

**DISASTER RISK REDUCTION AND
MANAGEMENT IN HILL TOWNS: GANGTOK**

A Project Submitted

in Partial Fulfillment of the Requirements for the Degree of

MASTER

In

Urban And Regional Planning

by

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2021-22**

CERTIFICATE

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ABSTRACT

Disaster is a major problem in hilly areas and a serious threat to sustainable development. Their impacts are diverse: as well as loss of life, injury and disease and the destruction of property and other assets. Disasters can also cause social and economic disruption, loss of infrastructure and other services and damage to the environment. In order to understand these problems, this study mainly focuses on how to reduce the impact of disaster and search for an alternative solution to cope with disaster in hilly areas.

Presence of dilapidated housing typologies and high rise building in city centre in a haphazard manner. Gangtok city falls under seismic Zone IV which lies on very sensitive zone. There is no hierarchy of size of developments as they are not integrated spatially or physically. The city of Gangtok is rapidly developing in both planned and unplanned manner outside the framework of urban development plan physical and social infrastructure are major concern areas of the city. As city growing the accessibility to facilities has change.

Changing land use and lack of proper landuse control, which make city vulnerable to disaster and practice of mixed landuse can be seen in various areas of in the city. As a result, those unplanned activities have been affecting the social fabric and its management and push the people to exposure to disaster risk and hence, there is need to adopt the landuse policy to minimise the exposure to disaster.

In view of the complexities and diversities of the disaster management, effective planning is needed for which political commitment and effective implementation policy is very necessary. It is also believed that lack of coordination, insufficient fund and resources, and their mobilization problems have to be addressed through the proper implementation of the practicable policy, disaster management plan and need to develop early warning to reduce disaster. In order to reduce hazard and vulnerabilities, this thesis deals with review of various policy and risk assessment of the city and develop suitable strategies and policy guidelines to reduce disaster risk in Gangtok.

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INTRODUCTION

Background of Study

In the recent past decades, disaster activity has increased over the hill cities and town, it has become dominant trend there is need to search for appropriate solution to overcome those challenge, there has been increase number of mortality due to disaster and also an increase of loss of property. One of the major concerns is that despite of various act and byelaws for reduce the disaster and management, it can't able to mitigate the disaster and the risk despite of various plan to mitigate the disaster. The frequency of disaster has increased over a period of time due to rapid urbanization in hilly areas, lead to haphazard development and making them more vulnerable. The increasing of urbanization and human population growth over the years have resulted significant pressure on land, due to physical and topographical constraint but in most of the time, disaster occur naturally, but at the same time people are vulnerable to disaster due to human action and human intervention that lead to disaster more adversely. Although it is observed that disaster like landslide, cloudburst, flash flood etc. have increase in hilly areas under the influence of climate change in greater extend which have huge impact on both urban and local level as a result scale of damage to property and loss livelihood has increase.

Need of Study

- Gangtok is located at Himalayas region which are high risk of earthquake activity and Gangtok city fall under the seismic zone IV.
- Under the influence of steep slope, landslide activity occurred very frequently mainly during the monsoon season and rainy day.
- Due to the rapid population growth and Urban expansion as mushrooming of structure, high rise building, dilapidate building are major concern which become vulnerable to disaster, there is urgent need of vulnerability assessment in the city.
- Encroachment on vulnerable areas, without proper assessment which consequently increasing in the vulnerability of communities exposed to the risk.
- Fire Accident frequently occurred in city and natural forest fire happened during dry season.

Why Gangtok

- Gangtok is city which high vulnerable to earthquake due to presence of various folded, faulted and thrust.
- It is entirely city situated in mountainous which consist of steep slopes, complex geology which make city very prone to landslide activity.
- The vulnerability of buildings can only be reduced with proper study of earthquake damage to the buildings in the past and planning structures and infrastructure accordingly so that they meet the challenges of earthquake safety in future.
- Increasing pace of infrastructure development is not in accordance with the land-use planning and construction practices which help to reduce the seismic vulnerability of the built environment.
- A Himalayan type of climate characterizes Gangtok. Altitude is the main factor controlling the climate and weather condition which make extreme to rainfall of the whole state including the capital city of Gangtok.
- Gangtok is as whole very highly vulnerable to both natural and man-made disasters.

Aim

- ◆ **To develop the strategies and framework for reducing disaster risk in Gangtok.**

Objectives

- To study nature and occurrence of disaster in Gangtok.
- To assess status of disaster risk of Gangtok City.
- To examine the role of agencies in managing the disaster.
- To identification of Issues, the criticalities and their vulnerability to disaster.
- To formulate planning strategies and policies guidelines to reduce disaster risk in Gangtok.

Scope

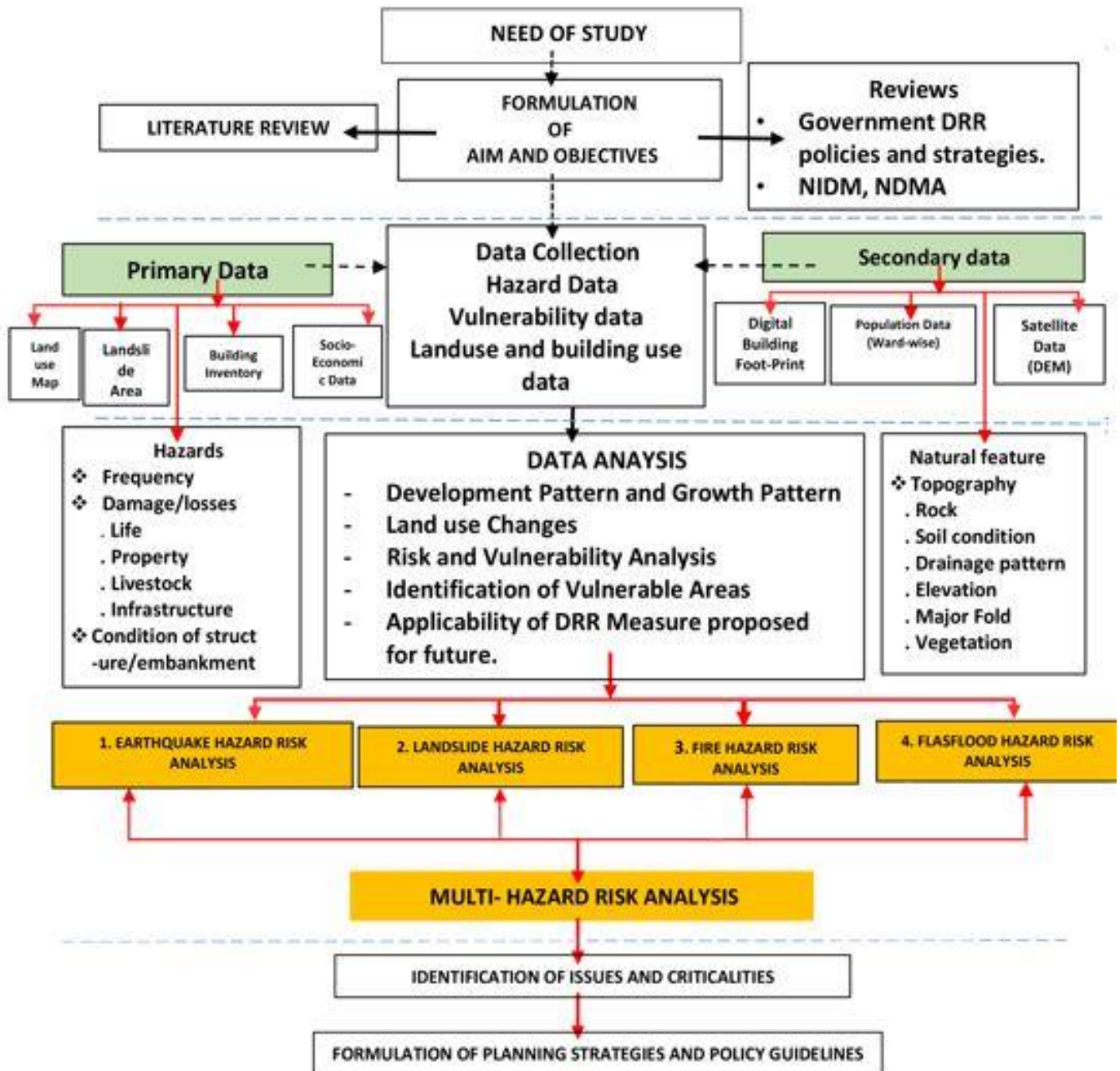
- The study is limited to Gangtok Municipal Corporation Boundary with total area of 19.5 (sqkm).
- The study deals with the disaster risk reduction as essential, can be promoted and implemented pre-disaster measure for large and small scale disasters.
- To reduce the disaster impact and human losses such as, earthquake, landslides, flashflood, fire, road accident etc. which are frequently occurred in Gangtok.
- It also focuses on the man-made and human cause disaster like haphazard and unplanned development, building regulation, landuse regulation etc.

Limitations

- i. The study based on secondary data sources, primary survey and observation study.
- ii. Due to non-availability historical data, trend analysis of earthquake and landslide could not have done effectively.
- iii. Primary survey was carried out by random sampling method and taking sample size of 0.5 per cent.
- iv. Planning strategies and policy guidelines would be applicable to Gangtok Municipal corporation area only.

Research Methodology

METHODOLOGY



LITERATURE REVIEW

Basic Concepts and Terminologies of Disaster

From the various individuals and international organisation has try to define the meaning of disaster follow as: A disaster can be defined as any occurrence that cause damage, ecological disruption, loss of humanlife, deterioration of health and health services on a scale, sufficient to warrant an extraordinary responsefrom outside the affected community or area.

"A disaster can be defined as an occurrence either nature or manmade that causes human suffering and creates human needs that victims cannot alleviate without assistance". (*American Red Cross (ARC)*)

"Disaster A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources". *UN Office for Disaster Risk Reduction, 2006 (UNISDR)*

Hazard

Any phenomenon that has the potential to cause disruption or damage to people and their environment. A hazard is natural event while the disaster is its consequence. A hazard is perceived natural event which threatens both life and property. A disaster is a realization of this hazard. (*John Whittoww*) When hazard involves elements of risks, vulnerabilities and capacities, they can turn into disasters. Hazards may be inevitable but disasters can be prevented.

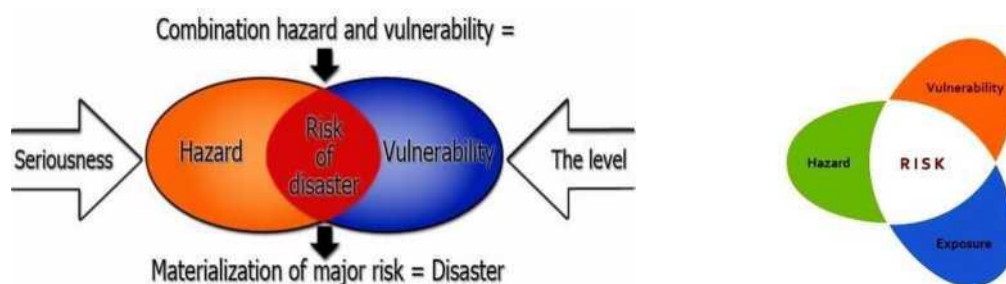
"Hazard A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption or environmental damage." *UNISDR Terminology on Disaster Risk Reduction (Geneva: UNISDR, 2009)*.

Disaster risk

Disaster risk is the potential to disaster losses, in lives, health status, livelihood, assets and service, which could occur to a particular community or a society over some specified future time period.

(Sources: Geneva UNISDR report, 2009)

EXPLANATION BY IPCC



Vulnerability

Vulnerability is the characteristic and circumstances of a community, structure, service, geographic area or assets that make susceptible to damaging effect of a hazard. 'The propensity of things to be damaged by a hazard'.

Vulnerability is defined as "the extent to which a community, structure, service, or geographic area is likely to be damaged or disrupted by the impact of a particular hazard, on account of their nature, construction

and proximity to hazardous terrain or a disaster prone area." The concept of vulnerability, therefore, implies a measure of risk combined with the level of social and economic ability to cope with the resulting event in order to resist major disruption or loss. This susceptibility and vulnerability to each type of threat will depend on their respective differing characteristics.

(a) Physical Vulnerability: Physical vulnerability relates to the physical location of people, their proximity to the hazard zone and standards of safety maintained to counter the effects. For example, people are only vulnerable to a flood because they live in a flood prone area. Physical vulnerability also relates to the technical capacity of buildings and structures to resist the forces acting upon them during a hazard event.

(b) Socio-economic Vulnerability: The degree to which a population is affected by a calamity will not lie purely in the physical components of vulnerability, but is contextual to the prevailing social and economic conditions and its consequential effect on human activities within a given society. disparate capacities of people are exemplified in risk analysis. Effects are seen to be directly proportionate to the poverty gap and poverty-intensity in the society/ location as it is the poor that normally live in high concentration in marginal areas (unstable slopes, flood plains) with little infrastructure and fewer resources to cope.

Disaster Risk Reduction

The concept and practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters:

- Reducing Exposure to Hazards.
- lessening Vulnerability of people and property;
- wise Management of land and environment;
- Improving preparedness.

Improving early warning system for adverse events are all example of disaster risk reduction. Disaster risk reduction denotes both a policy goal or objective, and the strategic and instrumental measures employed for anticipating future disaster risk; reducing existing exposure, hazard, or vulnerability; and improving resilience.

Disaster Risk Management

Disaster risk management is the systematic process of using administrative directives, organizations and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.

Disaster risk management processes for designing, implementing and evaluating strategies, policies and measures to improve the understanding of disaster risk and foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, resilience and sustainable development. (IPCC)

Types of Disaster

Disasters are extreme events within the earth's system that result in death or injury to humans and damage or loss of valuable goods, such as buildings, communication systems, agricultural land, forest, natural environment etc. The economic losses due to natural disasters have shown an increase with a factor of eight over the past four decades, caused by the increased vulnerability of the global society, but also due to an increase in the number of weather-related disasters.

- Disaster has broadly classified into two categories i.e. Natural and Man-made

FIGURE 3: TYPES OF NATURAL DISASTER

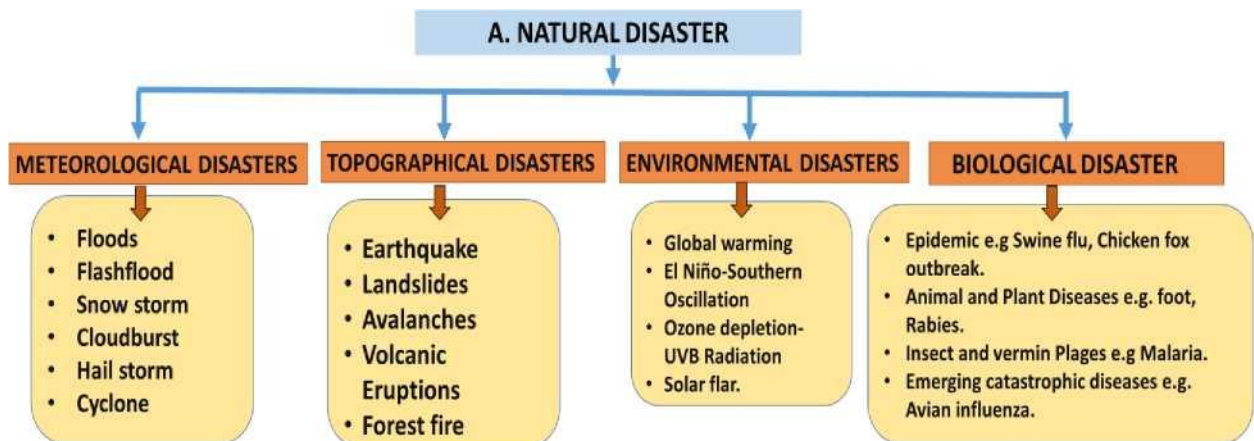
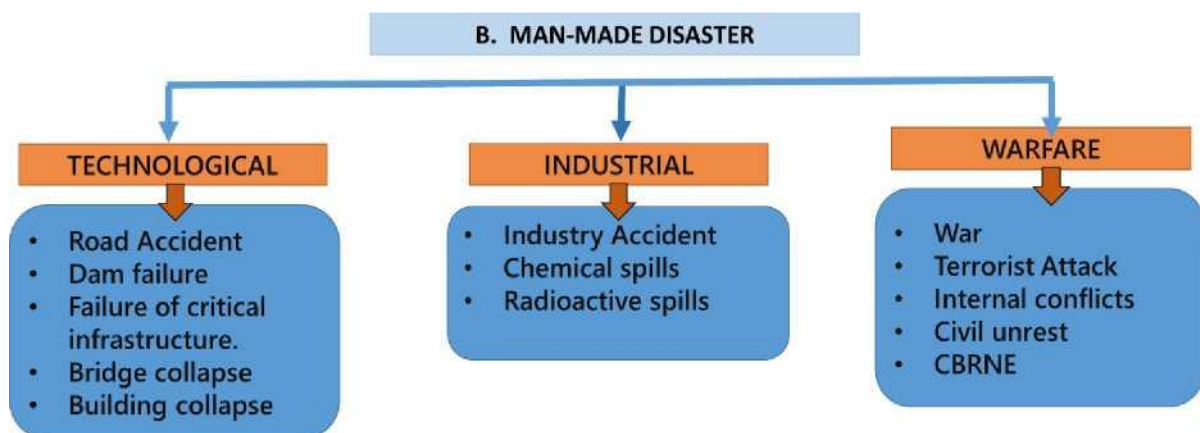


FIGURE 4: TYPE OF MAN-MADE DISASTER



Different Approach from various Organization toward risk management:

Insights on the process of risk management;

- Taking on risks is necessary to pursue opportunities for development. The risk of inaction may well be the worst option of all.
- To confront risk successfully, it is essential to shift from unplanned and adhoc responses when crises occur to proactive, systematic and integrated risk management.
- Identifying risks is not enough: the trade-offs and obstacles to risk management must also be identified, prioritized, and addressed through private and public action.

