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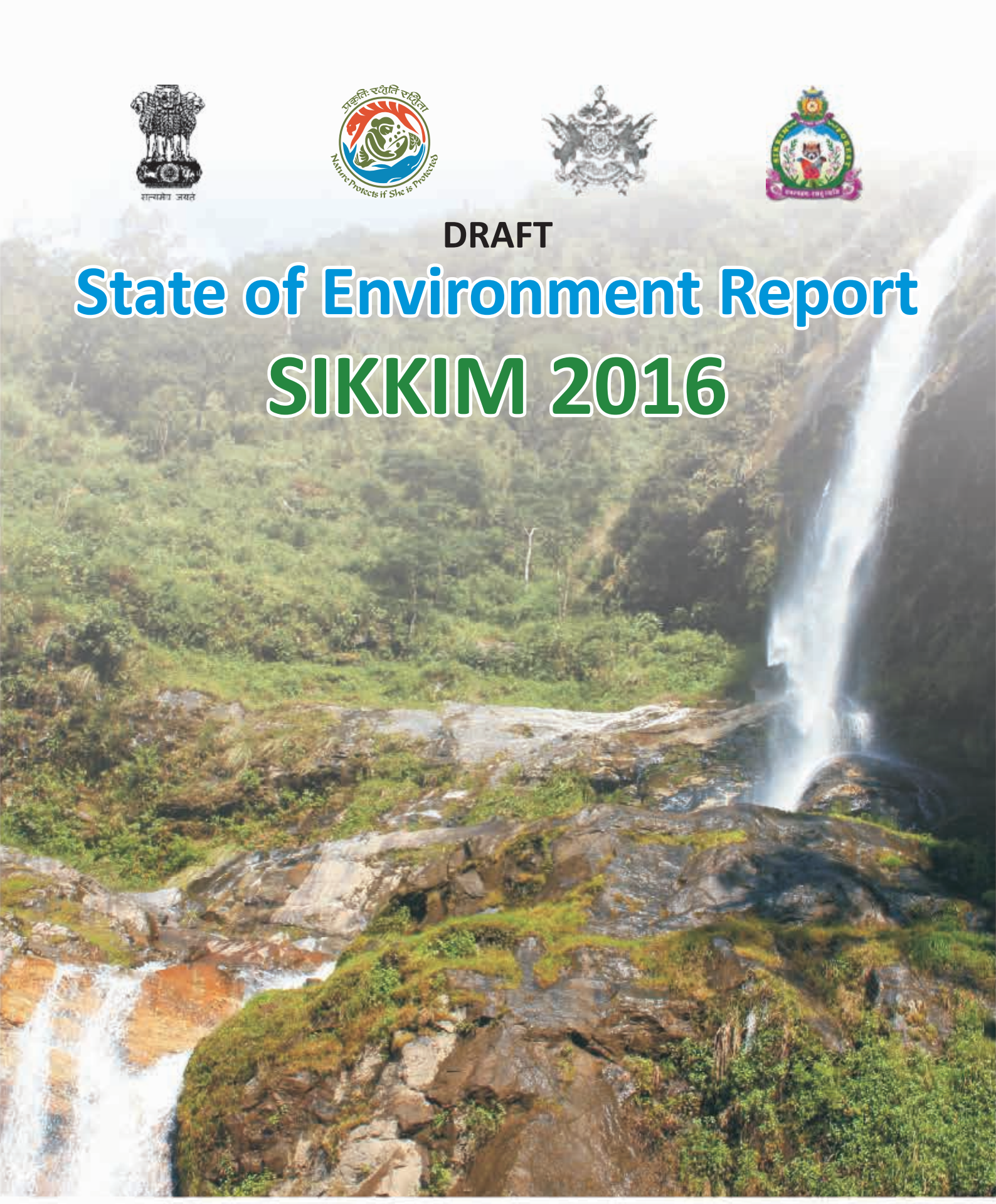
State of Environment Report

SIKKIM 2016



Environmental Information System
INDIA

Development Alternatives

State of Environment Report
Sikkim 2016

Environmental Information System
INDIA

Development Alternatives

Message from Honourable Chief Minister

Message from Honourable Minister of Forest

Rhododendron forest along Tholung – Kishong Trail

Foreword

Principal Secretary-PCCF

R. mekongense var. mekongense

Preface

ENVIS Coordinator

Acknowledgement

ENVIS SIKKIM, Sikkim Forest Department

Glossary of Terms

Agricultural Labourers: A person who works on another person's land for wages in cash or kind or share is regarded as an agricultural labourer. She or he has no risk in the cultivation, but merely works on another person's land for wages. An agricultural labourer has no right of lease or contract on land on which she/he works.

Biodiversity: Is the term given to the variety of life on Earth. It is the variety within and between all species of plants, animals and microorganisms and the ecosystems within which they live and interact.

Climate Change: A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.

Cultivator: A person is classified as cultivator if he or she is engaged in cultivation of land owned or held from Government or held from private persons or institutions for payment in money, kind or share. Cultivation includes effective supervision or direction in cultivation.

Debris: A debris is a moving mass of loose mud, sand, soil, rock, water and air that travels down a slope under the influence of gravity.

Sex Ratio: Is defined as the number of females per thousand males in the population. It is expressed as 'number of females per 1000 males'.

Soil: Is defined as the organic and inorganic materials on the surface of the Earth that provides the medium for plant growth.

Main Workers: Those workers who had worked for the major part of the reference period (i.e. 6 months or more) are termed as Main Workers.

Marginal Workers: Those workers who had not worked for the major part of the reference period (i.e. less than 6 months) are termed as Marginal Workers.

Moraine: A moraine is material left behind by a moving glacier. This material is usually soil and rock.

Non Workers: A person who did not at all work during the reference period.

Other Workers: All workers, i.e., those who have been engaged in some economic activity during the last one year, but are not cultivators or agricultural labourers or in Household Industry.

Work Participation Rate: Work participation rate is defined as the percentage of total workers (main and marginal) to total population.

Abbreviations

BOD	-	Biological Oxygen Demand
CES	-	Coverage Evaluation Survey
ENVIS	-	Environment Information System
ESI	-	Environmental Sustainable Index
FC	-	Faecal Coliform
FMP	-	Flood Management Programme
GLOF	-	Glacial Lake Outburst Flood
GSDP	-	Gross State Domestic Product
GSP	-	Green School Programme
IBAs	-	Important Bird Area's
IFMR	-	Institute of Financial Management and Research
IPCC	-	Inter Governmental Panel on Climate Change
IPM	-	Integrated Pest Management
JFMC	-	Joint Forest Management Committee
MGNREGA	-	Mahatma Gandhi National Rural Employment Act
MINRAS	-	Monitoring of National Aquatic Resources
MW	-	Megawatt
NIDM	-	National Institute of Disaster Management
NMSHE	-	The National Mission on Sustaining Himalayan Ecosystem
NO_2	-	Nitrogen Dioxide
NRDWP	-	National Rural Drinking Water Programme
ODF	-	Open Defecation Free
PES	-	Payment of Ecosystem Services
PM	-	Particulate Matter
PSIR	-	Pressure-State-Impact-Response
RKVY	-	Rashtriya Krishi Vikas Yojana
SAPCC	-	State Action Plans on Climate Change
SCCC	-	State Climate Change Cell
SDMP	-	State Disaster Management Plan
SMPM	-	State Medicinal Plant Board
SO_2	-	Sulphur dioxide
SPM	-	Suspended Particulate Matter
SSBB	-	Sikkim State Biodiversity Board
SSPCB	-	Sikkim State Pollution Control Board
TC	-	Total Coliform
WDC	-	Water Development Committees

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Disclaimer:
The photos used in the report are just placeholders and subject to change.
We acknowledge all the sources of photos used in this report.

Contents

Table of Contents

Executive Summary

The Sikkim State of the Environment Report-2016 is structured into four sections:

Section-I presents the Overview of the Sikkim in brief, with profile of Sikkim describing biophysical, social and economic aspect of the region/area.

Section-II presents the state of environment and trends and an analysis of four major themes (Air, Water, Land and Biodiversity). The state and trends have been analysed using the **Pressure-State-Impact-Response (PSIR) framework**.

The chapter on **Air** presents the state of air in Sikkim. It highlights the various steps that have been taken by the Government to make Sikkim a clean and green state.

The chapter on **Water** deals with various aspects of water resources of Sikkim. Glaciers, rivers and springs form the important component of the surface water resources of Sikkim. Despite fair amount of rainfall there is no water security in Sikkim. It is both affected by floods and droughts. There is a need to make interventions to stop surface run off. For proper planning and management of its water resources, Government of Sikkim has adopted a State Water Policy. Dhara Vikas is an initiative helping to alleviate the problem of rural water scarcity. Many initiatives of water harvesting, flood control and water storage by the Sikkim Government have gone a long way in meeting the water needs of the state.

The chapter on **Land** presents the status of land use and land management in Sikkim. The chapter dwells upon the myriad aspects of land use, including hurdles in the path of sustainability of agriculture, and occurrence natural calamities like earthquakes and landslides that culminate in land degradation. It also depicts the steps that initiatives that have been taken to mitigate soil erosion stemming from natural calamities.

The chapter on **Biodiversity** presents the current status of biodiversity in Sikkim. It throws light on pressures faced by biodiversity. The Government initiatives and programme implemented are also highlighted.

Section-III presents the Key Environmental Challenges pertaining to Sikkim. This section deals with urbanization and Climate Change as emerging challenge. It focuses upon the impacts of Climate Change and Urbanisation on environment of Sikkim.

Section-IV This section presents a number of appropriate alternative options or measures that the Sikkim Government could take to pave the path to attain the goal of Green Sikkim in a sustainable manner. To address Sikkim's environmental challenges, it is vital to focus on diverse options for discovering the possible solutions. This chapter highlights some of the critical issues pertaining to Sikkim's environment conservation initiatives, with the emphasis upon enhancing the collective responsibility of all the stakeholders for ensuring the environmental health of Sikkim.

Chapter 1: Overview

Sikkim is akin to a fairy tale land full of natural beauty, comprising the world's third highest mountain, Mt. Khangchendzonga, and a wealth of lush green forests and crystal clear rivers. This introductory chapter provides an overview of the history, demography, physiography, climate, biodiversity, economy, industry, agriculture, and the environmental initiatives of this heavenly state of India - Sikkim.

1.1. Introduction

Sikkim, a hilly State in the Eastern Himalayas, is one of the most beautiful States of India. It is lies between latitudes 27° 04' to 28° 07' N (North) and longitudes 88° 00' to 88° 55' E (East) and in physiographic zone of Eastern Himalayas. The State is sharing its boundary with vast stretches of Tibetan Plateau in the North, Chumbi Valley of Tibet and the kingdom of Bhutan in the East, Darjeeling district of West Bengal in the South and Nepal in the West. Total geographical area of the State is 7096 km^2. It extends to about 112 km from North to South and about 64 km from East to West. Sikkim has the world's third highest mountain, Mt. Khangchendzonga (8,596 m) located on the border of Sikkim and Nepal. The annual rainfall varies from 2700mm to 3200mm and the temperature in the State ranges from sub-zero during winter to 28°C during summer. (India S. o., 2015)

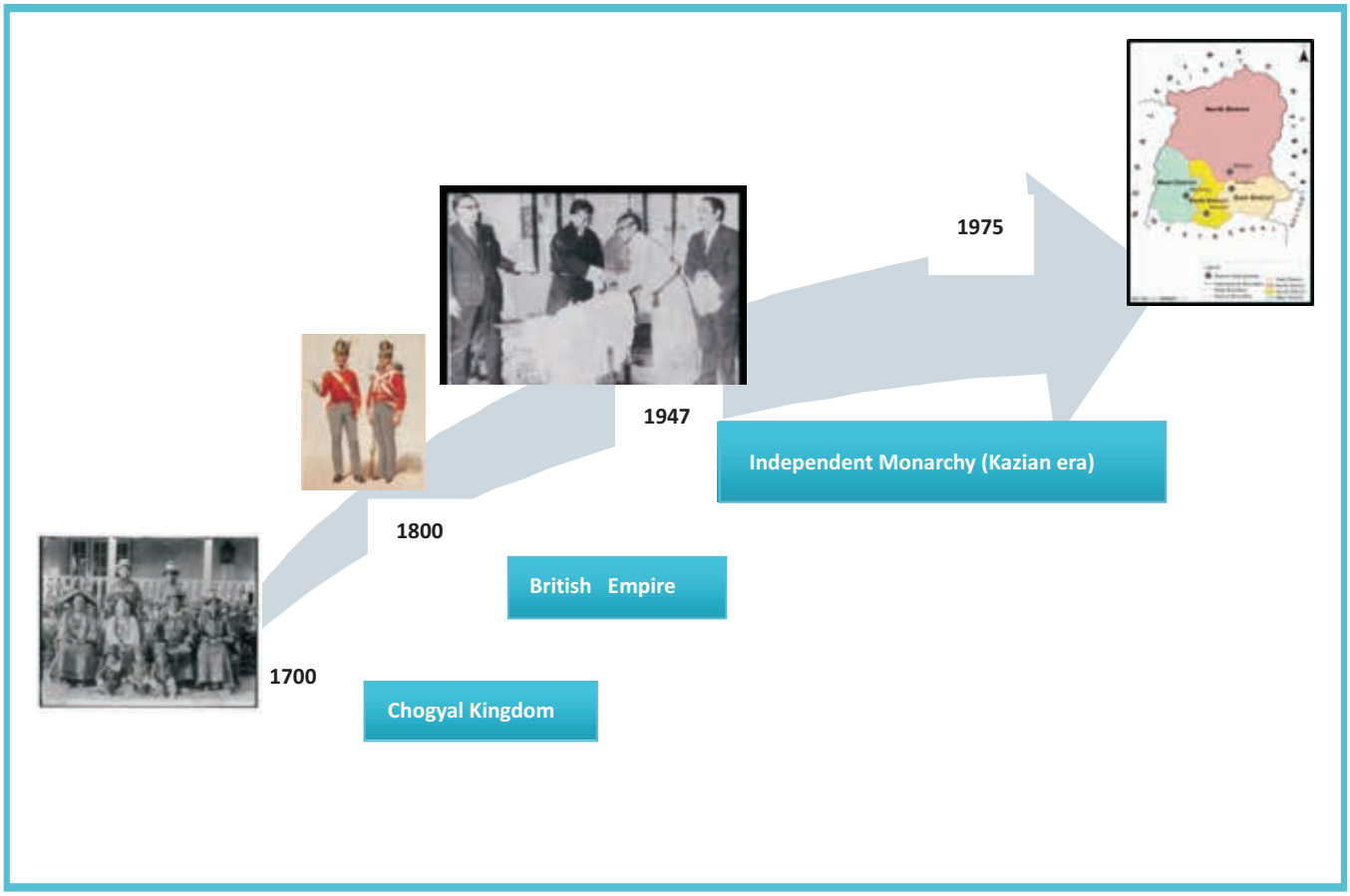
Map 1: Administrative Divisions

1.2. History

Till 1975, Sikkim along with Nepal and Bhutan was known as the Himalayan Kingdom. Its earliest known settlers, the Lepchas termed it as Neliang (the country of caverns which gave them shelter). Bhutias the Tibetan Migrants called it Iho'mon (the land of southern Himalayan slope). Being a major rice belt, it was called valley of rice.

The Shah rulers of Nepal invaded Sikkim from 1770 to 1810 and came to river Teesta. Upto the last 19th century, Chumbi valley was a part of Sikkim. Sikkim lost its foothills and Darjeeling hills in the south to British India from 1814 to 1816. After Passing of 38th Constitutional Amendment Bill on April 26, 1975 Sikkim became 22nd State of Indian Union. The flow chart below depicts the history of Sikkim. *(Sinha, 2015)*

Figure 1.1: History of Sikkim



1.3. Physiography

The State is enclosed on three sides by lofty mountain ranges of Greater Himalaya. The Singalila range stretches along the western boundary and separates the State from Nepal. The Donkya range forms the eastern boundary of Sikkim. The two trade routes between Sikkim and Tibet are Nathu La and Jelep La.

The crowning glory of the State is the world's third highest mountain - Mt. Khangchendzonga (8,596 m). It has five satellite peaks: Jano (7,710 m), Kabru (7,338m), Pandim (6,691 m), Narsing (5,825 m), and Siniolchu (6,888 m). The other important peaks are Rathong (6,087m), Simvo (6,811m) and Tolung (7,349 m). The northern portion of the State, particularly beyond Chungthang, is the highest region of the State. The region is sparsely populated with the Lachen and Lachung valleys being the only centres of human settlements.

Sikkim can be divided into following physiographic zones:

a. Lower hills: 300 m to 1800m
b. Upper hills: 1800m to 3000m
c. Alpine zone: 3000m to 4500 m
d. Snow land: 4500m and above

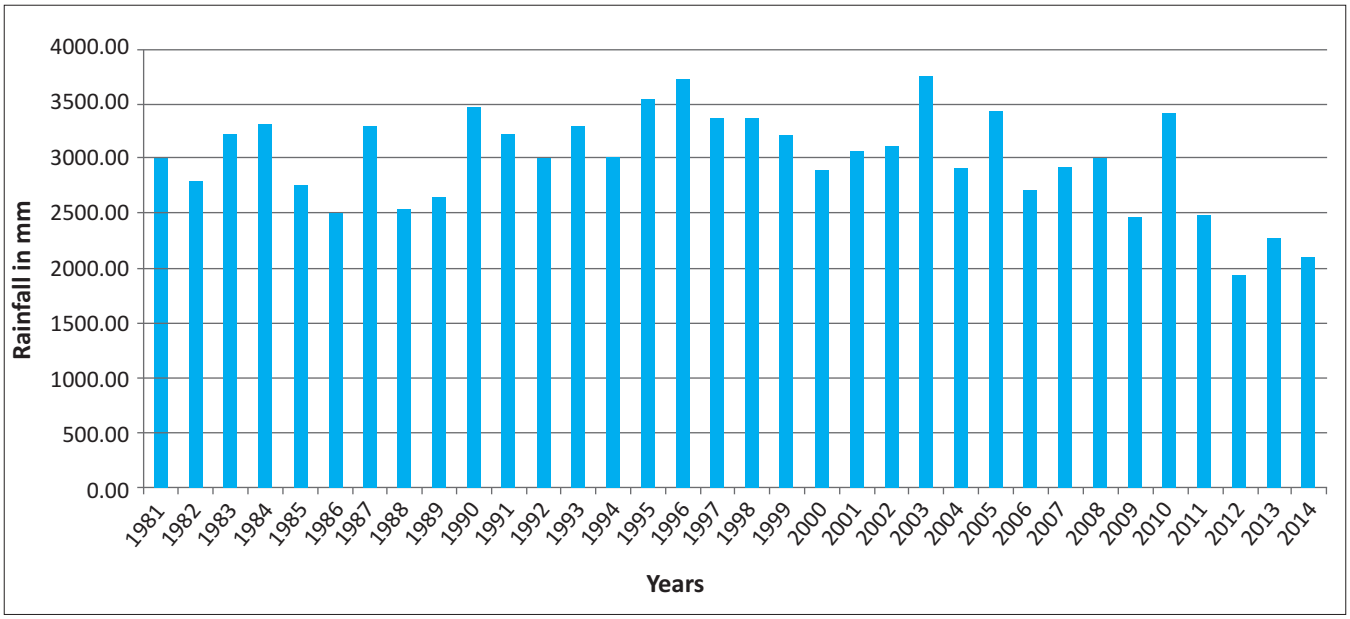
The general slope of the State is from north to south. However, the degree of slope varies from place to place. The slope in North district, except Teesta valley below Chungthang and in the north-eastern part of the East district, is 600m per km, towards south, in the Teesta valley bellow Chungthang and the area around Rabongla in the South district, the slope is between 300-600m per km. The rest part of the State consisting of the West District, southern portion of South District and extreme southwest part of North District have slope of 150m-300m per km. Glaciers are the important physiographic features of the State. They are mostly found in North district. The most important one is Zemu Glacier, which is 26 km in length and is situated at the base of Mt. Khangchendzonga.

1.4. Present Climatic Characteristics and Climate Change

Sikkim is the land of great climatic contrasts within very short distances. As per the location of the State the climatic regime is sub-tropical. But due to altitudinal variation across Sikkim majorly five climatic zones are found. Relief features such as high mountains act as barriers to the movement of the monsoon winds. Low temperature and high rainfall on the windward slopes, dry on the leeward side and heavy precipitation in the form of snow at the mountain tops are the main features of the climate.

The climatic diversity is not only due to difference in altitude but also configuration of mountain ranges from mere 300m to 8000m above mean sea level.

Figure 1.2: Rainfall Pattern in Sikkim



Source: sikenvis.nic.in/Database/Rainfall_4227.aspx

Sikkim has varied climatic zones. The State can be divided into four climatic zones:

a. Subtropical Humid Type
b. Semi Temperate Type
c. Temperate Type
d. Alpine Snow-Forest Type
e. Alpine Meadow

Sikkim has been observing a declining trend in rainfall. Rainfall patterns have become erratic; monsoons are usually late. Torrential rainfall has replaced the monsoon drizzle. This has resulted in high surface run off, dry period during winters. As a consequence of all this, there have been high incidences of forest fires and drying of springs. (Sikkim, 2012)

The winter, extends from November to March, is extremely cold and the minimum temperature in some places, particularly in north falls below the freezing point. The maximum temperature in winter is 14.9°C. The minimum temperature recorded is 7.70°C. Gangtok, the capital of the State shows higher range of temperature in winter. Gyalshing, which represents the west, is little bit warmer than Gangtok. On the contrary, summer is short, mild and pleasant and lasts from April to May but the heat is quite oppressive in deep valleys during this period. In summers the maximum temperatures are 20.7°C and minimum is 13.1°C. Variations are also observed in the pattern of rainfall. The state experiences monsoon from June to October, when it rains heavily. March witnesses the onset of thunderstorms and its frequency increases till the rainy season sets in around June.

1.5. Natural Resources

Sikkim is very rich in natural resources. It is home to nearly half of the nation's biodiversity. The State has wealth of one third of the country's flowering plants (Table 1.1). As many as 165 plants are named after Sikkim.

Table 1.1: Sikkim Biodiversity at a glance

Nature of Biodiversity	Number of species
Flora	
Flowering Plant	5500
Orchids	557
Rhododendrons	38
Conifers	16
Bamboos	28
Ferns and their allies	362
Tree Ferns	9
Primula	30
Oaks	11
Medicinal Plants	1681
Lichens	506
Magnolias	12
Trees and Tall Bamboos	717
Small Grasses	257
Bushes	112
Fauna	
Mammals	>144
Birds	568
Butterflies	689
Bees	30
Beetles	991
Fishes	48
Frogs	**16**
Lizards and Snakes	92
Reptiles	33
Amphibians	50

Source: ENVIS SIKKIM, 2015

The major soil types found in Sikkim are mountain meadow, brown, red, yellow and lateritic soil. In South District soils derived from sandstone phyllite, schisits gneisses and colluvial materials. Soils are generally acidic to very acidic in reaction having soil pH between 5.0 and 6.0. (Sikkim, Ground Water Information Booklet, 2013). Sikkim is part of the eastern Himalaya hotspot. Wide range of topography, varied climatic condition and high annual precipitation makes this region one of the richest physio-geographic regions of Himalaya.

The lowlands in the south, 800 feet to 5000 feet, experience a tropical climate. It has lush vegetation such as figs, laurel, Sal trees and bamboos. The temperate forest of oak, chestnut, maple, birch, alder, magnolia and silver fir dominates between 5000 feet and 13000 feet. Above 13000 feet is the alpine zone where juniper, cypresses and rhododendrons grow. The perpetual snowline lies at 16000 feet. Luxuriant forests cover 47% of the land; more than 5000 species of plant have been recorded in Sikkim. Over 550 species of orchids grow in Sikkim, epiphytal and terrestrial types, in the tropical and temperate zones.

Photo 1.1: State Flower (Nobile Orchid)

Photo 1.2: State Animal (Red Panda)

In spite of low accessibility, thick vegetation and soil cover, the State of Sikkim has a number of base metal occurrences. Most of the occurrences are in Daling Group of rocks in parts of West, South and East Districts of Sikkim. Base metal occurrences at Bhotang, Pachekhani and Dikchu have been explored. Water is a scarce and precious natural resource. The Teesta is the major river system in India though there are no lose metals, mines working currently. Among non-metallic minerals coal, graphite, dolomite, limestone, marble, wollastonite, talc, sillimanite and asbestos also occur. Dolomite deposits have been recognised and exploration has been caried out round Reshi by TATA Steel Ltd. A lease is yet to be granted.

1.6. Demography

The total population of the State is 6,10,577 *(Department of Economics S. a., 2015)*. In terms of population it holds the 29th position among the States and Union territories in the country. The decadal growth rate of population has shown sharp decline to 12.89% during the period 2001-11 from 33.06% during 1991-2001. The population is unevenly distributed with East Sikkim being densely populated and North Sikkim being sparsely populated.

Table 1.2 : Decadal Growth Rate

State/District	Population 2011	Percentage decadal growth	Density persons per square kilometres	
			2001	2011
SIKKIM	610,577	12.89%	76	86
North District	43,709	6.53%	10	10
West District	136,435	10.69%	106	117
South District	146,850	11.65%	175	196
East District	283,583	15.73%	257	297

Source: Census of India, 2011.

As per Census 2011, the population density of the state is 86 persons per square kilometre. The maximum concentration of population is in the East District i.e. 297 persons per square kilometre. The minimum concentration of population is in the North District, i.e, 10 persons per square kilometre due to the rugged terrain and topography (Table 1.2). There is an improvement in sex ratio of Sikkim from 875 in 2001 to 890 in the 2011, but this is still less than the national average of 940 (Table 1.3)

Table 1.3: Sex Ratio

Districts	1971	1981	1991	2001	2011
Sikkim	**863**	**835**	**878**	**875**	**890**
North District	853	789	828	752	767
West District	937	906	915	929	942
South District	909	854	892	927	915
East District	791	797	859	844	873

Source: Census of India, 2001; 2011

From the year 2001 the literacy rate has improved in Sikkim. As per Census 2011 the total literacy rate is 81.4%, with the male literacy rate being 86.60% and female literacy rate as 75.60%.

Table 1.4: Literacy rate

Districts	Literacy rate in percentage					
	Persons		Males		Females	
	2001	2011	2001	2011	2001	2011
Sikkim	**68.08**	**81.4**	**76.04**	**86.60**	**60.40**	**75.60**
North District	67.2	78	75.69	83.30	55.39	71.00
West District	58.8	77.4	66.82	83.50	50.11	70.90
South District	67.3	81.4	74.29	86.50	59.72	75.80
East District	74.7	83.9	81.20	88.50	66.80	88.50

Source: Census of India, 2001; 2011

1.7. Urban Development

Sikkim is a predominantly rural population State. Urban population accounts for nearly 25 percent (1, 53,578) of the total population (6, 10,577).

Table 1.5: Urbanisation Scenario

Year	Total Population	Urban	% of Urbanto Total
1951	137725	2744	1.99%
1961	162189	6848	4.22%
1971	209843	19668	9.37%
1981	316385	51084	16.15%
1991	406457	37006	9.10%
2001	540851	59870	11.07%
2011	610577	153578	25.15%

Source: Census of India, 2011

Urban development is not uniform throughout the State. The four districts of the State have nine urban centres in total. The East district is the most urbanized and accounts for nearly eighty percent of the total urban population. The primary reason for this may be attributed to the existence of National Highway-10 (NH-10) which runs through the district and connects the country to Nathula La pass, which is one of the major trade routes and an area of touristic interest for the country. Owing to this transportation connect, the east district has witnessed tremendous urban development.

Table 1.6: Urban Population

Districts	Total Area (in square km)	Total Urban Population (2011)
North	4226	4644
West	1166	5248
South	750	21199
East	954	122487

Source: Primary Census Abstract, 2011

As per Census 2011, the decadal growth has been pegged at 12.5% which is much below the national figures. However, the increase in urban population has been a whopping 156.52%; the factor of urban growth being attributed to the re-delineation of the municipal limits. The urban population as percentage of total population has increased from 11.07% in 2001 to 25.15% in 2011. The capital city Gangtok alone has a share of 65% of the total urban population of Sikkim *(Urban Development and Housing Department, 2016).*

As of Census 2011, only a single town belonged to class I with the population size of 100,000 and above. There is no town under classes of II and III with the population size of 50,000 to 99,999 and 20,000 to 49,999 respectively. Out of the nine towns, only one town i.e. Gangtok Municipal Corporation belongs to class I while (three) towns namely Namchi Municipal Council, Rangpo Nagar Panchayat and Nayabazar- Jorethang Municpal Corporation fall in class IV with the population size of 10,000 to 19,999. Jorethang Nagar Panchayat, Singtam Nagar Panchayat and Rhenock Census Town fall in class V with the population size of 5,000 to 9,999 while Mangan Nagar Panchayat, Gyalshing Nagar Panchayat and Naya bazaar Notified Bazaar Area fall in class VI with the population size of less than 5,000. The urban local bodies of Sikkim are detailed in Table 1.7.

Table 1.7: Urban centres in Sikkim

S.No	Name of The ULB	Status	Population
1	Gangtok Municipal Corporation	ULB	100286
2	Namchi Municipal Council	ULB	12190
3	Rangpo Nagar Panchayat	ULB	10450
4	Nayabazar-Jorethang Municipal Corporation	ULB	10244
5	Rhenock Census Town	CT	5883
6	Singtam Nagar Panchayat	ULB	5868
7	Mangan Nagar Panchayat	ULB	4644
8	Gyalshing Municipal Council	ULB	4013

*Source: Census 2011 *Gyalshing Nagar Panchayat has been upgraded to Gyalshing Municipal Council in 2015 ** The Jorethang Nagar Panchayat and Nayabazaar Notified Town Area have been combined to form the Nayabazaar-Jorethang Municipal Council in 2015*

Apart from the urban centres identified under the parameters of the Census Operations of India, the Urban Development and Housing Department has its jurisdiction over settlements called Bazaars. These are centres that do not qualify to be defined as urban centres as per the Census operation definition but are more than a hamlet. They are classified into Class II, III and marketing centres as per the economic importance of the bazaar.

Table 1.8: Status of Bazaars

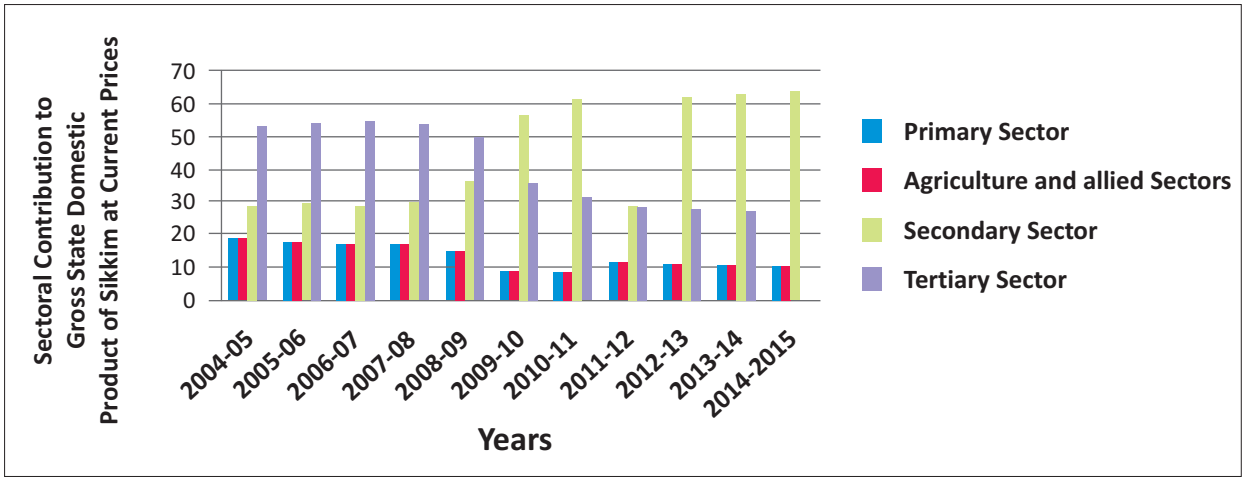
Bazars	East District	North District	South District	West District
Class I	01	-	-	-
Class II	06	01	04	04
Class III	09	04	08	13
Rural Marketing Centers	32	19	22	23

Source: Sikkim State Action Plan FY2015-2016 (http://amrut.gov.in/writereaddata/SikkimSAAP.pdf)

1.8. Economy

Sikkim's economy is primarily agrarian, though there are other sectors also like horticulture, tourism, mining, forestry, industries etc.

Figure 1.3: Sectoral Contribution to GSDP of Sikkim

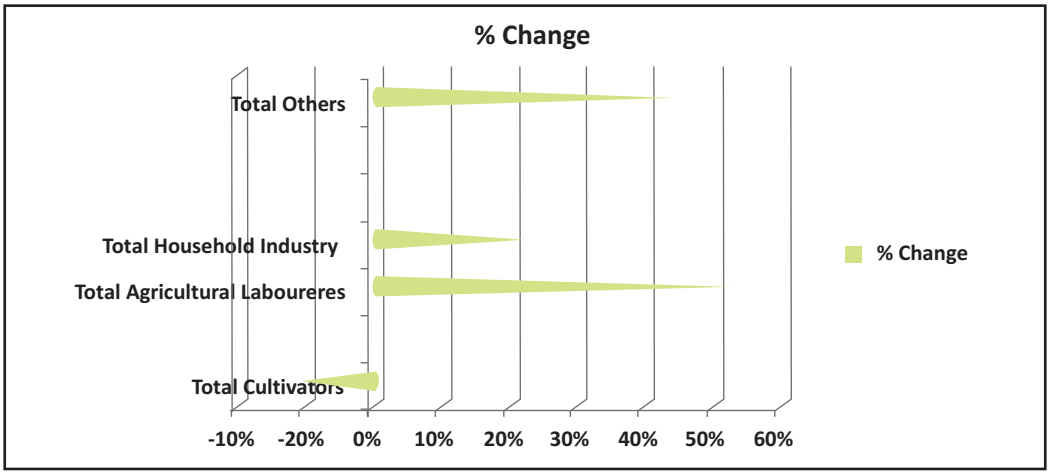


Source: Statistical Journal 2015, Department of Economics, Statistics, Monitoring and Evaluation Government of Sikkim

It is evident that the contribution to Sikkim's economy from agriculture and allied sectors has been on the decline, along with that from primary[1] and tertiary[2] sectors (Figure 1.4). There has been an increasing trend observed in the secondary sector[3]. Higher growth rate attained by the construction sector as well as electricity, gas and water supply was the reason of increase in the contribution from the secondary sector. Tertiary sector contribution was also on the decline since the hotels and restaurants grew at a slower rate *(Planning Commission, 2008)*. The female work participation rate in Sikkim is much higher than the national average *(India G. o., 2011)*. Sikkim reported the lowest percentage of population that is below the national poverty line, which is accounted as 8 per cent.

There is an increase of 17% in total workers population. A trend of 55% increase is clearly observed in the category of marginal workers. (Figure 1.4) The decreasing ratio of worker indicates the low level of economic diversification at the State level. There has been a decline in the total cultivator's population (Figure 1.4).

Figure 1.4: Percentage change in the Workers



Source: Human Development Report Sikkim, 2014

1. Primary Sector includes agriculture, forestry, fishing, mining and quarrying.
2. Tertiary sector include transport, communication, commerce, administration and other services.
3. Secondary sector include manufacturing, industry, building and construction work etc.

