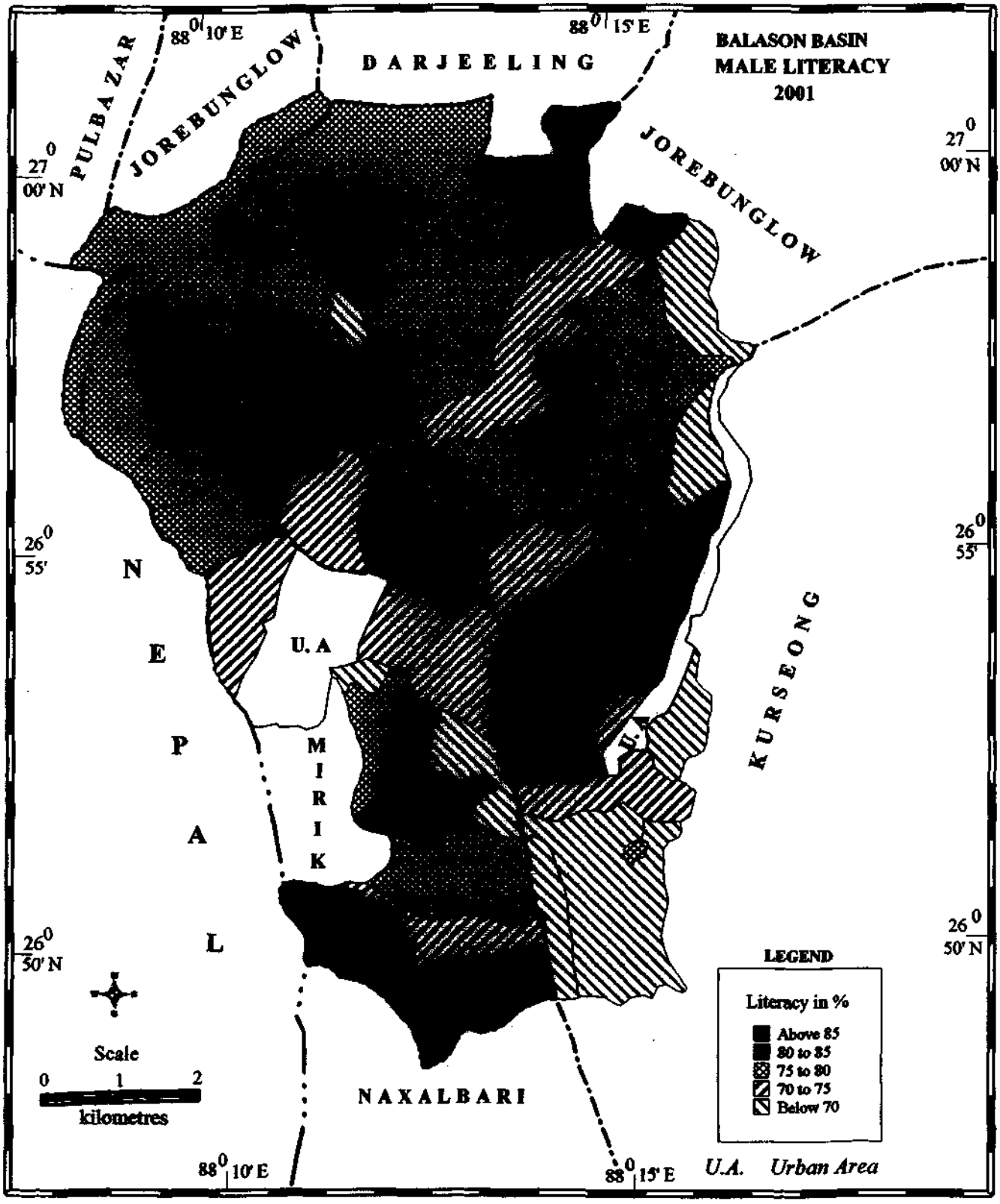

BALASON BASIN
MALE LITERACY
2001
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
PULBA ZAR
JOREBUNGLOW
DARJEELING
JOREBUNGLOW
KURSEONG
N
E
P
A
L
U. A
MIRIK
NAXALBARI
LEGEND
Literacy in %
Above 85
80 to 85
75 to 80
70 to 75
Below 70
Scale
0 1 2
kilometres
U.A. Urban Area

Fig. 3.8

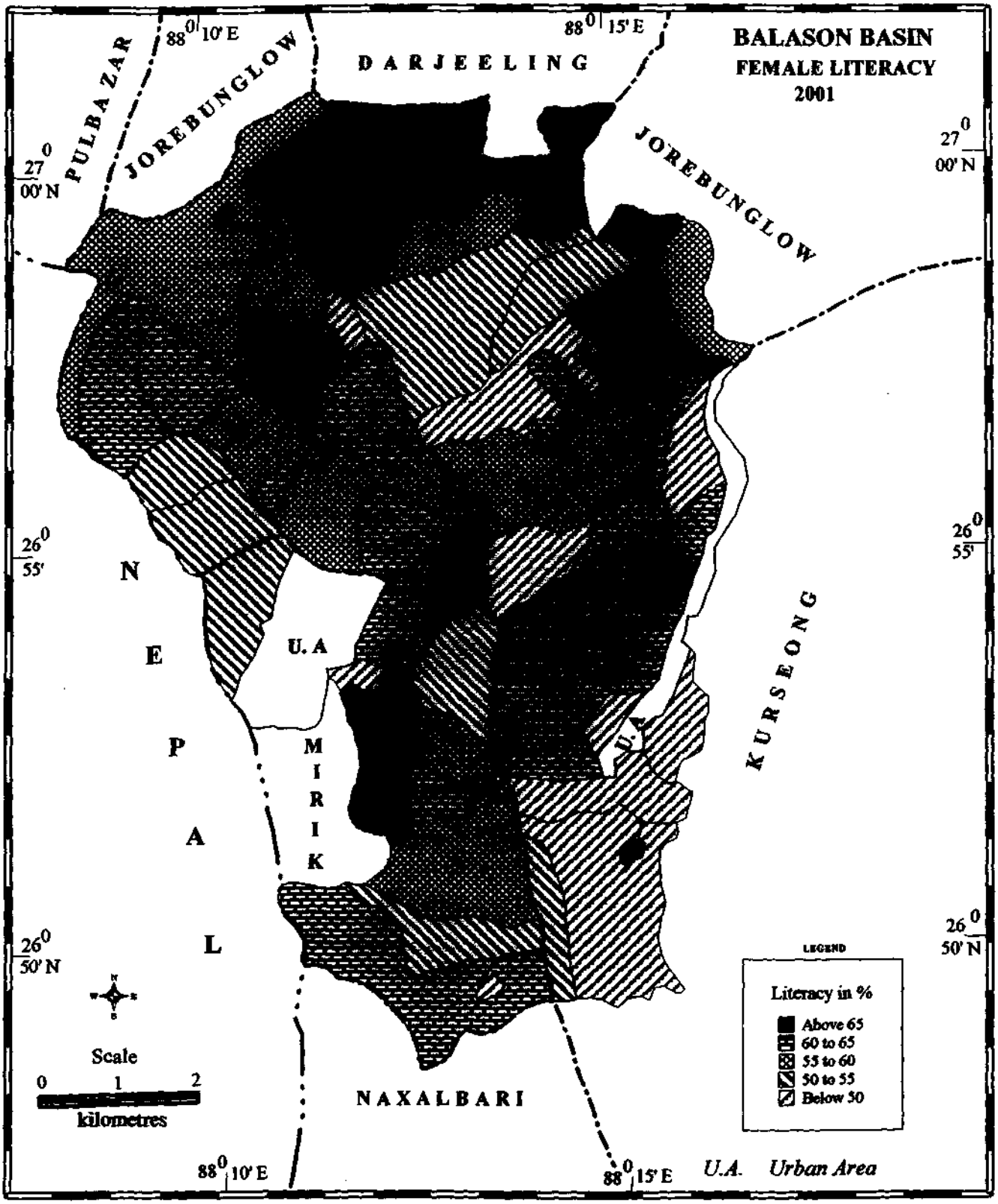

BALASON BASIN
FEMALE LITERACY
2001
PULBA ZAR
JOREBUNGLOW
DARJEELING
JOREBUNGLOW
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
N
E
P
A
L
U. A
MIRIK
KURSEONG
NAXALBARI
Scale
0 1 2
kilometres
LEGEND
Literacy in %
Above 65
60 to 65
55 to 60
50 to 55
Below 50
U.A. Urban Area

Fig. 3.9

3.3. DENSITY OF POPULATION

The distribution of arithmetic density of population can be explained by analyzing the density pattern. Population density is a useful abstraction, assisting in the analysis of diversity of man's distribution in space (Clark, 1977). Density of population is one of the most important parameters to determine the pressure of population on land. Density of population is not uniform in the study area. The difficult mountainous terrain, scarcity of agricultural land, paucity of water for irrigation, extensive soil erosion and thick forest cover have been some of the deterrents in the way of dense population in most of the areas.

Table: 3.9. Classification of villages according to density of population (persons/hectare).

Ranges	Category	No. of villages	Percentages
> 20	Very High	4	6.35
20 – 15	High	1	1.59
15 – 10	Moderate	4	6.35
10 – 5	Low	15	23.81
< 5	Very Low	35	55.55
Nil		4	6.35
Total		63	100.00

Source: Census of India, 2001.

Mostly tea gardens have low density of population. Population density ranges from 332 persons per hectare in Sukhiapokhri to 1 person per hectare in the forested villages, which is extremely uneven in nature. Percentage of population density below 10 persons per hectare was 79.37%, 63.49% and 84.13% in 2001, 1991 and 1981 respectively (Fig. 3.10). Population density keeps on fluctuating in the study area. Khasmahals are densely populated because people from different parts of the district grabbed these lands, as these are vested lands and settled down. As more and more people settled down, commercial activities started thus turning these areas into congested commercial centers. Such places have access to water, improved transport and communication and act as centers of administrative importance and economic activities. But such khasmahals are less in number in the study area.

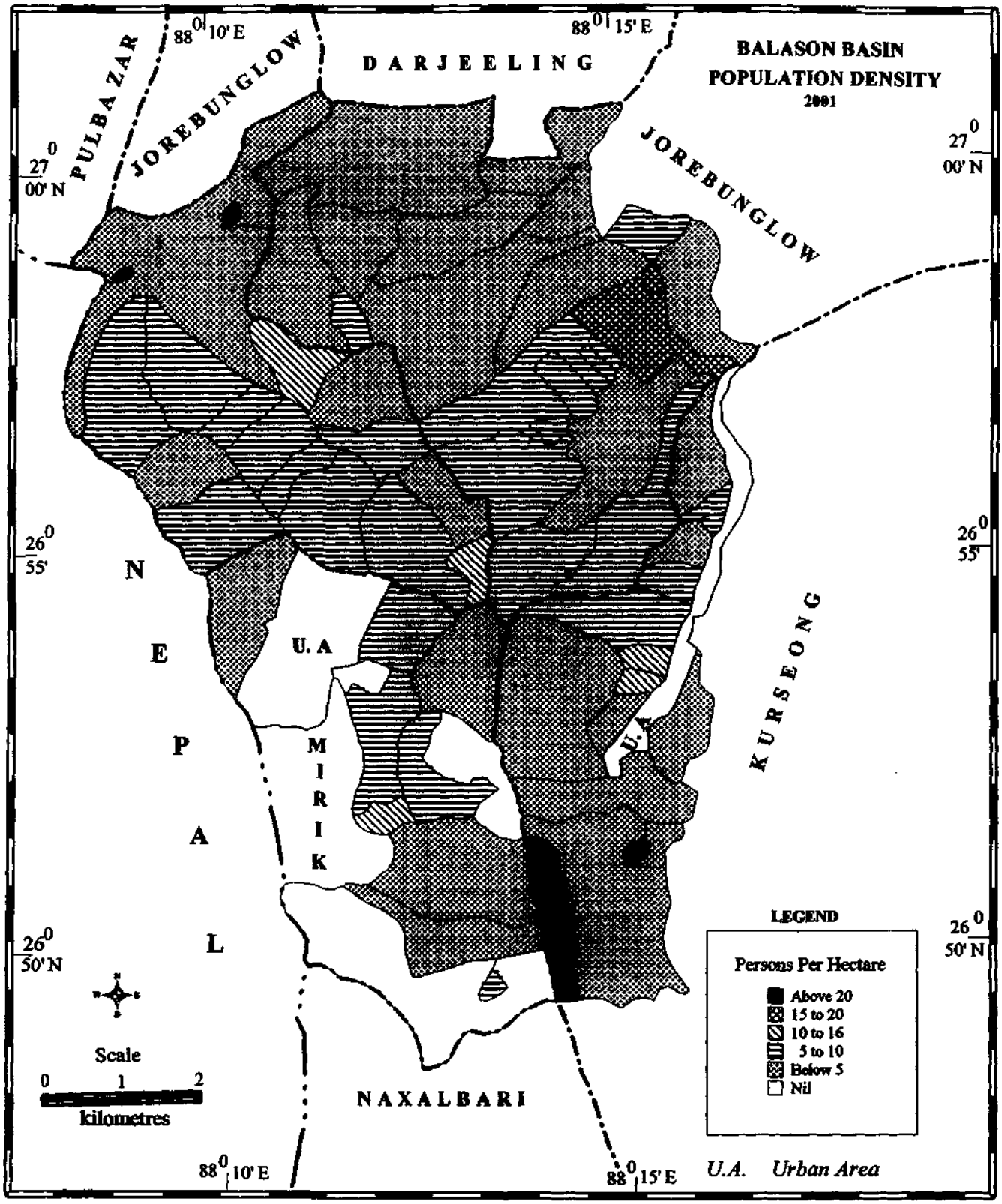

BALASON BASIN
POPULATION DENSITY
2001
DARJEELING
PULBA ZAR
JOREBUNGLOW
JOREBUNGLOW
KURSEONG
MIRIK
NAXALBARI
N E P A L
U. A
U. A
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
Scale
0 1 2
kilometres
LEGEND
Persons Per Hectare
Above 20
15 to 20
10 to 16
5 to 10
Below 5
Nil
U.A. Urban Area

Fig. 3.10

3.4. GROWTH OF POPULATION

Changes in population are more normal than stable states, so it is no surprise that observers attempt to isolate those elements, which combine to produce output measures of population (Baxter and Williams, 1978). A population is constantly in a state of influx. During this process the size of population varies and develops potentialities for unlimited growth (Rajkumar, 1986). The dynamics of population growth of an area over a certain length of time is the sum of the net migration in the region during the period under consideration (Singh, 1985). Population growth is one of the important aspects to study the pressure of population on land of an area. Fertility, mortality, migration, crude birth rate and crude death rate are the basic components of natural population growth.

Table: 3.10. Classification of villages on the basis of the percentage of growth of population. (1991-2001)

Population growth in %	Category	No. of villages (-)	Percentages (-)	No. of villages (+)	Percentages (+)
> 45	Very High	4	6.35	8	12.70
45 – 35	High	3	4.76	2	3.17
35 – 25	Moderate	2	3.17	3	4.76
25 – 15	Low	3	4.76	2	3.17
< 15	Very Low	10	15.87	20	31.75
Total		22	34.92	35	55.56

Source: Census of India, 2001.

In the study area, maximum villages have positive growth of population though the percentage of growth is low. Around 14% of the villages have recorded moderate (25% – 35%) to very high (> 45%) negative growth of population may be due to migration and low rate of natural birth. Tea gardens have the maximum positive growth of population due to lack of education and awareness. Five forest areas have no growth of population may be due to the restrictions imposed to settle in the forest area by the Forest Departments. According to 1981 Census, percentages of positive and negative growth of population were almost the same. But in 1991, 80.95% of the villages showed positive growth of population whereas 19.05% showed negative growth. This condition improved in 2001 with 55.56% of the villages showing

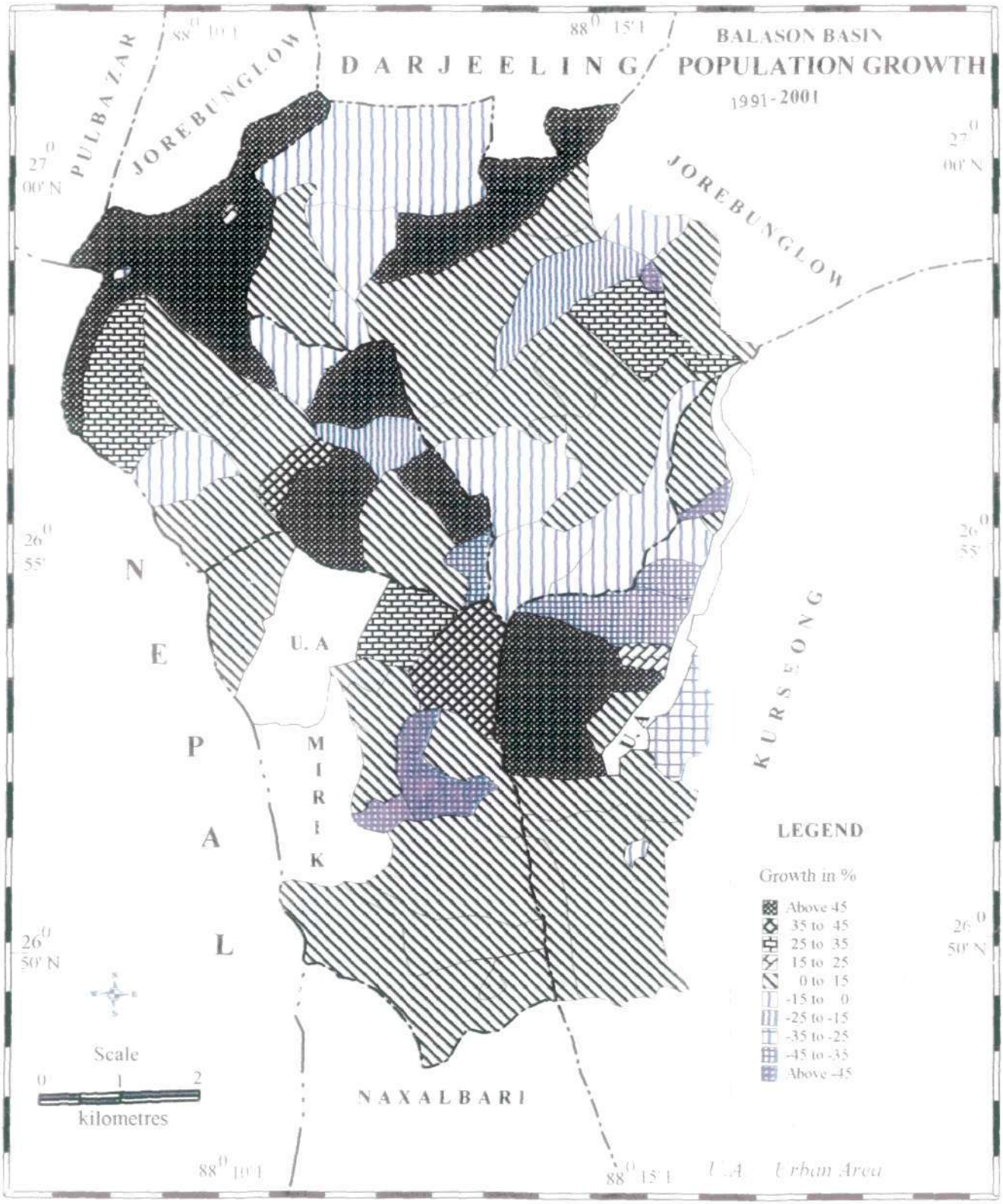

BALASON BASIN
POPULATION GROWTH
1991-2001
DARJEELING
PULBAZAR
JOREBUNGLOW
JOREBUNGLOW
KURSEONG
NEPAL
MIRIK
NAXALBARI
U.A
U.A
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
LEGEND
Growth in %
Above 45
35 to 45
25 to 35
15 to 25
0 to 15
-15 to 0
-25 to -15
-35 to -25
-45 to -35
Above -45
Scale
0 1 2
kilometres
U.A Urban Area

Fig. 3.11

positive growth of population, which decreased from before and 34.92% showed negative growth, which increased from before (Fig. 3.11).

3.5. OCCUPATIONAL PATTERN

Occupation reveals the nature of economic development and sophistication of a country (Ghosh, 1985). Occupation determines the individual's relationship with other individuals in the same and other occupations (Hall, 1975). Occupational structure is the unitary relationship pattern of the three occupational components – primary, secondary and tertiary working population of an area, which constitute the core of the economic system. Among all the social attributes of a given individual or group, occupation is of paramount importance. It is particularly significant for the population analysis, since to a considerable extent, the nature of work determines the surroundings both physical and cultural (Smith, 1948).

Distribution of workers indicates the employment scenario of the study area. Lack of agricultural land and water for irrigation discouraged agricultural activities in the river basin. Land is pre occupied by tea gardens, which provides employment to the people who emigrated from different areas. Percentages of cultivators and agricultural labourers are low whereas percentage of other worker is very high. The Tea District Emigration Act of 1868 gave rise to the first batch of legally recognized labour. By virtue of tripartite settlement during the last 25 years quite sizable volumes of employment in different categories have been created (Labour Gazetteer, 1994).

Table:3.11. Village wise distribution of percentage of total workers.

Total Workers in %	Category	No. of villages	Percentage of villages to total
> 45	Very High	3	4.76
45 – 40	High	9	14.29
40 – 35	Moderate	14	22.22
35 – 30	Low	26	41.27
< 30	Very Low	11	17.46
Total		63	100.00

Source: Census of India, 2001.

Total worker percentage is low in most of the villages of the Balason basin. Population growth is faster than economic growth. People are only dependent on agriculture but agricultural land is less compared to population. Limited avenues of employment kept the total worker percentage low. Maximum tea gardens, which are the only source of employment in the basin, are presently stagnant with zero employment opportunities. Young men leave the villages to join army and a few go to work in the cities. Maximum villages in the basin have less than 35% total workers. Out of 63 villages, number of villages having less than 35% total worker was 40 (63.49%), 35 (55.55%) and 37 (58.73%) in 1981, 1991 and 2001 respectively. But at the same time, the number of villages, having above 35% total worker, increased at the rate of 21, 22 and 26 in 1981, 1991 and 2001 respectively (Fig. 3.12).

Table: 3.12. Village wise distribution of percentage of main workers.

Main Workers in %	Category	No. of villages	Percentage of villages to total
> 90	Very High	17	26.98
90 – 80	High	18	28.58
80 – 70	Moderate	16	25.40
70 – 60	Low	6	9.52
< 60	Very Low	6	9.52
Total		63	100.00

Source: Census of India, 2001.

In the study area, there is a sudden hike in the percentage of main worker in 2001 than in 1991 and 1981. People working in the tea gardens and tea industries were always more but the sudden influx may be due to more people getting employed in trade, transport, construction and mining (Fig. 3.13).

Percentage of cultivators has drastically declined in the study area. According to 2001 census, there are only 12 villages having only 10% cultivators. But this amount was more in 1991 and 1981 being 21 and 20 villages respectively. This may due to the fact that agricultural land became limited due to terrain, sloping and scarce in the hilly areas. Agricultural land is also small in size and area due to fragmentation, making agricultural practice unprofitable. Agriculture in

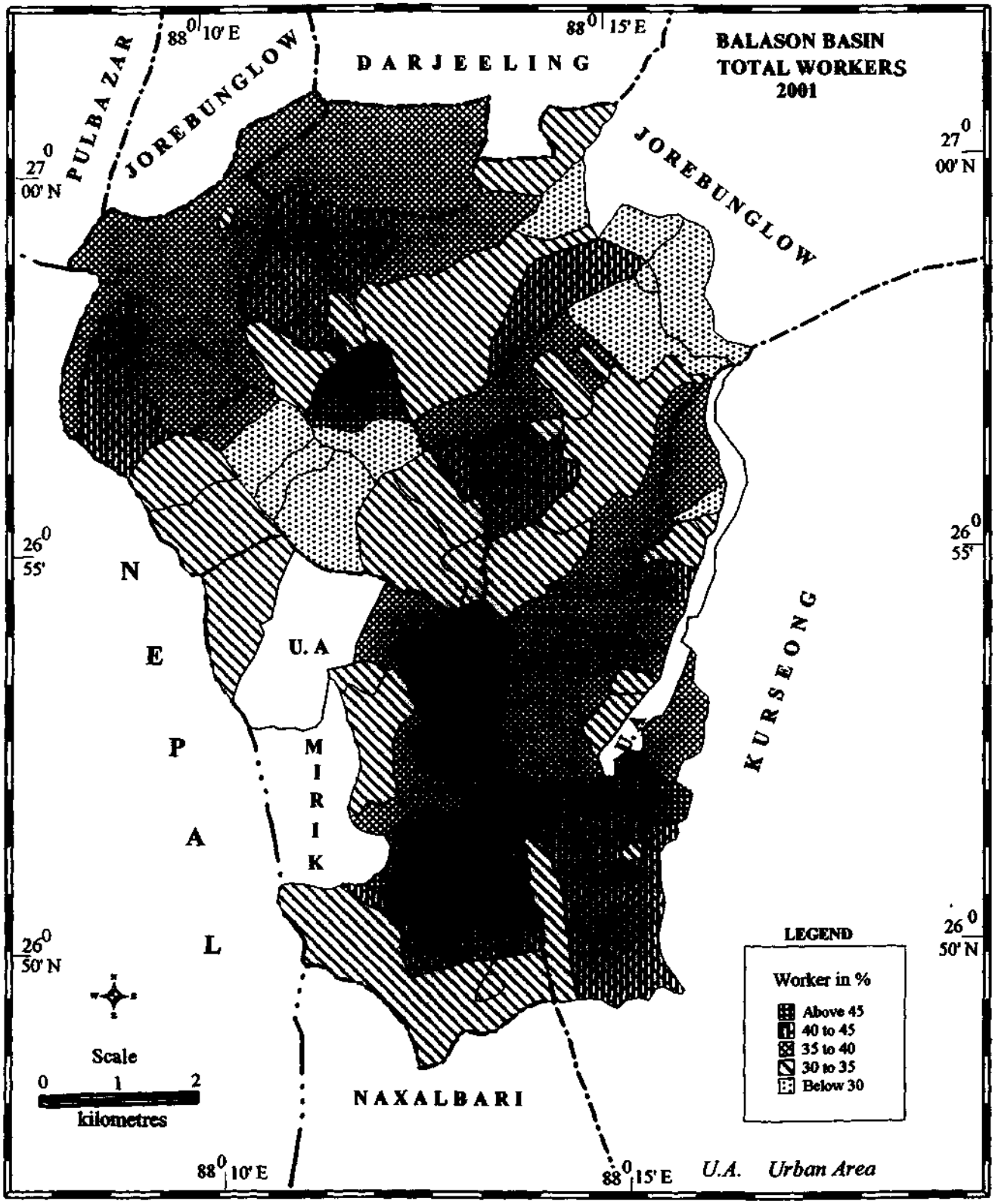

BALASON BASIN
TOTAL WORKERS
2001
PULBA ZAR
JOREBUNGLOW
DARJEELING
JOREBUNGLOW
KURSEONG
MIRIK
NAXALBARI
N E P A L
U. A
U.A
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
LEGEND
Worker in %
Above 45
40 to 45
35 to 40
30 to 35
Below 30
Scale
0 1 2
kilometres
U.A. Urban Area

Fig. 3.12

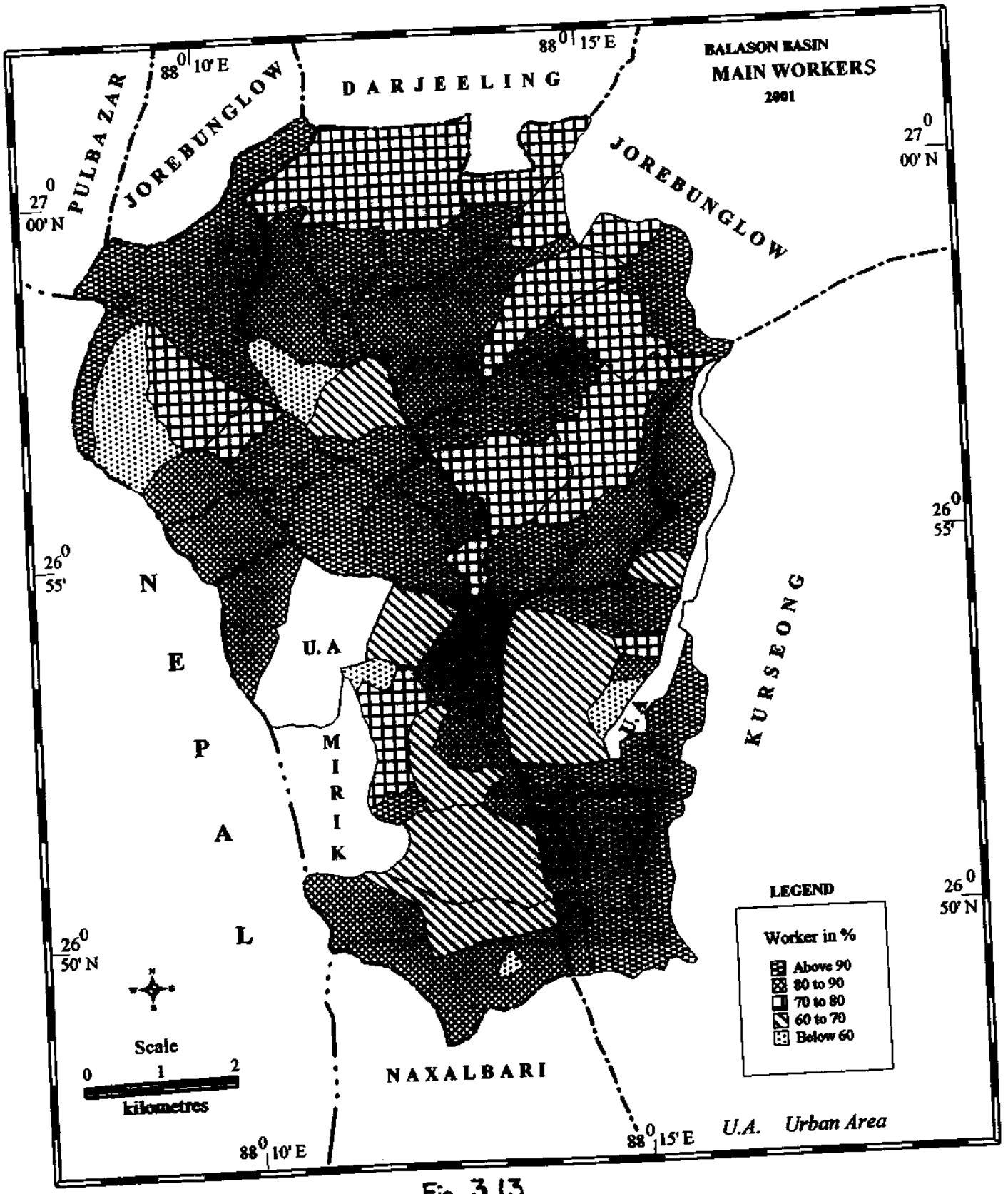

BALASON BASIN
MAIN WORKERS
2001
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
PULBA ZAR
JOREBUNGLOW
DARJEELING
JOREBUNGLOW
N
E
P
A
L
U.A
U.A
MIRIK
KURSEONG
NAXALBARI
LEGEND
Worker in %
Above 90
80 to 90
70 to 80
60 to 70
Below 60
Scale
0 1 2
kilometres
U.A. Urban Area

Fig. 3.13

Table:3.13. Village wise distribution of percentage of cultivators.

Cultivators in %	Category	No. of villages	Percentage
> 10	Very High	12	19.05
10 – 8	High	1	1.59
8 – 6	Moderate	2	3.17
6 – 4	Low	3	4.76
< 4	Very Low	40	63.49
Nil		5	7.94
Total		63	100.00

Source: Census of India, 2001.

the tea gardens is restricted. People in the tea gardens grow crops, in the backyard, only for self-consumption. Cultivation can only be done in the khasmahals and bastis, where the percentage of cultivators is the high. Mirik khasmahal has the highest percentage of cultivators i.e. 77.20% to total main workers. Among the khasmahals, Pokhriabong has the lowest percentage of cultivators i.e. 1.29% to total main workers (Fig. 3.14). Vegetable and fruit cultivation in Mirik and Sonada khasmahals are of high commercial value in the local markets.

Table: 3.14. Village wise distribution of percentage of agricultural labourers.

Agricultural labourers in %	Category	No. of villages	Percentage
> 8	Very High	12	19.05
8 – 6	High	3	4.76
6 – 4	Moderate	2	3.17
4 – 2	Low	4	6.35
< 2	Very Low	22	34.92
Nil		20	31.75
Total		63	100.00

Source: Census of India, 2001.

The percentage of agricultural labourers is lower than the cultivators in the Balason basin. Family members are only cultivating the small patch of land they have. So demand for agricultural labourers is decreasing day by day. Agricultural land is getting occupied by residential complexes, which are thought to be more profitable(Fig3.14a).

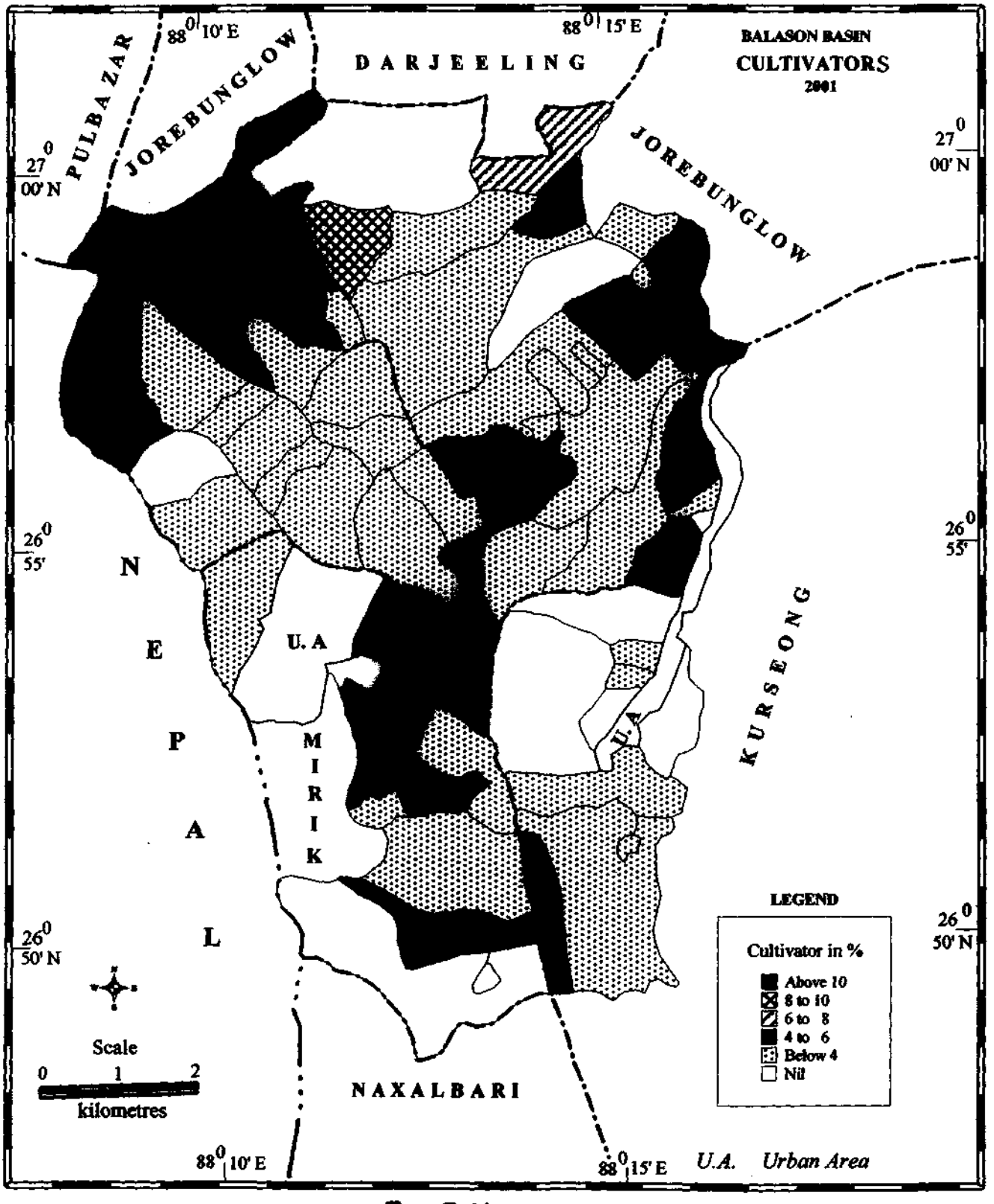

BALASON BASIN
CULTIVATORS
2001
DARJEELING
PULBAZAR
JOREBUNGLOW
JOREBUNGLOW
KURSEONG
NEPAL
U.A
U.A
MIRIK
NAXALBARI
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
LEGEND
Cultivator in %
Above 10
8 to 10
6 to 8
4 to 6
Below 4
Nil
Scale
0 1 2
kilometres
U.A. Urban Area

Fig. 3.14

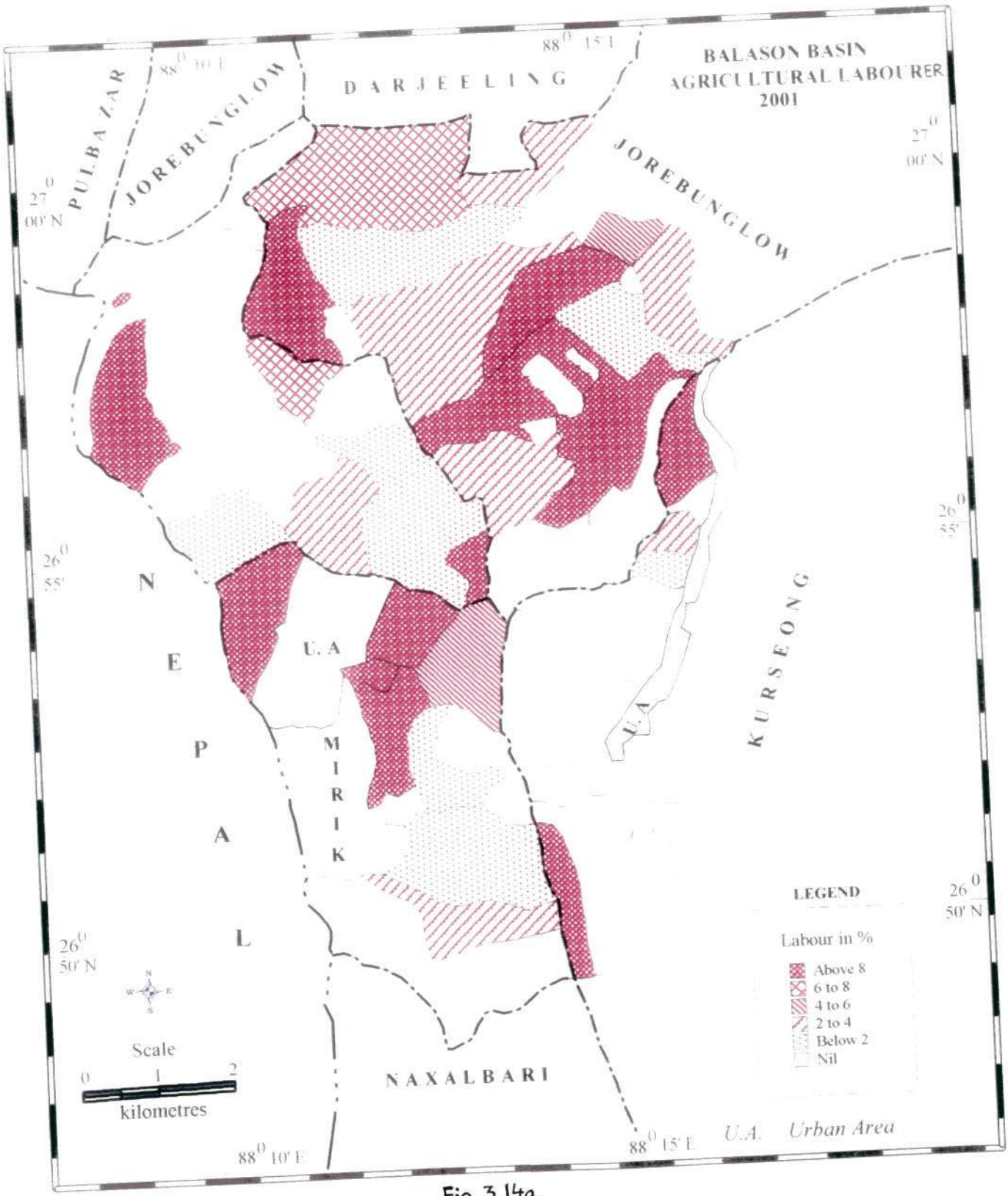

BALASON BASIN
AGRICULTURAL LABOURER
2001
DARJEELING
JOREBUNGLOW
PULBAZAR
JOREBUNGLOW
KURSEONG
NEPAL
MIRIK
NAXALBARI
U.A
U.A
88° 15' E
88° 10' E
27° 00' N
26° 55'
26° 50' N
LEGEND
Labour in %
Above 8
6 to 8
4 to 6
2 to 4
Below 2
Nil
Scale
0 1 2
kilometres
U.A. Urban Area

Fig.3.14a

Table: 3.15. Village wise distribution of percentage of other workers.