Case Studies

Case Study 1: Earthquake Capacity Building and Risk Reduction Measures In Gujarat Post Bhuj 2001 Earthquake.

The earthquake occurred on Friday, 26th January 2001. The extent of earthquake damage was immense about **13,805** persons dead and caused direct losses of about Rs 150 billion (approx. US \$ 3.2 billion) and indirect losses of about Rs 30 billion (approx. US \$ 650 million). The large magnitude 7.7 of the earthquake combined with the poor construction quality contributed to large scale damage to the building stock and a high number of casualties.

BASE MAP OF GUJARAT

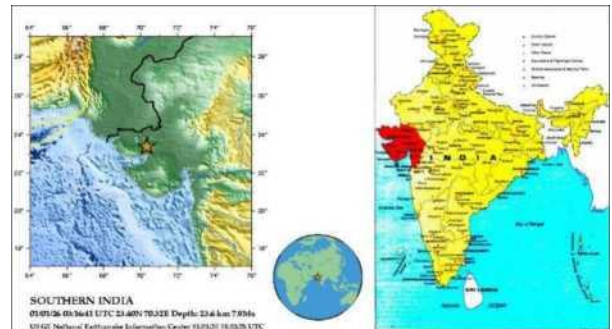
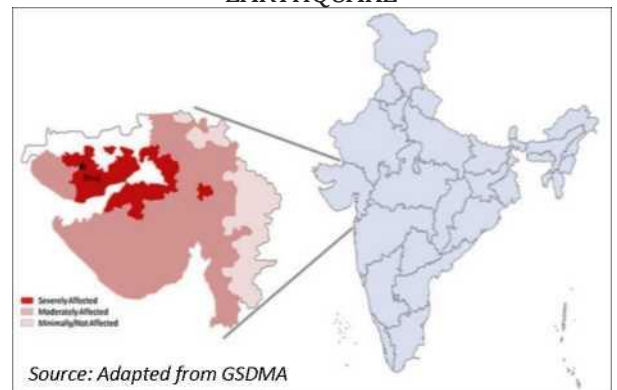


TABLE 1: GUJARAT DAMAGE ASSESSMENT

Damage Assessment	Extent
Number of casualties	13,854
number of injured	167,000
Estimate cost	5 billion US
Number of building destroyed	300,000
Number of building damaged	700,000
Number of earth dam damaged	14
area involve in landslides	10,000km ²
Area involve in soil liquidification	10,000km ²

Source: Adapted from GSDMA (2001)

AREAS AFFECTED BY THE 2001 GUJARAT EARTHQUAKE



Improvement in Various Sector and Policy	Initiative to Reduce Disaster Risk in Gujarat
1. Capacity Building And Risk Reduction Measures	<ul style="list-style-type: none"> i. Development of seismic engineering design skills, '(up graduating civil engineers and architects, equipped with adequate background in earthquake engineering, and a teacher training program to effect these changes.) ii. Up-gradation of skills in the unorganized construction sector and raising awareness levels at community level. iii. Multi hazards resistant construction has been provided and provided for using local materials in hazard resistant construction.
2. Policy Measure Reduce Risk(GSDMA)	<ul style="list-style-type: none"> i. The policy resulted in a shift of focus from relief oriented approach to proactive disaster mitigation and risk reduction. ii. The policy identified hazard mitigation, vulnerability reduction, capacity building, integration of development planning with disaster management and emergency preparedness as the key activities to be undertaken as part of the long term strategy. iii. Integrating development with disasters. iv. Suitable building codes has been revised and development control regulation has been revised.

Case Study 2: Landslide in Aizawl (11 May 2013)

Background: An abrupt rockslide on 11 May 2013 forced a series of building collapse at the eastern side of Aizawl, Mizoram, at 1120 m above mean sea level. All the way down to Ramhlun Venglai locality covering an area of about 1025 Sqm, which have been very high landslide prone regions of Aizawl.

PHOTOGRAPH 3: SHOWING LANDSLIDE IN AIZAWL

Impact of Disaster

- As results 17 casualties, 8 persons injuring from the collapse of 15 houses.
- The rockslide completely destroyed 15 houses (7 RCC buildings and 8 Kaccha type buildings) including community hall.
- An evacuated 4 storied RCC building of Public Works Department (PWD) of Mizoram. 17 vehicles, including 8 four-wheelers were buried under the debris.
- The main reason due inappropriate earth cutting under high steep slope, heavy rainfall, thunderstorm, human cause destruction due to overweight constructions.



Source: ENVIS Centre, Mizoram

Causative factor

- Excessive and torrential rainfall
- Absence of proper drainage system,
- Unsafe cutting of rock bed at the toe region which decreased resisting force.



Source: Disaster Management Centre, Administrative Training Institute, Aizawl

Lessons Learnt

- Strictly monitored and proper formulation of Building regulation on based of micro landslide zonation.
- Site development and slope modification work must be undertaken only under the supervision of the Authority.



Case Study 3: Leh Cloudburst (2010)

Background: In the midnight of August 6, 2010, Leh in Ladakh region of North India received a heavy rainfall of 12.8mm as a result cloud burst occurred all of a sudden that caught everyone unawares, flash floods and mud slides causing havoc and large scale loss of life and public infrastructure and private

property particularly in Leh region. Search and rescue immediately after the disaster. The injured and dead were shifted to Army Hospital and mass casualty management was started by the army doctors while relief work was mounted by the army and civil administration.

operations were launched by the Indian Army

PHOTOGRAPH 4: SHOWING DAMAGE BY CLOUD BURST, 2010



Causes:

- Cloudburst led to heavy rainfall in Leh region.
- The Indus river and its tributaries and waterways were overflowing.

Impacts:

- 234 persons died and over 800 were reported missing. Almost half of the people who died were local residents 49.6 per cent and foreigners 10.2 per cent.
- There was vast destruction, over 1000 houses were collapsed.
- The local communication networks and transport services were severely affected. Leh airport was flooded, road transport was badly disrupted as roads were washed away.



Source: Cloudburst in Leh 2010, International Association for Human Values and Art of Living, Project Report.

Response:

- More than 6000 personnel of Army, Air Force, Border Roads Organization, National Disaster Response Force and Indo Tibetan Border Police were deployed along with rescue equipment to assist the civil administration in relief operations. Large quantities of relief material.

Lessons Learnt

- Disaster preparedness plans and protocols for planning, training is play an important role to mitigate disaster.
- Emergency medical services and public health systems are very helpful in rescue and relief and in reducing casualties and adverse impact on the human life and socio economic conditions.
- There is need to strengthening the National Emergent Reserve Force, Air force, Indo Tibetan Border Police etc. has an important role during search, rescue and relief operation.
- Effective communication system has paramount importance in coordination of rescue and relief operations.

GANGTOK PROFILE

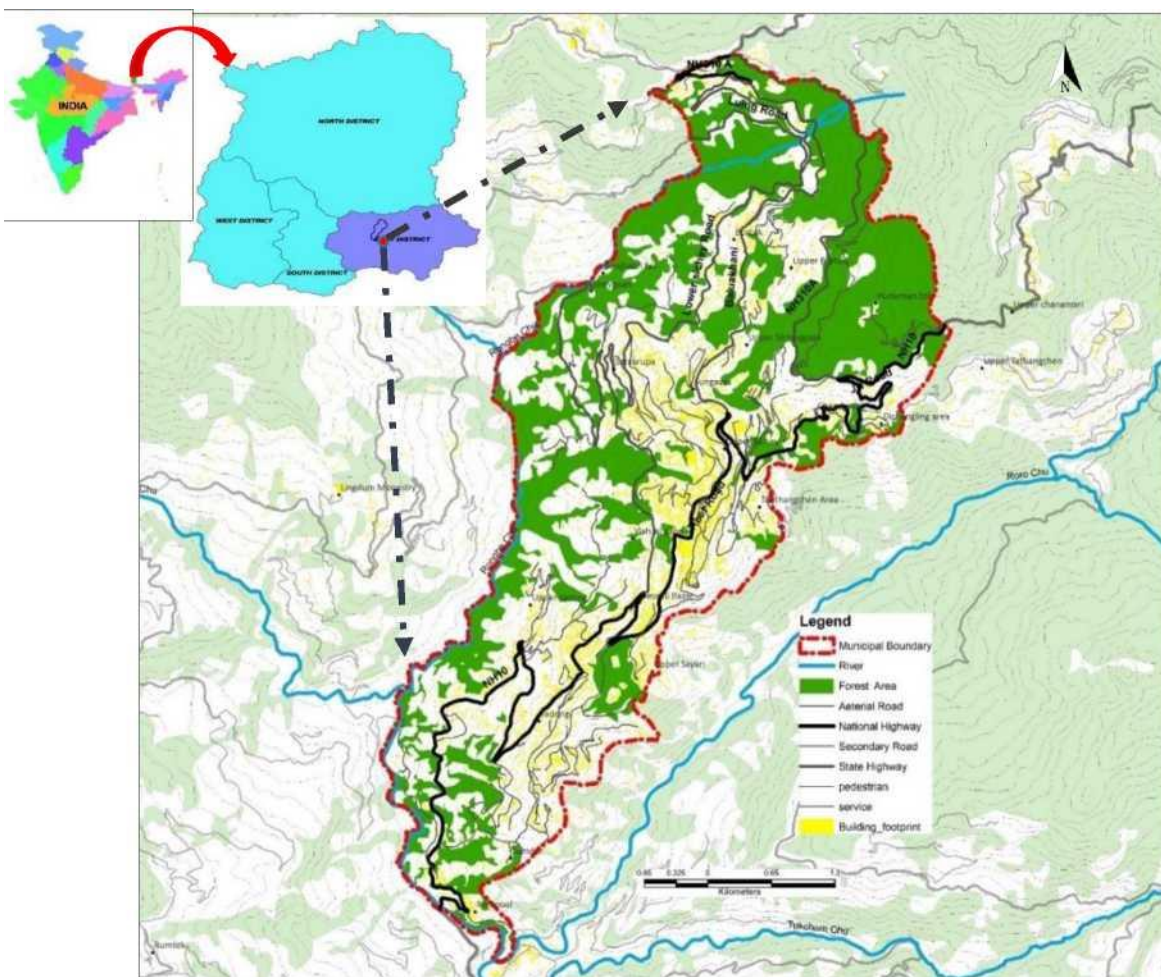
Introduction

Gangtok is the capital city of Sikkim and also the largest city of the State. The city is located at 27.3325°N 88.61°E. The inevitable physically expanding urban areas in a Gangtok City located in Eastern Himalayan range, at an elevation of 1,650m (5,410ft). Gangtok has served as the centre of administration, trade, religion and tourism both in the past and is serving in present as well. Gangtok is the major urban area in the state of Sikkim. Its attracts a large number of tourists both domestic and international. The average number of 3 lakhs tourists throughout the year because of its scenic beauty and proximity to snow clad mountains of Himalayas. Because of tourism



BASE MAP OF SIKKIM

and administrative activities, Gangtok has emerged as the main centre of economic activity and attracts people from all over the state for employment opportunities and better infrastructure. The complexity of urban development, especially in a hilly city like Gangtok is so rapid as it demands quick response and perspective physical planning of the city. The increasing population day by day in Gangtok city leads to the demand for urban land. The increased population has been accommodated in the new suburbs by deforestation and encroachment on land.

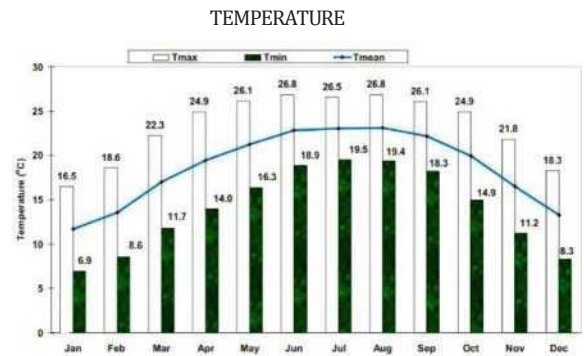


Source: UD & Housing Dept. Gangtok

BASE MAP OF GANGTOK CITY

Weather and Climate:

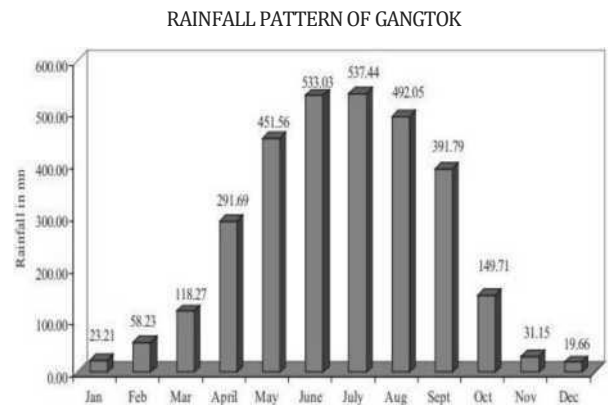
Gangtok city is characterized by subtropical highland monsoon driven climate. Because of its elevation and sheltered environment, Gangtok enjoys a mild, temperate climate all year round. Like most Himalayan towns, Gangtok has five seasons: summer, monsoons, autumn, winter and spring. Temperature ranges from an average maximum of 22°C in summer to an average minimum of 4°C in winter. Summers (lasting from late April to June) are mild, with maximum



Source: Gangtok Weather Report,

temperature rarely crossing 25°C. The monsoon season from June to September is characterized by intense torrential rains often causing landslides that block Gangtok's land access to the rest of the country. Rainfall starts to rise from pre-monsoon in May, and peaks during the monsoon, with July recording the highest monthly average of 649.6 mm. In winter temperature averages between 4°C and 7°C. Snowfall is rare, and in recent times Gangtok has received snow only in 1990, 2004 and 2005.