1.9. Tourism

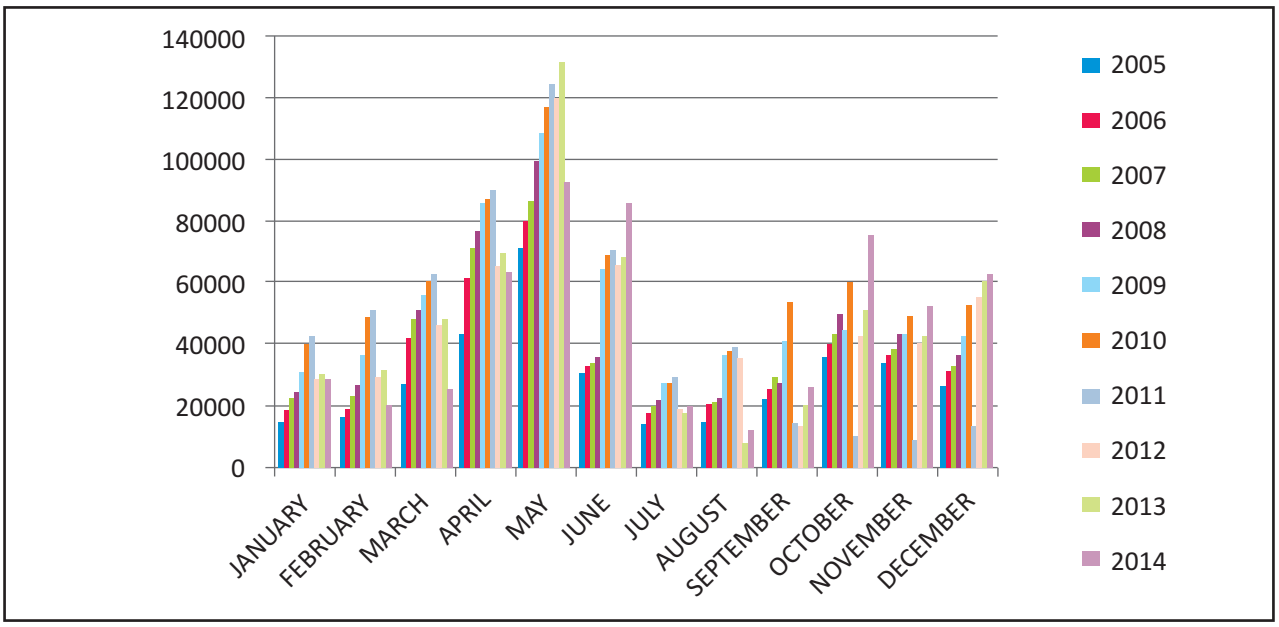
Sikkim with its beautiful landscape, rich biodiversity has tourism as one of the major contributors in the State's economy. The year 2010 has been declared as 'the year of tourism'. Sikkim is also been made the best region to visit in 2014 by Lonely Planet a leading global travel guide. Sikkim's Tourism Mission 2015 seeks to make tourism, the main livelihood of the people of Sikkim and each and every household and individual, a skilled force for the tourism Industry.

Table 1.9: Important Tourist Spots

East	West	North	South
Rumtek Monastery	Pelling	Kabi Lungechok	Namchi
Enchey Monastery	Singhshore Bridge	Phodong Monastery	Tedong Hill
Cottage Industry	Khecheopalri Lake	Lachung	Temi Tea Garden
Flower Show	Yuksom(Yuksom)	Yumthang	Maenam hill
Tibetology	Pamayangtse Monastery	Phensong Monastery	Phur Tsa Chu
Chorten	Sanga Cho ling Monastery	Chungthang	Rabongla
Saramsa garden	Dubdi Monastery	Singik	Jorethang
Hanuman Tok	Barsey	Lachen	Sadam-Tarey Bhir
Ganesh Tok	Rabdenste Palace Ruins	Gurudongmar	Bhleydungpa Yangang
Tashi view Point	Dzongri		Samdruptse
Tsomgo Lake			Chardham Solophok
Nathula			
Zaluk			
Aritar			
Ranka Tourist Village			

Source: ENVIS Sikkim, 2016

Figure: 1.5: Tourist Flow in Sikkim



Source: Tourism and Civil Aviation Department Sikkim, 2015

Table 1.10: Tourists Flow

S.No	Month	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	January	14245	17887	22286	24035	30395	40160	42314	28560	30292	28824
2	February	16100	18550	23465	26098	35883	48420	50652	29642	31278	19830
3	March	26100	41593	47465	51018	55965	60560	62438	45231	48102	24597
4	April	43702	61084	70684	76539	85669	87172	89238	65341	69054	63730
5	May	70744	80052	86448	99625	108778	116641	124323	120212	131804	92199
6	June	30480	32912	34025	35172	63905	68236	69784	65673	68205	85763
7	July	13760	17268	19462	22010	26992	27021	29540	18628	17161	19472
8	August	14382	20628	21428	22628	35826	37180	38964	35294	7713	11875
9	September	22738	25028	25295	26910	41285	53624	13943	12678	20115	25478
10	October	35396	39834	43218	49456	44865	59582	9682	42390	50461	75025
11	November	33480	35899	38215	43018	43720	48764	8326	39602	42836	53275
12	December	26523	31208	33213	35864	42345	52651	13249	55287	59728	62350
	Total	347650	421943	465204	512373	615628	700011	552453	558538	576749	562418

Source: Tourism and Civil Aviation Department Sikkim, 2015

The number of domestic tourists in Sikkim rose from 2005-2010. Sikkim attracted a record 7,00,011 tourists in 2010—which had been declared as 'the year of tourism'. The number of tourists dipped in 2011 due to a massive earthquake, but saw an increase in arrivals in 2012. The inflow of international tourists has been ever increasing since 2005 the inflow of domestic tourists increased by 61.77% from 2005 to 2014. The international tourists increased by 197.7% during the same time. Tourist arrivals have exceeded the population of the State. (Figure 1.10)

Khangchendzonga National Park

The park has been awarded the status of a mixed world heritage site on July 17, 2016 as it fulfils UNESCO's criteria for both cultural and natural heritage. It is also the first site in India to be granted the prestigious honour.

The park, situated in the North and West districts of Sikkim covers 25% of the state's total area. It is named after the world's third highest peak, Mt. Khangchendzonga at 8,586m above sea level. A number of lakes and glaciers grace the high altitude landscape in the park which supports a plethora of flora and fauna, many of which are endemic. The largest Himalayan predator, Snow Leopard is the flagship species of Khangchendzonga National Park (KNP) , which is given immense protection under India's national Wildlife (Protection) Act.

Tourism is estimated to contribute to around 8 per cent of the State GDP. Close to 2.9 million tourists visited Sikkim during the Eleventh Plan period between 2007 and 2012. This number is expected to rise to 5 million tourists during the Twelfth Plan period, between 2012 and 2017. (Tourism and Civil Aviation Department, 2014). Sikkim has been making a conscious effort to promote a variety of ecotourism activities. These include (i) activities in mountains such as trekking, bird and wildlife watching, hiking, photography, mountaineering, etc.; (ii) activities in rivers and lakes such as angling, rafting, etc. and (iii) participating in cultural and traditional events such as agro-tourism, handicraft making, fairs, festivals and Himalayan folkways.

Sikkim Ecotourism policy has also been framed during 2011. The vision of the policy is to establish Sikkim as an ultimate and unique eco-tourism destination, offering memorable and high quality learning experience to the visitors and contributing to poverty alleviation as well as promoting natural conservation. Simultaneously, the State has promoted ecotourism assets—natural and cultural features that attract visitors—such as landscapes, endemic or rare flora and fauna, local agricultural products, local culture and festivals, local folktales, history, historical monuments and heritage sights.

1.10. Industry

The State of Sikkim has been balancing both industrialisation and environment. Sikkim lags behind in industrial development. Sikkim has attracted considerable investments from pharmaceutical companies over the last five years. Tax incentives provided under the North-East Industrial and Investment Promotion Policy 2007 and additional incentives provided by the State Government have played an important role in attracting these investments. During 2007–10, the State attracted around 14 companies with a total investment of Rs. 25, 000 million. Sincere efforts are made to promote small scale and medium scale industries based on agriculture and forest products. Simultaneously, Government is making sincere efforts to promote traditional arts and crafts such as wood carving, cane bamboo work carpet weaving, thanka painting and traditional handlooms. In the year 2014-2015 industrial sector contributed to 61.28% to Gross Domestic Product of Sikkim. This sector has witnessed a growth of 32.44% from the year 2004-05.

1.11. Global Frameworks and Sikkim

Global frameworks are important for guiding the national and local action. It becomes relevant for a State like Sikkim to aim at the convergence of the below mentioned global frameworks.

1.11.1. Paris Agreement

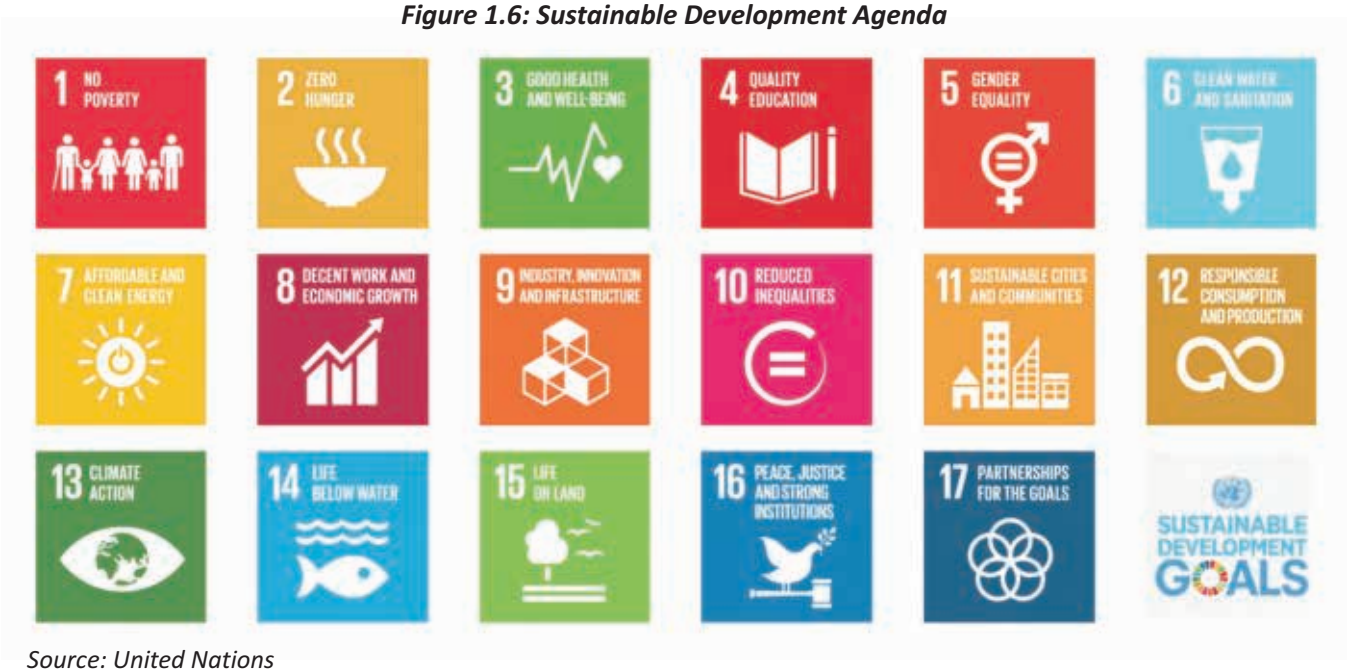
Paris Agreement (PA) provides for mitigation and adaptation measures with loss and damage as the third pillar. Sikkim SAPCC has prioritised adaptation over mitigation although most measures would have co-benefits from each other. The Sikkim SAPCC does not yet have any formal mechanism to address loss and damage arising from extreme and slow on-setting impacts. SAPCC is purely science base. Both at national and state level conceptual framework of SAPCC become important for climate planning.

Sectoral assumptions therefore are based on available observed data for selected regions as well as centrally sponsored model based studies not specific to Sikkim. It is very unclear how sectoral recommendations were arrived in the plan. One of the distinguishing features of Sikkim's Climate Plan as noted earlier, is that some actions have already being implemented using available funds.

1.11.2. Agenda 2030 Sustainable Development Goals (SDGs)

Linking climate change adaptation and DRR (Disaster Risk Reduction) with 17 SDGs is essential to strengthen the resilience agenda in Sikkim as there are several co-benefits. Though the state has been self-sufficient in maize and millet production, it has not fared well in other food crops which are essential for nutritional security. The state has been lagging behind in providing irrigation even with multiple dams constructed as only 11% of the total state agriculture land is under irrigation, whereas the Indian average stands at 35%. In all, 80% of the rural population of Sikkim depends on springs (for water) which are on decline due to various stresses including climate change. It will benefit the State on these and many other issues to integrate climate adaptation, SDGs and slow-onset disasters in the State's developmental planning and budgeting. The state would also need to focus majorly on goals 6, 7, 12, 13, 14 and 15; that address environmental protection (both land and water), clean water and energy access and climate change.

Figure 1.6: Sustainable Development Agenda



Source: United Nations

1.12. Environmental Initiatives and accomplishments of Sikkim

Sikkim has taken up many environmental initiatives to be a progressive State. The highlights of the initiatives are presented below in a yearly format:

1995

- The Government of Sikkim declared 1995-1996 as "Harit Kranti" year for greening Sikkim through people's participation and also adopted the ten-year period from 2000-2010 as "Harit Kranti Dashak".
- Felling of trees in Reserve Forests and export of timber outside the State was banned.

1996

- Incentives for eco-friendly, pollution–free, green industries under the State Industrial Policy, 1996.

1997

- Use of non-biodegradable materials like plastics, polythene bags and biomedical /chemical waste banned through legislation.
- Khangchendzonga National Park (KNP) extended from 850 to 1784 sq.km.

1998

- Sikkim Forests (Compounding of Offences) Rules, 1998 framed for speedy disposal of Forest offences and minimize forest offences.
- Participatory forest Management involving active people participation through Joint Forest Management Committee (JFMC) introduced.
- Cattle sheds in Barsey Rhododendron Sanctuary were removed after the ban on grazing.
- State Award "Raya Van Samraksham Evam Paryavaran Purashkar" instituted.
- Sikkim was found to be rated the highest in Forest Protection Index among all states of India. This was reported in Down to Earth magazine.

1999

- Smriti Vans (Memorial Forests) at Bulbuley above Gangtok established to take forest programmes to people's level. Smriti vans are at each Panchayat Unit.
- Sikkim Transit of Timber and other Forest Produce Rules, 1999 framed to regulate the transit of timber and curb illegal transportation of timber.

2000

- Khangchendzonga Biosphere Reserve with area 2619.92 sq.km declared.

- Total wildlife protected area reached 30.77% of total geographical area - one of the highest in the country.
- Sikkim Forests Cattle Trespass Rules, 2000 framed to control grazing.

2001

- Sacred peaks, caves, rocks, lakes, 'chorten' and hot springs notified; scaling of important peaks including Mt. Khangchendzonga (8598m) for mountaineering expeditions banned.
- Conservation of unique terrestrial and aquatic eco-system of wetlands/lakes started by prohibiting commercial activities to preserve the heritage and fragile ecology.
- Network of JFMC/EDCs and Watershed Development Committees (WDCs) created.
- State Biodiversity Park at Tedong, South Sikkim established.
- State Medicinal Plant Board (SMPB) set up to concretize action plan on medicinal Plants in the State.
- Ban on Chemical Fertilizers and Pesticides to save our fields from environmental pollution. Ban on Vulture killer NSAID Diclofenac through Government notification Sikkim became organic.
- Pangolakha Wildlife Sanctuary, East Sikkim declared.
- Herbal gardens prepared in different Panchayats.

2003

- Eleven Important Bird Areas (IBAs) in Sikkim identified and recognized by Government, the first of its kind in the country.
- Declaration in Legislative Assembly to transform Sikkim totally into an Organic state.
- State Biodiversity Strategy and Action Plan (SBSAP) prepared after detailed consultations. Sikkim State Biodiversity Board (SSBB) constituted.

2004

- Green indicators 2004, a report developed by a Noida-based group, found the Forest Protection Index of Sikkim to be the highest in the country.
- Project on 'Treatment on Landslides and Erosion control in West Sikkim' launched.

2005

- Sikkim Ecology Fund and Environment Cess Act, 2005 framed; one of the very unique Acts providing for levy of cess on industries, traders, consumers for using non- biodegradable materials.

2006

- Constitution of high Level Task Force (Environment Commission).
- Kitam Bird Sanctuary, South Sikkim declared.
- State Green Mission Launched.
- Wetland Conservation Programme formulated and six wetland complexes included in National Wetland Conservation Programme.
- State Environment Agency constituted to coordinate and implement activities relating to environment awareness, education and information in the State.
- The Sikkim Private and Other Non-Forest lands. Tree Felling Rules, 2006 framed to regulate felling of trees.
- The Sikkim forest (Allotment of areas for Quarrying of sand and Stone) Rules, 2006 framed to regulate quarrying.

2007

- Sikkim became one of the first States of India to constitute a State Council for Climate Change.
- National Bamboo Mission Launched.
- Sikkim became the first State in the country to constitute a high level team to study glaciers and alpine ecosystems.

2008

- Center for Development Finance (CDF) at the Institute For Financial Management and Research (IFMR) ranked Sikkim:
  a. First in Natural Resource Management
  b. First in Performance in Land Use
  c. Second best state in overall Environmental Sustainability Index
- Eco-Tourism Directorate created.
- Sustainable Forest Management Cell opened to develop practical methods, guidelines and strategies to apply ecosystem approach in Natural Resource Management.

2009

State again ranked highest by the Centre of Development Finance on ESI ranking in two categories.

a. Reducing pressure on the environment.

b. State's response to maintain their environment.

- Sikkim Government launched the "Ten Minutes to the Earth"
- Green School Programme (GSP) launched.
- Sling Dong Tinkitam Fairrieanum Conservation Reservation declared.

2010

- International Rhododendron Festival launched.
- Launched environment friendly eco-highways and green roads.
- With the objective of converting Sikkim into fully organic state within the targeted period as per HRD plan, Sikkim Organic Mission was launched on 15th August 2010.
- MoU signed For Sikkim Biodiversity Conservation and Forest Management Project to strengthen biodiversity conservation activities and forest managent capacity, to improve livelihoods of local people living inside or in forest fringes.

2011

- The state marks increase in forest cover from 45.97% in 2005 to 47.69% in 2011 as shown by satellite based forest assessment.
- Special management plans prepared for unique vegetation types like Rhododendrons.

2012

- Sikkim Ecotourism Policy launched to establish Sikkim as a beautiful and unique ecotourism destination.

2013

- 3,50,744 saplings planted during Paryavaran Mahotsav.

2014

- Mass cleanliness drives conducted in major towns like Gangtok, Namchi, Geyzing etc.
- Government imposed ban on manufacture, sale and use of all types of firecrackers within the state.
- KNP declared as one of the top 100 global green destinations.

2015

- Government imposed ban on burning of agricultural waste, leaves, litter, paper waste and garbage.
- Government notified an e-waste collection center at Gangtok Municipal Corporation.

1.13. Awards and Accomplishments in Forestry Environment and Wildlife

The table below indicates the awards and accomplishment of Forestry, Environment and Wildlife Department from the year 1999 to 2016.

Table 1.10: Awards and accomplishment in Forestry, Environment and Wildlife

S N	Year	Awards and Recognition
1.	1999	Shri Pawan Chamling, Chief Minister of Sikkim was adjudged the "Greenest" Chief Minister of India by Delhi-based Centre for Science and Environment (CSE).
2.	2006	India Today ranked Sikkim as 1st amongst twelve eastern states of India in overall performance during the 4th State of States Conclave at New Delhi.
3.	2008	Government Secondary School, Daramdin, West Sikkim was awarded the "Greenest" School of India in terms of water management under the Gobar Times Green Schools Programme by Centre for Science and Environment.
4.	2008	Environmental Sustainability Index (ESI) 2008 prepared by Chennai-based Centre for Development Finance (CDF) adjudged Sikkim as - 1st Rank/ BEST in Natural Resource Management - 1st Rank/ BEST in Reducing Pressure on Environment
5.	2008	Rashtirya Nirmal Gram Puraskar for Sikkim: In a glittering award giving ceremony, Sikkim earned the distinction of being the first State in the country to achieve 100 percent sanitation. The award including citation and a gold medal was given away by the president of India, Smt. Pratibha Patil to the Chief Minister of Sikkim, Shri Pawan Chamling.
6.	2009	ESI 2009 rated Sikkim as - 1st Rank/ BEST in Reducing Pressure on Environment - 1st Rank/ BEST in State's Response to Maintain Environment
7.	2010	CSE awarded three Sikkim Schools under Gobar Times Green Schools National Award 2010; - Govt. Sec. School, Reshi, West Sikkim (Top 10 of India) - Govt. Sec. School, Linkey, East Sikkim (Best Manager in Air) - Govt. Sec. School, Namcheybong, East Sikkim (Best Manager in Energy)
8.	2011	CSE awarded two Sikkim Schools under Gobar Times Green Schools National Award 2011; - Govt. Sec. School, Middle Camp, East Sikkim (Top 10 of India) - Govt. Sec. School, Lower Samdong, East Sikkim (Top 10 of India)
9.	2011	Organic Certification accredited by the National Programme for Organic Production (NPOP), India for wild harvest of products (Aconitum heterophyllum - tuber/root, Chiretta - whole plant, Seabuckthron - berries fruits, Seabuckthron - juice fruits) by Sikkim State Cooperative Supply and Marketing Federation Ltd.
10.	2012	ESI 2011 released by CDF on June 5, 2012 rated Sikkim as - Environmentally most sustainable States of India - Best in State's Policy Response

S N	Year	Awards and Recognition
11.	2012	CSE awarded three Sikkim Schools under Gobar Times Green Schools National Award 2012; - Govt. Sec. School, Dentam, West Sikkim (1st Rank) - Govt. Girls Sr. Sec. School, Deorali, East Sikkim (2nd Rank) - Govt. Sec. School, Tingley, South Sikkim (4th Rank)
12.	2013	CSE awarded two Sikkim Schools under Gobar Times Green Schools National Award 2013; - Govt. Sec. School, Penlong, East Sikkim (2nd Rank in New School Category) - Govt. Sec. School, Tingley, South Sikkim (2th Rank in Change maker category)
13.	2014	CSE awarded two Sikkim Schools under Gobar Times Green Schools National Award 2014; - Govt. Girls Sr. Sec. School, Namchi, South Sikkim (New School Category) - Govt. Sec. School, Lower Samdong, East Sikkim (Change makers category)
14.	2014	Khangchendzonga National Park declared as one of the top 100 global green destinations by a consortium of top global agencies working on environment and sustainable tourism.
15.	2014	ENVIS (Environmental Information System) Centre at Forest, Environment & Wildlife Management Department, Government of Sikkim was ranked 1st among 68 ENVIS Centres in India by the Ministry of Environment, Forests & Climate Change, Government of India.
16.	2015	Gangtok ranked among the top 10 cleanest cities in India and third among the State capitals according to the Swachh Bharat ranking done by the Union Urban development Ministry during August 2015.
17.	2015	Gangtok awarded as Cleanest Hill Station of the country by India Today Group at the Safaigiri Awards 2015.
18.	2016	Government Sr. Secondary School, Hee-Yangthang, West Sikkim awarded Paryavaran Mitra Puraskar for being one of the best two exemplar schools of the country for 2015 by the Centre for Environment Education, Ahmadabad on 11th January, 2016.
19.	2016	WIPRO, Bangalore awarded Government Secondary School, Bongten, West Sikkim as Best Earthian school amongst top 15 earthian schools of the country and also awarded TN Khoshoo Memorial Award on the basis of its project “Sustainability and Biodiversity”. The school was awarded certificate and cash prize of rupees one lakh during the awards function held on 5th February 2016 at Bangalore.
20.	2016	ENVIS (Environmental Information System) Centre at Forest, Environment & Wildlife Management Department, Government of Sikkim was awarded the Best State ENVIS Centre of the country by the Ministry of Environment, Forests & Climate Change, Government of India. The certificate has handed over by Shri Prakash Javadekar, Minister of State (Independent Charge) Environment, Forestand Climate Change during the inaugural function of National Evaluation workshop of ENVIS Centres held on 17th February 2016 at New Delhi.

S N	Year	Awards and Recognition
21.	2016	CSE awarded three Sikkim Schools under Gobar Times Green Schools National Award 2015; - Sonam Choda Lepcha Memorial Govt. Sec. School, Lingdong, Upper Dzongu North Sikkim (Rank 4) - Govt. Jr. High School, Mangzing, South Sikkim (Rank 8) - Govt. Girl's Sr. Sec. School, Geyzing, West Sikkim (First school to complete and submit audit report online) The green leaf trophies and certificates were presented on 23rd February 2016 at Stein Auditorium, India Habitat centre, New Delhi.
22.	2016	West District of Sikkim bagged the 'Cleanest District of India' award on the occasion of the 10th Civil Service Day awards ceremony in New Delhi held in April 2016.
23.	2016	Hon'ble Chief Minister of Sikkim ShriPawan Chamling received 'Certificate of Recognition' along with a cash prize of Rs. 5.0 lakh for making Gangtok the cleanest city in the North-East India from the Hon'ble Prime Minister of India Shri Narendra Modi at Shillong during May 2016. Hon'ble Chief Minister of Sikkim Shri Pawan Chamling also received 'Certificate of Recognition' for making Sikkim being recognized as the first open defecation free State in the North-East India.
24.	2016	The 40th World Heritage Committee on 17th July 2016 at Istanbul, Turkey has inscribed Khangchendzonga National Park of Sikkim, India as a UNESCO's World Heritage Site on 'Mixed' criteria recognizing the outstanding universal values for its both natural and cultural significance.
25.	2016	Sikkim declared as the first full-fledged Organic State of the country.
26.	2016	Khangchendzonga National Park, Sikkim listed amongst top 100 global sustainable destinations of 2016 by a consortium of top global agencies working on environment and sustainable tourism.
27.	2016	Gangtok, the capital town of Sikkim declared as the Cleanest Tourist Destination of the country by the Ministry of Tourism, Government of India

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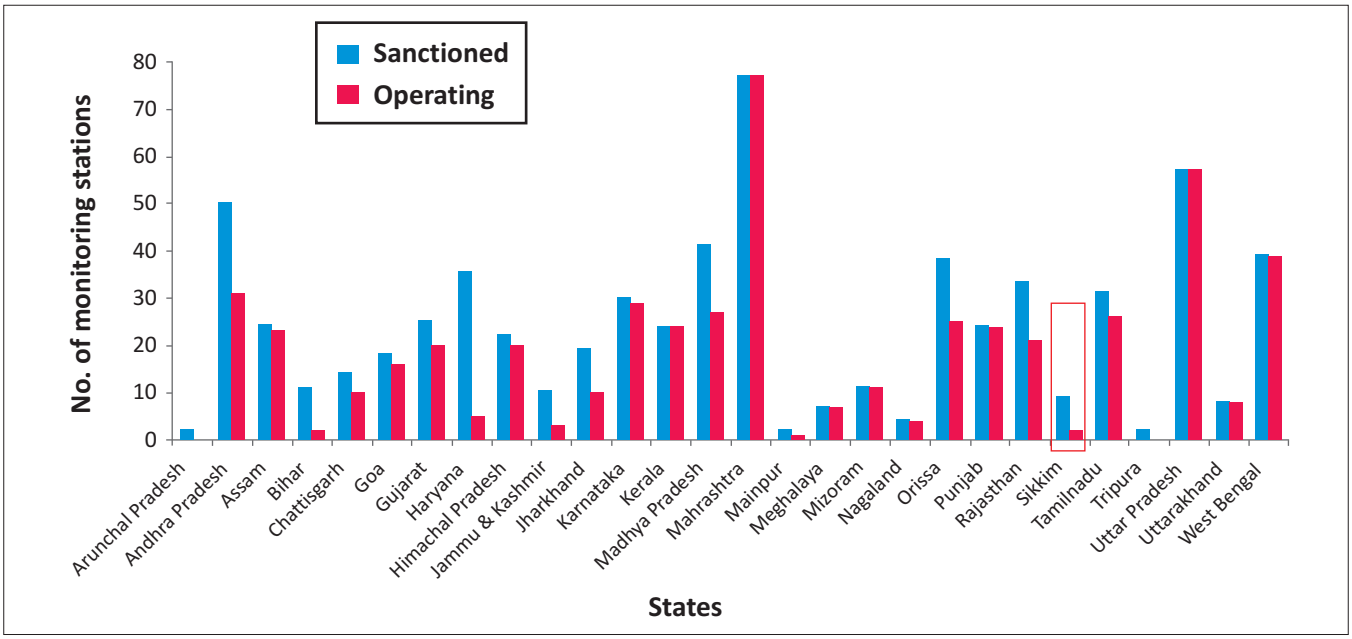
Section II of the report deals with the different emerging issues in Air, Water, Land and Biodiversity. These are further discussed in the section III of the Report. This section represents the existing conditions in Sikkim under PSIR (Pressure-State-Impact-Response) framework. It is presentation of most up to data and information on current environmental condition and trends. It also discusses the pressures leading to environmental changes in Sikkim along with the responses taken by the Government.

Chapter 2: Air

This chapter discusses the air environment of Sikkim. Gangtok is conferred Cleanest Tourist Destination by Union Ministry of Tourism. Sikkim has an air pollution free environment .The air environment of Sikkim is very clean due to initiatives taken by the Sikkim Government as ban on agriculture waste burning and banning of fire crackers.

The State of Sikkim with host of environment amelioration has emerged as the cleanest state. The state has also strengthened the traditional ethos of man-nature affinity of living together. Gangtok was conferred Cleanest Tourist Destination by Union Ministry of Tourism, Government of India. Clean air is essential requirement for human being. There are various sources both natural as well as man-made which are responsible for impairing the ambient air quality. The man-made pollution is chiefly the result of developmental activities whereas pollution from natural sources is inevitable.

Figure 2.1: Status of sanctioned versus operational air quality monitoring stations



Source: National Ambient Air Quality Status & Trends – 2012 published by Central Pollution Control Board, Ministry of Environment, Forests & Climate Change, August 2014

In the year 2014 the number of sanctioned air quality monitoring station in Sikkim is 2. The air quality of Sikkim lies within the permissible limits as per National Ambient Air Quality standards on the parameters of Sulphur dioxide and Nitrogen dioxide (Table 2.1)

Table 2.1: Revised National Ambient Air Quality Standards

S. No.	Pollutants	Time Weighted Average	Concentration in Ambient Air	
			Industrial, Residential, Rural and Other Areas	Ecologically Sensitive Area (Notified by Central Government)
1	Sulphur Dioxide (SO_2) µg/m^3	Annual 24 Hours	50 80	20 80
2	Nitrogen Dioxide (No_2) µg/m^3	Annual 24 Hours	40 80	30 80
3	Particulate Matter (Size < 10µm) or PM_{10}µg/m^3	Annual 24 Hours	60 100	60 100
4	Particulate Matter (Size < 2.5µm) or $PM_{2.5}$µg/m^3	Annual 24 Hours	40 60	40 60

Source: CPCB, 2014

The high amount of particulate matter is found in air of Sikkim due to natural factors as well as anthropogenic factors. The natural factors are disasters occurring in Sikkim. The anthropogenic factors are vehicular emissions etc.

The concentration of Particulate matter (94 microgram per cubic metre) is considered it is much above permissible limit (60 microgram per cubic metre) (CPCB, 2014)

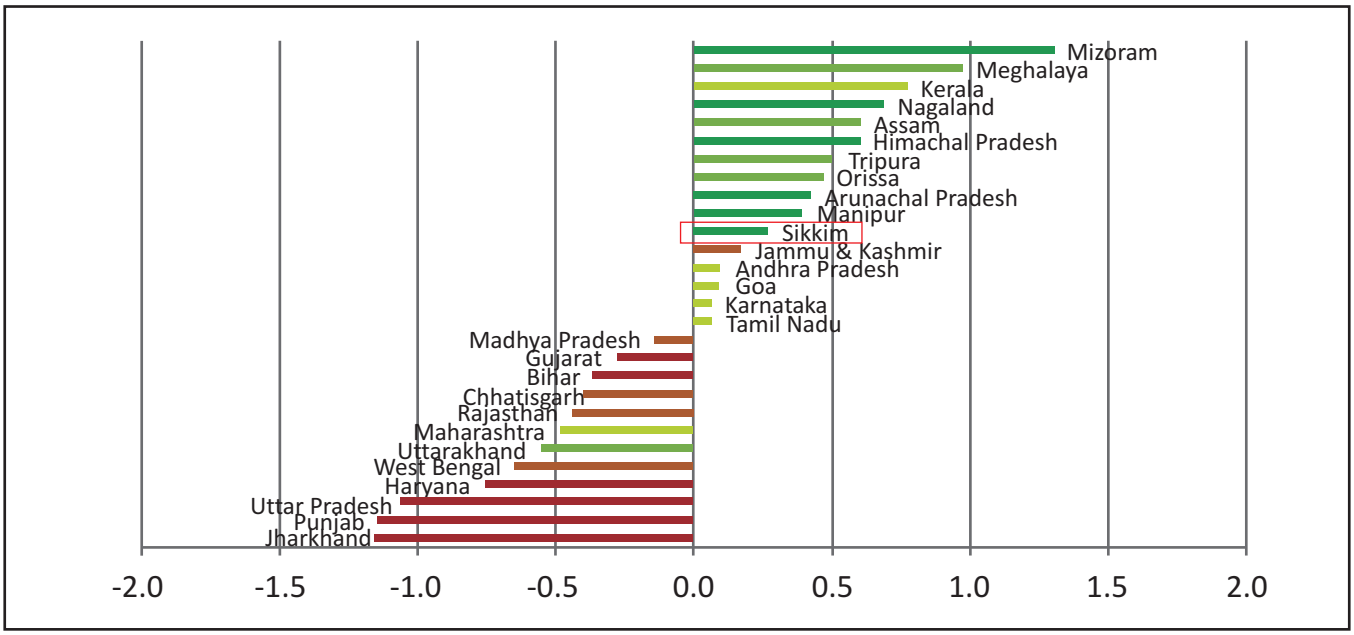
2.1 State

Sikkim as a state enjoy good quality air with high ESI scores (Figure 2.1). Environmentally Sustainability Index (ESI) is a comparative analysis of the environmental achievements ,challenges and priorities of Indian states. ESI is constructed as a composite index from 41 key environmental indicators selected using the Drivers-Pressures-State-Response(DPSIR) framework. A higher ESI scores indicates that the State enjoys the benefits of higher environmental quality currently and or has been able to create the potential to maintain the environment over a long run. A lower ESI reflects greater pressures on ecosystems, higher levels of pollution and degradation, vulnerability to environmental policies by institutions and civil societies. In most cases data were sought from the recently published Government Surveys .The 41 indicators are categorised under DPSIR framework, the weights are as follows:

- Driving Force(D)-7.32%
- Pressure on Ecosystem(P)-21.95%
- State of Environment(S)-26.83%
- Impact on Health and Ecosystem(I)-17.07%
- Policy Response(R)-26.83%

As per the ESI 2010, the states that are most sustainable are Arunachal Pradesh, Manipur, Mizoram, Nagaland, Sikkim and Himachal Pradesh. The least sustainable are Bihar, Haryana, Gujarat, Punjab, Rajasthan and Uttar Pradesh.