Other Workers in %	Category	No. of villages	Percentage
> 95	Very High	30	47.62
95 – 85	High	12	19.05
85 – 75	Moderate	9	14.29
75 – 65	Low	3	4.75
< 65	Very Low	9	14.29
Total		63	100.00

Source: Census of India, 2001.

The percentage of other workers is high in the study area because a large area of the basin is occupied by tea gardens. These other workers are the people who work in these tea gardens as permanent labourers. Tea gardens are the major source of employments in the basin. Almost 30 villages have above 95% other workers and mostly these are tea gardens. The workers who come under this category include factory workers, plantation workers, all Government servants, municipal employees, teachers etc. In the study area, out of the total main workers, 85% on an average are other workers. This percentage is quite high. In 1991and1981 the percentage was 73.34% and 74.99% in the corresponding areas (Fig. 3.15).

Table: 3.16.Village wise distribution of percentage of marginal workers.

Marginal Workers in %	Category	No. of villages	Percentage
> 40	Very High	6	9.52
40 – 30	High	6	9.52
30 – 20	Moderate	15	23.81
20 – 10	Low	19	30.16
< 10	Very Low	16	25.40
Nil		1	1.59
Total		63	100.00

Source: Census of India, 2001.

The percentage of marginal workers in the study area is low because percentage of total main workers is very high. Out of 63 villages in the study area, 40 are tea gardens employing maximum population of the Balason basin. So, marginal workers are less in the tea gardens because less casual workers are employed. Such tea gardens are Tarzum and Sagmaru, which have less than 2% marginal workers. The highest percentage of marginal workers are found in Phuguri forest, where people have no permanent job and are

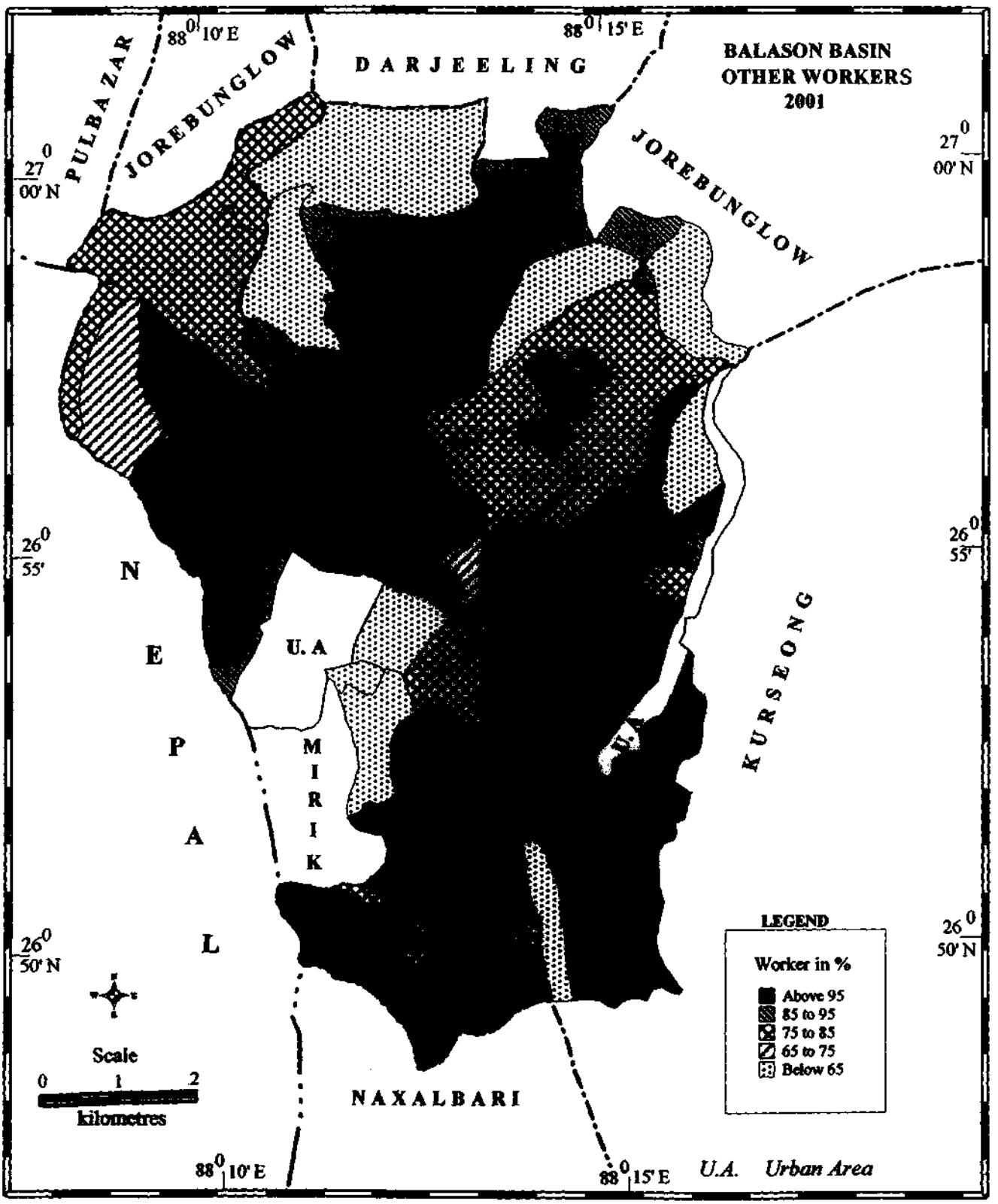

BALASON BASIN
OTHER WORKERS
2001
DARJEELING
PULBA ZAR
JOREBUNGLOW
JOREBUNGLOW
KURSEONG
NEPAL
U. A
MIRIK
NAXALBARI
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
LEGEND
Worker in %
Above 95
85 to 95
75 to 85
65 to 75
Below 65
Scale
0 1 2
kilometres
U.A. Urban Area

Fig. 3.15

temporarily employed by the Forest Department and live by collecting fuel wood and fodder from the forest. Among the tea gardens, Springside has the largest percentage of marginal workers i.e. 89.40%. Among the khasmahals, Pokhribong has 47.57% marginal workers, which is the highest. Female marginal workers are more in the tea gardens because they are employed during plucking of leaves. Male workers are more in the khasmahals because they are employed during cultivation and harvesting of crops and in construction work, trade and transport. Surprisingly, in 1991 and 1981 the highest percentage of marginal workers were 12.46% and33.33% respectively. This indicates a sudden increase in the percentage of marginal workers in 2001(Fig.3.16).

Table: 3.17. Village wise distribution of percentage of non-workers.

Non-Worker in %	Category	No. of villages	Percentage
> 70	Very High	11	17.46
70 – 65	High	26	41.27
65 – 60	Moderate	14	22.22
60 – 55	Low	9	14.29
< 55	Very Low	3	4.76
Total		63	100.00

Source: Census of India, 2001.

Non-worker percentage is quite high in the Balason basin, which indicates high growth of population and limited job opportunities. So dependents are more and pressure of population on family is high. This may deteriorate the standard of living. Total non-worker percentage ranges from 77.81% in Rangbul to 46.10% in Manjua forest. Percentage of villages having above 60% non-workers has increased through the last three decades. This was 65.08%, 71.43% and 80.97% in 1981, 1991 and 2001 respectively (Fig. 3.17).

CONCLUSION

Population is the central element around which all other elements revolve and derive geographical significance. According to 2001 census, the total rural population of the study area is 135615 and total urban population is 49160. So the rural population density is 452

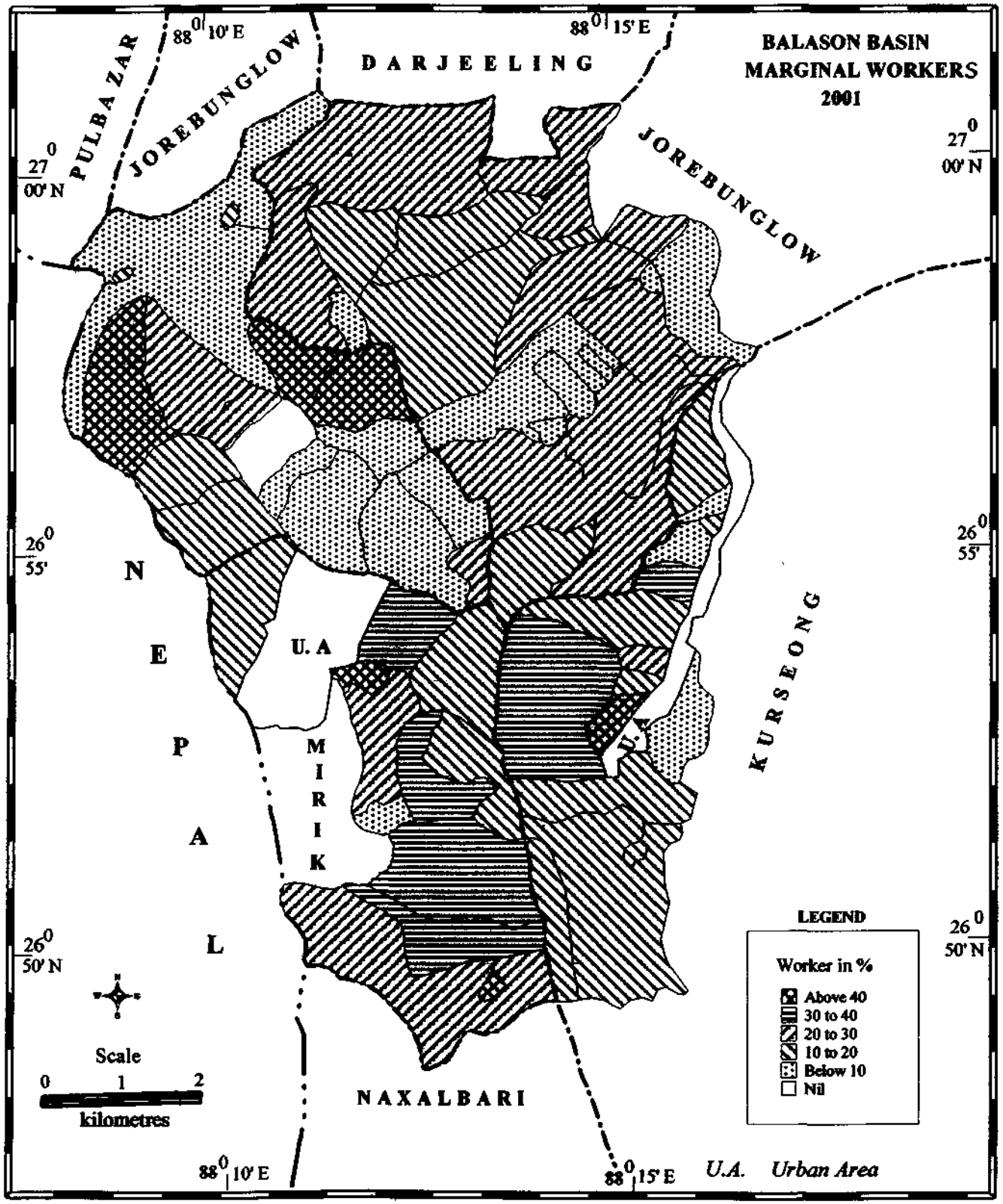

BALASON BASIN
MARGINAL WORKERS
2001
DARJEELING
PULBAZAR
JOREBUNGLOW
JOREBUNGLOW
KURSEONG
NEPAL
U. A
U. A
MIRIK
NAXALBARI
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
LEGEND
Worker in %
Above 40
30 to 40
20 to 30
10 to 20
Below 10
Nil
Scale
0 1 2
kilometres
U.A. Urban Area

Fig.3.16

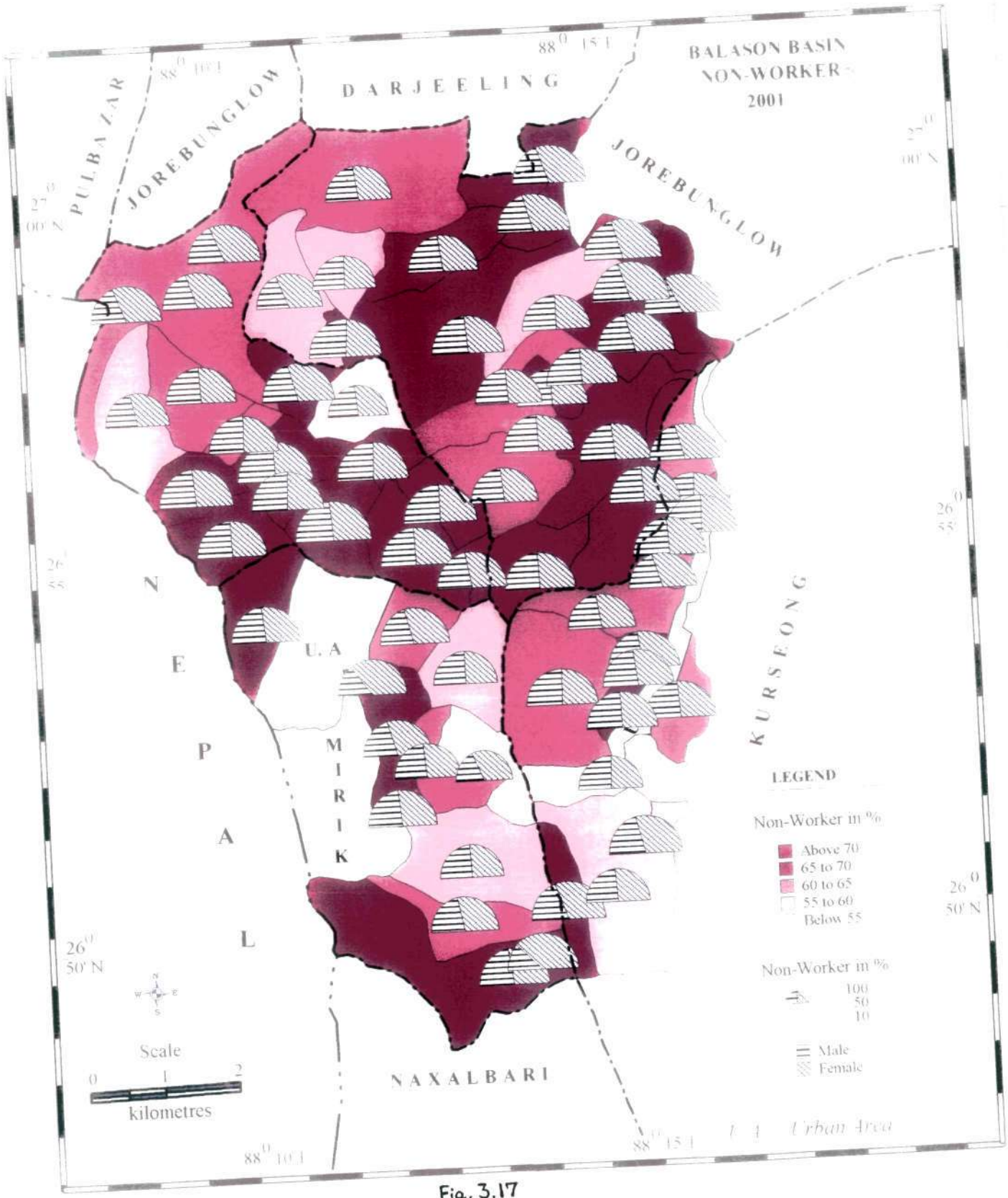

BALASON BASIN
NON-WORKER
2001
DARJEELING
JOREBUNGLOW
PULBA ZAR
JOREBUNGLOW
KURSEONG
NEPAL
U.A
MIRIK
NAXALBARI
88° 15' E
88° 10' E
26° 55'
26° 50' N
LEGEND
Non-Worker in %
Above 70
65 to 70
60 to 65
55 to 60
Below 55
Non-Worker in %
100
50
10
Male
Female
Urban Area
Scale
0 1 2
kilometres

Fig. 3.17

persons per km^2 and urban population density is 4256 persons per km^2. The population distribution in the study area is extremely uneven due to mountainous terrain, severe climate, non-availability of agricultural land and scarcity of water. Villages in the study area are mostly very small in size. Two forests namely Manjha and Ghoom Pahar are very large in size. Village having population less than 1000 is more in the study area. Villages having medium range of population decreased whereas villages having very high population increased during the last three decades. Majority if the villages have moderate to high sex ratio because tea gardens employ female workers more than males. People in the study area are mainly immigrants from Nepal, Bhutan, Tibet and Sikkim. In general the S.C. population is more than the S.T. population in the study area. Tea gardens have more of S.C. and general castes whereas khasmahals have more S.T. population compared to tea gardens. Here S.T. population is involved in non-farming activities and work as construction labourers, porters, water carriers etc. Literacy rate is high among males than females. Literacy rate has increased by leaps and bounds in the last three decades. With free and compulsory education many children are attracted towards the educational institutions in the present time. No detention policy of the Government and provision for mid day meal allure the children to go to school. Tea gardens show low literacy rate because of their remoteness, lack of proper infrastructure, lack of trained teachers and irregular inspection by the Government departments. In most if the villages, there is no scope for pursuing higher education because of lack of high schools in the villages. Government education is cheap whereas private educational institutes impart are very expensive at the same time. Female literacy rate is low because they mostly work in the tea gardens or remain busy with daily household chores. Population density is very low in majority of the villages. Adverse living conditions in the hills do not allow population to be dense. Only the khasmahals are densely populated because of availability of land to construct houses, availability of supplied water, good transport network and other

facilities.

Majority of the villages have positive growth of population. Such villages are tea gardens where people are still backward, uneducated and irresponsible. Among the total workers, main workers are more than the marginal workers. Main workers are mostly other workers because the area has many tea gardens and people working in the tea gardens constitute this group. Due to scarcity of agricultural land and water, percentage of cultivators and agricultural labourers occupy a meager share of the main workers. Non worker percentage is quite high, which indicates high dependency ratio. Since population growth is high and mortality rate is low, children and aged people fall under this group and number of villages having non workers is increasing through the last three decades.

CHAPTER IV

LAND USE IN THE BASIN

INTRODUCTION

The concept of 'land use' is often considered a relatively stable subject, related mainly to the use to which the land in certain region at a certain time is put (Viale, 1975). There are several general definitions of land use, the earliest of which was given in connection with the first land utilization survey of Britain from 1931 onwards. It stated quite simply that the object of survey was to discover 'for what purpose the surface of the country is used' (Stamp, 1948). According to Vink, 'the use of land is the result of a continuous field of tension created between available resources and human needs and acts by human efforts'. By land use it is implied that it is mankind's adaptation of land surface and man's need of different magnitudes for space for different uses (Northam, 1979). Thus, land must be carefully utilized, so that it may fulfill our various needs. The best use of each parcel of land requires a scientific and methodically appreciable classification of the present land use, which may help in investigating the best use of land after considering the major land use categories (Mondal, 1982).

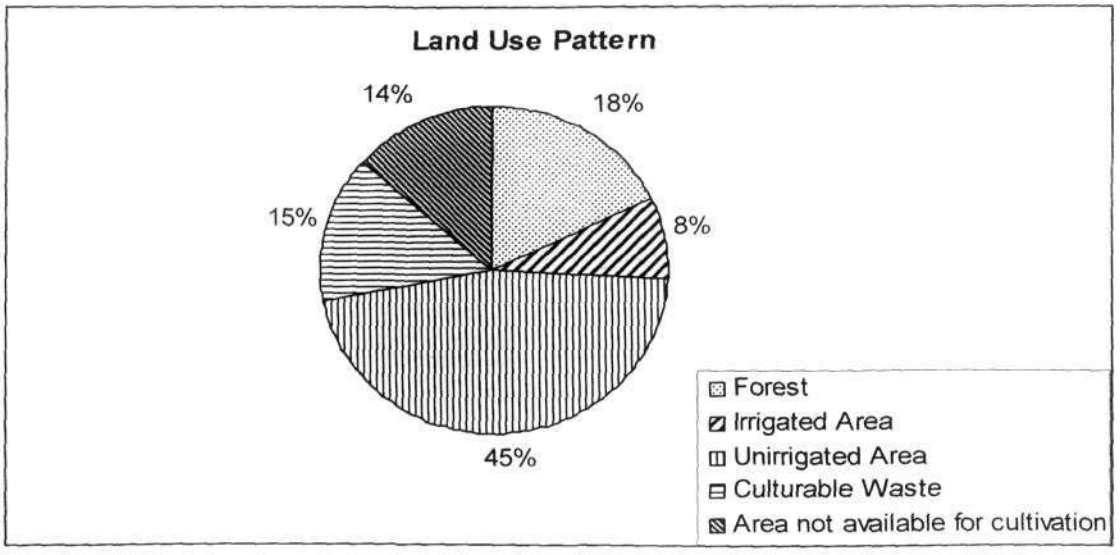


Fig. 4.1

4.1. GENERAL LAND USE

Land resource forms the most important natural wealth of the state and their proper utilization is a matter of concern to its people. Utilization of the land according to its capability ensures that this resource is utilized to the best extent. Its improper use leads to wastage and can lead to progressive deterioration and loss of productivity of this vital resource. One of the most significant features of land use in the study area is that only a small portion of land is suitable for agriculture due to the presence of steep slope and rocky terrain. Huge areas of the hill slopes are occupied by tea gardens, which provide employment to the people of the Balason basin.

Classification of land is a process, which assigns each part or tract of land in an area to its proper class in a system of classes. The classes in the system are determined in terms of the qualities of characteristics with which the classification is concerned. In India, the classification of land use has its root in agricultural statistics. The land use in India was broadly classified into five categories. 1. Area under forest, 2. Area irrigated by source, 3. Area unirrigated, 4. Area under culturable waste (including gaucher and groves) and 5. Area not available for cultivation (Fig. 4.1).

4.1.1. Area Under Forest

Forest is an important source of livelihood in the study area. Apart from extraction of timber, forest is also a source of fodder, fuel wood, medicinal plants and herbs. In the early stages, forests were considered as timber producing agencies without any reference to the role that they can play in watershed protection. While the forest cover ensures an optimum condition for infiltration, percolation and subsequent storage and discharge of water, the removal of vegetation tends to initiate a progressive chain of deterioration affecting the water regime in the end. Forestry also provides endless opportunities for research in crop physiology (Gazetteer, 1980).

All the forested villages have above 45% of land under forest. Among the tea gardens, New Fallodi has highest land under forest cover

i.e. 47.94%. In the study area, forest ranges from 91.49% in Phuguri Forest to 0.25% in Moolatey. In the northern part of the Balason basin, near the source of the river, vast stretches of land are covered by forest i.e. Mim Nagri Range (53.19%) and Ghoom Pahar Forest (46.48%). Phuguri Forest shows a remarkable increase in the amount of forest cover. It increased from 48.97% in 1991 to 91.49% in 2001. This clearly indicates that large-scale afforestation took place in the region. Forest cover also increased in 10 more villages out of which many lies along the right bank of the Balason river (Fig 4.2).

Table: 4.1. Percentage of villages having percentages of area under forest.

Forest %	Category	No. of Villages	Village %	Village area to total area in %
> 45	Very High	6	9.52	55.99
45 - 35	High	1	1.59	44.00
35 - 25	Moderate	2	3.17	27.12
25 - 15	Low	5	7.94	20.46
< 15	Very Low	24	38.10	6.57
Nil		25	39.68	0.00
Total		63	100.00	17.69

Source: DFO, Kurseong.

Table 4.1 indicates that number of villages having forest areas below 15% is highest in the study area and its percentage has increased through the last three decades. Out of 63 villages, the number of villages having below 15% forest area has increased at the rate of 16 to 19 to 24 villages from 1981 to 1991 to 2001 respectively. At the same time, the number of villages without forest cover has decreased from 34 to 30 to 25 from 1981 to 1991 to 2001 respectively. That means from 1981 to 2001 almost 9 villages added to there land some percent of forest by planting new trees. Since most of the villages are tea gardens, their share of forested land is quite less. Large-scale deforestation took place in 4 villages. Among these Rangbul shows a striking decrease in the forest cover, which is from 26.41% to 1.15%. Other villages, which show similar decline in forest cover, are Marma, Bukim and Longview T.G.

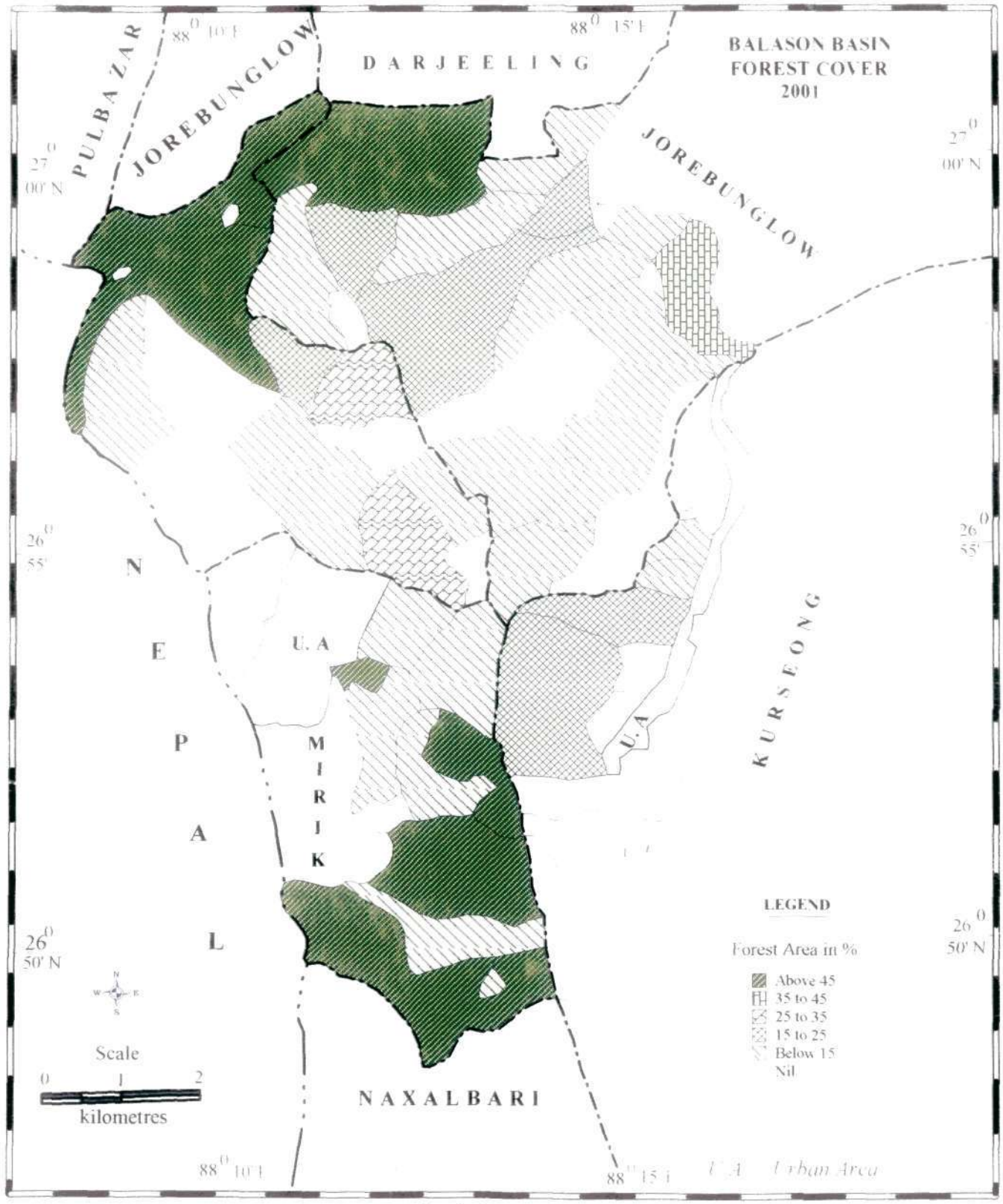

BALASON BASIN
FOREST COVER
2001
PULBAZAR
JOREBUNGLOW
DARJEELING
JOREBUNGLOW
KURSEONG
NEPAL
MIRIK
NAXALBARI
U.A
U.A
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
LEGEND
Forest Area in %
Above 45
35 to 45
25 to 35
15 to 25
Below 15
Nil
Scale
0 1 2
kilometres
U.A Urban Area

Fig. 4.2

Field observations revealed that though the forest cover has been increased but there is large-scale deforestation and degradation of forest due to high pressure of population on forestland for settlement, developmental activities and other anthropogenic acts. In the tea gardens, there are supposed to be some forestland in the past but in the course of time most of the tea gardens do not have any forest to supply fodder and fuel wood to the worker of the teagardens. As a result these workers are forced to collect their daily requirements of fodder and fuel wood from the nearby forest areas illegally or legally. It is also noticed that large scale grazing in the forest causing high rate of deforestation consequently increases soil erosion and over land flow. The depletion of forest resources has a wide-ranging impact on ecological balance ranging from the extinction of rare flora and fauna, to changes in climatic condition and lack of natural attraction of the area.

4.1.2. Cultivated Area

Percentage of cutivated land is high in the study area. Among the villages, the percentage of cultivated land ranges from 86.69% in Mangarjung T.G. to 14.42% in Sukhiapokhri. Percentage of villages within high range (60% - 70%) of cultivated land has increased from 1981 to 2001. there were 23.81% of villages under this high category in 1981, which became 36.51% in 2001. Villages having below 50% cultivated land also increased from23.81% in 1981 to 25.40% in 1991 to 30.16% in 2001. Percentage of villages in the moderate group (50% - 60%) decreased through the last three decades. In 8 villages cultivated land has increased between 1991 and 2001. During the same period, 13 villages showed decline in the percentage of cultivated land due to lack of irrigation facilities, poor production and uneconomic land holdings (Fig 4.3).

As there is no scope for other type of occupation, people try to convert the cultivable land into cultivated land by applying certain measures. Tea gardens occupy high share of cultivated land in the study area. Though irrigation facilities are less even then tea

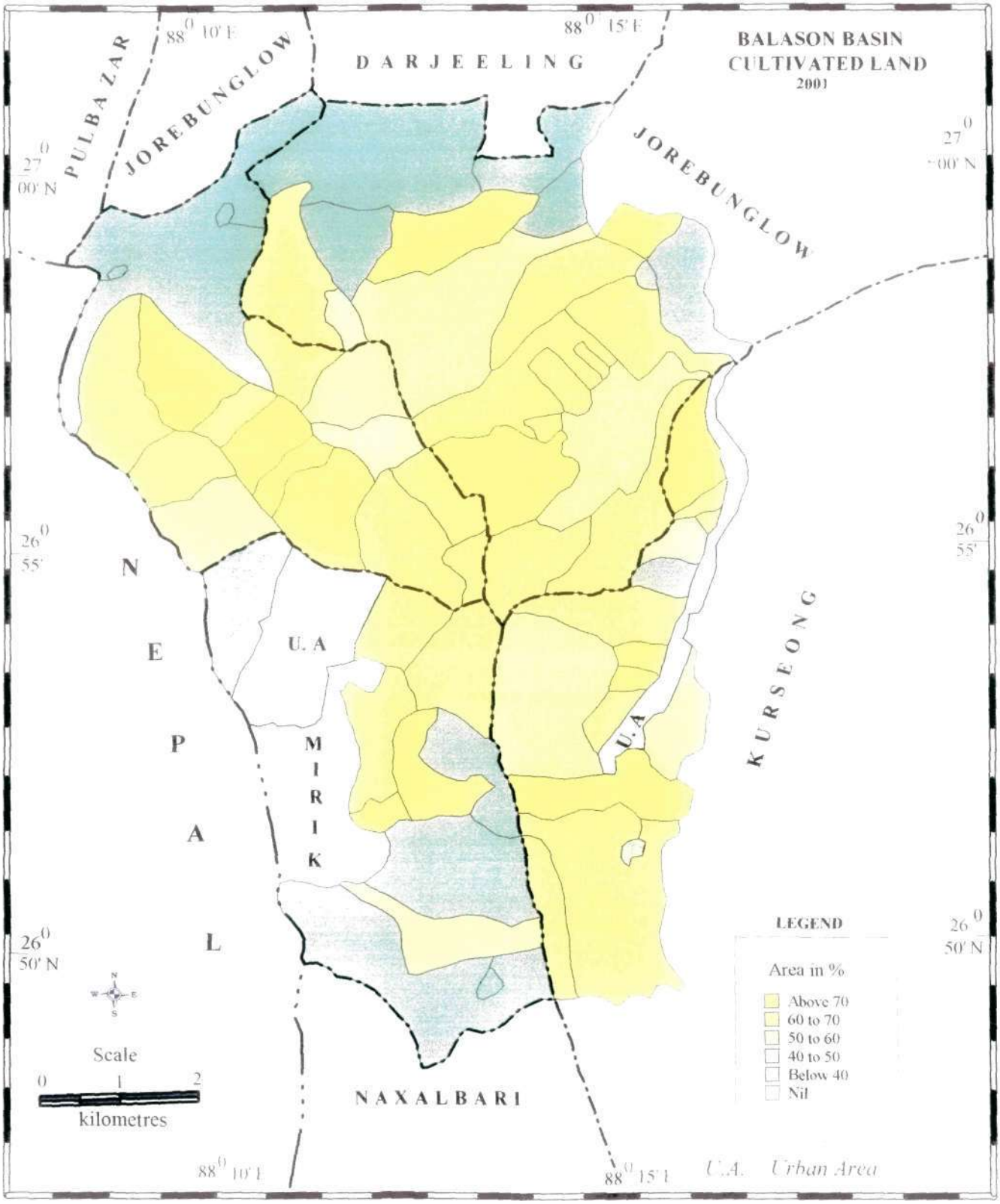

BALASON BASIN
CULTIVATED LAND
2003
DARJEELING
JOREBUNGLOW
PULBA ZAR
JOREBUNGLOW
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
N E P A L
U. A
MIRIK
U. A
KURSEONG
NAXALBARI
LEGEND
Area in %
Above 70
60 to 70
50 to 60
40 to 50
Below 40
Nil
Scale
0 1 2
kilometres
U.A. Urban Area

Fig. 4.3

plantations have developed depending upon monsoon rainfall. Moreover the tea gardens arrange for their own irrigation system during the dry season to save plants and production. Pruning is done in the dry season to save irrigation water.

Table: 4.2. Percentage of villages having percentages of area under cultivation.

Cultivated area %	Category	No. of villages	Village %	Village area to total area in %
> 70	Very High	12	19.05	81.93
70 – 60	High	23	36.51	65.26
60 – 50	Moderate	8	12.70	54.97
50 – 40	Low	3	4.76	48.98
< 40	Very Low	16	25.40	29.39
Nil		1	1.59	0
Total		63	100.00	54.17

Source: Census of India, 2001.

4.1.2a. Area Irrigated By Source

Irrigation in the study area is limited due to topographical conditions and remoteness of the cultivated land from the sources. The Balason basin lies in high rainfall zone. The sources of irrigation are rivulets and *jhoras* by diversion channels and over flooding. As the entire area is hilly so canal, wells, tanks and tube wells are not available. The only source of irrigation is the rainwater. The rivers and *jhoras* swell up with the onset of the monsoons and dries down with the lapse of monsoon. The practice of irrigating the crops is mostly confined to paddy, large cardamom and vegetables. The tea gardens maintain their own system of irrigation.

Irrigation of paddy has been done by rainwater and run off water from the hill slopes. Almost all paddy fields are irrigated at the time of planting and growing seasons. Large cardamom is normally grown at the hill slopes and the water from the *kholas* and *jhoras* are allowed to flow along the slope of the hills through the large cardamom fields. Intensive irrigation affects the soil and enhances soil erosion in well irrigated fields (Jana, 1994). Some crops like maize, wheat, barley and millets are grown in the soils where terraces are not required because these crops are grown in an unirrigated area. In tea gardens, pipes and

sprinklers are mostly used for irrigation.

Table: 4.3 Percentage of villages having percentages of area under irrigation.

Irrigated area %	Category	No. of villages	Village %	Village area to total area in %
> 40	Very High	1	1.59	50.00
40 - 30	High	5	7.94	36.74
30 - 20	Moderate	5	7.94	23.59
20 - 10	Low	4	6.35	15.99
< 10	Very Low	6	9.52	7.07
Nil		42	66.66	0
Total		63	100.00	8.23

Source: Census of India, 2001.

Percentage of irrigated land is low in the study area. There is a decreasing trend in the number of villages under irrigation in the last three decades. Percentage of villages under irrigation decreased from 38.10% in 1981 to 36.51% in 1991 to 33.33% in 2001 (Fig 4.4). among the villages, percentage of irrigated area ranges from 50.16% in Pokhribong Khasmahal to 1.81% in Mangarjung T.G. Villages, where land under irrigation increased from 1991 to 2001 are Dhajea T.G., Singbulli T.G., Longview T.G., Pokhribong Khasmahal and Pulungdung Khasmahal. On the other hand percentage of irrigated land has declined in three villages of Saurini Basti, Mirik Khasmahal and Nahori T.G. According to the table 4.3, 9.52% villages have above 30% irrigated land and 23.81% villages have less than 30% irrigated land. The hill slopes provide no facility to store water for irrigation. Rivers swell up during rainy season but this excess water cannot be stored due to lack of infrastructural facilities. Construction of reservoirs is risky unless proper engineering techniques are applied. Less irrigation facilities affect not only agriculture and tea plantations but also their production figures.

In the study area 9 tea gardens and 7 khasmahals enjoy the facility of irrigation by Government canals. Rest 4 tea gardens and 1 khasmahal has private source of irrigation. An area of 17.99 km^2 is irrigated by Government canals which is 73% of the total irrigated area. Rest 6.69km^2 area i.e. 27% is irrigated by private source. Longview T.G.