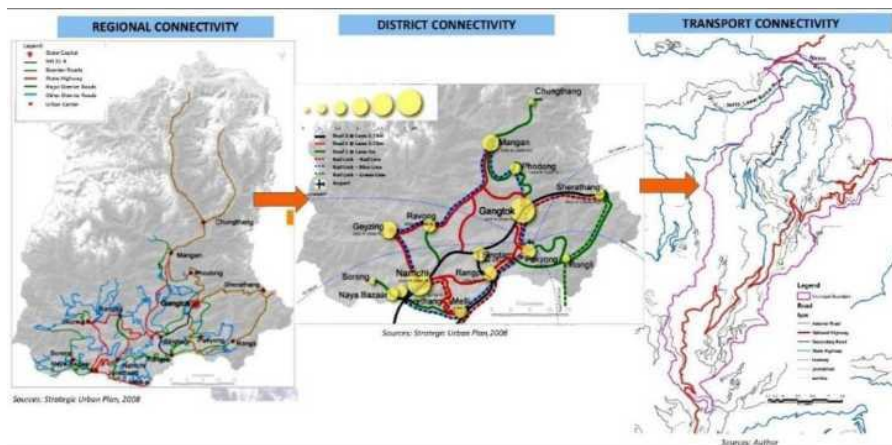
During spring and autumn, the weather is generally sunny and mild. Owing to its elevation, Gangtok is often enveloped in fog during the monsoon and winter months. The city has experience rainy season during June-August. During the summer temperature ranges from an average maximum of 22°C to an average minimum of 4°C in winter. The monsoon season starts from June and last till September and is characterized by intense torrential rains. In winter average temperature between 4°C and 7°C, it prevails by very dry over the city due to alpine climate.



Source: Gangtok Weather Report, 2017

Regional Connectivity:

Gangtok is connected by National Highway NH10 and NH31A to Siliguri which is a major town in the North Bengal. The nearest airport and railway located near Siliguri is 117 km away from Gangtok. Primary Road Network Length 125 Km with 75 per cent network having carriageway ranging to 6m-8m in the city.



Source: Strategic Urban Plan Report, 2008

Economy

The economy of Gangtok city is primarily agrarian. Industry is not much developed in the city. However, hospitality and tourism industry is plays very important role in generation employment in the city. Other industries like cottage and small industry are also good contribution to the economy of capital city.

- Agriculture: a majority of the population dependent on the agriculture for livelihood. The principle crops are rice, maize, wheat, large cardamom, potato, ginger and orange.
- Industry: the hospitality is one the largest industries in Gangtok. It's become one of the important tourist destination which attract large number of tourist both international and domestic tourist. There are various hotel and restaurant are to serve the tourist. Hence, hospitality industry ones the fastest growing industry in Gangtok. Its witness to huge number of inflow which contribute major business and economic activity in the city.
- Cottage and small scale industry: Cottage and small scale industry is another major industry in the city, its produce large number of handicraft, wooden and bamboo product. Other likes furniture, flower basket, flower vases, hats and other decorated items.

Gangtok Municipal Area (GMC)

Gangtok Municipal corporation which covered by 19.05 sqkm of total area. Gangtok has bounded by two rivers namely the Roro-chu river in west and the Rani khola river in the east respectively. The city expanded in linear growth along the NH 31A and NH 10 which serve city as main national highway and it majorly connected whole city. According to 2011 census it has total population of 100,286 in municipal corporation area. The average density of Gangtok is 53 persons per hectare (pph). With the addition of two new wards in the recent municipal elections of 2015. The two new wards have been created by bifurcation of existing wards with the external Currently, there are presently 17 wards in the Gangtok city.

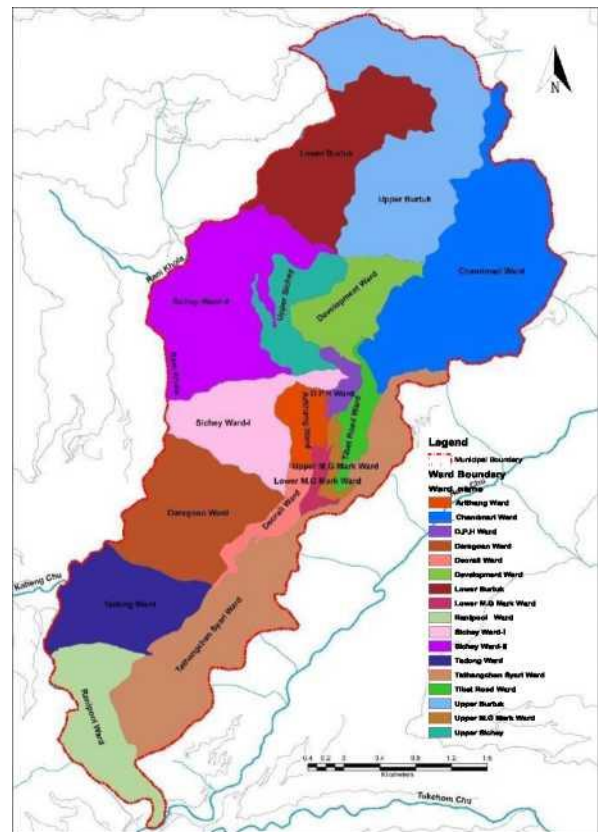
Central ward which contains all major economic activities including Govt. offices, markets and most of tourist centric infrastructure has the highest density.

All other wards which touch the boundary of Gangtok Municipal Corporation (GMC) have density less than 100 Persons/ Sq. KM.

Population

In 2001, Gangtok has maximum share of urban population of Sikkim state which account for 49 per cent. Gangtok account for over 77 per cent of total urban growth. It attracts large number of tourists throughout the year because of its scenic beauty and proximity to snow clad mountains of Himalaya. Because of tourism and administrative activities, Gangtok has emerged as the main Centre of economic activity and attracts people from all over the state for employment opportunities and better infrastructure. The growth of population is very high in the last decade. In 2001 it has 29,354 populations with growth rate

WARD MAP OF GANGTOK



Source: UD & Housing Dept. Gangtok, 2018

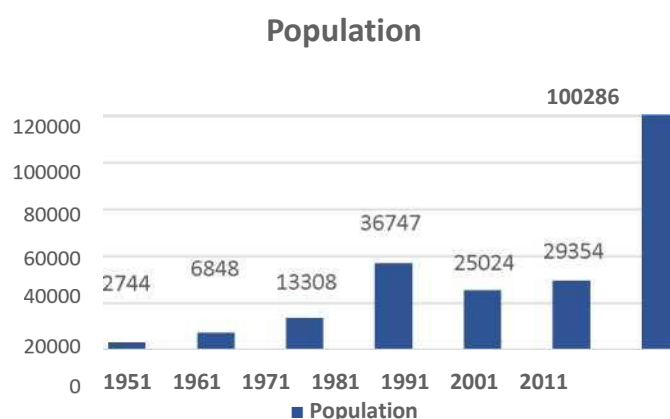
17.3 per cent. According to the Census of India, 2011, Gangtok municipal area population is 1,00,286 and the number of households is 27,464 with growth rate of 241.64. which is mainly due to migration from other parts of Sikkim and an increase in tourism activities, Gangtok population exploded in the last 10 years with an increase of 241.63 per cent.

It has been noted that Gangtok consistently recorded very high growth rate of population except for the decade 1981-91 which recorded a negative growth rate of 31.90 per cent due to reduction of the Gangtok notified area. The last decade i.e. 2001-2011 has shown the most phenomenal growth rate of 241.64 per cent. Below the table has been showed that the trend in the urban population and changing index of Gangtok town of Sikkim from 1951-2011. It is evident that total urban population has risen considerably from 2 thousand in 1951 to around 1 million in 2011. According to the table the growth of urban population increased approximately five times from the base year of 1951.

POPULATION GROWTH IN GANGTOK (1951-2011)

Year	Population	Growth (%)
1951	2744	
1961	6848	149.56
1971	13308	94.33
1981	36747	176.13
1991	25024	-31.9
2001	29354	17.3
2011	100286	241.64

GANGTOK POPULATION FROM (1951-2011)



Source: Census; 2011

from the above graph, the concentration of population in the East District (comprising of 88 per cent of the total Urban Population) alone may be attributed to several influences. Gangtok is the State capital and hence attracts a large number of people. This has eventually led to Gangtok becoming the primate city of Sikkim, Gangtok is the main base for tourism in Sikkim.

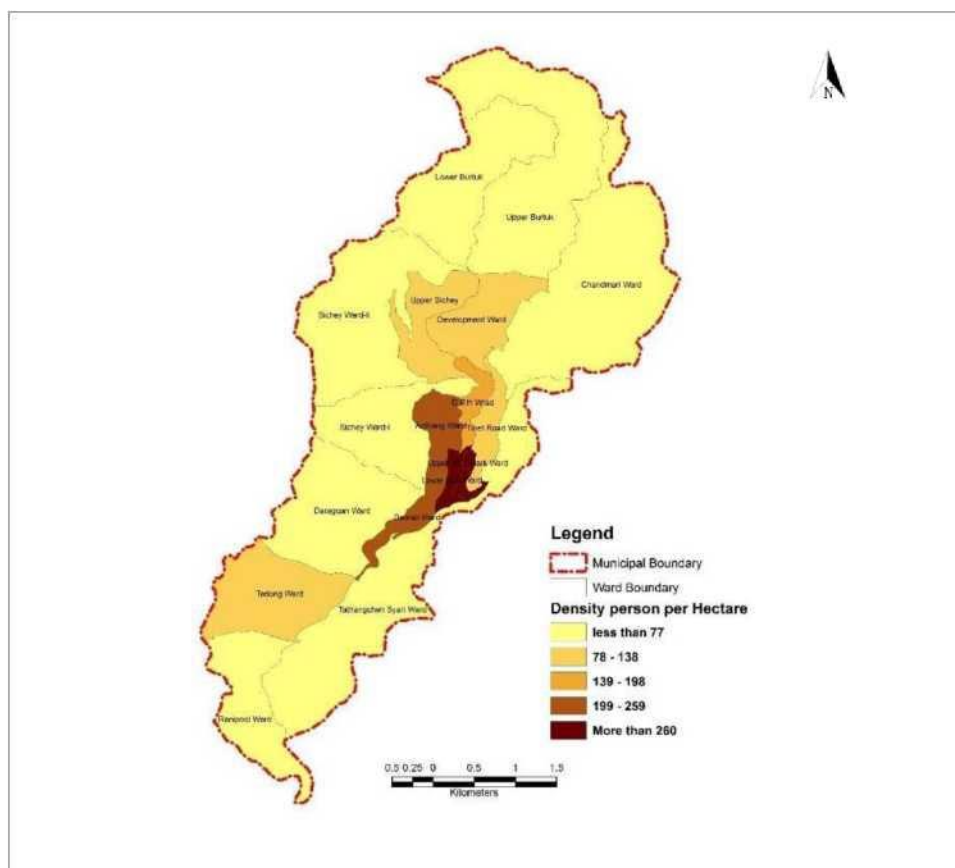
According to the census, population of Gangtok was 58,242 in 1991 and 82,149 in 2001 (decadal growth rate of 41 per cent). The preceding decade of 1981 to 1991 experienced a much higher growth of 58.5 percent. Gangtok has an average literacy rate of 69.7 percent, higher than the national average of 59.5 percent male literacy is 77.9 per cent and female literacy is 61.5 percentage. About 8 percent of Gangtok's population live in the nine notified slums and squatter settlements. Overall work participation rate is 39.31 per cent. The occupational structure of Gangtok shows a fairly large share of population 46.7 per cent engaged in formal service. Quite a substantial proportion of the population is having own shops and business. The rapid growth during the recent past has put enormous pressure on residence, civic amenities and existing public institutions.

WARD-WISE POPULATION GANGTOK UNDER GMC.

Ward no.	Name of Ward	Area in Hectare	Population	Density in (Hac)	Rank Density
1	Upper Burtuk	262.37	6572	25	13
2	Sichey Ward-I	109.24	2629	24	14
3	Upper Sichey	65.53	7979	122	6
4	Chandmari Ward	306.55	6177	20	16
5	Development Ward	74.79	6723	90	8
6	D.P.H Ward	20.64	3987	193	5
7	Arithang Ward	34.17	8212	240	4
8	Lower M.G Ward	12.60	4032	320	1
9	Upper M.G Mark Ward	8.93	2664	298	2
10	Tibet Road Ward	29.40	3266	111	7
11	Deorali Ward	28.74	6938	241	3
12	Daragoan Ward	158.88	9605	60	10
13	Tadong Ward	121.28	9325	77	9
14	Ranipool Ward	106.40	4520	42	12
15	Tathangchen Syari Ward	246.59	11028	45	11
16	Lower Burtuk	159.31	3385	21	15
17	Sichey Ward-II	205.15	3244	16	17
Total	17	1950.57	100286	Aver. 53	17

Source: Gangtok Municipal Corporation 2022

POPULATION DENSITY



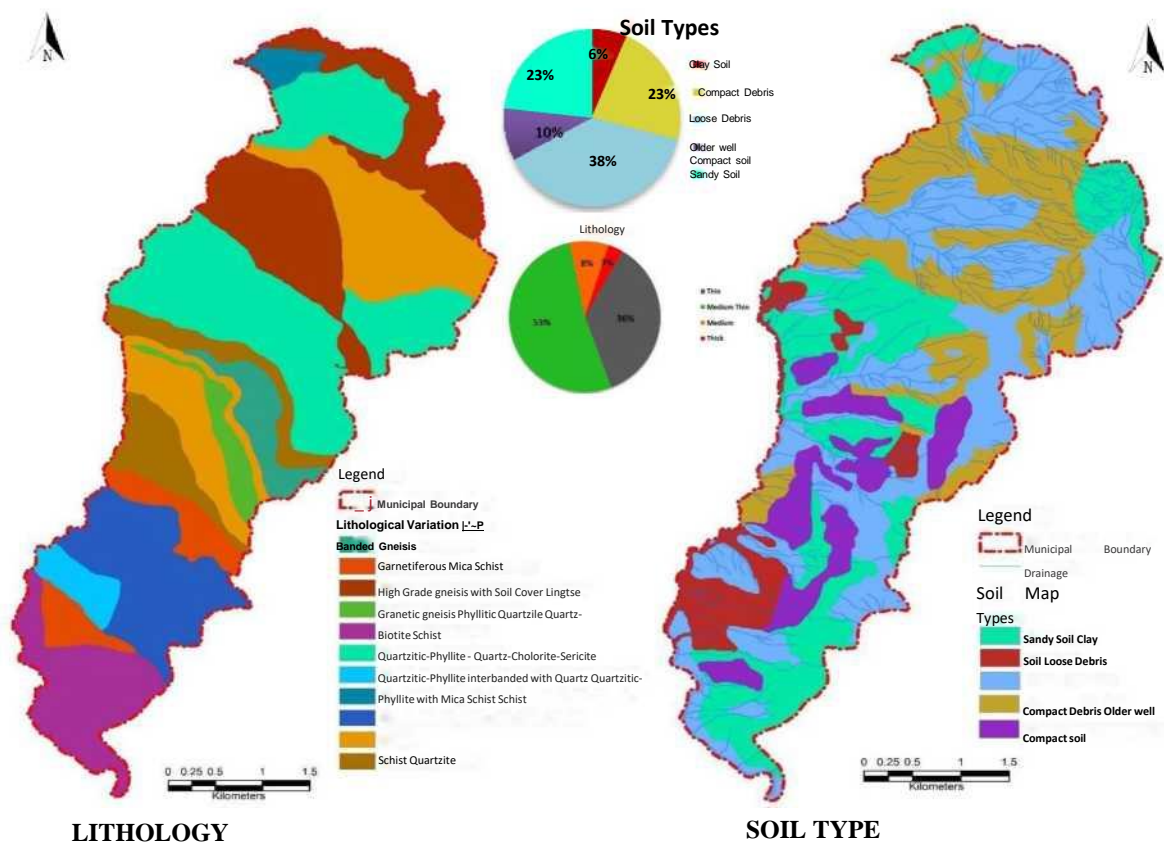
Source: Gangtok Municipal Corporation

Physiographic Character

Geology

The rock types of Gangtok region mainly consists of phyllites, schists and gneissic rocks of Daling Group and Lingtse granite gneiss. Due to high monsoonal rainfall and structurally disturbed nature of the area, rocks are highly weathered at many places. Because of the high weathering and erosion there are frequent landslides in the region. Northern and central part of the city are primarily composed of rock which have higher Mohs scale value with schist, gneiss and quartz being major component of the rock found here. On the other hand, Southern portion have rocks with lowers Mohs scale value with phyllite, mica and chlorite being major component in Gangtok.