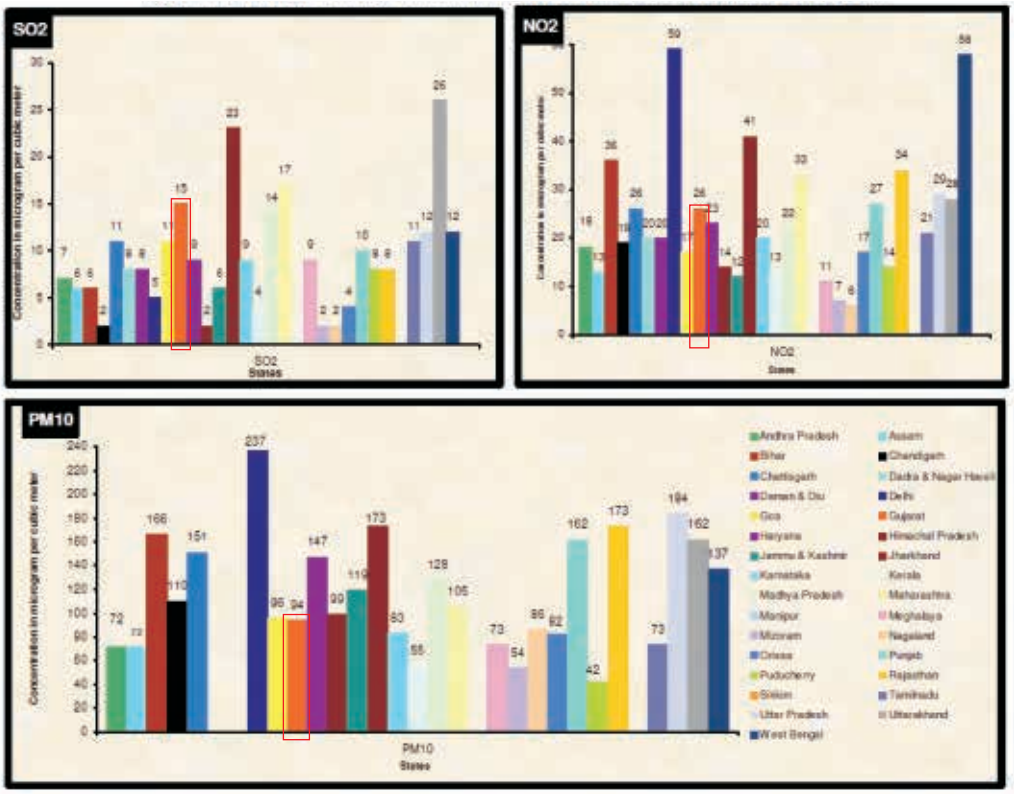
Figure 2.2: State-wise Standardised Scores on Air Quality and Pollution



Source: Environmental Sustainability Index for Indian States 2011, Centre for Development Finance

As per Environmental Sustainability Index for Indian States 2011, Centre for Development Finance Sikkim is having one of the best air quality conditions in India. (Figure 2.1)

Figure 2.3: Air Quality Status of States



Source: National Ambient Air Quality Status & Trends – 2012 published by Central Pollution Control Board, Ministry of Environment, Forest & Climate Change, August 2014.

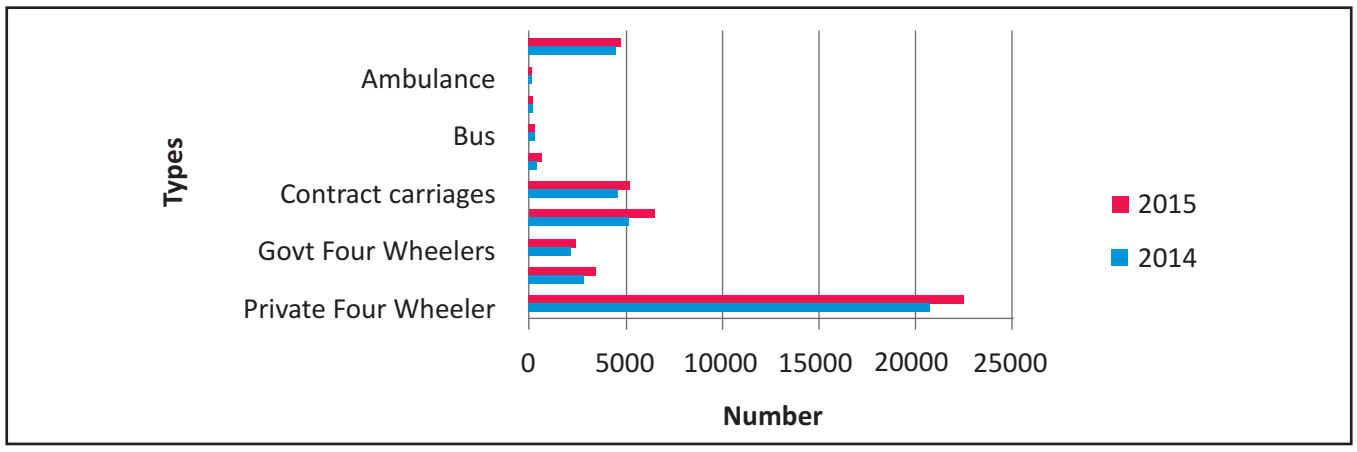
2.2. Pressures

There are various factors as population growth, vehicular emission load, indoor and industrial emissions which are affecting the air quality of Sikkim.

2.2.1. Vehicular Emission Load

Exhaust emission from petrol and diesel vehicles constitute a major pollution hazard to the environment. Vehicular emission becomes one of the important factors contributing to air pollution in Sikkim. There has been considerable amount of increase in the number of vehicles from the year 2014 to 2015.

Figure 2.4: Increase in Vehicles



Source: Transport Motor Vehicle Department Sikkim, 2015

Air pollution may be described as contamination of the atmosphere by gaseous, liquid, or solid wastes or by-products that can endanger human health and welfare of plants and animals, attack materials, reduce visibility. Gangtok lies in the category of ecological sensitive zone. (CPCB, 2014)

Table 2.2: Air Quality of Gangtok

Pollutant	Present Condition in Gangtok	Ecologically Sensitive Area (Notified by Central Government)
Mean SO_2 concentration of major cities (population over 100,000)	5.2 µg/m^3 (2014) 5.9 µg/m^3 (2015)	20
Mean NO_2 concentration of major cities	15.6 µg/m^3 (2014) 16.5 µg/m^3 (2015)	30
Mean PM10 concentration of major cities	54.7 µg/m^3 (2014) 60.2 µg/m^3 (2015)	60

Source: Sikkim State Pollution Control Board, (2015)

**Since 1989 the Ministry of Environment and Forests have indentified and notified Ecological Sensitive Areas.*

The air quality of Gangtok are within permissible limits.

2.2.2. Natural Disasters

Sikkim has a hilly and mountainous terrain. The area receives heavy intense rainfall. Landslides are common phenomenon in Sikkim; hence land clearing becomes an important activity. The major air pollutants are the suspended particulate matter (SPM) which includes dust (both fine and coarse). The increase in sulphur dioxide and nitrogen dioxide can lead to acid formation in the rain water. The wet and dry deposition of sulphur dioxide damages vegetation degrades soils building materials and water course.

2.2.3. Industrial Pollution

All industries in Sikkim comply with the national standards and are much below the permissible limits. (Table 2.3)

Table 2.3: Industrial Air Quality Data – 2014-15

Name of Industries	Place	Year	Month	Sampling Location	SO_2 µg/m3	NO_2 µg/m3	PM_{10} µg/m3	$PM_{2.5}$ µg/m3
M/s Golden Cross Pharma Pvt. Ltd.	Tarpin Block, Rorathang East Sikkim	2015	October	Near Main Gate	18 µg/m^3	56 µg/m^3	73 µg/m^3	34 µg/m^3
M/s Alkem Laboratories Ltd.	Kumrek, East Sikkim	2015	November	Near Main Gate	14 µg/m^3	51 µg/m^3	61 µg/m^3	39 µg/m^3
M/s Cipla Ltd.	Kumrek, East Sikkim	2014	August	Near Main Gate	14 µg/m3	34 µg/m^3	58 µg/m^3	21 µg/m^3
M/s Torrent Pharma. Ltd.	32 No. Middle camp, East Sikkim	2014	September	Factory Premises	27.17 µg/m3	31.17 µg/m^3	90.17 µg/m^3	52.33 µg/m^3
M/s Zydus Wellness Sikkim	Mamring Block, South Sikkim	2015	December	Main Gate	BDL	11.6 µg/m^3	53.5 µg/m^3	25.5 µg/m^3
M/s Zydus Healthcare	Bagey Khola, Majhitar, East Sikkim	2015	July	Near Main Gate Area	BDL	BDL	34.9 µg/m^3	21.0 µg/m^3
M/s Sun Pharma Lab. Ltd.	Namli Block, Ranipool, East Sikkim	2015	August	Near ETP Area	BDL	10.2 µg/m^3	24.8 µg/m^3	15.9 µg/m^3
M/s Denzong Albrew Pvt. Ltd.	Mulukhey, Darpaney, Rhenock, East Sikkim	2015	September	In between DG Set & Boiler	BDL	17 µg/m^3	24 µg/m^3	10 µg/m^3
M/s Godrej Consumer Products Ltd.	Mamring, Namthang Road, South Sikkim	2015	September	Near Main Gate		23 µg/m^3	41 µg/m^3	16 µg/m^3

Source: Sikkim State Pollution Control Board, (2015)

Note: All the parameters are under the prescribed national standard.

Table 2.4: National Standard

NATIONAL STANDARD	SO_2 µg/m^3	NO_2 µg/m^3	PM_{10} µg/m^3	$PM_{2.5}$ µg/m^3
	80	80	100	60

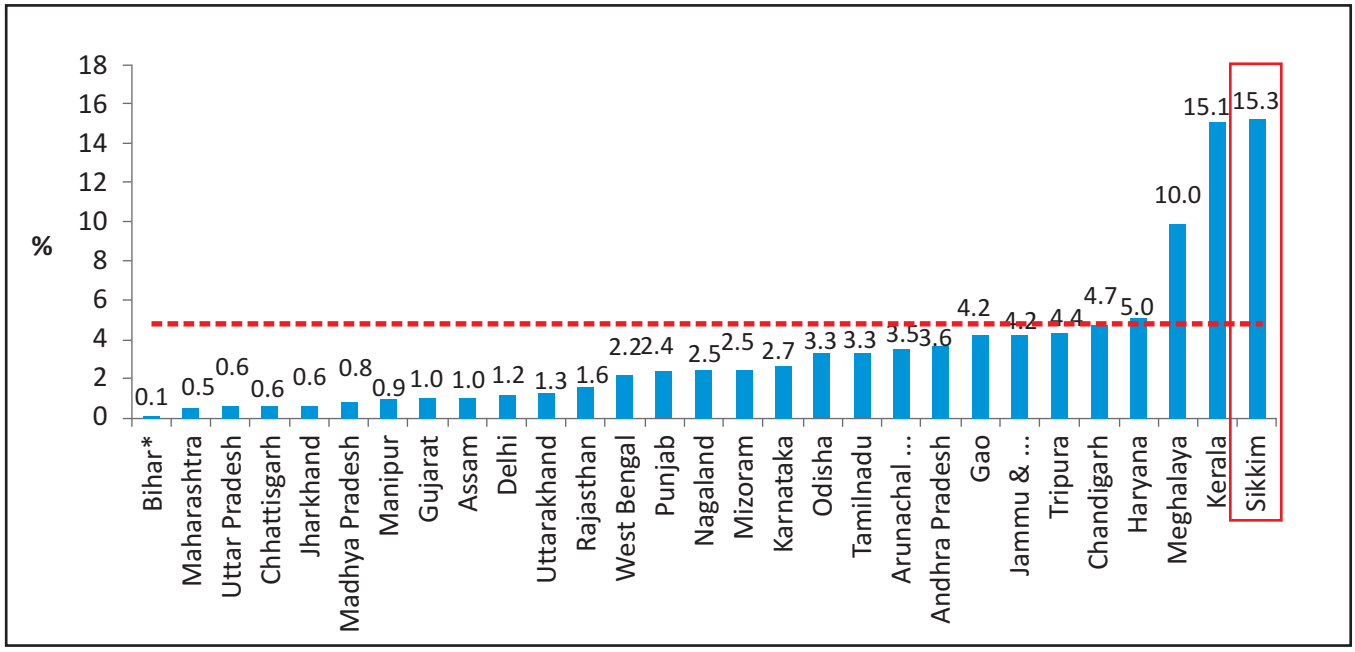
Source: Central Pollution Control Board, (2015)

2.3: Impacts

2.3.1: Deteriorating Human Health

Air Pollution leads to a significant amount of mortality and morbidity in all developing countries. The incidence of respiratory diseases is very high in Sikkim (15.3%) which is much higher than the Indian Standard of 4.77% (Figure 2.7). Even if we observe state-wise medically certified deaths due to diseases of respiratory systems in 2011 which is higher than Indian average of 9.71%.

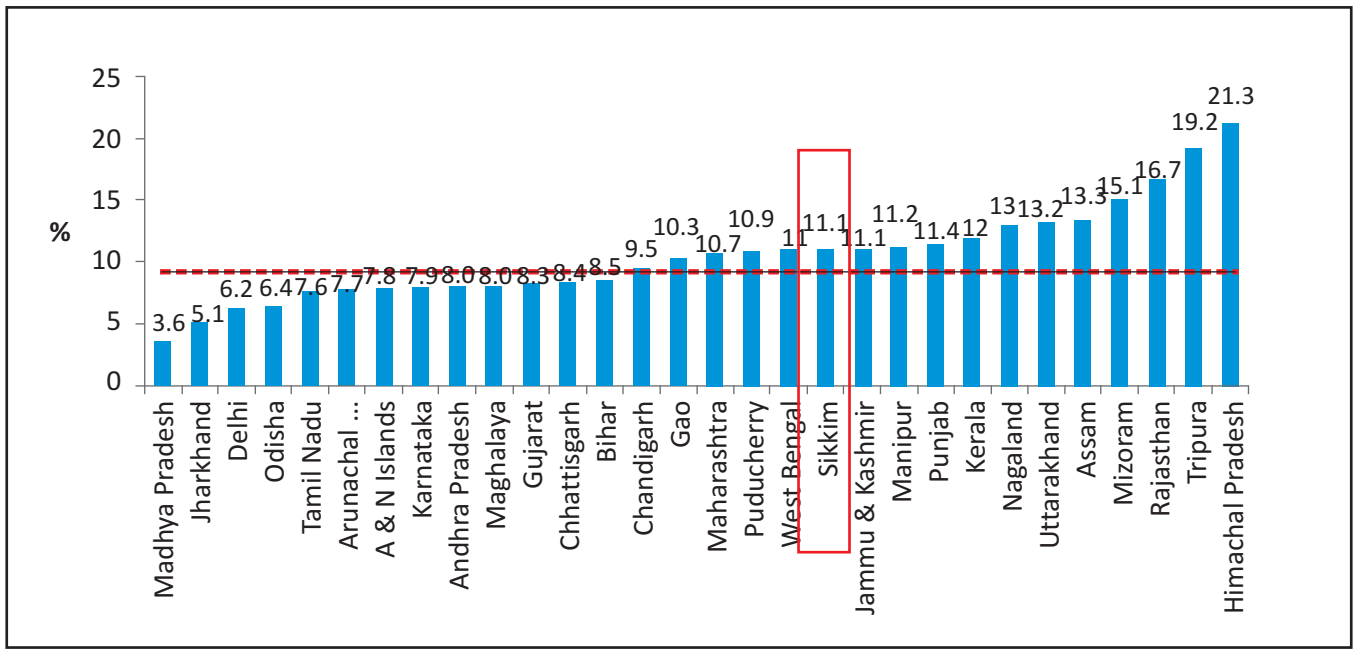
Figure 2.5: State-wise Acute Respiratory Infection (ARI) Cases



** The red line indicates all India value.*

Source: Central Bureau of Health Intelligence, 2013

Figure 2.6: State-wise Mortality Percentage due to Respiratory Diseases



Source: Central Bureau of Health Intelligence, 2013

Sikkim has mortality percentage above India level i.e.11.1%.

2.4. Response

Sikkim State Pollution Control Board (SSPCB) has a regular Ambient Air and Water Quality Monitoring Programme to assess the status of pollution in the natural environment. These monitoring programmes are funded by the Central Pollution Control Board, Ministry of Environment, Forest and Climate Change, Government of India.

Sikkim has prohibited the burning of agricultural waste, leaves, litter, paper wastes and garbage within the State of Sikkim under Air Pollution Act 1981.This prohibition shall, however, not cover the use of processed agricultural wastes, leaf litter, and garbage as fuel and controlled burning of forest litter for the purpose of scientific management of forest fires.

Sikkim Government has banned the manufacture, sale, and use or bursting of firecrackers during 2015 which is a positive step towards reducing air pollution.

The State Government has distributed smokeless chullahas in North and West district in order to reduce the magnitude of indoor pollution. Some of the other steps are – formulation of Public Transport Policy 2005-2006 and promotion of a dynamic fuel policy.

One of the objectives of State Green Mission is to achieve 100% environment conscious citizen in Sikkim by 2015.Under National Environment Awareness Campaign the various target groups including taxi drivers, Government employees, school teachers have been identified as predominant 'agent of change'.

The initiative of declaration of 'Paryavaran Mahostav' aims at developing Sikkim into model green state.

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Chapter 3: Water

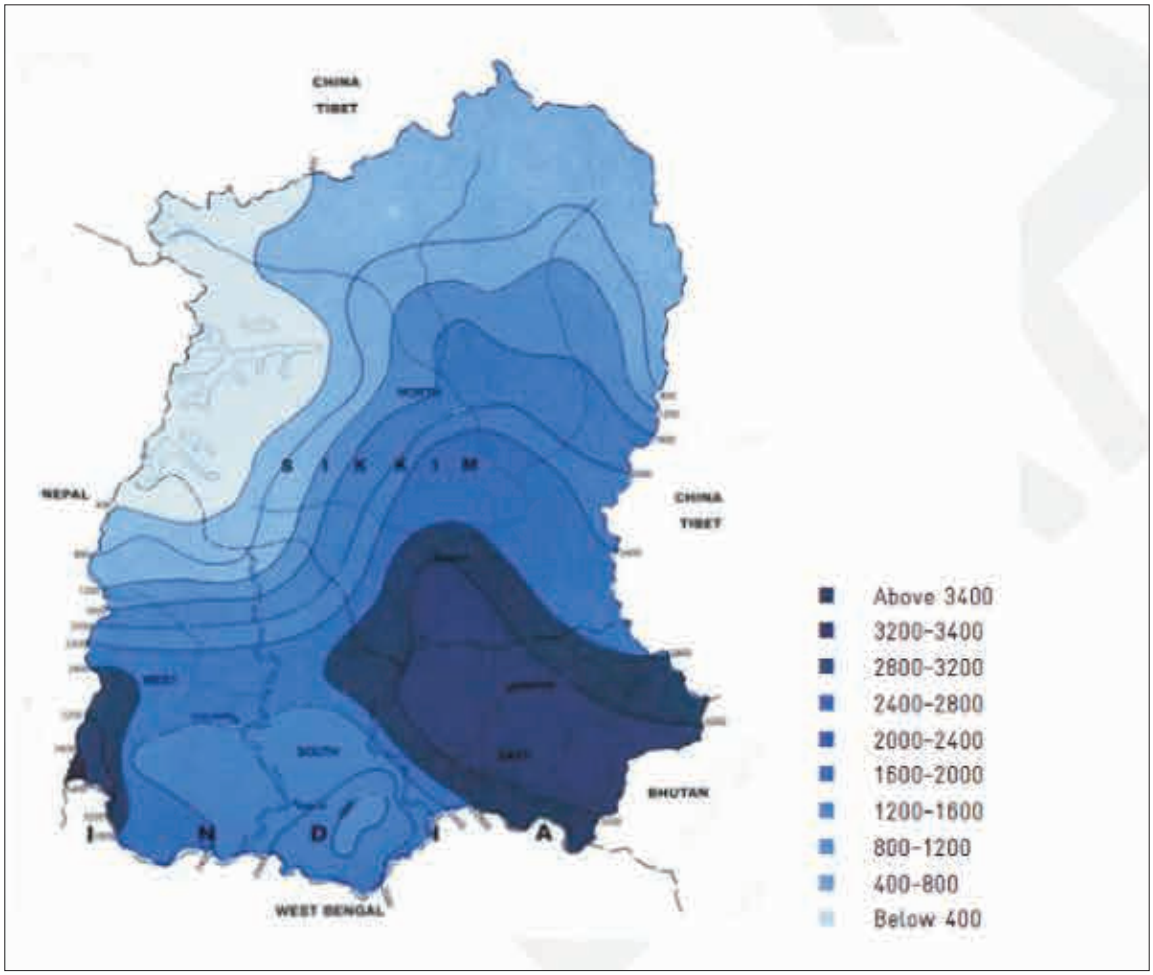
Freshwater is a finite and vulnerable natural resource. With the increasing population, there is a need to search for alternate sources of water. Glaciers, rivers and springs form an important component of the surface water resources of Sikkim. In Sikkim, some areas are affected by both floods and droughts. This chapter also discusses major initiatives of Sikkim Government in terms of Water Management.

3.1. State

The State of Sikkim is gifted with enormous water resources available in the form of rivers and natural springs. There are altogether 84 glaciers, covering an area of about 440.30 sq. km (Glaciers Atlas, of Teesta basin, Sikkim Himalaya, 2001).

Sikkim receives a fairly good amount of rainfall which is a vital factor for availability of water resources in any region.

Map 3.1: Rainfall contour map of Sikkim



Source: Sikkim State Action Plan on Climate Change (2012-2030), Government of Sikkim

The mean annual rainfall is minimum at Thangu (82mm) in North Sikkim and maximum at Gangtok 3494 mm in east Sikkim. South East and South West part of Sikkim receives very high rainfall.

3.1.1. Surface Water

Glaciers, rivers and springs form the important component of the surface water resources of Sikkim.

3.1.1.1. Rivers

Teesta is the major river system in the State, which originates as Chhombo Chhu from a glacial lake Khangchung Chho at an elevation of 5,280 m . The glacial lake lies at the snout of the Teesta Khangse glacier, descending from Pauhunri peak (7,056 m) in the north-western direction. Along its traverse from its origin to the plains, the river receives drainage from a number of tributaries on either side of its course. The tributaries on the eastern flank are shorter in course but larger in number, whereas the tributaries on the western flank are much longer with larger drainage areas, consequently contributing much more quantum of discharge to the main Teesta river.

Table 3.1: Major Tributaries of Teesta

Left Bank Tributaries	Right Bank Tributaries
Lachung Chhu	Zemu Chhu
Chakung Chhu	Rangyong Chhu
Dik Chhu	Rangit
Rani Khola	
Rangpo Chhu	

Source: The State of Environment Sikkim, 2007

The most important tributary of river Teesta is Rangit. At Melli, Teesta merges with river Rangit, which originates from Rathong Glacier.

The major left-bank tributaries are Lachung Chhu, Chakung Chhu, Dik Chhu, Rani Khola, and Rangpo Chhu and the right bank tributaries of Teesta are Zemu Chhu, Rangyong Chhu and Rangit River. The major tributaries of Rangit are Rang bhang, Relli, Rathong and Kalej.

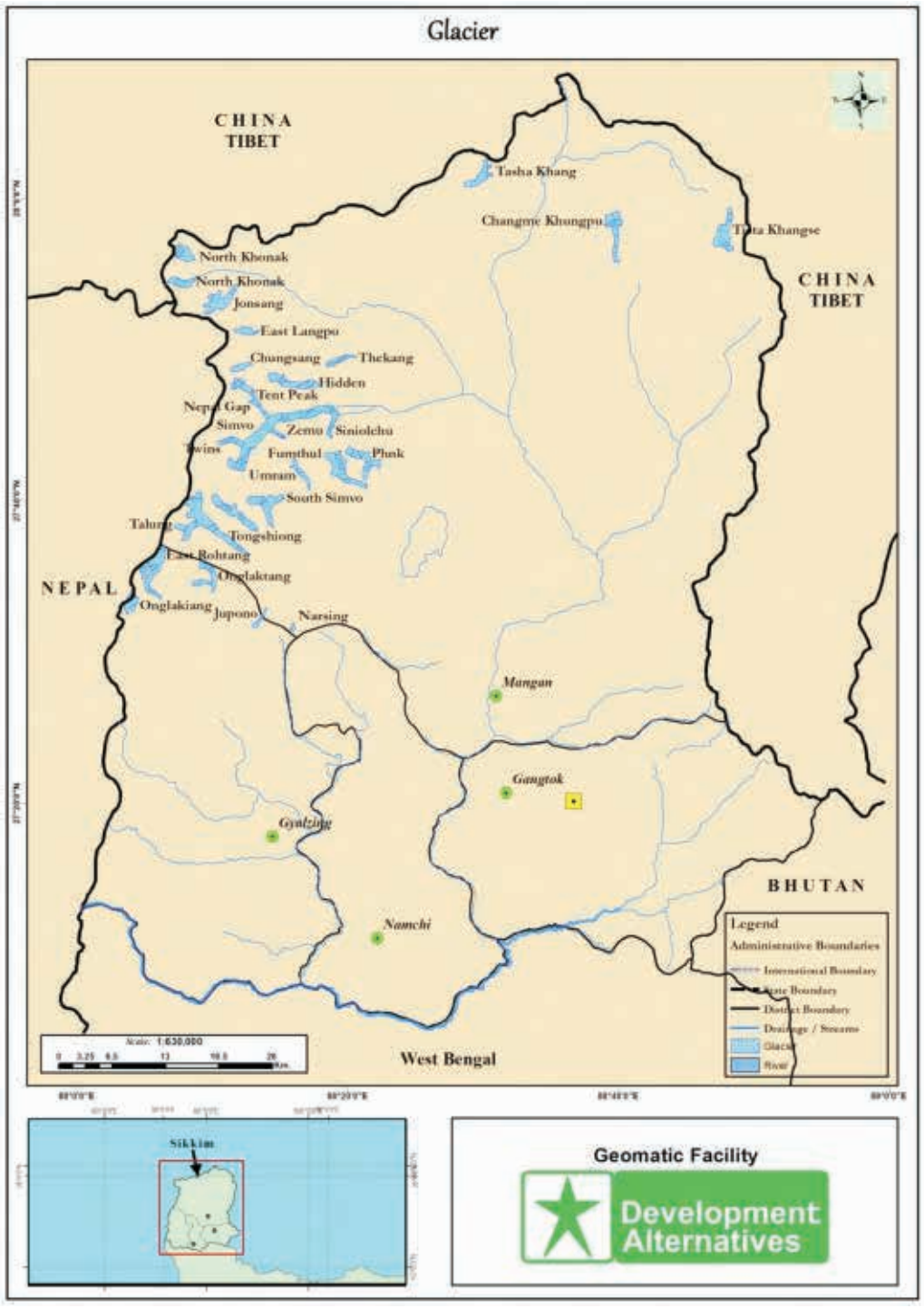
Map 3.2: Drainage pattern

Source: ENVIS, Sikkim

3.1.1.2. Glaciers

The important glaciers in Sikkim are Zemu, Rathong and the Lonak. The Zemu glacier is the largest and the most famous glacier of the eastern Himalayas. This is about 26 km in length and is situated in a large U-shaped valley at the base of the Khanchendzonga Mountain in the north-western Sikkim. The Teesta River rises from the snout of Teesta Khangse glacier. Various icefalls and waterfalls have formed at the junction of the tributary glaciers with the Zemu glacier.

Map 3.3: Glaciers of Sikkim



Source: Topographical and Forest resource Atlas of Sikkim

3.1.1.3. Lakes

Tsomgo literally means "source of the lake" in Bhutia language. 'TSO' means lake and 'MGO' means head. Around 40 kilometers away from Gangtok, this serene and holy lake is situated at an altitude of 12,000 feet on the Gangtok-Nathu La highway. It is about one-kilometer-long, oval in shape and 15 meters deep. It is also home to Brahmini ducks, besides being a stopover for various migratory birds. The lake remains frozen during the winter months up to mid-March. Between March and August, it is possible to see a variety of flowers in bloom, including the rhododendrons, various species of Primula, blue and yellow poppies, irises etc. It is also an ideal habitat for the red panda and different species of birds.

Photo 3.1: Changu Lake

Khechupalri Lake of West Sikkim is located at an altitude of 1700 m above the mean sea level. The lake watershed has mixed broad leaved forests and agricultural land with a total area of 12 sq. km, having two villages, which includes 91 ha specifically as the lake's watershed area. The lake is subjected to a high influx of tourists. It is also considered sacred and a good number of pilgrims visit the water body. Significant land use change during the past four decades has culminated in its deterioration.

Photo 3.2: Changu Lake

Other Lakes

Other important lakes of Sikkim are presented in the table below:

Table 3.1: Important Lakes in Sikkim

Name of Lakes	District
Gurudongmar	North
Cholamu	North
Sima Choka	North
Menmecho	East
Changu(Tsomgo)	East
Bidang Cho	East
Khed-Cheod-Palri(Khecheoperi)	West
Lam Pokhari	West
Laxmi Pokhari	West
Dud Pokhari	West
Samiti Lake	West
Ram Laxman	West
Majur Pokhari	West

Source: Sikkim: A Statistical Profile: 2002; 2003, Government of Sikkim

3.1.1.4. Springs

Springs are the most obvious attributes of Himalayan geo-hydrology and the source of domestic and drinking water to the hill folks. Further springs have been the important indicators of the status of underground water and water-table across the elevated land systems. Thus the number of spring's increases during the monsoon season and decreases during the drier period. Sikkim has always been known for its thermal springs, which are found all over the state. These waters have great therapeutic value because of the presence of fluorine and sulphur. The most important are the ones located at Reshi, Yumthang and Ralang.

Several seasonal springs surface during the rainy season. Locally known as "*mulphutnu*" they have always served as major source of domestic and drinking water in both rural and urban areas. A simple geomorphic explanation of *mulphutnu* is the gradual rise of the water table due to the seepage of rainwater underground for many days together. As the water table

rises, it hits the rock surface or other outlets and oozes out through a fractured area, weak surface points or any form of outlets serving as a good and potable source of water for three to six months. However, there may be perennial springs that serve as the source of drinking water for the whole year.

Photo 3.3: Reshi Hot Spring

3.1.2: Ground Water

Sikkim being a hilly state has low storage capacity of rain water due to quick run off. The net ground water availability of Sikkim is 0.046 bcm (billion cubic metre). The total annual draft for Sikkim is 0.010 bcm of which for irrigation is 0.003 bcm and for domestic and industrial use is 0.07bcm. *(Resources, 2012-2013)*

Table 3.2: Ground Water in hilly States

States	Net Ground Water Availability	Irrigation (bcm)	Domestic and Industrial Use (bcm)	Total Annual Draft of Ground Water(bcm)	Stage of Ground Water Development (%)
Sikkim	0.046	0.003	0.07	0.010	21
Mizoram	0.039	0.000	0.004	0.004	1
Nagaland	0.038	N.A	0.008	0.008	2.14
Tripura	2.74	0.09	0.07	0.16	6

Source: Ground Water Year book India 2012-2013, Published by Central Ground Water Commission, and Ministry of Water Resources.

In terms of net ground water availability, Sikkim is a niche higher than Mizoram and Nagaland but lower than Tripura. It is observed that the total annual draft also follows the same trend. But, Sikkim is considered to be the highest in the sphere of ground water development. In the year 2009, the four districts fall under the safe category when the criterion is availability of ground water. The percentage allocated to the State in terms of development of ground water as a resource is 21% *(Resources, 2012-2013)*.

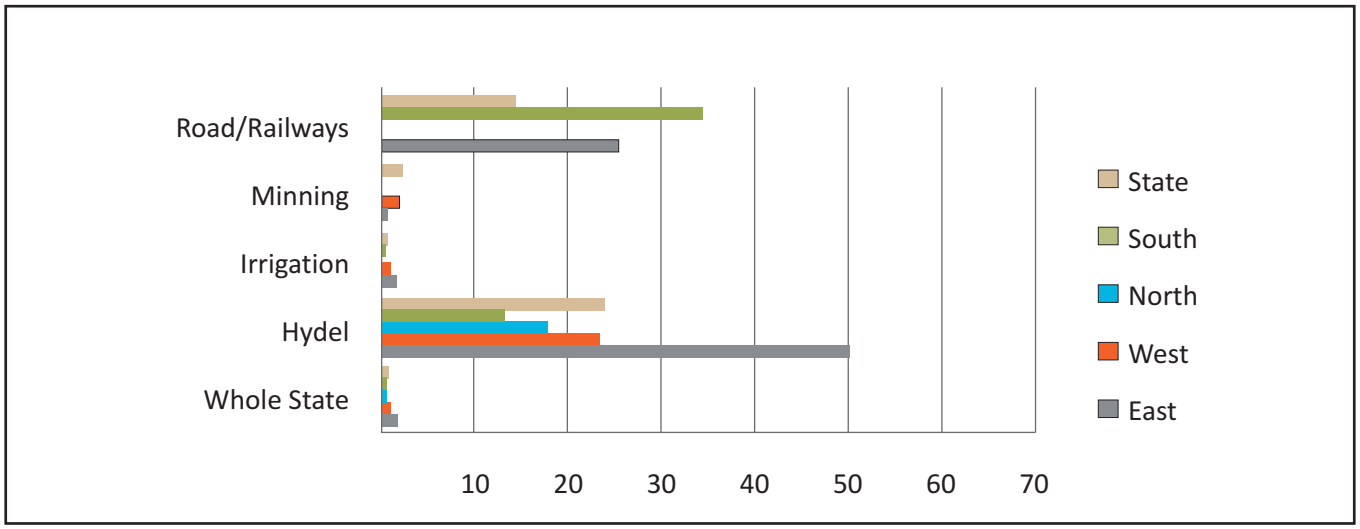
3.1.3. Hydroelectric Projects

Hydropower sector is one of the potential areas for generating revenue to improve the socio-economic conditions of the people. Actually, hydropower is considered as the green power available to mankind and the Government of Sikkim's policy has been to synchronize development imperatives with a conscious effort to attain environmental sustainability. Hydropower is considered a cleaner and greener source of energy when compared to other sources. The significance of hydropower is that:

- The cost of operation is not susceptible to market price fluctuations
- It has multipurpose benefits including generation of power.

Himalayan ecosystem degradation is emerging as major concern in the present era. One of the current factors contributing to environmental degradation is installation of hydroelectric projects. The hydroelectric projects led to increase reservoir triggered seismicity and various other consequences. The State Government has set up the Sikkim Power Development Corporation (SDPC) to tap into the state's hydropower potential, which is estimated to be around 8,000 MW. Independent power producers (IPPs) have approved 29 hydroelectric power (HEP) plants for development. These projects are at various stages of construction and would have an installed capacity of close to 5,350 MW when complete.

Figure 3.1: Land Diversion for various purposes



Source: ENVIS, Sikkim

West District has the maximum land diversion. The land use pertaining to land diversion at the higher end is road or railways and hydel power. As per the Central Electricity Authority, 2008, the hydel power developed is 13.86% of its total capacity.

Table 3.3: Status of hydroelectricity in Sikkim

	Identified Capacity as per Re-assessment Study	Capacity Developed		Capacity which can't be developed		Capacity yet to be Developed	
	MW	MW	%	MW	%	MW	%
Sikkim	4286.00	594.00	13.86	1919.00	44.77	1773.00	41.37
All India	148701.00	32442.50	21.82	13574.00	9.13	102684.50	69.05

Source: Central Electricity Authority, 2008

the major hydroelectric projects which cater to the energy needs of Sikkim are indicated below in the tables.

Table 3.4: Sikkim's Hydroelectric Projects

S. No	Name	Capacity (in MW)	Location	District
1	Teesta V	510	Singtam	East
2	Rangit	60	Legship	West
3	Kalez	2	Kalez	West
4	Lower Lagyap	12	Ranipool	East
5	Jalli	2	Sangh Khola	East
6	Rimbi I	NA	NA	NA
7	Rimbi II	1	Rimbi	West
8	Rothak	0.2	Rothak	South
9	Rongnichu	2.5	Nimtar	East
10	Chatten	1	Lachen	North
11	Meyong Chu	4	Naga	North
12	URHP	6	Nimtar	East
13	Manglay	2	Manglay	South
14	Lachung	0.2	Lachung	North
15	Rabom Chu	3	Chungthang	North
16	Rongli	5	Rongli	East
17	Lachung	3	Lachung	North

Source: Energy and Power Department, Government of Sikkim, 2015

Table 3.5: Energy Consumption

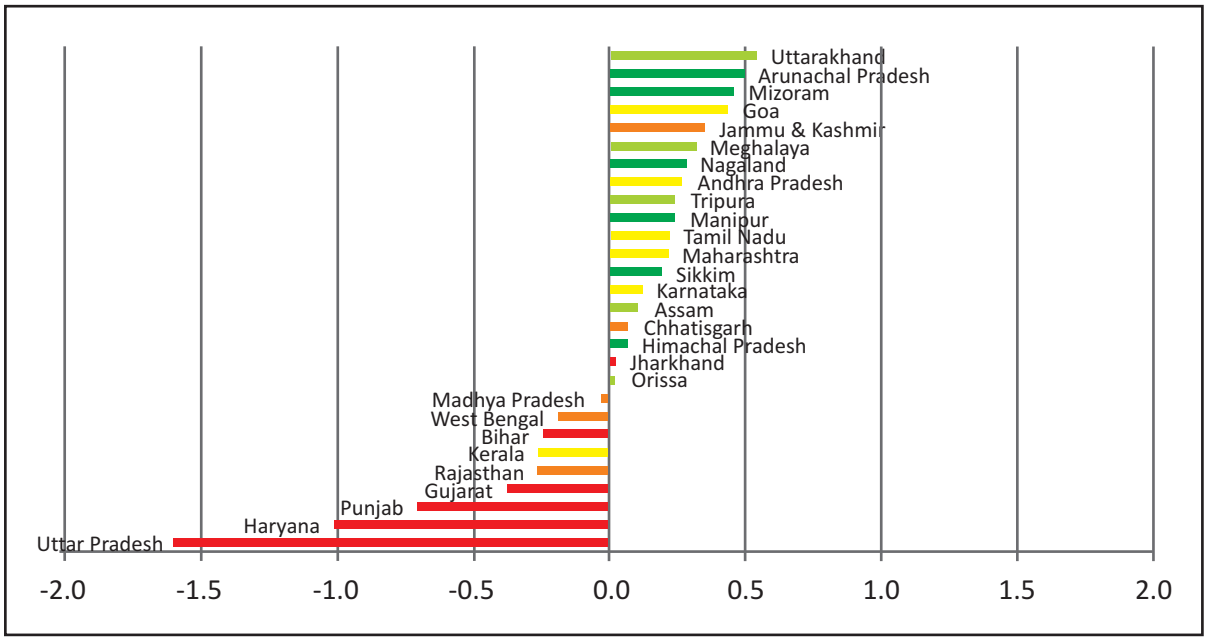
		Energy Consumption (MU)		Population		Per Capita Consumption (in kWh)	
S. N	Year	Rural	Urban	Rural	Urban	Rural	Urban
1	2010-2011	130.54	69.17	480981	59870	271.41	1155.4
2	2011-2012	136.89	71.37	456999	153578	299.54	464.73
3	2012-2013	126.68	79.49	456999	153578	277.19	517.61
4	2013-2014	135.1	78.06	456999	153578	295.62	508.29
5	2014-2015	119.88	74.12	456999	153578	262.33	482.63

Source: Per Capita Energy Consumption, Energy and Power Department, Government of Sikkim, 2015

There has been a rapid increase in energy consumption if we observe its consumption pattern from the year 2010 to 2015.