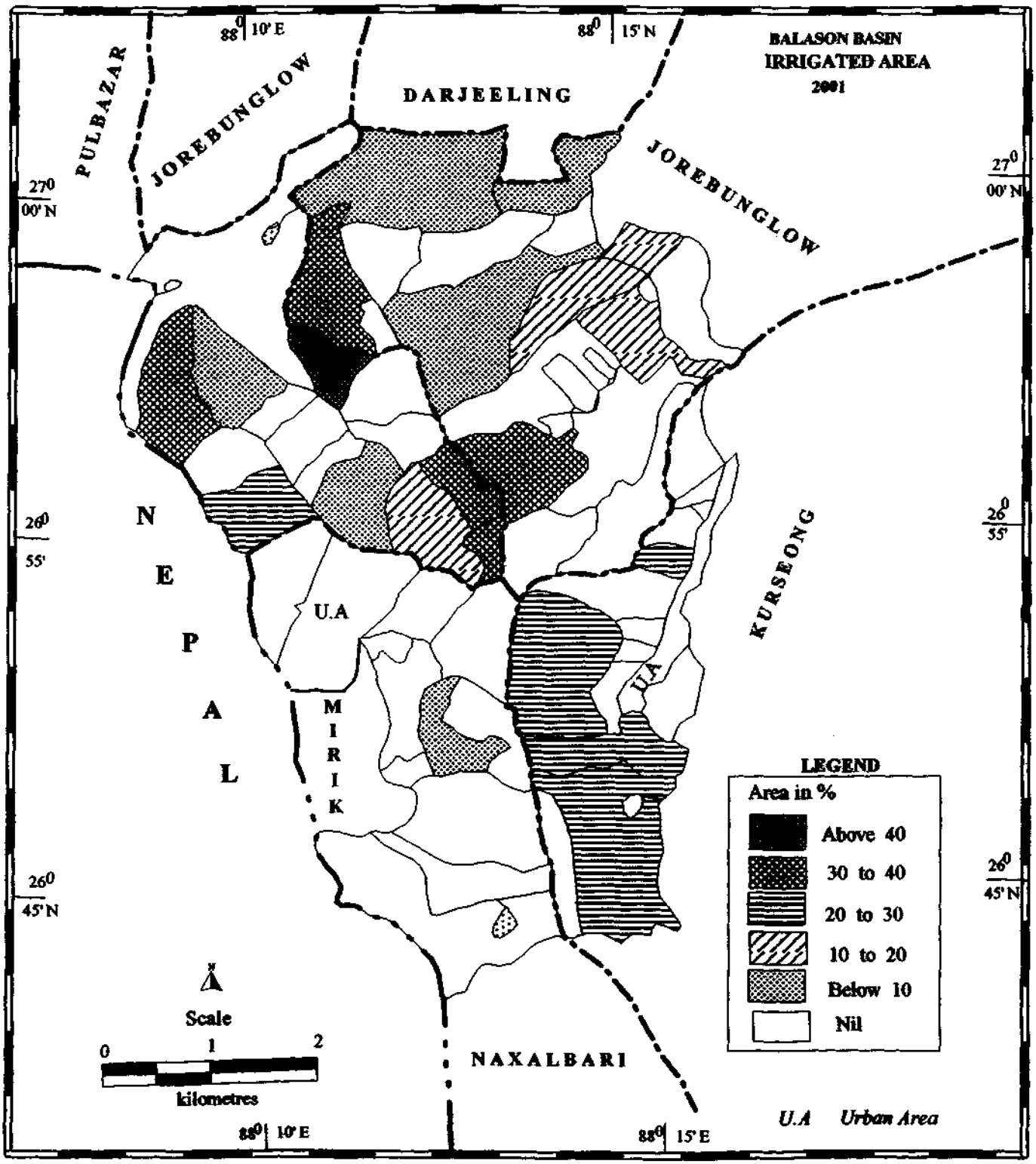

BALASON BASIN
IRRIGATED AREA
2001
88° 10' E
88° 15' N
PULBAZAR
JOREBUNGLOW
DARJEELING
JOREBUNGLOW
27° 00' N
26° 55'
26° 45' N
N E P A L
U.A
MIRIK
KURSEONG
U.A
NAXALBARI
LEGEND
Area in %
Above 40
30 to 40
20 to 30
10 to 20
Below 10
Nil
Scale
0 1 2
kilometres
U.A Urban Area

Fig. 4.4

is the only village which has both Government canal and private source, as means of irrigation.

Due to high cost of maintenance and management, the existing irrigation channels or *jhoras* have been blocked by soil erosion and land slides. There is a little probability of constructing new channels because almost all *jhoras* and streams become dry during dry period due to low rainfall and poor seepages for low vegetation cover. As a result the area under irrigation in majority of the villages having irrigation in the past has been declined during the last few years. This affects the crop production and net sown area severely in the study area.

4.1.2b. Unirrigated Area

With the ephemeral character of streams, highly concentrated rainfall for few months accentuated by the physiographic diversities are rendered in the Balason basin's cropped area devoid of adequate irrigation facilities. As a result percentage of unirrigated land is high in the study area. But the percentages of villages having more unirrigated area are gradually declining in the Balason basin through the last three decades. Among the villages the percentage of unirrigated land ranges from 85.51% in Tarzum T.G. to 5.36% in Kharia Basti. Percentage of villages having less than 40% unirrigated area decreased from 69.84%

Table: 4.4. Percentage of villages having percentages of area un-irrigated.

Un-irrigated area %	Category	No. of villages	Village %	Village area to total area %
> 80	Very High	4	6.35	82.88
80 – 60	High	21	33.33	65.08
60 – 40	Moderate	14	22.22	49.09
40 – 20	Low	17	26.98	30.75
< 20	Very Low	6	9.52	17.48
Nil		1	1.59	0
Total		63	100.00	45.94

Source: Census of India, 2001.

to 68.25% to 61.90% in between 1981, 1991 and 2001 respectively. Percentage of unirrigated area has increased in many of the villages due to lack of irrigation facilities. However it is revealed from the field

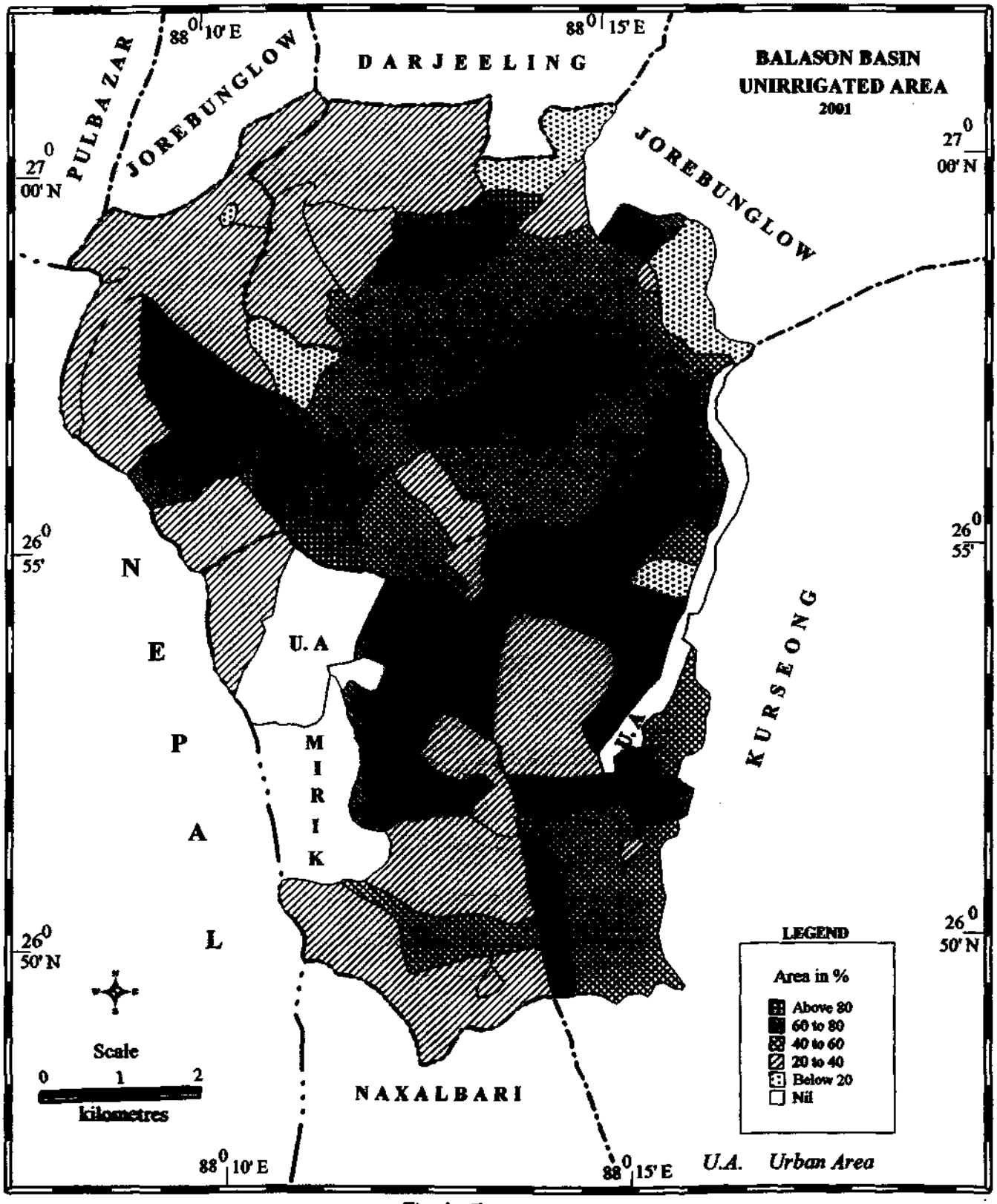

BALASON BASIN
UNIRRIGATED AREA
2001
DARJEELING
PULBA ZAR
JOREBUNGLOW
JOREBUNGLOW
KURSEONG
MIRIK
NAXALBARI
U.A
U.A
U. A
N
E
P
A
L
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
Scale
0 1 2
kilometres
LEGEND
Area in %
Above 80
60 to 80
40 to 60
20 to 40
Below 20
Nil
U.A. Urban Area

Fig. 4.5

study that the unirrigated area has been declined in certain villages due to increase in irrigational facilities and nearness to the *jhora* and streams (Fig 4.5).

4.1.3. Culturable Waste

Culturable waste includes fallow lands or lands covered with shrubs and jungles, grazing lands and meadows. Such lands are available only along the rocky, steep slopes of the Balason basin. The reason for having such lands may be one or more of the following reasons:

1. Poverty of the cultivators,
2. Paucity of irrigation water and
3. Non-profitable nature of farming.

Table: 4.5. Percentage of villages having percentages of area under culturable waste.

Culturable waste %	Category	No. of villages	Village %	Village area to total area in %
> 35	Very High	4	6.35	41.29
35 – 25	High	8	12.70	28.73
25 – 15	Moderate	11	17.46	18.10
15 – 5	Low	20	31.75	10.67
< 5	Very Low	15	23.81	3.18
Nil		5	7.94	0.00
Total		63	100.00	14.62

Source: Census of India, 2001.

In the study area, percentage of land under culturable waste is low. The percentage of land under culturable waste ranges from 57.01% in Jorebunglow to 0.79% in Makaibari T.G. (Fig 4.6). Thus Jorebunglow has very high density of population and the area is expanding vertically because above 50% of the land is culturable waste. Areas having above 5% culturable waste have increased by 38.09% between 1991 and 2001. Area under culturable waste increased in 7 tea gardens because landslide, soil erosion and natural calamity made the land unfit for economic use. On the other hand, percentage of culturable waste has decreased in 5 villages because of construction of houses, roads and modern developmental activities.

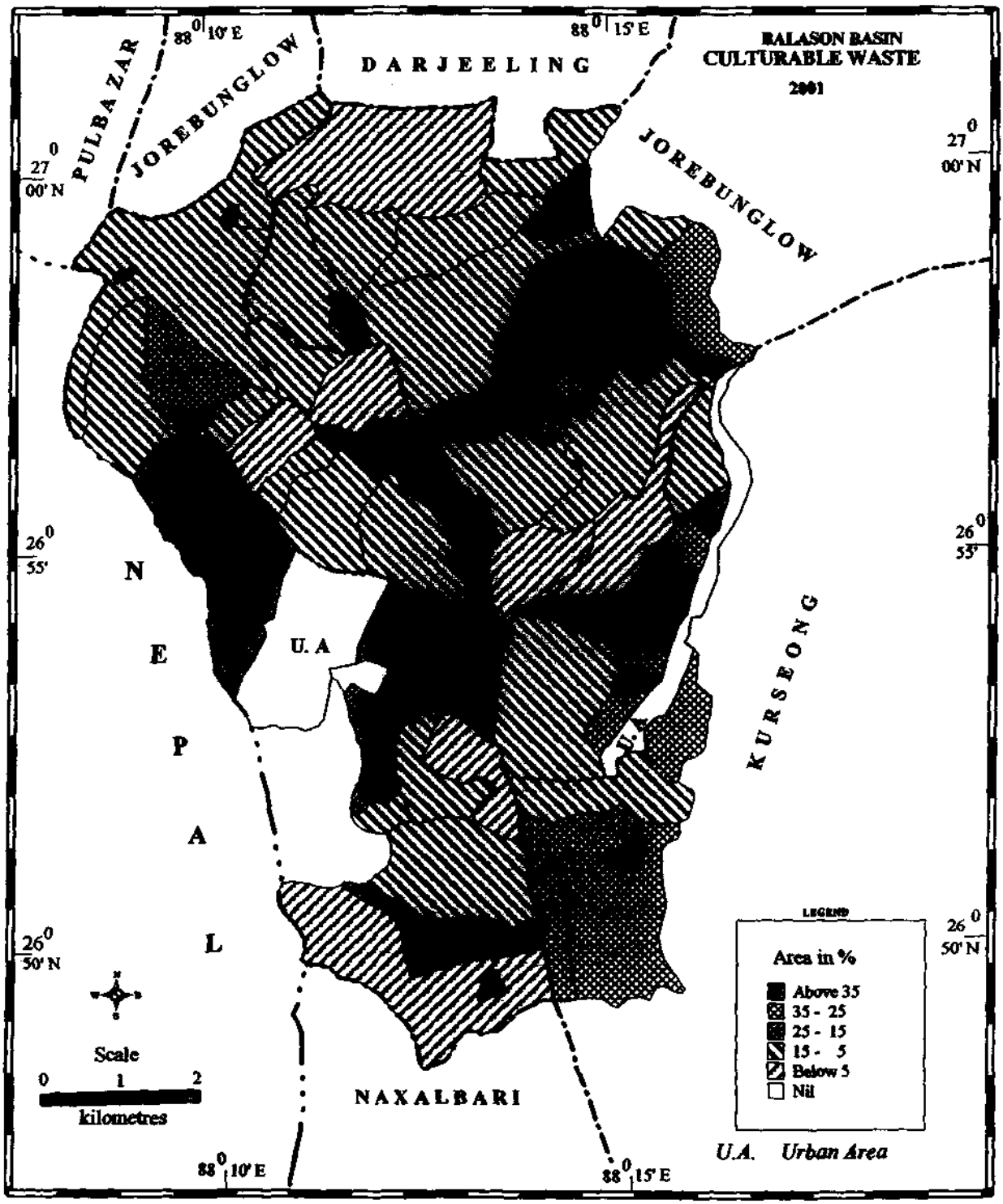

BALASON BASIN
CULTURABLE WASTE
2001
88° 10' E
88° 15' E
27° 00' N
26° 55'
26° 50' N
PULBA ZAR
JOREBUNGLOW
DARJEELING
JOREBUNGLOW
N
E
P
A
L
U.A
KURSEONG
NAXALBARI
LEGEND
Area in %
Above 35
35 - 25
25 - 15
15 - 5
Below 5
Nil
U.A. Urban Area
Scale
0 1 2
kilometres

Fig. 4.6

4.1.4. Area Not Available For Cultivation

According to table 4.6, area not available for cultivation is less in the study area. It ranges from 85.58% in Sukhiapokhri to 1.09% in Manjha Forest (Panighata F.Rly.). Area under very high (>35%) percentage has decreased whereas area under high (35%-25%) and moderate (25%-15%) percentage has increased from 1991 to 2001. Much of this land is utilized for road and building construction (Fig 4.7).

Table: 4.6. Percentage of villages having percentages of area not available for cultivation.

Area not available for cultivation %	Category	No. of villages	Village %	Village area to total area in %
> 35	Very High	7	11.11	50.72
35 – 25	High	9	14.29	52.30
25 – 15	Moderate	17	26.98	19.40
15 – 5	Low	21	33.33	9.61
< 5	Very Low	8	12.70	2.97
Nil		1	1.59	0.00
Total		63	100.00	13.52

Source: Census of India, 2001.

Sukhiapokhri is densely populated, so, the requirement for this type of land is more here. Other village where percentage of area not available for cultivation is high is Kharia Basti, Punkhabari, Hill Cart Road and Simana Basti. Among the tea gardens, percentage of this area is highest in Gopaldhara (44.02%) and lowest in Nahori (1.26%). In 11 villages, percentage of land under area not available for cultivation has increased from 1991 to 2001 due to high pressure of population, for construction of houses, roads and other constructional works. In 8 villages the percentage of this land use decreased.

4.2. LAND TENURE SYSTEM

Land reform involves an alteration to the nature of land tenure by direct intervention by the planners or the government. Land tenure is the system of ownership of land and of title to its use. Rights to land use are complex and varied especially in a large and diverse country like India. They involve various aspects of security, legality and variety

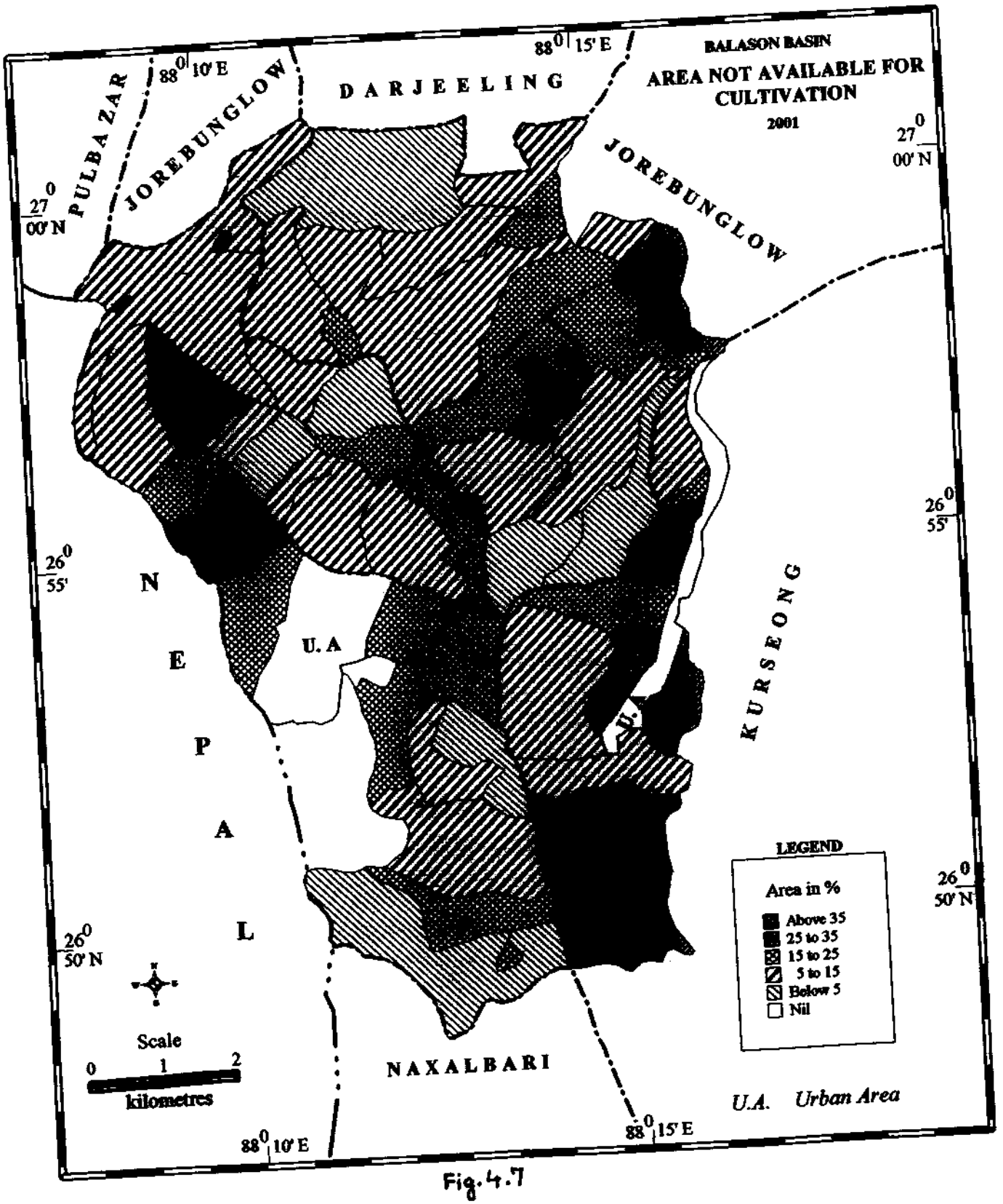

BALASON BASIN
AREA NOT AVAILABLE FOR CULTIVATION
2001
88° 15' E
88° 10' E
DARJEELING
PULBA ZAR
JOREBUNGLOW
JOREBUNGLOW
27° 00' N
26° 55'
26° 50' N
N
E
P
A
L
U. A
KURSEONG
NAXALBARI
LEGEND
Area in %
Above 35
25 to 35
15 to 25
5 to 15
Below 5
Nil
Scale
0 1 2
kilometres
U.A. Urban Area

Fig. 4.7

of relationships between the user and the owner (especially with reference to the mode and amount of payment). The following are the most important types of land tenure which have been prevalent in different parts of the world as well as India.

i) Owner occupation.
ii) Tenancy
iii) Use Right
iv) Institutional with Wage Labour
v) Collectivism.

The concept of 'collectivist' tenure is being applied to the promotion of joint forest management, whereby village communities located on the fringes of the government owned forest land are being involved in the protection of forest areas, in return for which they are to get 25% of the share of the proceeds of the sale of timber, the rest being revenue of the forest department of the government. The villagers (the members of the Forest Protection Committees) also have the right to collect and use fuelwood (without felling trees) and non-timber forest products free of cost. This is a method of harnessing private potential for higher and sustainable production from an environmental system.

While tea plantations have been introduced and developed during the British rule, shares and bonds are currently being floated by private companies for various types of timber plantations, indicating a change in the ownership and development of arboreal production system (Choudhuri, 2001).There types of land tenure systems prevailed in India at the time of Independence. The basic difference between them was the mode of payment of land revenue. West Bengal had a land tenure system known as Permanent Settlement which promoted landlords called Zamindars. In the Zamindari system the land revenue was collected by the Zamindars from the farmers. The revenue collection pressure created a layer of intermediaries. The lowest strata of actual cultivators were the share croppers, known mainly as Bargadars. After Independence in 1947, Zamindars were replaced by new landlords called Jotedars. The Jotedars, mainly rentiers from the

erstwhile Zamindar, again turned out to be not the actual cultivators in general and many of them were absentees. The West Bengal Bargadars Act of 1950 was abolished by the West Bengal Land Reforms Act, 1955. in order to protect the interest of the bargadars, it has been laid down that the landowner will be entitled to terminate cultivation by a bargadar on the following four cases:

(a) When the bargadar fails to cultivate the land or uses it for non-agricultural purposes,

(b) When the land is not cultivated by the bargadar personally,

(c) Where the bargadar fails to tender the share of the produce to the land owner, and

(d) Where the land-owner requires the land for bringing it under personal cultivation.

Normally bargadars are evicted on the plea that the land would be used for "personal cultivation". "Personal cultivation" means cultivation by a person of his own land on his own account---

(a) by his won labour, or

(b) by the labour of any member of his family or

(c) by servants or labourers on wages payable in cash or in kind, or both.

The West Bengal panchayat system in its structural form came into being in 1978 after the panchayat election. The rural political leadership which led the widespread peasant movement culminating in forced land refer and a sizeable percentage of the small and marginal farmers and bargadars found a platform in the newly set up panchayat system. The panchayats in West Bengal may, therefore, be called a product of land reforms.

Teagardens, mills, factories: Lands held by an intermediary in the capacity of a tea garden, mill or factory could be retained up to a certain limit, the state Govt. deciding how much land was required for the purpose of the tea garden, mill or factory as the case might be. It was further laid down that the non-agricultural lands of an intermediary comprised in his homesteads, buildings and structures in

khas possession should not exceed 20 acres as might be chosen by him. Thus in effect, as a consequence of abolition of Zamindari, intermediary could retain more than 20 acres of non-agricultural land and 25 acres of agricultural land in his possession. There was no limit to the land held by him as tank fishery or as a trustee in respect of an exclusively religious or charitable trust or land comprised of orchards or used for the purpose of livestock breeding, poultry farming or dairy. As a result the vesting of the lands of the intermediaries in the state, the collectors of the districts were authorized to take charge of all estates and rights of intermediaries which had vested in the state.

In the period between 1835-1881 may be called as the period of 'introduction' of agriculture in a land full of forest and wasteland in Darjeeling hill area, the period between 1881-1951 may be called as the period of 'consolidation' through different experiments of Land Tenure system. In the hill area, agriculture competes with tea for land and tea competes with agriculture for plantation. Both can only increase at the cost of forest. The land tenure system which the British Govt. introduced in the area is very novel. When whole of India had Zamindari system, in Darjeeling the British introduced a raiyotwari tenurial system. The only 'Zamindar' was Chebu Lama, who helped the British in the Anglo-Sikkim wars. But his Zamindari was not in any sense 'permanent'. Ultimately after the death of Chebu Lama, land was taken away by the Govt. and it was removed as 'Relling Estate Khasmahal' it is a novel system in Darjeeling that Zamindari system was not prevalent in this area.

The system that existed in this area is a mixture of mandal system and raiyatwari system to start with. The mandals in one period of history had immense power of rural people. They were keepers of law and dispenser of justice and acted as intermediary between Govt. and the tiller. But gradually the mandal system faded away and Govt. had to deal with raiyots directly.

The raiyotwari system had various evolutionary phases but the main point to note is that, in between Govt. and the raiyot, there was

no intermediary. Alienation of land from Nepali farmers to plainsman was legally prohibited and the Govt. controlled the optimum size of holdings. Transfers, which increase the size above 20 acres or reduce it below 5 acres, were not sanctioned. The average size of holding was about 5 acres and most of the farmers were owner cultivators. The incidence of rent was tolerable. Apart from that the land was given to the Buddhist monasteries nearly without rent to satisfy the sentiment of Lamas and local tradition. Alienation of land was not rampant but there were cases when Lepcha land was taken by Nepalis.

4.3. AGRICULTURAL PRACTICES

The agricultural pattern in Darjeeling hill area is somewhat different from that of the plains mainly due to the physical constraints in the area.

(i) The landscape consists of rugged terrain, full of ridge and spur topography of rather sharp incline and deep riverine valley. This reduces the scope of agriculture in the region.

(ii) Due to steep slope accompanied by high rainfall, it becomes difficult to channelise the excess water in the agricultural fields in any systematic manner. Though high land (lekh) is considered to be 'healthier' than the low land (awal) for cultivation, but high land is less sought for. This is due to water scarcity on the high lands and crops also ripen later due to less temperature.

(iii) The cropping pattern has a bias for food crops.

(iv) Land available for cultivation is extremely low.

(v) The best quality of land is occupied by the tea gardens in the study area.

(vi) Agricultural labourer is a new concept and their percentage is very low. The prevailing form of cultivation here is family ownership or owner-cultivator type.

(vii) Crop items like oranges, potatoes and spices are more implant than rice.

4.4. PROBLEMS OF AGRICULTURAL SECTOR

i) Extreme poverty of the farmers.

ii) Excessive dependence on the private money lenders cum traders.

iii) High degree of illiteracy.

iv) Remoteness of some agricultural villages.

(v) Farmers' ignorance of the changing world and market conditions.

(vi) Corruption in the administrative system.

(vii) Constant fall in average holding of agricultural land due to the laws of inheritance.

(viii) Growing unemployment in the agricultural sector.

(ix) Political instability in the area, hinders, the proper running of the agricultural schemes.

(x) Introduction of Panchayati system without adequate sincerity.

(xi) There are examples where the utilization of money was not in conformity with the sanctioned allotment.

(xii) In many cases fund sanctioned for a particular project had been diverted to other projects.

(xiii) The absence of any co-ordination between various Govt. departments, public sector undertaking and banks, made matters even worse.

(xiv) Fund allotted is very less compared to the requirement.

(xv) Very few producing villages are connected with the markets by all – weather roads. Absence of motorable roads has forced the producers either to sell their produce at the village level itself at low price or to pay a considerable amount of money for carrying the produce from the farm to the market, making higher marketing cost.

(xvi) The price difference between the producing centers and the wholesale market is often very large.

(xvii) Farmers are too poor and to understand the ideas of cooperative movement.

(xviii) A balanced growth among consumers' marketing and credit societies are not well maintained.

(xix)Most of the credit societies are controlled directly or indirectly by

local political leaders.

The commercial banks prefer financing the wholesalers and tea sector rather than the rural farmers. This is mainly due to unforeseen complications and lack of securities. The general shortage of trained man power, poor quality of financial management, marketing difficulties etc. are notable factors for the slow growth of commercial banking business in the study area. This is further compounded by political pressures of different kinds.

4.5. CHARACTERISTICS OF CROPPING PATTERN

Maize occupies the topmost position in respect of area under individual crop. Land, that remains moist and situated in low elevation and blessed with relatively sunny atmosphere, provides ideal condition for growing maize. In the study area maize is grown on any soil, at any altitude between 1000m to 1500m in both panikhet as well as sukhakhet. Millet is another important crop in the study area, locally known as kodo. It is grown at a relatively lower altitude, mostly in dry land (sukhakhet) and yields less income. It is sown in April-May and harvested in October-November. It is not only consumed by poorer people but is also used to prepare local liquor. Aman paddy or winter rice is grown on terraced and irrigated land applying organic manure. This crop occupies less land in the study area. Wheat is a super cereal crop grown in the hills. Black wheat is cultivated in dry land up to a height of 2350m. The yield of wheat falls with the increase in altitude. Barley is another cold weather crop cultivated in the study area. Its cultivation remains confined within 1600m. altitude. It is sown in September and harvested in winter. Its cultivation fetches a higher income to the farmer. Potatoes and vegetables are important crops of the study area. These are grown in many parts of the study area like Sonada, Rangbul, Sukhiapokhri, at an altitude between 1300m. and little higher than 26660m. Potato is grown plentifully and is generally harvested twice in a year, once in summer and once in winter. There is great demand of local seed potato, specially the variety which is

Photograph 4.1 Cultivation of Potatoes

Photograph 4.2 Sprinkler Irrigation

Photograph 4.3 Cultivation of Vegetables

harvested in summer. The demand comes not only from the plains of West Bengal but from other parts of India too. The average yield varies depending upon weather conditions. Vegetables like beans, carrot, asparagus, broccoli, cabbage, cauliflower sprouts, spinach, peas, radish, tomatoes etc. grow in plenty.

Cardamom, locally known as elaichi (a scented spice) is very valuable cash crop in the study area. It occupies top position in terms of yield, produced per unit of land. This crop grows at an altitude varying from 3330m. to 1600m. along the *jhoras*, in a rich soil which must have a shade and retain moisture. New cardamom fields need to be thoroughly weeded. No crop is obtained in the first two years. Only halt-crop is harvested in the third year followed by full crop during the next eight years. Plants loose vitality after the tenth year and continue to produce at a diminishing rate up to the fifteenth year. New plantation seedlings are transplanted in May-June, two to three feet apart. Ginger is another special agricultural product of the study area. Land situated between 330m. and 1300m. height, is suitable for its cultivation. Reasonable quantity of output can be obtained continuously for 4 to 5 years from the same plants but for maintaining quantity and quality, replication is necessary at the expiry of every 4 to 5 years. Farmers generally prefer dry land for its cultivation. Low cost of production and relatively inferior quality land required for its cultivation are some of the added advantages. Ginger, like cardamom has a wide market throughout the country. Oranges are the most popular, prestigious and profitable fruit grown in many parts of the study area. Just like Darjeeling tea, Darjeeling orange is famous for its taste and quality.

There are two broad varieties of orange, small and light ones and bigger ones with loose casket. The better quality oranges are generally grown in rich black soil at elevations of 670m. to 1300m. Plants in the orangeries grow on terraces. Two acres on an average, is the size of an orange orchard. One acre of land accommodates 120 to 125 trees and each tree gives 500 to 3000 fruits per annum, depending on various

factors including the age of the tree. Under the old method of cultivation, one acre of land contains even 200 treas. Transplantation of the seedlings take place in the months of May and June and generally 4m. to 6m. distance is maintained between the seedlings. Distance kept between the seedlings or tree is one of the factors determining the size of the fruits. The more the distance, the larger is the size of the fruit. Generally seedlings of 4 years maturity are used for replantation, when these are raised from seeds. The trees from these seedlings begin to bear fruits from their seventh or eighth year. But this gestation period can be reduced, 3 to 4 years, if seedlings made by grafting are replanted as per modern technology. A fully grown up orange tree attains the height from 5m. to 6.5m. in the study area. Since 1965, there is a constant extension of area under orange cultivation but the rate of extension achieved so far is not satisfactory. Oranges grown in and around Mirik subdivision is mostly exported to Bangladesh. Oranges are also grown in the tea garden area of Moondakotee, Avengrove, Nagri, Dhajea, Singbulli Seyok and many others. Oranges grown in the entire study area are send to Siliguri, from where these are send to Bangladesh, Kolkata and Delhi.

Marketing of cash crops in the study area is still strongly influenced by money lenders cum traders. They exploit the farmers. A group of middle men residing at the important collection centers, control more or less the entire marketing system. The farmers are forced to bend in front of the local money lenders because of lack of institutional credit systems. Factors like indefinite delay in getting the loan sanctioned from the lending institutions, the necessity of complying with numerous formalities etc. are equally responsible for the exploitation, the farmers are going through. Important features regarding the unsatisfactory growth of orange cultivation, in the study area, are as follows:

(i) Orchards are mostly occurring in homesteads and have less then 50 plants.

(ii) The locations of orchards are mostly above 800m. High altitude makes it difficult to harvest and market the crop.

(iii) Orange plants are mostly 20 years old.

(iv) A large number of orchards have no irrigation facilities which reduce production.

(v) Fertilizer is hardly used in the orchards.

(vi) Many of the orchards are mixed having maize, ginger, millets, soyabean, cabbage or potatoes as the second corp.

(vii) Lack of use of insecticides and pesticides, affects the rate of production.

Measures to improve orange cultivation:

(i) Short term & long term measures has to be implemented.

(ii) Use of fertilizer, pesticides etc. are recommended.

(iii) BDO will supply seedling and pruning material at 50% subsidy.

(iv) Marketing system has to be improved.

(v) Regulated markets are started.

(vi) Food processing units are opened to diversity the product potential.

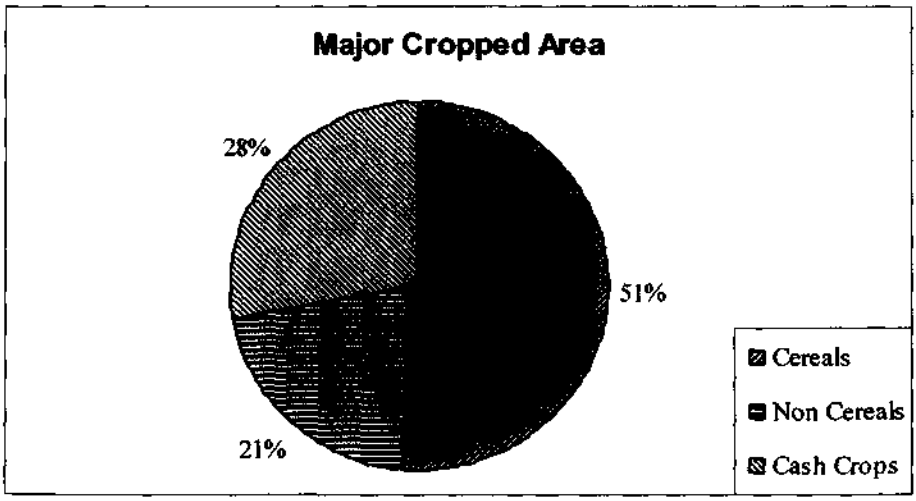


Fig. 4.8

The crops of the study area are broadly divided into three groups. These are:

i) cereals including paddy, wheat, maize and millets;

ii) non cereals including potato, vegetables, mustard, pulses, soyabean; and

iii) cash crops including ginger, cardamom, orange.

According to Fig. 4.8, the cereal crops occupy the major share (51%) of cropped land in the study area. The cash crops are the second important with 28% of the cropped area under them. Vegetables occupy the lowest percentage of area in the basin.

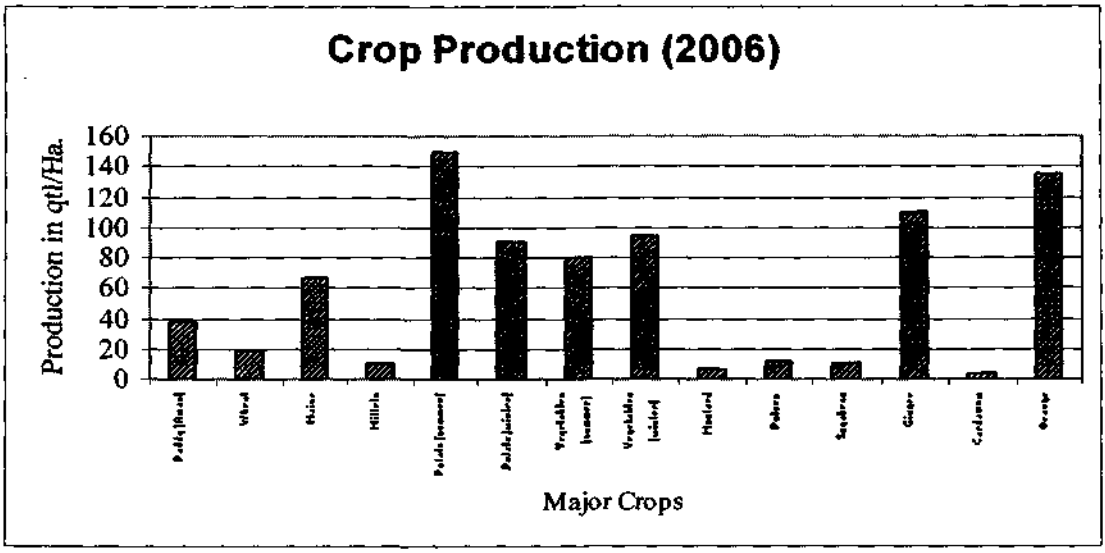


Fig.4.9

From Fig.4.9, it is evident that though vegetables occupy the lowest percentage of area yet its production is the highest (443 qtls/ha). Cash crops are both in the second position in terms of area covered and production. Cereal crops, in spite of occupying maximum land, produce little compared to others. Among all the crops, cropped area under maize is the highest whereas production of potato is highest. Summer potato, which is produced in high quantity, can be used as seed for winter.

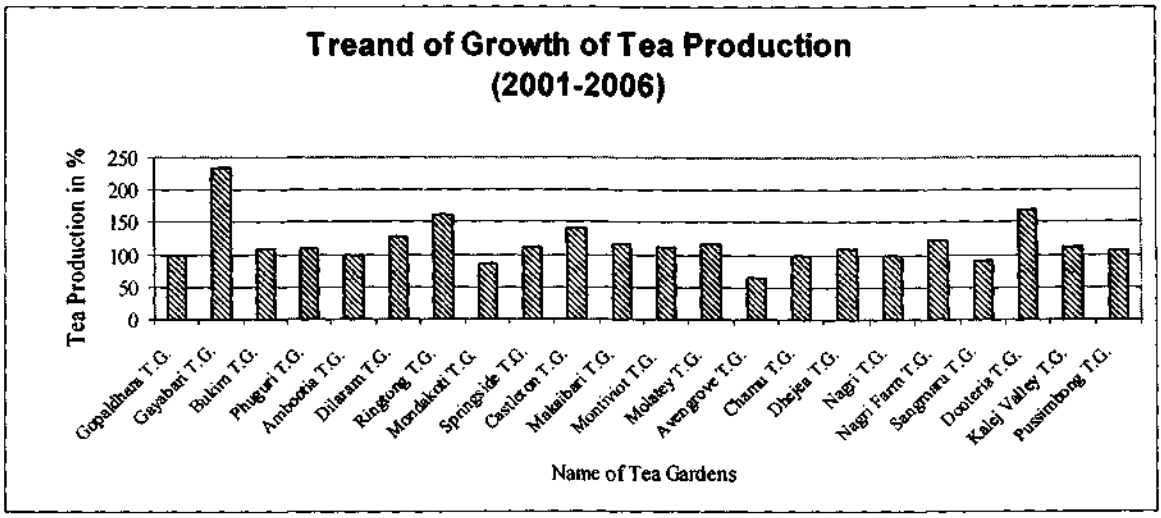


Fig.4.10

Since agriculture is the main occupation of the people and entire study area is covered by tea gardens therefore evaluation of tea production is necessary, to realize how far it will lead to sustainability. Though production figures are not always available even then the trend of growth of tea production can be shown for few tea gardens, for a stretch of six years. Among the tea gardens where there is a consistency in positive trend of growth for the last six years are Dilaram and Kalej Valley. All other tea gardens have a fluctuating nature of production. In Fig.4.10, the Gayabari T. G. has the highest trend of growth. Here production has increased through the last six years due to implementation of organic fertilizers and new techniques of scientific tea cultivation.

CONCLUSION

Land is one of the most important natural resource of the world. Land use is considered as a mirror, which reflects the ecological health and economic potential of an area. Land uses, in the study area, are of five types namely forest area, irrigated area, unirrigated area, culturable waste and, area not available for cultivation. Among all these, unirrigated area occupies the major share of land use because of scarcity of water due to non availability of water storage system. Though rainfall is heavy but it is concentrated only in the monsoon

months i.e. June to September. So cultivation, mainly tea plantation, is to be done without irrigation. Forests occupy the second major share of land use in the study area. Due to afforestation and several other conservation measures, forest cover has increased in Phuguri forest, Manjua forest. Tea garden like Purba Phuguri shows remarkable increase in its forest area. Phulungdung Khasmahal and Saurini Basti also are in favour of forest conservation. But tea gardens like Marma, Bukim and Longview has lost their forest cover. Rangbul shows a major decline in forest area due to increase in population pressure. Loss of forest area in the tea gardens is forcing the workers to encroach into the reserve forest areas for collecting fuel wood and fodder. Similarly, percentage of irrigated land is very less (8.33%) in the study area. Due to mountainous terrain and steep slope, rain water cannot stand on the surface and flows down to the plains. Hard rocky landform do not allow underground recharge neither can underground water be extracted. There is less infrastructure for storing rainwater during limited monsoon months and using it in the dry season. So less irrigation results in poor production of crops and tea leaves. Cultivation is mostly done without irrigation. So, unirrigated land is more in the study area. But this trend is gradually declining and more and more land is coming under the preview of irrigation.