MAP 13: LITHOLOGY AND SOIL



Source: City Disaster Management Plan; Gangtok, 2012

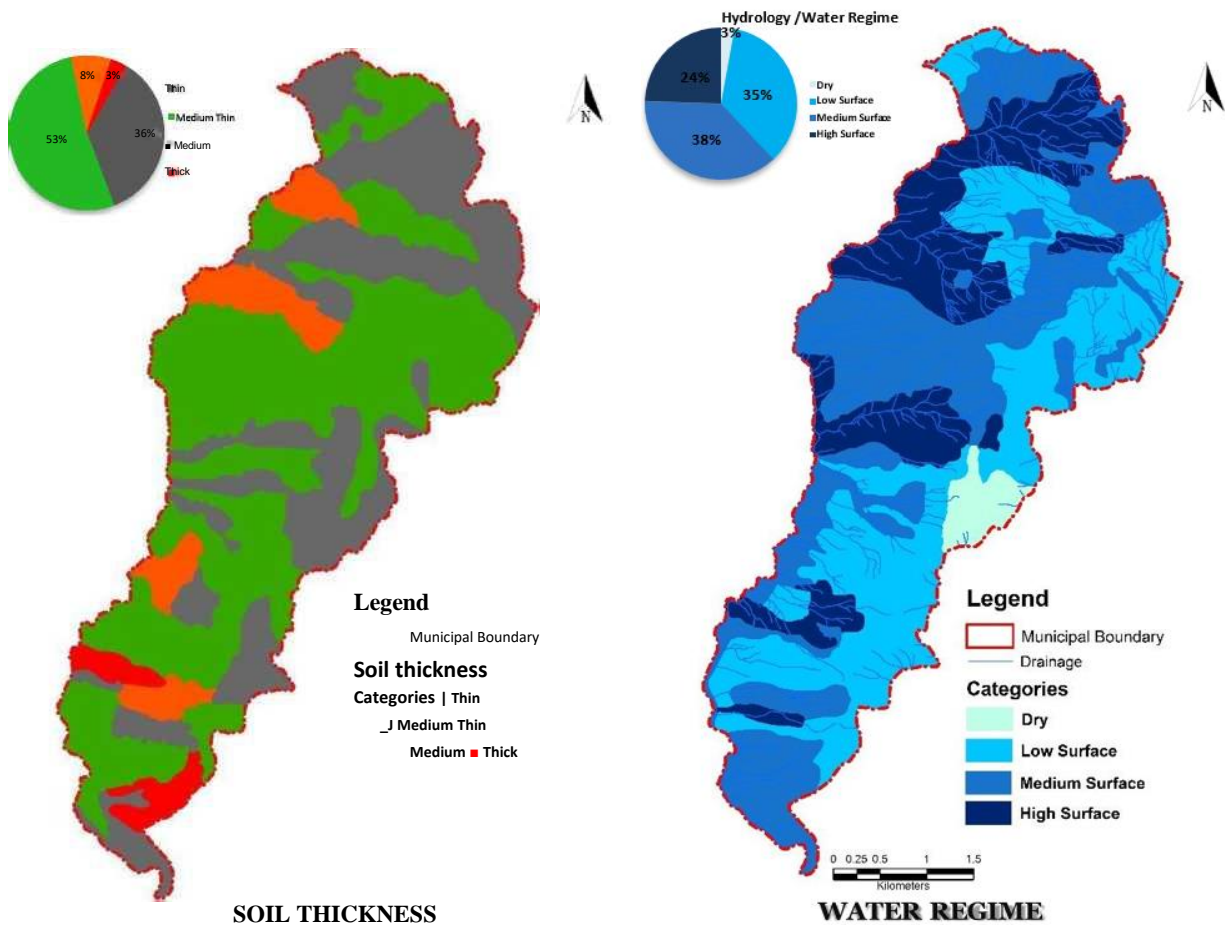
Soil types and Thickness

The soils in the region are excessively drained, coarse to fine loamy with slight surface stoniness. The soils are acidic in nature with pH below 6.0. The soil shows contrasting morphologies under varying topographic settings. Soils in north and eastern part of the Gangtok Municipal Area (GMA) are thin and highly sandy when compared to the western part. Such soils have low strength and permeability, high sensitivity and compressibility and are not suitable for construction activity.

Gangtok city primarily consist of loose or compact debris which makes its highly vulnerable since debris tend to shake more easily during earthquake and this making foundation of structure susceptible to failure. Central and southern part of city has mixed composition with stripes of layer of each category of soil.

Since larger parts here are made of clay or well compacted soil, they tend to stick together during an earthquake and hence are less vulnerable areas.

SOIL THICKNESS AND WATER REGIME



Source: City Disaster Management Plan; Gangtok, 2012

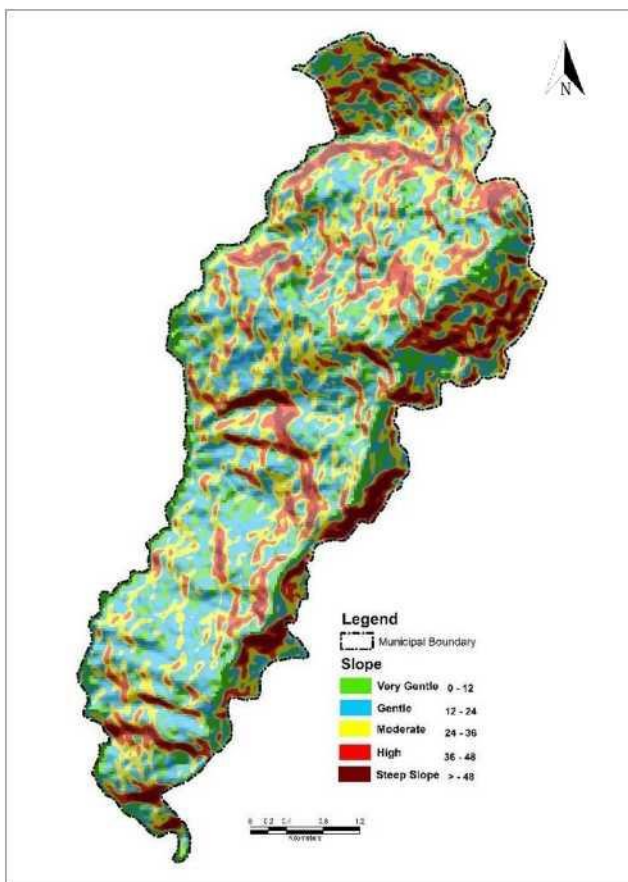
The characteristics of soil varies from place to place due to topographical variations. The texture of the soil is loamy sand to silty clay loam. Soils are generally acidic in nature having the pH value of 5.0 to 6.0. Brown red and yellow soils is found in a small area around Rangpo town.

3.9.3 Water Regime

While higher ground water table level is positive aspect of water resource conservation and management, it also increases the vulnerability of area due to earthquake since higher water table can cause water to rise and mix with vulnerability assessment of Gangtok city and its mitigation measures soil to cause liquefaction effect. North-eastern part of city has very high level of water table and hence is more vulnerable than the south-western part where the water table is much deeper and even dry in certain parts. Due to higher relief and steep gradient of the area, the subsurface flow of ground water is intercepted with manifest as seepages and springs. The area is characterized by high rainfall which is primary source of ground water. The springs are not deep seated. Direct infiltration and rainfall through joints, fracture, weathered zones of the rocks and through soil covers is the principal mode of recharge of the springs. Due to steep slope most of the precipitation in the area is lost as surface run off through streams, kholas and intermittent springs which are tapped through pipe lines and distributed by gravity

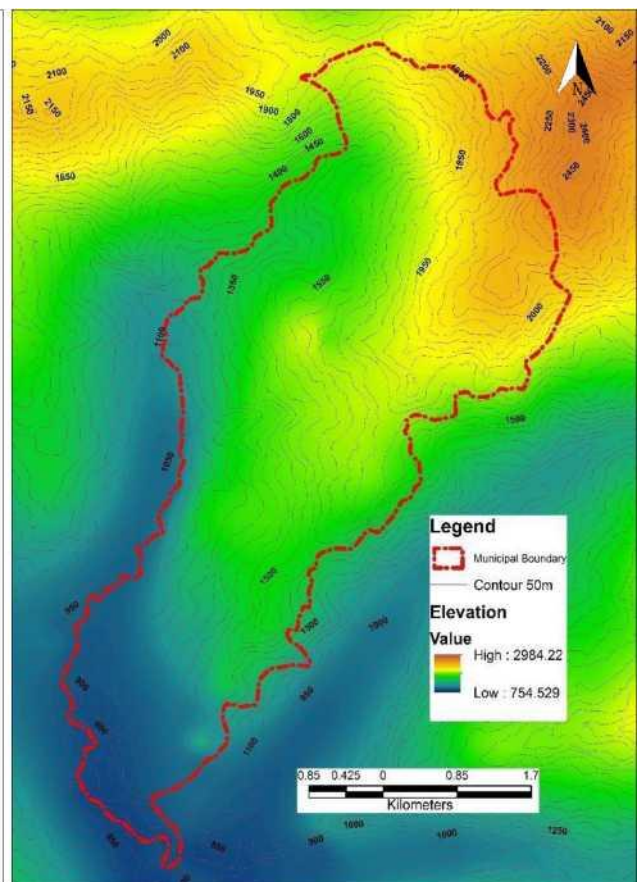
Combined with faults, slope can form deadly sinking slope which are likely to complete destroy the area during earthquake. About 56 percent of total area fall under moderate slope (range from 20° to 30° degree). 31 percent of total area fall under very gentle slope which less than 12° degrees. An 12 percent of total area of municipal fall under undevelopable land which degree of slope more than 42° which is not suitable for any development. The general slope of the western side of the ridge vary from 30° to 42° but in certain stretches around Adampool below Amdo Golai and Rani Khola areas of Sichey, slopes are gentler and varies from 10° to 15°. On eastern side the slopes varies from 20° to 45°. In the areas with more than 60% slope (30° from horizontal), the rocks are disturbed and susceptible to slope failures.

In term of elevation of city situated in hilly terrain which highly elevation varies, lowest elevation is recorded near Ranipool areas about 900 metre above sea considered lowest point in the Gangtok city.



SLOPE MAP

Source: DEM, USGS



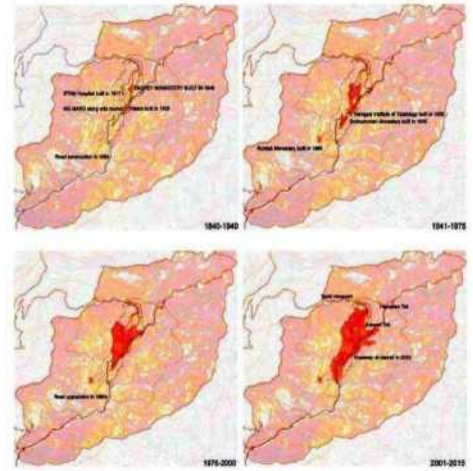
ELEVATION MAP

Source: DEM, USGS

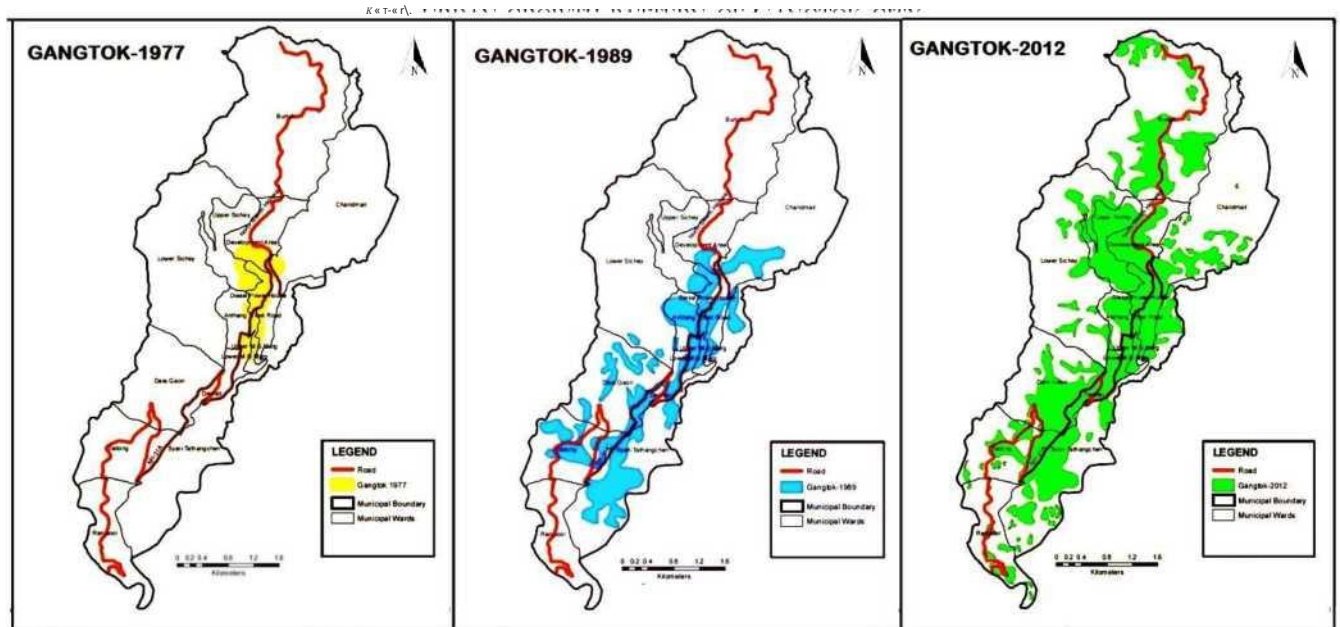
Main city areas such as Upper mg Marg ward, Development ward, Arithang ward, upper sischey, Tibet road these areas where elevation attained to 1500 metre above the sea level. Highest point of elevation recorded in Hanuman Tok point which about 2,250 metre and this area fall under Chandmari ward. Due to variation in elevation that affecting distribution of Rainfall pattern and temperature in the city. During the monsoon season upper part of gangtok received heavy rainfall in compared to lower part of the city. The average mean temperature in the lower altitudinal zone, it varies from 1.5 degree centigrade to 9.5 degree centigrade. Temperature varies with altitude and slope which presently experience in the city.

Urban Growth Pattern

The phenomenon of urbanization in Gangtok is centric, which reinforces the imbalanced urban structure and primacy of Gangtok City. The Gangtok Municipal Corporation was formed in 2010 with 15 wards as part of the reforms under the JNNURM. With the addition of two new wards in the recent municipal elections of 2015, the two new wards have been created by bifurcation of existing wards with the external. Currently, there are 17 wards in the city of Gangtok. It is a rapidly growing hill city dependent on a fragile environment. It is the primary city of a predominantly rural character urban settlement where nearly half the population are in Government service and there is virtually no industry.



Source: Regional Landscape Study of Gangtok Report, 2016



Source: State Annual Action Plan (SAAP) for FY 2015-16

- Present growth pattern of city toward west direction and northern direction can be seen. Due to new institutional development and availability of land led to attraction of new development. E.g. upper
- The growth of population is very high in the last decade. According to the Census of India, 2011, Gangtok municipal area population is 100,286 and about 27,464 number of households recorded.
- Due to migration from other parts of Sikkim an increase in tourism related activities, Gangtok population exploded in the last 10 years with an increase of 258.37 per cent as result major change in demography profile of Gangtok.
- As Gangtok has developed on an elongated narrow ridge, the urban growth pattern of Gangtok has been determined mainly by length and width of crest and slopes.
- The main important buildings of the capital are situated on the narrow crest of the ridge. From the point of view of geo-hazards more significant as its development on steep slopes, which exhibits high

LANDUSE PATTERN OF GANGTOK

Gangtok has mixed land-use pattern due to the unplanned development. All public and semi-public spaces, commercial, retail activities and residential complexes are the major land uses found in the city the growth of city is highly concentrated along the NH10 and NH-31A, national highway running through mainly western slope of the region and high density of settlement are found along the national highways. As we move away from the national highway, the building use changes to mostly residential. As not much land is available for expansion due physical constraints, at the same time based on the need and availability, land is allocated to different uses. The military areas are usually considered as the restricted areas which are located at the north and the south extents of the city, which are now blocking the growth of city along its length and forcing city to grow towards the slopes nearer to the river.