As per Environmental Sustainability Index for Indian States 2011, Centre for Development Finance Sikkim is one of the best on the indicator of water quality and availability when compared with other states of India.(Figure 3.1)

Figure3.2: State-wise standardized scores on Water Quality & Availability



Source: Environmental Sustainability Index for Indian States 2011, Centre for Development Finance

Environmentally Sustainability Index (ESI) is a comparative analysis of the environmental achievements, challenges and priorities of Indian states. ESI is constructed as a composite index from 41 key environmental indicators selected using the Drivers-Pressures-State-Response(DPSIR) framework. A higher ESI scores indicates that the State enjoys the benefits of higher environmental quality currently and or has been able to create the potential to maintain the environment over a long run.

3.2. Pressures

Increasing water demand due to the ever-growing population and pollution are the major pressures on the water sector in Sikkim.

3.2.1. Water Pollution

Sikkim solely depends on surface water bodies. Springs flow from the water reserved in the underground bowels of the rock strata, which have been recharged with rain water. The recharging will take place only if there is vegetation, otherwise the ground will not soak water which will quickly flow down the valley and will get lost. Water Quality (surface water) data analysis of 168 observations points out that 55 % are not complying with pH and 84% are not confirming to BOD (Biological Oxygen Demand). On the other hand, DO (Dissolved Oxygen), Conductivity, FC (Faecal and Total Coliform) are all confirming to the desired levels required in a riverine environment. Hence, the overall surface water quality is declining.

The Central Pollution control Board monitors water quality of Sikkim under MINRAS (Monitoring of Indian National Aquatic Resources) programme.

Five rivers of Sikkim are monitored at 14 locations by Central Pollution Control Board. All the 14 locations are not complying with the water quality criteria. The rivers in which these 14 locations are situated are - Dikchu, Maney Khola, Rangit, Ranichu and Teesta. The polluted rivers of Sikkim are in priority class V. The criterion for priority V is monitoring a location having the BoD between 3-6 mg/l. The polluted river stretches in Sikkim are provided in the table below.

Table 3.6: Polluted River stretch of Sikkim

S. No	River	Stretch Identified	Towns Indentified	Approx. length of the Stretch (in Km)
1	Dikchu	Nampong to Dikchu	Dikchu	4
2	ManeyKhola	Adampool to Burtukk	Adampool	2
3	Rangit	Dam Site (NHPC) to Treveni	Legship, Jorethang, Triveni	20
4	Ranichu	Namli to Singhtam	Ranipool, Namli, Singhtam, Gangtok	15
5	Teesta	Melli to Chungthang	Melli, Rangpo	60

Source: Central Pollution Control Board, 2015

It was observed that the water run-off and, hence, the water supply to the public in Sikkim was irregular. If East Sikkim received plenty of water throughout the year, the South district suffered from huge shortages several times.

Based on the water demand and supply, field surveys were done primarily in two major cities, namely - Namchi in South Sikkim and Gangtok in East Sikkim. Many villages in the vicinity of Namchi have extreme water shortages throughout the year (Ministry of Environment and Forests, 2010)

It was observed that the water run-off and, hence, the water supply to the public in Sikkim was irregular. If East Sikkim received plenty of water throughout the year, the South district suffered from huge shortages several times.

Table 3.7: Water Utilisation by sectors in Sikkim

	Year wise tentative Projections (Million cubic meters)				
	2010	2020	2030	2040	2050
Irrigation use					
a. Kharif	1764.00	2058.00	2352.00	2499.00	2646.00
b. Rabi	371.00	484.28	557.05	649.89	742.74
Urban Suburban Areas(PHED)	23.70	42.51	55.27	71.86	93.41
Rural Areas (RMDD)	17.00	20.72	25.28	30.79	37.53
Industries (Department of Commerce and Industries)	0.42	0.53	0.66	0.83	1.03
Maximum Requirement of Water for Kharif Season (I A+II+III+IV)	1805.12	2121.76	2433.19	2602.48	2777.97
Minimum requirement of water during Rabi season (IB+II+III+IV)	412.12	528.04	638.24	753.37	874.71

Source: State Action Plan on Climate Change Sikkim, 2012-2030

Ratey–Chu Watershed: A Case Study

Ratey–Chu Watershed covers an area of 51.79 km^2 with a relative relief of 1700m. It hosts around 15 wetlands fed by precipitation, snow melt and niche glacier.

The prominent lakes in the valley are Hans Pokhari, West Lake, Pemthang Chho and Biren Jheel spread across North (South-East) and East (North-East) districts of Sikkim. Ratey-Chu is the only water source providing water to Gangtok. Water near Ratey-Chu is pumped into a water pressure brake tank located near 2nd Mile and then ferried to the Selep Water Treatment Plant.

The demand for water is going to increase with the burgeoning population of the State. Hence, there is a dire need of searching alternatives to fulfil the water demand.

Photo 3.4: Small streams are drying up

3.2.4. Receding Glaciers

The temperature in Gangtok has been rising at the rate of 0.2–0.3°C per decade. Therefore, since 1957 the increase in temperature has been around 1–1.5°C. Annual rainfall is increasing at the rate of nearly 50 mm per decade, except in winter months, which during the period 2006–10 have been exceptionally dry. Comparison of long-term meteorological data available for Gangtok station (1957 to 2005) in terms of the trend over the last few years (2006–09) shows an acceleration of these patterns, with winters becoming increasingly warmer and drier. (K.Seetharam)

These changes in snowfall patterns would have an impact on the livelihood of the pastoralist communities and affect the fodder productivity for livestock. A study conducted by the Department of Science and Technology on the East Rathong Glacier in West Sikkim shows that the total recession of the glacier during the last 43 years (1965–2008) is about 1.44 km and about 320 m in last nine years (1997–2006), with an average rate of 35.5 m/year. Thinning and retreat of glaciers results in formation of new glacial lakes and enlargement of existing ones, increasing the chance of Glacial Lake Outburst Flood (GLOF) events. The climatic change/variability in recent decades has made a considerable impact on the glacier lifecycle in the Sikkim Himalayas. The melting of glaciers and accumulation of melt water in the lakes has significantly increased the volume of water in the glacial lakes. The increase in area of glacial lakes behind unstable moraine dams poses more danger of downstream flooding. This has made the downstream regions more vulnerable (Binay Kumar).

3.3. Impact

3.3.1. Deteriorating Human Health

In rural areas of Sikkim Natural surface water is only the source of drinking water .Long-term impacts of drinking chlorinated water results in adverse health outcomes.

3.3.2. Drying of Wetland

Retreat of the glacial stock due to unnatural melting negatively impacts the Himalayan river ecosystem as the volume of the snow-fed rivers gets affected in the long run. In the short run, it invokes numerous natural hazards like Glacial Lake Outburst Floods (GLOF), soil erosion, flash floods, river floods and landslides. Such drying of wetlands has started getting noticed in the ecology of Sikkim Himalaya.

Further, small streams that feed the large rivers are drying up more recently due to excessive deforestation in and around the major watersheds of the region. This has not only affected the volume of the major rivers but also impacted the delicate relationship of flora- fauna and human habitation, especially the livelihood of the poor rural hill folks.(Khawas, 2005)

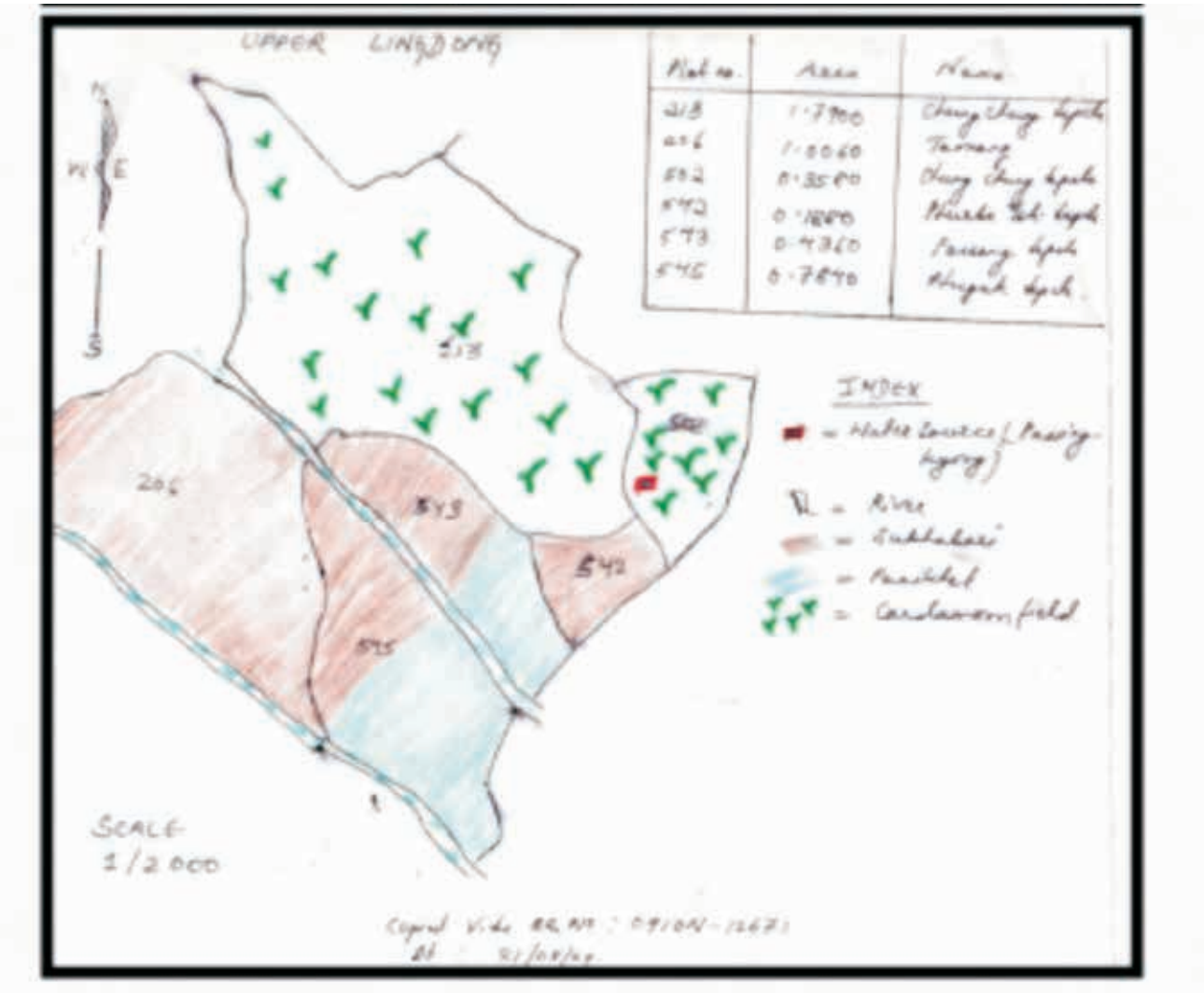
3.4. Response

Water is an important component for the survival of mankind. In Sikkim, certain areas are affected both by floods and droughts. In order to tackle this situation, proper coordination is required between districts and state level administration. For appropriate planning and management, Government of Sikkim has adopted the State Water Policy that enables Sikkim to balance and diversify the needs arising out of development.

3.4.1. Dhara Vikas

Dhara Vikas (meaning, spring-shed development) is an innovative programme to revive and maintain the drying springs in the State. A robust climate adaptation strategy for drought-prone districts, Dhara Vikas, is helping alleviate the problem of rural water scarcity by reducing the surface runoff of rainwater and allowing more water to percolate down to recharge underground aquifers, which, in turn, ensures an increased discharge from springs.

Map 3.5: Planning of Dhara Vikas in Sikkim



Source: MGNREGA-Spring shed Development Dhara Vikas in Sikkim, Rural Management and Development Department, Government of Sikkim.

3.4.2. Water Harvesting

Over the years, the local people of Sikkim have evolved efficient water harvesting systems, together with their traditional land management systems. Construction of water channels, regulation of water flow and drawing of drinking water were traditionally organized as community enterprises. Common traditional sources of drinking water are natural springs (locally called *dharas, pandhera* etc), and streams (locally called jhoras or kholas). The locals have traditionally evolved an ingenious method of transporting water from these sources to their houses by using bamboo poles. However, in recent years, rubber pipes have replaced most of these bamboo channels *(Khawas, 2004)*.

3.4.3. Flood Management Programme (FMP)

The Ministry of Water Resources, Government of India had sanctioned Flood Management Programme (FMP) during 2007-08.In all, 24 schemes at the cost of Rs. 8620.94 lakhs, have been completed by 2014-2015. This programme has supplemented the State Government in terms of irrigation facility. It has also helped in generating employment for the farmers, thus helping to improve their economic conditions.

3.4.4 Strengthening water storage infrastructure

With increasing water scarcity during the winter months of February-April, the water storage infrastructure at the household, community and village level needs to be augmented. The farmers innovatively harness the flow of springs to fill up water tanks, which are utilized for irrigating kitchen garden, green house crops and domestic uses. These water tanks (with the facility of roof-water harvesting) have provided a new lease of to many villages with acute drinking water problem. Hundreds of such water storage tanks (having a capacity ranging from 10,000 to 40,000 litres) have been constructed with funds leveraged from three national programmes, namely - MGNREGA, National Rural Drinking Water Programme (NRDWP) and Rashtriya Krishi Vikas Yojana (RKVY).

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Chapter 4: Land

Land as a resource is scarce in Sikkim due to the hilly terrain. This chapter focuses on land, analysing the various factors which act as a pressure leading to land degradation. A sustainable use of land is the only way to save Sikkim's degrading land that is highly prone to disasters like earthquakes and landslides. In future, traditional knowledge is going to play a pivotal role in managing land as Sikkim's vital natural resource.

4.1. State

Sikkim as a State is blessed with abundant natural resources, wherein land is the most precious heritage and physical base of biomass production of all life-supporting systems. As human needs and population grow, the pressure on land and other natural resources continues to increase. The steepness of the terrain, tectonic instability and heavy monsoon rainfall and rapid population growth adversely affect the land resources in Sikkim.

Sikkim constitutes 0.02 percent of the total land area of India. The State is highly susceptible to acute soil erosion problems due to its undulating topography and high intensity of rainfall. In fact, forests occupy the maximum land area of Sikkim (Figure 4.1). There are various pressures on Sikkim's land in terms of agriculture, susceptibility to disasters, urbanization etc. In order to balance Sikkim's environment, sustainable land management becomes the need of the hour.

4.1.1. Land Use Pattern in Sikkim

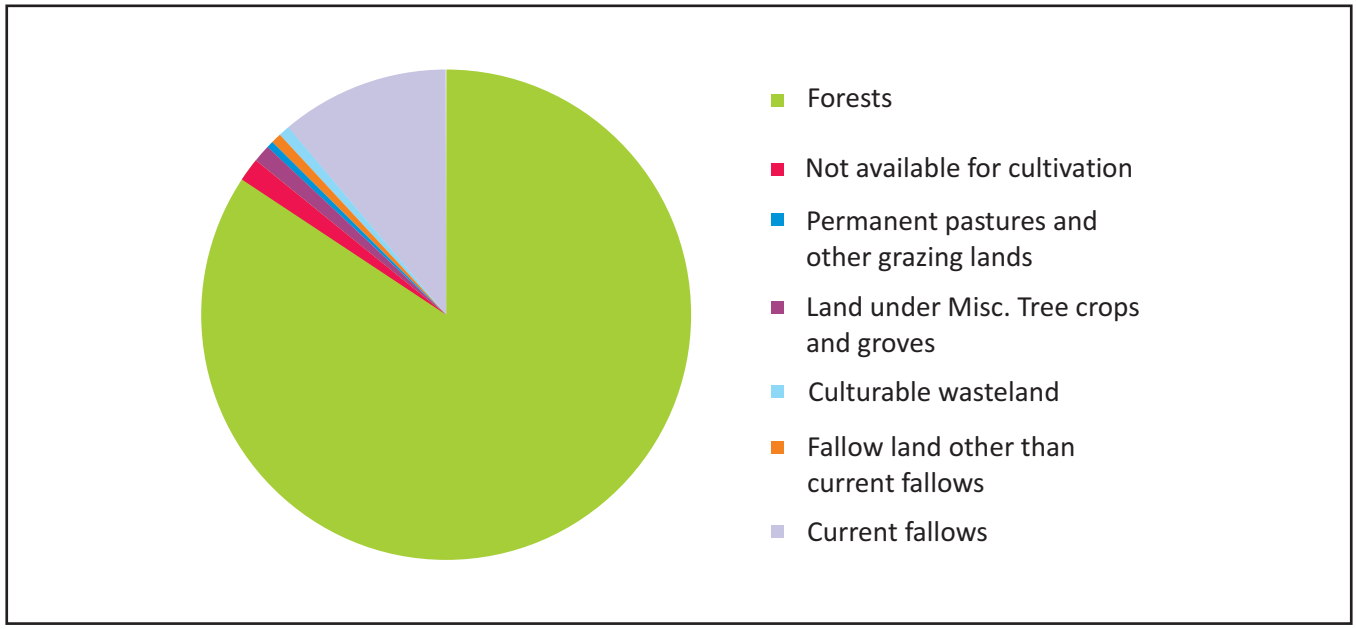
In Sikkim, the land use is mainly governed by the hilly terrain of the State. The land use could be classified into different categories, as depicted in the table below.

Table 4.1: Land Use in Sikkim

Land Use	Area in'000ha	Percentage
Total Geographical Area	770	
Reporting area for land Cultivation	693	100
Forests	584	84.31
Not available for cultivation	11	1.54
Permanent pastures and other grazing lands	0	0
Land under Misc. Tree crops and groves	8	1.13
Culturable wasteland	3	0.48
Fallow land other than Current fallows	4	0.65
Current fallows	5	0.72
Net area sown	77	11.17

Source: Land use Statistics, Ministry of Agriculture, Government of India, 2012-13

Figure 4.1: Land Use in Sikkim



Source: Land use Statistics, Ministry of Agriculture, Government of India, 2012-13

4.2. Pressure

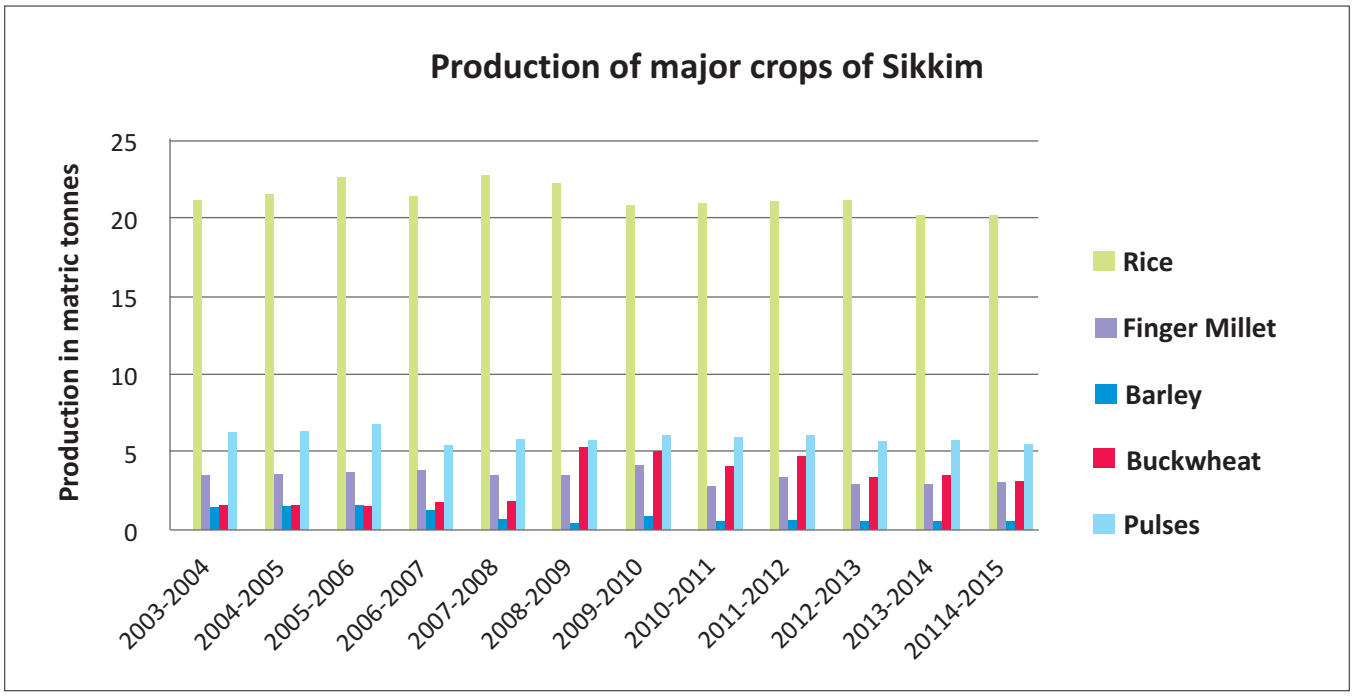
4.2.1. Agriculture and allied sectors

The economy of Sikkim is linked with agriculture that serves as the main source of livelihood and economic security of a sizeable native population. The growth, however, has been restricted because of biotic and abiotic factors. It is estimated that over 80 per cent of the rural population depends on agriculture and allied sectors for economic, food, and nutritional security. The agriculture systems practiced in Sikkim are integrated with nature. Sikkim is totally a hilly state whose agro-climate conditions range from Sub-tropical to Alpine. Agriculture is of the mixed type and still at the subsistence level rather than the commercial level.

Due to adverse geographical situation and difficult terrain condition, the extension of area under cultivation appears to be difficult. With the increasing population, the pressure on land has continued to increase resulting in low per-capita land availability.

Photo 4.1: Agriculture in Sikkim

Figure 4.2: Crops production



Source: Annual Reports, Food Security & Agriculture Development Department, Government of Sikkim

Table 4.2: Crop Production in Sikkim

Years Crop	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015
Rice	21.19	21.61	22.69	21.45	22.85	22.23	20.93	20.97	21.08	21.34	20.26	20.18
Finger Millet	3.57	3.6	3.78	3.9	3.53	3.53	4.18	2.89	3.45	2.96	2.97	3.09
Barley	1.51	1.52	1.59	1.27	0.66	0.47	0.92	0.61	0.63	0.59	0.59	0.6
Buckwheat	1.55	1.56	1.64	1.79	1.79	5.35	5.07	4.06	4.72	3.38	3.49	3.16
Pulses	6.38	6.44	6.76	5.45	5.89	5.79	6.06	5.97	6.11	5.83	5.83	5.6

Source: ENVIS Sikkim, 2013-2014.

A declining trend is observed among most of the crops but the overall productivity remains the same. (See Figure 4.2 and Table 4.2). Sikkim agriculture is witnessing an on-going process of agricultural transformation from cereal-dominated subsistence agriculture to high-value, cash crop dominated commercial horticulture. The precise changes in cropping patterns in terms of the area under different agricultural and horticultural crops from 1975-76 to 2004-05 indicate a definite shift in cultivation towards horticultural crops. However, from 1995 onwards the cropped area (of three crops) started declining. (ENVIS, 2015).

4.2.2. Disaster Risks

The Himalayas are young lofty mountains and are rated to fall under higher zonation on seismicity and landslides. Therefore, the natural hazards associated with the mountain chain needs to be contended with while initiating developmental activities. As per NIDM and Vulnerability Atlas of India, Sikkim is located in the The Himalayas are comparatively young mountains and

are rated to fall under higher zonation on seismicity and landslides. Therefore, the natural hazards associated with the mountain chain need to be at parity with developmental activities. As per NIDM and Vulnerability Atlas of India, Sikkim falls in the seismic zone IV[3]. This is a high risk area which makes Sikkim highly vulnerable to natural calamities. Additionally, it records a very high annual rainfall, exceeding 5000mm, which triggers more natural calamities. Every year, a noticeable number of people of Sikkim are affected by natural disasters among which landslides, floods, river bank erosion and earthquakes. The Sikkim Disaster Management Authority (SSDMA) mentions in its report that the increase in disasters is due to human activities. Earthquakes and unusual rain-storms are the main triggers of disasters, leading to land degradation (SSDMA, n.d.).

3. A seismic zone is a region with frequent seismic activity. The activity could either be rare or common. India divides its seismic regions from 2 to 5. With seismic zone 5 experiencing the highest level of activity and zone 2 the lowest.

Case study of Landslide Treatment - West Sikkim

The main focus in the landslide areas has been on stabilizing the slip area, keeping in mind the topography of the area, causes for the erosion, type of landslides that occur ranging from rockslide, rock falls, rock toppling, debris slide, and rock-cum-debris slide. The slide areas were so huge that no proper demarcation of the slide could be drawn. The landslides in all the areas studied have shown a colossal growth in terms of its flora. The bio-engineering works and soil moisture conservation works have blended very well to stabilize the area. The topography of the entire area was different. The type of erosion varied from place to place.

Recommendations

To ensure complete stabilization of eroded areas, the following measures need to be taken:

- Extensive drainage system, sub-surface drainage pipes, perforated pipes is one of the solutions to excessive leaching of soil, which may requires additional investments.
- As during the monsoon season, there arise seasonal springs that flow unsystematically in the hilly terrain carrying with them rich soil nutrients, further decreasing the capacity of the soil to retain excess water. Pollarding may be the solution to reduce the pressure of soil erosion and landslides and also provide adequate supply to fulfill the daily requirement of fuel wood, timber and fodder.

Source: Impact of Landslide and Erosion Control Treatment, A study in West Sikkim in Schemes and Policies Implemented from 1995-96 till 2010-11, Forests, Environment & Wildlife Management Department, Government of Sikkim.

4.2.3. Landslides

Heavy or prolonged rainfall, snow-melt, water-level change, ground water conditions and seismic triggers are the major causes of landslides in Sikkim.

Landslides account for a considerable loss of life, property and damage to communication networks, human settlements, agricultural and forest land. In all, there have been 642 landslides in Sikkim from 1957-2005, depicted in the table below.

Table 4.3: Number of Landslides

Districts	Number of landslides
North	32
South	368
East	153
West	89

Source: Sikkim State Disaster Management Authority, 2006

North Sikkim has an annual average of two landslides per sq. km, resulting into a mean land loss of 120 metres per km and a soil loss of 2500 tonnes per sq. km.

The maximum number of landslides is observed in South Sikkim due to complex geological setting combined with contemporary crustal movements, varying slopes, heavy rainfall, *"along with ever-increasing human interference in the ecosystem".* (M.S Rawat, 2012).

Human interference in the form of an accelerated pace of construction activities, especially with regards to road development exposing the inner rock structures that are further weakened by rains (SSDMA, n.d.).

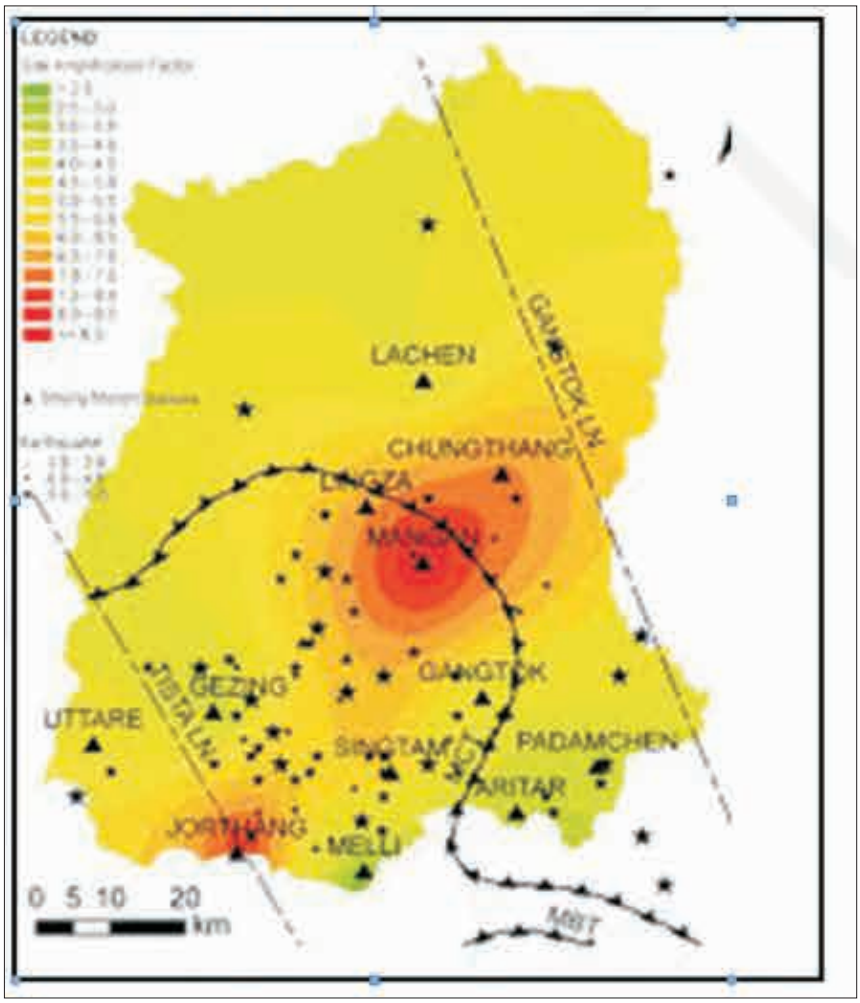
Photo 4.2: Landslides in Sikkim

4.2.4. Earthquakes

Earthquakes are a threat to all areas of Sikkim as the State falls under the Seismic Zone IV. Higher magnitude earthquakes can cause huge loss of life and property. One such earthquake was observed in 2011, with a magnitude of 6.8 on the Richter scale. The high intensity tremor triggered various types of natural calamities in the form of landslides, road blocks, falling boulders, lake bursts, flash floods, falling of trees, and caused severe damage to life and property Urbanization increases the vulnerability due to earthquake-induced landslides. (Land Revenue and Disaster Management Department, 2012).

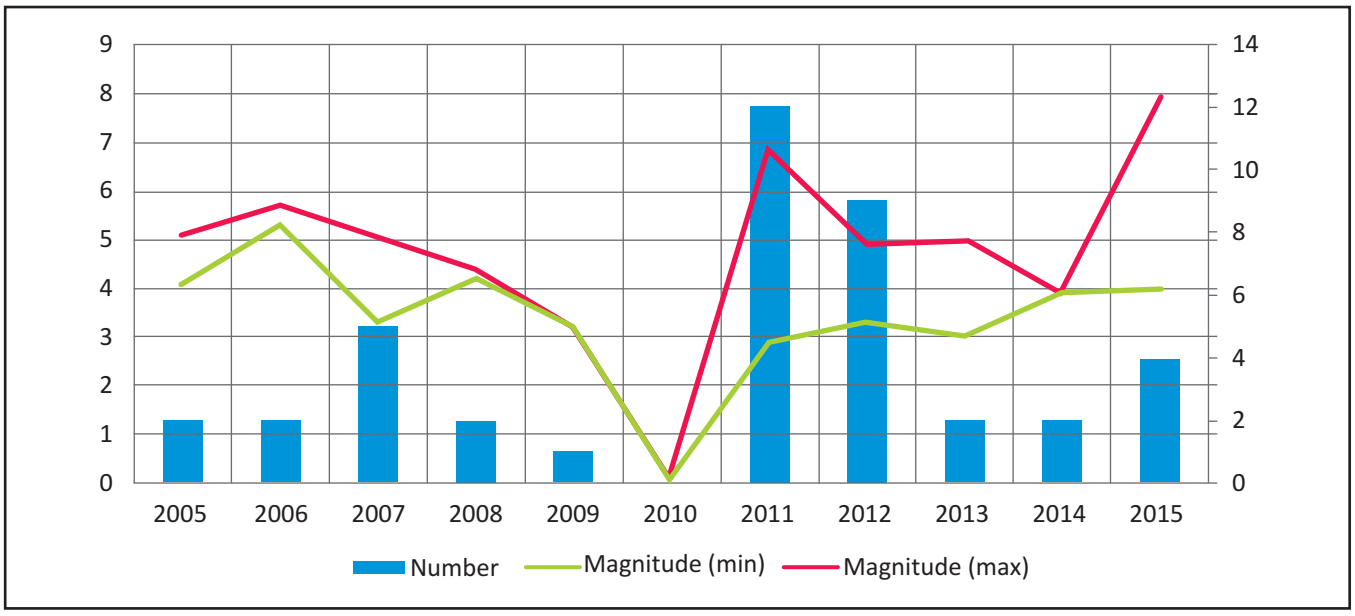
Photo 4.3:Earthquake in Sikkim

Map 4.1: Earthquake map of Sikkim



Source: ENVIS, Sikkim

Figure 4.3: Earthquake in numbers and magnitude in Sikkim



Source: ENVIS Sikkim

Table 4.4: Earthquake in number and magnitude

Year	Number	Magnitude
2005	2	4.1-5.1
2006	2	5.3-5.7
2007	5	3.3-5.0
2008	2	4.2-4.4
2009	1	3.2
2010	--	--
2011	12	2.9-6.8
2012	9	3.3-4.9
2013	2	3.0-5.0
2014	2	3.9
2015	4	4.0-7.9

Source: ENVIS Sikkim

There has been occurrence of maximum earthquakes during 2011, though such incidences have decreased since then. Recently, the year 2015 has again witnessed an increase in earthquakes (Figure 4.3, Table 4.4).

4.2.5. Forest fires

Fires are the biggest hazards to forests and are a grave threat to the entire ecosystem of the region. Forest fires start mostly due to natural causes such as lightning and high atmospheric temperatures, coupled with low humidity. But, there are also man-made causes for forest fires that range from electric sparks or ignition material. Besides the loss of precious flora and fauna, forest fire severely affects the regeneration of plants, soil moisture regime and the nutrient balance. At the same time, it also renders the trees highly prone to insect and fungal attack. The damage depends upon the frequency, intensity of fire, type of forest, availability of fuel and local climatic factors. The number of cases of forest fires has increased since 2005 as depicted in the table below.