Due to the presence of the tea garden, percentage of cultivated area is high in the study area. Land under culturable waste is low. In Jorebunglow, 50% of the land use is culturable waste. In the study area, only 13.52% of the land is not available for cultivation. Area not available for cultivation is high in Kharia basti, Punkhabari, Hill Cart Road and Simana Basti indicating more constructional work in such villages. Land thus used has certain ownership and title of its use. Land revenue has to be paid to the Govt. for holding such lands. The tea garden lands are taken from the Govt. for a lease period of 99 years. Every time after the span of the lease, it has to be renewed. For holding each acre of land people has to pay land revenues to the Govt., panchayat etc. Khasmahals are Govt. lands and revenue is also

charged on then. Tea garden authorities are regular payees of land revenue whereas farmers are irregular due to their poor economic conditions. Agricultural products like paddy, wheat, maize, vegetables, ginger and cardamom are grown in the study area. Cropped area under cereal crops is the highest in the basin. With respect to production, potato has the highest yield. Application of new techniques, proper flow of funds for agricultural development is very necessary for the agricultural activities to sustain in the study area. Trend of growth of tea is fluctuating in nature in majority of the tea gardens. Gayabari T. G. shows a higher rate of growth with production percentage being highest among all the other T. G's.

Utilization of land depends upon people participation to harness return from different uses in terms of crop, forest, horticulture etc. So people have to be acquainted with knowledge and experiences for optimum utilization of land. So it is necessary to study the different socio-economic functions. These have played an important role in developing the natural and human resources. So their distribution and availability to the inhabitants of the study area, which are to be in the next chapter, is essential.

CHAPTER V

SOCIO-ECONOMIC FUNCTIONS AND THEIR DISTRIBUTIONS

INTRODUCTION

Socio-economic functions play important role, for eradication of rural poverty and all round development of an area. These functions not only help in checking the rural people to go to urban areas for getting and fulfilling their daily needs but also directly helps in the developmental process. Socio-economic functions are generally concentrated in large and populated villages to fulfill the demand of the people and to serve the neighbouring areas of the villages. These functions are tools for improving the economic as well as social status of the inhabitants and indirectly compete with the nearby towns. High standard and number of socio-economic functions in a village reduces the functional gap between urban and rural areas. As a result, the crowding for such facilities in the urban area can be minimized. Socio-economic functions like educational institutions, health services, communications, transports, markets, banks and co-operatives, drinking water and power supply etc. help to raise the economic and social standard of the inhabitants of the region. The size of population and the economic conditions of the inhabitants primarily control the concentration of socio-economic amenities in a village. In the study area, the socio-economic amenities are less and unevenly distributed due to various physical, climatic and economic factors.

5.1. EDUCATION

Education is universally accepted and it is a major instrument towards achieving the goal. To meet the aspiration of the people and to achieve the goal, education to the people is very important. Among the functions, primary educational institutes play most important role in spreading education in the rural areas, because they are the prime institutions to teach and to give proper training to the children for

increasing literacy rate. In the study area, many new schools have opened may be because of need and government subsidy. To bring more and more children to the schools, government is giving free textbooks and mid day meals. According to table 5.1, the percentage of villages having primary schools (> 4) has increased. The total number of primary schools in the Balason basin also increased from 113 in 1981 to 120 in 1991 to 171 in 2001. This increase includes both government and private schools. Recently there is a trend of opening private English medium schools in the tea gardens since Government schools prefer to teach through mother tongue.

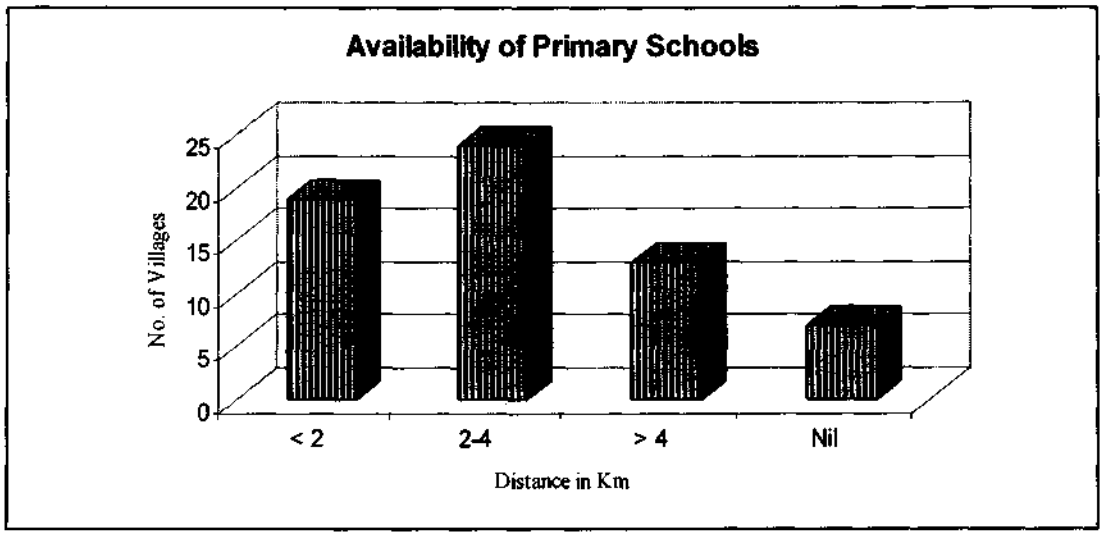


Fig.5.1

Table: 5.1 Distribution of educational institutions.

		Number of Villages		
Educational institutions	Number of Edu. Inst.	1981	1991	2001
Primary School	< 2	20	18	19
	2 – 4	24	28	24
	> 4	5	5	13
	Nil	14	12	7
Middle School	< 2	10	9	18
	> 2		1	6
Secondary	< 2	8	6	7
	> 2	0	1	4
Senior Secondary		5	2	4
College		0	0	2
Others		0	3	11

Source: Census of India,1981, 1991, 2001.

All the khasmahals in the study area, has the highest number of primary schools where the demand for education is high for high population and the literacy rate is also high. There are DGHC run primary and senior high schools in the tea gardens and villages in the study area. Such schools provide employment to the local educated people.

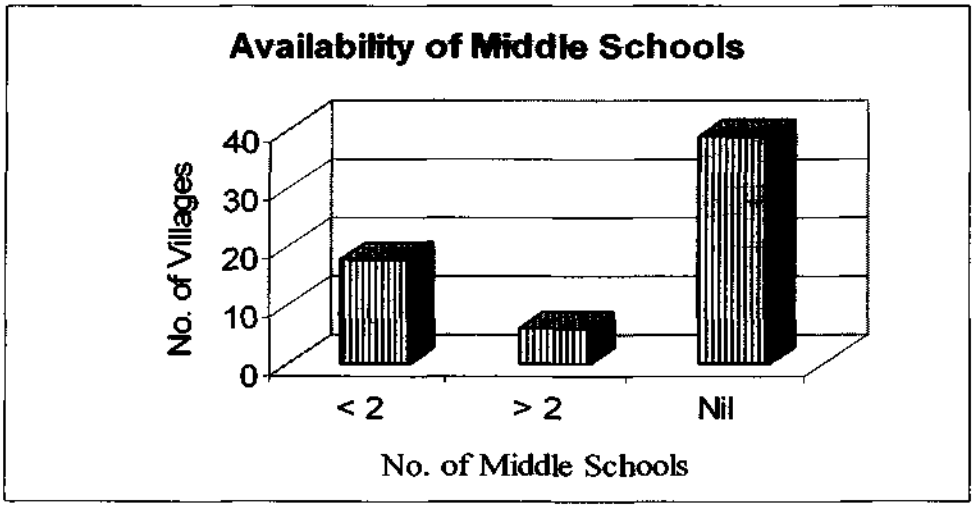


Fig. 5.2

Middle schools, secondary schools and senior secondary schools are very few in the study area and are most unevenly distributed. Compared to 171 primary schools in 2001, there are only 33 middle schools, 17 secondary schools and 4 senior secondary schools. Number of villages having other schools has increased due to consciousness among the aged people. There are two colleges in Sonada khasmahal, which are Silecean College and training college (ITI). More technical, vocational and management colleges should be opened, which in turn can help the tea industry by providing skilled manpower from the locality.

5.2. HEALTH SERVICES

Health is a vast subject having various dimensions. WHO (1971) defined health as a "state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". Health

furthermore can be thought to be a dynamic equilibrium, which is determined by a wide variety of biological, socio-cultural, economic, political and environmental factors. The details of various health services available in the study area are given in table 5.2.

Table: 5.2 Distribution of different medical facilities.

Health services	Distance in km.	No. of Villages		
		1981	1991	2001
Hospital	< 5	11	1	9
	5 – 10	0	0	8
	> 10			46
Dispensary		20	29	37
M.C.W.	< 5	1	1	16
	5 – 10			5
	> 10			42
C.W.C.		1	1	10
H.C.		3	6	3
P.H.C.	< 5	1	1	13
	5 – 10			16
	> 10			34
P.H.S.		4	2	30
Others		4	2	5

Source: Census of Indis,1981,1991,2001.
MCW: Maternity and child welfare center; CWC: Child welfare center; HC: Health Center; PHC: Primary health center; PHS: Primary health sub center.

Health is the positive state of well being of an individual. It involves not only the medical factors but also social and economic factors. In the study area, 2 villages have hospitals, 37 villages have dispensaries, 11 villages have MCWs, 10 villages have CWCs, 3 villages have HCs, 6 villages have PHCs, 30 villages have PHSs, and 5 villages have other medical facilities. The pattern of distribution of all these health service institutions is very uneven. Out of 63 villages in the study area, hospitals are situated within a distance of 5 kms from 7 villages, 5 - 10 km from 8 villages and more than 10 kms from 46 villages. Similarly, to avail the medical facilities provided by MCWs , 6807 people has to travel a distance of 5 kms, 8147 people travel 5 – 10 kms and 120661 people travel more than 10 kms. Tea gardens like Maharani, Edenvale, Kalej Valley and Ringtong has no medical facilities. Jamadar Bhita Khasmahal also has no medical institutions

and the nearest hospital is situated at a distance of more than 10 kms. Majority of the people depend upon dispensaries and primary health sub-centers for medical services.

Table: 5.3 Availability of different medical facilities.

Medical Institutions	No. of villages	No. of medical institutions	Ratio of population served	Ratio to total population
Hospital	2	2	1:34	1:67808
Dispensary	37	47	1:2003	1:2885
M.C.W.	9	18	1:1166	1:7534
C.W.C.	10	26	1:1050	1:5216
H.C.	13	3	1:886	1:45205
P.H.C.	6	6	1:4133	1:22603
P.H.S.	30	31	1:2360	1:4375
Others	6	7	1:3565	1:19374

Source: Census of India, 2001.

Supporting medical staff like Registered Medical Practitioners (RMP), Subsidized Medical Practitioners (SMP) and Community Health Workers (CHW) are found in a few villages. Out of 63 villages, 10 villages have 11 RMPs, 5 villages have 6 SMPs, and 12 villages have 36 CHWs. The clubs in the villages give space to the Government and NGO organizations to conduct medical awareness programmes on HIV-AIDS, Polio vaccination, TB etc. Workers of WHO and UNICEF, also visit the different villages and tea gardens if people show interest and are conscious about public health and hygiene. Tea gardens like Bukim, Singbulli etc. have their own ambulances. Others use hired taxis when needed. Thus, the total medical facilities are in a deplorable condition in the study area. Facilities are concentrated in certain villages and large part of the basin is neglected from the primary medical services which is very important not only to control birth and death rates, but to make people aware of diseases like AIDS and TB. There is a slight improvement from 1991, when there were 25 villages without any medical facilities. Now the number went down to 10 villages, where medical services are day's dream. So, though health services have improved in the last three decades but still the facilities provided are inadequate and insufficient to the demand. Many of the tea gardens are still deprived of any medical facility. A few tea gardens have their own

arrangements but that too is poorly maintained. People suffer a lot from ill health due to lack of health services. For health related problems, people has to rush to the nearest urban centers like Kurseong, Mirik, Darjeeling and even Siliguri for treatment. This is not only expensive but also impossible because of non-availability of ambulance services in the area. People are also very poor and are unable to bare the high cost of transport and medical facilities provided. Inaccessibility of the tea gardens from the major medical centers is also an important factor that hindered people to avail such facilities

5.3. COMMUNICATIONS

In this age of internet and mobile phones, amenities like post telegraph and tele phone services still play an important role in the economic development of an area. Especially a rural area can develop at a faster rate if its communication network is good. People communicate with each other to carry out any progressive work. To make any plan successful, communication gets the first and foremost importance.

Table: 5.4 Number of villages having different types of communications.

Type of Communications	No. of villages
Post Office	26
Post & Telegraph Office	3
Tele Phone	48
Not Available	14

Source: Census of India, 2001.

According to Table 5.4, Post & Telegraph office is found only in the 3 villages (Punkhabari, Sonada Khasmahal and Sukhiapokhri).All these 3 villages are not only highly populated but are also well connected by roads. The number of villages having phone connections and Post Offices has increased in the last three decades. Sonada Khasmahal, which is located on the Hill Cart Road having large population, has the largest number of phone connections (500) in 2001. Out of 37 villages, where there is no Post Office, can avail such facility within a distance of 5 kms in case of 23 villages and at a distance of more than 5 kms in case of 14 villages (Fig. 5.3). Similarly, out of 15

villages, where phone connection is not available, can enjoy the same facility within a distance of 5 kms in case of 7 villages and at a distance of more than 5 kms in case of 8 villages. Still there are 14 villages, which are cut off from the rest of the area due to the absence of any form of communication services.

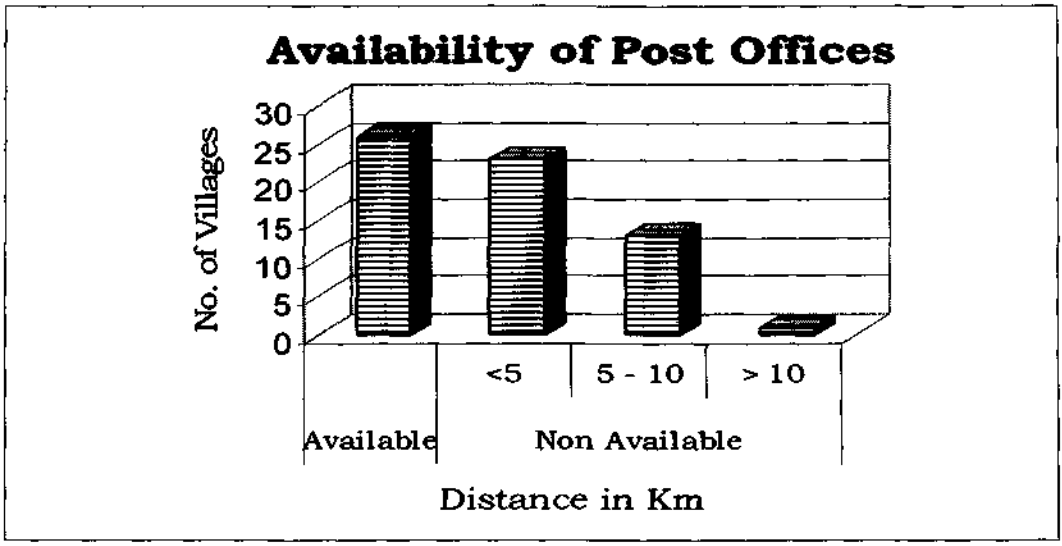


Fig. 5.3

In the tea gardens, only the managerial staffs have phone connections and that too mobile. According to 2001 Census, only landline phones are counted so many tea gardens are without any phone connection, which is not the reality. During field survey it has been found that few of the tea garden labourers also have mobile connection. Mobile phones are available everywhere in the study area.

5.4. TRANSPORT

Transport system generally serves two purposes namely accessibility and mobility. An effective transport system is indispensable for the effective utilization of resources and mobility of people and goods. It not only helps in the supply and distribution system of commodities but also collects the local production to the outside markets. Transport helps to improve the level of livelihood and economic condition of the producers. Good transport network not only develops a region but also increases connectivity with outside.

The Himalaya Railway, which is declared as a world heritage, passes through many of the tea gardens in the study area along its eastern edge parallel to the Hill Cart Road. It is a meter gauge railway and is unprofitable to the Government because of lack of passengers and high cost of maintenance. But the tourists enjoy the slow ride through the hills and forests, to enjoy the scenic beauty of the Darjeeling hills. In the study area Tung, Sonada and Ghoom Railway Stations are located.

Other than the railways, roads are very important for the vehicles to ply. Unless and until there are proper roads, neither people nor vehicle can move. In the study area, there are three types of roads, namely metalled roads (Pucca roads), Un-metalled roads (Kuccha road) and footpaths. In the mountainous and hilly areas people make their own shortcut roads by walking continuously along the same path, up and down the hill slopes. Such man made paths are called footpaths. These roads are either steep or in the form of steps but makes the journey by foot, short and time saving. People in the tea gardens also use such roads to carry their day-to day necessities.

Metalled roads surround the study area like to horseshoe. Along the western side of the basin runs the SH 12A, this runs from Siliguri to Mirik. Then it runs via Pashupati to Sukhiapokhri. Along the eastern side the NH 55 (Hill Cart Road) connects Siliguri to Kurseong, Sonada, Jorebunglow and Darjeeling. Two more metalled roads are i) The Old Military Road or Pankhabari Road and ii) newly built Rohini Road. All these roads connect Siliguri and Darjeeling via Kurseong. Unmetalled roads inside the tea gardens are constructed and maintained by Panchayat, DGHC and tea garden authorities. Metalled roads are under PWD.Roads are very poorly maintained in the tea gardens. Out of 19 un-metalled roads of 1981, 12 roads were coverted to metalled. Most of the tea gardens have un-metalled roads.

The people in the tea gardens are mainly dependent on local transportation system like jeeps. Out of 63 villages, 27 villages have bus services. Rest of the villages are connected by roads but vans, trucks, jeeps, cars can only ply through such roads. All the tea gardens

have jeep services from their gardens to the nearest market centers. Such services start from 7 to 9 a.m. in the morning from the tea gardens and 1 to 3 p.m. in the afternoon from the market centers to the tea gardens. People usually avail such transport facilities on Sundays when the tea gardens are closed.

5.5. BANKING FACILITY

Financial institutions play a major role in the development and the standard of life of the people of an area. Such institutions not only sanctions loan to the cultivators and others but also encourages savings habit among the people. The study area has 6 banks which includes 2 commercial banks and 4 co-operative banks. The commercial banks are situated in Mangarjung T.G & Pokhribong khasmahal. Out of rest 61 villages, 17 villages have commercial bank within a distance of 5 km, 27 villages have within a distance of 5 to 10 km and 17 villages have at a distance of more than 10 kms. The 4 villages where co-operative banks are situated are Sukhiapokhri, Chamu T.G, Samrik T.G and Molatey T.G. Other than these, 7 villages have agricultural credit societies, 3 villages have other form of credit societies. People have to travel 5-10 kms to avail these facilities. Since Post Offices have certain banking facilities, people try to use that when in need. People in the tea gardens are mostly economically poor in income and hardly have any money left to save. For them the loan facility is the main attraction. But khasmahals are highly populated and people does lot of monetary transactions in such places. So in khasmahals such facility is a must. However, in the study area, few khasmahals enjoy banking facilities. Gramin banks are situated in Pokhribong, Sukhiapokhri, Saurini Basti, Sonada from where people are given loans for fishery, dairy farming, poultry, piggery etc. Few nationalized banks are situated in Kurseong and Mirik and for any financial need people have to go to the nearest town.

5.6. INDUSTRY

Tea industry is the only major industry in the study area. Almost all the tea gardens have factories. This industry is the major source of employment in the study area.

5.7. ELECTRICITY

Power is one of the most important infrastructural elements for economic development. The availability of power reduces pressure on forests, which provide fuel to the rural areas. The amount of electricity consumed by an area indicates the pattern and intensity of development. Electricity plays a very important role in this age of electronics and electrical gadgets.

Table: 5.5 No. of villages having different types of power supply.

Types of power supply	No. of villages
Domestic	28
Domestic & Commercial	27
Nil	8
Total	63

Source: Census of India, 2001.

Hydro electricity is the main source of power in the study area supplied by WBSEB. According to 2001 Census, 44.44% of villagers use electricity for domestic purposes only. Other users of electricity are tea industries. In the study area, 42.86% of the villages use electricity for industrial purposes. But electricity is not used in the agricultural sector. Due to hilly terrain, agricultural machineries cannot be used, but it can be used in irrigation and storage etc. Electric pumps are used for irrigation. Irrigation system (channelisation) mainly runs depending on gravitational force. Tanks and reservoirs are situated at higher elevations and water flows down due to gravitational force. Rural electrification is a sign of rural development. Number of villages using electricity both for domestic as well as industrial purposes has increased from 11 in 1991 to 27 in 2001. This definitely is a positive indication of rural development. But all the houses of the villages do not enjoy the facility. Still there are 8 villages in the study area, which

are not connected by electricity. Though electricity has reached in the villages, but remote part of the villages are still out of reach to avail this facility. Important facility like streetlights are not found anywhere in the study area. Only tea factories have some lighting arrangements as a safety measure. Tea gardens like Sungma, Chamu, Nagri Farm, Bukim and Dooteria have their own hydel power generating units. All tea gardens have generators of 100 to 150 KV power supply capacity to run the entire factory during power failure. The surplus power produced by the generators is transmitted to the manager's bunglow and near by labour lines.

5.8. DRINKING WATER

Supply of potable drinking water to the inhabitants, is one of the most important determinants of level of development of an area. Drinking water, in the study area, is available in all the villages mostly from taps or springs. Out of 63 villages, 53 villages have tap water connection and people of 60 villages collect water from springs but 38 villages have access to both tap and spring water. The most remarkable change, which took place, is the availability of water in the dry summer months. All the villages in the study area have supply of drinking water in summer either from taps and springs. Since water is supplied mostly through plastic pipes, it frequently gets damaged and there is every possibility of water getting contaminated. So people have to be more careful when they fetch drinking water.

Table: 5.6 Number of villages having different sources of drinking water.

Sources	No. of villages
Tap	15
Spring	9
Tap & Spring	38
River	1
Total	63

Source: Census of India, 2001.

With the development in the field of socio economic amenities, the number of residents owning private tap is increasing. Occasionally

there is a shortage of water supply, which affects the level of livelihood pattern of both, urban and rural areas, so few people arrange for their own water supply. Even from a long distance through pipelines. They are not dependent on Government supply. But the majority of people have to depend on Government for supply of safe drinking water. In tea gardens like New Fallodi, Singbulli and Phuguri there is severe crisis of water from January to April. People has to fetch water from dharas (seepage areas), which are kilometers away. DGHC plays an important role in supplying water via pipelines. Water tankers also carry water to the villages.

5.9. RECREATIONAL FACILITY

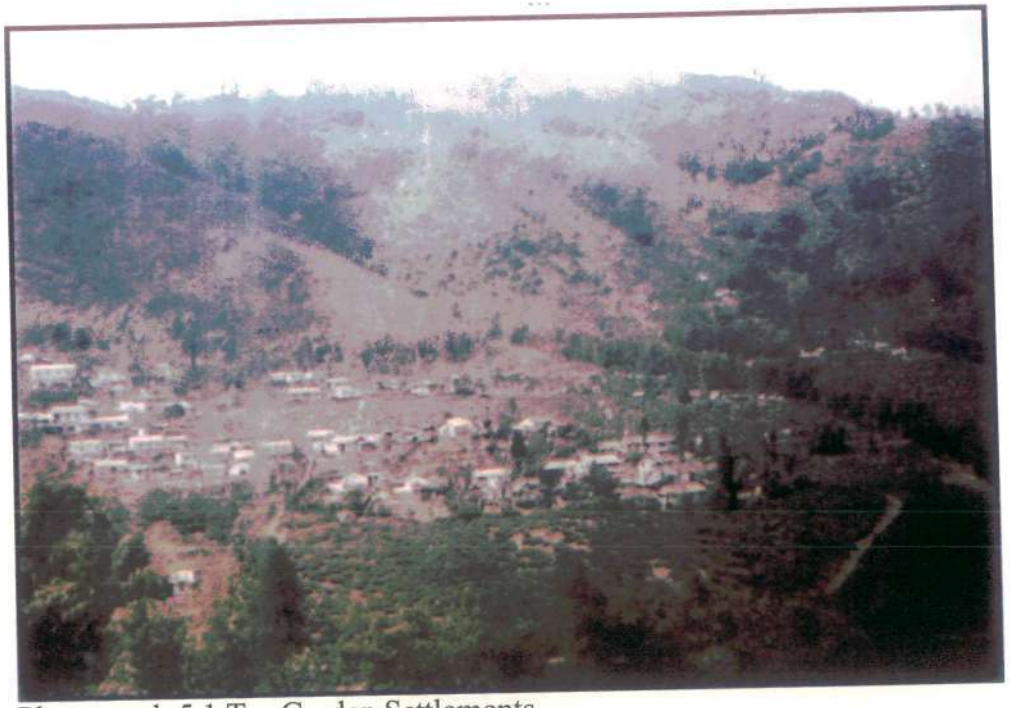
Recreation is important in every ones life. After a day long, hard working schedule everyone needs same recreation to distress their body, mind and soul. If there is no recreation, people get over-stressed and the work-capability decreases. In the study area recreational facilities are very limited. Sports play an important role as a medium of recreation among the youths. This is evident from the fact that there are 21 sports club in 18 villages in the study area. There are very limited flat lands in the hills. So in spite of people's interest in sports, numbers of playgrounds are less. Football is a very favourite game played among the people of the area. Majdura Sporting Club of Sukhiapokhri organizes cricket and football matches. Ghoom Jorebunglow Sporting Club organizes cultural programmes, blood donation camps, *safai abhiyan*,and plantation programmes. They also felicitate the best students of the different board examinations. Other famous and active clubs of the study area are Pussimbong Sporting Club and Nagri Sporting Club. There are 2 video halls and one stadium. There are no cinema halls even in Kurseong and Mirik. Cable T.V connections are there in all the khasmahals and few of the tea gardens. Tea gardens people mostly prefer personal dish connections. Drinking locally made liquor is a great pass time. Local festivals are all celebrated with great enthusiasm in the study area.

5.9.1. Tourism

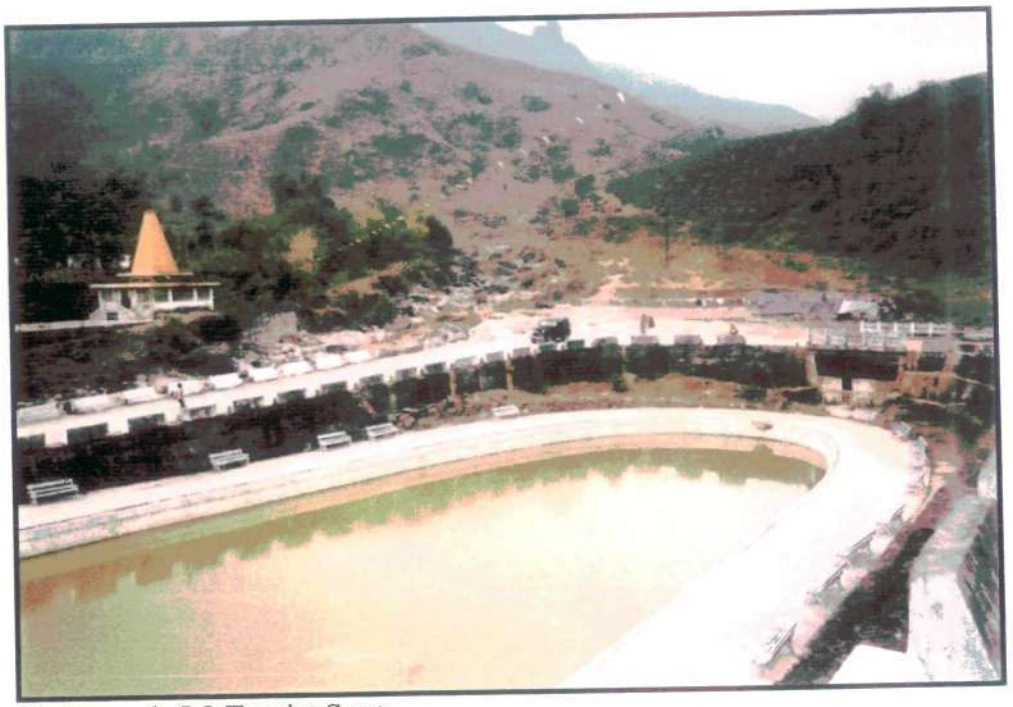
The word 'tourism' is derived from the word 'tour' meaning 'a journey in which one returns to the starting point'. Tourism may be defined as the sum of phenomena and relationships arising from the travel and stay of tourists in a locality for a duration of at least 24 hours. Tourism is the product of leisure. Tourism is nothing but a form of recreation which involves traveling in the expectation of pleasure (Nandi et al., 1999).

Despite many natural constraints, the study area is a rich repository of tourism potentials. Mirik, in the study area, is one of the hill resorts, at an altitude of 1767m, with its own special charm. There is a 1.25 km long lake fed by perennial streams. The important places of interest in and around Mirik are the lake, Kawlay Dara, Deosi Dara, Rai-dhap, Tea Estates, orange orchards, cardamom groves and Devi-sthan. Dudhia, 30kms from Mirik, is a beautiful picnic spot. Trekking from Mirik to Saudkphu, Phalut has become very popular. Short trek from Mirik to Kurseong via Balason river and Namsu could be covered within one day only.

Kurseong, situated at an elevation of 1458m, is another hill station in the study area. Because of its lower elevation, Kurseong enjoys a milder and very healthy climate throughout the year. It is the peace, serenity and the healthy climate that attracts many tourists to this place. The tea gardens and forests attract tourists from all corners of the world. The places of tourist interests are Eagle's Crag, Dow Hill Deer Park, Dow Hill Forest museum, Giddapahar Mandir, Ambootia Shivmandir, Makaibari Tea Estate etc. Kurseong is also a town of schools. Many residential English medium Schools encourage the flow of guardians and students to and from Kurseong. Both Mirik and Kerseong are connected to Siliguri and Darjeeling via rail, road and airways. The nearest airport is in Bagdogra, about 2hrs from both Mirik and Kurseong. Both the centres have banks, post office, health services, police station, religious places, library, restaurants and hotels etc. needed to develop tourism. Recently tea gardens are planning to



Photograph 5.1 Tea Garden Settlements



Photograph 5.2 Tourist Spot

open up for tourism. Makaibari Tea Garden rents its guest house for tourists. Other tea gardens in Darjeeling also have arrangements for tourists' accomodation. But in the study area this concept is yet to develop.

CONCLUSION

Socio – economic conditions of the people of an area is the indicator of all round development of that area. These functions are the tools, which improve the economic as well as social status of the inhabitant, Education is one such tool which is still not used properly. Basic requirement like primary education, cannot be provided in many villages due to absence of institutions imparting such education. It is evident from the fact that middle, secondary and senior secondary schools are even less in number compared to the primary schools, in the study area. There is hardly any scope of spread of education because the people are much more interested in getting employment in the tea gardens than to get education. Women work as labourers in the tea gardens and children work in home. Similar to education, health services provided in the study area are a deplorable condition. Dispensaries are the only medical institutions which are there in many of the villages but in reality these are non functional due to either lack of doctor or medicines. MCWs are more in number than CWCs and both services are available in greater number of villages than before. Primary Health Centers also increased in number which is a positive sign, but these are also in very bad state as dispensaries. Medical practitioners are very less in number, compared to the requirement of the people. Few tea gardens have their own medical units but for the treatment of any major disease, people have to rush to the hospitals situated in the nearest towns, which is not only inconvenient but also expensive. Communication network is poorly developed, with 14 villages having no such facility. Transport network comprising of the Darjeeling Himalayan Railways (a world heritage site) and NG55, passes along the eastern boundary of the study area. State Highway 12A joins

Siliguri and Jorebunglow via Mirik. The railways are running at a loss because of its low speed and high cost of coal required to run the engine. At the same time roads are also not maintained properly leading to potholes which not only reduces speed but also harms the vehicles. Roads in the tea gardens are mostly unmetalled and foot paths are quite common. Few of the tea gardens have bus services whereas rest depends on jeeps only. But all these services are inadequate. Financial institutions are very less in the study area, with few cooperative and gramin banks along with post offices serving the purpose. Hydro electricity is the main source of power in the study area with irregular supply. All tea gardens have their own generators to cope with such irregularities. Remote houses in the rural areas are still in darkness. Though drinking water has reached all the villages but there are complains regarding its insufficient supply. Taps and springs are the major sources of drinking water. Tourism spots are few in the study area with almost no development. Vast potential of tourism is not yet utilized fully. The population of the study area is mostly dependent upon tea gardens and remains very busy during the day. Their recreation involves, drinking, playing games like footfall and organizing cultural shows. Village clubs play important role in organizing blood donation camps, Pulse Polio projects and plantation programmes. So in general it can be concluded that socio-economic functions are poorly developed and proper planning is required for the development of the study area. This involves identification of the various problems prevalent in the study area, which is done in the next chapter.

CHAPTER VI

MAJOR PROBLEMS IN THE BASIN

INTRODUCTION

The study area is situated in the mountainous tracts of the Darjeeling Himalayas. The hill slopes are occupied by lush green stretches of tea gardens, terraced agricultural lands and isolated rural settlements. Due to rugged topography of the land, infertility of soil, remoteness of villages and many such related factors, the study area confronts different problems every now and then. All this problems are very critical and needs proper attention. The problems are mainly physical, institutional and socio-economic.

6.1. PHYSICAL PROBLEMS

Physical problems deal with types and causes of soil erosion, landslides and the harm caused by their occurrences.

6.1.1. Types of Soil Erosion

The removal of soil from the surface of the earth is known as soil erosion. Since the area receives heavy rainfall, the drops of rain hitting the ground and the water moving over the land both cause severe soil erosion. Deforestation leading to thin vegetation cover also enhances the speed and effectiveness of running water causing soil erosion. The different types of soil erosion are as follows:

6.1.1a. *Splash Erosion:* The most important cause of breakup of soil clods is the impact of fast falling rain drops in a severe storm, as they posses very considerable kinetic energy and momentum. The greater is the intensity of the storm, larger is the drops and faster they fall their velocity may even exceed that for free fall because of air turbulence in the storm. The falling rain drops accelerate until the frictional resistance of air is equal to the gravitational force and then continues to fall at that velocity, called the terminal velocity (Datta, 1986).

Since the Balason basin experiences quite stormy rainfall, any

uncovered soil is exposed to series of dangers of splash erosion. This is true for cultivated areas with ploughed soils. Tea gardens with poor density of forests are also open to such threats of splash erosion. Splash erosion is seen in Ambootia and Patong Tea Gardens, where soils on slopes have been ploughed. The new plantations of tea take fine to ten years to cover the ground fully. Such new plantation is different tea gardens will get eroded for the next few years. The patches having low canopy density of tea bushes is Singel Tea Garden are also suffering from splash erosion. Younger tea plantations of Maharani, Longview, Mangarjung, Kalej Valley tea gardens are also getting affected by splash erosion. A newly cut Pumong Phatak – Dudhia road, is also affected by splash erosion. In hills, potato is harvested during July by excavation of soil. The tilted soil is exposed to the full force of the monsoon showers. Large scale splash erosion takes place in such potato fields. Vegetables such as beans, cabbage etc are cultivated after harvesting potato, but they hardly provide any protection against lashing rain strums. In Mahaldiram forest, with thin vegetation cover, splash erosion takes place along with over grazing by cattle. The soils loosened by hoofs of cattle are splashed around such degraded forests and are susceptible to splash erosion.

6.1.1b. *Sheet Erosion*: The run off takes the form of sheet flow and channelized flow; former coupled with rain drop action produces sheet erosion. Its effects are gradual and after go unnoticed until most of the top soil go unnoticed unit most of the top soil is removed. The differences in susceptibility of various soils to sheet erosion depends principally on, slops, climate and character of the soil. Steep and moderately steep hill slopes and those subjected to heavy or intense rains are likely to be the most trouble some. Areas where loose shallow top soil overlies a tight dense clay sub-soil or other impervious sub-layers are most susceptible to sheet erosion (Schwab, 1971).

In the region, from June to September 20-27 rainy days occur in each month with 5-20 days having rain fall more than 50 mm (Starkel, 1970). Such a situation makes bare grounds, poor canopy density tea

bush areas, deforested lands, over grazed lands and forest fire affected lands, quite prone to sheet erosion. Sheet erosion can be easily identified in ploughed fields where small stones and pebbles are seen lodged on small columns of soil is washed away by sheet erosion. Often farmers place small boulders on the bounds to protect the soil from getting eroded by sheet erosion. In Ghoom–Simana Reserve Forest, a patch between Lepcha Jagat and Sukhiapokhri shows appreciable amount of sheet erosion. The high rain in the areas does not spare even lands covered with scrubs vegetation. Such scrubs lands, occurring in tea garden forests, are also being sheet washed surreptitiously. Maling bamboo, which grows above 2000m altitude, gives fairly good cover but can not stop sheet washing of the soil. Patches in tea gardens in Maharani, Ringtong, Singel, Springside, Ambootia, Patong and Mangarjung and many others, having scanty tea bushes, are being sheet washed extensively. New tea plantations in Marma, Bukim and Longview Tea Garden are very susceptible to sheet erosion and needs protection by mulching. Abandoned agricultural lands in and around Sonada, Sepoydhura, Dilaram, Tung, Rungbul, Sukiapokhri, Rongbong, Saurini and Mirik Khasmahal also show signs of sheet erosion. Invisible effects of sheet erosion gives was to yet another advanced stage of soil erosion called rill erosion.

6.1.1c. *Rill Erosion:* Rill erosion is said to occur when flow channels become sufficiently large and stable. Rill erosion is considered as the advanced stage of sheet erosion and can be regarded as transitional stage between sheet erosion and gulling. On soft freshly ploughed soils, especially those of high silt content and having slopes greater then 4 to 5 percent, riling is probably the commonest form of soil erosion (Bennett, 1955). This is more severe in fallow lands and on bare hill slopes. Exposed soil horizons are vulnerable to rill erosion, which situation is commonly encountered in zones of podzolisation and yellow soils, commonly found in the study area.

Although, rill erosion is often overlooked, it is this one which erodes the soils the most (Schwab, 1971). In the study area rill erosion

is observed in fallow lands and degraded forest areas. Ghoom Pahar Forest and Mim Nagri Range are ideal locations to observe such erosion. Tea gardens like Nahori, Okas, Ringtong, Chamu, Sagmaru also show rilling in areas having low density of tea bushes. Banks of Ghatta *jhora* show rill erosion in its upper reaches. Extensive rilling is seen on the steeper slopes of Pachhim *nadi*. Rilling is seen in Molatey Tea Garden and Nagri spur where slopes are steeper with very little vegetation. Dhupi plantations contain very little ground flora and so rills develop faster in Dhupi plantations. Highly grazed lands are also prone to rill erosion. Abandoned agricultural fields between Sonada, Rangbul, Saurini, Mirik and Rongbong show copious amount of rill erosion. Rilling is predominant in all tea gardens with poor canopy of tea bushes. The rill erosion, if unchecked and not controlled in time, is succeeded by still more damaging gully erosion.

6.1.1d. *Gully Erosion:* Gully develops from rills and their development is influenced by several factors, which affect both the extent and the development of gullying. The meteorological factors affecting gullying in the study area are rainfall intensity and its duration, temperature and solar radiation. Geomorphological and pedological factors include slope, relief, soil structure, parent material, soil moisture holding capacity, degree of soil cover, aspect of the site and pattern of seasonal changes.