Gangtok has shown the decline of residential area, considerably increasing of public and semi-public use due development of new institutions.

FIGURE 13: LANDUSE PATTERN OF GANGTOK FROM 1975-2018

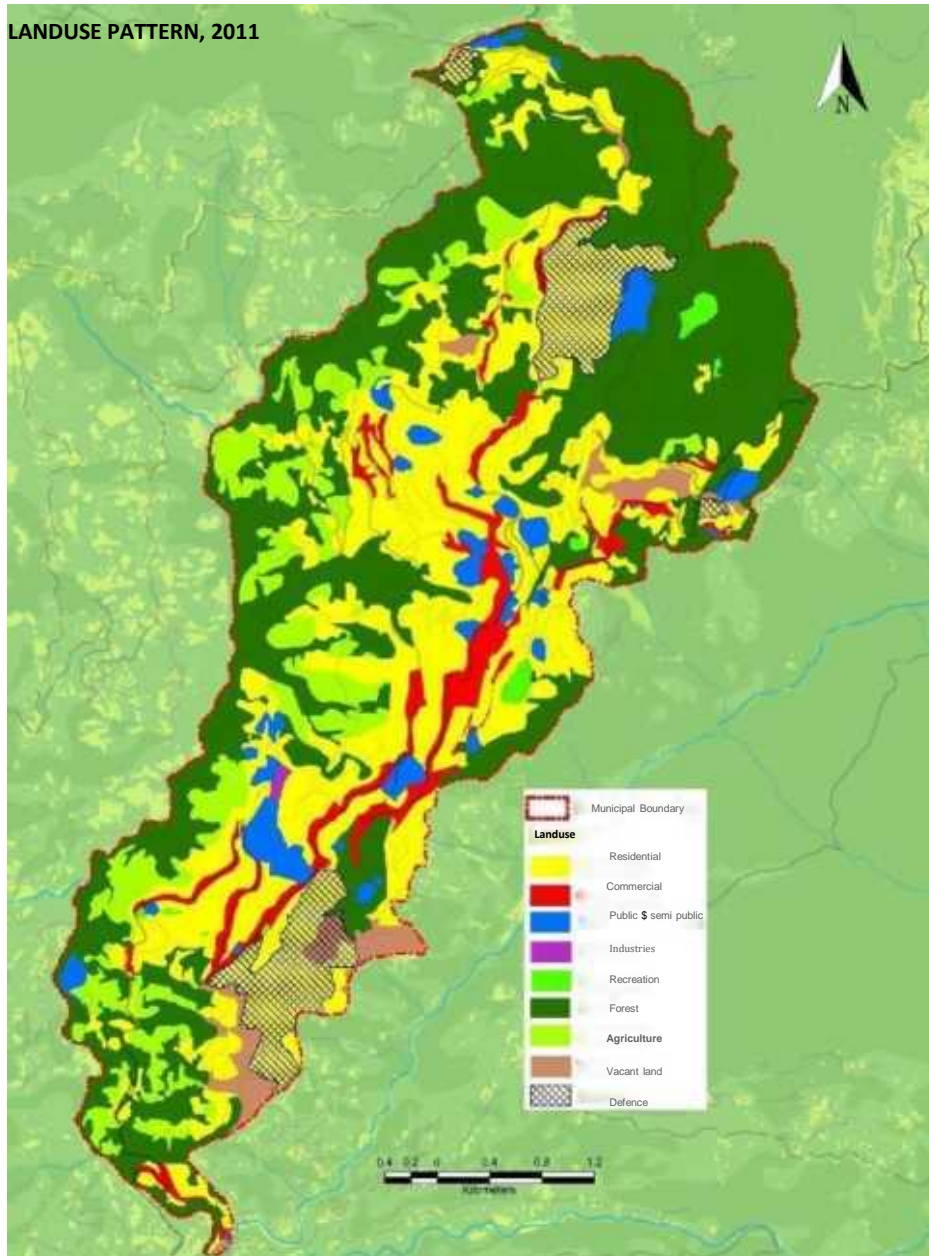
Landuse Pattern of Gangtok from 1975-2018						
Landuse	1975	1985	1995	2006	2011	2018
Residential	65	54.82	49.56	33	32.01	31.01
Commercial	6.85	6.3	4.63	4	4.03	3.29
Industrial	1.1	7.27	9.03	5.03	8	0.06
Public and Semi-public	0.6	1.7	4.19	2.02	2.01	4.72
Recreational	12.6	17.65	22.03	3.49	4.08	0.81
Transport	13.42	12.21	10.57	9.08	11	11.76
Agriculture	-	-	-	8.02	5.06	7.84
Forest	-	-	-	25.05	21.78	35.33
Undeveloped	-	-	-	6	5	3.1
Vacant land	-	-	-	4.03	7.02	2.09
Total	100	100	100	100	100	100

Source: CM Plan; Gangtok, 2010

The land use pattern of Gangtok town has been categorized in six categories i.e. residential, commercial, public and semi-public, transportation, industrial and recreational. In the post-merger period, public and semi-public area had also been expanded from 0.6 percent in 1975 to 21.4 percent in 2011. Residential area has declined from 65.5 percent (1975) to 36.01 percent in 2011.

There has been 7 percent and 1.7 percent increase in the transport and recreational sectors respectively from 1975 to 2011. However, the land use pattern of industry drastically declined from the previous of 2006. Due to explosion of population during 2011 vacant land has reduce from 4.3 percent to 2.09 percent.

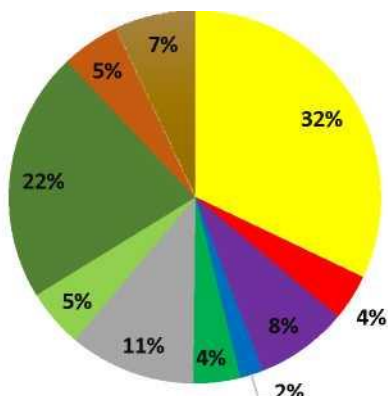
LANDUSE PATTERN, 2011



Source: City Development Plan.

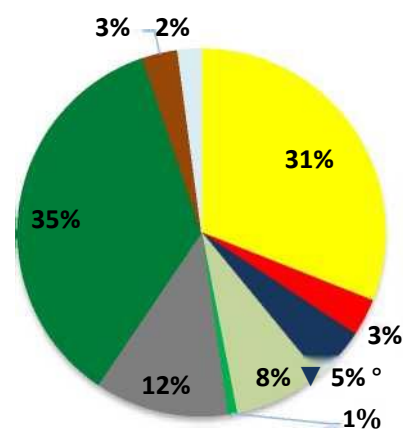
LANDUSE 2011

Landuse 2011



- Residential
- Commercial
- Industrial
- Public/Semi-Public
- Recreational
- Transport
- Agriculture
- Forest
- Undeveloped
- Vacant land

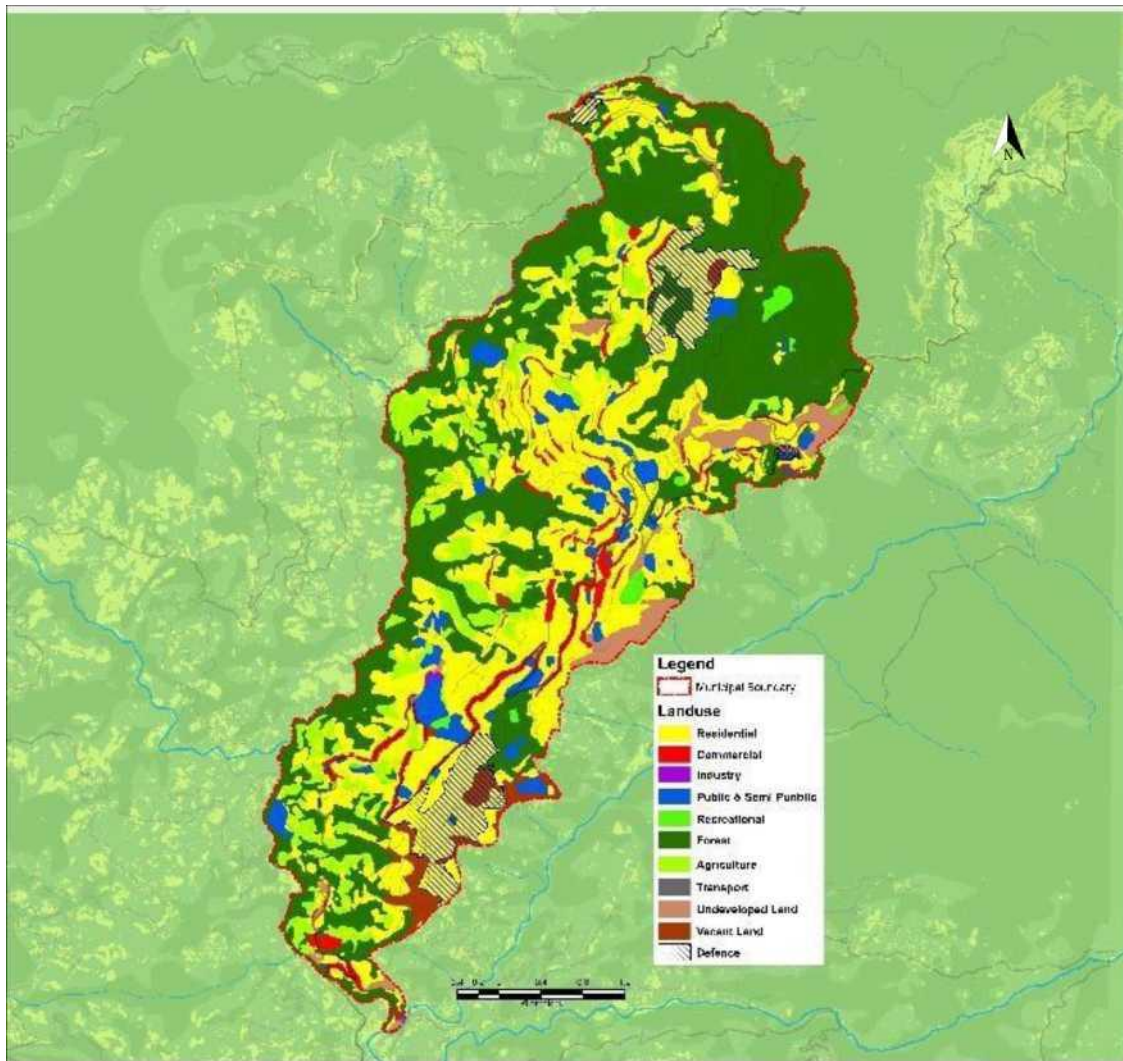
LANDUSE 2022



- Residential
- Commercial
- Public & Semi-Public
- Industry
- Agriculture
- Recreational
- Transport
- Forest
- Undeveloped Land
- Vacant Land

Source: Primary Survey,

LANDUSE PATTERN



Source: Primary Survey

LANDUSE PATTERN

LANDUSE 2022	Area in (Hectare)	Percentage (%)
Residential	607.00	31.01
Commercial	64.00	3.29
Public and Semi-public	92.00	4.72
Industrial	1.00	0.06
Recreational	16.00	0.81
Transport	230.10	11.76
Agriculture	153.00	7.84
Undeveloped	60.00	3.10
Forest	694.00	35.33
Vacant land	40.00	2.09
TOTAL	19.573	100.00

Source: Primary Survey

In 2022, residential use has been decline to 31 percent whereas, in 2011 32.1 percent this main due to vertical expansion in the city.

Earthquake

LOSS AND DAMAGE ASSESSMENT, 2011 EARTHQUAKE

The loss and Damage from Earthquake 2011	
Loss and Damaged	Number
Human live lost	60
Injured	710
Houses	34159
Historical Monument, Monasteries	259
Government Building	1255
Road Damage	3230km
Bridges/Culverts	8135
Water Supply	1596
Power Infrastructure	Major damaged
Schools	759
Hospitals	377
Cattles	525
Sheep, Goat, Pigs lost	808
Flood control Management	533
Community infrastructure	109

Source: SSDMA Dept. Gangtok,

Landslide

Landslides become continuous challenging to hill city. it is natural but at the same time it is close related to urbanisation process and development activities. Gangtok city located at complex geological setting combined with contemporary crustal movements, varying slopes, heavy rainfall which make city vulnerable to landslide. an accelerated pace of construction activities, earth-cutting and especially with regards to road development at various corner of the city which led to exposing the inner rock structures that are further weakened by rains. During the monsoon season i.e. June - August,

in those months' experience intensified heavy monsoon rains as result landslides

SHOWING LANDSLIDE SITE IN GANGTOK



Fig: Bagthang slide Gangtok, far view



Fig: Bagthang slide Gangtok, close view



Indra Pass Road Landslide view



Chandmari Landslide view

Source: SSDMA Dept. Gangtok

in the form mudslides and debris very active in the city. Within the Gangtok city most landslide active zone are located at Upper Brutuk, Chandmari, Luing, Pakyong, Lower Sichey.

Earthquake Risk Analysis

To develop earthquake risk analysis by taking consideration of natural factor such as lithology, slope degree (More than 45 degree slope), soil thickness, thrust and faults etc. and man- made factor building material, building density, building age, dilapidated building etc. which are the main factor contributes the seismic activity. Earthquake hazard risk analysis was calculated based on assumed weighted overlay analysis tool of Arc GIS by taking following layer:

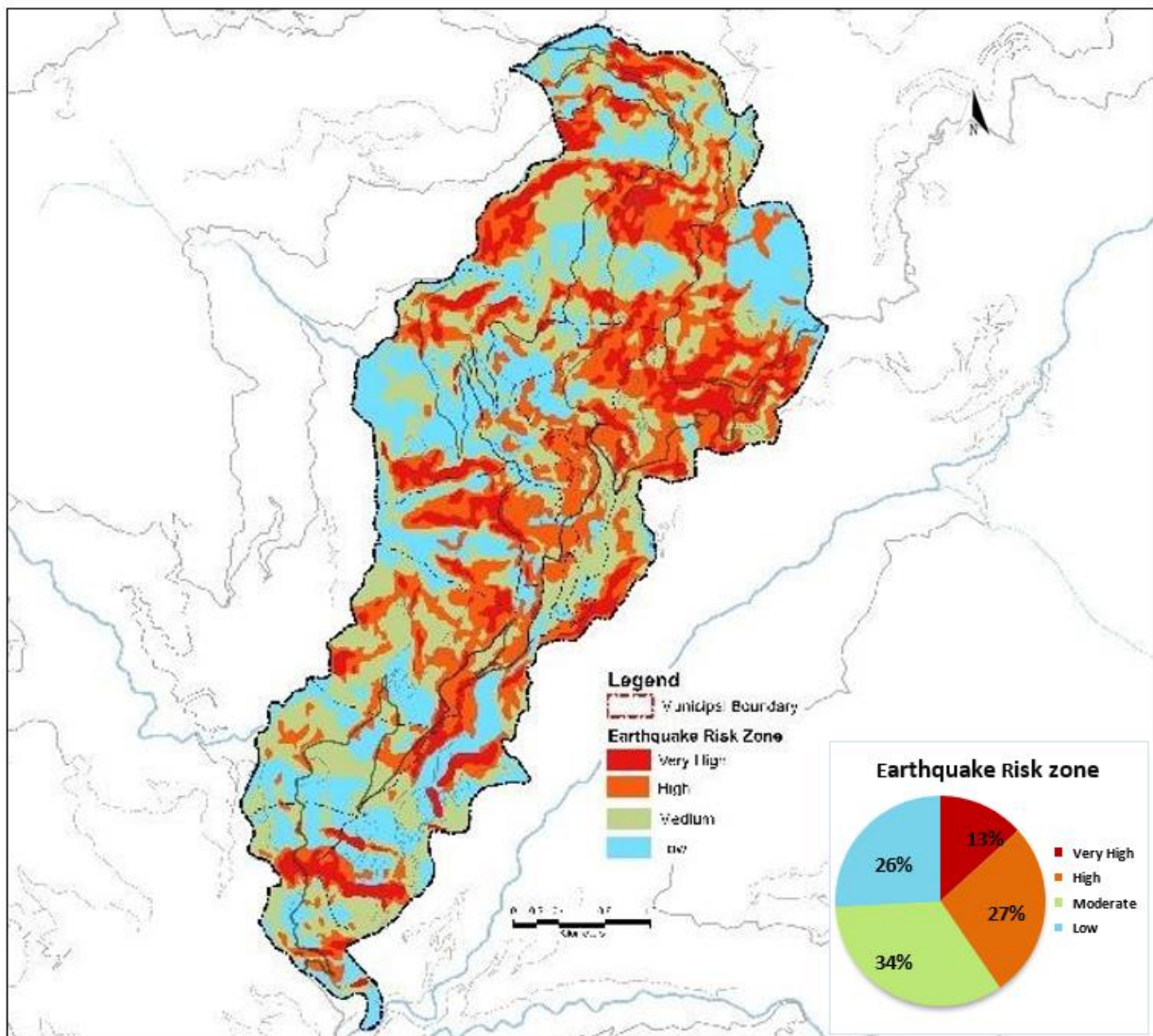
Natural factor

1. Lithology.
2. slope.
3. Soil types.
4. Thrust and faults.

Man-made Factor

1. Building density.
2. Building Material.
3. Building Age.
4. Dilapidated Building.

EARTHQUAKE RISK ZONE ANALYSIS

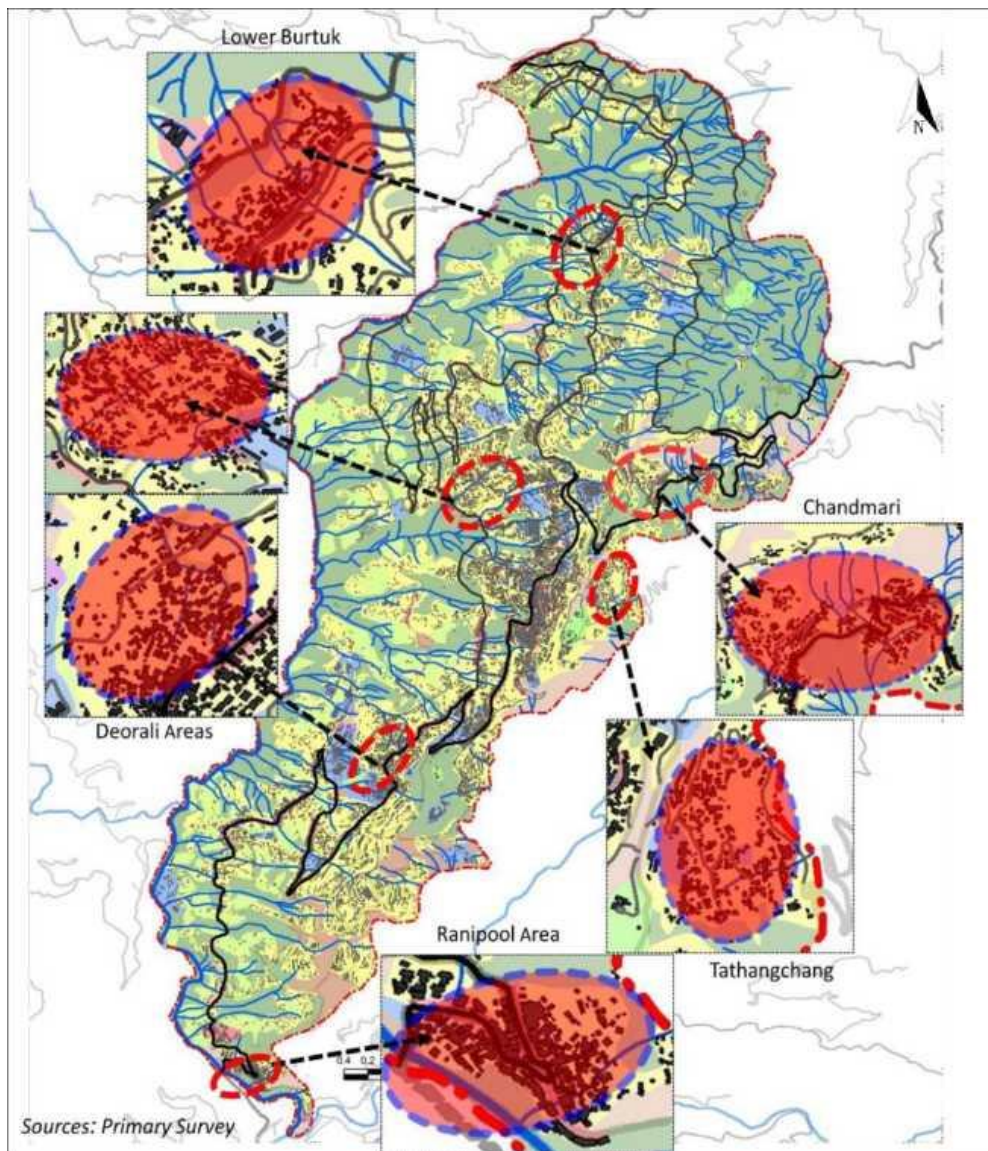


Source: Author

Critical infrastructure Areas

Gangtok, is underlain by Precambrian rock which contains foliated phyllites and schists; slopes are therefore prone to frequent landslides. Surface runoff of water by natural streams (jhora) and man-made drains has contributed to the risk of landslides. From the primary survey various colony such as Lower Burtuk, Ranipool, Chandmari, Coperative colony proper drainage system are not provide as result soil erosion problem came up. Building come up over natural drainage system, no proper conservation of natural drainage hence, during rainy season water discharge has increase led to waste away building.

CRITICAL INFRASTRUCTURE AREAS IN GANGTOK



As per the secondary data available, it is estimated that 57% of domestic solid waste is dumped in jhoras (natural streams), 15% in open spaces while about 8% onto streets. The city also operates a compost plant at the existing dumping site. Inadequate storm water drainage system one major problem in city.

Inadequate drainage management accentuates the high landslide risk and has caused building collapses and casualties. Steep slopes are overloaded with multi-story buildings. The Drainage system extends to

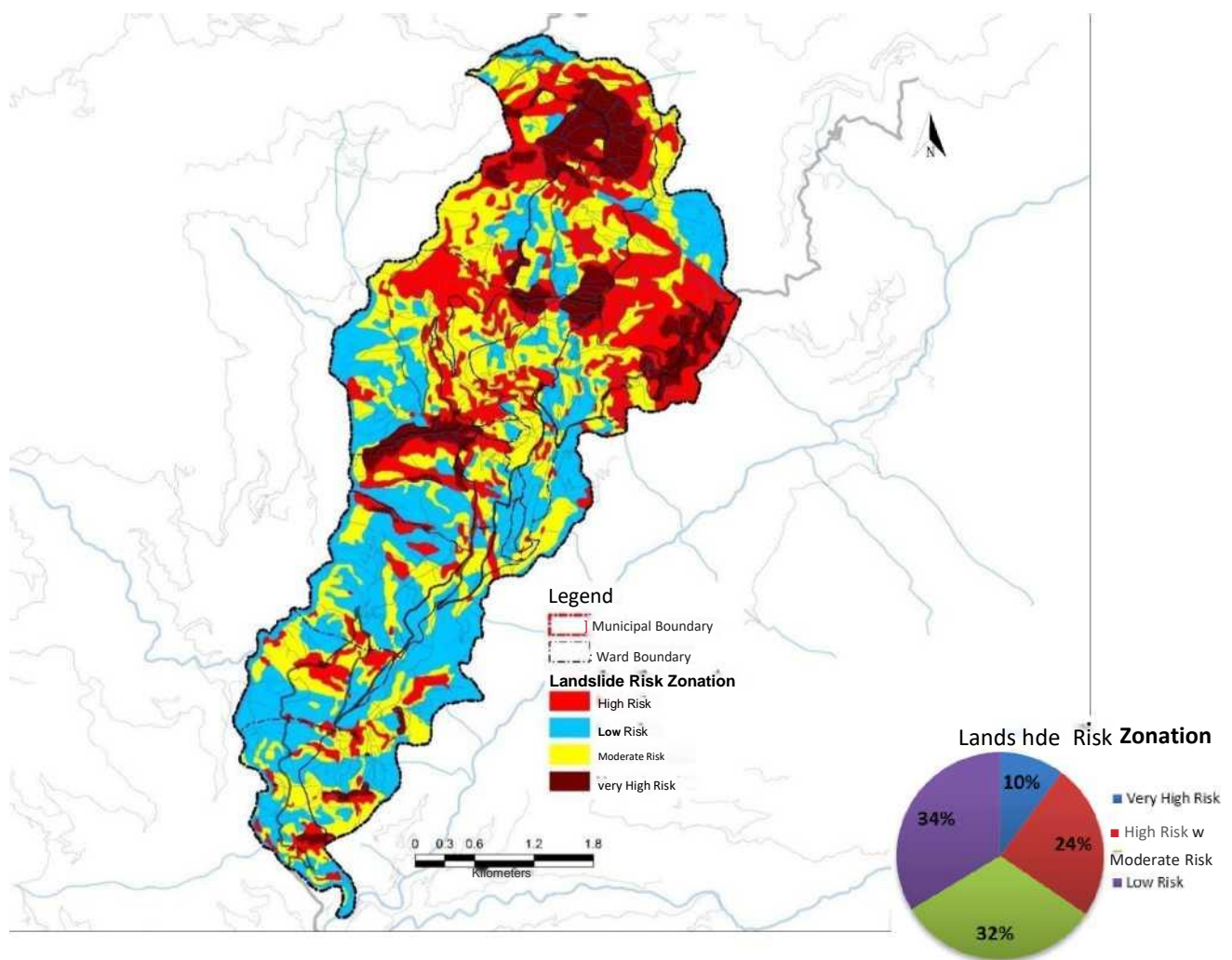
less than half the current urban area, with no proper coverage on the western face of the Gangtok ridge. There are no proper monitoring and maintenance carried out to existing drainage in the city. About 83% of the drains unlined and choked with solid waste and acting as conduits for solid waste and sewage. Poor drainage conditions coupled with porous and permeable soil formations and uncontrolled slope cutting for developmental activities have led to increased slope failure and incidence of landslides and subsidence.

6.2.4 Landslide Risk Analysis

The geological feature and topography of Gangtok are characterised by young mountainous terrain which are prone to landslide. The frequency of landslides and the cumulative effect on the socio-economic life of the city need to emphasis. Landslide risk analysis done with the help of GIS Analysis by using overlay weighted method with the help of compiling of several layer.

1. Geology.
2. Soil types.
3. Slope map.
4. Water regime map
5. Landslide Point map

LANDSLIDE RISK ZONATION



Source: Author

LANDSLIDE RISK ZONATION IN HECTARE

Ward Name	Very High Risk	High Risk	Moderate Risk	Low Risk
Arithang Ward	2.09	11.60	13.49	7.00
Chandmari Ward	37.86	131.47	79.28	57.75
D.P.H Ward	0.00	1.59	13.73	5.32
Daragoan Ward	1.72	19.02	43.47	94.69
Deorali Ward	0.00	2.36	10.95	15.46
Development Ward	11.16	17.60	33.53	12.50
Lower Burtuk	41.52	44.32	59.61	14.35
Lower M.G Ward	0.00	1.89	3.21	7.51
Ranipool Ward	3.40	12.23	28.69	62.04
Sichey Ward-I	19.54	26.50	24.11	39.09
Sichey Ward-II	9.80	52.48	67.22	75.63
Tadong Ward	0.65	21.38	36.67	62.60
Tathangchen Syari Ward	7.43	23.84	78.82	136.28
Tibet Road Ward	0.00	3.50	10.39	15.51
Upper Burtuk	60.71	76.22	83.18	42.27
Upper M.G Mark Ward	0.00	0.05	2.23	6.64
Upper Sichey	2.00	29.15	32.85	1.56
Total	197.87	475.17	621.43	656.18

Source: Author,

- Chandmari landslide point, Upper Burtuk areas, 6 miles near holy cross school, Luing area etc. are main active and sensitive areas which are very prone to landslide activity.
- Under very high risk zone about 197 Hectare and its affecting 1,844 populations which constitute 1.84 per cent of total population.
- 24 per cent area come under high risk area with 18.18 per cent of Population affected.
- 32 per cent of area come under moderate risk with 39.27 per cent of population to the total population.
- 34 per cent of area has fell under low risk area with 40 per cent of population located in low risk areas

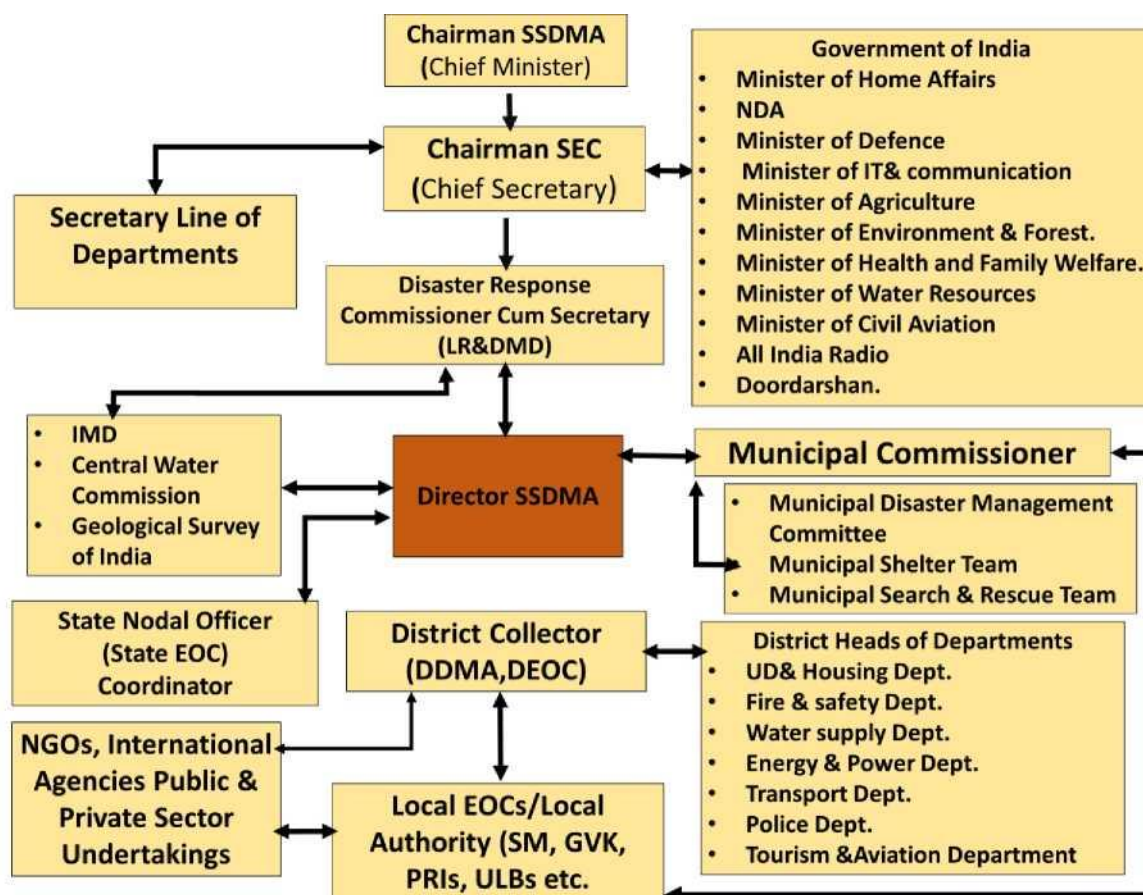
ROLE OF AGENCIES AND INSTITUTIONAL SETUP

As disaster management is a multi-disciplinary process, State and Nodal Departments have a key role in the field of disaster management. The structure of function distributed various department.

7.1 Institution Structure of Disaster Management in State Level

The Disaster Management structure in the State based on Sikkim State Disaster Management Act -2007. This state act actually represents the National Disaster Management Act - 2005. The State Disaster Management Authority and the Office of the DRC, Land Revenue& Disaster Management Department (LR&DMD) are the major institutions in the State that deal with all the phases of disaster management. All line departments of the State Government, the District Collectors, other technical institutions, community at large, local self-governments, NGOs etc. are the stakeholders of the State Disaster Management Plan.