Table 4.5: Forests Fires

Year	Cases of forest fires	Type of fire	Types of species damaged	Forest area damaged
2005	31	Ground fire	Ground bushes, Sal, Rhododendron	225 ha
2010	34	Ground fire	Ground bushes, plantations, Bamboo rhizomes, Teak, Chirpine	136.5 ha
2014	80	Ground fire	Ground bushes, herb plantation, Sal, Teak, mixed species, Bamboo, Rhododendron, and Juniper.	881 ha
2015	103	Ground fire	NA	502 ha
2016	19	Ground fire	NA	113 ha

Source: ENVIS Sikkim

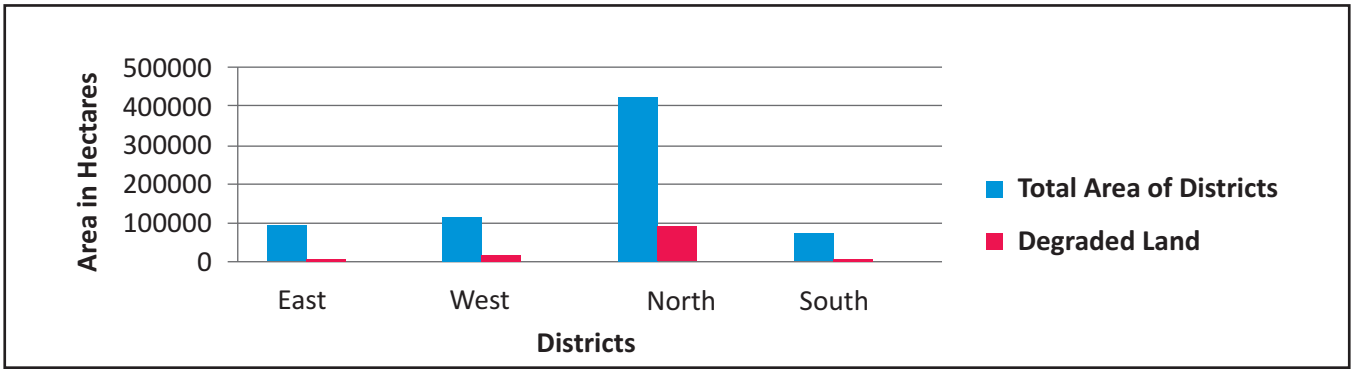
4.2.6. Urbanisation and development

Urbanization has been a rapid phenomenon across the state, though concentrated in a few centers like Gangtok, Namchi, Rangpo etc. The state has 9 urban centers whilst the share of population living in urban areas has gone up from 11.07 to 24.97 percent over the last decade. Consequently, there has been a rise in demand for developmental infrastructure, extension of road network, housing, economic opportunities and transportation facilities, creating huge requirements for land that needed to be diverted for varied uses.

4.3. Impact

In Sikkim, land degradation seems to be a major environmental concern. The total degraded land of Sikkim constitutes 17.32% of the total geographical area. (Cooperation, 2012. The causes of land degradation in Sikkim range from rocky wastes to severe water erosion (Table 4.6). South Sikkim is suffering from severe water erosion. East and West districts are affected both by severe water erosion and rocky waste. North District witnesses the maximum land degradation due to rocky wastes and glacial erosion (Sikkim, 2007).

Figure 4.4: Degraded Land in Sikkim



Source: Soil and Land Use Survey of India, Ministry of Agriculture and Cooperation 2012, Government of India.

Table 4.6: Land Degradation in Sikkim

Land Classification	Kind of Degradation
Agricultural Land	Severe Water Erosion
Forest	Severe Water Erosion/Landslides
Open Scrub	Rocky Waste, Glacial Erosion, Severe Water Erosion/Landslides
Wasteland	Rocky Waste, Glacial Erosion, Severe Water Erosion/Landslides
Pasture Lands	Rocky Waste, Glacial Erosion, Severe Water Erosion/Landslides

Source: Report on Inventory of Degraded Lands of East, West, North, South Districts of Sikkim using Remote Sensing Techniques, 2007, published by Government of Sikkim.

There has been a significant increase in wastelands in the category of snow covered/glacial areas and land with open scrubs. Over a total of 23 wasteland classes, Sikkim has shown a decline of almost seven percent in wasteland area from 2005 to 2009. (Table 4.7)

Table 4.7: Category wise distribution and change in Wastelands

(Area in Sq.Km.)

District Name	Land With Open Scrub			Under utilised/degraded forest (Scrub domain)			Barren Rocky / Stony Waste			Snow Covered / Glacial Area		
	2005-2006	2008-2009	Change	2005-2006	2008-2009	Change	2005-2006	2008-2009	Change	2005-2006	2008-2009	Change
East	1.03	10.57	9.54	4.51	4.21	-0.30	111.67	104.15	-7.52	5.12	2.52	-2.60
North	2.54	7.43	4.89	24.45	24.93	0.48	351.15	145.17	-205.98	2474.07	2662.62	188.55
South	2.26	1.68	-0.58	15.05	14.95	-0.11	5.09	3.66	-1.43	29.19	29.54	0.35
West	0.53	0.55	0.02	16.94	17.10	0.16	111.99	109.24	-2.75	125.28	134.83	9.55
Total	6.37	20.23	13.87	60.96	61.18	0.23	579.90	362.22	-217.67	2633.66	2829.51	195.85

Source: Wasteland Atlas of India 2011.

In all, 46.12% of the total land area falls under the wasteland category (Table 4.7). North Sikkim District recorded a maximum change of 188.55 sq. km. of its area under snow covered/glacial wasteland, while East Sikkim District recorded a negative change of -2.60 sq. km. Land with open scrub Area is the minor wasteland category, accounting for an area of 20.23 sq. km. (2008-09). East Sikkim District recorded a maximum change of 9.54 sq. km. under the land with open scrub, while South Sikkim District recorded a negative change of 0.58 sq. km. in same category.

Quantitative loss of land is also a phenomenon where land is lost to natural disasters like landslides and earthquakes. Exposed rocky surfaces are eroded by wind and water, rendering the land unusable.

4.3.1. Loss of biodiversity

From 2009-16, 2482.87 hectares of forest land has been diverted for various uses across the state. Though compensatory afforestation measures are reportedly successful, it is not absolutely effective in preserving the indigenous flora of the area. Land use change and agriculture intensification are one of the major reasons for biodiversity loss with pesticide use, synthetic nitrogen fertilizers, land consolidation, drainage and the use of heavy machinery being major factors (Organic farming and biodiversity, Government of Sikkim). The state houses 72% of the Indian species of Rhododendrons, 26% of all Indian flowering plants and 424 species of medicinal plants, indicating the need to preserve biodiversity in its natural habitat (Sikkim Action Plan on Climate Change).

4.3.2. Loss of human life and property

A 6.8 magnitude measuring earthquake struck Sikkim in 2011 and claimed 60 lives, in addition to injuring 719 people. The damage caused by the earthquake was intensified by seasonal heavy monsoon rains that caused landslides, mudslides and floods destroying thousands of homes, buildings, trees and infrastructure. More than 300 landslides occurred all over the state, ruining green patches of land and, disturbing the road connectivity to major towns like Mangan, Chungthang, and Lachung and even NH31A, main route connecting Sikkim and West Bengal. It was followed by road blocks, falling boulders, lake bursts and flash floods with incessant rain which continued for over a week after the earthquake (India Disaster Report, 2012)

4.3.3. Land pollution

The city of Gangtok has a population of approximately 6 lakhs with just one dedicated disposal site. At the site in Lower Martam, 50 metric tons of solid waste is dumped daily (Gangtok Municipal Corporation) in an unscientific manner. Leachates and contamination from synthetic products is a major contributor to land pollution across such sites in the whole state.

Organic Mission in Sikkim

The organic mission in Sikkim was formally launched on 15th August, 2010. The state engaged 6 accredited certification bodies in accordance with the criteria laid down by National Policy on Organic Production. Practices like forgoing the use of chemicals, use of organic manures, more diversified crop rotation, conservation tillage, more diversified farm structure etc. are essential factors that help enhance not only biodiversity, but strengthen natural cycles and improve environmental performance that in turn increases the sustainability of organic farms. This is an effective step in decreasing the pressure on land resources in the state where 80% of the rural population is dependent on agriculture and allied sectors for livelihood.

4.4. Response

- Sikkim has been declared a 100% organic State in the year 2016. January 18 declared as Organic farming day in Sikkim. The state covers 75,000 ha of land under organic farming.
- The State has a designated Disaster Management Authority responsible for its State Disaster Management Plan (SDMP). The disaster management plan includes community participation, structural and non-structural measures like relooking at disaster management programmes, amendment of laws and legislations to focus on creating resilience, creating regulations for better land use and safety, etc. Additionally, a State Disaster Relief Fund was earmarked according to the Disaster Management Act, 2005, which aims to support such plans.
- The forest fire management program is implemented during the fire season. Fire lines are cleared and fire camps set up for tackling fires. The JFMCs are equipped with firefighting equipment, training and awareness programs.
- The state has also been proactive in approving and checking compensatory afforestation for the forest land diverted to other purposes. From 2009-16, 2482.87ha of forest land have been diverted for various purposes, to compensate for which 4990.10ha of non-forest and forest land has been stipulated for afforestation.
- Land degradation treatment by Environment and Science divisions including landslide treatment, check dams, gully plugging and protective walls.

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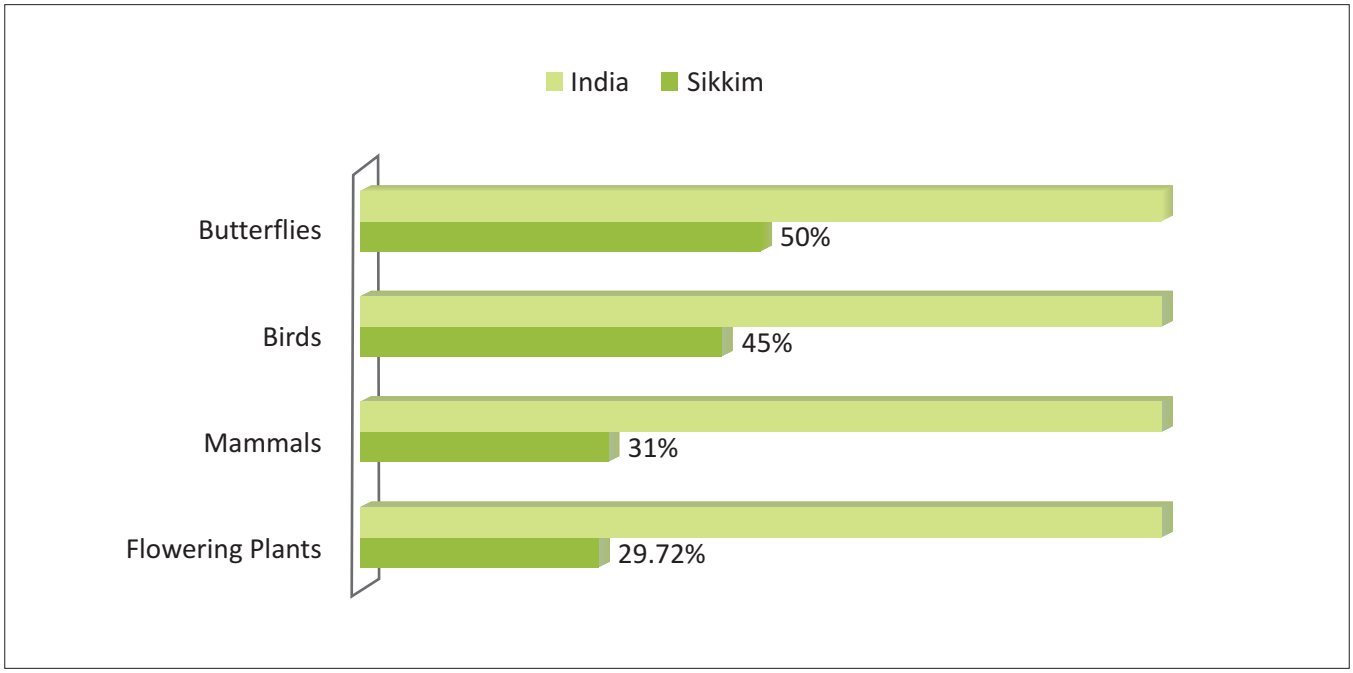
Chapter 5: Biodiversity

Sikkim is rich and unique in Biodiversity. The major issues impacting Sikkim's biodiversity are highlighted in this chapter. Sikkim is located in the ecological hotspot of lower Himalayas. This chapter also highlights how Government is responding to threats pertaining for a better and sustainable environment.

5.1. State

Sikkim is located in the Eastern Himalayas and is globally renowned for its rich biological diversity. The unique terrain, climate and biogeography of the state have resulted in the sustenance of varied eco-zones in close proximity. In addition, the harmonious presence of several ethnic groups, with distinct identities and traditional livelihoods, adds to the treasure house of knowledge on biodiversity. It is a land of vast variation in altitude from around 300 meters to 8586 meters above the sea level. The State houses 29.72 per cent of India's flowering plants. Rhododendrons, Primulas and Orchids constitute 33.88, 42.96 and 42.55 per cent of India's total diversity respectively (Figure 5.1). In terms of birds and butterflies, 52.28 per cent of the butterfly species and 43.68 per cent of the bird species of India are present in Sikkim. Globally, Sikkim is one of the richest habitats for birds. The highest numbers of vascular plants are named after Sikkim.

Figure 5.1: Biodiversity in Sikkim



Source: ENVIS Sikkim, Sikkim has habitats ranging from sub-tropical to cold deserts and has India's smallest bio-geographic province - Tso Lhamo Plateau. It is famous for the most extensive zone of krummholz (stunted forests) in the Himalayan zone (Tambe).

Sikkim has habitats ranging from sub-tropical to cold deserts and has India's smallest bio-geographic province - Tso Lhamo Plateau. It is famous for the most extensive zone of krummholz (stunted forests) in the Himalayan zone *(Tambe)*.

Being an agrarian State, a large variety of agricultural crops are grown in Sikkim. Over 175 cultivars of 69 crop species are cultivated, with rice having the highest number of cultivars (43), followed by maize (26). Elevation plays a prime role in fashioning the eco-regions of the State. This is evident from the presence of Sal forests in the Rangit Valley in the south to the temperate fir forests in the north, beyond which lie the trans-Himalayas and the cold desert of the Tibetan plateau.

Photo 5.1: Flora and Fauna of Tso Lhamo Plateau

Forests are extremely important for ensuring environmental functions. They facilitate climate regulation, soil and biodiversity conservation, and also ensure water security. Forests are a home to a wide variety of plants and animals and provide a range of ecosystem services and sustainable livelihood opportunities for local communities.

Sikkim represents five major types of forest systems: tropical, sub-tropical, temperate, sub-alpine and alpine forests. These forest systems harbour some of the unique and endemic species of flora and fauna.

The tropical forests are dry deciduous found in the valleys of Teesta and Rangit. Dillenia pentagyna, Dysoxylum floribundum, Albizia procera, and Alnus Nepalensis are few of the common species found in this area. Temperate forests are found in the Himalayan region in India. These are coniferous trees that have broad leaved trees and aren't very tall. In Yathang and Lachung such trees are found like fir, juniper, deodar, chilgoza, oak and ash. The Alpine forests are found in Chopta Changu areas in Sikkim. These are low scrub, dense evergreen forest, consisting mainly of rhododendron and birch. It can withstand heavy snowfall and mosses and ferns cover the ground during summer and spring. Above Yanthang in Sikkim we have the subalpine forests. The common tree species are red fir, black juniper, birch, and larch. Rhododendron is also a common species. Due to heavy rainfall and humidity in this area the timberline is also high.

5.1.1. Forests

Forest has been the major land use in the State, occupying 3392 sq. km. of the total geographical area of Sikkim (ENVIS Sikkim, 2015-2016). Legally, these forests are classified into Reserved Forests (76.83 per cent) and Protected Forests (5.48 per cent). As a matter of fact, Sikkim has a forest cover which is higher than 33%. The State has 47.80 per cent of its total geographical area under the forest and tree cover (0.43 per cent of India's forest and tree cover), of which 7.05% of the area is under Very Dense forests, 30.44% under Moderately Dense forests and 9.82% under Open forests (Figure 5.1). Outside the Green Wash (India F. S., State of Forest Report , 2013), the State has 1,392 sq. km of area under forest cover, which accounts for 19.62% of the total geographical area.

Biodiversity and Women

Biodiversity and women are strongly inter connected with each other because women particularly those living in rural areas and mountainous areas have a strong relationship with the forest ecology because they are responsible for gathering food, fire wood, fodder and water for the family. However, even today, despite their daily interaction with and dependence on natural resources, women have less access to and control over them than men. Women's work and knowledge is central to biodiversity conservation and utilization. They produce, reproduce, consume and conserve biodiversity. In forestry too, Women's knowledge is crucial to the use of biomass for feed and fertilizer.

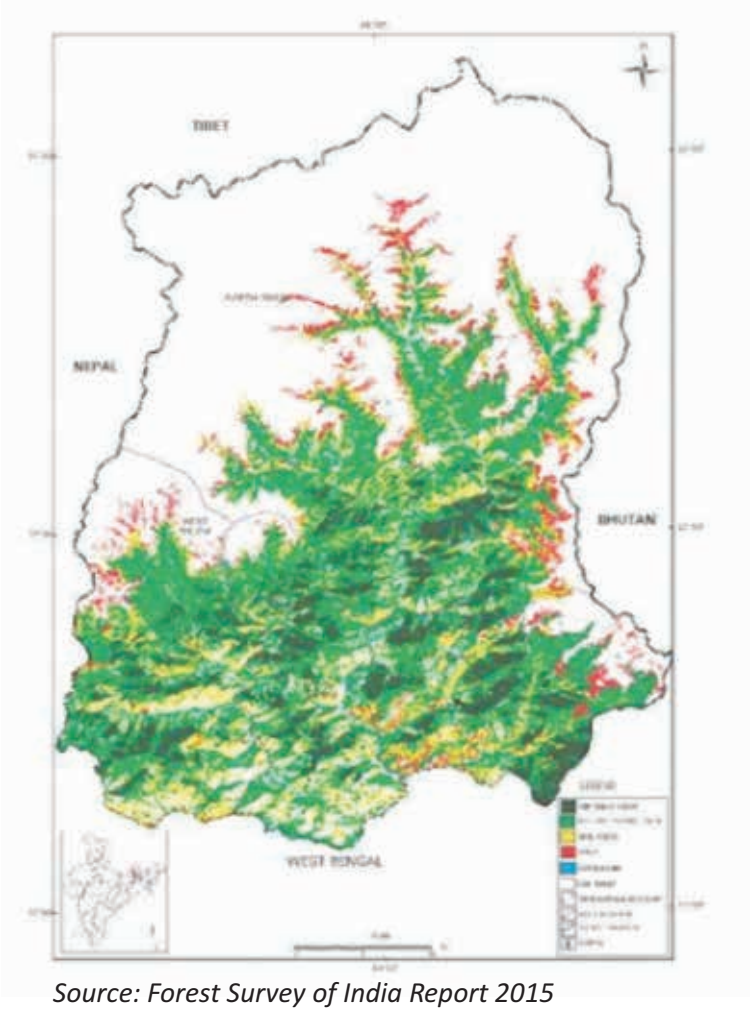
In agriculture, women has had been seed custodians since time immemorial and their knowledge and skills should be the basis of all crop-improvement strategies. When women conserve seed, they conserve diversity and therefore conserve balance and harmony.

Table 5.1: Forest Cover of Sikkim

Forest Cover within Green Wash	Area in sq. km
Very Dense Forest	390
Moderately Dense Forest	1,323
Open Forest	252
Sub-total	1,965
Forest Cover outside Green Wash	
Very Dense Forest	110
Moderately Dense Forest	837
Open Forest	445
Sub-total	**1,392**
Total Forest Cover	3,357
Tree Cover	35
Total Forest and Tree Cover	3,392
%age of State's Geographical Area	47.80%
%age of India's Forest and Tree Cover	0.43%

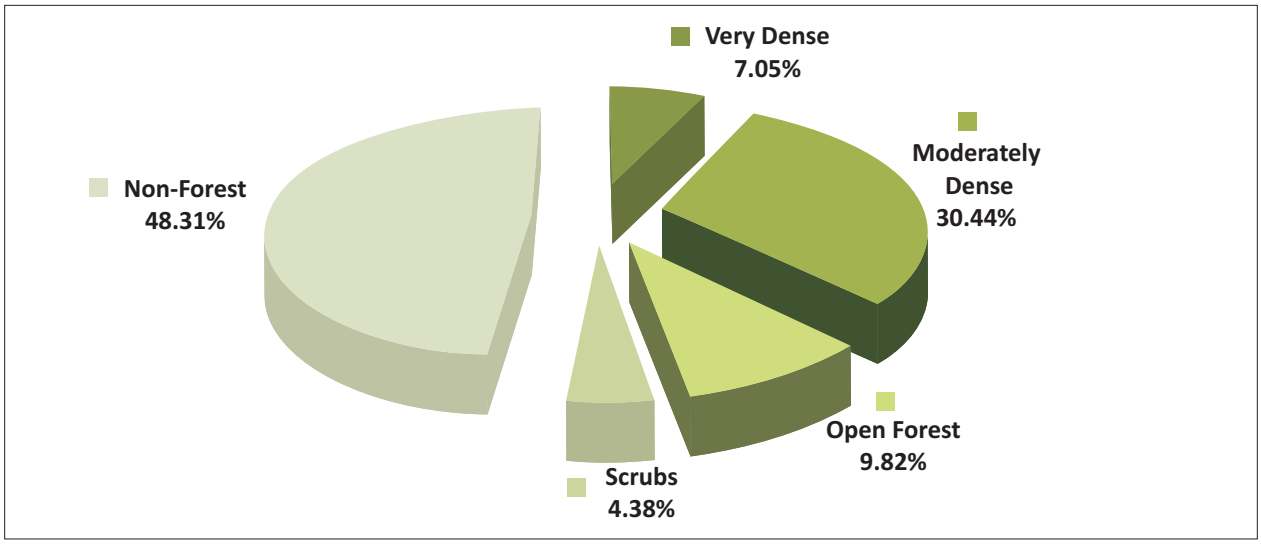
Source: Forest Survey of India Report 2015

Map 5.1: Forest Cover of Sikkim



Source: Forest Survey of India Report 2015

Figure 5.2: Forest Cover of Sikkim



Source: Forest Survey of India Report 2015

In fact, the forest cover has been nearly constant since 2009 despite several developmental activities in the State (Figure 5.2). The slight decline in the total forest cover in 2013 as compared to 2011 is attributed to earthquake-induced landslides in Sikkim in 2011 (India F. S., State of Forest Report, 2013). Similarly, there has been a minor decline in the total forest cover from 2013 to 2015 due to natural as well as anthropogenic disturbances such as landslides, road construction and shifting cultivation. (India F. S., State of Forest Report, 2015)

Table 5.2: Sikkim's Forest Cover

		2007		2011		2013		2015	
Districts	**Total area**	**Total Forest (sq. km)**	**Percentage of geographical area**	**Total Forest (sq. km)**	**Percentage of geographical area**	**Total Forest (sq. km)**	**Percentage of geographical area**	**Total Forest (sq. km)**	**Percentage of Geographical area**
East	954	699	73.27	699	73.27	699	73.27	699	73.27
North	4,226	1,315	31.12	1,317	31.14	1,316	31.14	1,315	31.12
South	750	571	76.13	571	76.13	571	76.13	571	76.13
West	1,166	772	66.21	772	66.21	772	66.21	772	66.21
Grand Total	**7,096**	**3,357**	**47.34**	**3,359**	**47.32**	**3,358**	**47.32**	**3,357**	**47.31**

Source: Indian State of Forest Report, 2007, 2011, 2015

South District has the maximum forest cover followed by the East District. This green cover is intact due to the strict implementation of the existing forest policies in the State as well as the sensitivity of the Government and the citizens

5.1.2: Protected Area

The State of Sikkim has 30.77% of its total geographical area under the protected area network (PA) with seven Wildlife Sanctuaries and one National Park (Table 5.3). The Khangchendzonga National Park is spread in North, South and West Sikkim within the altitudinal range of 1400 m asl - 8598 m asl.

Sikkim's diverse faunal base includes more than 125 species of mammals of which many species viz., Red Panda, Snow Leopard, Clouded Leopard, Musk Deer, Tibetan Wolf, Red Fox, Indian Wild Dog, Hog Badger, Tibetan Sheep or Argali, Tibetan gazelle, Serow, Goral, Tibetan Wild Ass, etc. are included in the Indian Red Data Book. Some of the endangered mammalian species of Sikkim are Bharal, Fishing Cat, Golden Cat, Leopard Cat, Marbled Cat, Himalayan Tahr, Pangolin, Spotted Lingsang, Tibetan Fox, etc. are also found in Sikkim.

Similarly, few of the bird species of conservation concern in Sikkim are Black Necked Crane (Migratory), Blood Pheasant Lammergeyer, Large Falcon, Monal Pheasant, Peafowl, Tibetan Show Cock, Satyr Tragopan, Snow Partridge, etc.

Table 5.3: Protected Areas in Sikkim

S.No.	Name of Protected Area	District	Area (Sq. km)
1.	Fambong Lho Wildlife Sanctuary	East Sikkim	51.76
2.	Kyongnosla Alpine Sanctuary	East Sikkim	31.00
3.	Pangolakha Wildlife Sanctuary	East Sikkim	128.00
4.	Maenam Wildlife Sanctuary	South Sikkim	35.34
5.	Kitam Bird Sanctuary	South Sikkim	6.00
6.	Barsey Rhododendron Sanctuary	West Sikkim	104.00
7.	Shingba Rhododendron Sanctuary	North Sikkim	43.00
8.	Khangchendzonga National Park	West/North/South	1,784.00
Total Area of Pas			**2,183.10**
9.	KNP Buffer zone	North/ West	836.00
10.	Khangchendzonga Biosphere Reserve (KNP+Buffer =1784+836)	North/ West	2620.00
Total Area of PAs			**7096.00**

Source: http://www.sikkimforest.gov.in/Wildlife.htm

5.1.3. Medicinal Plant

Medicinal plants ought to be given the status of "National Resource". It may make substantial contributions to our economy and generate employment as well. Conservation and development of the country's medicinal flora will not only serve the national interest, but will also serve global needs, since there is a growing worldwide demand for natural medicines.

A strong traditional system of medicines based on 424 species of medicinal plants is present in Sikkim (SoER Sikkim, 2007). They are mostly found in forests like 90% of the medicinal plants in India. Abelmoschus manihot (L.), Medikus Curcuma longa Roxb., Datura stramonium Linn. are some of the popular medicinal plants in Sikkim. These plants are used to treat epilepsy, leprosy paralysis, asthma, typhoid, diabetes, hemorrhages during childbirth, cholera. Therefore, they act as a primary healthcare need and are even available in Auyurvedic texts. They are important part of local tradition in Sikkim and play a considerable role in the rural sector. Sikkim has great potential of Yarsta Gunbu which has high demand end in international market. The medicinal plants are less utilized on a commercial basis, and the Sikkim Government can gain income if these medicinal plants are marketed well.

5.1.4.Wetlands

Wetlands are amongst the most productive ecosystems

on Earth (A.Ghermandi, 2010). They exhibit enormous diversity according to their genesis, geographical location, water regime and chemistry, dominant species, and soil and sediment characteristics (Space Applications Centre, 2011). The major lakes of Sikkim are Changu (Tsomgo), Khecheopalri, Gurudongmar, Cholamu, Menmecho, Lampokhari, Samiti etc. The Tsomgo lake is one of the important tourist sites in Sikkim.

Wetland ecosystems form an ideal habitat for Red Panda, Rhododendrons and various species of birds. Gurudongmar is located at an altitude of 5,183 meters above sea level and it is the largest glacial lake located in the northern district of Sikkim. It is the source of the stream Chhombo Chhu, which ultimately meets another stream flowing from Tsho Lhamo and together form the Teesta River.

Tsomgo is located at an altitude of 3,700 meters above the sea level, being one of the 11 sacred high-altitude lakes in Sikkim, notified by the Sikkim Government in 2001 as 'a religious place more than 100 years old'. Besides, teeming with a variety of floral and faunal species, the wetland receives huge flocks of waterfowl (about 10-15 at one time) which use this site for halting and transit.

The North district of Sikkim has the maximum percentage of geographical area under its total wetland area (Figure-5.4).

Figure 5.4: Distribution of Wetlands in Sikkim

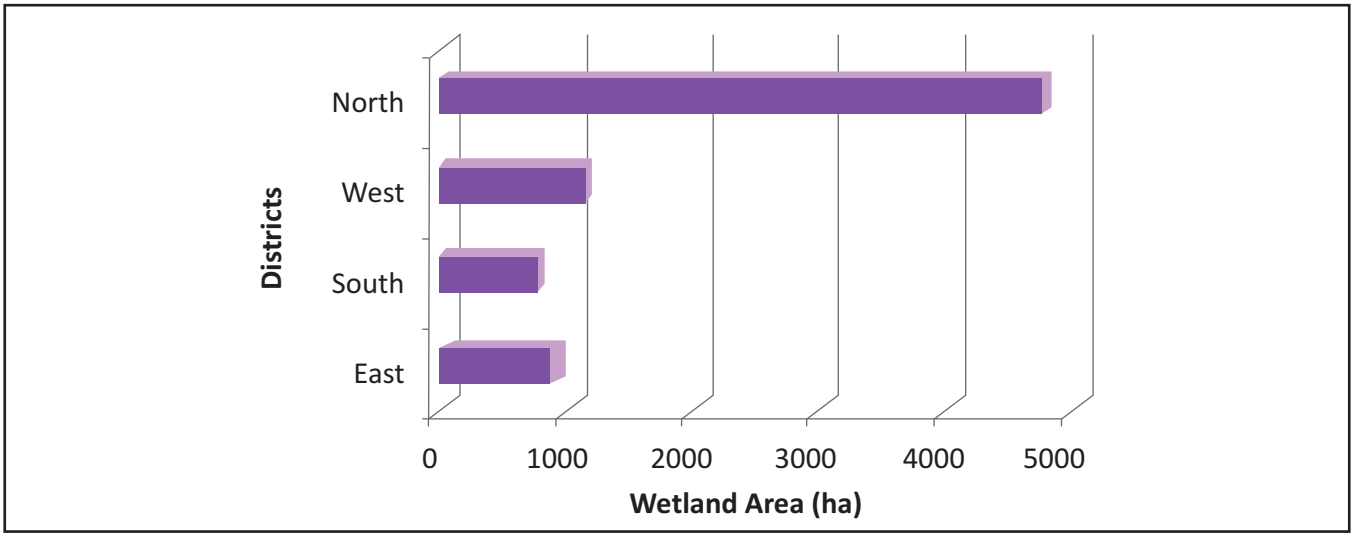


Table 5.4: Distribution of Wetlands in Sikkim

		Geographic area	*Wetland area*	*% of total wetland area*	*% of district geographic area*
S. No.	**District**	**(ha)**	**(ha)**		
1	North	422600	4764	63.72	1.13
2	West	116600	1069	14.30	0.92
3	South	75000	739	9.88	0.99
4	East	95400	905	12.10	0.95
	Total	709600	7477	100.00	1.05

Source: National Wetlands of Sikkim -2010, Published by Space Application Centre, Indian Space Research Organisation, Ahmedabad

5.2. Pressure

The biodiversity of Sikkim faces a number of threats like soil erosion, deforestation, air pollution, waste management, habitat fragmentation etc. These environmental threats stem from natural and anthropogenic factors. In fact, disasters and developmental activities lead to biodiversity loss to a great extent.

Rhododendrons of Dzongu Valley Sikkim

The majority of rhododendrons explored in the Sikkim Himalayas are entirely new to rhododendron world. A major part of Dzongu especially the upper reaches, falls inside the Khangchendzonga National park only included in tentative list of UNESCO's World Heritage Site.

Photo 5.2: Rhododendron Campylocarpum var.elatum

Some of the newly discovered species i.e.R.Mekongense.The unique species found are R.Maddenni and R.Niveium

Source: A Note on Rhododendrons of Dzongu Valley Sikkim, The New Zealand Rhododendron, Volume 3, 2015

5.2.1. Introduction of alien/exotic species

International Union for Conservation of Nature and Natural Resources defines Alien Invasive Species as a species which becomes established in natural or semi-natural ecosystems or habitats, act as an agent of change, and threatens native biological diversity.

Alien species are non-native or exotic organisms that occur outside their natural adapted ranges and dispersal potential (M.A.Mc Geoch, 2010). However, some of the alien species become invasive when they are introduced deliberately or unintentionally outside their natural habitats into new areas where they express the capability to establish, invade and out-compete native species *(A. S. Ragubhanshi, 2005)*.

5.2.2. Zoonotic Diseases

In Sikkim recently there has been many cases of zoonotic diseases such as FMD (Foot and Mouth Disease), Avian influenza (Bird Flu), Canine and Feline Distemper, Rabies and Swine flu. These diseases effects domesticated as well as wild animals.

Wild animals like Golden Jackal and Hill fox are carriers of rabies virus which is usually fatal to livestock and human beings. Hence such infections cause high mortalities. In order to prevent heavy economic losses regular immunization is the need of the hour

5.2.3. Waste Management

Presently, waste is becoming a hazard for environment. As Gangtok faces increasing urbanization and migration, it has a proportional increase in the generation of solid and liquid wastes. This in turn escalates pollution which affects health care, environmental quality, tourism, and sustainable development in general. Gurudongmar and Tsomgo wetlands are facing problems due to garbage accumulation and inadequate infrastructure for functional public toilets. The wetland ecosystem faces problems due to cattle grazing and religious offerings (WWF, 2015). There has been a decline in the status of biodiversity due to improper management of solid waste in other parts of Sikkim (Department of Forest, 2011). However, Gangtok is among the 9th cleanest city in India according to CSE (2016).

5.2.4. Climate Change

Biodiversity is also impacted due to rainfall and temperature variance. Sikkim currently, since the last decade annual rainfall has decreased at the rate of 17.77 mm/year, respectively. There is also a decrease in number of rainy days. This has a clear impact on life in the forests (H. Rahman et.al in Arrawatia & Tambe, 2012). Climate induced changes have directly or indirectly impacted the habitat and distribution limits and the food availability for wild animals. Due to the shortage of food, wild animals wander around human habitations in search of food. For example, one of the probable reasons for random movement of Himalayan Black Bear in villages and towns in recent years could be climate change. This species eats acorns and nuts of the previous year, and if the productivity of such nuts decreases due to unusual weather events, they wander around for other foods. Many other animals might have been the victims of such events. Increase in temperatures and low humidity over Sikkim have also caused increase in forest fires causing loss of flora and fauna.

5.3. Impact

Impact on biodiversity can be zeroed down to population growth and overconsumption in addition to climate change. Pollution generated due to these issues can affect the air, water, vegetation or animals in various ways. Homogenization of species and habitat alteration is among the visible impacts of such a change. Habitat alteration or fragmentation is the loss and subdivision of a habitat and the corresponding increase in other habitats in the landscape. Increase in agricultural lands while removing natural forests is a good example. In various parts of Sikkim, populations of many plant species are becoming rarer due to increasing anthropogenic pressure and diminishing forest area. Homogenization of ecosystems is when there is a decrease in the number of native species in a habitat while being replaced with "weedy" widespread species causing homogenization. Habitat destruction and fragmentation is threatening the survival of many endangered species. Introduction of exotic (non-native) species into an area, either by accident or on purpose is also a major threat to the native species.

Such alien species, generally, do not have their natural predators to keep populations in check and hence, can rapidly affect local species and invade large tracts of land and water. For example, Titebati (Artemesia milagirica) and Banmara (Eupatorium adenophorum) are spreading uncontrollably in parts of Sikkim. They suppress regeneration of the natural flora, and can cause reduced yields and increased harvesting costs on agricultural land. Some invasive species (e.g. Parthenium) also can cause animal health problems.
An impact of climate change on biodiversity in Sikkim is through the change in seasonal flowers and growth of new crops in the region. There is also a change in habitation of various birds, animals and insects. The treeline is also shifting upward due to climate change. Tree species from the low altitude tree are gradually shifting towards high altitude zones as the climate is more suitable for survival. Alnus nepalensis found around Gangtok is a species that usually is found in warmer regions. There is also an increase in growth of weeds and shrubs like banmara that hamper the growth of forests (Climate Himalaya, 2011).

5.4. Response

The Sikkim Government has built up a repository and dissemination centre in Environmental Science and Engineering to support e-governance. Modern technologies of information acquisition, processing, storage, retrieval and dissemination of environmental information have been geared up. There has been an extension of Indian State-level Basic Environment Information Database (ISBEID).