Recent and continuous organic uplift is main cause of gully erosion in parts of the areas and gullying is independent of other factors in such areas. Thermal changes in the lower parts of the crust or compression due to foreland/hinterland in organic belt may be reason of such uplift (Ahmad, 1973). Loams and sandy soils are most susceptible to gullying while skeletal soils suffer the least. Cultivation techniques and agricultural practices have bearing on the susceptibility of any soil, leads to gullying. Mechanism of erosion and transportation of soil particles by flowing water is of crucial significance to understand the gullying. In the study area, mostly due to presence of skeletal soil gullies are not so common. This is also because of the presence of steep slope and high permeability of soil mantle. Most of the gulllying action

in the study area is restricted to first and second stage of gully development.

6.1.1e. *Stream Bank Erosion:* Besides gullying, another important soil degradation process is stream bank erosion. The stream bank erosion is yet another form of fluvial erosion. The scouring, gonging and under cutting of banks and mud flows are major processes of bank erosion. The steam bank erosion differs from the gully erosion in that the former applies to the lower end tributaries and to the streams that have continues flow and relatively flat gradient (Michael et al., 1981). Stream bank erosion is affected by soil character, cover, size and character of floods, velocity of current, land use and stability of stream bed during floods and climatic conditions. Stream bank erosion is very severe in higher order section of rivers in the study area. Such erosion is seen in the lower reaches of Dudhia, Manjwa and Marina rivers. Bank of Balason river, from south of Nahori Tea Garden to Dudhia bridge, shows severe bank erosion. Banks of Ghatta – Hussain *khola* near Singel Tea Garden also show severe bank erosion.

6.1.1f. *Pothole and Tunnel Erosion:* Potholes develop when easily erodible parts in steam bed is more eroded that it surroundings. This is usually encountered is areas where gully passes through a stretch having great difference in levels (Datta, 1986).

6.1.1g. *Sloughing Erosion:* Sloughing is another important form of fluvial erosion. In sloughing, a natural slope, a man made cut or embankment, under certain hydraulic conditions experiences a severe reduction of strength and soil flows like a thick fluid. It is retrogressive landslide, in which the failure surface develops through tension cracks and soil liquefies under untrained conditions. Poorly graded fine sand or silt is the seat of such a failure and takes place on account of hydro-dynamic forces, erosion action of water and non-homogeneity of deposits (Patel, 1980). Soils in such location are also found to be non-cohesive and non-plastic with higher water permeability (Lakhanpal et al., 1980). In the study area, many of the bank failures are a result of combined actions of stream bank erosion and sloughing. Such failures

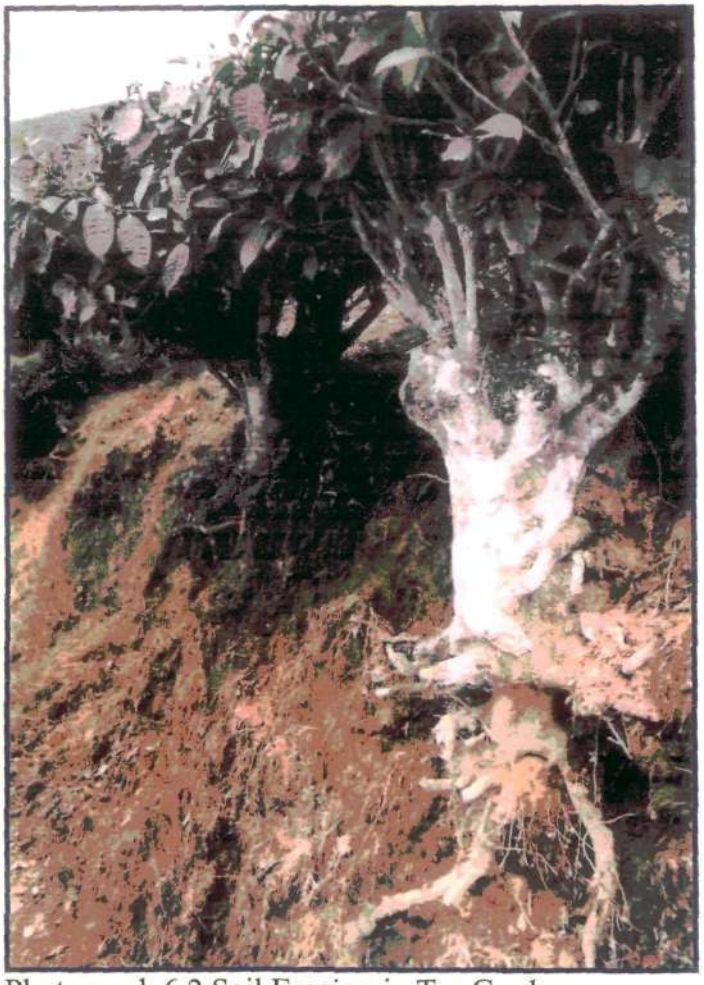
often take place during the first flooding of the season, especially if it is severe in nature.

6.1.2 Causes of Soil Erosion

Soil erosion is caused by different factors like physical, agricultural, socio-economic etc. Human activities are the main cause of soil erosion. High population pressure, leading to scarcity of food and shelter, forces people to exploit the forested land, over populate the villages, degrade the existing environment etc.

6.1.2a. *Deforestation*: Deforestation is caused due to indiscriminate cutting and felling of trees in a forested area. Deforestation leads to a number of pedological, hydrological and environmental degradation. Removal or thinning out of canopy exposes the soil beneath to the full erosivity of rain storm. This encourages various soil eroding processes and mechanisms to become active. So long top soil contains some organic matter, soil particles are not easily splashed by the impact of rain drops. The organic matter, however, does not last long. Organic molecules with low molecular weight are first to depart, others follow soon. Soluble salts and soil nutrients are leached down far quickly than the organic matter. In situations of splash erosion, fine soil particles block the pore spaces making soil impervious. Even there be elaborate root channels, water is not allowed to percolate down. Thus, volume of run off is increased with consequent effect on soil erosion. In the study area privately owned forests are well protected except for small patches in Rangbul which is getting exploited at a faster rate. In tea gardens like Marma, Bukim and Longview, forests are getting depleted at a faster rate. Existence of such forests is totally threatened by the pressure of collecting fodder and fuel wool from the forests. So forests, under tea gardens are mostly degraded. Forest areas flanked by high density of population are getting degraded faster. Forests in the northern part of the basin are getting damaged at a faster rate than the southern part due to illicit collection of fuel wood. Landslides and forest fires are also reducing the forested area in the basin.

Photograph 6.1 Deforestation



Photograph 6.2 Soil Erosion in Tea Garden

6.1.2b. *Faulty Cultivation Methods*: Tea cultivation occupies the major share of land use in the study area. But there are some pockets of agriculture in sprawling tea gardens, which are practicing faulty methods of cultivation. The ultimate result of which is soil erosion. The study area by virtue of having a very heavy rainfall generates large amount of run off from the fields. Cultivation on contour terraces act as a series of miniature reservoirs to hold excess run off and provide increased time opportunity to soil to absorbs as much water as possible (Singh et al.,1991).

From field survey, it is evident that several tea gardens have raised tea crops without proper terracing of land. In other cases, even if terraces are made, they are poorly maintained as in Singel T.G. and do not provide any protection to soil against run off. Invariably in such regions, the tea bushes are extremely sickly and this causes low yields. In Ambootia T.G., extensive soil working has been done to raise new plantation without any terracing. Though the slope is not steep and area is protected from straw mulch during rains, the soil and nutrient losses are formidable. In agricultural lands, most of the terraces are ill maintained and outwardly sloping ones. Since construction and maintenance of terraces is expensive, only wealthy farmers are able to maintain proper terraces. Outward sloping terraces are seen in and around Dilaram,Tung, Sepoydhura and Pachhim. Among the tea gardens, Cedar, Mondakotee and Nahori has outwardly sloping terraces. Large numbers of abandoned tracts of land are seen around Gorabari and Pachhim, probably, due to low fertility and presence of rock outcrop. Wherever impounding of water is done for cultivation as for paddy, landslides often result. This is also seen that no proper arrangements are made for disposal of excess water from the terraced fields. Terrace risers get broken at different places and once impounded water is released, it goes down breaking a series of them. This result in gullying, landslide and land becomes degraded and unfit for further cultivation. Cultivation in such lands become unprofitable since the top soil is being washed away turning the soil infertile.

Among the agronomic practices, cultivation of potato and maize are quite extensive in the study area. Both of these need intensive soil working during rainy season. Cultivation of maize without any soil conservation measure causes heavy erosion on the sloping land (Khybri, 1991). Both maize and potato, along with vegetables are considered as soil depleting crops as they leave little or no residue on or in the soil (Michael et al., 1981). Unscientific method of potato cultivation causes soil erosion. No crop rotation is seen as most of the agriculture is single cropped and rain fed. This leads to degradation of soil over a period of time. The fact that simply by adopting appropriate cultivation procedures, it is possible, without any great increase in cost to reduce soil erosion by up to 80 percent, is realized little by cultivators (Zachar, 1984).

6.1.2c. *Unauthorized Quarrying for Boulders: Jhoras* in the humid area carry lot of large sized boulders on its bed as it flows down. These boulders prefect the underneath soil from getting washed away by the torrential gushing waters. The boulders also act as natural barriers and reduce the velocity of the fast flowing water thus reducing the erosion power of the streams or *jhoras*. The decreased energy gradient of running water provides stability to the *jhora* banks and beds. Removal of the boulders by unauthorized quarrying, in dry season, exposes the underlying soil. Soil being weak is easily removed by fast running water during the rainy season causing severe soil erosion. As per Forest Conservation Act, 1980, boulders in hills are permitted to be brought only from a few river beds in plains. But the illegal practice of quarrying river bed boulders in the hills has increased by leaps and bounds. Being cheaper than that brought from plains, these boulders get ready market. Unauthorized quarrying is also done in the tea gardens to construct roads, culverts, bridges and building. These boulders are usually dug out from the degraded areas within the tea gardens leading to further degradation of the area. The stretch of Hill Cart Road between Gorabari to Rinchingtong has several sites of unauthorized quarrying. A site, 100m down the road from Dilaram bazaar, is

Photograph 6.3 Stone Quarrying

subjected to intensive quarrying. A *jhora* crossing Hill Cart Road, 200m north of Tung railway station, is also subjected to intensive quarrying. On a site 100m down of the Hill Cart Road from Sonada bazaar, a precipitous uphill slope alone the road is being quarried dangerously. Quarrying is done in Rangbang nadi near Mangarjung T.G. Along the road sides, quarrying is more noticeable because of easy transportation facilities. Near Cedar basti, a few sites of unauthorized quarrying are seen. The list is the least exhaustive. Because of paucity of time and resources, detailed survey could not be undertaken. However, it is believed that unauthorized quarrying has taken a very serious dimension in the study area. In innumerable spots, men and women could be seen breaking the boulders into chips for selling. After the loose boulders are collected, rock outcrops jutting either in the bed or on the bank are attacked with hammer and chisel, which is even more dangerous. These rock outcrops are the anchors and help transfer the weight of the landmass lying upslope to the deeper strata of earth. When they give way, mass failures occur.

6.1.2d. *Unscientific Water Disposal:* Nature has designed each *jhora*, however small or large, to carry a certain quantity of water from its catchments. If this quantity is altered, the *jhora* redesigns itself. If flow is augmented, velocity of flowing water, hydraulic radius of flow and gradient of surface of flow, increases. This shall be a high energy situation and hence unstable. To reduce the energy situation, the *jhora* will either widen the flow channel or meander. The former reduces the hydraulic radius and the latter the surface gradient of flow. The combination of these two causes soil erosion, lumping of the banks and ultimately landslide.

In the study area, when a drainage system traverses a road, it is better if its flow characteristics and natural catchments are not altered. But that is not done, on cost consideration. Each *jhora* is not provided with a safe passage across the road. The present practice may be economical for the time being but the overall loss in the long run is colossal. The unmetalled roads in the study area provide another

instance of unscientific water disposal. The roads are often not provided with side drains. So during rain storm, water flows over the surface of such dirt roads. Agricultural fields, even if terraced, do not have proper system of disposal of excess water by grassed water ways. In few cases, water from *jhora* is directed through irrigation channels for flood irrigation and excess water is not properly disposed off. This leads to soil degradation down slope. Such instances of unscientific water disposal are seen it Maharani T.G., Ringtong T.G., Chamu T.G., Mangarjung T.G. and Nagri Farm T.G. They are contributing a lot, to the sediment load of Pachhim and Rangbong *nadi.* In Rangmuk, Okas, Mondakotee and Gopaldhara T.G.'s, roads are not provided with proper side drains and water flows over the road causing soil erosion. In many tea gardens, foot paths have degenerated into rills and gullies.

6.1.2e. *Extension of Roads:* Construction and extension of roads is yet another activity causing lots of soil erosion. This involves removal of soil from the hill slopes for making road benches. The removed soil is never transported from the site or used otherwise and gets washed down with the onset of monsoon. It buries productive fields rendering them waste. Ultimately soil is washed down the stream and land becomes bare and infertile. Road benches change the hydrological characteristics of the streams which traverses them. This often forces the stream to flow on the surface of road dislodging freshly exposed soil particles. Because of obstructing road bench, water starts flowing chaotically, causing failure of road bench.

Construction and extension of roads is a continuous process for the development of an area. Though two national highways surround the entire study area yet lane and by lanes are getting constructed on demand of population expansion. New roads lead to new settlements. Without good transport facility an area cannot develop. A new road from Pubang Phatak (located near Lepchajagat) to Dudhia is under construction and an air strip on a site about 2km south west of Rangbul, has been constructed. The Pubong Phatak – Dudhia road is a very ambitions and challenging project taken up by Darjeeling Gorkha

Hill Council. This is under construction and initially caused severe soil erosion in upper Balason catchment. As the cutting of road bench proceeds further, it contributed increasingly high amounts of sediment load on top of a spur emanating from Rangbul. Here, too, flattening of ground involved huge amount of earth cutting. The dug up earth was washed down to, both Upper Balason and Rangmuk rivers. Many roads which are under construction in different tea gardens are also causing soil erosion.

6.1.2f. *Over Settlements:* Population is increasing at a faster rate in the study area. To support the ever increasing population, houses are being constructed in the study area in large numbers. Houses are mostly of concrete with multiple stories on the two sides of the major communicating roads, which exerts excessive pressure on the unstable hill slopes. Tea Garden houses are comparatively light weight since they are mostly made of bamboo, tin, mud and wood. The khasmahal areas namely, Jorebuglow, Sonada Khasmahal and Achalal Hatta posses a major threat with its heavy concrete houses. Since horizontal expansion is not possible, houses are expanding vertically, which is even more dangerous. Urban areas like Kurseong, is predicted to have major landslide in future due to increasing number of houses constructed every year on the hill slopes. Tea garden like Ambootia, Longview, Marma, New Fallodi, Pussimbing, Dooteria, Rangmuk Cader, Mangarjung and Sugmari also are facing the problem of congestion due to over settlement.

6.1.2g. *Overgrazing:* Overgrazing constantly threats the existence of soils, on the surface of the study area. This is a menace and generally does much more serious damage to vegetable cover than is actually believed. In 52 percent of India's forest, there is no regeneration owing to the combined effect of biotic pressures, the chief among which is over grazing. While the policies advocate a strict grazing practice, cattle entry into reserve forests continue to be free and unregulated (Sunder, 1992). Sheep and goat are arch enemies of vegetation. Sheep graze on grass only whereas goat is a voracious browser which devours leaves,

twigs, small branches and leading shoots of the plants, either killing them or mauling them very badly. Overgrazed slopes show erosion and characteristic heavy trails of cattle crisscrossing one another. Overgrazed grasslands degrade into bush land and dry thickets. The removal of protective vegetation combined with the trampling of the soil surface by animal hooves, leads to rapid loss of soil, a lowering of infiltration rate and flash flooding (Edward et al., 1990).

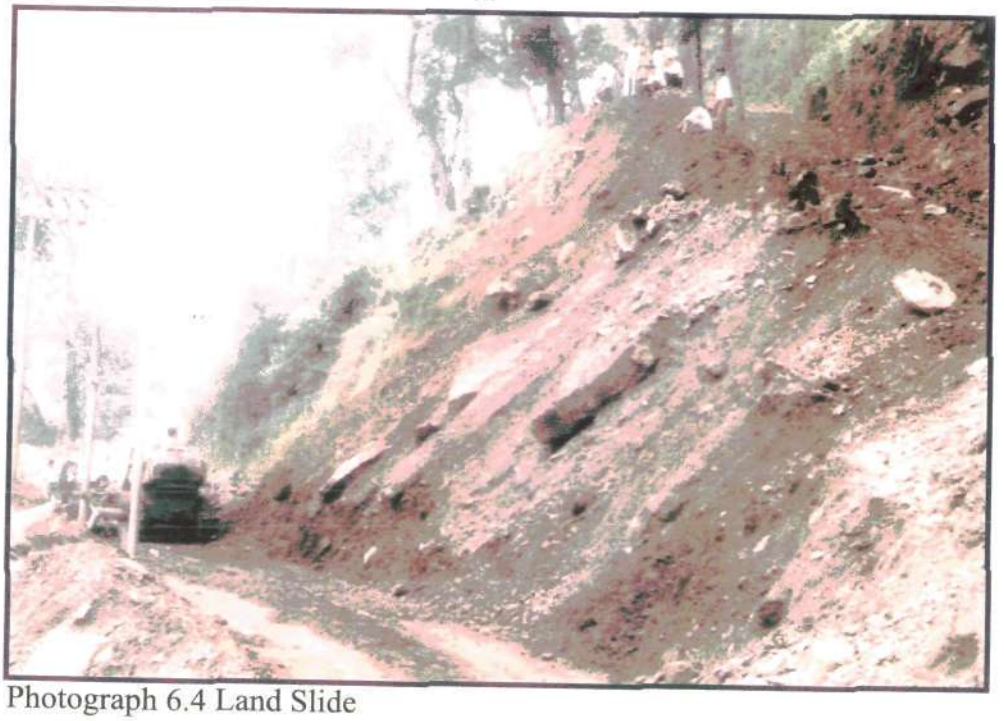
In Darjeeling Forest Division, which contributes north and north-western parts of the forests in the study area Ghoom Pahar Forest along with Phuguri and Manjha Forest in the east, open grazing was earlier allowed only in areas north of little Rangit river. Elsewhere, it was restricted and allowed only on the strength of permits. The deleterious effect of overgrazing on soil and regeneration are noticeable in these parts of upper hill forests where undergrowth has been reduced to such species which are non-palatable to cattle. Natural regeneration of tree species has become practically non-existent as a result of continued browsing and trampling. There are a number of departmental *bathans* where cattle are stall fed. The owners are allowed to collect fodder from the adjoining forests and there are fenced areas around the stalls where cattle can exercise. This system was introduced to discourage open grazing which often degenerates into overgrazing. But in practice, *bathan* stall feeding has been found to be of limited utility due to indifferent attitude of cattle owners (Govt. of West Bengal, 1970). Though Darjeeling Grazing Rules were made, way back in 1895, even then unauthorized grazing took place all along the boundaries of different forest areas situated in the study area. In younger plantations adjoining the localities, damage to seedlings is caused particularly by goats (Govt. of West Bengal, 1959).

6.1.2h. *Forest Fire:* In Darjeeling District, forest fire is a great source of danger in upper hill forests. In these forests fire breaks out easily due to strong winds and presence of dense bamboo under growth. The study area, where upper hill forests are less, does not suffer from any serious forest fire. In excessively dry weather, younger plantations do

suffer from ground fires. Protection of younger plantations from grazing produces profuse regeneration of grasses. These grasses dry during summer and act as fuel for occasional fire.

6.1.2i. *Construction of High-Tension Electric Lines:* In recent years, construction of high-tension electric posts in the tea gardens of Mirik and Sukhiapokhri police station areas, have exposed the underground soil and made the soil loose. Such construction causes washing away of the loose soil during monsoons. As a result soil was eroded in huge quantity.

6.1.2j. *Landslide:* Weak geological formations in the study area, is one of the major factors for failure of slope or landslide. Excessive wetting of soil in the north eastern part of the study area also bring about increased pore pressure leading to instability. Paddy cultivation by impounding water often leads to landslides. About 100mm to 200m precipitation in 24hrs, is usually sufficient to cause failure in Darjeeling Himalayas (Starkel, 1972). The most comprehensive report on the landslips of the Darjeeling District was published by the Geological Survey of India in 1966 where of slips have been termed 'soil slip', 'bedris slip' or 'rock slip', depending upon the material involved in the slip. Almost every year, due to incessant rain, landslips of different kinds occur along the Hill Card Road joining Kurseong and Darjeeling. For almost a decade, this has become a regular incident in the study area. Punkhbari Road is severely destroyed by landslides in 2003. Notorious Ambootia landslide lies at the southern tip of the study area, the size of which exceeds every year during the rainy season. Soil erosion degrades the top soil and reduces the soil fertility leading to progressive deterioration and finally disappearance of vegetation. This leads to extremes of climate indicated by rise in temperature. Humidity decreases and rainfall becomes erratic. Evaporation of soil moisture increases. In the study area, soil erosion has reduced the density of forest vegetation and vice versa. The effect is pronounced with overgrazing. Tea bushes become sick and yield decreases. Fertilizer input increases, increasing cost of production. Soil loss from



Photograph 6.4 Land Slide

Photograph 6.5 Land Slide

agricultural land and deposition of the same on the river bed is equally harmful. Rocky eroded debris, deposited on the agricultural land, turns it unfit for cultivation. Formation of rills and gullies also turn the agricultural tract into badland. Debris deposition, forces the river to change its course and at time blocked rivers cause flash flood, destroying the cultivated land along its banks. In the upper reaches of all most all the tributary river basins, large numbers of abandoned agricultural fields have been noticed. Shallow soil when gets removed by sheet erosion, land turns infertile and farmers abandon such lands. These lands are usually overgrazed, subsequently, causing reversal of natural restoration processes, if any (Patel, 1996). Most severe degradation is seen on the steeper slopes which are overgrazed.

With the disappearance of forests, fodder supply becomes limited. Overgrazed pastures affect the general health of the livestock. Supply of timber and fuel wood also decreases further aggravating their scarcity. In the study area, there is acute shortage of fodder. Commonly cattle are seen moving around inside reserved forests in huge numbers. People also collect fire wood from the forests illegally. Reduced forest cover, reduces infiltration capacity and the surface flow greatly increases. This results in frequent floods. Sedimentation of river beds reduces the water holding capacity, thus causing flood. Because of reduced infiltration, underground reservoirs are not replenished like before and consequent steams, which are fed by such sources, become dry after rainy season. Perennial springs have become non-perennial in the study area. In Longview T. G. and Jamadar Bhita Khasmahal streams are being replaced by tap water. Kurseong town and adjoining areas faces severe water crisis during the dry months. In absence of monitoring of rivers during dry season over a long period of time, it is not possible to draw any quantitative inference regarding the reduced supply in the study area. Accumulating sediments silt up the reservoirs and clog the irrigation channels. This causes mal-functioning of both the structures. Damage of communication routes, houses, agricultural land are the most visible effect of landslides. The instances of highway

and railway embankments being washed away by cutting of uncontrolled water, land slips, landslides and debris avalanche during rainy season is a common feature. It has been estimated that more than fifty percent of annual cost of maintenance of communication routes are due to landslide. According to past records, the Hill Cart Road and Punkhabari Road had been affected by landslides in 1950, 1968, 1980, 1991 and 1993.

The recent landslides, which occurred on 1998 severely, affected the Kurseong subdivision particularly the Hill Cart Road and few other roads. On 2003, there were also a large number of slides in and around Darjeeling and Kurseong town. Landslide severely affected settlements and twelve lives were lost. Heavy rainfall activated the debris slides. Unscientific cultivation and harvesting of ginger disturbed the cohesiveness of soil and aggravated soil erosion. On 2004, a series of devastating landslides crippled the tourist movement in the study area by disconnecting the Hill Cart Road at various places. Roads along the *jhoras* helped the flowing water to seep underground and cause subsidence. On 2005, landslides caused by heavy rain claimed two lives in the hills. Houses were also disrupted. On 2006, the Darjeeling hills as a whole have been affected by numerous small slides damaging more than 50 houses (Basu et al., 2006).

6.2 PROBLEMS FOR AGRICULTURAL DEVELOPMENT

Agriculture is controlled by a host of natural conditions like soil, rainfall, duration of sunshine, slope of land etc. Each part of the study area faces problem due to variation in physiography, climate, soil and water. These problems can be broadly divided into physical, institutional and cultural.

6.2.1 Physical Problems

6.2.1a. *Topography:* The steep, rugged topography limits the scope of agriculture in the study area. Rice, maize and potato can be done only in the terraced lands. The terraces in most cases are unscientific in shape and structure. Improper drainage in the terraces, disturb the

entire terracing system during times of heavy rainfall.

6.2.1b. *Uneven Distribution Of Rainfall And Sunshine:* The rainfall is concentrated between June and September and is most unevenly distributed over the study area. Thus the distribution of soil moisture is also even leading to uneven production of crops in different parts of the study area. Rain accompanied by hail damages the crops. Recently snowfall also is causing great damage to the crops in Sonada and Rangbul.

The variation in sunshine leads to the variation of cropping pattern and ripening season. The lower hills enjoy longer duration of sunshine and thus ripening of crops take shorter time.

6.2.1c. *Soil Fertility and Erosion:* Due to incessant rain, fast flowing surface run – off removes the top soil turning it infertile. This problem of soil erosion and loss of soil fertility can be observed in almost all parts of the study area.

6.2.2 Institutional Problems

i) The land distributed to the landless and marginal farmers were mostly inferior.

ii) Agricultural land was defined by use condition instead of soil quality.

iii) Such vested lands were kept barren or used for other purpose.

iv) Land holdings are very small and unprofitable to cultivate. Fragmentation of land is the major cause for such condition.

v) The steep slope and thin layer of soil restricts the use of machines like tractors, threshers to carry out farming operations more quickly and efficiently for maximizing out put.

vi) Lack of irrigation facilities affects the production of crops. The available irrigation systems are entirely dependent on monsoon rains and become dry in winter season.

vii) The poor economic condition of the farmers restricts them from arranging for irrigation, machines, HYV seeds etc. Thus they stick to traditional methods only.

viii) High cost of fertilizers and insecticides deters the farmers

from using such things.

ix) The banks do not show much interest in giving credit or loans to the farmers because of the small nature of loans and low return. Long tedious process of clearance of loan, discourages the farmers to go to the financial institutions. In fact they go to the local money lenders who charge high rate of interest which harms the interest of the farmers.

x) Lack of draught animals in the farms make the farmers work harder in the agricultural land.

xi) The land revenue department faces few problems regarding payment of revenue. Fifty percent of the farmers are reluctant to pay the revenue in time. They are mostly late in paying the land revenues. The tea garden owners has to pay land revenue to the Land Revenue Department, Government of West Bengal and Panchayat in time, unless which their production might be stopped by such authorities.

xii) Non-payment of wages: The wages of the tea plantation workers of West Bengal are the lowest in the organized sector. The workers barely manage to survive with the paltry daily wages of Rs. 49.25 in West Bengal, which is lower than Rs. 65.88 in Assam (The tea garden workers in Assam and West Bengal receive concessional foodstuff as part of their wages). This low wage prevail in spite of the fact that labour productivity in West Bengal is one of the highest in the country and so is the land yield and overall price of tea. However, at times, due to the closure of the tea gardens or change in management or internal problems, the workers are deprived of even the low wages, which they are receiving.

xiii) Land management problem: The tea gardens, in the study area are 'set garden' which are registered tea gardens and have taken land on lease from the forest department for 99 years. But there are new, relatively small, unregistered tea gardens which are cropping up in large numbers in different parts of North Bengal which do not care for plantation legislations and sell tea leaves produced by poorly paid labour in the wholesale market at a cheaper rate.

xiv) Problems in marketing: India, the world's largest producer of tea, with annual production exceeding 850 million kgs, has been hit badly because its traditional markets in the countries that made up the former Soviet Union have been steadily drying up. Tea produced by applying certain specified organic fertilizers are only in demand in the world market. On top of that, domestic consumption of tea, which accounted for 673 million tones in 2001, has increasingly been losing out to the manufacturers of bottled beverages. Transnational like Coca-Cola and Pepsi have been carving out large chunks of the market ever since they were allowed into the country under India's decade-old liberalization policies.

xv) Administrative problems: The theft of tea leaves and tea garden resources like irrigation pipes etc is a major problem.

xvi) Degraded tea plantations: The degraded tea gardens like Ambootia, Monteviot, Dooteria, Springside, Castleton etc. became so because of heavy soil erosion due to high velocity of rainfall along with neglected land management, i.e. lack of proper soil conservation and drainage measures. Large parts of Dooteria T.G. have been cleared for construction of helipad, thus causing land degradation. Due to lack of funds, old tea bushes cannot be changed which results in decline of crop yield.

6.2.3 Cultural Problems

The process of decision making and implementation of agricultural practices in rural areas is very much influenced by socio – cultural factors like religious importance of the crop, local demands and traditional value of the crops etc. The socio-cultural influence changes the cropping pattern, crop diversification and crop combination. In the study area, traditional agricultural practices still prevail in almost all the villages. This may be due to higher percentage of illiteracy among the farming community. The younger generation has a tendency to migrate to urban areas leaving the agricultural farming to older people, which is another problem.

6.3. SOCIO ECONOMIC PROBLEMS

6.3.1 Education

In spite of increase in population, many tea gardens still have only one primary school and no other educational institution. Since the women goes out to work in the tea gardens, it is their children who looks after the family, cooks food and fetch water from far off taps, tanks and springs. The children have no time to go to schools. Specially, the spread of education among girls is low due to poverty, social customs, negative parental attitude, poor accessibility to schools and non-availability of schools, which have women teachers. Low participation of girls in education has a direct impact on their social changes and future prospects. Due to absence of proper targeting and monitoring of achievements, Government subsidies tend to become ineffective in attracting children to the schools. This is more so because they are given regardless of the socio-economic background of the beneficiaries. In the khasmahals, the scenario is totally different. In response to the demand for 'better education', a large number of private schools have opened up in the last few years. Most of the private schools charge high fees compared to government schools and have English as the medium of instruction. Even then, the success of private schools is an indication of the fact that the quality and standard of education in the public sector are not commensurate with the expectations of parents. Especially in the tea gardens, high growth of population due to high birth rate is increasing unemployment. People are not adequately skilled and educated so the managerial staff are all coming from outside. Growing unemployment is making the local people aggressive and they are getting involved in all sorts of anti-social activities. Condition of the women and children workers: Women workers are under tremendous pressure. They are restricted by lack of skills from joining other income earning activities. An absence of alternate employment opportunities and unfavorable conditions for migrating long distances in search of alternate opportunities of work makes their life more miserable.

The analysis indicates that there is a need to rationalize the existing structure of the education system. There is also need for improving the preparation, motivation and deployment of teachers and for inspection and supervision of schools in remote areas. Further, poor maintenance and inadequate infrastructure of existing schools need to be taken care of. Improvement in education can only be possible if the following are the strategic thrust areas:

1. Education for all.
2. Provision for quality education.
3. Access to schools within walking distance of each village.
4. Improvement in school infrastructure.
5. Formalized system of teacher recruitment.
6. Encouragement of education to the weaker sections of society.
7. Widening scope of vocational education.
8. Establishment of technical colleges.

6.3.2 Health Services

The total medical facilities are in a deplorable condition in the study area. Facilities are concentrated in certain villages and large part of the basin is neglected from the primary medical services which is very important not only to control birth and death rates, but to make people aware of diseases like AIDS and TB. There is a slight improvement from 1991, when there were 25 villages without any medical facilities. Now the number went down to 10 villages, where medical services are day's dream. So, though health services have improved in the last three decades but still the facilities provided are inadequate and insufficient to the demand. Many of the tea gardens are still deprived of any medical facility. A few tea gardens have their own arrangements but that too is poorly maintained. People suffer a lot from ill health due to lack of health services. For health related problems, people has to rush to the nearest urban centers like Kurseong, Mirik, Darjeeling and even Siliguri for treatment. This is not only expensive but also impossible because of non-availability of ambulance services in the area. People are also very poor and are unable to bare the high

cost of transport and medical facilities provided. Inaccessibility of the tea gardens from the major medical centers is also an important factor that hindered people to avail such facilities.

6.3.3 Communications

Due to hilly terrain, remoteness and natural calamities, landline phones are mostly out of order. Mobile connections are provided at cheaper rates and are easily available so that people can afford. But tea garden workers are so poor that in spite of such offers, they are unable to avail such services. Since the study area is hilly and mountainous, to arrange for communication facilities is not only difficult but also expensive. If there is any fault in the telephone line, it takes many days for the Telecommunication Department workers to find it out because the line passes through steep mountain slopes or deep-forested areas. Natural calamities like thunderstorms, lightning and land slides totally damage and disrupt the communication system. Moreover the communication system is Government funded and there are limitations to connect the isolated villages scattered in different parts of the mountainous terrain. As a result, communication is not at all developed in the study area.

6.3.4 Transport

Government tries to run the rails at a loss, since it is declared as a world heritage. Local passengers are less and not really interested to avail the railway services due to its slow speed and low frequency. Though every tea garden have their own vehicles for transporting green leaves to the factory or finished tea to the markets but they do not have for domestic purposes. Tea workers have to wit many hours to get vehicles, which will take them to their destinations. Break journey is very common in the area, which wastes lot of time and money. People in the area can travel 5 - 10 kms by walking. Children go to schools by walking long distances. The laborers carry their goods on their head and shoulders from the village to local market and vice versa. People need a very hard life in the study area, which is still undeveloped in

transport network. Excessive rain turns the roads into drains and water channels in rainy season. No proper drains are constructed along the roadside. Potholes collect rainwater and become dangerous for plying vehicles. Most of the time during rainy season, the roads get blocked due to landslides. Part of road sinks and there is disruption of transport services for days. During this period, price of all essential commodities rise as supply is disrupted and mountains get detached from the plains. It is true that in this mountains terrain it is very difficult to construct and maintain the roads by the government due to lack of labour and funds, but the attention to increase road connection is low and untimely. Moreover the other roads like unmetalled roads and footpaths in the villages are in deplorable condition during the rainy season. Lack of transport facilities, cause damage to the crop production because it cannot be transported to the market in time. Especially perishable items like fruits, vegetables, milk etc are maximum affected. Farmers face severe loss. Moreover there are no proper storage facilities by which producers can be benefited. In the hilly areas, roads are winding and narrow, limiting the conditions for buses to ply. Moreover the low frequency of such services affects the transport system. Such vehicles have limited capacity to accommodate the increasing number of commuters and the transportation cost is very high, which is out of reach of common people.

6.3.5 Banking Facility

With respect to the number of people staying in the Balason basin and the total area covered, banking and credit facilities are extremely low and limited. Loan facilities are provided by the Gramin and other banks. But the processing and disbursement of loan is a very tedious process. At times the type of loan given is different from the local requirement. Few nationalized banks, cannot play a very significant role in developing the economic structure of the region as a whole and the people in particular because mostly they are located in the towns or larger settlements, situated far away from the villages. It is not only difficult but also expensive for the inhabitants of the small

remote rural settlements to avail such facilities by going to such big towns.

6.3.6 Electricity

Rural electrification is the most daunting task in the study area both because of the extreme and unfriendly topographical conditions and huge technological and financial resources involved. The configuration of villages in the hills is highly scattered sometimes making any community project not only cumbersome but also uneconomical. But all the houses of the villages do not enjoy electricity. Though electricity has reached in the villages, but remote part of the villages are still out of reach to avail this facility. Important facility like streetlights are not found anywhere in the study area. Due to shortage of supply from the source, a large number of villages remain in darkness or without electricity in both day and night in the study area for considerable hours. Moreover there are disruption in supply of electricity due to heavy rainfall and other natural calamities like landslide, theft, felling of posts. As a result villagers do not get regular supply of electricity, even though the study area is located very near to the hydel power station of Ramam, Fazi and Rinchingtong in Dargeeling district.

6.3.7 Drinking Water

Though water sources are there in summer even then water is only supplied for few hours of the day. In the hills, water gets collected all through out the night and in the morning stored water is supplied for few hours only. So naturally, there is severe crisis of water in rainless dry season. Scarcity of water forces poor people to break pipelines and stopcocks. People also steel the pipes. So people mostly use plastic pipes which leaks almost always causing great loss of precious water, in the study area. Pipelines mostly run along the roadsides drains and dirty water, at times, seeps inside the pipes. This causes some diseases like diarrhea, and gastric problem. People in the urban areas, boil drinking water but rural people due to dearth of fuel cannot afford to do so and mostly suffer from waterborne diseases.

Amount of supply of water depends on the availability of water in the *jhoras* and springs. During summer these *jhoras* become dry and the supply of water to the villagers is restricted due to inadequate storage.

6.3.8 Political Problems

Administration in the study area faced severe political crisis since November 2007 when people boycotted work in demand for a separate state – Gorkhaland. All tea gardens, Govt. offices, transport network, markets were closed for almost a week. People started agitating against the demand for 6th Schedule status in the Darjeeling Hills by fasting and strikes were called for more than a week. The situation could be controlled by the interference of the Chief Minister, West Bengal Government. This political agitation and strikes called by the Gorkha Jana Mukti Morcha caused severe loss in tea, tourism and transport mainly in the study area. Such political disturbances for the last 10 to 15 years are causing great economic loss in the study area.

CONCLUSION

Soil is the major component on which depends the agricultural economy and tea industry in the study area. The top soil is threatened by sheet erosion whereas more severe erosional features like rills and gullies are also found in plenty in the study area. Since heavy rainfall is concentrated over a short span of time, soil erosion has to be a major problem. Steep slopes accompanied by heavy rainfall causes soil erosion. Other factors like deforestation, faulty cultivation methods, unauthorized quarrying of boulders add to the already existing conditions of soil degradation. Landslides are quite frequent in the study area, which affects the life of the people in a disastrous way. Loss of life and property is a common incident related to landslide. It also destroys agricultural lands. Agriculture is the dominant occupation of the study area and due to high rate of soil erosion there are various problems which affect agriculture and production. Agricultural sector faces problems like steep slope, uneven distribution of rainfall, inadequate supply of inputs, lack of irrigation etc. In the context of

socio economic development, the study area has significant differences due to the various locational and remoteness of the villages. So education, health services, communication and transport etc. are far below the standard level. Children has very less scope of attaining knowledge by education mainly in the tea gardens due to non – availability of schools. They are 25 villages without any medial services. Communication and transport sectors are poorly developed but have positive scopes of improvement. Banking facilities are hardly available. Remote and scattered villages in the study area are yet to receive electricity. Though drinking water is available in all the villages, its supply during the dry months i.e. December – May is irregular and limited. Tourism has vast scope but there is no proper planning for its development. Tea industry is also facing few problems regarding its manpower and management. Since tea gardens are vastly spread over the study area hence all the above mentioned problems are directly or indirectly affecting the life of the people of the tea gardens.

So, different strategies have to be formulated and implemented to see that the area can develop at a faster rate. Such strategies are discussed in the following chapter.

CHAPTER VII

CONSERVATION AND MANAGEMENT

INTRODUCTION

Soil-water-plant resources are nature's gift to mankind. Overgrazing, deforestation, faulty cultivation, shifting cultivation and carelessly built roads in the catchments, has led to devastating effects downstream. These include gullying and floods leading to destruction of farm lands and villages; drop in flow during the dry season and consequent loss of crops; and siltation of reservoirs and canals. The problem has been further aggravated due to high rate of population growth – both human and livestock, resulting in indiscriminate exploitation of natural resources, for meeting the ever-increasing demand for food, fodder, fuel, fiber and fertilizer. Thus continuous degradation of production base and imbalance in land-water-plant, human-animal systems is leading to ecological imbalance and economic insecurity, through severe soil erosion and threat to the quality of our life.

7.1. WATER MANAGEMENT

Water is among the most essential requisites that nature has provided to sustain life on the Earth. Now a days, perhaps water out stress all geo-environmental factors to enter more prominently into considerations of human and economic development and environmental quality. It must be realized that rapidly increasing demand for water, degradation of water due to contamination, water scarcity in both rural and urban areas, frequent incidences of water borne diseases etc., are becoming order of the day. Hence, the development of water resource for their optimum use involves proper conservation, management and proper planning of the resources.

7.1.1. Control of Water Losses

This method is applicable mainly in the uses of groundwater as

well as surface water in irrigation. Water is lost due to adoption of faulty method of irrigation and seepage from the canal system. The application losses also result when field irrigation channels, grading and shaping of fields, consolidation and rectangulation of holding, suitable methods of irrigation, irrigation scheduling, rotational supply of water, appropriate cropping patterns etc. are either inadequate or non-existent. This type of water loss can be checked by volumetric charging of water or educating the farmers about the adverse consequences which they have to face if they don't control flow of irrigation water. Canal seepage can be checked by lining the canals, though it involves heavy expenditure. Drip and sprinkle method of irrigation should be increasingly adopted.