FIGURE 44: INSTITUTION STRUCTURE OF DISASTER MANAGEMENT IN STATE LEVEL



Source: SSDMA Dept. Gangtok, 2018

The authority and responsibility for developing, implementing and regular upgradation of a plan lies with State Disaster Management Authority. However, the process is collectively owned by all stakeholder groups represented in Inter Agency Group, Sikkim. The roles and responsibilities SSDM are followed as:

- Promoting an integrated and coordinated system of disaster management including prevention or mitigation of disaster by the State, local authorities, stakeholders and communities.

7.3 Role and Responsibility of Various Departments and Their Function

Roles and responsibilities for policy making and planning, public health facilities, construction administration, operations and performance monitoring are managed by different department at various levels in Gangtok. Within each level, the functions are further distributed among many in various department, with each department carrying out a specific task and sometimes more than one department carrying out the same task, often resulting in mismanagement. Below the table describes the responsibilities of various departments which as followed:

Department	Team Leader	Various Function & Responsibility
PLANNING DEPT.	Chief Town Planner	<ul style="list-style-type: none"> Collection, evaluation, dissemination, and display of incident information, maintaining status of resource, and preparing the Incident Action Plan and incident related documentations. Prepare alternative strategies and control operations. preparation of Incident Action Plan (IAP). Oversee preparation and implementation of Incident Demobilization Plan Incorporate Plans (e.g. Traffic, Medical, Site Safety and Communication) into IAP
RELIEF & REHABILITATION	CMO/DCSO	<ul style="list-style-type: none"> Coordination of available resources, including those allocated from the state government and disaster area, in support of the disaster affected community. Arrangement of relief camp and later permanent solution for the affected victims.
Transport Dept. (Road & Air)	RTO	<ul style="list-style-type: none"> Transportation chief is responsible for arrangement of transport facilities to the incident area in coordination with branch director. It could be either from road, Air or other means.
SEARCH & RESCUE	SP/Chief Fire Officer/Deputy Controller, Civil Defense	<ul style="list-style-type: none"> The operations section is responsible for directing the tactical actions to meet the incident objectives within a stipulated time. Removal of trapped and injured persons from collapsed buildings and other collapsed structures, administering first aid, and assisting in transporting the seriously injured to medical facilities. This activity involves the use of professional and volunteer search and rescue teams including the use of dog teams.
COMMUNICATION	ADIO/DIOS	<ul style="list-style-type: none"> Collecting the information from the incident area and developing and releasing information about the incident to the news media and to other appropriate agencies and organizations after dully taking approval from IC or the competent authority
Logistic Section		<ul style="list-style-type: none"> The Logistics Section is responsible for providing adequate services and support to meet all incident or event needs. Apart from support & Service branches, Finance is also a branch in Logistics. The Finance Branch is responsible for keeping track of incident-related costs, personnel and equipment records,

	Municipal Commissioner/ BDO	and administering procurement contracts associated with the incident or event
Water, Electricity, Transport	Executive Eng, (PWD/PHED) RTO	<ul style="list-style-type: none"> Restoration and repair of Electric and Water supply system to minimize the impact.
Emergency Medical Response	CMO (Health Dept., Pharmacist, NGOs)	<ul style="list-style-type: none"> Mass fatality management, Public health management & providing Medical facilities during emergency, Mental health services

Source: SSDMA Dept.-Gangtok

Function Ward Disaster Management Committee

1. Reviewing the various Hazards in their respective wards.
2. Analyze and identification of the vulnerable areas in their wards.
3. Working in coordination with DDMA East.
4. To make arrangements of various public facilities for any emergency actions.

Role of Nodal Officer

1. Maintenance of detail number of victims (male/female, children, adult, old or disable person)
2. Arrangement of food, water, medicines, blankets etc in co-ordination with section head.
3. Co-ordination with In-charge temporary assembling point, Section head and control room.
4. Requisition of doctors to be and other emergency items in consultation with Section head.
5. Detail report of the victims accommodated submitted to control room via section head.

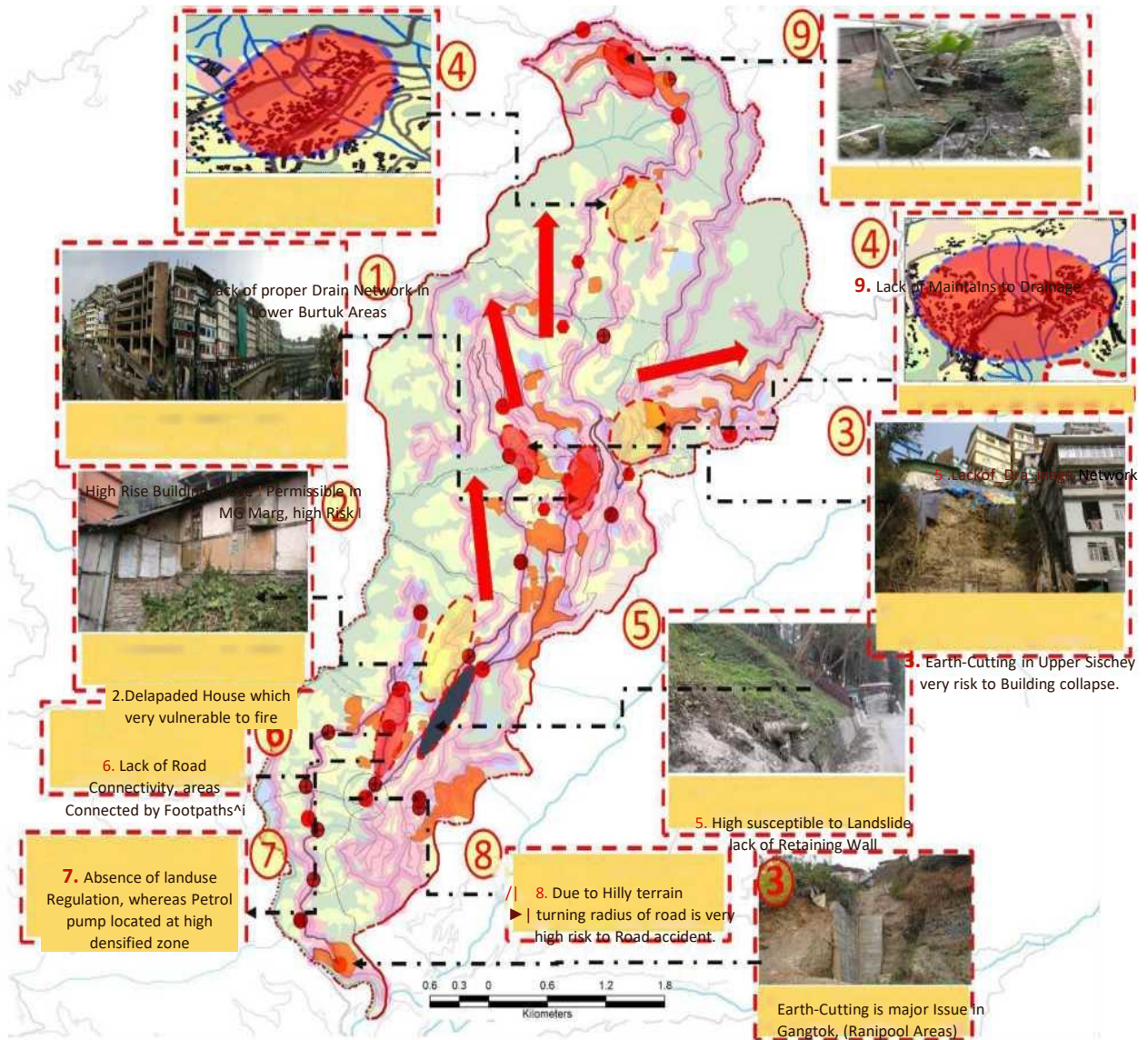
INFERENCES:

- Gangtok has consisting of various department with assign different function.
- Lack of coordination within the department, which lead to loop the function.
- Lack of awareness among the community and no proper monitoring system to problematic areas such as slum area which are high vulnerability to disaster and outer areas of city are neglected.
- Implementation problem
- No proper allocation of fund on operation and maintenance to needy areas.
- Lack of NGOS Participation and local Participation for disaster Risk related initiative done in city.
- The City Management team need to adopt new technology to forecast disaster.
- Need to enhance budget allocation for weaker section.
- Need to extent links between disaster agencies and service provider.

ISSUES AND CRITICALITIES

Gangtok has experience a very rapid population growth in last decades due to huge housing and tourism demand. Due to lack of planning and haphazard growth has resulted in the construction of buildings on steep and unstable slopes with improper construction practices. Lifeline structures like hospitals, power stations, and telecommunication installations and water supply stations are located in high-vulnerability areas with poor connectivity. Weak enforcement of byelaws and poor emergency management capacity has added the risk. Gangtok is characterised by weak lithology which make the areas fragile and Eco sensitive zone to disaster. Below the table mainly discuss various issues and problem of the Gangtok city.

	ISSUES AND PROBLEM
1.Landuse & Urban Growth	<ul style="list-style-type: none"> • Due to high population growth the haphazard development in the city, Upper Sichey and Chandmari areas. • No proper Landuse is follow in the city which make city more vulnerable.
2.Earthquake	<ul style="list-style-type: none"> • Many areas building byelaws are not follow. • 40% of settlement are Old structure and dilapidated
3.Landslide	<ul style="list-style-type: none"> • Lack of Drainage network in city. • Earth-cutting is one of major issue in city. • Blocking of natural drainage and catchments areas building. • Along the road subsidence took place and no Retaining wall.
4.Fire	<ul style="list-style-type: none"> • In Gangtok present of various Slum pocket both Notified and Unnotified are very vulnerable to Fire. • High density in the Core of city which make more prone to fire hazard especially commercial areas • Many colony not accessible to fire fighting
5. Critical Infrastructure	<ul style="list-style-type: none"> • Area like Tadong, Upper Burtuk colony are not accessible to road only connected by footpath. • Disposal of solid waste in the public drains which lead to block during rainy season.
6. Management	<ul style="list-style-type: none"> • There is no provision of Disaster management plan in the Master Plan of Gangtok. • Lack of awareness among the community level to Disaster.
7. Road accident	<ul style="list-style-type: none"> • Activity like Road accident hazard frequency are increasing.
8. Forest fire	<ul style="list-style-type: none"> • Forest fire frequency high in Nov-April month



- Absence of landuse Plan with appreciate zoning regulation and result of haphazard development growth, in ribbon pattern along NH 31 A which passed through the centre of the city of Gangtok. There is need to development holistic approach of urban planning to addressed the problem.
- Along the main road side high susceptible to landslide, especially during rainy days. There no proper retaining wall was given.
- Construction activity and earth-cutting activity increases in the city, lack proper monitoring and no guidelines to check those activities which make high risk.
- Presence of dilapidated building in high densified areas which make vulnerable to earthquake.
- Basic infrastructure like drainage, solid waste management system is important component of city but, in Gangtok many colonies having drainage problem. absence of proper monitoring and maintenance of drain are not done.

PLANNING STRATEGIES AND POLICY GUIDELINES

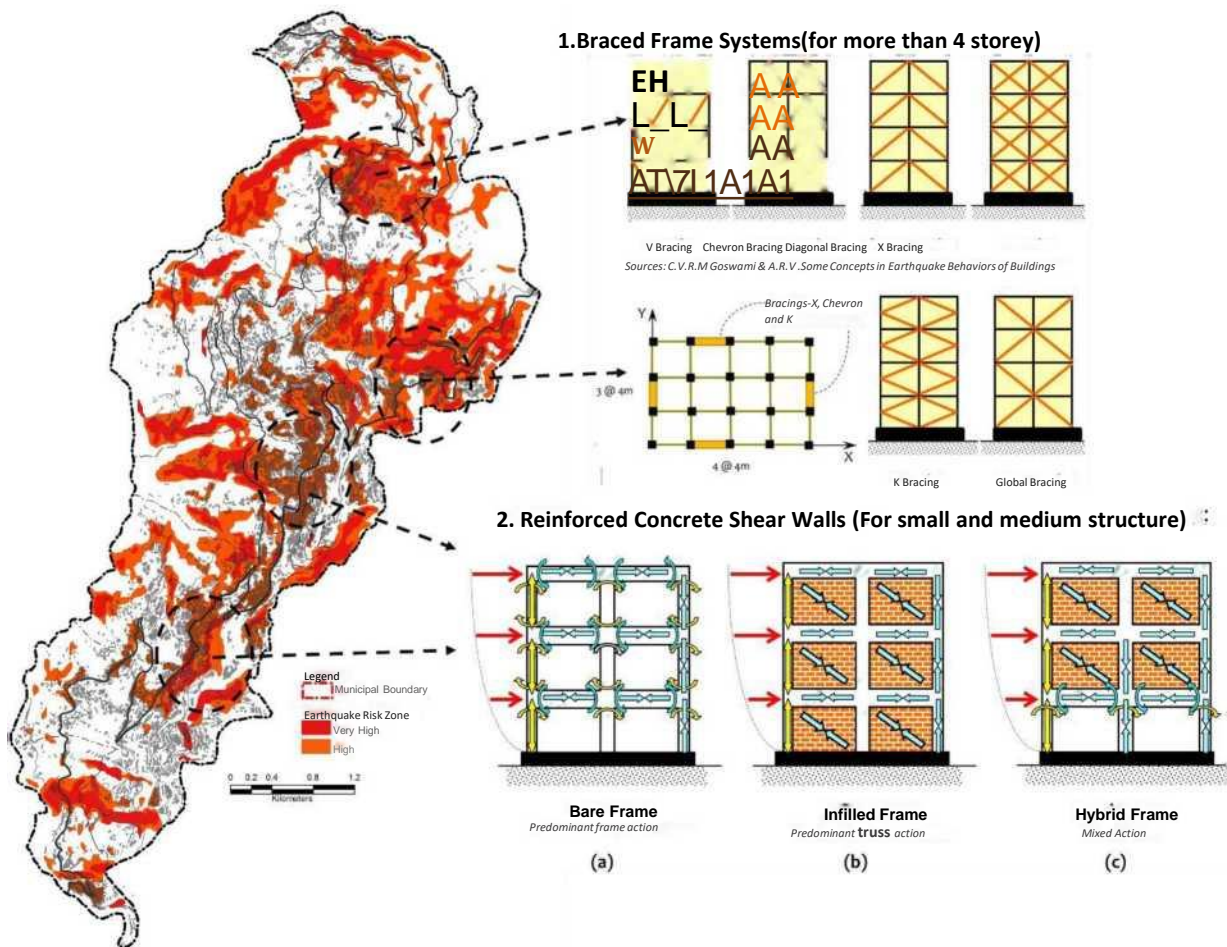
Planning Strategies

To adopt any strategy in the domain of disaster management must either aim to reduce vulnerability of existing settlement area or prevent future development in the vulnerable area. In this context the proposal developed on the base of risk and vulnerability assessment suggests planning interventions to reduce growth prospects from vulnerable zones and induce the growth in non-vulnerable zones. For the zones which have high vulnerability and are already developed, the interventions suggested ahead will reduce the residing population vulnerability in case of any disaster and aid to reducing loss of human lives and promote faster recovery. In the end, Development Control Regulations (DCR) which are most prominent source of intervention used in the domain of planning to promote development which is safe and sustainable of the Gangtok city will be compared with ideal DCR which should be followed.

Strategy 1: To Adopt Earthquake Advanced Building Techniques

In order to enhance the building safety and reduce high risk to earthquake. There is need to adopt advanced modern building technique and technology city like Gangtok where seismic vulnerability is very high. At the same time there is need to control high-rise building and follow regulation. Ward like upper MG marg and Arithang ward having old Building structure and presence of dilapidated building make more vulnerable.

FIGURE 46: PROPOSAL FOR EARTHQUAKE ADVANCED BUILDING TECHNIQUE



Source: Author

Although earthquake resistance design of structures is help reduce the impact of earthquake. There is an urgent need to sensitize the common people about the seismic hazard and tangible seismic risk that community is facing on account of using unsafe construction practices. Awareness and capacity building of human resources at all levels as well community level and the creation of suitable and effective enforcement mechanisms should be adopted towards seismic safety. This task is enormous and must involve all sections of society.