The state has launched an innovative and unique programme for the participatory conservation of the alpine areas by enrolling local community level resource persons as **Himal Rakshaks** or **Honorary Mountain Guardians.** These Himal Rakshaks have been trained on participatory monitoring of the alpine areas. For the conservation of high altitude lakes impacted by tourism, the local community has been empowered and involved in lake management through the **Pokhri Samraksham Samiti** initiative. The practice of grazing is totally banned in these forests.

A comprehensive plan for development of the lakes as eco-tourism destinations would be attempted. Restoration measures like desilting, providing silt detention structures, weed control, abatement of pollution, awareness etc. are being adopted. **Khecheopalri (West Sikkim), Tsomgo (East Sikkim) and Gurudongmar (North Sikkim) wetland** complexes **would be attempted to be included in Ramsar Sites**.

A State Level River Conservation Authority is proposed to be set up with the objective to keep the rivers pollution free and to maintain a healthy aquatic ecosystem. The concept of Eco-protection of river/rivulets and the mechanism for 'Pay when you litter' against any dumping garbage and waste material will be developed. All the villages/ residential areas adjacent to main streams and rivers will be actively involved in the management and conservation of rivers by formation of River Conservation Protection Force.

The base line data for water quality of all water bodies, bio-indicators and human habitation effect will be collected and GIS mapping will be done for all water bodies in Sikkim.

The Government of Sikkim has constituted the Sikkim State Wetland Authority for conservation and management of wetlands in the State. The Government of Sikkim launched the State Green Mission with a view to raising avenue plantation and beautification of all vacant and waste lands. The major objectives of the programme are to create a green belt and avenues for meeting aesthetic recreational needs of the people and beautify the areas for tourist attraction. Under Integrated Watershed Development Program (IWDP) for Non-forest areas through the Zilla Parishad with more emphasis on fuel wood and fodder plantation to reduce pressure on natural forests and to enhance the productivity of land.

The Government of Sikkim has imposed a five-year ban on collection of all medicinal The notification on eco-sensitive zones relates to areas surrounding the Maenam Wildlife Sanctuary, Kitam Bird Sanctuary and Barsey Rhododendron Sanctuary as eco-sensitive zones. Development activities, including mining, quarrying or setting up new ‘major’ hydro-electric projects, will not be allowed in these areas.

The purpose of an eco-sensitive zone is to create areas that can act as shock absorbers around the identified stretch to protect environment and wildlife. The extent of eco-sensitive zone, under the notification, varies from 25 meters to 200 meters from the existing boundary of the national parks and sanctuaries, depending on the topography of the region and its proximity to international boundaries with Nepal and China.

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Chapter 6: Urbanisation

This section of the report deals with the trends, patterns and status of urban development in Sikkim. The pressures arising due to urban growth on environment like population growth, urban transport, urban economic activities and construction activities have been highlighted in the section. All chapters of this section highlight the issue in PSIR framework that is Pressure-State-Impact-Response framework. The complex relationship between socio-economic and environment has been established, whereas impact are evaluated as consequences of the pressures. Last section of the chapter deals with responses which deals with Government initiatives to mitigate the negative impacts of the changes and keep them on track of sustainable development.

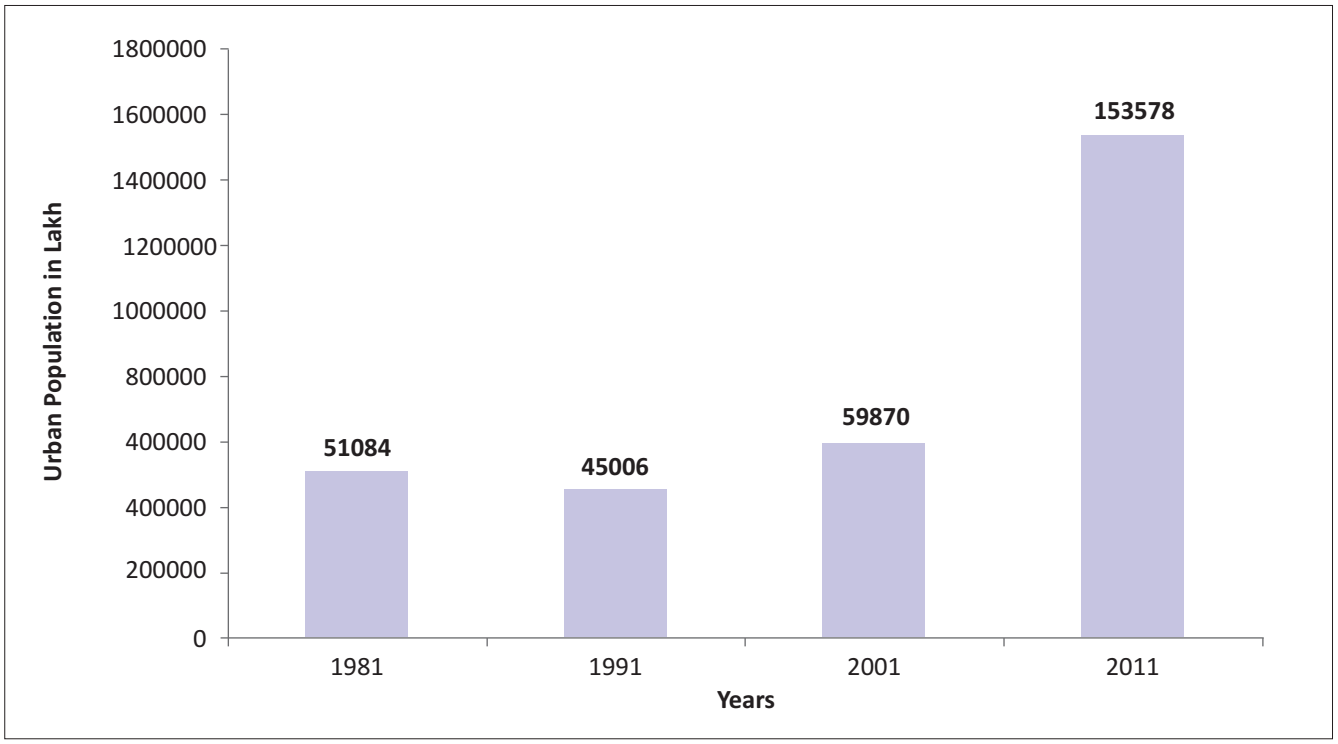
6.1. Introduction

Sikkim has witnessed rapid urban growth in last one decade from 11.07 to 24.97 percent recording annual exponential growth of 9.3 percentage points. There are 9 urban centres in the state, three of its districts share their boundaries with the neighbouring countries except the South district. As per the Surveyor General, India figure, North district is the largest sharing 4226 Km2 (59.55 per cent) of the total area of the state. West district has 1,166 Km2 (16.43 per cent) and is at the 2nd position, South district has 750 Km2 (10.60 per cent) and the East district claims 954 Km2 (13.44 per cent) thus being in the third place in terms of area.

6.2. Trends in urban Population

Out of the total population of 0.64 Million 74.85 per cent of the state population lives in the rural areas while 24.97 per cent of the state population lives in urban areas according to 2011 census. Spatial population variation could be found in the districts, as 89.38 per cent of the population in the North district lives in the rural areas while only 10.62 per cent are in urban area at Mangan (Nagar Palika). In West district 96.15 per cent population lives in rural area while only 3.85per cent population lives in the urban areas at Gyalshing (NP) and Nayabazaar (NBA). In South district 85.56 per cent population lives in rural areas while the only 10.62 per cent are in urban area at Mangan (NP). In West district 96.15 per cent population lives in rural area while only 3.85per cent population lives in the urban areas at Gyalshing (NP) and Nayabazaar (NBA). In South district 85.56 per cent population lives in rural areas while the remaining 14.44 per cent lives in the urban areas at Namchi (M.CL) municipal council and Jorethang (NP) Nagar Palika. Similarly, in the case of the East district 56.81 per cent population lives in rural area while 43.19 per cent in the urban areas at Gangtok (M.Cor), Municipal Corporation, Singtam (N P), Rangpo (NP) and Rhenock (CT) Census Town. Higher percentage of urban population in the East district reflects the reason that all the four urban centres including Census Town fall in the jurisdiction of East District. There has been decadal growth of -4.99 per cent and 156.52 per cent in the rural and urban population respectively during the decade 2001-2011 census.

Figure 6.1: Increase in Population



Source: Census of India (1951-2011)

The percentage of decadal growth stands at 12.36 per cent. While the rural population has fallen by 5.2 per cent, the urban population of Sikkim has shot up by 153.43 per cent. The population of North district of Sikkim has fallen by 2.7 per cent in rural areas in the past 10 years while the urban population has grown by 272.44 per cent.

The maximum urbanisation has taken place in South district of the state at 434.44 per cent and the minimum in East district at 128.47 per cent. The growth population in the two other districts of North and West are 272.44 per cent and 187.23 per cent respectively.

Total urban populations of the state 153,578 persons are scattered in the eight statutory towns and one census town. Gangtok (M.Cor), the capital town of the state is obviously the most populated with 100,286 persons followed by Namchi (M.Cl) and Rangpo (NP) with 12,190 and 10,450 respectively. The census town, Rhenock has the population of 5,883 persons. Thus it is apparent that all the four towns sharing 122,487 (79.76 per cent) are located in the East district. South district has the urban population 21,199 which constitute 13.80 per cent of the total urban population. Similarly West district has 5,248 (3.42 per cent) and the North district has 4,644 (3.02 per cent) of the total urban population of the state, the least among the rest.

There is a rapid growth in urban population from the year 1971.There has been a decline in the rural population from 2001 to 2011, whereas the urban population has increased rapidly from 1981 to 2011.

There were no urban centres in Sikkim half a century back. The single most important factor that expedited the process of urbanisation in Sikkim has been the construction of surface roads and entry of vehicular traffic. . On an average day, about 30,000 vehicles enter and exit Gangtok. The maximum volume of traffic is between Indira bypass and Metro Point (55174 PCU) while the volume between Zero Point and Metro Point is quite high (approx. 36,500 PCU). Of the total trips, about 74% of the trips generated and 64% of the trips are attracted by Gangtok city itself. This clearly presents Gangtok as a major consumption and distribution center of the State of Sikkim. (JNNURM)

Definition of Urban Area

1. a. All places with a municipality corporation, cantonment board or notified town area.
   b. All other places which satisfy the following criteria
      I. A minimum population of 5000
      ii. At least 75% of male working population engaged in non-agriculture pursuit and
      iii. A density of population of at least 400 /sq. km (1000/ sq. mile)
2. A district /sub-division/ tehsil headquarters, if not a statutory town, need to be treated as a census town only if it satisfies the demographic criteria mentioned in Para 1(b). The character of urbanization is nonetheless changing as the biggest cities in the developing world gain denser population and extends further into the countryside and as crossroad and marked towns rapidly transform into urban centers. (India, Census of India, 2011)

6.2. State

Sikkim is divided into four districts. The table below shows the number of towns in each district.

Table 6.1: Sub Divisional Administration Unit in Sikkim

Districts	Sub Divisional Administration unit	Number of towns
North	Mangan, Chungthang	2
East	Gangtok, Pakyong, Rongli	3
South	Namchi, Ravong	2
West	Gayzing (Gyalshing), Soreng	2

Source: Census, 2011.

During every census decade, the number of Census town, Municipal Corporations, Municipal Councils, Nagar Panchayats and Notified Bazaar Area in Sikkim changes due to addition of new census towns, declassification of old census towns, conversion of villages into Municipal Corporation, conversion of Municipal Councils, conversion of Nagar Panchayats into corporations and merging of municipal councils into corporation etc. For the purpose of comprehensive analysis of various demographic characteristics, towns have been divided into six classes by population size. Following table presentation gives the number of urban units in each population size and class.Example: Gyalshing and Namchi have been added to the list of urban centres in 2011 as they witnessed population growth from 828 to 4013 and 979 to 12190 respectively. (Census of India 2011)

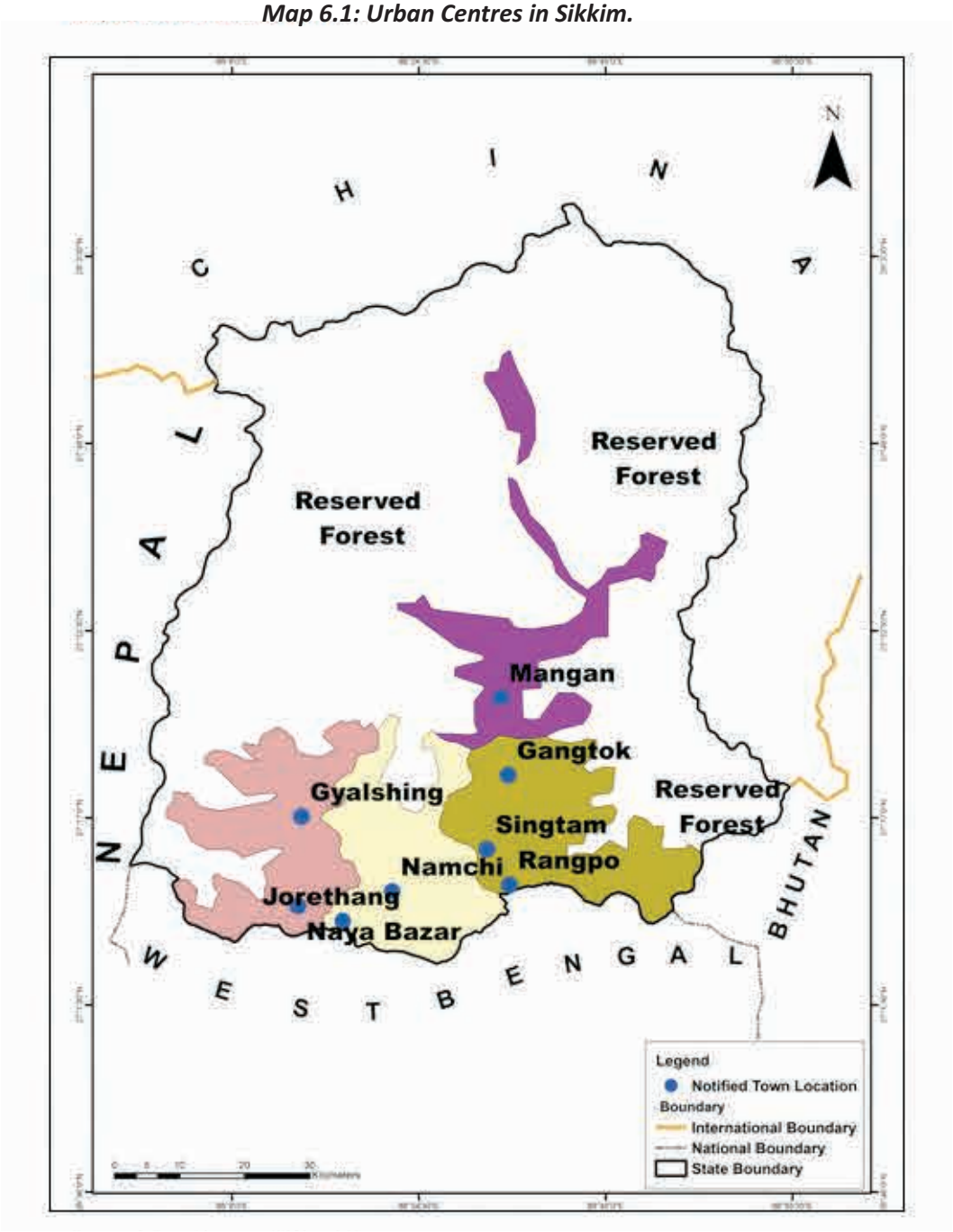
Table 6.2: Size, Class and status of Towns

Class	Population Size	Number of Towns
1	100000 and above	1
2	50,000-99999	-
3	20000-49999	-
4	10000-19999	2
5	5000-9999	3
6	Less than 5000	3

Source: Census of India1971-2011, Government of India

In Census 2011 only single town belong to class I with population size of 100,000 and above i.e. Gangtok. There is no town under classes of II and III with population size of 50,000 to 99,999 and 20,000 to 49,999 respectively. Out of the total nine towns one town Gangtok Municipal Corporation belong to class I while two towns namely Namchi Municipal Council and Rangpo Nagar Panchayat fall in class IV with population size of 10,000 to 19,999. The three towns each namely Jorethang Nagar Panchayat, Singtam Nagar Panchayat and Rhenock Census Town falls in class V with population size of 5,000 to 9,999 while other three towns each namely Mangan Nagar Panchayat, Gyalshing Nagar Panchayat and Nayabazaar Notified Bazaar Area fall in class VI with population size of less than 5,000.

Map 6.1: Urban Centres in Sikkim.



Source: Development Alternatives

Table 6.3: Decadal Growth by State and District per Person, 1971 to 2011(Urban)

Census Year	Sikkim	North	West	South	East
1971-1981	159.73	135.65	54.84	339.03	154.08
1981-1991	-11.9	2.95	475.25	-52.12	-26.29
1991-2001	33.03	55.42	-81.32	53.6	65.83
2001-2011	156.52	272.12	187.72	437.23	131.75

Source: Census of India1971-2011, Government of India

The maximum decadal growth has been observed during the decade of 2001-2011.The maximum growth is being observed in the South district of Sikkim which may depict its potential of becoming an urban centre in future.

6.3. Pressures

The key pressures which effect urbanisation are problems of rise in population, increasing urban economic activities. Urban transportation and rise in construction activities in the state.

6.3.1. Population

Sikkim has witnessed decadal population growth rate of 156.52 percentage points (2001-11), with spatial variations amongst the urban centres of the state. This resulted in concentrated population pressures on urban centres like Gangtok, Rangpo , Namchi Singhtam and Naya Bazaar- Jorethang. Since 2007 tourism in the state has risen by approximately 21 percent resulting in increase in pressure on state and environment.

6.3.2. Increasing Construction Activities:

As population is increasing over years, complementarily construction activities are also increasing to cater the need of housing and infrastructure development in the state. As Sikkim does not have availability or access to local materials, they have to import it from neighboring towns like Siliguri, Darjeeling. The commutation of material through heavy vehicles increase the pollution and carbon foot prints which results in environmental degradation. This could be witnessed at development of National Highway 31 where most of the construction development is taking place due to easy accessibility of roads and rising demand by urbanizing towns like Rangpo and state capital Gangtok.

6.3.3. Urban Economic Activities

Tourism in Sikkim has emerged as the new profession of the local citizens with its vast natural potential. Promotion of tourism, homestay, cultural tourism, trekking tourism, ecotourism, wellness tourism, flori–tourism and adventure tourism has given fillip to the tourism trade in the state where a large of number of people are engaged under different employment opportunities. According to tourism and civil aviation department there is frequent inflow of tourism in the state specially in the month April to June hence this increase pressure on local resources and increases the threats to protected areas by deteriorating the bio diversity of the region due to increase in land pressure and pollution. (City Development Plan Gangtok)

6.3.4 Urban Transportation:

Given the terrain of Sikkim and in view that connectivity and accessibility are the key bottom lines, the growth of urban centres has been linear in nature, which means that the urban development of Sikkim has been taking place on main roads and on the arterial roads connecting the town and the state to West Bengal. This has also proved to be a major challenge for the state in addressing the issue of town development, due to the mixed land use pattern, where no area could possibly be earmarked for specific activities. The main mode of transportation in Sikkim are Taxi and Buses, which contribute to the transportation economy of the state

6.4 Impacts

6.4.1 Impacts on Habitats and transport

The types of changes that will affect urban areas can be due to as changes in means, changes in extremes, and changes in exposure With continued increase in urban habitats, as the rural population shifts to urban areas, changes in means of climate parameters will intensify the stresses faced by poor urban residents on a day-to-day basis, and may reduce or deplete their stocks of assets and resources they require to face occasional extreme events. While increase in the intensity of these extreme events shall have significant implications for the households, livelihoods of these group of people. Specifically in relation to urban areas, the IPCC states that “climate change is almost certain to affect human settlements, large and small, in a variety of significant ways”. Climate change is likely to exacerbate many of the risks faced by low-income urban residents – the IPCC also states that “poor communities can be especially vulnerable, particular those concentrated in relatively high-risk areas” (Willbanks et al 2007: 359). Urban areas developing countries such as India, already house a large percentage of the people and economic activities most at risk from climate change, including extreme weather events.

Table 6.4: Likely impact of climate change on urban habitats

Changes in Mean	
Temperature	Increase in energy demand for heating and cooling
	Worsening of air quality
	Impacts exaggerated by the urban heat island effect due to a higher density of habitats
Precipitation	Increased risk of land slides
	Distress migration from rural areas
	Interruption in food supply
Changes in Extreme Rainfall Cyclones	Higher risk of land slides
	Disruption of livelihoods and urban economy
	Distress migration from rural areas
Heat or Cold Waves	Short term increase in energy demand
Changes in Exposure Population Movement	Movement from stressed rural areas
	Extended vector habitats
	Exposure to heat stress

Source: Willbanks 2007

The transport sector a major source of GHG emission. Avoiding or reducing transport, shifting transport to less polluting modes and improving existing modes are the three major starting points. The relevant policy instruments include planning, regulatory, economic, information as well as technical instruments. Improved transportation planning, better roads, improved efficiency of energy use in transport and introduction of bio fuel mix in fossil fuel, and more use of CNG are some of the measures that can be introduced to reduce emissions from this sector in Sikkim. However, other than being the source of emissions, the road transport sector is also at risk due to climate change in Sikkim, as the roads may be exposed to increased incidences of land slides. Also increase in extreme precipitation may increase the number of accidents due to increased skidding on wet roads. Further melting of perma frost at higher altitudes may affect the high altitude roads that link the international borders. Therefore, a strong road network that is resilient to climate change is essential for the economy of the state, as it is land locked and goods and people travel in and out of the state using the roads. Improved design of roads to make them climate proof is therefore essential.

6.4.2. Solid Waste Management

Solid Waste management is another influencer of urbanisation. In the city of Gangtok, MSW (Municipal Solid Waste) collection is done through community bins and by municipal trucks on pre-informed timing. The arrival of these trucks is notified by ringing of bells. It is reported that 40 tonnes of waste was collected on each day during 2012-13. Mangan Nagar Panchayat (MNP) practices door- to- door collection on a daily basis. MNP is the first agency in the state to install an organic waste converter, which is processing 300 kg of organic waste per day. MNP is also collecting waste which contains 50% compostable organic matter, 20% recyclables plastics, 16% rags, with the remaining portion being inert. Segregation and storage norms are not followed strictly by any municipality. Even transportation, processing and disposal norms are followed in specific

situation. Solid waste disposal is one of the biggest problems for urban centres in Sikkim. In Gangtok, only 40% of the waste is collected and the rest is dumped into natural water systems and valleys. In 2015, all districts combined produced 105.7 Metric Tonnes/day, and this is projected to increase to 141.9 MT/day in 2025 (Sikkim Strategic Plan, 2008). Even toxic and biomedical wastes do not have disposal mechanisms. Waste accumulation causes increased pollution and diseases in areas that do not have effective disposal mechanisms. Hence, there is a need to understand the composition of municipal solid waste for proper recycling and appropriate management.

Important set-up of Municipal waste processing and disposal facilities:

MSW from areas under Gangtok Municipal Corporation are sent to Martam. The waste is dumped here, the dumping site of sanitary landfill in Martam is underway. The project was funded by Asian Development Bank and is led by Urban development and Housing Department of the state. The collection through community bin and collection from door steps is done, in 20140- 15 it is reported that 40 tonnes per day waste was collected.

MSW from Namchi Municipal area is dumped at Sipchu, near Jorethang (west Sikkim), the site is funded by CPCB. The municipal waste collected by Namchi Municipal Corporation in 2014-15 was 5.25 tonnes per day.

MSW from Gyasing Municipal Corporation is also sent to Sipchu. The total municipal waste collected from GMC was 2 tonnes per day out of 3 tonnes of waste generated per day. The waste consisted of 60-65% organic waste and 30-35% recyclable waste. (CPCB Sikkim).It was also noted that these municipal corporations have delivered partial compliance, in other words approximately 50 per cent of the MSW rules have been followed by the local bodies.

Integrated MSW Plan

Wastes: Waste collected at the source are categorised into wet waste (A) B.3 Valuable Materials (dry waste): These are materials that can be sold for value including metal parts (e.g. aluminum an d steel cans, scrap metal, computers, metal electronic parts), plastic bottles (clear, opaque), rubber, glass, textile. Each type of materials is sorted separately, packed and weighed. These materials are then transported by contracted waste haulers to West Bengal (e.g. Siliguri) for sale to recycling vendors.

A.1 Composting (wet waste): All wet waste collected are trucked Wastes: Waste collected at the source are categorised into wet waste (A) and dry waste (B). The MSW is considered as an kind of garbage generated at residences, shops, hotels, and commercial establishments. It includes kitchen waste, plant waste, dry waste, paper, cardboard, glass, as well as demolition ash produced from minor modifications of households / buildings. An aggressive program to collect all the waste at source has to be implemented. As much as 50% of the waste collected can be recycled as valuabl e materials (40%) and composted (10%). Separate garbage bins for wet and dry wastes are provided. This program will be modeled after the Aus AID Arithang 2005 demonstration project. A. Wet Waste: These wastes include kitchen waste, vegetable peels, fruit waste and uneaten food. B. Dry Waste: These wastes include plastic bottles, glass bottles, metal waste, rubber items, articles made up of textiles, and other items which A.1 Composting (wet waste): All wet waste collected are trucked to a composting facility. A.2 At the facility, two waste streams are produced – fine composted residue (A.2), which can be sold as fertilizers (A.4); and A.3 Uncomposted materials (wet waste): The uncomposted materials will be transported to the regional landfill (B.4). B.4 Regional Landfill (dry waste): Because of the steep mountainous terrain, it would be very difficult to locate an engineered MSW landfill in Sikkim. Additionally, there is a recent call for collaboration from large urban cities in neighbouring states to jointly combine resources to select an engineered landfill. (Source: Guidance note for private sector participation and regional municipal waste management facilities. Jan. 2007). Thus, Sikkim Strategic 141 waste, rubber items, articles made up of textiles, and other items which have resale value. B.1 Transfer Station (dry waste): The dry waste collected is transported to specific transfer stations for sorting. Sorting is performed to group them into valuable materials (B3) and other materials (B2). The sorting process is performed by a combination of equipment sorters and trained workers. B.2 Unsorted Waste (dry waste): Unsorted waste that has no value will be transported to a regional landfill (B.4

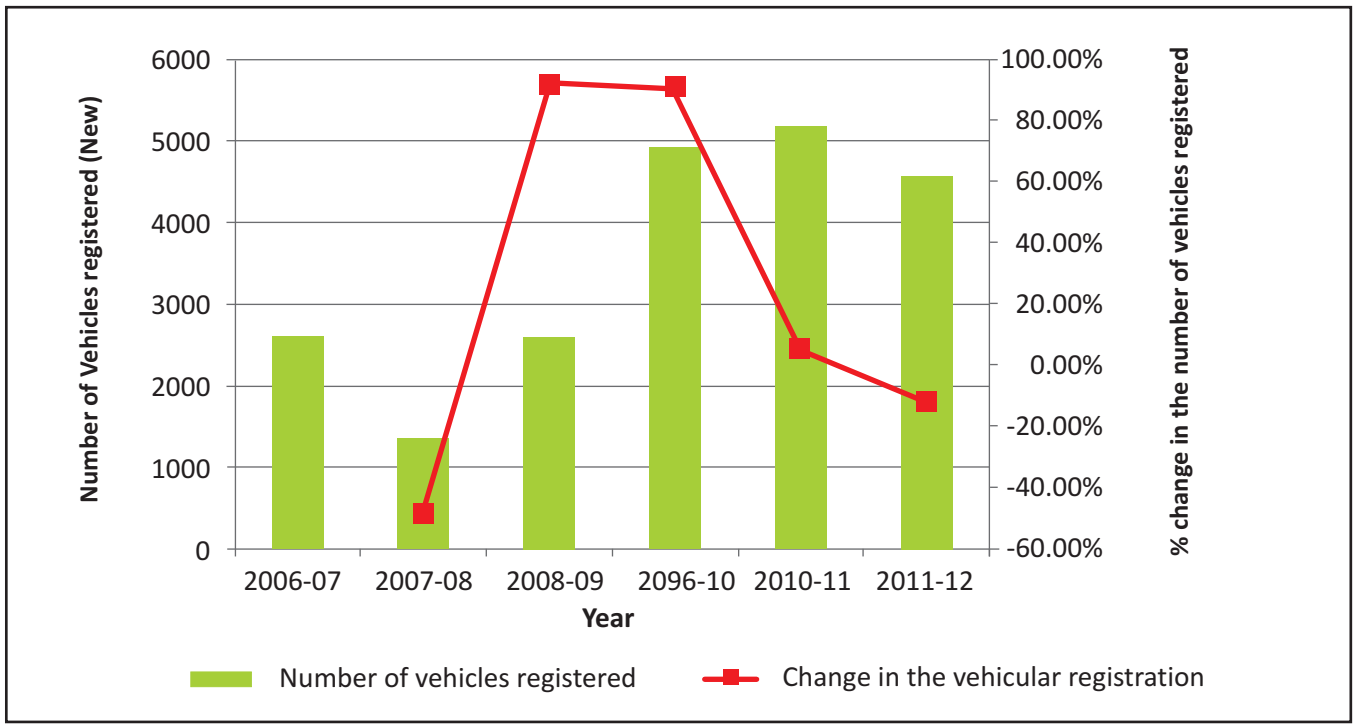
Therefore, to avoid the current practice of open dumping, there is urgency to source for this regional landfill outside of Sikkim.

Source: UdHd Sikkim

6.4.3. Air Pollution

Any increase in urban activities is generally accompanied by an increase in vehicular movement. A good indicator of expected vehicular movement is the increase in the number of registered vehicles in the state. This increase corresponds to an increase in vehicular emission, which is a contributor to air pollution. Statistics reveal that there has been a 90 percent increase in registration of new vehicles in 2008-09 and 2009-10. A sudden dip in vehicular registration is witnessed from year 2010 onwards due to revision of taxes for purchase of new vehicles.

Figure 6.2: Year-wise new vehicles registered



Source: data.gov.in

Table 6.5: Year-wise new vehicles registered

	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Total number of new vehicles registered	2604	1343	2575	4911	5157	4551
% Change		-48.43%	91.73%	90.72%	5.01%	-11.75%

Source: data.gov.in

The vehicular emissions have damaging effects on both human health and ecology. The detrimental effects may be direct or indirect, ranging from reduced visibility to cancer and death in some cases due to acute exposure of pollutants like carbon monoxide. These pollutants are believed to affect the respiratory and cardiovascular systems directly. In particular, high levels of sulphur dioxide and Suspended Particulate Matter are associated with increased mortality, morbidity and impaired pulmonary function. In addition to pollution, the increased vehicular density leads to congestion on roads and traffic snarls.

6.4.4. Lack of Basic Infrastructure Services

6.4.4.1. Availability of Safe Drinking Water

Less or no availability to safe drinking water is an issue all over India. Although most households in Sikkim have drinking water source within their premises, the water supply is untreated (96.9%) and channelled from springs and streams at higher ridges (Sikkim SAPCC, 2015).

As of now, WSPHED supplies 60-70 lpcd of water to the city of Gangtok, the major urban centre in state. Presently, the water supply service levels stand as follows:

Table 6.6: Status of Water Supply Services level

Sr. No	Indicators	Present Status
1	Coverage of water supply connections	*75%
2	Per Capita supply of Water	60-70 lpcd
3	Extent of metering water for connections	0%
4	Extent of non-revenue water	50%
5	Quality of Water Supplied	70%
6	Cost recovery in water supply services	1.43
7	Efficiency in collection of water supply related charges	80%

Source: Sikkim State action Plan FY 2015-16;(http://amrut.gov.in/writereaddata/SikkimSAAP.pdf)

The water quality in Sikkim varies from excellent to highly poor depending upon the seasons. Further, the frequent landslides and flash floods cause water contamination in the supply lines. This causes massive disruption in the water supply to households in addition to inviting the threat of several water-borne diseases. Water quality was also performed in Gangtok and its neighbourhood, viz. Singtam, Tadong, Deorali, Sichey, Selep, Ranipool and Rumtek. The average pH value was found to be 8.4 ± 0.1. Except for the chlorinated water at the Selep water treatment plant, the water samples were found to have microbial presence. In Selep, chlorination is primarily used for disinfection of the collected water. However, it is known that drinking chlorinated water on a long term may lead to cancer, mutations and other adverse health outcomes.

As is evident, there is an immediate need to augment the water supply service levels and brief them at par with national benchmarks to avoid future shortages.

Table 6.7: PH value and Microbial activities in water of Urban Centres

City	Source of Water	pH Value	Microbial Activity
Namchi, South Sikkim	PHE raw	7.8	Present
	PHE treated 7.9	7.9	Present
	Tinjhir Dhara	7.7	Present
Solophok, Namchi, South Sikkim	Chardham storage tank	8.5	Present
	Chardham storage tank at Shiva monument	9.5	Absent
Singtam, East Sikkim	Rolep Dhara	8.2	Present
Ranipool, Gangtok, East Sikkim	Ranikhola	8.4	Present
	Sewerage water after treatment	8.2	Present
WTP, Selep, Gangtok, East Sikkim	Inlet water	8.1	Present
	Chlorinated water	10.6	Absent
	Final staged water	8.1	Present
Rumtek, Gangtok, East Sikkim	Simsar	8.5	Present
	Natural source, Sirwaw	8.0	Present

Source: Water quality and quantity analysis in Sikkim, North Eastern Himalaya: Archana Tiwari

6.4.4.2. Sanitation

Sanitation is a very important component of human and urban well-being, considering that poor hygiene and lack of sanitation which contribute to about 88% of diarrhoea deaths in India (SoE India, 2009). However, there is growing impetus with Swacch Bharat campaign to build up sanitation facilities all over India. But, Sikkim raced past ahead of other states. In 2011, 4.8% of the urban population had no latrine facilities, whereas currently it is the only state to have achieved 100% ODF. (Ministry of Drinking Water and Sanitation, 2014, India)

Table 6.8: Type of Urban Latrine Facility 2011

Type of Sanitation	Percentage of Households
Piped Sewer System	34.4
Septic Tank	55.7
Other Systems	1.8
With slab/ ventilated improved pits	1.8
Open Pit	1.5
Disposal to open Drain	0
Public Laterine	2.6
Total Number of Households	**35761**

Source: Census of India 2011

6.4.5. Wastewater Management

In India, there is a major lacuna in waste water treatment and generation. Sikkim too does not have a good wastewater management system as it has only one treatment plant. Additionally, only 60% of Gangtok is connected to the sewer system. The growing urbanization also adds to these woes by causing issues in laying down water distribution plants, service pipe grids etc. (Ministry of Drinking Water and Sanitation, 2014, India).

Path of managing waste water in Sikkim

- Selep waterworks has a present treatment capacity of only 21 MLD . Expansion of treatment facilities to accommodate the entire volume of 42 MLD is in progress which is supported by Ministry of Urban Development, Govt. of India under UIG component of JNNURM. The distribution network will be streamlined under ADB program. The Tranche I ADB Project covering Burtuk and its surrounding areas and Chandmari Block was 60% completed.
- Gangtok is covered by sewerage system up to 45% only. The remaining areas will be covered under different schemes to be supported by National River Conservation Directorate and Asian Development Bank. The present treatment capacity of the plant at Adampool is 8 MLD only although the liquid waste generation is to the tune of 13 MLD. The sewer network and treatment capacity is being augmented under NRCD programme.

Source: PHE and Water Security department Sikkim 2013

6.5. Responses

In order to counter the impacts of growing urbanization, the Sikkim Government has constituted the City Development Plan and the Mobility Plan to manage the traffic and to address the issues of infrastructure and urban poor.