7.1.2 Conservation Through Artificial Recharge

Artificial recharge of the groundwater may be defined as the augmentation of natural infiltration of precipitation or surface water into under ground formations. Artificial recharge may be needed for improving the water quality, for disposal of flood waters, and for reduction of salt water intrusion and for the prevention of land subsidence etc. the selection of a suitable recharging method depends upon local topography, soil conditions and quality of water to be recharged and its ultimate use.

a) Methods of artificial recharge by water spreading:

i) Flooding method.

ii) Basin method

iii) Furrow or Ditch method

iv) Natural Channel method

v) Irrigation method.

b) Recharge through wells:

c) Recharge through seepage:

7.1.3 Conservation of Soil Moisture

The moisture content of the soil is defined as the amount of water lost when it is over dried and may be expressed as the volume of water per unit volume of bulk soil. The infiltrating water when stored in the

soil pores raises the moisture content. The major loss of water is occurred through evapotranspiration by plants. Soils with large amount of available water are generally more favourable for plant growth.

7.1.4 Conjunctive Use of Surface and Ground Water Resources

Conjunctive use of water resources of an area or a region means proper utilization of its groundwater and surface water together, is a planned manner. Large development can be achieved by integrating both these resources. Thus, conjunctive use involves optimum utilization of available surface water during the years in which the rainfall is above the average and storing the excess water underground by artificial recharge.

7.1.5 Water Quality Management

A comprehensive multi-pronged water quality management strategy includes strict implementation of pollution control laws, promotion of cleaner technologies, fiscal incentives and economic instruments of appropriate prices, taxes and property rights.

7.1.5a *Water Conservation for Pollution Control:* Water is still treated as a free good, to be used liberally and to be sullied with impunity. Pricing water to reflect its scarcity value, can encourage users to be more prudent is its use. Better pipeline management, reused and recycled domestic wastewater for agricultural and industrial purposes, drip and sprinkler irrigation technologies can curtail water losses. To reduce water damage we have to reduce fertilizer or pesticide or chemical sun-off from agricultural fields reducing the amount of pollutants that eventually find their way into the water bodies. Polluters usually do not feel the effects of pollution caused by them and adverse effects are borne by the third parties. Quantifying and putting a cost to the polluters for these adverse effects of pollution and then incorporating them into the decision making process and deciding the price of water accordingly can resolve such problems.

7.1.5b *Encouraging Industry to Act:* Waste water treatment facilities should be made mandatory in the industries. Industrial effluents must be treated and clean water should be drained out of industries before

meeting other water sources.

7.1.5c *Domestic and Agriculture Pollution Control:* Cheaper domestic waste water treatment technologies, like biological treatment need to be examined as alternatives to the more expensive conventional treatments. The first important Step in the agriculture sector is to curtail over use of fertilizers and pesticides. Environment friendly practices like vermiculture, use of organic manure and integrated pest management practices that obviate the need for persistent pesticides should be vigorously encouraged.

7.1.5d *Mass Partnership:* It is visually impossible for the Govt. alone to monitor the water management systems. People should be more conscious and aware and create pressure on the industries and other agents which a polluting water to rectify their habits and maintain a clean profile.

7.1.5e *Institutions:* To monitor industrial, domestic and agricultural pollution institutional mechanisms that could involve the stack holders need to be evolved. The Pollution Control Board should generate and maintain data that can be made available to the concerned citizens, who can play an important role to consume water resource and maintain environmental health.

7.1.6 Change in Municipal Systems and Recycling Methods

Numerous cities all over the world are facing the stark reality that it will be extremely impossible and expensive to increase the supplies of water by traditional means. They are discovering the real steps to reduce water consumption and wastage. A considerable number of cities have programming to repair the leaky water pipes and installed low-flow shower heads, water displacement devices in toilets etc.

7.1.7 Exroscaping

Planting of less water consuming plants over the bear surfaces, open lands and lawns of the houses is considered another measure of water conservation especially in dry regions. These plants do not require additional watering whereas consume less water than the

previous plants.

7.1.8 Grey-Water Recycling

Slightly dirty water collected from sinks, showers, bathtubs, laundry tubs, collected in holding tanks and used for such purposes as flushing toilets, watering lawns, gardening, washing cars etc. is considered another measure to save wastage of fresh water.

7.1.9 Methods to Increase Water Inputs

Due to increasing demands for water and disparity of water distribution throughout the earth, hydrologists and engineers have tried to sort out the problems by other methods like

a) Towing ice-bergs from higher latitudes to lower latitudes,
b) Desalinization of ocean water,
c) Cloud seeding,
d) Transporting water thousands of kilometers from water rich to water poor regions,
e) Inter linking of rivers. Most of these ideas are related with environment, political and economic concern.

7.1.10 Rain Water Harvesting or Storm Water Management

Rain water harvesting is done by constructing a reservoir, which receives and holds the surface run-off during periods of heavy shower or storm waters. Water from this may be gradually infiltrated into the soil or it my trickle out slowly through a stand pipe mounted in the reservoir or pond. Thus the reservoir plays a role imitating groundwater storage and it may also create a pocket of natural wet land supporting wildlife. Large storm water reservoir-flood controlling reservoirs may serve additionally as recreational areas with the facilities of boating, fishing and so on. Small trenches and wells filled with rock, sands and gravels get rain water from the nearby roof tops, parking zones, roads, etc. allow to percolate the water through soil. This type of infiltration may again recharge the ground water table and also helps to supply water for drinking purposes. (De, 2005).

7.1.11 Accelerated Water Storage Development

Numerous water storage structures like Low Density Poly Ethylene (LDPE) and Ferro cement tanks are constructed to store water.

7.1.12 Role of Media, Communities and Professional Societies

People have to be made an integral part of the water management system. Media like T.V., Radio, FM channels etc. should play a vital role in educating the people and making them aware of the fact that water is precious and we must know how to use it judiciously. Communities and professional societies can conduct rallies exhibitions, painting competitions on water related matters, its proper use and conservation.

7.1.13 Water Management Measures for the Tea Gardens

Tea is a rainfed crop and remains with inadequate or no rain for a period of five months starting from December to April. During this period of five months plants suffer from water stress which affects photosynthesis, respiration and growth there is an internal water deficit causing dehydration of protoplasm, reduction in cell and leaf size. Scorching and wilting are the visible sign in drought prone areas, young tea plants suffer more which leads to death and the mature bushes suffer severely during the bud break which leads to late flushing. The measures adopted for water management are –

7.1.13a *Proper Shade Establishment:* Tea is a shade loving plant. Proper shade management not only provides leeway to the bushes from being exposed to direct sun but also acts as a good neighbour to the tea bushes by providing nutrient and water.

7.1.13b *Improving Soil Structure:* The prime factor before implementation of water management is to study the initial moisture content in the soil, which promotes cohesive forces of soil particles and water molecules. Soil should be in good tilth so that the roots can penetrate deep in the soil for an easy access to water and nutrient. Capillarity, infiltration, percolation and air movement is easy in sandy loam type of soil. Soil water content should be in between field capacity

and permanent wilting point. The soil structure should be improved by breaking the hard pans, rehabilitation of worn out soil by adding cattle manure, oil cakes, compost and mulching with grasses like Guatemala, Citronella, Lemon grass, pusa napier and water hyacinths etc. will provide organic matter to the soil and subsequently the population of micro organism will increase making various nutrients available to the plants by the process of mineralization.

7.1.13c *Mulching*: Mulching in young tea areas should complete before moisture depletes from soil and mulch materials dry out. Mulching is the practice of spreading an extraneous material on surface of soil to increase water infiltration, check evaporation, reduce soil erosion, improve edaphic environment and suppress weed growth. (Kumar et al., 2002)

7.1.14 Tillage and Land Grading

Tillage is known to increase infiltration rate, reduce evaporation and enhance root penetration into deeper layers of soil. Increased infiltration results in higher soil-water storage in the root zone of crops and greater availability of soil water for crop decreases the need for supplemental irrigation. Land grading is essential for uniform distribution of water by surface irrigation or undulating and sloping lands. It obviates chances of over flooding of low-lying areas and under irrigation of raised locations.

7.1.15 Fertilizer Use

Use of high doses of fertilizer should be avoided where water supplies are limited.

7.1.16 Cropping Pattern

The role of crop planning in making more efficient use of water is important because

a) crops differ markedly in timings and amount of their irrigation needs,
b) they exhibit a wider range of photosynthesis efficiency for similar water requirements and

c) they exhibit differential sensitivity to water stress imposed at various growth stages. Short season species grown during rainy season require less irrigation then the long duration and summer season species. Reduction of growing season by even a few weeks during summer can bring about a saving of one or two irrigations. Further, crops with deeper and more profuse root systems utilize greater amount of profit-stored water and can withstand drought better than the shallow-rooted crops. Mathematical models based on water production functions should be developed and used for optimizing cropping patterns for high water-use efficiency (Kumar et al., 2002).

7.2 SOIL-WATER MANAGEMENT

Soil-water management aims at soil conservation. Soil conservation aims at obtaining the maximum sustained level of production from a given area of land while maintaining soil loss below a threshold level (Morgan, 1986). The various effective soil conservation methods are 1) agronomic measures, 2) soil management and 3) mechanical methods.

Agronomic measures like planting cover crops, contour farming, mulching, strip cropping, inter-cropping with legumes, using high yielding improved seeds, fertilizers, manures, pesticides etc. should be practiced. Land from 33 to 50 percent slopes may be utilized for suitable horticultural plantations. Land shaping, such as orchard terraces may be used. Barren slopes, which have thin soil are not suitable for tree growth and thus may be developed into grasslands. Terrace risers in the agricultural land may be protected by growing fodder tree species or horticulture plants or grasses.

7.3 LAND USE AND CONSERVATION AGRONOMY

The differences in erosion rates caused by different land use practice on the same soil are much greater than the corresponding values from different soils under the same land use. Therefore, the best

land management may be defined as the most intensive and productive use of which the land is capable of without causing degradation.

Contour planting involves cultural operations across the slope i.e. by keeping them on contour or nearly so. The contour furrows so created would form a multitude of mini barriers across the flow path of the runoff which improves vastly the detention storage in situ.

Contour binding consists of constructing narrow based trapezoidal embankments (bunds) on contours to impound water behind them so that all the impounded water is absorbed gradually into the soil profile for crop use.

Graded bunds are constructed in relatively high rainfall (>600mm) areas where the excess water is to be removed safely out of the fields to avoid water stagnation. These are narrow based versions of the channel terraces where the design of the channel of a sufficient capacity rather than the embankment is important. In fact the bund serves only to guide the water spilling from the channel safely. The grade of the channel is predetermined, depending upon the soil type so as to be non-erodible under the action of the flowing water.

Bench terracing has been practiced in the steep hill slopes since time immemorial. Bench terracing, which involves converting the original ground into level step-like fields, constructed by half cutting and half filling, helps in reducing the degree of slope, substantially. In rainfed areas, bench terracing is practiced normally in the 16-33% slope range.

Grassed waterways serve as outlets for channel type of terraces to conduct the surplus waters safely into natural drainage courses without causing gullying. Where grassed waterways cannot be located in natural courses, they are artificially constructed and are located, if possible, along fence lines or hedge rows to avoid inconvenience to farm operations. Grassed waterways are usually constructed one or two seasons ahead of the construction of channel terraces and diversions so that by the time the accumulated excess runoff is let into the waterway the vegetation in it is well established to take care of the

onslaught of the following water and no gullying takes place. The vegetation in the grassed waterway should be periodically trimmed, bushes and shrubs removed. Sediment accumulation in the water course should be cleared periodically.

Diversion drains are provided at the top of the arable area to intercept the uncontrolled flow of runoff water from the upper catchment area and to conduct it laterally safe into a natural or protected water course. The provision of diversion drain is vital since all the conservation structures lower down in the cultivated land are designed with the assumption that the water from the upper non-agricultural land is safely diverted. If the diversion drain fails to serve this purpose, the water released from the system is almost certain to breach all the structures in the agricultural area. Diversion drains are also provided to divert the storm runoff away from gullies so that gully head extensions can be avoided. While grassed waterways are constructed along the prevailing slope, diversion drains are provided across the slope on a slight gradient.

Gully plugs prevent the eroding and down cutting of gully beds. They reduce the gully bed slope thereby reducing the speed of runoff water, redistributing it and improving the percolation. They encourage the deposition of silt and create favourable soil moisture regime for the development of plant cover. Gully plugs of various materials such as brushwood, log, earth, boulder, sand bag, brick and stone masonry are used in India. The size and material used for gully plugs depend on their width, length and bed slope (Tajwani et al, 1960).

Land levelling or grading is done by removing excess material from high areas and filing the low areas, to remove the surface irregularities, to make the surface plane and control the flow of water. This provides better surface drainage and checks soil erosion.

Jhora training is done by making permeable gabion drop and guide structures. The guide walls are provided along the bank in descending steps. The slope in the bed of the *jhora* is broken by providing gabion drops across it.

The catchwater drains are basically constructed for diversion of runoff from sites likely to get damaged more than others. Catchwater drains are used extensively for the treatment of landslides. Besides landslide, surface run off is also needed to be kept away from sinking zones. In such cases, a series of parallel catchwater drains are needed.

Retaining wall and breast wall have been the chief gravity structures, constructed along the roads. A retaining wall is a wall built to resist the pressure of earth filling deposited behind it, after it is built. A breast wall is a similar structure built to protect the freshly cut surface of a natural ground, whether with vertical or inclined face, to prevent it from fall due to the action of climatic factors.

The training of a river involves construction of revetments, spurs and retards to confine the flow and protect the bank from scouring.

Check dams are usually constructed in series, to raise bed level up to a height where safe support is provided to the slopes, to reduce the river gradient and to reduce the water depth by widening the river bed.

Palisades and wattles are constructed along the contours on the sloping ground having loose debris susceptible to move down slope at the slightest disturbance. Palisades are mechanical structures constructed on steeper slopes. These are pole terraces, which increases the debri holding capacity of the slip. These are usually applied on slopes steeper than 30 degrees. Wattling, on the other hand, are more biological in nature and are applied on milder slopes with slope less than 30 degrees.

Choice of Crop: In older days, crops were divided into two categories, viz. row crops or erosion permitting crops or soil robbers and erosion resistant crops or soil conserving crops or soil builders. Soil erosion depends not on what crop is grown but on how it is grown. So crop management is more important than the type of crop. Crop canopy should be such that it covers maximum exposed land. Plant roots are the best binding factors for soil. Grass root followed by legume

Photograph 7.1 Soil Conservation Method (Palisade)

Photograph 7.2 Soil Conservation Method (Protecting Wall)

root, help in improvement of soil structure owing to higher root mass and root secretion, which help in binding of soil particles.

Cultural practices includes the following:

a) Land preparation including post-harvest cultivation and preparatory tillage influence and rather increase infiltration rate, obstruction to surface flow and decreases the rate of erosion.

b) Advancing dates of sowing, at times, help in soil-water conservation.

c) Contour cultivation, adopted on sloppy lands, controls soil erosion.

d) Too dense crop geometry may lead to severe moisture and nutrient stress from soil. So crop population and crop spacement should be such that less soil gets eroded. v) Advantages of mixed cropping are good crop cover, feeding of crops from different soil layers and under rainfed an assurance to farmer against total crop failure.

e) Mulching of open land surface in a cropped area is done by spreading stubble, trash or any other vegetation. The objectives of mulching are to minimize splash and influence of rain on bare surface, to reduce excessive heating and to allow microbiological changes to occur at optimum temperature. The different types of mulching are polyethylene mulching, stubble mulching, trash mulching etc. The limitation with mulching practice is the non availability of plant residues for mulching purposes.

f) Adoption of organic manures and green manures not only supply plant food elements like fertilizers but also help in improving the soil physical conditions. Soil structure and infiltration rate increases there by reducing soil erosion.

g) Crop residue retention was found to be a valuable asset for the reduction of soil erosion but is practiced mostly in the developed countries.

h) Line sowing of mixed crops give rise to intercropping which reduces soil erosion.

i) Strip cropping involves growing of few rows of erosion resisting and erosion permitting crops in alternate strips on contour or across the slope with the objective of breaking up long slopes on farm and preventing erosion and soil loss

j) Crop rotation involves incorporation of legumes with cereals in a sequence in order to take advantage of different feeding zones, both for nutrient and water, and to offset disadvantages of mono-cropping in controlling insects, pests and diseases.

The aims of soil management are to maintain the fertility and structure of the soil because fertile soil results in higher crop yield, good plant cover and therefore, in conditions which minimize the erosive effects of raindrop and run off. Good soil fertility can be achieved by applying organic matter because it improves cohesiveness of soil, increasing water retention capacity and also promotes a stable aggregate structure.

The various mechanical measures (also called engineering measures) usually involve construction of mechanical barriers across the direction of flow of rainwater to retard or retain the run off and thereby reduce the soil and water losses.

The important principles to be kept in view while planning mechanical control measures (Rama Rao, 1960) are:

a) Increasing the time of concentration of run off and thereby allowing more of it to be absorbed and held by the soil.

b) Intercepting a long slope into several short ones so as to maintain less than a critical velocity for the run off water. c) Protection against damage due to excessive run off.

7.4 NATURAL RESOURCE MANAGEMENT

In the mountainous areas, arable land is limited and existence of forest is a must. So there is less scope of expansion of agriculture at the cost of forest. Forest land is very important for the survival of the mountainous ecosystem. Forests not only checks soil erosion but if managed scientifically can provide sufficient fuel and fodder to the

people of such regions. High population growth exerts tremendous pressure on the forest land. Deforestation is very harmful for the maintenance of balanced ecosystem. So forest being one of the most important natural resource, needs proper scientific management for the sustainability of the fragile mountain ecosystem. There is huge scope of turning wastelands into forests to save the ecosystem. Moreover healthy forestry practices can lead to economic development of an area. Presently, sustainable development is redefined as a management system for the use of renewable natural resource that ensures food supplies, income and livelihood for present and future generations and improves rather than merely maintains the economic productivity and ecology of those resources. Forest lands are classified under Reserved Forest, Protected Forest and Unclassed forests. Reserved forests are scientifically managed and well stocked to provide effective cover to the soil. Protected Forests are forests whose, unless otherwise prohibited, rights of user are admitted in respect of forest produce, grazing, break-up land for cultivation etc. These forests are over-exploited and hence subject to erosion. Unclassed forests comprise of village forests, panchayat forests, civil and soyam forests. Owing to unscientific management and unregulated over – exploitation, these forests are also degraded. To regain all such degraded, highly eroded and deforested lands, correct forestry practices are the need of the time. By proper measures, based on scientific principles of silviculture and other forest managements, forests could be availed of in perpetuity, without further degradation. Various methods of forest management have been developed taking into account the type of forests, the requirement of the species, with particular reference to soil, water and light conditions, favourable for their growth and local or industrial needs for produce from the forest. To develop natural resource like forest, availability of area specific healthy seedlings is very important factor. So the first move is to set up proper nurseries which can produce the various seedlings required for the proper functioning of the forest management programmes. Organization like World Bank, funds for the development

of natural resource of any area. The objectives of different forest management programmes are discussed, from where proper methods have to be selected for the development of the study area.

7.4.1 Social Forestry

Social forestry is the practice of planting trees on barren lands, wastelands, along the roads, canals, railway lines etc. The main components of social forestry are strip plantation and farm forestry.

7.4.2 Farm Forestry

The basic component of operation is the organization of a substantial programme of the planting of trees on the bunds or boundaries of fields of the farmers, which is to be taken up by the farmers themselves. The basic objective of 'Vana Mahotsav' accepted in the planned development of forestry is to encourage farmers to participate in this programme and regenerate forests for their own benefits. The Govt. has exempted the value of trees standing on agricultural land from wealth tax to encourage afforestation. It meets the fuel wood demand of the rural areas and generates a source of income to the villagers.

7.4.3 Strip Planting

Strip planting not only reduces pressure on natural forests but also creates sufficient resources on public and private lands for meeting the local demand of timber, fuel wood and fodder. Strip planting along the road side is also intended to have an aesthetic appeal.

7.4.4 Joint Forest Management

The idea of joint forest management was introduced to protect and develop the degraded forests with the co-operation of fringe dwellers. Under JFM, the forest fringe dwellers participate in the protection of the forests and its resource in lieu of which they are granted certain benefits. The dwellers are allowed "25% of the sale proceeds at every final harvesting of the concerned plantation/forests (i.e timber, pole etc). They are also entitled to collect 'fallen twigs, grasses, fruits, flowers, seeds etc." as well as one forth of the produce obtained as intermediate yield from multiple shoot cutting, thinning

etc. For all these, the dwellers have to form the Forest Protection Committee (FPC). The FPC is formed by dwellers living near the ordinary forests. After the formation of the FPC, the members have to involve themselves at least five years in forest protection before being eligible for the benefits. The FPCs are formed by the divisional forest officer in consultation with the local panchayat samiti. The committee selects the beneficiaries, identified from amongst the economically backward people. The main objectives of JFM are to conserve and improve forest productivity.

7.4.5 Agro-Forestry or Inter – Cropping

The term 'Agro-Forestry' encompasses any and all techniques that attempts to establish or maintain both forest / tree and agricultural production on the same piece of land. Agro-forestry is a system of land use which combines growing or raising crops (and or livestocks) with woody plants. Land can be used to produce agricultural crops- agriculture; animals and their products – animal husbandry; and trees and their products – forestry. The product can be obtained by either growing or raising them separately or in different combinations. Agro-forestry includes silvo-pastoral, horti-pastoral and fodder–fuel plantation system. The fuel fodder plantation or silvo-pastoral system of grassland development is probably the best system for overcoming the shortage of fuel and fodder. This can be practiced on vast areas of cultivable wastelands and marginal forest lands. The leaf fodder is rich in nitrogen, crude protein, phosphorus etc. and can reduce cost on concentrates fed to animals during lean season of fodder availability. Fodder trees like *Lencaena latisiliqua*, *Albizzia lebbek* etc. are highly recommended. When in orchards, fodder crop is grown, it is known as horti-pastoral system. Raising horticultural plants on a degraded land is more profitable and economical per unit area per unit time as compared to that of trees or gasses. Where soil and climatic conditions are favourable, either multi-storeyed cultivation of horticulture plants or agronomical crops with fruit trees (orange and ginger etc.), can be raised successfully and thus increase the productivity per unit area per

unit time. Cultivation of fruits is a highly remunerative enterprise. Horticulture has been, is own and will continue to be of great economic, political and social importance to mankind. Present day horticulture may be defined as the science and technology involved in production, processing and merchandising of fruits, vegetables, flowers etc.

Livestock management is a type of natural resource management because livestocks not only provide milk and meat but they are used as traction power and for transport. They also produce ample organic manure. Proper grassland management if implemented, then livestocks can easily get their share of fodder from such grasslands. Fast growing grasses with high nutritive value, needed to be grown. Pisciculture is another way to lead to sustainable development. Water bodies artificially created or natural fishes of fast growing variety which has high economic value. Cultivation of medicinal plants may be of great economic importance because demand and export of these valuable herbs is increasing day by day. Trained manpower is needed for collecting, drying, grading, storing and marketing of these herbs. The medicinal species need to be conserved and managed in a scientific and judicious manner by planned cultivation on the pasture lands. The cultivation of herbal plants will boost the economy of the region.

7.5 HUMAN RESOURCE MANAGEMENT

Human beings are the most intelligent among all the creatures in the world. Such a resource needs proper utilization for the development of the society. Human resource is useless if not utilized properly. To develop human resource, attainment of knowledge and education is very important. People have to be educated not only academically but also scientifically and technically. Skilled human resource in different spheres of life is important. Constant research should be carried out to develop the human resource. Along with education, there should be enough scope of employment. Employment generating units like IT sectors, tourism sectors and industrial sectors should be opened up. Training in floriculture, horticulture, technical skills should be

imparted which can lead to self sufficiency by self employment. To develop human resources, growth rate of human beings should be checked by applying different birth control measures. Environment and living conditions of people has to be developed by providing them with all the basic amenities, necessary for life. Human activities need to be eco-friendly for the sustainable development.

CONCLUSION

Since soil erosion, is one of the major problems of the study area, so immediate attention is given to the importance of soil – water conservation in the study area. Water has to be channelized properly so that there is minimum loss by various methods. Artificial recharge can be practiced in the foot hill regions. Recycling and reuse of water, conserves water to a great extent. The leakage in pipes and water supply systems need proper attention. New methods like grey-water recycling, exroscaping, rain water harvesting needs to be practiced on a larger scale. Above all people has to be made aware of the fact that water is precious and needs to be used judiciously. In agricultural fields water wastage can be managed by proper utilization of water and applying scientific techniques. Methods like mulching, choosing proper cropping pattern is gaining importance in the study area. Soil conservation measures like contour planting, terracing, construction of diversion drains, *jhora* training is to be done extensively in the study area. Natural resource management by social forestry, joint forest management, agro forestry should be practiced by the people of the basin. Afforestation by planting local, fast growing varieties will help in sustainable development of the area. Human resource management can be rightly done by educating the general masses and developing responsibility sense among them regarding their surround environment.

Apart from different management methods which are suggested to be adopted in the study area, review of the past strategies which were already implemented for the development of the basin in general

and the people in particular, is to be done on an urgent basis. New strategies should be formulated for the present situation and suggestions should be given for future development. All these are done in the following chapter, for the overall development of the study area.

CHAPTER VIII

MAJOR STRATEGIES FOR THE DEVELOPMENT OF THE BASIN

INTRODUCTION

The study area being situated in the hills and majority of the area being dominated by tea garden villages, development strategies need to be area specific. People of the area are mainly dependent on the tea gardens and their socio-economic status is so low that they are unaware about the policies formulated for them by the Govt., through panchayats and NGOs. People have to be mire aware to utilize the benefits of such policies, which will lead to the upliftment of their living conditions and life itself.

8.1 PAST STRATEGIES

Scientific planning is very essential for sustainable development. Developmental strategies can be successful if only they are formulated keeping in mind the problems of a particular area and the various problems confronted by the people of that area. Since independence, Govt. has formulated many developmental strategies, some of which are implemented in the study area. In some cases the achievement is significant but in most of the cases achievement is not successful due to lack of monitoring and management of the policies and strategies implemented by the Govt. and other agencies.

8.1.1 Past Strategies for Rural Development:

By definition, development is the act or process of developing or growth evolution within the framework of available resources. Its primary aim is the removal of poverty and socio-economic evils which are interlinked with it. Since independence, many strategies were adapted for rural development. The objectives were to examine whether the benefit of such strategies reaches the needy families and whether those can generate income and employment opportunities.

The Govt. of India has undertaken many programmes for rural development which can be broadly categorized as:

a) Programmes for Agricultural Development
b) Programmes for Industrial Development
c) Employment Oriental Programmes and
d) Programmes for the Development of Backward Areas.

8.1.1a *Agricultural Development Programmes*

(i)Community Development Programme (C.D.P).

(ii)Small Farmers Development Agency (S.F.D.A.).

(iii)Marginal Farmers and Agricultural Labourer's Development Agency (M.F.A.L.D.A.).

(iv)Intensive Agricultural Development Programme (I.A.D.P.).

(v)Intensive Agricultural Area Programme (I.A.A.P.).

(vi)High Yielding Varieties Programme (H.Y.V.P.), and

(vii)Multiple Cropping Programme (M.C.P.).

i) The closest of micro-level planning is the Community Development Programme which is the first attempt of the Govt. of India for rural development with an account on 'Panchayat Raj', Co-operative and Agricultural Development. The concept of this programme is based on the development of blocks with an area and a certain population size.

ii) Small Farmers' Development Agencys' primary objective is to guide, assist and co-ordinate the existing agencies in order to serve the small farmers in a better way and to enable them to earn the benefits of the new strategy like the large farmers' agency.

iii) MFALDA was set up to assist the marginal farmers in optimum utilization of their small landholdings by taking vegetable growing, horticulture, dairy farming, poultry farming etc. The main aim is to generate additional income by challenging credit improved inputs and improved practices into their activities. It also gives employment in the leisure hours of the year or day.

iv) In IADP the cultivators were induced to adopt package of improved agricultural practices such as the use of improved seeds, fertilizers, pesticides, improved implements, proper soil and water managements etc. in order to bring about significant increase in yields per hectare and to increase the level of agricultural production of major crops.

v) Intensive Agriculture Area Development was launched covering two-fifth of the districts of India. Because of high coverage with limited resources, this programme could not provide certain supporting facilities.

vi) Both IADP and IAAP were concerned with the promotion of intensive agriculture which was relatively less responsive to fertilizer and other inputs within the introduction of high yielding varieties. The propagation of high yielding varieties over fairly large areas was taken up as a full-fledged programme from kharif season of 1966-67 in selected areas. This programme was introduced where there was assured irrigation or rainfall, proper drainage, existence of strong input supply agencies such as co-operative societies etc.

vii) Multiple cropping was suggested both in irrigated and rainfed areas. The aim of this programme is to produce more per unit of time in a unit of land by multiple cropping. This was advocated much in areas where initially one crop was grown in a year to raise three to four crops in order to fully utilize the farm inputs and to engage labour throughout the year.

All these programmes no doubt, contributed to agricultural development but the benefits reaped by different areas differed. This was because the needs and problems differed area-wise or region-wise and preparing programmes and implementing them in all the areas without the consideration of local problems, resulted in less than optimum utilization of resources.

8.1.1b *Programmes for Iudustrial Development*: The Govt. of India had undertaken many programmes for industrial development with special

emphasis on cottage and small scale industries. Among these the Industrial Estate Programme was undertaken to bring about dispersion of industrial activities in the undeveloped areas. The planning commission had pointed out that "a large number of our industrial estates started in rural areas and semi-urban areas languished mainly owing to unsuitable location, lack of integrated planning and marketing facilities and shortage of raw materials".

8.1.1c *Employment Oriented Programmes*: There were many farmers and labourers lying below poverty line waiting for employment opportunities. The only way to bring benefits down to the lowest section of people was by providing them adequate employment opportunities.

8.1.1d *Crash Scheme for Rural Development*: The objectives of this programme were two fold, direct generation of employment to landless labourers and creation of durable assets.

8.1.1e *Programmes for Development of Backward Areas*: Special programmes were designed for the development of backward areas by eradicating the problems responsible for its backwardness.

8.1.1f *Comprehensive Area Development Programme (C.A.D.P.)*: Increase in agricultural production and its proper distribution is the main aim of this programme. Its objective include – i) functional integration of complementary physical facilities like power, irrigation, road etc. so that the modern technological innovation can be used for the optimum utilization of the physical resources like tanks, lands, minerals, canals, etc. within the area. ii) Self-reliance in financing the project by making it economically viable. iii) A restructuring of the rural socio economic institutions to make total productive use of the manpower potentials in an area, guaranteeing maximum production in minimum cost and an equitable sharing of the produce. iv) Increase in production for generating immediate employment and creating the basis for its quick transformation into direct CADP area. The success of all these programmes depend on the choice of programe in the region and other factors like availability of irrigation facilities, fertilizers, pesticides and high yielding variety seeds. The choice of programmes also depends on

the character of the region and the problems of the farmers. Proper funding was not available to execute such programmes. People were also unaware about the functioning of such programmes.

8.1.2 Past Strategies for Forest Development

Forests are renewable resources and have contributed substantially to the economic development of the country by providing goods and services to the people and industry. They also generate substantial volume of employment. In addition, forests play an important role in enhancing the quality of environment by influencing the life support system and also interwoven with our culture. The Forest Department in British India was constituted in 1864. In 1865, the Indian Forest Act was enacted, directing state monopoly right over the forests. The revised Forest Act of 1878 gave the power to the state to democrate valuable tracts of forest for railways and other purposes. The ownership of the entire forest tract was acquired by the British Govt. of India by the Forest Act. As a result, land area under State Controlled Reserved and Protected Forest increased. The Indian Forest Act of 1878 was amended in 1890, 1891, 1901, 1911, 1914, 1918 and 1920, till a comprehensive Indian Forest Act was formulated in 1927. The major drawback of the Act is related to the extent of control over forest exercised by the state. The 1865 Act provided for the protection of a forest only after it had been selected and declared as a government forest and according to this Act the customary use of forest land by the forest dwellers was based on privilege not on right. The first official forest policy of Govt. of British India was pronounced in 1894. It aimed at forest preservation by 'regulating, the rights dwellers. Later, revised forest policy of 1952 classified forest on a functional basis into: a) Protected Forests, b) Natural Forest c) Village Forest and d) Tree Lands. From 1864 to 1972, forest management strategies were markedly biased in favour of commercial and industrial exploitation, with little attention paid to sustainability or to social justice. The National Forest Policy of 1952 (still is vague in revised form) spelled out that India should aim at maintaining one-third of its total land area under forests;

60 percent in the hills and 20 percent in the plains. Among others, the policy stressed that: i) basis of annual cut should be sustained yield, harvesting only the increment leaving the forest capital intact; ii) wildlife need to be protected and forest grazing regulated; iii) adequate forest laws to be promulgated; iv) professional training and research need to be intensified. The policy recommended functional classification of forests was i) Protection Forests, ii) National Forests, iii) Village Forests and iv) Tree Lands, and stressed the need for increasing tree land outside government forests. Important forestry related legislations in force were the Indian Forest Act, 1927, the wildlife (Protection) Act, 1972, and the Forest (Conservation) Act, 1980. All these Acts were revised afterwards. The Wildlife Protection Act of 1972 was amended and made more stringent in 1991. It took initiatives for the creation of a vast network of protected parks and sanctuaries. But there were no legal definitions of Protected Area, Biosphere Reserves etc. Moreover, Section 18 of the wild life (Protection) Act 1972 defined the Sanctuaries as forested land. Subsequent amendments to the Act have deleted the word 'forested land'. Forestry developmental activities were concentrated primarily on industrial timber production. Apart from large dimensioned, long-rotation species (Sal, Teak, etc) much efforts were made for raising extensive short-rotation, fast growing plantations for meeting fuelwood requirements. The National Commission on Agricultural (NCA) introduced the concept of 'Social Forestry' in 1976. Following the recommendations of the National Commission on Agriculture (1976), Forest Development Corporations were established in most parts of India to operate "commercial" forestry on more businesslike manner. Simultaneously, a programme of social forestry was also launched to bring non-forestry land under tree cover through people's participation. This latter effort was intensified in 1985 when the National Wastelands Development Board was established. During the 'seventies' forest areas were under threat due to increasing pressure on forests and on tree-growth outside the forest, to meet the various household and industrial consumption demand of the growing

population. Diversion of state forest lands to non-forestry uses also added to the situation. This adversely influenced environment and ecology. Policies and policy instruments conceived to address the above concerns consisted of:

i) Social forestry with people's participation;

ii) Forest Development Corporations were established to create 'man-made forests' to meet the demand for wood;

iii) Departmentalization and nationalization of harvesting and trade of a variety of forest produce to reduce illegal removals and introduce fair-trade practices. All the above policies will rejuvenate the depleted forests. Promulgation of the wildlife (Protection) Act, creation of a designation of areas as Biosphere Reserves, and intensification of soil and water conservation activities including afforestation of fragile forest areas, were measures, aimed at checking environmental and ecological degradation.

Unfortunately, the above policy measures could not fully address the problems at hand. Social forestry activities were most successful on private lands, the commercial interest of tree growing being the prime motivator. Community participation was low and the expected decrease of consumption pressure on state forests was minimal (Banerjee, 1990). The Govt. of West Bengal gave official recognition to the Forest Protection Committees (FPC) in 1989, although FPCs have been in existence for atleast a decade and a half. A major contribution of the FPCs has been the generation of employment for the local people. As the tree – growers does not have to many any financial investment, the programme was alterative to the poor. A modified version of social forestry was Agro-forestry. It is indeed a new name for an ancient land use practice where in land was used for agriculture, forestry and animal husbandry. The Five-Year Plan clearly draw the linkage between the land reforms programme was the integration made more effective than in the FPCs which aim not morely at increasing the forest cover and the upgradation of degraded lands, but also at involving the forest

dwellers in the process of regeneration and at the same time contributing to their upliftment. In West Bengal, Joint Forest Management was also introduced, which later achieved great success. The Forest Conservation Act more difficult to convert forest land to non-forest use, without the clearance of the Central Govt. which has consolidated its territorial extent.

8.1.3 Past Strategies for Tea Cultivation:

In 1841, Dr. A Campbell brought Chinese tea seeds from Kumaon and planted them in his garden in Darjeeling town – commercial cultivation began around 1852-53. By 1874, there were 113 tea gardens in Darjeeling district alone. Tea crisis in 1932 completely paralysed the tea industry. The planters of North – East India was very much perturbed about how to keep the industry alive. In this respect, the tea planters made their decision that tea industry as a whole should limit the production and cultivation of tea at least for some years and try to expand the internal and external markets. The ball thus set rolling by Indian and non-Indian planters culminated in the biggest event for the sustenance of the tea industry, namely the setting up of the International Tea Committee and International Tea Market Expansion Board in 1933 and the passing of Tea Control Act by the Govt. of India. The Indian Tea Association established a Scientific Research Organization in 1899 which was the precursor of the 'Tocklai Experiemental Research Station' funded in 1911. In 1938, an advisory department was set up with the aim of transferring technology to members of the Indian Tea Association. In 1964, the Tea Research Association was formed to take over the management of the Tocklai Experimental Research Station. Under the Tea Act 1953, the Union Govt. had taken the tea industry under its control. The Tea Board was formed under the act and it was directed towards the development of the tea industry and trade in the sphere of production, extending area under tea cultivation, improving quality of tea, promoting co-operative efforts among growers and manufacturers exports of tea to foreign countries, issuing of export license, collecting tea statistics and

adopting welfare measures for workers. The Consultative Committee of Plantation Association consisting of 9 tea associations from Assam, Dooars, Terai, Darjeeling and Southern India has implemented several development programmes. The North – Eastern Tea Association, Tea Association of India, United Planters Association of Southern India, Assam Tea Planters Association, Bharatiya Cha Parishad, Dooars Branch Indian Tea Association, Darjeeling Tea Planters Association, Terai Indian Planters Association and Kangra Valley Small Tea Planters Association have contributed to the betterment of the living standards of the local people. All the tea gardens are the members of one or other of these producers associations. The tea gardens were the most backward areas of the basin. People immigrated as labourers and were illiterate. There were many acts and policies formulated by the govt. but all remain unimplemented by the authorities due to ignorance of the labourers and shrewd management techniques of the owners.

8.2 PRESENT STRATEGIES

India lives in villages and village uplift is the key to the progress of the country. Since independence, there has been a great exodus of population from the villages to the cities and towns. In spite of this, the majority of our population still lives in villages. Successive Five–Year Plans have deployed huge funds for village development.

In the agricultural sector, farmers still practice monoculture. Crops grown are wheat, mustard, winter vegetables, summer vegetables, winter potato summer potato, maize, bhadoi, ginger, cardamom, millets, pulses, soyabean, winter (or aman) rice, oranges, etc. Ginger, orchard and large cardamom are perennial crops. These fields grow the some crop throughout the year and are cash crops with great commercial value. Maize is gaining more importance in the eastern side of the study area. Agriculture based villages like Kharia Basti, Sonada Khasmahal, Rangbul, Pokhribong, Rongbong Basti, Mirik and Saurini Basti enjoy the same facilities provided under different schemes by DGHC Agricultural Offices. The present trend in the

agricultural sector is the development of oilseeds and pulses besides maize. Soil conservation and watershed management are some of the key areas of development. Organic farming is mainly gaining importance in the tea growing sector. Organic manures and pesticides like cowdung, castor cake, neem cake are much in demand. Introduction of bio fertilizer, encouragement of compost manure production by using egg shells, egg crates, dry straws, grasses, shrubs, cow dung, dry leaves and twigs etc. are much is practice. Young people are encouraged to earn by growing mushrooms, by providing them training. Nurseries, growing tea seedlings and other seedlings for the Forest Department are also gaining importance among the youths. Govt. schemes like Rashtriya Krishi Vikas Yojna (RKVY), National Watershed Development Project for Rainfed Areas (NWDPRA), National Horticulture Mission (NHM) help the farmers in different ways in the study area. Mini-kits are distributed amongst the farmers. Maize seeds are also given to the farmers in the study area. Farmers get fertilizers, fungicides and pesticide at 50% subsidy. Training programmes to practice different methods of cultivation are conducted by the village panchayats. Potato seed multiplication farms are located in Rangbul and Sonada which distributes potato seeds for growing potato. Summer potato of the hills can be used as seed potatoes in the plains. Since organic manure is used, production is less. Due to lack of water storing facilities, crops are mostly rainfed. Under National Horticulture Mission, 50% subsidy is given for the cultivation of gladiolus, orchid, carnation, jarbera etc. A vermicompost plant is set up in Mirik. Under different schemes plastic crates, sprayers etc. are given to the farmers. Seeds, sprayers and implements are given from Block Development Office's. Organic manures are mostly used in tea gardens so that bacteria, fungi, earthworms should be able to survive. Bank loans for agricultural purpose are still not very easy to get.