1. Braced Frame Systems (for more than 4 storey):

Braces frame system very helpful to reducing overall lateral displacement of buildings, and in reducing bending moment and shear force demands on beams and columns in buildings. In India some cities like Guwahati has successfully demonstrate the cross bracings building for resist Earthquake.

2. Reinforced Concrete Shear Walls (For small and medium structure):

Reinforced Concrete Shear Walls Reinforced concrete shear walls on well-designed foundations are probably the best system to resist seismic loads in low to medium rise construction. They are less sensitive to design and construction detailing than moment resisting frames.

TABLE 28: BUILDING HEIGHTS CONTROL REGULATION

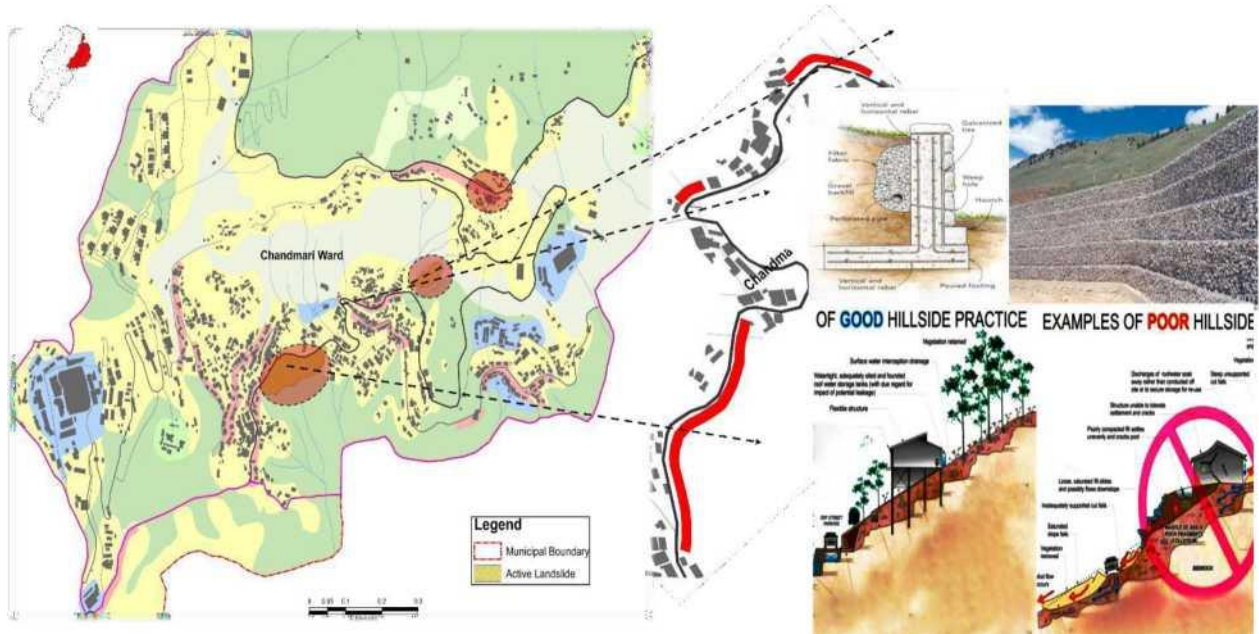
Risk Categories	Permissible Building Height
Very High	2
High	3
Moderate	4
Low	6

*Note-

Above 40° Degree slope totally restriction of any development considered as 'No Development Zone'. Proper maintenances of dilapidated building through renovation and retrofitting.

Gravity Retaining Wall in Landslide Prone Chandmari Area

MAP 44 : GRAVITY RETAINING WALL IN LANDSLIDE PRONE CHANDMARI AREA



Source: Author, 2018

Chandmari ward is one of most sensitive zone to landslide. There are number of active landslide point within this ward. Chandmari ward is characterized by unstable slope, composed of loose debris soil, lack of proper drainage, etc. which make areas prone to landslide activity. Active landslide can be seen along the JN road side which become threat to local resident. Through proposal of Retaining wall along the road slide it can control lateral movement and by plantation of new tree which is very effective method to landslide.

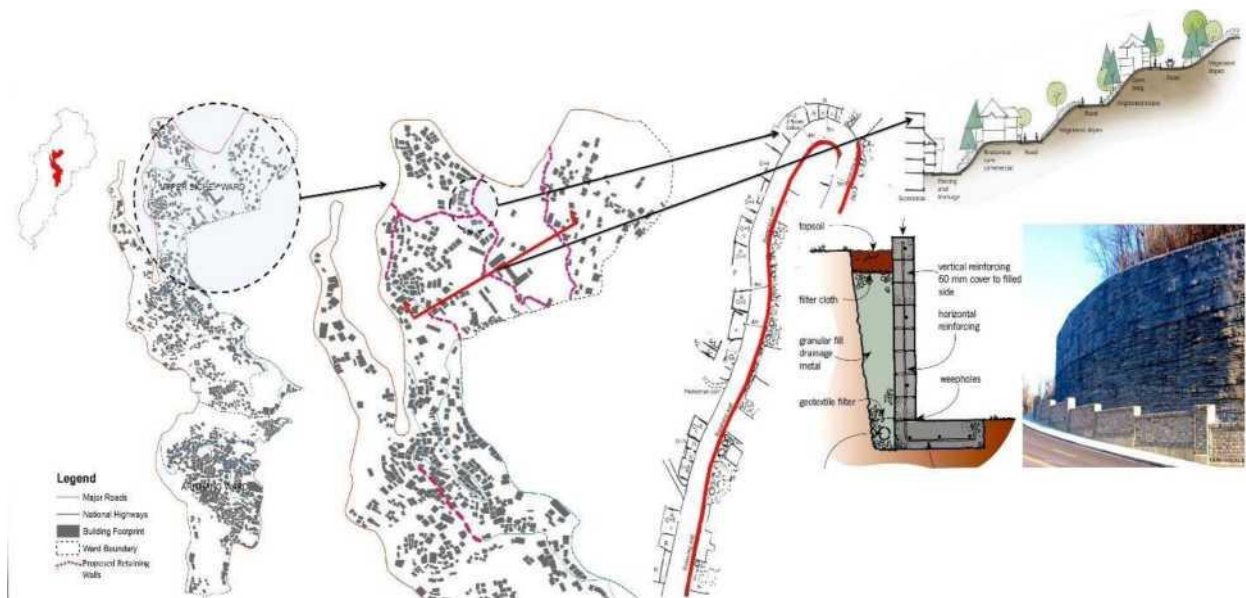
I.Gravity retaining wall

- The walls which resists the earth pressure due to backfill by its own weight.
- They are constructed with stone masonry or plain concrete.

Retaining Wall for Landslide Prone (Upper Sichey Area)

Proposal is mainly focus to reduce disaster risk. Upper Sichey areas should be construct a retaining wall. Presently there is no retaining wall along the road side and weak lithology which make areas susceptible to landslide. Retaining walls are suitable for slip-out type of slides

MAP 45: RETAINING WALL FOR LANDSLIDE PRONE (UPPER SICHEY AREA)



Source: Author

- Upper Sichey areas are very prone to landslide, there is no proper drainage was provides along the road side.
- Due to increase of new construction activity and earth-cutting activity creates major problem, also increase the susceptible to landslide especially during rainy season.

Recommendation and Policy Guidelines

- Disaster identification: identification hazard and risk is an important step to risk management. It includes determining the likelihood of a disaster occurring, its intensity and magnitude, and the possible affected areas of a community and there is need to proper assessment and proper map to identify the multi hazard zone and also focus on Micro level.
- The use of integrated disaster management approach: future development plans of the study are should take into consideration the issue of urban drainage system that would protect the vulnerability of the residents and the environment.
- Participatory approach and bottom up: since the community is key in ensuring for sustainable development in hilly areas of any recommended solution disaster risk reduction, the community or the people should be active participation must be there and involved in every step of the would be solutions to the reduce disaster problems as can be learned from the best practice case studies reviewed.
- Developed the method of early warning system: As the technology has advance and smart there is need to adopt for giving assist in predicting the extent of natural disaster risk, which can help to prevent and reduce disaster to some extent also, help to reduce the casualties impact.
- Monitoring of climate change: Information systems within departments to be strengthened focusing on collection of baseline data and measure changes periodically with climate change impacts. All the developmental works of the department related to climate change should be closely monitored hence forth. Outcomes and evaluations to be studied minutely to slow down the process of climate change by efficient implementation of the programmes undertaken. A separate cell for Planning, Monitoring and Evaluation (PME Cell) is to be strengthened and empowered within the department for surveying climate change with pinpoint agendas. All planning of strategies to be done with the help of GIS and advance techniques in meteorology.
- Adopt Risk Transfer Instrument Insurance: Risk management and control strategy that involves the contractual shifting of a pure risk from one party to another. Insurance as a risk management tool provides benefits to stakeholders ranging from regions, national governments, to communities, households and individuals.
- Restriction of new construction in high hazard and Risk Areas: In Gangtok construction activity and earth-cutting activity on unstable land and sensitive zone are main issue in city which led to more expose to risk. These activities increase the vulnerability to population and building.
- Community-Based Vulnerability & Risk Assessment: community-based DRR approaches, mainly focus on community level that physical, social and economic, there is need of proper risks assessmentand management. Over the last ten years, growing recognition of the necessity of enhancement of community participation for sustainable disaster reduction has often been translated into some actions to carry out community-based vulnerability and risk assessments. To addressed those problem, need to draw Action plans, enact appropriate policies, mobilization of resources and strategies to reduce community vulnerability to disasters.

	RECOMMENDATION	POLICY GUIDELINES
1.Landuse & Urban Growth	<ul style="list-style-type: none"> • Identification of conflict landuse Area/zone and reassignment of landuse according to suitability. • Restriction of development in high hazard zone. 	<ul style="list-style-type: none"> • Initiation proper landuse regulation and systematic assignment of landuse in the city. • Enforcement of Integrated Risk and vulnerability assessment in legal document Master Plan and Ward level.
2.Earthquake	<ul style="list-style-type: none"> • Proper checking of building layout. • Proper checking and maintain, through the fixed density it can reduce the impact of earthquake. • Hazard zonation mapping in micro level. 	<ul style="list-style-type: none"> • Earthquake building resistance design should be encouraged in the city • Building byelaws are need to revisit and building Height recommend according to suitability.
3.Landslide	<ul style="list-style-type: none"> • Without the recommendation of Urban Development Dept. no construction activity should be allow, especially monsoon season. • Restriction of new construction in unstable land and sensitive zone. 	<ul style="list-style-type: none"> • Through the GIS based Master Plan which enhance the analysis efficiency. • Used LIDAR based system to assessment the landslide and developed early warning system
4.Critical Infra-structure	<ul style="list-style-type: none"> • Cleaning and maintenances of drainage system from time to time. • Old and dilapidate should be renovated and retrofitted. 	<ul style="list-style-type: none"> • Restriction of building height, use fire safety application. • Create Buffer zone in natural drainage system and water catchments areas.
5. Management	<ul style="list-style-type: none"> • Through the awareness campaign in community and local level create awareness • Integration of Disaster Management Plan in coming Master Plan. • Enhance the collection system and creating efficient bins in colonies 	<ul style="list-style-type: none"> • Create various scheme and project that full participation of community to Reduce the risk. • Encouragement of public-private partnership in infrastructure. • Increase the fund allocation under slum redevelopment scheme and provide proper sanitation.

CONCLUSION

Urbanization is one of the major processes which has affected the nature of land cover in hill areas. The rapid growth of urbanization combined with the explosive population growth led to continuous put pressure on the existing civic amenities and public institutions. Last few decades Gangtok has a dynamic change in the urban areas and its surrounding regions due to which the available limited land resources in the city are exhausted. The characteristics of demography and pattern of land use are entirely changed over the period of time.

Gangtok centric which reinforces an imbalanced urban structure and primacy of Gangtok City. The pressure mounted on the surrounding environments, land is causing faster rate of land conversion from non-urban to urban. This results in uncontrolled aerial expansion to vulnerable areas of the city as well as problem of providing basic public services and facilities. To achieve a proper sustainable development, it is imperative that disaster management plan, urban planning and development need to be integrated.

In Gangtok, the spatial distribution of the residential area is controlled by the topographical features and communication lines which are again guided by the topography. In the absence of any sizeable land. Disaster issues should be addressed to ensure healthy and sustainable urban growth. A disaster management plan may be put into place to avoid landslides and drainage problems. To encounter the disaster risk there is need of provide proper public health facilities and service facilities such as open space, fire service, road connectivity would act as bridge during emergency.

Reducing the risk associated with disasters cannot be dealt with in isolation assessment of risk factors is a key prerequisite in planning and implementing measures to reduce their impact. Mapping of extreme risk, strengthening existing buildings, protecting infrastructure, setting standards of construction through building codes and enforcing compliance to set standards should be initiated to regulate or discourage development in vulnerable areas, so that future disaster impacts can be substantially reduced.

This study has mainly explored risk profile such as earthquake, landslide, fire and flash-flood in the Gangtok city and the planning implication measures to reduce the disaster risk through proper assessment and management. any disaster risk reduction project and vulnerability mapping need to be comprehensive and must consider all possible disasters. There is need to adopt community based participation approach for sustainable disaster reduction through Action plans, enact appropriate policies, mobilization of resources, by adopting new strategies and shared public decision making process required for effective mitigation.

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SCHOOL OF PLANNING AND ARCHITECTURE LUCKNOW U.P.

Disaster Risk Reduction and Management in Hill town

CASE STUDY: Gangtok, Sikkim

QUESTIONNAIRE FOR CTTY LEVEL PRIMARY SURVEY

APPENDIX F -SURVEY

QUESTIONNAIRE Survey Questionnaire on Gangtok City Disaster Risk

Reduction

Name: _

Age: _

Address: _

Signature: _

The number of rating you want to give. Rate from 1- 5; 5 is the highest and 1 is the lowest. 1-Very Poor, 2-Poor, 3-Satisfactory, 4-Very Satisfactory, 5-Excellent I.

PROGRAMS AND PROJECTS

It aims to assess the preparedness of Gangtok City Government with regards to the implementation of their programs and projects.

(Prevention and Mitigation)

1.1) Regular declogging of drainage and canals	1	2	3	4
1.2) Dredging and desilting activities in coordination with other agencies	1	2	3	4
1.3) Proper waste disposal	1	2	3	4
1.4) Identification of appropriate location for food preparation	1	2	3	4
1.5) City wide-community based early warning system	1	2	3	4
1.6) Provision of whistle, flash light, compass	1	2	3	4
1.7) Public information dissemination	1	2	3	4
1.8) Trainings and Seminar on Calamity Preparedness	1	2	3	4
1.9) Proper documentation of damage, needs and assessment	1	2	3	4

(Recovery and Rehabilitation)

1.10) Coordination with neighboring local governments regarding rivers and roads clean-up drives 1 2 3 4 5

11) Stress debriefing for the community and government employees involved 1 2 3 4 5

II. FACILITIES

It aims to assess the preparedness of the Gangtok City Government with regards to the availability and capacity of their facilities to respond to the needs of the people.

2.1) Evacuation Centers 1 2 3 4

(Relief goods, enough space, electricity, water supply, sanitation, etc)

2.2) Hospitals 1 2 3 4 (Availability of doctors, equipments, facilities, medicines, etc.)

III. EQUIPMENTS

It aims to assess the preparedness of Gangtok City Government with regards to the availability and capacity of their equipments to respond to the needs of the people.

3.1) Light equipment 1 2 3 4

(power saw, generator, rubber boat, oxygen tank, tower light, command tent, etc.)

3.2) Heavy Equipments 1 2 3 4

(dump truck, water tanker, road graders, telescopic crane, etc.)

IV. RESCUE AND RELIEFS

It aims to assess the preparedness of Gangtok City with regards to the capacity and responsiveness of the following in times of Calamities.

4.1) Police Department	1	2	3	4
4.2) Fire Department	1	2	3	4
4.3) Rescuer/ Volunteer	1	2	3	4

V. Suggestions and Recommendations For the betterment and improvements of the Gangtok City Government Disaster Preparedness. (Put Check on the space provided)