Some of the other initiatives of the Government are:

6.5.1 Sikkim Building Construction Regulation, 2001

As per this act

(i) The maximum height of buildings constructed in allotted sites or private holdings within a notified area shall be in accordance with the suitability and profile of the locations based on the stability map of the area as prepared by the Mines and Geology Department from time to time which shall be as follows: - Stability zone Admissible number of floors (1). 5 ½ storeys (2). 1 ½ storeys (3). 3 ½ storeys (4). 2 ½ storeys (5). 1 ½ storeys (6). No construction is allowed. Provided that the height of buildings shall be regulated in accordance with the size of the plot allotted or possessed and structural design of the foundation of the proposed building; (b) after sub-regulation (V) the following sub regulation shall be added, namely: - "(vi) Any structure beyond the permissible number of floors or allotted area or approved Blue print Plan completed or under construction on or before the date of notification of these regulations, shall be regularized after payment of regularization fee to be prescribed by Notification by the Government. (UdHd Sikkim)

6.5.2 State Urban Livelihood Mission

The Sikkim Urban Development Agency which is a registered society has been identified as the State Urban Livelihoods Mission i.e. the nodal agency in the State of Sikkim for implementation of NULM in the selected cities and towns of Sikkim. The SULM shall be responsible for – 1. Coordination of all legislative and policy formulation under NULM 2. Identification of cities to be covered under NULM 3. Deciding on a Delivery Mechanism.

6.5.3 Sikkim Non-Biodegradable Garbage Control Rules, 1997

Is act to prevent throwing or depositing non-biodegradable garbage in public drains, roads and open

places open to public view in the state of Sikkim and for matters connected therewith or incidental thereto. (b) provide separate dustbins for temporary deposit of non- degradable garbage other than those kept and maintained For deposit of bio-degradable garbage; (c) provide for the removal of contents of receptacles, deposit and of the accumulation at all places provided or appointed by it under clause (a) of this section; and (d) arrange for recycling of the non-biodegradable garbage collected under this Act.

6.5.4 Nirmal Bharat Abhiyan

The concept of sanitation was expanded to include personal hygiene, home sanitation, safe water, garbage disposal, excreta disposal and waste water disposal. With this broader concept of sanitation, CRSP adopted a "demand driven" approach with the name "Total Sanitation Campaign" (TSC) with effect from 1999. The revised approach emphasized more on Information, Education and Communication (IEC), Human Resource Development, Capacity Development activities to increase awareness among the rural people and generation of demand for sanitary facilities. Sikkim has done remarkably well to become India's first state with 100 percent sanitation coverage, according to a report of the drinking water and sanitation ministry. The state has also sensitized people to adopt a holistic approach to improve sanitation and hygiene for a clean environment while accelerating overall development in the state he state has constructed 98,043 household latrines, surpassing the target of 87,014 of these 61,493 latrines have been built for below poverty line (BPL) families. Sikkim Government launched a community-led total sanitation campaign in 1999 for achieving full sanitation in the 7,096 sq km area of the state.

6.5.5 Bio Medical Waste

(Management and Handling) Rules,2000: These rules apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle bio-medical waste in any form. Bio-medical waste shall be treated and disposed of in accordance with Schedule I, and in compliance with the standards prescribed in Schedule V.

(1) Every occupier, where required, shall set up in accordance with the time-schedule in Schedule VI, requisite bio-medical waste treatment facilities like incinerator, autoclave, microwave system for the treatment of waste, or, ensure requisite treatment of waste at a common waste treatment facility or any other waste treatment facility.

(2) Bio-medical waste shall not be mixed with other wastes.

(3) Bio-medical waste shall be segregated into containers/bags at the point of generation in accordance with Schedule II prior to its storage, transportation, treatment and disposal. The containers shall be labelled according to Schedule III.

(4) If a container is transported from the premises where bio-medical waste is generated to any waste treatment facility outside the premises, the container shall, apart from the label prescribed in Schedule III, also carry information prescribed in Schedule IV.

(5) Notwithstanding anything contained in the Motor Vehicles Act, 1988, or rules thereunder, untreated bio-medical waste shall be transported only in such vehicle as may be authorised for the purpose by the competent authority as specified by the Government.

(6) No untreated bio-medical waste shall be kept stored beyond a period of 48 hours :

provided that if for any reason it becomes necessary to store the waste beyond such period, the authorised person must take permission of the prescribed authority and take measures to ensure that the waste does not adversely affect human health and the environment.

(7) The Municipal body of the area shall continue to pick up and transport segregated non bio-medical solid waste generated in hospitals and nursing homes, as well as duly treated bio-medical wastes for disposal at municipal dump site].

(8) Chemicals treatment using at least 1% hypochlorite solution or any other equivalent chemical reagent. It must be ensured that chemical treatment ensures disinfection.

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Chapter 7: Climate Change

Sikkim being among the Himalayan states is highly vulnerable to climate change due to glaciers and stream water dependence. It is also dependent on river discharge for hydropower generation. Climate change is expected to impact the biodiversity, hydrology and livelihoods in Sikkim. However, the state is actively driven to combat these effects, as apparent from its Green mission to the ideational state action plan on climate change. This section explores the changes in Sikkim's climate and the responses the Government has taken to mitigate it.

7.1. Introduction

Climate Change impact at the global level has become a major concern today and Sikkim Himalaya is no exception. In the regional context, Climate Change has contributed to the unpredictable or erratic rainfall pattern; drying up of local springs and streams; migration of species to higher elevations; shifting of sowing and harvesting period of crops; emergence of invasive species and incidence of diseases/pests in crops as well as in fodder species. Building resilience in both human and ecological systems to an optimum level is the best possible way to adapt to climatic variation, though not much is known about the vulnerability of mountain ecosystem to climate change (Rai G. S. in Arrawatia & Tambe, 2012).

The India Meteorological Department (IMD) records reveal that there were slight changes in the climate of Gangtok between 1958 and 2005. The maximum temperature has been falling by 0.3 °C per decade, and the minimum temperature has been rising by 0.2 °C per decade. The annual rainfall has been increasing by 49.6 mm per decade. (Anon, 2008)

7.2. Physical Impact

The third assessment of the Intergovernmental Panel on Climate Change has projected the rise in temperatures and precipitation (Table 7.1)

Table 7.1: Temperatures and Precipitation Projections

Projections	Temperatures	Precipitation
Rise in Temperature	2020-1.4°C	2020-3%
Rise in Precipitation	2080-3.8°C	2080-11%

Source: Climate Change and Sustainability of Agro-biodiversity in Traditional farming of The Sikkim Himalaya - Ghanashyam Sharma and Lalit Kumar Rai (Arrawatia & Tambe, 2012)

7.2.1. Melting of Glaciers

With varied climatic conditions glaciers adjust their size and flow in order to maintain synergy with the changing climate. The field observations prove that lakes have been growing in size and volume from 1965 onwards. Sometimes the phenomena of development of new lakes have also been observed. The lakes develop due to glacier retreat and melting. There has been past events of Glacial Lake Outbursts Flood (GLOF) in the Sebu Chu Valley of North Sikkim.

Glacier thinning and retreat in the Sikkim Himalayas has resulted in the formation of new glacial lakes and the enlargement of existing ones due to the accumulation of melt-water behind loosely consolidated end-moraine dams. Such lakes are inherently unstable and subject to catastrophic drainage, they are potential sources of danger to people and property in the valleys below them (ICIMOD 2011). Local communities living in the region are dependent upon the lakes for their livelihood regardless of whether they are settled or nomadic (SAC 2011).

Recent studies, being carried out by Centre for Development of Advanced Computing (C-DAC), Pune, jointly with Sikkim State Council of Science and Technology, Gangtok, have shown that many glacial lakes in Sikkim Himalayan region have expanded over the years revealing the impact of climate change on glacial lakes and associated hazards. Statistics reveal that the cold desert of North Sikkim is highly sensitive to climatic variation.

Dig Isho - A Case Study

Lakes that are formed due to glacial meltwater are usually unstable. Sudden catastrophic release of water from such lakes is called a glacial lake outburst flood (GLOF).

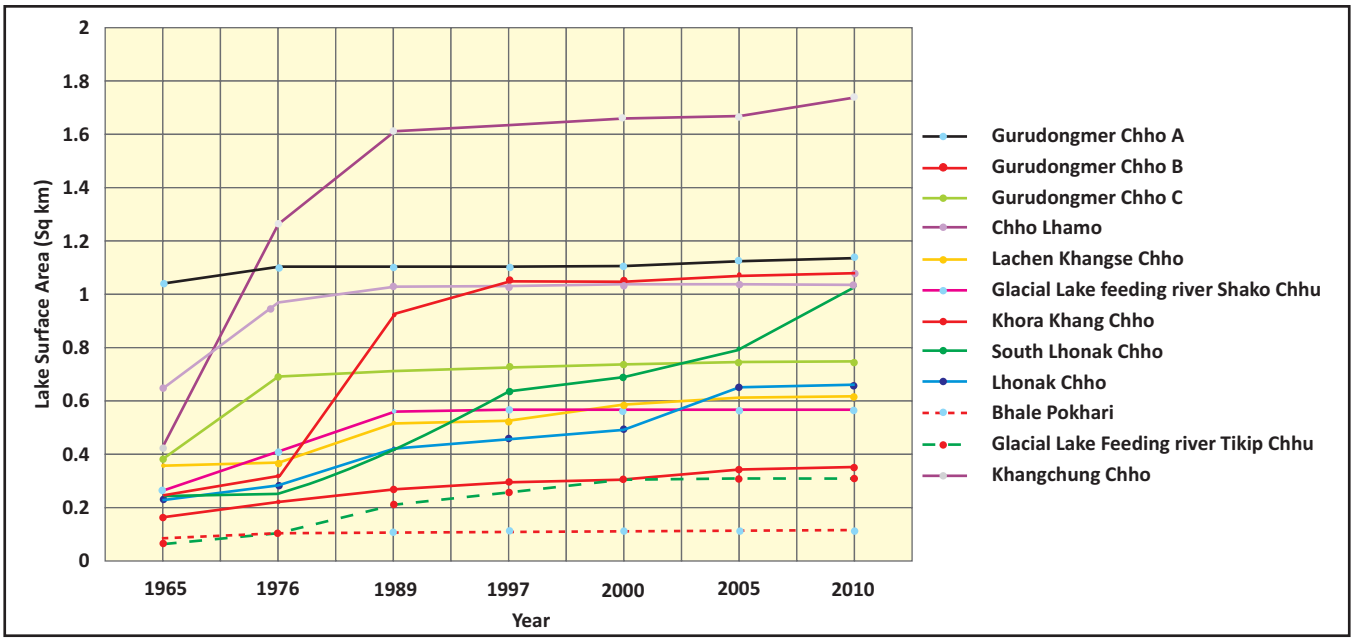
The best and well known example of a GLOF was on 4th August 1985 at Dig Tsho, a moraine-dammed glacial lake in the Khumbu area of eastern Nepal. Dig Tsho as many of the lakes in Sikkim, was not a large glacial lake rather a small 'clean-ice' glacial lake.

The catastrophic outburst event was triggered by a large avalanche that fell into the lake from a steep glacial surface, producing a surge wave.

Most affected areas were close to the origin of the outbreak.The newly built Namche Small Hydroelectric Project, 14 bridges, about 30 houses, and many hectares of valuable arable land, as well as a heavily damaged trail network, resulted from 5 million m3 of water plummeting down the Bhote Kosi and Dudh Kosi valleys (Vuichard & Zimmermann, 1987).

The GLOF at Dig Tsho is an example that even small lakes may cause serious damage, especially if there are populated areas and infrastructure located near the hazard source.

Figure7.1: Increase in Surface Lake area



Source: Impacts of Climate Change Glacial Lake outburst Floods(GLoFS)- Binay Kumar and T.S Murgesh Prabhu

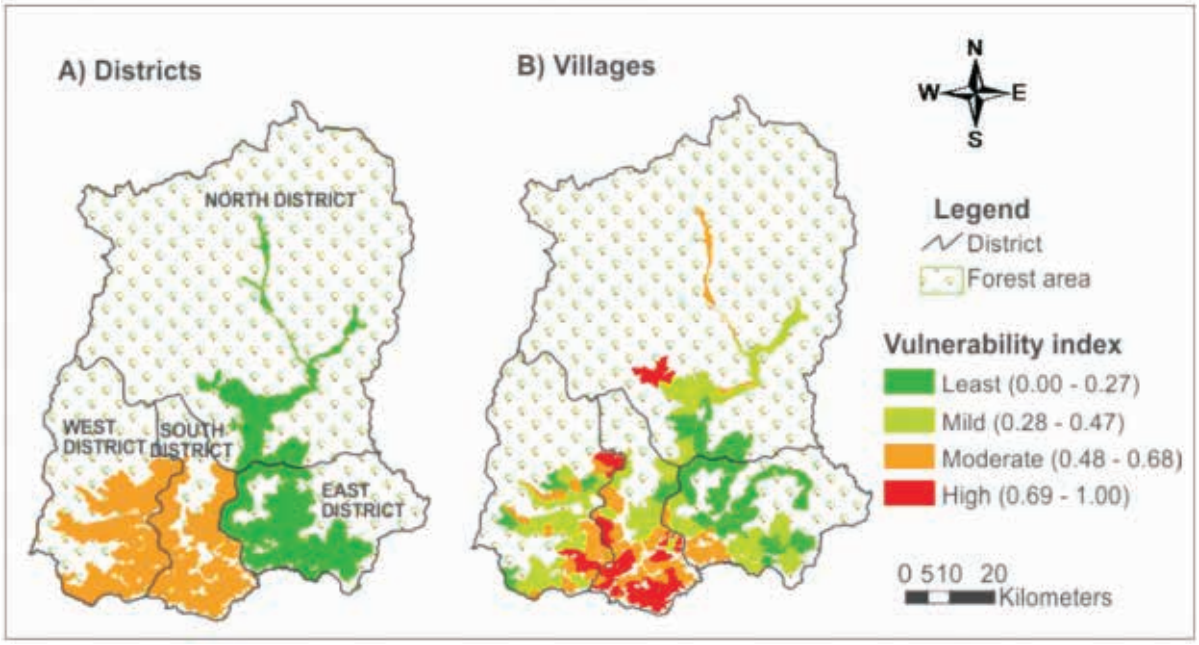
There has been a significant increase in the surface area of most of the glacial lakes. (Figure 7.1). Enhancement in the area of glacial lakes behind unstable moraine dams poses more dangers of GLOFs.

The Gurudongmagar Chho B complex has increased nearly four times between 1969 to 1989. Besides this, there has been a significant increase in the area of Lake Gurudongmagar Chho A.

7.2.2. Extreme events

Climate Change is bringing more frequent intense rainfall which leads to landslides across the mountains of Sikkim. Rapid changes in temperature and intensive precipitation may lead to rapid melting of glacier ice and putting pressure on the moraines damming the snout.

Map 7.1: Climate related vulnerability of rural communities of Sikkim



Source: Tambe, Arrawatia, Bhutia,and Swaroop, 2012

7.2.3. Changing Temperature and Rainfall trends

The projected mean annual rainfall varies from a minimum of 940-149mm to 1330-174. 5mm. The increase with respect to 1970s is from 0.3% to 3%. The North-East region has shown a considerable decline in winter months with respect to 1970s, with no additional rain projected to be made available during the period between March to May and October to December. The rainfall during June, July and August is likely to increase by 5mm in 2030s with reference to 1970s. If we see the trend of rise in temperature, it ranges from 1.8 to 2.10 C (Prabhu).

7.3. Socio –Economic Impact

The communities as well as economy of Sikkim are affected by Climate Change to large extent.

7.3.1. Community vulnerability to climate change

Rural communities are most vulnerable to Climate Change due to lesser adaptive capacity and fewer mechanisms to cope with the climate risks. A study by Tambe et al. (2012) found that South district was found to be the most vulnerable followed by West. East and North districts were found to be relatively resilient to climate related change. However, areas like Karzi-Mangnam and Sakyong-Pentong villages, which were not highly exposed, were found to be highly vulnerable due to their high sensitivity and low adaptive capacity. The rural communities have already started coping with the impacts of climate change using indigenous methods. Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), the national flagship programme, has become an important source of climate-proof cash income in the rural areas.

7.3.2. Agriculture and Livestock

Only about 12% of the total land area of Sikkim (7096 sq km) is cultivable between the vertical elevation gradients from tropical (300 m) to the Trans-Himalayan region (5000 m), where about 65% of the total population of 6,07,688 (Census 2011) depends on agriculture for their livelihood. In the sub-tropical zone (less than 1,000 m), the production of important cash crops like ginger, orange, and other fruits has declined due to prolonged droughts and outbreak of pests, diseases and weeds. This zone was earlier a productive area with multiple cropping.

The storage and preservation of seeds is also becoming increasingly difficult due to pests, diseases and dry winters. Communities in the middle and upper hills were found to be less vulnerable, and warmer winters provided new opportunities for vegetables such as tomato, chilli, carrot, cucumber, passion fruit and

beetroot, coupled with higher production and early ripening as well. However, due to global warming, there is a likelihood of spread of vector-borne diseases spreading towards the upper hills. Sikkim Government will need to rise to these challenges and make right policy choices in the face of competing strategic options, keeping in mind the long-term interest and commitment towards sustainable environment and the well-being of people.

Farmers have observed the colonization of invasive species such as *Chromolinaadenophorum, Eupatorium odoratum, Bidensbiternata, Artemisia nilgirica, Lantana camara, Ageratum conyzoides, Cestrum aurantiacum, C. fasciculatum, and Galingosaparviflora* causing problems in the farmlands, forests, traditional agro-forestry systems, fallow lands, croplands and wetlands (Rai G. S. in Arrawatia & Tambe, 2012). These invasive species are fast colonizing and have spread from sub-tropical to temperate agro-climatic regions, causing productivity decline. The spread of Artemisia nilgirica, Bidensbiternata, Eupatorium adenophorum, E. odoratum etc. has resulted in a steep decline of grasses, firewood, timber etc. Also, lack of adequate food resources in the nearby forest areas has caused wild animals to invade croplands. In the croplands, clearing invasive species involves tremendous labour input for land preparation for cultivation and management.

In the recent years, farmers have witnessed that tree fodder production has declined significantly. One of the reasons is that pests eat up the leaves before they mature for harvesting, especially during the lean season. With the colonisation of invasive species, the common fodder species such as Digitariasanguinalis (GhogeyBanso), Paspalumconjugatum (ChitreBanso), Panicumrepens (Phurkey), Thysanolaenaagrostis (Amliso) are declining. (Rai G. S. in Arrawatia & Tambe, 2012).

Sharma and Rai (2012) describe a number of changes at low, medium and high altitudes, primarily in response to reduced pasture lands, warming and decrease in precipitation. Pastoralists at high altitudes move around less and have become sedentary in nature. Productivity of several crops has decreased while crop diversification has increased. The farmers of the Sikkim Himalaya have lost the comparative advantage of large cardamom since the production of this commercial traditional crop has declined drastically in the last ten years. The total cultivation area of large cardamom was 26,700 ha in Sikkim and around 3,300 in Darjeeling until 2000, which has now reduced significantly (Arrawatia & Tambe, 2012).

Due to the untimely rainfall, fodder production has reduced vegetation. This is followed by emergence of pests eating up the green foliage of trees. The impact of climate change because of untimely precipitation is visible on the phenology of fodder species of both sub-tropical and temperate agro-climatic zones. One highly preferred fodder tree - Ficuslacor (locally called RatoKabro, SetoKabro) is displaying budding and growing foliage in November, while the natural season of new foliage emergence is February end.

7.3.3. Forest

The forest degradation was caused mainly due to open grazing, forest fires, selective felling of commercially important mature trees from forests and clear felling of temperate forests for meeting the demand for timber, firewood and charcoal. As a result, thickets of secondary, unpalatable shrubs and bamboo had increased substantially in these degraded forests.

Forests can play an important role in mitigating the impacts of climate change by functioning as a carbon sink, water tower and also in checking natural disasters. In the years to come, the State will need to focus more on management interventions to enhance the growing role of forests.

There is an urgent need to protect and regenerate these small-sized and fragmented forests as they are susceptible to encroachment and degradation. Protection of these forests is critical to prevent the loss of the characteristic biodiversity that they possess. (Sikkim Human Development Report,2014). Scarcity of land is likely to assume significant importance in Sikkim and would require a serious debate on the long-term land-use planning policy. With the growing population, demand for growth and employment will only increase and land is a critical input for sustaining economic development.

Erratic rainfall, extensive dry spells during winters, early summers and decrease in annual rainfall in recent past due to climate change has increased the incidence of forest fires in Sikkim (R.K. Sharma et al. (n.d): Study of forest fires in Sikkim Himalayas, India using Remote Sensing and GIS Techniques).

With warming of the climate, the forest fire is ascending upwards and impacting the temperate oak and sub-alpine conifer forests which are not habituated to this new threat. High calorific value, aggressive middle storey vegetation and slow growing nature of these old growth forests make them especially vulnerable to this new threat fuelled by a warming climate. Regarding Sikkim, a detailed study on patterns of forest fires due to climate change is certainly lacking. Due to the significant decreasing trend in the mean maximum temperature during monsoon, and a significant increasing trend in the mean minimum temperature throughout the year as a whole, a significant decreasing trend in the diurnal range of temperature has been experienced in recent years, resulting in the annual increasing trend in annual range of temperature leading to the prevalence of a warmer climate in Sikkim.

A change in climate can have far-reaching consequences on diverse species, their distribution and ecology on the whole. A study has shown that the suitable bio-climatic envelope for rhododendrons, one of the most important floras of the state, would shrink considerably under the climate change scenario. The threats to Tibetan gazelle (Procapra picticaudata) and southern kiang (Equus kiang polydon) in northern Sikkim are higher due to increasing trends in temperature (Climate Change and its impact upon the forests of Sikkim. Ravindranath et al.) With flowering and fruiting being affected by the changing climate, availability of food inside the forests for wildlife has changed over time. This has a direct correlation to more incidences of wildlife straying into villages, leading to increased human- wildlife conflict.

A report ranks Sikkim as the second most vulnerable state addressing the impacts of climate change within the Kangchenjunga landscape. (Chettri et al., n.d.)

Photo 7.1: The multi-layered forests of the Eastern Himalayas are especially vulnerable to climate change impacts

7.4. Responses

Sikkim Government is an environmentally conscious state. Even people of Sikkim are very conscious of changing the environs around them. Rural folk have started supplementing farming livelihoods with non-farm activities like MGNREGA, tourism, trade, non-farm labour and even migration in extreme cases.

To ensure the lake conservation initiative in its true perspective, the assistance of local community has been inbuilt into the mechanism by constitution of Lake Conservation Committee, locally termed the Pokhari Samraksham Samiti. The creation of Sikkim Ecology Fund has also been notified. For assessing the growing stock and amount of carbon present in the forests of Sikkim, a vegetation carbon pool assessment is being carried out under ISRO's Biosphere Geosphere Programme: The Department of Space, Government of India has agreed to install an 'Eddy Covariance CO2 and other trace gasses flux tower' in Sikkim for a detailed study regarding the net carbon absorbed by forests and vegetation pool which will be linked with prospective earning of carbon credits as per UNFCCC guidelines.

In Sikkim, mountain springs, i.e. Dhara in local parlance, have been traditionally playing a vital role in providing water security to nearly 80% rural households. Development of these spring sources under the banner of Dhara Vikas or Spring-shed Development is being taken up across the villages.

The Government of Sikkim is promoting Natural Resource Management based Climate Change Adaptation Programme. Sikkim has also taken up the initiative for setting up Village Resource Centres with the support of the Department of Space at the Block level. More than 15 village resources are already in operation for skill development, scientific awareness and use of remote sensing and GIS technology and for Natural Resource Management at the village level. Government of Sikkim has also put an 'environmental cess' on various non-bio-degradable materials.

The State Action Plan on Climate Change has been formulated by Government of Sikkim to help communities adapt to the changing climate. The State Action Plan on Climate Change (SAPCC) advocates a strategy to meet the challenge of climate change and improvement in the ecological sustainability of Sikkim's developmental path.

As water is among the most impacted resource due to climate change. The government of Sikkim has took adaptation measures in the form of rural water storage infrastructure. This would help in artificial recharge in upper catchments to revive the dry season discharge of streams. This has been specifically done in Rolu, Seti, Reshi and Rohtak in south and West Sikkim (Arrawatia & Tambe, 2012).

The National Mission for Sustaining Himalayan Ecosystem (NMSHE) supported Sikkim State Climate Change Cell (SCCC) was established in October 2014 under the aegis of Sikkim State Council of Science and Technology, an autonomous organization of Department of Science and Technology, Government of Sikkim. The State Climate Change Cell has the mandate to focus and address various issues related with climate change to fulfil the objectives of NMSHE and State Action Plan on Climate Change (SAPCC). (DST).

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Chapter 8
Conclusion and Recommendations

This section presents the various policy and institutional options to cater to the emerging challenges of Sikkim state. The suggested options could be effectively utilised to address the key environmental challenges as it is essential to focus on diverse alternatives to discover the probable solutions.

An important step towards checking environmental degradation is making people in general aware of their surroundings by informing them and making them more sensitive towards their environment. Sensitizing and empowering people to take decisions at the local level would go a long way in tackling the environmental challenges of Sikkim. This builds up the case for Environmental Education – both at the formal as well as informal level.

It is essential to equip the local government and communities with proper budgets, necessary resources, as well as capacity building and monitoring mechanisms. While the State must transfer a certain amount of authority (along with the onus) to the local Governments since the local people and institutions are well aware of the ground realities of the local environmental issues. E-governance would not assist in monitoring the progress of the different Government schemes, and also act as a positive catalyst in terms of integrating the socio-economic and environmental goals for sustainable development of Sikkim.

There is also a need to put a monetary price tag on all the minor forest produce and other products of nature. This is bound to check environmental degradation and help internalize environmental aspects in Sikkim's economic policy-making. Economically speaking, prices of our natural resource must reflect their social costs and, hence, subsidies must be provided only to the poor and no one else so that users become well aware of the scarcity values of ecosystem services. As a matter of fact, Payment for Ecosystem Services (PES) and Ecosystem Service Evaluation (ESV) are vital and effective tools to check environmental devastation.

8.1. Land

Agriculture, which is the mainstay or lifeline of Sikkim's populace, is facing grave natural calamities like earthquakes and landslides that culminate into soil loss and land degradation. Sikkim Government has taken a number of steps or measures to check and mitigate soil erosion stemming from natural calamities. With the advent of climate change, there are various options to ensure food security to the people of Sikkim, such as seed banks, crop insurance, agro-forestry and appropriate irrigation technologies. Sikkim is being declared as first organic state which is a really appreciable step taken by the Government.

While introducing new varieties to ensure livelihood security of the poor relying on agriculture, focus should be on optimizing productivity with maximum profits. Research and Development will play a vital role in identification of new cultivators that are resilient to higher temperatures, water stress and high concentration of Carbon Dioxide.

Sikkim has all types of crops which need to be identified. The local varieties have good capacity to fight against any invasion and threat. The gene bank and preservation of these landraces would be an excellent effort to cope with future threats and climate change. Multi-location adaptive research works have to be formulated giving top priority to these areas. The ICAR stationed in Sikkim, Krishi Vigyan Kendras and supporting departments will have to play a key role in this venture.

There is great scope to increase the productivity of land and farmers' economy by creating small water resources for increasing irrigated areas, land development, use of efficient farm power and implements, harnessing more rainwater, disseminating renewable energy gadgets and introducing small scale agro-based industries.

Farm mechanization has become a more challenging task where every step has to be taken with greater care keeping in view the climate change. The micro size power tillers (with better efficiency in terms of manoeuvring in small size terraces with zero tillage operation, weeding capacity, seed drill and easy intercultural operation) have become highly essential. Crop diversification programmes need to be initiated to change the practice of farmers of growing crops which are sensitive to climate change. Systematic technological packages should be provided to the production pockets, based on their level of development.

High value commodities should be identified for each of the districts and the production cost should be reduced by providing the minimum support price, so

that the farmers could reap maximum profit from his produce.

Integrated Pest Management (IPM): As the policy of the State is being 100 percent organic, all farmers are required to adopt the organic Pest and Disease Control Management System. The chemical control of diseases and pests is to be replaced by physical and biological means.

Seed Production and Certification: The State will have to be self-reliant in organic seed production. For quality seed production, the State needs to develop the infrastructure for appropriate storage and seed testing in every district.

The farmers should be encouraged to take certified seed production to produce their ¬¬own quality seeds to minimize the dependency on outside sources. It is vital to establish high resolution weather stations for weather data collection at the micro-level, covering the entire State and disseminating the information regularly to raise awareness among the farming community on weather related risks and help farmers in making critical farming decisions and efficient crop management practices. The training centres should be equipped with all the facilities to train farmers and field staff.

8.2. Air

Air-pollution worldwide is a growing threat to human health and the natural environment. If we observe the air quality of Gangtok, the pollution is mainly due to a rise in the number of vehicles as well as the industries. The industrial policy of Sikkim aims at creating conducive industrial growth, keeping in mind the available natural resources and socio-economic environment. It also aims at maintaining the Green State Image while promoting industrial activities.

Enhanced fossil fuel combustion in the transport sector (due to continuous increase in motorised transport), fossil fuel combustion in industries; the industrial processes and release of waste water from industries as well as homes; improper methods of solid waste management, fossil fuel use in commercial and residential establishments; and, the use of fire wood in rural homes for space heating, cooking and warming of water are some of the causes of emissions of greenhouse gases contributing to global warming. Further, the release of pollutants such as sulphur dioxide, nitrogen dioxide, particulates etc are leading to the degradation of air, water and the soil.

As far as pollution control norms is concerned, as per the State of Environmental Pollution Report done in 2004, close to 80% of all vehicles were complying with the emission control norms, as per a survey which was done in connection with the report. In terms of Policy, as per the National Fuel and Emission Policy, all new vehicles in Sikkim will have to be Euro-III compliant, which came in to force in June 2010.

8.3. Water

Water Crisis is the situation which is likely to happen in future. In order to be well prepared, rain water harvesting techniques should be promoted at the household level. Dhara Vikas has been a good initiative of the Government in terms of conserving the drying springs. Tourists and local people should be made fully aware of conserving the water bodies and not polluting them by dumping waste material.

In fact, glaciers, rivers and springs from an integral and inherent component of the surface water resources of Sikkim. Despite receiving a fairly good amount of rainfall, Sikkim has a low storage capacity of rain water due to quick run off as it is a hilly state. In Sikkim, hilly areas are worst affected by floods and droughts. For proper planning and management of its water resources, Government of Sikkim has adopted a State Water Policy. A robust climate adaptation strategy for drought-prone districts, Dhara Vikas, is helping to alleviate the problem of rural water scarcity by reducing surface runoff of rainwater and allowing more water to percolate down to recharge the underground aquifers. Similar initiatives of water harvesting, flood control and water storage by the Sikkim Government could go a long way in meeting the water needs of the State.

Hosting ten major rivers, the State needs to value the local people who utilize the water resources upstream in a sustainable manner. This could be done in such a

way that the richly populated areas that stress the water resource may incentivize people upstream who keep it clean for them. For this, a system may be suggested which should benefit the poor people upstream and provide them more incentives to improve and sustain environmental resources on the whole.

Prolonged water stress in plants is one of the vital issues resulting in low production of crops. Hence, discovering scientific ways and means to use water efficiently and provide water in critical moisture stress conditions for crop health is the prime goal in water management system. Ongoing programmes such as drip irrigation, construction of rain water harvesting structures, installation of community tanks and bench terraces are to be promoted to enhance crop productivity (with less usage of water) and simultaneously conserve the rapidly diminishing water resources.

Through repair of damaged channels, creation of micro-irrigation systems and construction of water harvest structures, fallow land should be brought under cultivation after harvesting the paddy crop. Newer technologies in water conservation and their efficient utilization in drier spells have to be encourages for augmented anyhow. As a matter of fact, hydroelectricity is a major source of power in the current scenario. As per the geographical location of the State, other options like wind and solar energy may be explored since Sikkim has an advantage in terms of its location on higher altitude.

The above points lead us to the importance of planning environmental strategies at a regional level in order to prevent further environmental degradation and develop Sikkim's natural resources sustainably. Further, there is a pressing need for conservation of water resources as it is the most important element in the biosphere since it sustains all sorts of life forms. Also, the ongoing national programmes could be leveraged to strengthen rural and urban water security. These programmes include Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), National Rural Drinking Water Mission (NRDWP), Integrated Watershed Management Programme (IWMP), Rashtriya Krishi Vikas Yojana (RKVY), etc.

8.4. Biodiversity

Some birds, insects, mammals and plants are already showing changes in their geographic distribution and have moved northwards or to higher altitudes in response to the observed climate changes in Sikkim. There is an increasing evidence that many species with the northern limit of their range currently in the tropical and subtropical regions in Sikkim are expanding further north and onto higher grounds. In contrast, the southern limits of some cold adapted species may be pushed northwards as temperatures increase and due to limited space available at such heights may become extinct e.g. Snow Leopard. Alpine plant species on mountain ranges with restricted habitat availability above the tree line will experience severe fragmentation, habitat loss, or even extinction as they cannot move to higher elevations.

As temperatures have increased, spring and summer events are taking place earlier than usual. The evidence includes leafing, fungal fruiting, spawning of amphibians, arrival of migrants and insect emergence. Species are both increasing and decreasing in abundance in correlation with the climate change. In fact, climate change can also cause a change in habitat preference. For example, the Red Panda of Sikkim may experience changes in his habitat as the temperate ecosystem, which is his preferred habitat, starts shrinking.

Species do not respond simultaneously to climate change, which in turn leads to changes in the species' composition found in a particular habitat and even in the interaction between these species. Changes in species' composition include intrusion of invasive species and the interaction between the species may eventually lead to ecosystem-level changes. Changes in ecosystems can hamper their ability to provide essential services, such as carbon sequestration and food provision.

Sikkim is 0.02% of India's total land area. Forest occupy maximum of land available in Sikkim. There are various drivers of change as agriculture and allied sectors, disasters like landslides, earthquakes etc. Land degradation is most prevalent in the Northern District of Sikkim.Witnessing the current scenario, farmers'

traditional knowledge should be taken into consideration while making conservation and developmental efforts. Advance Technology like remote Sensing can be used to generate better quality data pertaining to dimensions of land degradation.

There should be an attempt to make a specific programme on medicinal plants for the research and development programme on in-situ and ex-situ conservation. There is a dire need to create a greater biodiversity data base. Pragmatically there is a need to develop a proper infrastructure so that the wetlands don't get polluted. Though commendable work has been done in terms of valuation of biodiversity resources, still we have a long way to go. This certainly calls for more regional, national and international coordination.

8.5. Climate Change

Climate Change is an emerging problem in Sikkim. Climate change, triggering glacier melts and erratic precipitation, may likely change the amount, duration and time of the runoff from glaciers, leading to an altered hydrological cycle. Climate Change may, thus, be riding over and above the anthropogenic pressures leading to degradation of environment that affect the ecosystem services provided by the wetlands.

Sikkim Himalaya with its rugged topography, on-going seismic activity (by active tectonics) and extreme rainfall is subjected to intense landslide activities. Climate Change, bringing more frequent intense rainfall, may exacerbate the landslides across the mountains of Sikkim. Also, rising temperatures and intensive precipitation may lead to rapid melting of glacier ice and snow. As Sikkim is a disaster prone area and development as a factor is increasing the pressure on the present infrastructure, promotion of green and sustainable infrastructure is a feasible option. Disaster Management should be promoted in all forms.

As the climate warms, the soils are likely to be drier in the summer months, leading to less evaporation, less recycled moisture in the atmosphere, and hence less rains during summer. Further, fire mediates the responses of forests to climate change, either by accelerating species turnover or by selecting fire-adapted species. Additionally, increase in forest fire incidences would lead to increase in crop predation in fringe villages by species driven out of the forest, like the Indian Peafowl, as well as genetic dilution in Red Jungle fowl.

Climate Change leading to degraded biodiversity of forests is likely to impact the quality and quantity of forest products and adversely impact the associated livelihoods of communities thriving on the same. The concepts like eco-tourism, apiculture, sericulture, medicinal Plants, cane, bamboo for small scale cottage industries and natural fibres should be promoted.

With Climate Change, it is anticipated that the decline in forest biomass may accelerate and rural communities and road transport workers staying and working in the forest fringes (dependent on fire wood extraction from forests) are likely to experience the energy crunch, especially for cooking and heating purposes. Hydroelectricity could prove to be a major source of power in the current scenario. As per the geographical location of the state, other renewable energy options like wind and solar energy may be explored as sustainable alternatives.