All the major commercial banks, cooperative banks, agricultural credit banks give out loan to the villagers for both farm and non farm activities. While banks do direct financing, organizations like NABARD

does indirect finance. This system of indirect financing is known are refinancing. NABARD gives the money to the different banks and they, under certain terms and conditions disburse the loan amount to those who apply for it. In the study area, people from both farm and non farm sectors avail these loans. Those who need loan for agriculture or non-farm activity, has to prepare a project which shows the knowledge of the person in the same field, his credentials and loan repayment capacity. If all these things are satisfactory, then loan is sanctioned. Sick cooperative banks in the study area, gets training on how to increase their deposits by encouraging local peoples' participation in banking. Self Help Groups, under District Rural Development Agency, get loans at the rate of three times the amount, the group has accumulated.

For the development of the study area, Govt. takes loan from NABARD (macro financing) to improve the socio-economic conditions. Govt. takes loan for construction of roads, hydel power projects, lift irrigation, surface irrigation etc. Micro finance is gaining importance among the people due to its nature of low capital start. Training provided by different NGOs aim at inculcating banking habits among the people of the Balason basin. Since capital is the most important necessity for any developmental work, people have to be more aware of the benefits of banking. Before financing any project, NGOs do the necessary field research work and according to their report, project planning is finalized by authorities like NABARD, World Bank, Central Govt., Foreign Development Agency etc. DGHC gets fund from the various above mentioned financial organizations for various developmental projects like building roads, providing drinking water to the remote villages, building schools etc. Projects funded by World Bank, Central Govt. and Foreign Development Agency are supervised by NABARD. People of the study area submit projects for doing floriculture, fishery, dairy farming, poultry etc. Gramin banks in Pokhribong, Sukhiapokhri, Saurini, Sonada give loans for all the above purposes. West Bengal Farmers' Old Age Pension Scheme is a Govt.

scheme under which old farmers get Rs500 per month. The Block Development Office, through the Panchayats, gives this facility to the old farmers who are now unable to work in the agricultural land. In Kurseong Block alone, 102 old farmers are under this scheme.

The present rural development scheme functioning in the study area is NREGA. The National Rural Employment Guarantee Act was enacted in September 2005 and its objective is to provide 100days of guaranteed unskilled wage employment to each rural household opting for it. The NREGA makes a paradigm shift and stands out among the plethora of wage employment programmes, as it bestows a legal right and guarantee to the rural people through an Act unlike the other wage employment programmes. The ongoing programmes of Sampoorna Grameen Rozgar Yojana (SGRY) and National Food for Work Programme (NFFWP) have been summed in NREGA. The focus of the Act is on works relating to water conservation, drought proofing (including afforestation), land development, flood control and rural connectivity in terms of all weather roads. Panchayat have a key role in planning, implementing and monitoring of the Act through preparation of perspective plan, approval of shelf of projects, execution of works at least to the extent of 50% in terms of costs. The Act envisages strict vigilance and monitoring. It also envisages a grievance redressal mechanism and helpline. NREGA is a poverty alleviation movement which not only assures employment but helps for future income generation of the entire community.

Present strategies in rural development like

(i) Sampoorna Grameen Rozgar Yojana,
(ii) National Food For Work Programme,
(iii) Pradhan Mantri Sadak Yojana,
(iv) Indira Awass Yojana,
(v) Swarnajayanti Gram Swarozgar Yojana,
(vi) Integrated Child Development Scheme etc.

The objective of Swarnajayanti Gram Swarozgar Yojana (SGSY) is to bring the assisted poor families above the poverty line by organizing

them into Self Help Groups (SHGs) through the process of social mobilization, their training and capacity building and provision of income generating assets through a mix of bank credit and Govt. subsidy. The scheme emphasizes establishment of activity clusters through selection of key activities based on aptitude and skill of the people, availability of resources and market potentiality. The scheme adopts a process approach and attempts to build the capacities of the rural poor. It provides for involvement of NGOs, CBOs, individuals, banks and Self Help Promoting Institutes in nurturing and development of SHGs, including skill development. The office of the Child Development project executes schemes like Integrated Child Development Scheme (ICDS). Under this scheme the Anganwadi centers take care of and assist, accepting and lactating mothers. Children within the age group 0-6 years are given APL & BPL nutritious meal, once in a day. These centers also look after primary cell. These schemes employ women because its objective is women empowerment in different community activities.

PWD is in charge of infrastructural development of the study area. Various works like road widening, *jhora* training etc. are done by them to protect the roads from getting destroyed during heavy rain leading to landslide. *Jhora* training work made of drops and guides are seen as one passes by the metalled roads of the study area. Very recently, road side drain (32km) from Kurseong to Darjeeling, along Hill Cart Road is being constructed. These drains help in transporting rain water following the slope of the land, systematically. Recently, many culverts are also constructed along with approaches for widening the roads. Out of many such works, culvert no. 190 was constructed in 2006. Near St. Mary's there is 600m road widening. In 2007, many culverts were constructed along with approaches, among which culvert no 191, 331, 363 and 393 are worth mentioning. Though fund flow is very limited in the study area, necessary works are done on priority basis. Under the head of OR (Ordinary Repair) Fund, minimum amount is allotted for the hills, which is inadequate for maintenance of National Highway 55

and other roads in the study area. Though *jhora* training is done by PWD, but lack of proper maintenance result in the entire thing getting washed away during monsoons. Theft of wire netting and stone boulders is another importance problem. Drop structures accumulate fine sands encouraging weed growth, restricting the flow. Thus after some time the structure fails. Large number of retaining and breast walls has been constructed for the protection of road benches in the study area. Besides roads, protection of homestead lands, bridle paths, buildings and other structures, too, has been given the protection walls. The terrain in the study area, being steep and rugged, it is impossible to build any large structure without constructing retaining and breast wall. In most cases, before constructing the retaining wall, loose materials, which are likely to slip are not removed and slopes are not trimmed and flattened. These faulty measures make the structures quite vulnerable. Some river training and stream bank protection works are done in different parts of the study area. Such works are mainly done by the tea garden authorities like Sangmaru T.G., Mangarjung T.G., Rangumk Cedar T.G., Ambootia T.G. etc. Rubble checkdams with boulders, constructed in series, are extensively used in the study area, for control of moving debris in smaller landslides. The Govt. Departments mostly construct defective structures and the maintenance of such structures is neglected. Govt. Departments like Forest Department and Border Roads Organization, constructs palisades and wattles in different parts of the basin. Construction work by Border Roads Organization is funded by Central Govt. and the villages like Bukim T.G., Gopaldhara T.G., Seyok T.G., Rangbang Basti, Simana Basti, Sukhiapokhri and Manjha Forest, in the study area, gets the advantage of such constructional works since these are situated in and around the international border areas of Nepal and India.

Land terracing and mulching is done in the agricultural lands of the study area to conserve soil. Farmers depend on protective vegetation belts, to prevent soil erosion, than on mechanical ones. Species like Amla, Ambake, Arkavla, Arupate, Buk, Mithe Champ,

Dalne Katus, Utis etc. are planted. For fodder, trees like Pipli, Gogun etc. are important. Good soil binding perennial grasses are also grown as fodder. *Amlisho* is grown as both soil binder and brooms are made from the flowers, which is of great economic value. Mulching is done by straw. Water channels in the agricultural land are strewn with boulders to reduce the speed of flow of excess water. Major soil and water management schemes, executed in the study area are Operation Soil Watch (OSW), National Watershed Department Programme for Rainfed Agriculture (NWDPRA) and Integrated Afforestation and Ecodevelopment Project Scheme (IAEDPS). Under OSW, afforestation is done in Ghoom Simana region of the study area. Two landslides were treated with engineering structures in Rongbang Basti. A series of catchwater drains are constructed in and around Sukhia pokhri. Few *jhoras* in upper Balason catchment were treated with drop and guide structures. Due to lack of proper fund, the NWDPRA projects are running in a very small scale. Govt. schemes like IAEDPS was implemented to attain the goals of restructured wasteland development programme. Many wastelands in the study area were turned into forest lands.

Hydel power in the study area is available from power stations situated at Fazi, Singtom, Bijanbari, Little Rangit and Richingtong. But all these plants are of very low capacity in the KW range. Ramman Hydro Electric Project (Stage – II) with a total capacity of 51MW, comprising 4 units, each of 12.75MW, had started its generation partially in 1995 through its first unit. To receive the power from Ramman to Siliguri, a 132KV sub-station is being constructed at Labong. Chukha Hydel Power Station in Bhutan, also supplies electricity to West Bengal.

All the above mentioned schemes are implemented in the study area. But due to illiteracy and ignorance of the people of the study area, benefits of the schemes are not reaching to the desired ones.

8.3 FUTURE STRATEGIES

Both the pre and current strategies do not address some of the important issues of overall development of the area. Policies are framed by the Central and State Govt. but their application and execution in different parts of India gives different results. Area specific planning is required, to get the overall benefit.

8.3.1 Human Resource

Growth of population should be reduced by increasing awareness and education among the people. Easy methods of family planning should be implemented and contraceptive pills should be made available to the women free of cost. Anganwadi centers should be made more active. More and more such centers should be opened up. All the villages should have one such center. Rural development schemes like NREGA, SGRY, NFFWP should be executed in a more organized manner. The real needy people should be identified and schemes should be executed with full sincerity and honesty. Govt. and panchayat officials have to rise above their self interests and then only all round development of the study area is possible. Self Help Groups should be given more support from the NGOs and Govt. They should encourage and train local people to prepare items like potato chips, chilli and other pickle, handicraft items made from bamboo, woolen garments etc.

8.3.2 Forest

Forest conservation methods like social forestry, agro-forestry, siliviculture, joint forest management should be made popular among the local people. People residing near the forest should be trained in such a way that they will take care of the forest as well as reap the benefits of the forest products. Livestock should be stable fed to control overgrazing. To ensure ample supply of fodder wastelands should be reclaimed and managed. It is essential to choose the fast growing and useful indigenous tree species to suit the agro-climatic zone in the study area. Vast tracts of degraded and wastelands should be used for sustainable forestry with selected tree species or combination of

species. Afforestation, accompanied by post afforestation management is very important. After afforestation, the newly planted seedling should be watered and saved from grazing animals. Local species are best suited for afforestation but in small patches new plants should be grown on an experimental basis. In this sphere also, available fund should be judiciously used. Forest Departments should have their own nurseries so that they spend less money for buying seedlings. Forest Departments should sale the products directly to the people by Govt. managed outlets, in major cities and towns.

8.3.3 Agriculture

Land is the main physical component on which agriculture is dependent. So, new technology like Computerization of Land Records (CLR), is the future need of the study area. GIS mapping technique should be applied to have proper maps and demarcation of land schemes. Strengthening of Revenue Administrative and Updating of Land Records (SRA & ULR) should be immediately implemented in the study area.

Though agriculture occupies very less share of the economy, even it is important for those who are practicing it. There is huge scope of agricultural development in the study area. Supply of mini-kits should be handed over to the farmers in distress. Unlike tea, cultivation of crops and vegetables should use chemical fertilizers along with organic fertilizers. This is expected to increase production to a considerable extent. Government should distribute agricultural inputs like HYV seeds, chemical fertilizers; pesticides etc. to the farmers and make them understand the benefits they can reap from multiple cropping. Since soil erosion is one of the major problems of the study area, cropping techniques, which help in soil conservation, should be adopted for sustainable development. Proper crop management is also necessary for the success of agriculture. Because of favourable climatic conditions, horticulture and floriculture are slowly gaining ground. Proper training programmes should be organized in the study area. According to Honourable Governor of West Bengal, the horticulture and

floriculture section of the University of North Bengal should be set up in the Darjeeling hills. Products of floriculture need to be transported to the markets as fast as possible. So development of fast transportation network is the most urgent need of the area. More emphasis should be given on fruit cultivation. Researches should be carried on to explore all possible avenues in the sphere of fruit cultivation. Fruits like apple, which are brought from other hilly states, should be grown in Darjeeling hills itself. If marketing strategies are properly formulated then in near future fruit cultivation will play an important role in the market by earning huge profits. Cultivation of cash crops like large cardamom and ginger should be done on a large scale. Proper marketing of such items can fetch more money. Livestock farming and animal husbandry by rearing locally adaptable varieties of cow, poultry, goat and pig can be encouraged. Animal husbandry can give promising returns if done properly. Milk chilling plant and dairy industry can be developed to utilize the animal husbandry products. Hides of different animals can also be used as raw material for small scale leather factory in the nearby areas.

Share of funds, allotted for the development of agriculture in the hills are extremely less, compared to the requirement. The methods of accessing fund or subsidy for agriculture is very difficult in the study area. Illiterate farmers are expected to submit projects, on the basis of which they are selected to receive the benefits given by the Government Agriculture Department. Because of this, only educated farmers or farmers with the help of middlemen can apply for such schemes. This process should be changed immediately and benefits should be provided to the needy ones. ATMA (Agricultural Technology Management Agency), a central Govt. funded project, implemented through Ramkrishna Misssion, is expected to cause total socio-economic development of the farming community. This project also aims at increasing production in the agricultural sector. West Bengal Farmer's Old Age Pension Scheme should be continued and more and more farmers should be brought under this scheme. Supply of mini-

kits should be handed over to the farmers, in distress. Unlike tea, cultivation of crops and vegetables should use chemical fertilizers along with organic fertilizers. This is expected to increase production to a considerable extent. All agricultural villages should be well connected to the main marketing centers via proper all weather roads. Storage facilities for agricultural products should also be there in the study area. The District Seed Farms should be involved in extensive research and development. The new initiative should be multi-agency extension strategies in farming system approach and farmer centric extension services. Scope of irrigation has to be increased. Crops like maize, which are rainfed and do not require much water should be grown in plenty as a measure to conserve water and at the same time continue earning. Old tea bushes should be removed @ 2.5% per annum. 'No tillage replantation' may be practiced. At the time of replanting, care should be taken to make a balance of high yielding and high quality clones and seed stocks. The concept of judicious blend of inorganic, organic and bio-fertilizer should be given importance in the study area. Introduction of bio-fertilizers like Azotobacter, Azospirillium, Bacillus megatherium can be useful because these can curtail the requirement of inorganic fertilizers without telling upon on the productivity. Aspect of vermiculture and compost should also gain more importance. Amount of pesticide residue in tea may be reduced by strengthening the acceptability pattern of the concept of Integrated Pest Management. Integration of the methods of chemical control, biological control, genetic control, use of plant extracts, insect growth regulators, sex pheromones, sterile male technique can produce good result in the study area and help in producing tea without residual toxicity. Shorter plucking rounds of 5-6 day duration can yield high quality tea. 'Small Tea Growers' Training Programme', organized by University of North Bengal, should be conducted in the study area. More stress should be given for shifting the Tea Management Institute of University of North Bengal, to the study area. This will encourage the local educated youth to be academically strong and knowledgeable and their employment

Photograph 8.1 Panoramic View of Tea Gardens

Photograph 8.2 Tea Garden in Mirik.

opportunities will increase. The 'premium tea of the world' called 'Champagne of Tea' is grown in the study area. Though the Darjeeling hill produces 10 million kgs of tea each year, in the world market 40 million kgs of tea is sold in this name. To stop this, immediate action like patenting of 'Darjeeling Tea' should be done. Tea cultivated by applying organic manure only, is gaining more importance and is also fetching higher prices in the market. Tea thus produced is known as organic tea. New ways of sustaining the economic viability of organic tea includes: development and standardization of improved packaging practices; training and guidance on social and environmental needs; diversification of additional income; making consumer aware of the medicinal properties of drinking organic tea; developing competitive market strategies and creating special markets.

Co-operative societies have to be encouraged for storing and purchasing of farm products. Marketing management need to be strengthened by evolving marketing department, transport department, both lending and storing of agricultural products. Proper financial and marketing strategies are important. NABARD is planning to directly finance different sectors in near future. Public Private Participation (PPP) means involvement of local farmers in identifying the problems of land resource and finding out the solutions. Watershed approach for the agricultural development with PPP will be encouraged. Watershed approach is an integrated effort of land development for effective soil and water conservation with a view to 'in-situ' utilization of rain water for crop production and animal husbandry. The practice of modern scientific methods of agriculture e.g. poly house or green house technology should be strengthened. Such arrangements might encourage the educated youth to take up agriculture as an occupation. Diversification of agriculture and allied sector can be done in the field of horticulture, olericulture, floriculture, cultivation of medicinal and aromatic plants, as the prevailing agro-climatic conditions are quite suitable. Regulated market with proper infrastructural and transport facilities should be implemented on an urgent basis. Food processing

units should be opened up to utilize the perishable items more efficiently and profitably. Livestock farming and animal husbandry by rearing locally adaptable varieties of cow, poultry, goat and pig can be encouraged. Problems like encroachment an agricultural and forest areas, mass movement of soil during monsoon, indiscriminate and haphazard disposal of solid waste from the construction sites, unplanned disposal of sewage and effluents etc. need immediate attention.

8.3.4 Tourism

T h e economy of the Darjeeling district depends on tea, tourism and timber. As tea has lots of scope for expansion, similarly tourism also has huge potentialities which are yet identified. Till date tourism is highly restricted to certain areas in the Balason basin. So there is need to decentralize the tourism activities and alternative tourist sites should be set up with adequate supply of the basic amenities. Eco-tourism which will provide both economic benefit and also conserve the natural resources should be taken up as the future project. Eco-tourism can be divided into:

i. Nature tourism
ii. Wildlife and Forest tourism
iii. Wilderness tourism
iv. Adventure tourism
v. Religious tourism
vi. Plantation Agriculture tourism and
vii. Alternative tourism.

Conducted tours to different tea gardens of the area will give huge pleasure to the tourists. But while implementing all these, measures should be taken to conserve the environment of the area, which is of prime importance for the development of sustainable tourism.

CONCLUSION

Since independence, under the different Five – Year Plans, Govt. of India has formulated different policies for the development of India. In the past years, many strategies were implemented along which few were partly successful and a few were not. The rural development programmes kept on changing to adjust to the present situations and mitigate the present crisis. Different developmental works are being executed but planning has to be more scientific and area specific. Strategies of sustainable development should be adopted for the future. Then only the study area will achieve on all round development.

CHAPTER IX

CONCLUSION

Balason watershed , in the Darjeeling district of West Bengal, is a basin drained by river Balason and ten major tributaries. All these rivers rise in the Himalayas and flow either southwards, southeastwards and southwestwards to reach the plain land. All the rivers flow through deep gorges as the terrain is mountainous. The hard gneissic rock in the northern part of the basin is resistant to erosion whereas southern part has comparatively softer rock, less resistant to erosion. The difference in elevation in the basin is very high with elevations ranging from 300m to 2300m. In few places the land is steep whereas in others it is rolling. The area of the basin is 229 km^2. Such vast area has rocks of Daling series and Darjeeling gneiss. In the southern part of the basin all the stratas of rocks are inclined towards the north at rather high angles. In the central part, the dips are rolling and irregular and towards the north the dips are southerly. This suggests that there is complete inversion of rock stratus due to the synclinal thrust of the Himalayan uplift. The rock layers are extremely folded and crumbled in many places making it loose and vulnerable. From Kurseong to Ghoom on the eastern side of the study area, the gneiss lies as a continuous belt. The presence of gneiss in the study area has a very profound effect on the other parameters having bearing on the soil and the development of drainage on such soils. The fast flowing mountainous rivers have easily cut their valleys on such rocks by the method of corrosion. Severe down cutting has resulted in the formation of 'V' shaped valleys. The homogeneous nature of rock has helped in the development of dendritic pattern of drainage all over the Balason basin. Where the rock is hard, the slope formation takes the shape of convex slope. In many cases knick points are present on the course of the rivers as a sign of upliftment. The Balason and its tributaries drain the tea gardens in the area. The land has steep slope

ranging from 15° to 30°. Medium sloping land is more in the area where land is sloping. Usually, high relative relief zones coincide with high steepness of slope, which indicates that the rivers in the basin are in their youthful stage with more erosive power. Climate of the basin have typical monsoon type of characteristics with temperature ranging from 7.8°C to 23°C. Incessant rainfall occurs in between June and September. During this time the surface run off causes maximum soil erosion in the watershed area. For the last few years snowfall is also causing severe problems to the crops but attracting tourists from different parts of the world and India itself. Humidity in the air is always high. Heavy rainfall accompanied by comparatively low average temperature causes podzolization and leaching in soil. Soil forming process is slow and in most places skeletal soil layers are farmed. Where the slopes are gentle mature soils are found and such places are ideal for tea plantations. The vegetation type is mainly dominated by humid temperate forests along with few scrubs. Though forests are getting highly degraded due to increase in the number of population and livestocks, they are the most valuable natural resource of the study area. Other than forests, human resource is the most important resource in the area.

The villages where people reside are mostly small to medium in size. In tea garden villages, people had scattered settlements to take advantage of the limited resources available in such areas. The khasmahals mainly developed as places of residence, are densely populated and few are congested due to smaller size. In such khasmahals people has to struggle for resources though its availability is adequate due to improved socio-economic conditions. Khasmahal like Sonada, has the highest population and Maujha Forest, the lowest. Whether population is high or low is not much important as the availability of all the basic amenities provided to them is important. The area being covered by tea gardens, it is the authorities of the tea gardens who are responsible to take care of the problems of the local people and providing them the basic amenities. Rural lifestyle

dominated by women and men both working in the tea gardens control the rate of socio-economic development of the area. Sex ratio is moderate with maximum villages having 1000 females per 1000 males. This is because, tea gardens employ more females than males. Among the SC's and ST's, SC's dominates the study area. ST's are mostly found in the Khasmahals where they are engaged in all sorts of non-farming activities. Literacy rate in the study area is high because in the vast forested areas, two persons out of three residents are literates. Since population less literacy is high. Males have a high rate of literacy than the females. Though free meals are attracting children to the schools but they are interested more about the meal and less about the education. Children are also engaged in works in the tea gardens. Literacy rate is increasing through the last three decades inspite of all these constraints in the educational system. Many schools do not have teachers and there is no inspection done by the authorities on a regular basis. Population density ranges from 332 persons / hectare in Sukhiapokhi to 1 person / hectare in the forested villages. The population distribution is very haphazard in pattern. The village of the basin has high positive growth of population which needs to be controlled for the proper planning and development of the study area. The percentage of cultivators and agricultural labourers are low compared to other workers. Other workers include people working in the tea gardens. The percentage of marginal workers in the study area is low because percentage of total main workers is very high. Since the tea gardens employ maximum permanent workers, marginal workers in the form of causal staff are less in the tea gardens. All these groups of workers are engaged in different activities like agriculture, forestry, tea garden labourers and other non - far activities.

Among the different land uses, unirrigated land covers maximum area. This indicates that both tea plantations and agriculture are rainfed. Forests occupy the second major share of land though its exploitation has led to its destruction and degradation. Culturable waste occupies the third position and there is lot of scope to utilize

these lands for sustainable economic development in future. Area not available for cultivation is being utilized to its optimum level whereas irrigated land is the least with no proper system of irrigation available in the area. The tea gardens are taken on lease from the Govt. for 99 years. All other lands are owned by the people themselves. Revenue system is prevalent and all land owners have to pay taxes. Alienation of land from Nepali farmers to plainsman is legally prohibited and the Govt. controlled the optimum size of holdings. Most of the farmers are owner cultivators. The incidence of rent was tolerable in the study area.

Except paddy all other crops are grown depending up on rain. Cropped area under cereal crops is the highest in the basin whereas production wise potato has the highest yield. Production in the tea gardens fluctuates every year. Among all the tea gardens, Gayabari shows a steady rise in production. Optimum utilization of land can only be possible if people have knowledge and experience in the same field.

Socio-economic condition of the people is in a deplorable condition with insufficient number of educational institutions present in the area. Though primary education is available in most of the villages yet middle schools, secondary schools and other schools are very few in numbers. Low participation of girls in educational institutions indicates that girls are still neglected in the society. Govt. funded free education is often threatened by private school because they teach in English medium which is in great demand in present day society. Medical services are inadequate in the study area. People have to travel 10kms to avail improved medical facilities. Villages where there are medical services do not have either doctors or medicines. Compounders and untrained nurses attend the patients in most cases. For serious cases patients have to be rushed to nearby hospital located in the towns. Transport system is also poorly developed with the prevalence of the more unmetalled roads which becomes dangerous during the monsoon months due to heavy rain. Undeveloped transportation system incurs economic loss not only to the farmers but also to the others because they have to purchase daily commodities at

high price. About 43% of the villages, those are located on the Hill Cart Road, have bus services while the rest depend on jeeps and cars. Very few villages have banking facilities. About 70% of the villagers have to travel more than 5kms to avail such facilities. Tea is the only industrial sector in the study area and lives of the local people are mainly dependent upon tea industry. Electricity still did not reach many of the remote villages. The supply of electricity is also irregular in the villages those are connected with electricity. All the tea gardens in the basin have their own generators to cope with the shortage of electricity supplied by WBSEB. Hydel power is the main source of electricity in the region. Electricity is not used in the agricultural sector at all. Drinking water is available in all the villages though its supply is insufficient during the lean season i.e. December to April. Other than tap water supplied by the Govt., people also fetches water from nearby springs. People of the basin lead a very merry life inspite of having less advantageous life. They entertain themselves by playing football, cricket; by organizing cultural rpogrammes; by gardening; by attending religious prayers by Sat Sangh, Satya Sai etc. People enjoy drinking local liquor and celebrate all local ceremonies and cultural functions with pomp and splendor. Though there is scope to develop tourism but tourism is not developed in the study area due to non availability of basic amenities. Only places around Mirik and Kurseong have gained some importance with respect to tourism.

The study area being situated in the hills with steep terrain, thin layer of soil, harsh climatic conditions, posses lot of problems. The most thought provoking problem is the erosion of top soil. Soil is an important natural resource and it supports life by growing tea and crops in the study area. Since soil is being eroded at a faster rate it is not only threatening the agrarian economy but also existence of life. Any type of fast flowing surface run off is causing severe soil loss in degraded forest areas, cultivated land, practicing faulty methods of cultivation like improper terracing, lands with thin layer of soil, areas with thin tea cover and land having improper method of disposing

excess water. Heavy monsoon rainfall causes all such problems. Landslides in the basin are quite frequent and cause maximum soil erosion. Landslides also affect life and property with immense loss of agricultural land. Overgrazing makes the soil loose and over settlements also exert pressure on the agricultural land and forest. Rugged topography, uneven distribution of rainfall and infertility of soil are the main causes for limited agricultural development in the study area. Fragmentation of land, lack of irrigation, poor economic condition of the farmers, less availability of credit all add to the existing situation of backwardness. Inadequate socio-economic facilities provided to the people, is in itself a major problem. Lack of education institutions, medical facilities, communication, transport etc. needs special attention.

Treating all the problems with scientific planning and methods will lead to more economic development of the Balason basin. Water management system like conservation of soil moisture, conjuctive use of both surface and ground water, peoples participation for recycling and reuse of water can bring havoc changes in all the sectors of development in the study area. Rain water harvesting is very important in the hills but storage tanks to store rainwater are not available. Water management in the tea gardens include proper shading by planting more trees in the gardens, mulching is done by straw in gardens which has young tea bushes. Among the soil water management systems different agronomic practices like planting cover crop, contour farming, intercropping with legumes, strip cropping would be beneficial. Grassed water ways, diversion drains, gully plugs, trained *jhoras*, retaining walls - all artificial ways of soil – water conservation must be maintained and repaired at regular intervals of time. Natural resource management including social forestry, farm forestry, joint forest management etc. should be practiced to a large extent by the people of the study area. Livestock rearing for the production of milk and meat can be done in the study area because it gives additional income and nutritious food to the people. Human resource management is also equally important

because it helps to raise the standard of life and awareness about self and regional development. This can be done by imparting true education to the people both academic and technical. Training is agricultural activities like horticulture, floriculture, is gaining ground over the last few years.

Development of an area can not be done without proper scientific planning and people's participation. Past strategies adopted for the development of the study area were partly successful. Rural development strategies like Community Development Programme, Employment Oriented Programme and Programmes for the development of Backward Classes were all implemented. But people were mostly unaware of the functioning of such projects. Past strategies for forest development were very stringent and did not allow people to share the benefits of forest which in turn forced them to exploit the forest illegally and lead to its further degradation. Social forestry was only successful on private lands, the commercial interest of tree growing being the prime motivator. The tea gardens were the most backward areas with illiterate people dominating the society. The tea garden owners exploited these people and provided them with less than what they deserve. Most of the machineries were old and those were not modernized due to financial and administrative constraints. To develop the entire agricultural and tea growing sector, help of Govt. and NGOs are essential.

Spread of education and awareness in recent years made the people of the study area comparatively conscious and they are gradually getting involved in all the developmental activities meant for them. Though, this percentage is very low. Rural developmental strategies like NREGA assures 100 days of guaranteed unskilled wage employment to each rural household opting for it. The focus of such programme is on works relating to water conservation, drought proofing (including afforestation), land development and rural connectivity in terms of all weather roads. Panchayat plays the key role in planning, implementing and monitoring of the scheme by preparing active plan,

approving self projects and executing works at least to the extent of 50% in terms of cost. Child development projects executes schemes like Integrated Child Development Scheme, under which Anganwadi centers take care of and assists, expecting and lactating mothers. Advice is given on practicing different measures of birth control. Children within the age group 0-6 years are given APL & BPL nutritious meal, once a day. In the agricultural sector farmers are provided with HYV seeds, pesticides at 50% subsidy under different agricultural programme. Training programmes to teach different new methods of cultivation are conducted by the village panchayats. Irrigation facilities, have improved than before but is inadequate. Under National Horticulture Mission, 50% subsidy is given for the cultivation of flowers like gladiolus, lilium, carnation, orchids etc. Farmers were supplied with plastic crates, sprayers etc. Aged farmers are given Rs. 500 per month under the West Bengal Farmers' Old Age Pension Scheme. In the tea gardens, their requirement is mostly fulfilled by the garden authorities. But presently panchayat system is introduced in the tea garden area so that they enjoy both the facilities provided by the tea gardens and the Govt. In the rural sector organizations like NABARD, World Bank is financing indirectly through the various commercial banks. Self help groups are formed to develop banking habits and financial self sufficiency among the people. For the construction of roads, houses and for starting different non farm activities, loan is sanctioned if projects showing high profit returns can be submitted to the Govt. All the above mentioned schemes which are running in the study area has few problems in common for which their implementation can not be done successfully and needy persons are not really getting the benefits. The fund flow for successful running of the schemes is extremely less. Many projects are shifting their funds to carry out other projects. There are many loopholes and defects in the plans. Above all the authorities have to be honest, sincere and less corrupted so that the plans can be successfully executed. For all these, new and less defective strategies need to implemented for the future.

Future strategies for the development of human resources in the study area are vital for the overall development of the Balason watershed. Educational institutions should be established in each and every rural area. All such institutes should have trained teachers who can impart education by teaching – doing – learning process. Education should be less bookish and more practical which the students will enjoy. High growth rate of population has to be checked by applying various methods of family planning. Street plays should be conducted to reach the masses easily and make them understand the benefit of having a small family. Smooth flow of Govt. and non Govt. funds and wise distribution of such funds can lead to proper functioning of any rural development project, implemented in the study area. Rural women should be encouraged to form Self Help Groups for generating employment. To conserve soil from getting eroded, conservation strategies like social forestry and joint forest management should be implemented. Afforestation along with post-afforestation management, to see that the planted seedlings can survive in the harsh natural environment, is more important. Forest Department should employ more local people to work in the forest. In agricultural land, various land management methods like proper maintenance of terraces, no activities on steep slopes, construction of rainwater disposal drains should be implemented. Govt. has to supply more HYV seeds, fertilizers, pesticides to the poor farmers. High priced cash crops should be introduced. Fruit cultivation should be done due to the presence of suitable agro-climatic condition, to raise the economic standard of the people. Training programmes for the cultivation of mushrooms, flowers, orchids and medicinal plants should be done extensively. Cultivation on high hills by constructing poly houses or green houses is becoming popular and such methods of cultivation should be adopted to increase production and earnings. Animal husbandry should be done by growing fodder in the wasteland. *Amlisho* should be grown for making brooms. Bamboos can be grown to start handicraft industry in the region. Organization like NABARD should more actively participate in financing

the rural development projects. In tea cultivation quality is more important than quantity, in the study area. Darjeeling tea being internationally famous needs to be produced without using any chemical fertilizers. More and more tea gardens should produce tea by applying organic fertilizers which can fetch exorbitant price in the world market. Tea industries should have modern energy saving machineries and should implement latest technology in tea production. Scientific packaging and publicity is also important to capture both local and international markets. Organic tea should be promoted as a health drink. Immediate patenting of 'Darjeeling Tea' is advisable. Tea research and management institutes should be opened in the study area so that local people can reap the advantage and get educated. This will open new avenues for employment for the locals in the managerial section rather than ordinary labourers. The tea garden authorities should take more care to develop the socio-economic conditions of the people by providing them with all the basic amenities needed to lead a standard life. The tea plantation workers should be judiciously used during the cold, dry months by engaging them in raising new tea plants, fuel tree, medicinal plants, which will add to the income of the tea gardens at no additional labour cost. In the tea gardens, preventive measure should be adopted to check soil erosion.

During monsoon, the Balason watershed is badly affected by landslide almost every year. Mostly these slides occur along the Hill Card Road and Pankhabari Road. These landslides lead to total destruction of roads and railway and traffic flow gets totally disrupted. During this time the price of all necessary commodities increases and it is beyond the buying capacity of the local people. To avoid such circumstances, proper disaster management measures should be implemented in the study area. Availability of bulldozers to remove the slide bedris from the road, rehabilitating the people who incurred great losses due to the slide, controlling price of the necessary commodities in the market so that poor people can survive and immediate engineering measures to stop further slide, should be the main disaster

management techniques which need to be implemented in times of need. Encroachment of settlements on the road and railway line should be stopped legally.

Balason watershed though under extreme pressure of population yet has lots of scope and potentialities for development if planning is formulated and executed properly. The region has high potentiality for the development of tourism. The economy of the hills of the Darjeeling district is largely dependent on tea, tourism and timber. Since Kurseong and Mirik are the only tourist centers in the study area, natural resource and environment is under excess pressure and threat in such areas. So tourism should be decentralized and alternative sites of natural beauty should be developed as tourist spots. Eco-tourism should be adopted where the benefits of tourism can percolate down to the village level and local communities. Eco-tourism conserves the environment and protects the ecology by spreading tourism to far away remote areas.

Since watershed is a manageable hydrological unit, integrated management of the watershed is the way to attain sustainable development of a region. Many plans were implemented but a micro level planning concerning the micro watershed can also be implemented. Thus, each and every part of the watershed can be taken care of, in the process of development, infrastructurally and economically. Though there are certain constraints in development in the hill area but it can be overcome considering the people and the potentialities of resources of the region. But the resources which are available in the study area are not properly utilized for the benefit of the people and development of the area. So, there must be an integrated plan in the area concerning the potentialities of rich natural and human resources. If all these are considered at the time of formulation of some development plans, the Balason Watershed may be one of the unique developed areas, in the state of West Bengal, in future.

BIBLIOGRAPHY

Banerjee, U. 1990: Forest and Forestry in West Bengal: Problems, Prospects, Experiences and Recent Trends; geographical Review of India, Vol 52, No. 3, 4-9.

Barshad, I. 1976: Chemistry of soil Development, Ed. F.E. Bear in Chemistry of the Soils, Oxford & IBH Publishing Co., 66, Janapath, New Delhi – 110001.

Basu, S.R. et al 2006: Landslides Scenario of the Darjeeling Himalayas in West Bengal, India; Geographical Review of India, Vol. 68, No. 2, 161-173.

Bennett, H.H. 1955: Elements of Soil Conservation, McGraw Hill Book Co.

Bhattacharya, K. 2005: Need of Small Hydro Power Development in West Bengal, Indian Journal of Landscape Systems and Ecological Studies, Vol. 28, No. 1, 48-57.

Bose, R. 2006: Economy in Water Management; The Assam Review and Tea News, July 2006, 18-20.

Census of India 1981: District Hand Book – Darjeeling District.

Census of India 1991: District Hand Book – Darjeeling District.

Census of India 2001: District Hand Book – Darjeeling District.

Chadha, S.K. (1989):- Environmental Hazards in Himalaya, Ed. S.K. Chadha in Environmental Holocaust in Himalaya, Ashish Publishing House, New Delhi.

Chakravarti, P.K. 1998: Changing Scenario of Recreation in Darjeeling – Sikkim Himalaya and Foot Hills, Geographical Review of India, Vol. 60 No. 4, 534-541.

Chattopadhhyay, S. 1995: Wasteland Development Policies in India: A Review; Geographical Review of India; Vol. 57 No. 3; 286-291.

Chorley, R.J. 1971: The Drainage Basin as the Fundamental Geomorphic Unit, Ed. R.J. Chorley in Introduction to Fluvial Processes, Metheun & Co., London.

Chow, V.T. 1964: Hand book of Applied Hydrology, McGraw Hill Book Co.

Clark, J.I. 1977: Population Geography, Pergamon Press Ltd. New York.

Das, P.K. et al 2007: Success of Harnessing of Non-Conventional and Renewable Energy in W.B.; Indian Journal of Power and River Valley Development, Jan – Feb 2007.

Das, S. 2006: Development of Tourism in Darjeeling Town: Some Issues, Geographical Review of India, Vol. 68 No. 4, 435-444.

De, S.K. 2007: A study of Water Resources of the Balason Basin of the Darjeeling Himalayas, India and Its Conservation; Indian Journal of Power and River Valley Development, Mar-Apr 2007, 122-129.

Dury, G.H. 1969: Relation of Morphometry to Run-off Frequency, Ed. R.J. Chorley in Introduction to Fluvial Processes, Methuen & Co., London.

FAO Cons. Guide, 1985: Watershed Management and Field Manual, 13/1, Vegetative and Soil Treatment Measures, FAO, Rome.

Friedrich, C.A. 1969: Fire on the Watersheds of the Nation, Ed. A. Stefferud in Water, Oxford & IBH Publishing Co., New Delhi.

Gerrard, A.J. 1991: Mountain Environments, CBS Publishers and Distributors, New Delhi.

Ghosh, B.N. 1985: Fundamentals of Population Geography, Sterling Publishers Pvt. Ltd., New Delhi.

Govt. of West Bengal 1959: Fourth Working Plan: 1954-55 to 1963-64, Kurseong Forest Division, Vol. I.

Govt. of West Bengal 1970: Tenth Working Plan: 1967-68 to 1976-77, Darjeeling Forest Division, Vol. I.

Govt. of West Bengal 1976: Fifth Working Plan: 1969-70 to 1988-89, Kurseong Forest Division, Vol. I.

Govt. of West Bengal 1981: West Bengal Gazetteer Unit, Darjeeling District, Centre for Studies in Social Sciences, Calcutta.

Govt. of West Bengal 1986: A Report on Integrated Development Project for Preservation of Ecosystem in Senchal Area, Hill Affairs Branch Secretariat.

Govt. of West Bengal 1994: Plantation Workers in West Bengal, Labour Gazetteer, Dept. of Labour, Special Issue.

Govt. West Bengal 1980: West Bengal District Gazetteers – Darjeeling, Govt. Press, Calcutta.

Hall, R.H. 1975: Occupations and Social Structures, Prentice-Hall Inc, Eaglewood Cliffs, New Jersey.

Hooja, R. 2006: Management of Water for Agriculture; Irrigation, Watersheds and Drainage; Rawat Publications.

Hooker, J.D. 1854: Himalayan Journals, 2 Volumes, London.

Hornbeck, J.W. et al 1984: Forest Hydrology and Watershed Management, Ed. K.F. Wegner in Forestry Handbook, John Wiley and Sons Inc.

Jackson, M.L. 1976: Chemical Composition of Soils, Ed. F. Bear in Chemistry of the Soils, Oxford and IBH Publishing Co., New Delhi.

Jana, M.M. & Patel, S. 1995: Soil and their characteristics in Upper Balason Catchment Area, Indian Journal of Landscape System and Ecological Studies, Vol. 20, No. 2.

