

CLIMATE RESILIENCE STRATEGY

Shimla



Climate Resilience Strategy - Shimla

Climate Resilience Strategy: Shimla City, India

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1 Introduction

1.1 Climate change and climate change adaptation

Although climate change occurs naturally over relatively long periods of time, the global climate is now changing at a much more rapid rate primarily as a result of anthropogenic emissions of greenhouse gases (GHG). In the past two decades or so, global efforts have been stepped up to curb the sources of GHG emissions and enhance the sinks of GHGs through international dialogues and agreements, national policies and programs, as well as actions at the local level. These efforts are critical in controlling and reducing the levels of GHGs in the atmosphere. However, with the levels of GHGs that are already present in the atmosphere, changes in climatic patterns are taking place with impacts at the local level. Therefore, alongside mitigation initiatives, adaptation to climate change needs to be undertaken to safeguard the interests and well being of local communities, especially the poor and vulnerable.

There is inter-dependency between adaptation and mitigation, which emphasizes the need to undertake both these measures simultaneously. In order to cope with the impacts of climate change caused by increased concentrations of GHGs in the atmosphere local governments and communities have to identify potential threats and adapt to them. Further, the development pathways that they choose for the growth of their cities have to balance their socio-economic needs with the global responsibility of reducing emissions (mitigation actions) while securing the well being of their citizens against potential climate events (adaptation). The idea therefore is to identify interventions that provide multiple benefits (co-benefits), including reduced emissions and increased adaptive capacities.

1.2 Climate change impacts on cities

Cities, being the engines of economic growth, are a very critical part of our system. Climate change poses several threats on the ecosystems, including urban ecosystems.

The world is urbanizing rapidly, with concomitant increased consumption of resources and ecological degradation across the globe. The cities face multi dimensional pressure of rapid economic growth, grossly inadequate infrastructure and social amenities and the disturbances due to climate change. Hence, urban population is vulnerable to climate change.

Climate adaptation is needed in cities primarily because of the following:

- Climate change adaptation ensures the functionality of urban systems in changing climate scenarios and their corresponding impacts
- Adaptation does not only address the risks associated with climate change impacts in the future but also reduces risks associated with current climate variability
- Climate change adaptation improves disaster risk management practices for instance early warning systems and evacuation plans developed for areas currently prone and/or likely to face floods or storm surges will significantly help in reducing damages and loss of assets and lives
- Climate change adaptation ensures sustainability of development trajectories
- Climate change adaptation safeguards current and future well-being of all social groups as well as investments in infrastructure

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Climate impacts and vulnerabilities hinder the process of development. The cross-sectoral and inclusive characteristics of climate change adaptation helps counter these impacts and supports sustainable development by reducing vulnerabilities, enhancing adaptive capacities and helping in securing investments.

This Climate Resilience Strategy document aims to address these issues and build the resilience of the city against the changing climate. This strategy has been developed in association with ICLEI South Asia and Oceania with support from the Rockefeller Foundation under the Replication and Dissemination phase of ACCCRN.

1.3 Objectives of the development of Climate Resilience Strategy

The primary objectives of the development of the Climate Resilience Strategy for Shimla includes:

- Assessment of past and future climatic trends to determine possible climatic impacts that could be faced by the city
- Assessment of risks to identified fragile urban systems that could be impacted by climate change
- Assessment of vulnerability of fragile urban systems and vulnerable population of the city
- Identification of resilience strategies to overcome the impacts of climate change on the fragile urban systems
- Serve as a guiding document for the city to introduce the concepts of climate change to urban planning and development

1.4 Methodology of the assessment

The ICLEI ACCCRN Process (IAP) has been used to develop the Climate Resilience Strategy for Shimla. The methodology has been developed by ICLEI by drawing from the experiences of the previous phase of ACCCRN and other ICLEI methodologies to ease the process of resilience planning for local governments.

IAP consists of phases (see Figure 1.4.1:), where each phase comprises of a series of steps. They have been developed in the form of tools. The whole process is iterative in nature with increased level of details in each iteration.

Engagement: Phase 1 begins with gaining political support in the city. This is important in order to carry out the project activities in the city. This is followed by a scoping exercise, which helps in gaining insight about the various city services and the problems faced by the city. Further, a climate core team involving the key officials from the city government is formed. The climate core team is responsible for the execution of project activities in the city. A stakeholder group is formed from the citizens of the city with representatives from various relevant institutions and organizations of the city. The climate core team then forms a communication plan for the city highlighting the key messages to be conveyed to the public and the ways for doing so.

Climate Research and Impact Assessment: A shared learning dialogue (SLD) with the stakeholder group is organized. This interaction aims to have a mutual learning and sharing of experiences from the city. Further an assessment of the past climatic trends and future climatic projections are conducted. This assessment can be conducted with the help of local university or research institution or any pre existing assessment can be

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consulted. In the absence of either of the two any significant regional or national level assessment may be consulted. Further the fragile urban systems of the city are identified. The reasons for the fragility of these urban systems are determined and the impact of the anticipated climatic changes on these already fragile urban systems is estimated. Later a risk assessment is conducted in order to prioritize these urban systems in terms of their likelihood to be impacted by the changing climate and the consequence of these impacts.