Climate Change may adversely alter the production of biomass and fruits on which the wild animals thrive. As a result, the animals may come in direct conflict with the local people residing just outside the forests. Sikkim, being a global biodiversity hotspot, has a diverse fauna living in close proximity to human beings. The basic economy being agrarian, the boundaries between forest areas and human settlements are forever pushed, with resultant damage to crops and livestock. In the recent past, there has been a dramatic increase in direct encounter incidents involving Himalayan black bears with stray incidents of leopards. Actually, one of the causes for such situations might have been the climate change.

Information system within the Department has to be strengthened, focusing on the collection of baseline data and measuring changes periodically with climate change impacts. All the developmental works of the department related to climate change should be closely monitored from now onwards. The outcome and

evaluation have to be studied minutely to slow down the process of Climate Change by efficient implementation of the Government programmes.

8.6. Managing Urbanization

With the increasing tourist flow and an increase in Sikkim's population, solid waste management and air pollution are becoming grave environmental problems. Bio-composting can be feasible solution to the waste disposal problem. Landfill sites are becoming inadequate to cope with the amount of solid waste generated. Moreover, they are not well maintained. Hence, Government of Sikkim needs to take appropriate measures for sustainable management of solid waste. In fact, transportation needs to be linked to the land-use. And, public transportation needs to be improved in order to check the rise in the number of private vehicles. Involvement and awareness of local people will make a huge amount of difference in checking the vehicular pollution. Though the State Government has taken a number of steps for minimizing the impact of tourism on the natural health of Sikkim, a few more initiatives should be taken to check the degradation of the lakes and hot springs of the State.

In future, ecotourism in a sustainable manner will not only increase the livelihood of the local people but will also generate income which can be referred to as one form of payment for ecosystem services.

Summing Up

Ultimately, the goal of sustainable development could only be attained through greening the economy, where Green Economy is defined as that transition in economy which results in improved human beings and social equity, while significantly reducing the environmental risks and ecological scarcities.

Annexures

Annexure I

Photos of Inception Workshop

Forest Minister TsheringWangdi Lepcha giving inaugural speech

Proceedings –Technical Session

Stakeholder Consultation Participation

List of Participants

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Annexure II

Impact of Climate Change Glacial Lake outbrust Floods (GLoFS)

Lake Name/Year	1965	1976	1989	1997	2000	2005	2010
Gurudongmar Chho A	1.048	1.099	1.099	1.099	1.104	1.115	1.134
Gurudongmar Chho B	0.249	0.322	0.925	1.046	1.046	1.073	1.076
Gurudongmar Chho C	0.48	0.687	0.718	0.728	0.732	0.745	0.745
Chho Lhamo	0.649	0.963	1.031	1.031	1.031	1.031	1.031
Khangchung Chho	1.178	1.261	1.605	1630	1661	1.661	1734
Lachen Khangse Chho	0.36	0.37	0.516	0.523	0.586	0.613	0.613
Glacial Lake feeding river Shako Chhu	0.273	0.409	0.561	0.561	0.561	0.561	0.561
Khora Khang Chho	0.166	0.217	0.269	0.296	0.302	0.342	0.351
South Lhonak Chho	0.242	0.251	0.41	0.633	0.691	0.794	1.028
Lhonak Chho	0.231	0.282	0.418	0.46	0.494	0.652	0.656
Bhale Pokhari	0.09	0.104	0.108	0.114	0.114	0.114	0.114
Glacial Lake feeding river Tikip Chhu	0.069	0.108	0.214	0.257	0.308	0.311	0.311

Working Population

Category	Persons	Census 2001	Census 2011	% Change
Total Cultivators	Males	1,31,258	1,17,401	-11%
	Females	70,107	63,327	
	Persons	61,151	54,074	
Total Agricultural Labourers	Males	17,000	25,986	53%
	Females	8,762	12,883	
	Persons	8,238	13,103	
Total Household Industry	Males	4,219	5,143	22%
	Females	2,849	2,947	
	Persons	1,370	2,196	
Total Others	Persons	1,10,566	1,59,608	44%
	Males	83,998	1,15,201	
	Females	26,568	44,407	

Source: Human Development Report Sikkim, 2014.

Annexure III

Medicinal Plant and its Uses

Sl. No.	Botanical Name	Local Name	Distribution	Types	Part used & Uses
01	*Abies wabbiana*	Gobresalla	Temperate & subalpine 5200-13800 ft	Tree	Leaves & Gum Tonic, Tuberculosis. Internal hemorrhage
02	*Abrus precatorius*	Lalgeri	Lower hills 900-4000 ft	Climbing shrub	Fruits/roots Tonsil & Pneumonia
03	*Acorus calamus*	Bojho	Middle hill 3000-6000ft.	Herbaceous plants	Root/Rhizome Vermifuge, fever antispasmodic, Insect repellent
04	*Aconitum heterophyllum*	Bikh, Atish	Sub-alpine to Alpine 8000-13000 ft.	An erect Herb	Roots, Anti-fertility agent, tonic, stomachic, anti-periodic, hysteria, piles, throat diseases
05	*Aegle marmelos*	Bael	Lower Hill Forest up to 2000 ft.	Thorny small & medium tree	Fruits & roots
06	*Asparagus racemosus*	Kurilo	Tropical/ sub-tropical / Lower/ middle hill forests	Woody climber under shrub	Tuberous root Diabetes, jaundice, urinary disorder
07	*Aconitum ferox*	Bikh, Bish,	Temperate / Alpine 10000-14000 ft.	Perennial Herb	Tuberous roots Cough, asthma, leprosy, fever snakebite, skin diseases
08	*Astilbe rivularis*	Buriokahti	Temperate 5000-9000 ft.	Herb	Leaves/ roots/ Rhizome, Diarrhea, dysentery, blood purifier
09	*Adatoda vasica*	Asuru	Lower hill forest.	Bark, root leaf, flower	It is good insecticide, leaves & root expectorant & antispasmodic. It is used as remedy for asthma, cough, fever, gonorrhea leprosy, Phthisis.
10	*Azadirachta indica*	Nimpati	Common throughout, India	Roots, bark, leaves, flower, fruits, seed & gum juice	As an anti-septic, treatment of small fox, as tooth brush, prophylactic for mouth & teeth, used as febrifuge.
11	*Aesandra butyraceae*	Chewri	Middle hill forest	Fruits	Used in rheumatism
12	*Allium wallichi*	Ban Lasun	Subalpine region	Leaves	Seasoning spices
13	*Aloe barbadensis*	Ghiukumari	Lower hill forest	Plant leaf root, leaves and flower	Used on burns, purgative, efficacious in treatment of leucoderma.
14	*Alstonia scholaris*	Chatiwan	Foot hill & lower hill	Bark, latex and flower	Bark as tonic, in fever, skin disease in treatment of leucoderma.

Sl. No.	Botanical Name	Local Name	Distribution	Types	Part used & Uses
15	*Amomum subulatum*	Elaichi	Cultivated	Seed	Stomachic, heart and liver tonic
16	*Artemisia vulgaris*	Titaypati	2000 to 5000 ft.	Leaf extract	Leaf extract used on cuts and bruises to stop bleeding mostly in nose bleeding. Supposed to possess detergent effect &used as cleansing agent.
17	*Aconogonum molle*	Thotne	Lower hill forest	Young Shoots	The plants is used as an astringent and eaten relished in the hills as vegetable and pickle. It has similar flavour as their of the Himalayas rubarb.
18	*Berginia ciliata*	Pakhanbed -	Temperate to sub-alpine 5000-13000 ft.	Herb	Root & rhizome Tonic, fever, boils, astringent
19	*Bauhinia vahlii*	Verla	Lower hill forest	Seeds bark leaves	Seeds used as tonic, aphrodisiac, leaves demulcent, bark is useful in skin disease, diarrhea
20	*Bauhinia variegata*	Koirala	Middle hill forest	Flower / fruits	Flower juice is taken to cure dysentery, diarrhea& stomach pain. The flower buds are taken for skin disease & ulcer. Fruits are used for blood purification.
21	*Bauhinia purpurea*	Tanki	Lower Hill Forest	Large flower Roots, Bark	The astringent bark is used to control diarrhoea. The flower are laxative and root is carminative The bark root and flowers are also useful as maturant for boils and ebcesses. Used against animal bite
22	*Bagonia picta*	MagarKanhce	Upto 7000 ft. in Sikkim	Succulent stalks	Extracts from stalks used for venereal disease.
23	*Berberis aristata*	Chutro		Root, Bark	Used in jaundice, malaria, fever &diarrhea. It is also used externally to cure eye disease.
24	*Betula utilis*	Bhojpatra	Upper hill forest	Bark	Used to heal up the wounds.
25	*Bischofia javanica*	Kainjal	Middle hill forest	Leaves & bark	Leaves contain Vit.'C', Bark contains tannin
26	*Bombax ceiba*	Simal	Middle hill forest	Root	Used for curing diarrhea& dysentery
27	*Buddleja asiatica*	Bhinsenpatee	Upto 4000ft	Leaves, flower & stem.	Used in skin complaints & as abortificant.
28	*Callicarpa arborea*	Guahelo	Lower hill forest Common in Darjeeling & tarai	Bark & root	The bark juice is given to treat fever. The root is chewed in cases of boils on the gums.
29	*Callicarpa macrophylla*	Sumali	Lower hill forest	Bark	Used in rheumatism gonorrhea

Sl. No.	Botanical Name	Local Name	Distribution	Types	Part used & Uses
30	*Calotropis gigantea*	Ankh	Lower hill forest	Latex	Latex used in sprain & swelling.
31	*Carica papaya*	Mewa	Lower hill forest	Leaf	The digestive enzyme papain is extracted from the milky sap.
32	*Cassia fistula*	Raj briksha	Below 11000 ft.	Fruits, leaves	The fruits are used for asthma, diabetes, and eczema. Leaves used for treating skin diseases.
33	*Cassia sp.*	Methizar	Lower hill forest	Leaf & root	The leaf powder is given to relieve indigestion & stomach pain. The root paste is used for ringworm.
34	*Centella asiatica*	Gora taprey	Upper hill forest	Leaf	Leaves are used for asthma and skin disease, Urinary discharges and improving memory.
35	*Cinchona officinalis*	Sinchona	Middle hill forest	Bark	Quinine is extracted as remedy for malaria.
36	*Cinnamomum tamala*	Sinkauli	Tropical &ssub-tropical Himalaya upto 3000 to 5000 ft.	Bark & leaves	Leaves are stimulant used in rheumatism, in colic &diarrhea. Bark is given in gonorrhea.
37	*Citrus indica*	Chaksi	Middle hill	Fruits	Stomach problems.
38	*Clematis buchnaniana*	Pinaaseylahara	Lower hill forest	Root	Used to cure sinusitis.
39	*Clerodendron infertunatumr*	Chitu	Lower hill forest	Bark /leaves	Leaves are of anthelminthic, fresh juice of the leaves is tonic and febrifuge.
40	*Cordyceps sinensis*	Yarchagombuk	Alpine	Whole plant	Rejuvenates liver, heart & cheeks again process & built up immune system.
41	*Costus speciosus*	Bet laure	Tropical to temperate	Root	Useful in fever, bronchitis, anemia, rheumatism and diabetic.
42	*Calendula officinalis*	Calendula	Lower Hill	Flower, Leaves.	It is antiseptic and antifungal, cointains hormones and vitamin A. It is diaphoretic, stimulant, antispasmodic and small pox. It is also used in healing wounds, ulcers, burns.
43	*Catharanthus roseus*	Sadabahar	Lower Hill	Plant	Anticancer, antitumor, leaves are diuretic.
44	*Chenopodium album*	BethuSaag	Middle and Lower Hill	Plant	It improves appetite, laxative, diuretic, eye diseases, throat troubles, piles, blood heart and spleen diseases.
45	*Citrus medica proper*	Bimbira	Lower Hill	Fruits and rind	It is used as a pot herb in piles. Fruits are used in the treatment of indigestion and typhoid and dysentery.

Sl. No.	Botanical Name	Local Name	Distribution	Types	Part used & Uses
46	*Dolichus uniflorus*	Gahat	2500 ft.	Seeds	Cure Measels, Chicken pox, tumors, asthma.
47	*Dioscerea bulbifora*	Gittha	4000 ft.	Tuber	Aphrodisiac, stomachic, improves appetite.
48	*Dichroa febrifuga*	Basak	Middle hill at 6000 ft.	Small tree	Roots& Leaves Fever, malaria
49	*Daphne cannabina*	Kagatey	Upper hill forest	Bark & root	The bark decoction is given to treat fever. The roots are used for intestinal troubles.
50	*Desmodium sp.*	Sakhinojhar	Himalaya forest upto 2000 ft.	Bark & flower	Decoction of bark used for hemorrhage, diarrhea poisoning & eye disease, flower used in biliousness.
51	*Dichorea febrifuja*	Vasak	Middle hill forest	Leaf & root	The decoction of leaves is taken for fever. The root is given as a tonic.
52	*Digitalis purpurea*	Fox glove	Middle hill forest	Leaves	Heart tonic & cardiac stimulant.
53	*Dillenia indica*	Ramphal	Lower hill forest	Barks & leaves	Fruit juice with sugar works ass cooling beverage in fever and cough mixture: bark, leaf for diarrhoea& dysentery.
54	*Dioscorea deltoidea*	Kukurtarul	Lower hill forest	Barks & tuber	Roots-tuber is edible & also used for washing clothes, to kill lice & fish. Used in contraceptive pills.
55	*Dioscorea alata*	Ghartarul	Lower Hill Forest	Tuber	It is used in fever, leaves in rash and itch and plants in constipation. The tubers are anthelmentic useful in leprosy, piles, gonorrhoea.
56	*Drymaria cordata*	Abhijal	Upto 5000 ft.	Whole plant	Above ground parts-steamed and smelled during sinus trouble. Plant paste for fever, cold and cough also used for dog bites, headache.
57	*Eleocorpus spaericus*	Rudraksh	Upto 4000 ft	Fruit	Used in Vata and Kapha disease of head, epileptic fits.
58	*Evodia fraxinifolia*	Khanakpa	Upto 7000 ft.	Fruit	Antipyretic, treatment of typhoid.
59	*Entada scandens*	Pangra	Middle hill forest	Seeds	Emetic, astringent.
60	*Ephedra gerardiana*	Somlata	Lower hill forest	Whole plant	Plant raises blood pressure & used to relieve asthma high fever.
61	*Equesetum debile*	KurkureJhar	Throughout hills	Aerial part	Clotting agent used in wound, nose bleeding & bleeding of urinary tract.
62	*Eupapatorium odoratum*	Kalijhar	Lower hill forest	Leaves & tender bud	Extract from leaves used in cuts and wounds.

Sl. No.	Botanical Name	Local Name	Distribution	Types	Part used & Uses
63	*Eupatorium cannabium*	Banmara	Lower hill forest	Leaves & stem	Leaf and stem extract used on cut & bruises to stop bleeding & infection.
64	*Euphorbiia royleana*	Siwri	Lower hill forest	Latex	The latex is used to cure cuts & stop bleeding; It is also used to relieve earache, cough & asthma.
65	*Emblica officinalis Gaertn* *Phyllantus emblica Linn.*	Amla	Tropical/ sub-tropical Lower Hill Upto 4000ft.	Small Tree	Fruits, leaves, flowers, roots, bark seeds Multiuse
66	*Edgewotthia gardeneri*	Argaily	4000-7000 ft	Shrub	A fish poison, stem bark is used in paper manufacture.
67	*Eucalyptus globosa*	Tarpin	Lower Hill	Leaves	Yield a strong pungent essential oil, valued in medicine as an antiseptic, febrifuge and anthelmentic.
68	*Fapophyrum esculentum*	MitheyPhapur	Upto 6000 ft.	Grains	Used in diet in colic, diarrhea
69	*Fagopyrum dibotrys*	Ban phapar	5000 – 11000 ft.	Fruit & Grains	Diet in colic, used in lungs infection and pulmonary abscess.
70	*Ferula narther*	Hing	Rocky location	Gum	Used in asthma, cough, hysteria & epilepsy.
71	*Ficus semicordata*	KhasreyKhaneu	Lower hill	Latex & bark	Latex, bark applied on boils to check infection.
72	*Fraxinus floribunda*	Lakuri	Middle hill	Bark	Bark-boiled & applied for gout.
73	*Foeniculum vulger*	Sounp	Lower and Middle Hills.	Leaves, tender shoots, fruit	It is used as flavouring agent of foods, curries and salad. Seeds are good in digestion, removes stomach pain regulates mensturation, improves apposite, breast milk production.
74	*Garuga pinnata*	Dubdabey	Lower hill forest	Bark, root	The bark juice is applied to treat dislocated bones & to heal wounds. Root bark is used for curing skin disease.
75	*Gloriosa superba*	LangareyTarul,	Sub-Trropical Lower hill up to 3500 ft.	Herbaceous & glabrous climber	Tubers, roots flowers Chronic ulcers, leprosy, piles, abdominal pains
76	*Glycyrrhiza glabra Linn.*	Jethimadhu	Sub- Himalayan tract (Cultivated)	Erect & tall perennial plant	Roots Cough, fever, dysentery, chronic Hepatitis
77	*Glyeine soja*	vhatmas	6000 ft	Erect	Astringent property, a nutritional diet, rich in vitamins and minerals

Sl. No.	Botanical Name	Local Name	Distribution	Types	Part used & Uses
78	*Hippophae salicifolia*	Achuk	Temperate 5000-10,000 ft.	Shrub	Fruits/bark Lung dieases, skin Eruptions. Irritations
79	*Heracleum wallichi*	Chimphing	8000-13000 ft.	Small shrub	Roots Tonic , aphrodisiac
80	*Orchis latifolia* -	Panchamlay	Alpine 8000-12000 ft.	Erect herb a terrestrial orchid	Tubers Tonic, diarrhea, dysentery, chronic fever
81	*Holarrhena antidysentrica*	Anleykhirrn	Lower hill forest	Bark	Orally administered in amoebic dysentery.
82	*Hymenodictylon sp.*	Latikaran	Lower hill forest	Bark	Orally used for treating haemorrhoids (Piles).
83	*Hypericum patilum*	Urila	3 to 7000 ft.	Seed	Seeds are aromatic & stimulant.
84	*Jatropha curcas*	Kaden, Hathi-kane	Lower hill forest	Juice	The Viscid juice stops bleeding of wounds. Also applied to treat burns, scabies, eczema & ringworm.
85	*Juglans regia*	Okhar	Upper hill forest upto 5000ft.	Fruit & oil	Oil is used for headache. Bark is used for dye & acts as an detergent.
86	*Kaempferia roturela*	BhuiChampa	Below 5000	Tuber	Bone settlers
87	*Leea macrophylla*	Bulyettra	Lower hill forest in Darjeeling & Sikkim.	Roots, leaves & seeds	Tuber for ringworm & guinea worm, leaves paste floor stopping bleeding.
88	*Linderaa neesiana*	Siltimbur	Temperate Himalayas, Nepal & Sikkim.	Bark & fruits	It is aromatic, carminative.
89	*Litsea citrata*	Siltimur	Upper hill forest	Fruits Plants	Dried fruit used for stomach trouble.
90	*Lycopodium clavatum*	Naagbeli	Middle hill/upper hill to 6000 ft.	Creeping plant	Plants & Spores Rheumatism, pulmonary disorder , chronic kidney
91	*Lycopodium clavatum*	Nagbeli	Upper hill forest	Roots & leaves	Used in treating rheumatism.
92	*Mentha viridis*	Pudina	4000-8000 temperate Himalayas	Roots	Leaves are given in fever & bronchitis, oil is used for rheumatism.
93	*Moringa oleifera*	Sajana	Lower Hills	Root, bark and fruits	Root is tonic, used in piles urinary discharge and asthma, bark is useful in heart complaints eye diseases.
94	*Melia azederach*	Bakaina	Lower hill Forest	Entire plant	Root is astringent, removes biliousness, pain in heart, useful in vomiting, leucoderma.

Sl. No.	Botanical Name	Local Name	Distribution	Types	Part used & Uses
95	*Marsdenia roylei*	BaahuniLahara	Lower hill forest upto 5000ft. in Sikkim & Darjeeling.	Entire plant	It has a cooling & alternative effect in gonorrhoea.
96	*Melia azadirach*	Bakaina	Lower hill forest	Roots	Root is astringent, removes biliousness, pain in heart, use full in vomiting, leucoderma.
97	*Mentha viridis*	Nageswari	4000 to 8000 trmperate Himalayas.	Root	Leaves given in fever & bronchitis; oil is used for rheumatism.
98	*Mesua ferrea*	Nageeswari	Lower hill forest	Bark	Orally administered in various skin diseases (mostly poxes)& in menstrual disorder
99	*Mimosa pudica*	Lajjawanti	Lower hill forest	Leaf & leaves	The leaf & root paste is used in case of piles & diseases of kidney. The root is used in treating asthama, fever, cough, and dysentery, vaginal &uterine complaint.
100	*Moringa oleifera*	Sajana	Lower hill forest	Root, bark & fruits	Root is tonic, used in piles, urinary discharge &asthama ,bark is useful in heart complaints, eye diseases.
101	*Myrica esculenta*	Katusi	Middle hill forest	Bark	Used against fever. The paste of the bark is applied on the chest to get relief from cough & bronchitis.
102	*Marsdenia roylei*	BaahuniLahara	Lower hill forest upto 5000ft. in Sikkim & Darjeeling.	Entire plant	It has a cooling & alternative effect in gonorrhoea.
103	*Melia azadirach*	Bakaina	Lower hill forest	Roots	Root is astringent, removes biliousness, pain in heart, useful in vomiting, leucoderma.
104	*Mentha viridis*	Nageswari	4000 to 8000 trmperate Himalayas.	Root	Leaves given in fever & bronchitis; oil is used for rheumatism.
105	*Mesua ferrea*	Nageeswari	Lower hill forest	Bark	Orally administered in various skin diseases (mostly poxes)& in menstrual disorder
106	*Mimosa pudica*	Lajjawanti	Lower hill forest	Leaf & leaves	The leaf & root paste is used in case of piles & diseases of kidney. The root is used in treating Asthama, fever, cough, dysentery, vaginal & uterine complaint.
107	*Moringa oleifera*	Sajana	Lower hill forest	Root, bark & fruits	Root is tonic, used in piles, urinary discharge & asthama, bark is useful in heart complaints,eye diseases.

Sl. No.	Botanical Name	Local Name	Distribution	Types	Part used & Uses
108	*Myrica esculenta*	Katusi	Middle hill forest	Bark	Used against fever. The paste of the bark is applied on the chest to get relief from cough &bronchitis.
109	*Nyctaanthus arbortistiis*	Parijat	Lower hill forest	Leaves, bark	Leaves are boiled & the decanted water is taken to control malaria fever. Bark paste is used for dislocated bones, flower are offered to god & goddesses.
110	*Nardostachys jatamansiDC.*	Jatamansi	11000-17000 ft.	Perennial herb	Whole plant & root stock Skin diseases, leprosy, ulcers, cough
111	*Ocimum sanctum*	Tulasi	Lower hill forest	Leaf/root	The leaf juice is applied to cure scabies & other cutaneous diseases. Infusion of leaves is given as a remedy for gastric trouble, flu, colds &bronchial infection. Root for fever
112	*Oxalis corniculata*	Chariamilo	Lower hill forest	Whole plant, root	Leaf juice is eaten to cure dysentery & fever, anemia , and for appetite, digestion.
113	*Oroxylum indicum*	Totola	Lower hill upto 2500 ft.	Small weak tree	Bark, root bark, fruits,/fever, bronchitis, dysentery, asthma
114	*Podophyllum hexandrum*	Bankankari, Panchpatey	9000-14000ft.	An annual shrub	Whole plant, roots, fruits Torpid fever, diarrhea, mental disorder, plague
115	*Physalis minima*	Jangaliphokphokey	Below 5000 ft.	Fruits	Used as tonic, diuretic ,laxative and useful in inflammations
116	*Phytolacca acinossa*	Jaringo	Middle hill forest	Leaves	Fresh juice applied on cuts & wounds to stop bleeding & infection
117	*Panax pseudoginseng*	Mangan	Above 8000ft.	Roots	The root is taken to reduce fever, indigestion &vomiting: also used as tonic.
118	*Phyllanthus emblica*	Amla	Lower hill forest	Fruits	Dried food for burning sensation of heat & urinary discharge, liver complaint & eye trouble.
119	*Picrorhiza kurooa*	Kutki	Above 7000 ft.	Roots	Used as laxative, brain, tonic, emetic; goods in paralysis
120	*Piper longum*	Pipla	Lower hill forest	Fruits	Dried unripe fruits alternative tonic; ripe fruits, aromatic, stomachic carminative
121	*Potentilla fulgens*	Bajradanta	Lower hill forest	Plants /roots	The plant juice is taken to treat stomach trouble, cough & cold. The root powder is considered to cure

Sl. No.	Botanical Name	Local Name	Distribution	Types	Part used & Uses
122	*Pteri biaurita*	Thadounew	Middle hill forest	Stem	Mashed stem applied on cuts & wounds to stop bleeding & infection
123	*Polygonum viviparum*	Ratnaula	Middle hill forest	Root	Root juice boiled with water is given in case of fever, recommended for jaundice& stomach trouble.
124	*Punica granatum*	Darim	Above 7000 ft.	Fruits	Unripe fruit is useful in vomiting, fever, heart diseases, sore throat, diarrhoea and dysentery.
125	*Rubia manjita*	Majhito	Upper hill forest	Stem roots	Root-tonic, alternative astringent, stem used in scorpion bite, plant used as dye.
126	*Rubus ellipticus*	Aeiselu	Middle hill forest	Root, fruits	Root & young shoots for colic pain. Root paste is applied to treat wounds. Fruit juice is used to cure fever and cough.
127	*Rumex nepallensis*	Halhaley	Lower hill forest	Root	Root dried or fresh extract used orally in hepatitis, loss of hair, also plant used as dyes.
128	*Rhus semialata*	Bhakimlo	Lower hill forest	Fruits	Fruits dried-extract used in diarrhea, swellings and wounds.
129	*Ricinus communis*	Rairi	Upto 3000 ft.	Leaves roots	Leaf juice is used to cure headache, boils & dysentery. Paste of young leaves used to cure jaundice. Roots for skin diseases.
130	*Rheum australe*	Padamchal	Above 6000ft.	Rhizome	Dried rhizome &roots used as astringent, tonic stomachic. The petals as pickles.
131	*Rubia cordifolia*	Majito	Middle & upper hill 4000-7000ft	Perennial herbaceous climber	Root & Fruit Anti- dysenteric, uterian pains, voice , complexion
132	*Rhododendron Anthopogon*	Sunpati	Alpine 11000-16000ft.	Dwarf evergreen shrub	Whole plant except root, incense, snuff to induce sneezing
133	*Rhododendron arboreum*	Laligurans	Temperate & upper hill 4000-10,000 ft.	Medium size evergreen tree	Flowers, young leaves, dysentery, diarrhea, headache
134	*Rauwalfia serpentina*	Sarpgandha	Lower Hill Forest up to 2000 ft.	Shrub	Roots, high blood pressure Snake bite, insomnia,
135	*Rubia cordifolia*	Majito	Middle & upper hill 4000-7000ft	Perennial herbaceous climber	Root & Fruit Anti- dysenteric, uterian pains, voice, complexion

Sl. No.	Botanical Name	Local Name	Distribution	Types	Part used & Uses
136	*Selinum tenuifolium*	BhutKesh	6000-13000 ft	Leaves & Fruits	Leaves, aromatic, carminative, fruit used in skin diseases, scabies.
137	*Sapindus mukrosssi*	Ritha	Lower hill forest	Fruits	The juice of fruit is used to cure burnt part of the body. The fruit is also used for epilepsy.
138	*Swertia chiraita*	Chiraita	Upper Hill / Temperate 5000-10,000ft	Annual. Perennial herb	Whole plant Tonic, leucoderma, skin diseases, chronic fever.
139	*Smilax zeylanica*	Kukur Dainey	Tropical Upto 6000 ft.	Thorny climber	Used in Urinary complaints and dysentery Roots are taken as tonic
140	*Saussurea costus*	N - Kapisful, Kuth	8000 – 13000 ft.	Perennial herb	Bronchitis, vomiting, epilepsy, Headache, hysteria
141	*Solanum nigrum*	Kalobehi,	Worldwide	Shrub Weed	Fruits, roots, leaves Leucoderma, dysentery, vomiting, asthma, bronchitis, fever, urinary discharge
142	*Stephania glabra*	Taubarkey	Lower hill forest	Root bulb	Powder used in diabetes, tuberculosis, asthma, fever.
143	*Taxus baccata*	Dhengresalla	6000-11000 ft.	Medium tree	Leaves extracts used in breast cancer
144	*Tamaarindus indica*	Titari	Lower hill forest	Bark/fruits	A decoction of bark is given in cases of paralysis, ulcers & inflammations; fruit used for cough blood disorders.
145	*Taxus baccata*	Dhengresalla	Above 8000ft.	Leaf/bark	Leaf extracts used in breast cancer.
146	*Terminalia ballerica*	Barra	Lower hill forest	Fruits Bark	It is useful in dealing with bronchitis, asthma &respiratory trouble. Bark used for anemia and leucoderma.
147	*Terminalia chebula*	Harra	Lower hill forest	Fruits	Used as tonic; to cure eye diseases, heart & bladder diseases.
148	*Thysanolaena maxima*	Amliso	Upto 6000 ft.	Roots	Roots, dried or fresh, paste applied to cheek boils.
149	*Toona ciliata*	Tooni	Lower hill forest	Bark flower	Bark is astringent, febrifuge The flower is given in menstrual disorder.
150	*Trichosanthus bracteata*	Indreyni	Middle hill forest	Fruits roots	Fruits cures asthma, roots used in lung diseases of cattle
151	*Tupistra nutan*	Nakima	Upto 6000 ft.	Flower	Appetizer and Diabetic
152	*Tinospora cordifolia*	Garjo	6000 ft.	Stamp, Root	Diabetic
153	*Uritca dioca*	Sisnu	Lower hill forest	Whole plant	Roots dried or fresh paste applied on minor fractures. The tender shoot/leaves taken as vegetables.

Sl. No.	Botanical Name	Local Name	Distribution	Types	Part used & Uses
154	*Viscum articulatum*	Harchur	Lower & Upper hill 1000-6000 ft.	Herb	Whole plant Ulcers, epilepsy, muscular pains, injuries, fracture
155	*Valeriana jatamansi*	NakaliJatamansi	Middle hills	Herb	Root is given in case of hysteria, epilepsy and neurosis. It is Carminative and stimulant.
156	*Woodfordia fruticosa*	Dhayeroo	Lower hill forest	Flower, bark	Dried flower for piles, liver complaints Bark for gastric trouble.
157	*Zanthoxylum allatum*	Bokeytimbur	Lower hill forest	Fruits	Fruit carminative, stomachic, seeds used to cure dyspepsia & cholera.
158	*Zingiber officinale*	Aduwa	Cultivated	Rhizome	Its laxative, aphrodisiac, carminative useful in heart diseases, throat & asthma.
159	*Zizyphus sp.*	Bayer	Below 1000ft.	Bark fruit	Bark as tonic. The ripe fruits to cure thirst and in blood diseases.
160	*Zanthoxylum acanthopodium*	Bokeytimbur	Below 7000 ft	Fruit	Food poisoning

Annexure IV

Mountains in Sikkim

Sl. No.	Name of Peak	Height (m)	Height (ft)	Location			
				East	West	North	South
1.	Khangchendzonga	8474	27803			+	
2.	Mt. Sivo	7468	24500		+		
3.	Jongsong	7462	24482		+		
4.	Tent Peak	7366	24165		+		
5.	Pyramid peak	7129	23390		+		
6.	Pauhungri	7128	23385			+	
7.	Nepal Peak	7100	23294		+		
8.	Siniolchu	6927	22725			+	
9.	Mt. KhangchenGyao	6889	22600			+	
10.	KhangchenGyao	6858	22500			+	
11.	ChomuYumo	6854	22485			+	
12.	Langpo Peak	6852	22480			+	
13.	Domo	6792	22284		+		
14.	Gurudongmar	6736	22100			+	
15.	Mt. Kabru	6707	22005		+		
16.	Rathong Peak	6679	21911		+		
17.	Pandim	6675	21900		+		
18.	Kabru Dome	6639	21780		+		
19.	Sanglaphu Peak	6224	20420			+	
20.	Khnagpu Khangse	6157	20200			+	
21.	Lama Angden	6116	20064			+	
22.	Phulang	6041	19820				
23.	Sanglaphu	6041	19820				
24.	Chummakhang East	6035	19800		+		
25.	Mt. Thingchinkhang	6010	19718		+		

Sl. No.	Name of Peak	Height (m)	Height (ft)	Location			
				East	West	North	South
26.	Singkamo	5852	19200			+	
27.	Lakho Khangse	5822	19100			+	
28.	Burum Khangse	5811	19064			+	
29.	Kokthang	5796	19016		+		
30.	Khnagpup Khangse	5761	18900			+	
31.	Jhopuno	5351	17556			+	
32.	Narsingh	5127	16821		+		
33.	Arralang	4524	14842		+		
34.	NamprikPhuk	4223	13855			+	
35.	Dzongri Top	4130	13549		+		
36.	Chameringu	4066	13341	+			
37.	Dzongri	4030	13221		+		
38.	Pemikhangchhen	3982	13065				
39.	Dhond	3683	12082		+		
40.	JaureDanra	3631	11911		+		
41.	Singalila	3399	11152		+		
42.	Phalut	3086	10123		+		
43.	Tal Danda	3035	9956				+
44.	Labi	3018	9902				+
45.	Kephyaklo	2954	9691	+			

Annexure V

Impacts of Air Pollution

Carbon Monoxide	Affects the cardio vascular system, exacerbating cardiovascular disease symptoms, particularly angina; may also particularly affect foetuses, sick, anaemic and young children, affects nervous system impairing physical coordination, vision and judgments, creating nausea and headaches, reducing productivity and increasing personal discomfort.
Nitrogen Oxide	Increased susceptibility to infections, pulmonary diseases, impairment of lung function and eye, nose and throat irritations.
Sulphur Dioxide	Affect lung function adversely.
Particulate Matter and Respirable Particulate Matter (SPM and RPM)	Fine particulate matter may be toxic in itself or may carry toxic (including carcinogenic) trace substance, and can alter the immune system. Fine particulates penetrate deep into the respiratory system irritating lung tissue and causing long-term disorders.
Lead	Impairs liver and kidney, causes brain damage in children resulting in lower I.Q., hyperactivity and reduced ability to concentrate.
Benzene	Both toxic and carcinogenic. Excessive incidence of leukaemia (blood cancer) in high exposure areas.
Hydrocarbons	Potential to cause cancer

Annexure VI

National Ambient Air Quality Standards

S. No	Pollutant	Time Weighted Average	Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (Notified by Central Government)
1	Sulphur dioxide	Annual 24 hours	50 80	20 80
2	Nitrogen Dioxide	Annual 24 hours	40 80	30 80
3	Particulate Matter(size less than 10um)or PM10 ug/m3	Annual 24 hours	60 100	60 100
4	Particulate Matter(size less than 2.5um)or PM2.5 ug/m3	Annual 24 hours	40 60	40 60
5	Ozone(O3) ug/m3	Annual 24 hours	100 180	100 180
6	Lead(Pb) ug/m3	Annual 24 hours	0.50 1.0	0.50 1.0
7	Carbon Monooxide(CO)mg/m3	Annual 24 hours	02 04	02 04
8	Ammonia(NH3)ug/m3	Annual 24 hours	100 400	100 400

Annexure VII

Biodiversity in Sikkim

Biodiversity at a Glance	Nos
Flowering Plants	5500
Orchids	557
Rhododendrons	38
Conifers	16
Bamboos	28
Ferns and Ferns allies	362
Tree Ferns	9
Primulas	30
Oaks	11
Medicinal Plants	1681
Lichens	506
Magnolia	12
Trees and Tall Bamboos	717
Small Grasses	257
Bushes	112
Mammals	>144
Bees	30
Beetles	994
Birds	568
Butterflies	689
Moths	7000
Insects	5892
Fishes	48
Frogs	16
Lizards and Snakes	92
Reptiles	33
Amphibians	50
Mountain & Peaks	28
Glaciers	84
Lakes and Wetlands	534
Rivers and Streams	>104