Jana, M.M. 1988: Identification of Problems for Development in Agriculture: A case study in the Lower Silabati Basin, Indian Journal of Landscape System and Ecological Studies, Vol. II, No. 2, 168-172.

Jana, M.M. 1991: Ecology and Tea in Darjeeling Himalaya, The Geographical Thoughts (Ed), Vol-2, Dept of Geography and Applied Geography, North Bengal University.

Jana, M.M. 1992: Environmental Degradation and Developmental Strategies in India, Ashis Publication, New Delhi.

Jana, M.M. 1994a: Characteristics and Patterns of Soils in Darjeeling District in West Bengal, Perspective in Resource Management in Developing Countries, Ed. B. Thakur, Vol. V, Concept Publishing Co., New Delhi.

Jana, M.M. 1994b: Growth of Population and Its Characteristics in the Hill Areas and Plains of Darjeeling District, The Himalayan Environmental and Society, Ed. A.K. Pal et al, Vikas Publishing House, Pvt. Co., New Delhi.

Jana, M.M. 1995a: Soil Conservation in Darjeeling Himalayas Using Remote Sensing Techniques, Sustainable Reconstruction of High Lands and Head Water Regions, Ed. R. B. Singh et al, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Jana, M.M. 1995b: Flood Hazard Zonation Mapping Using Remote Sensing Techniques, Development Issues in Marginal Regions, Oxford & IBH Publishing Co., New Delhi.

Jana, M.M. 1996: Forest Resources in Darjeeling Himalayas: Need for Sustainable Development; North Eastern Geographer, Vol. 27, No. 1 & 2, 53-65.

Jana, M.M. 2000: Causes of Depletion of Forests and their Conservation in India; Indian Journal of Landscape Systems and Ecological Studies, Vol. 23, No. 1, 59-69.

Jana, M.M. et al 1997: Bank Erosion in River Balason: Its Nature, Cause and Impact; Indian Journal of Landscape System and Ecological Studies, Vol. 20, No. 1.

Kumar, S. 2007: Exploring Possibility of Bring Second Green Revolution in India: The Case of Wheat, August 2007, 71-74.

Langbein, W.B. et al 1975: General Introduction and Hydrological Definitions, Ed. A.R. Eschner et al in Readings in Forest Hydrology, MSS Information Corporation, New York.

Mallet, F.R. 1874: On the Geology and Mineral Resources of the Darjeeling District and the Western Duars, Memoir, G.S.I., II (I), 1-72.

Mallet, F.R. 1874: On the Geology and Mineral Resources of the Darjeeling District and the Western Duars, Memoir, G.S,.I., II (I) 1-72.

Mani, A. 1981: The Climate of the Himalaya, Ed. J.S. Lal in Himalaya-Aspect of change, India International Centre, New Delhi.

Nandi, P. et al 1999: Tourism and Environmental Degradation: Facts and Remedies, Geographical Review of India, Vol. 61 No. 1, 22-29.

Northam, R.M. 1979: Urban Geography, John Wiley and Sons, New York.

O'Malley, L.S.S. 1907: Bengal District Gazetteers, Darjeeling, Logos Press, New Delhi.

Oyebande, L. 1981: Sediment Transport and River Basin Management in Nigeria, Ed. R. Lal in Tropical Agriculture Hydrology, International Book Distributors, Dehradun.

Patel, S. 1996: Study of Soil Erosion Problems in Eastern Balason Catchment, Unpublished Ph.D Thesis, University of North Bengal.

Raghuraman, S. 1975: Hydrology and Its Contribution to Landslides with Special Reference to Problems in Sikkim, Ed. Indian Society of Engineering Geology in Landslides and Toe Erosion Problems with Special Reference to Himalayan Region.

Rai, M.S. 2006: Landslides Causes and Treatment in the Darjeeling Hills – A Case Study; The Indian Forester, Vol. 132, No. 9, 1146-1154.

Raistrick, A. 1943: Geology A Comprehensive Introduction, The English University Press, Bungay, Suffolk.

Ramkumar, R. 1986: Technical Demography, Wiley Eastern Ltd., New Delhi.

Rautela, P. 2000: Water Resources in the Himalayas: Harvesting, Tradition and Change; Concept Publishing Company, New Delhi.

Rohatgi, S. 2005: Delineation and Classification of Waste and Based on Satellite Imagery: A Case Study of Darjeeling Himalayas; Geographical Review of India, Vol. 67, No. 4, 372-387.

Saha, B.K. et al 1982: Detailed Soil and Land Use Survey of Priority Sub-Watersheds, Report No. AGRI-584, AISLUS, Ministry of Agriculture, Govt. of India, New Delhi.

Shahnawazul, I. et al. 2007: Need of a New Revolution in Agriculture, Agricultural Situation in India, August 2007.

Singh, A.K. 1985: Population and Settlement in U.P.: A Geographical Analysis, Inter India Publications, New Delhi.

Singh, G. et al 1990: Manual of Soil and Water Conservation Practices, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Singh, P. 2005: Role of NGOs for Sustainable Development of Rural Areas; Geographical Review of India, Vol. 62, No. 2, 171-176.

Singh, S. B. et al 2003 Forest Resources and Its Management A Case Study of MWDR, Nepal; Indian Journal of Landscape System and Ecological Studies, Vol. 26, No. 1, 48-58.

Singh, S.B. et al 2005: Integrated Watershed Management in a Hill Area of Uttaranchal; Indian Journal of Landscape System and Ecological Studies, Vol. 28, No. 1,33-9.

Smith, G.D. et al 1969: How Water Shaped the Face of Land, Ed. A. Stefferud in Water, Oxford & IBH Publishing Co., New Delhi.

Smith, T. L. 1948: Population Analysis, McGraw Hill Book Company, New York.

Starkel, L. 1972: The Role of Catastrophic Rainfall in the Shaping of Relief of the Lower Himalaya (Darjeeling Hill), Geographia Polonica 21, Warszawa, Poland.

Trewortha, G.T. 1972: A Geography of Population: World Patterns, John and Sons, Pregaman Press, New York.

Tuteja, U. 2007: Indian Agriculture: In Search of Second Green Revolution, Agricultural Situation in India, August 2007.

Varshney, R.S. 1977: Engineering Hydrology, Nem Chand and Brothers, Roorki, U.P.

Vink, A.P.A. 1975: Land Use in Advancing Agriculture, New York.

Wentworth, C.K. 1950 A Simplified Method of Determining the Average Slope of a Land Surface, American Journal of Science, Vol. 20, 184-194.

Yadav, Y.P. 1976: Effect of Land Use on Infiltration Characteristics, Agri. Engr., 18: 5-10.

Yadav, Y.P. et al 1982: Environmental Trends in Darjeeling Hills with Special Reference to Rainfall Pattern in Balason Catchment, Paper 1, ERS, FRI, Dehradun.

Zachar, D. 1984: Erosion and Other Destructive Phenomena, Ed. O. Riedl et al in Forest Amelioration, Elsevier Science Publishers, Amsterdam.

ABBREVIATIONS

^0C	Degree Centigrade
C.W.C.	Child Welfare Center
DGHC	Darjeeling Gorkha Hill Council
F. P. C.	Forest Protection Committee
ft	Feet
GIS	Geographical Information System
Govt.	Government
H. S.	Horizontal Scale
H.C.	Health Center
Ha.	Hectare
J.F.M.	Joint Forest Management
Kgs	Kilograms
km^2	Square Kilometer
KV	Kilo Volt
KW	Kilo Watt
Ltd.	Limited
m	Meter
M.C.W.	Maternity and Child Welfare Center
NABARA	National Bank for Agriculture and Rural Development
No.	Number
P.H.C.	Primary Health Center
P.H.S.	Primary Health Sub-center
P.O.	Post Office
P.T.O.	Post and Telegraph Office
P.W.D.	Public Work Department
qtl	Quintal
S.C.	Scheduled Casts
S.T.	Schedule Tribes
T. G.	Tea Garden
V. S.	Vertical Scale
WBSEB	West Bengal State Electricity Board

APPENDICES

Appendix - I
Name and Location Code of Different Villages of the Study Area

Census 2001 Police Station	Location Code	J.L.No	Name of Village
KURSEONG	1	1	Dayal Thong(D.R.)T.G.
	2	2	Maharani T.G.
	3	3	Edenvale T.G.
	4	4	Sepoy Dhura(D.R.)T.G.
	5	5	Kharia Busty
	6	6	Singel T.G.
	7	7	Montiviot T.G.
	8	8	Karbia T.G.
	9	10	Castleton T.G.
	10	11	Spring Side T.G.
	11	12	Ambootia T.G.
	12	13	Makai Bari T.G.
	13	14	Punkhabari
	14	15	Longview T.G.
	15	16	Jamadar Bhita Khasmahal
MIRIK	16	2	Bukim T.G. (Tharbu)
	17	3	Phuguri Forest
	18	5	Saurini Basti
	19	6	Mirik Khasmahal
	20	7	Marma T.G.
	21	8	Manjua Forest
	22	9	Singbulli T.G.
	23	10	Purba Phuguri T.G.
	24	12	New Fallodi T.G.(Ghyabari)
	25	13	Patong T.G.
	26	14	Panighata Manager's Bunglow
	27	15	Manjha Fst.(Pan.F.Rly)
JOREBUNGLOW	28	8	Ghoom Pahar Forest
	29	9	Pulung Dong Khasmahal
	30	10	Pulung Dong T.E.
	31	11	Pubong T.G.
	32	12	Pussimbong T.G.
	33	13	Jorebunglow
	34	17	Rang Bul
	35	18	Sonada Forest
	36	19	Hill Cart Road
	37	20	Sonada Khasmahal
	38	21	Kalej Valley T.G.
	39	22	Dooteria Forest
	40	23	Dooteria T.G.
	41	24	Rongmook Cedar T.G.
	42	25	Okas T.G.
	43	26	Moonda Kotee T.G.
	44	27	Ring Tong T.G. (Gunawar)
	45	28	Nahori T.G. (Balason)
	46	29	Ringtong T.G. (Margaret's Hope)
SUKHIAPOKHRI	47	2	Simana Basti
	48	3	Sukhiapokhri

49	4	Mim Nagri Range
50	5	Achhalal Hatta(Rongbong Basti)
51	6	Chamu T.G.
52	7	Soolbongs T.G.
53	8	Seyok T.G.
54	9	Gopal Dhara T.G.
55	10	Mangarjung T.G. (Nagri)
56	11	Sagmaru T.G. (Sungma)
57	12	Tarzum T.G.
58	13	Pokhribong Khasmahal
59	14	Samrik T.G. (Simripani)
60	15	Molatey T.G. (Aveneroge)
61	16	Dhajea T.G.
62	17	Nagri Farm T.G.
63	18	Dhajea Khasmahal

Appendix – II a
QUESTIONNAIRE FOR DATA COLLECTION (VILLAGE)

1. Village Profile:

Village	Rev. Block	C.D. Block	Nearest Town	Distance	Households

2. Population:

Area in km^2	Population	Male	Female	Density/km^2	Growth 91-01

3. Population Composition:

S.C.	S.T.	Others	Hindu	Buddhists	Christian	Muslims

4. Type of farmers:

Small	Marginal	Medium	Large	Very large

5. Occupation:

Cultivators	Agl. Labourers	Quarrying	Industry	Trade & Com.	Const.	Others
Male						
Female						
Total						

6. Land uses

Area under cultivation	
Area under non-agri.	
Cultivable waste	
Trees & Grasses	
Forests	
Permanent pasture	
Current fallow	
Others	
Total	
Net sown area	
Gross Sown area	
Cropping intensity	
Net Irri. Area (Rabi)	
Net Irri. area (Kharif)	

7. Types of Vegetation:

Trees	
Shrubs	
Scrubs	
Others	

8. Major Crops:

Crops	Area in ha	Production in qtl.	Yield in qtl/ha
Paddy			
Maize			
Fruits			
Vegetables			
Ginger			
Large Cardamom			
Mustards/Oil seeds			
Pulses			
Millets			
Others			

9. Cropping Pattern:

Rabi	Kharif	Single	Double	Multiple	Mixed

10. Mode of cultivation:

Traditional	Improved	Electricity	Ploughing	Irrigation

11. Nature of disasters:

Floods	Cyclones	Droughts	Soil erosion	Fog/Mist	Landslides	Others

12. Causes of soil erosion/Landslides:

Agriculture	Settlement	Population	Deforestation	Modernization

13. Disaster mitigation measures:

Landslide		
Soil erosion		
Pollution		
Floods		
Droughts		
Diseases		
Others		

14. Irrigation:

Name of crops	Crops irrigated	Sources of irrigation	Frequency of irrigation	Time of irrigation
Paddy				
Vegetables				
Large Cardamom				
Wheat				
Maize				
Pulses				
Potato				
Others				

15. Pesticides used:

Items	Amount in kg/ha	Cost per kg	Source supply
Pesticide			
Insecticide			
Traditional medicine			
Fungicide			
Others			

16. Amenities:

Type	Number	Distance in Km.	Student Population	Teacher Population
Primary School				
Secondary				
Sr. Secondary				
Health services				
Post/Telegraph				
Market				
Bank/Cr. Soc.				
Bus services				
Electricity				
Drinking Water				
Block Office				
VLW Services				
Sanitary				
Sewage				
Police station				

17. Livestocks:

Animals	Number	Local/HYV	Grazing places
Cow			
Sheep			
Goat			
Pig			
Others			

18. Environmental Degradation:

Deforestation	Population	Chemical Fertilizers	Pesticides	Vehicles	Water

19. Industries:

Name	Number	Private/Govt.	No. of workers	Production
Agricultural				
Cottage				
Carpet making				
Small scale				
Others				

20. Major resources:

Agricultural		
Forest		
Industrial		
Water		
Others		

21. Management of Resources:

Agricultural		
Forest		
Industrial		
Water		
Others		

22. Development plans:

Agricultural		
Industrial		
Economic		
Infrastructural		
Family Planning		
Others		

23. Amount of sanction and achievements during last plan periods:

Plan	Agl.	Industries	Developm.	Environ.	Health	Amenities

Appendix – II b
QUESTIONNAIRE FOR DATA COLLECTION (TEA GARDEN)

1. Name of the tea garden :
2. Police Station or Block :
2a. Year of establishment :
2b. Owner of the tea garden :
3. Area of Tea Garden :
4. Area under :

New tea	Old tea	Crop	Forest	Settlement	Adm. Block	Open space

5. Tea production (in kg.)

Green tea	Black tea	CTC		

6. Source of tea:

Own tea	Purchased tea

7. Types of tea:

	Green Tea	CTC	Black Tea
Production			

8. Amount of Expenditure:

Salary	Maintenance of factory	Maintenance of tea garden	Fertilizer	Irrigation	Nursery

9. Amount of income from production:

Leaf	Green tea	Black tea	CTC	Others

10. Yearly sale:
11. Mode of sale:

Direct	Middleman	Others

12. Distance of nearest auction centre:
13. Management:

Own	Guided by others

14. Factory : Present/Absent/If not:
15. Name of processing units :
16. Nature of processing units :
17. Machines used : Old / New / Modern.
18. Packing : Sent raw / Packed.
19. Import/Export :
20. Drainage within tea garden :
21. Irrigation :

Source	Area under irrigation	Frequency	Mode of irrigation

21a. Problems of Irrigation :
b.Months having water scarcity :
c.Does it affect production : Y/N
d.Can Govt. help? : Y/N If yes, how? :
22. Soil types :
23. Rate of Soil erosion :
24. Soil conservation techniques :
25. Types of Terrain : Flat / Terrace/Undulating.
26. Terrain management :
27. Weather Station : Present / Absent.

28. Tempt & Rainfall data :

29. No. of workers:

Managerial staff	Labourers	Planters	Pluckers	Others

30. Status of workers:

Local	Other states	Heired	Permanent	Male	Female

31. Type of payment :

32. Labour line:

No. of houses	Types of accommodation	Water supply	Electric supply	Sewerage	Drainage	Toilet	Bath

33. Road : Metalled/Unmetalled/ Length within the T.G.

34. Kitchen garden : Y/N

35. Supply of fuel:

Wood	Kerosene	L.P.G.	Paid or Free

36. Frequency of supply :

37. Marketing facilities : Weekly / If not, distance of the nearest market

38. Medical facilities : Weekly/ If not, distance of the nearest health centre.

39. Postal Services : Y/N

40. Telephone & Telegraph services: Y/N

41. Banking facilities : Y/N

42. If no bank, how they save money? :

43. Educational Institutions:

	Primary	Secondary	High Sc.	College	Special
Govt.					
Aided					
Private					
Co-ed					

44. Problems :

Water logging	Age of plant	Type of plucking	Weeding

Shade trees	Mulching	Fertilization	Landslide or landslip	Pesticides

Garbage dumping	Solid waste dumping	Sewerage dumping	Soil erosion	Type of safety tank

45. Govt. aid:

46. Mass awareness programmes:

Appendix – III a
Census Abstract 1991

Police Station	Sl.No.	J.L.No.	Name of Village	Area.Ha	Area sq.km.	Tot Pop_91
KURSEONG	1	1	Dayal Thong(D.R.)T.G.	283.28	2.83	1152
	2	2	Maharani T.G.	138.81	1.39	1897
	3	3	Edenvale T.G.	37.23	0.37	152
	4	4	Sepoy Dhura(D.R.)T.G.	165.11	1.65	605
	5	5	Kharia Busty	137.15	1.37	1137
	6	6	Singel T.G.	454.99	4.55	3879
	7	7	Montiviot T.G.	78.69	0.79	620
	8	8	Karbia T.G.	91.46	0.91	579
	9	10	Castleton T.G.	247.67	2.48	1425
	10	11	Spring Side T.G.	221.81	2.22	611
	11	12	Ambootia T.G.	1021.03	10.21	2280
	12	13	Makai Bari T.G.	612.08	6.12	1555
	13	14	Punkhabari	6.65	0.07	515
	14	15	Longview T.G.	1360.77	13.61	3993
	15	16	Jamadar Bhita Khasmahal	94.90	0.95	2057
MIRIK	16	2	Bukim T.G. (Tharbu)	1325.36	13.25	4059
	17	3	Phuguri Forest	195.87	1.96	0
	18	5	Saurini Basti	458.92	4.59	3811
	19	6	Mirik Khasmahal	812.62	8.13	3123
	20	7	Marma T.G.	629.70	6.30	2019
	21	8	Manjua Forest	663.69	6.64	0
	22	9	Singbulli T.G.	361.79	3.62	5899
	23	10	Purba Phuguri T.G.	93.89	0.94	1973
	24	12	New Fallodi T.G.(Ghyabari)	1052.19	10.52	3742
	25	13	Patong T.G.	608.25	6.08	2133
	26	14	Panighata Manager's Bunglow	26.91	0.27	0
	27	15	Manjha Fst.(Pan.F.Rly)	1570.71	15.71	0
JOREBUNGLOW	28	8	Ghoom Pahar Forest	1394.76	13.95	1004
	29	9	Pulung Dong Khasmahal	628.08	6.28	2179
	30	10	Pulung Dong T.E.	106.43	1.06	552
	31	11	Pubong T.G.	410.76	4.11	1425
	32	12	Pussimbong T.G.	559.69	5.60	1490
	33	13	Jorebunglow	305.94	3.06	534
	34	17	Rang Bul	435.45	4.35	3198
	35	18	Sonada Forest	249.69	2.50	0
	36	19	Hill Cart Road	71.63	0.72	2084
	37	20	Sonada Khasmahal	580.73	5.81	6967
	38	21	Kalej Valley T.G.	637.79	6.38	3134
	39	22	Dooteria Forest	507.89	5.08	0
	40	23	Dooteria T.G.	1182.91	11.83	4367
	41	24	Rongmook Cedar T.G.	714.28	7.14	4705
	42	25	Okas T.G.	221.36	2.21	1150
	43	26	Moonda Kotee T.G.	584.78	5.85	3762
	44	27	Ring Tong T.G. (Gunawar)	767.69	7.68	3242
	45	28	Nahori T.G. (Balason)	477.94	4.78	2283
	46	29	Ringtong T.G. (Margaret's Hope)	693.23	6.93	3675
SUKHIAPOKHRI	47	2	Simana Basti	4.45	0.04	482
	48	3	Sukhiapokhri	12.14	0.12	3376
	49	4	Mim Nagri Range	1332.24	13.32	1308
	50	5	Achhalal Hatta(Rongbong Basti)	650.33	6.50	2241

Sl.No. = L.C.Code - Location Code

51	6	Chamu T.G.	476.46	4.76	2066
52	7	Soolbongs T.G.	299.47	2.99	1992
53	8	Seyok T.G.	486.45	4.86	2161
54	9	Gopal Dhara T.G.	353.48	3.53	1818
55	10	Mangarjung T.G. (Nagri)	552.40	5.52	2413
56	11	Sagmaru T.G. (Sungma)	245.64	2.46	1526
57	12	Tarzum T.G.	229.05	2.29	1813
58	13	Pokhribong Khasmahal	269.93	2.70	2956
59	14	Samrik T.G. (Simripani)	452.04	4.52	1088
60	15	Molatey T.G. (Aveneroge)	318.08	3.18	2528
61	16	Dhajea T.G.	323.34	3.23	874
62	17	Nagri Farm T.G.	573.44	5.73	3574
63	18	Dhajea Khasmahal	135.57	1.36	2727
		Total	29997.07	299.97	129910

Census 1991

Sl.No.	J.L.No.	S.C. Pop	S.T. Pop	Literacy	T_ Worker	T_ Main Worker	T_Marg.Worker	T_Non Worker
1	1	97	19	591	279	279	0	873
2	2	308	2	1177	529	529	0	1368
3	3	0	5	101	50	50	0	102
4	4	2	10	326	228	228	0	377
5	5	16	0	688	577	564	13	560
6	6	434	91	2245	1144	1130	14	2735
7	7	94	24	332	188	188	0	432
8	8	17	0	325	177	177	0	402
9	10	193	25	786	466	466	0	959
10	11	9	0	284	215	215	0	396
11	12	58	4	1476	629	621	8	1651
12	13	146	4	583	713	713	0	842
13	14	34	7	295	119	119	0	396
14	15	576	117	1454	1663	1662	1	2330
15	16	287	39	611	880	879	1	1177
16	2	68	8	1942	1291	1264	27	2768
17	3	0	0	0	0	0	0	0
18	5	405	117	2508	1599	1598	1	2212
19	6	101	10	1595	1182	1095	87	1941
20	7	90	4	944	744	688	56	1275
21	8	0	0	0	0	0	0	0
22	9	253	677	3387	2132	2018	114	3767
23	10	235	14	1362	391	391	0	1582
24	12	179	0	1254	1280	1280	0	2462
25	13	110	57	987	475	742	3	1658
26	14	0	0	0	0	0	0	0
27	15	0	0	0	0	0	0	0
28	8	29	0	612	373	373	0	631
29	9	24	466	1126	1189	1127	62	990
30	10	0	0	195	227	227	0	325
31	11	61	10	726	669	638	31	756
32	12	49	7	690	364	364	0	1126
33	13	21	224	358	118	117	0	426
34	17	219	257	1943	1021	1021	1	2176
35	18	0	0	0	0	0	0	0
36	19	170	185	1474	627	625	2	1457

37	20	503	1757	4146	2296	2220	76	4671
38	21	176	22	1606	988	987	1	2146
39	22	0	0	0	0	0	0	0
40	23	159	130	1491	1192	1190	2	3175
41	24	396	20	2001	1843	1841	2	2862
42	25	144	0	534	446	446	0	704
43	26	129	48	1347	1630	1630	0	2132
44	27	86	35	1396	1112	1111	1	2130
45	28	164	4	1099	726	726	0	1557
46	29	183	66	1809	1101	1073	28	2574
47	2	21	150	299	125	123	2	357
48	3	414	739	2484	1013	952	61	2363
49	4	133	196	700	215	215	0	1093
50	5	88	310	1073	984	900	84	1257
51	6	2	0	736	930	930	0	1136
52	7	108	19	896	600	600	0	1392
53	8	176	52	1059	949	949	0	1212
54	9	159	6	669	506	506	0	1312
55	10	233	0	1221	790	790	0	1623
56	11	160	0	746	500	498	2	1026
57	12	271	0	918	572	568	4	1241
58	13	126	323	1470	682	597	85	2274
59	14	108	0	574	389	363	26	699
60	15	175	104	620	885	885	0	1643
61	16	34	0	366	282	282	0	592
62	17	172	94	1925	1089	1088	1	2485
63	18	247	250	1485	898	897	1	1829
		8852	6708	65047	44282	43755	797	85637

Appendix – III b
Census Abstract 2001

Police Station	Sl.No.	J.L.No	Name of Village	Area.Ha	Area sq.km.	Tot.Pop_01
KURSEONG	1	1	Dayal Thong(D.R.)T.G.	283.28	2.83	1170
	2	2	Maharani T.G.	138.81	1.39	974
	3	3	Edenvale T.G.	37.23	0.37	169
	4	4	Sepoy Dhura(D.R.)T.G.	165.11	1.65	582
	5	5	Kharia Busty	137.15	1.37	664
	6	6	Singel T.G.	454.99	4.55	2399
	7	7	Montiviot T.G.	78.69	0.79	756
	8	8	Karbia T.G.	91.46	0.91	886
	9	10	Castleton T.G.	247.67	2.48	958
	10	11	Spring Side T.G.	221.81	2.22	652
	11	12	Ambootia T.G.	1021.03	10.21	4240
	12	13	Makai Bari T.G.	612.08	6.12	1564
	13	14	Punkhabari	6.65	0.07	437
	14	15	Longview T.G.	1360.77	13.61	4558
	15	16	Jamadar Bhita Khasmahal	94.90	0.95	2129
MIRIK	16	2	Bukim T.G. (Tharbu)	1325.36	13.25	4334
	17	3	Phuguri Forest	195.87	1.96	69
	18	5	Saurini Basti	458.92	4.59	4008
	19	6	Mirik Khasmahal	812.62	8.13	3945
	20	7	Marma T.G.	629.70	6.30	2814
	21	8	Manjua Forest	663.69	6.64	141
	22	9	Singbulli T.G.	361.79	3.62	3116
	23	10	Purba Phuguri T.G.	93.89	0.94	1047
	24	12	New Fallodi T.G.(Ghyabari)	1052.19	10.52	4197
	25	13	Patong T.G.	608.25	6.08	2139
	26	14	Panighata Manager's Bunglow	26.91	0.27	197
	27	15	Manjha Fst.(Pan.F.Rly)	1570.71	15.71	29
JOREBUNGLOW	28	8	Ghoom Pahar Forest	1394.76	13.95	913
	29	9	Pulung Dong Khasmahal	628.08	6.28	2266
	30	10	Pulung Dong T.E.	106.43	1.06	508
	31	11	Pubong T.G.	410.76	4.11	1359
	32	12	Pussimbong T.G.	559.69	5.60	2509
	33	13	Jorebunglow	305.94	3.06	1363
	34	17	Rang Bul	435.45	4.35	3065
	35	18	Sonada Forest	249.69	2.50	141
	36	19	Hill Cart Road	71.63	0.72	1109
	37	20	Sonada Khasmahal	580.73	5.81	9030
	38	21	Kalej Valley T.G.	637.79	6.38	2428
	39	22	Dooteria Forest	507.89	5.08	251
	40	23	Dooteria T.G.	1182.91	11.83	4724
	41	24	Rongmook Cedar T.G.	714.28	7.14	4908
	42	25	Okas T.G.	221.36	2.21	1167
	43	26	Moonda Kotee T.G.	584.78	5.85	3389
	44	27	Ring Tong T.G. (Gunawar)	767.69	7.68	3341
	45	28	Nahori T.G. (Balason)	477.94	4.78	2232
	46	29	Ringtong T.G. (Margaret's Hope)	693.23	6.93	3167
SUKHIAPOKHRI	47	2	Simana Basti	4.45	0.04	330
	48	3	Sukhiapokhri	12.14	0.12	4031
	49	4	Mim Nagri Range	1332.24	13.32	1967
	50	5	Achhalal Hatta(Rongbong Basti)	650.33	6.50	2944

51	6	Chamu T.G.	476.46	4.76	2183
52	7	Soolbongs T.G.	299.47	2.99	1998
53	8	Seyok T.G.	486.45	4.86	2097
54	9	Gopal Dhara T.G.	353.48	3.53	1889
55	10	Mangarjung T.G. (Nagri)	552.40	5.52	4901
56	11	Sagmaru T.G. (Sungma)	245.64	2.46	2163
57	12	Tarzum T.G.	229.05	2.29	1894
58	13	Pokhribong Khasmahal	269.93	2.70	2870
59	14	Samrik T.G. (Simripani)	452.04	4.52	1652
60	15	Molatey T.G. (Aveneroge)	318.08	3.18	2107
61	16	Dhajea T.G.	323.34	3.23	1379
62	17	Nagri Farm T.G.	573.44	5.73	3609
63	18	Dhajea Khasmahal	135.57	1.36	1557
		Total	29997.07	299.97	135615

Sl.No.	J.L.No	S.C. Pop	S.T. Pop	Literacy	T_Worker	T_Main Worker	T_Marg Worker	T_Non Worker
1	1	90	26	652	420	356	64	750
2	2	94	20	726	265	253	12	709
3	3	2	8	125	55	47	8	114
4	4	2	0	424	187	174	13	395
5	5	45	4	503	265	167	98	399
6	6	209	22	1764	944	849	95	1455
7	7	126	20	555	268	195	73	488
8	8	35	0	629	290	242	48	596
9	10	152	2	504	354	338	16	604
10	11	45	0	385	217	23	194	435
11	12	383	11	2982	1579	1025	554	2661
12	13	165	0	912	741	664	77	823
13	14	0	2	322	132	112	20	305
14	15	624	504	2471	1944	1680	264	2614
15	16	225	144	1248	654	558	96	1475
16	2	76	30	2761	1489	1284	205	2845
17	3	0	0	27	23	2	21	46
18	5	383	67	2865	1368	969	399	2640
19	6	182	655	2662	1444	965	479	2501
20	7	106	3	1775	1261	1024	237	1553
21	8	0	6	87	76	62	14	65
22	9	370	11	2218	1192	828	364	1924
23	10	156	6	812	377	352	25	670
24	12	240	5	2844	1873	1180	693	2324
25	13	117	75	1342	862	588	274	1277
26	14	7	8	118	67	29	38	130
27	15	0	6	22	10	8	2	19
28	8	16	145	653	359	261	98	554
29	9	20	529	1504	948	754	194	1318
30	10	0	0	238	161	157	4	347
31	11	49	8	996	592	534	58	767
32	12	194	7	1718	876	786	90	1633
33	13	109	478	1107	416	326	90	947
34	17	208	306	2472	680	528	152	2385
35	18	0	85	89	36	34	2	105
36	19	121	106	854	293	282	11	816
37	20	532	1580	6596	2337	1855	482	6693
38	21	183	16	1459	1020	736	284	1408

39	22	25	42	195	69	50	19	182
40	23	278	198	3110	1515	1248	267	3209
41	24	385	52	2941	1951	1798	153	2957
42	25	110	0	838	396	383	13	771
43	26	89	26	2250	1357	1067	290	2032
44	27	204	24	2173	1135	859	276	2206
45	28	75	0	1343	762	682	80	1470
46	29	155	41	2173	1094	872	222	2073
47	2	10	89	235	115	101	14	215
48	3	271	708	3140	1201	1029	172	2830
49	4	72	258	1355	753	690	63	1214
50	5	134	317	2047	1288	705	583	1656
51	6	87	0	1549	779	579	200	1404
52	7	173	5	1316	711	551	160	1287
53	8	174	40	1366	682	601	81	1415
54	9	184	22	1217	644	568	76	1245
55	10	288	11	3191	1153	1121	32	3748
56	11	186	24	1540	626	618	8	1537
57	12	206	6	1334	508	508	0	1386
58	13	86	502	2234	885	464	421	1985
59	14	115	9	1178	845	506	339	807
60	15	58	116	1477	615	569	46	1492
61	16	2	0	918	432	400	32	947
62	17	137	99	2611	1117	1078	39	2492
63	18	101	292	1125	523	397	126	1034
		8871	7776	92277	47231	37671	9560	88384

Appendix – IV a
Land use pattern 1991

Sl.No.	J.L.No	Forest	Irri. Area	Un Irri Area	Cul.Waste	A_N_A Cul
1	1	0.00	0.00	2.31	0.12	0.40
2	2	0.00	0.00	0.88	0.23	0.28
3	3	0.00	0.00	0.24	0.00	0.13
4	4	0.14	0.00	0.82	0.18	0.52
5	5	0.00	0.30	0.75	0.04	0.28
6	6	0.81	0.00	3.04	0.00	0.71
7	7	0.00	0.00	0.57	0.02	0.20
8	8	0.00	0.00	0.70	0.02	0.19
9	10	0.00	0.00	1.42	0.41	0.65
10	11	0.00	0.00	1.48	0.06	0.68
11	12	2.41	2.31	3.65	1.10	0.74
12	13	0.00	1.42	3.84	0.05	0.81
13	14	0.00	0.00	0.02	0.00	0.04
14	15	1.03	2.35	6.05	0.71	3.48
15	16	0.00	0.00	0.59	0.04	0.32
16	2	1.21	0.00	10.93	0.04	1.07
17	3	0.96	0.00	0.51	0.19	0.30
18	5	0.12	0.61	3.24	0.06	0.56
19	6	0.00	1.62	5.11	0.38	1.01
20	7	2.43	0.00	2.83	0.23	0.81
21	8	3.10	0.00	2.23	0.40	0.91
22	9	0.00	0.00	3.62	0.00	0.00
23	10	0.00	0.00	0.94	0.00	0.00
24	12	0.00	0.00	10.52	0.00	0.00
25	13	0.00	0.00	6.08	0.00	0.00
26	14	0.00	0.00	0.15	0.00	0.12
27	15	10.11	0.00	3.28	2.32	0.01
28	8	6.48	1.01	3.64	2.38	0.43
29	9	0.30	2.50	1.50	1.00	0.48
30	10	0.00	0.00	0.50	0.40	0.16
31	11	0.90	0.00	1.20	1.50	0.50
32	12	0.36	0.00	4.50	0.40	0.32
33	13	0.30	0.28	0.53	1.74	0.20
34	17	1.15	0.75	2.75	0.20	0.64
35	18	0.00	0.00	0.00	0.00	0.00
36	19	0.00	0.00	0.18	0.15	0.38
37	20	0.35	1.10	2.36	1.15	0.85
38	21	0.60	0.91	2.96	0.86	1.04
39	22	1.18	0.00	1.20	1.50	1.20
40	23	2.02	0.91	5.20	2.37	1.34
41	24	0.00	0.00	5.40	0.97	0.77
42	25	0.00	0.00	1.39	0.11	0.71
43	26	0.20	1.90	3.10	0.36	0.29
44	27	0.77	0.00	3.85	2.03	1.03
45	28	0.35	0.45	1.65	1.26	1.07
46	29	0.00	0.00	4.35	2.27	0.31
47	2	0.00	0.00	0.01	0.01	0.02
48	3	0.00	0.00	0.00	0.00	0.12
49	4	7.09	0.00	3.63	1.58	1.03

50	5	0.08	2.51	1.86	1.67	0.38
51	6	0.00	0.40	2.84	0.17	1.35
52	7	0.00	0.00	1.81	0.84	0.34
53	8	0.00	0.00	3.31	0.73	0.83
54	9	0.00	0.82	1.00	0.17	1.56
55	10	0.10	0.10	4.69	0.23	0.41
56	11	0.04	0.00	1.74	0.36	0.30
57	12	0.16	0.00	1.96	0.08	0.10
58	13	0.40	1.21	0.40	0.40	0.27
59	14	1.21	0.00	2.61	0.50	0.20
60	15	0.01	0.00	1.57	1.00	0.60
61	16	0.40	0.40	1.81	0.11	0.51
62	17	1.57	0.80	2.86	0.14	0.36
63	18	0.00	0.51	0.40	0.22	0.22
		48.35	25.17	154.54	35.48	34.57

Appendix – IV b
Land use pattern 2001

Sl.No.	J.L.No.	Forest	Irri.Area	Un Irri. Area	Cul.Waste	A_N _A Cul
1	1	0.00	0.00	2.31	0.12	0.40
2	2	0.00	0.00	0.88	0.23	0.28
3	3	0.00	0.00	0.24	0.00	0.13
4	4	0.14	0.00	0.82	0.18	0.52
5	5	0.08	0.30	0.07	0.00	0.92
6	6	0.81	0.00	3.04	0.00	0.71
7	7	0.00	0.00	0.57	0.02	0.20
8	8	0.00	0.00	0.70	0.02	0.19
9	10	0.00	0.00	1.42	0.41	0.65
10	11	0.00	0.00	1.48	0.06	0.68
11	12	2.41	2.31	3.65	1.10	0.74
12	13	0.00	1.42	3.84	0.05	0.81
13	14	0.00	0.00	0.02	0.00	0.04
14	15	0.00	3.38	6.05	0.71	3.48
15	16	0.00	0.00	0.59	0.04	0.32
16	2	0.00	0.00	4.86	5.23	3.16
17	3	1.79	0.00	0.00	0.17	0.00
18	5	0.39	0.00	3.01	0.49	0.70
19	6	0.52	0.00	5.17	1.02	1.42
20	7	0.70	0.00	3.99	0.41	1.20
21	8	4.26	0.00	2.01	0.12	0.24
22	9	0.02	0.31	2.45	0.54	0.29
23	10	0.00	0.00	0.73	0.13	0.08
24	12	5.04	0.00	4.07	0.39	1.02
25	13	0.08	0.00	3.45	1.12	1.43
26	14	0.03	0.00	0.10	0.07	0.06
27	15	10.11	0.00	3.11	2.32	0.17
28	8	6.48	1.01	3.64	2.38	0.43
29	9	0.79	2.51	1.51	1.00	0.48
30	10	0.00	0.00	0.50	0.40	0.16
31	11	0.90	0.00	1.20	1.50	0.50
32	12	0.36	0.00	4.50	0.40	0.32
33	13	0.30	0.28	0.53	1.74	0.20
34	17	0.05	0.75	2.75	0.20	0.60
35	18	1.10	0.00	0.39	0.15	0.86
36	19	0.00	0.00	0.18	0.15	0.38
37	20	0.35	1.10	2.36	1.15	0.85
38	21	0.60	0.91	2.96	0.86	1.04
39	22	1.18	0.00	1.20	1.50	1.20
40	23	2.02	0.91	5.20	2.37	1.34
41	24	0.00	0.00	4.61	1.15	1.38
42	25	0.00	0.00	1.39	0.11	0.71
43	26	0.20	1.90	3.10	0.36	0.29
44	27	0.77	0.00	3.85	2.03	1.03
45	28	0.50	0.00	3.21	1.01	0.06
46	29	0.00	0.00	4.35	2.27	0.31
47	2	0.00	0.00	0.01	0.01	0.02
48	3	0.00	0.00	0.02	0.00	0.10
49	4	7.09	0.00	3.63	1.58	1.03
50	5	0.08	2.51	1.86	1.67	0.38
51	6	0.00	0.40	2.84	0.17	1.35
52	7	0.00	0.00	1.81	0.84	0.34

53	8	0.00	0.00	3.31	0.73	0.83
54	9	0.00	0.82	1.00	0.17	1.56
55	10	0.10	0.10	4.69	0.23	0.41
56	11	0.04	0.00	1.74	0.36	0.30
57	12	0.16	0.00	1.96	0.08	0.10
58	13	0.40	1.35	0.33	0.36	0.24
59	14	1.21	0.00	2.61	0.50	0.20
60	15	0.01	0.00	1.57	1.00	0.60
61	16	0.40	1.10	1.11	0.11	0.51
62	17	1.57	0.80	2.86	0.14	0.36
63	18	0.00	0.51	0.40	0.22	0.22
		53.05	24.68	137.82	43.86	40.56

Appendix – V
Area and production under different crops (2006)

	Name of crops	Cropped area in hectares	Crop Production in quintals/ha.
Cereal Crops	Paddy (Aman)	240	38
	Wheat	120	19
	Maize	2185	67
	Millets	280	10
	Total	2825	134
Non Cereal Crops	Potato (Summer)	500	150
	Potato (Winter)	195	90
	Vegetables(Summer)	271	80
	Vegetables(Winter)	33	95
	Mustard	60	6
	Pulses	45	12
	Soyabean	40	10
	Total	1144	443
Cash Crops	Ginger	370	110
	Cardamom	500	4
	Orange	660	135
	Total	1530	249