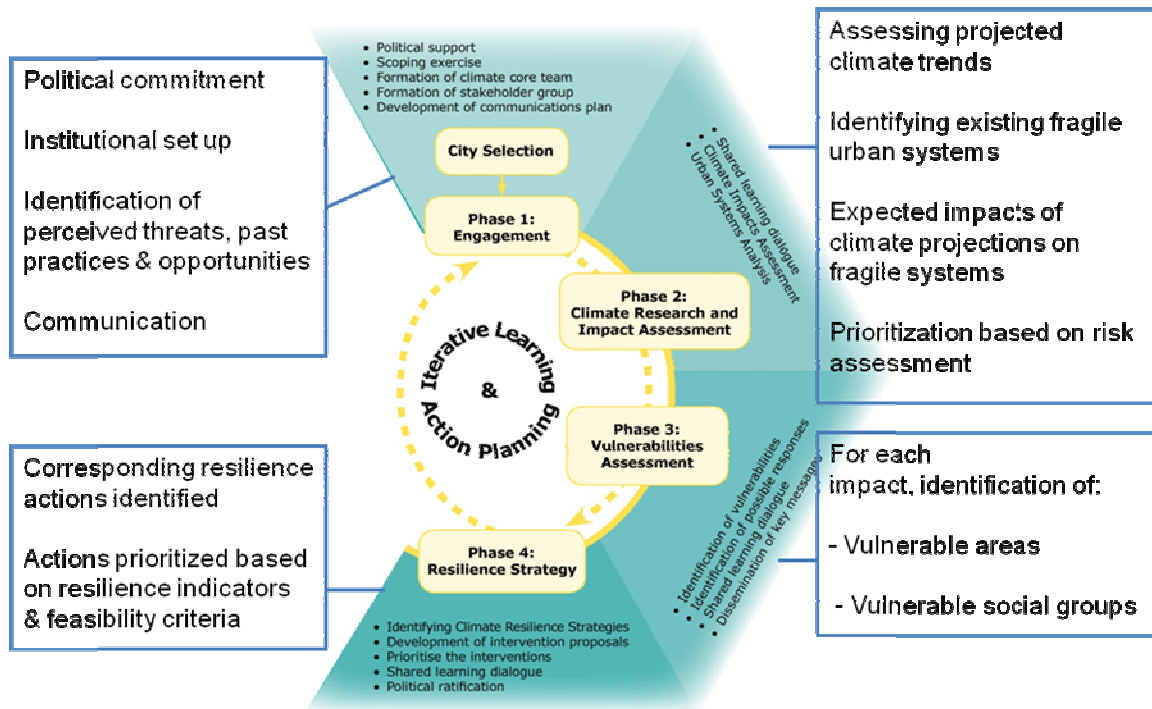


Figure 1.4.1: ICLEI ACCCRN Process

Vulnerabilities Assessment: This phase helps in identifying the key vulnerabilities of each of the fragile urban system. It determines the spatial vulnerability of each fragile urban system. It also identifies the vulnerable population and the potential supporting actors for each system. This information is gathered in consultation with the stakeholder group through shared learning dialogue.

Resilience Strategy: The relevant resilience interventions for the city are identified. These interventions are prioritized on the basis of their feasibility and applicability to the city. The resilience strategy is then developed and is ratified through political support.

Implementation and Monitoring & Review: After identifying the resilience interventions for the city, concrete project implementation plans can be prepared. Opportunities for financing and implementing these projects need to be explored. These projects can then be implemented and further monitored and reviewed.

2 City profile

Shimla is the capital town of Himachal Pradesh in Northern India. It is located in the lap of lesser Himalayan range. It is also known as the 'Queen of Hills'. This name was given to Shimla by the British who used to retire to Shimla during the summers. During the British rule Shimla was known as the summer capital of the country. It still continues to be a summer relief for the whole country and is one the most famous tourist destination of Himachal Pradesh. The picturesque mountains of Shimla make it a must travel destination and brings solace to many during the summers to escape the heat of the plains. Shimla can be called 'a Wonder of Colonial Era'. The British established many architectural masterpieces such as Vice Regal Lodge, Gorton Castle, Railway Board Building, Gaiety Theatre, Town Hall, Auckland House, Ellerglie, Barnes Court, Bungalows, Churches and Challet Day School.

2.1 Location

The town of Shimla is built over several hills and connecting ridges. It is situated in the North-West Himalayas. The city occupies an area of 19.99 sq. km¹. It is located at an altitude of 2,205 m in the lower Himalayan range between 31°06' North and 77°13' East. Jhakhoo hill is the most elevated spur of Shimla. The city has been divided into 25 wards. It is a Zone IV (High Damage Risk Zone) as per the Earthquake hazard zoning of India. In Shimla the sediments eroded from Himalayas 30 million years ago have been deposited. The shape of the city is said to be an irregular crescent². The city is connected by rail, road and air with the rest of the country. Shimla district is covered by the catchment area of the rivers Sutlej, Pabbar and Giri. The district drains itself into these rivers. The Sutlej is the principal river of the district for water supply, which is about 21 km from the city. Shimla is covered by the thick forest of pine, rhododendron and oak³.

2.2 Climate⁴

Shimla has a sub-tropical highland type of climate. The temperature in peak winters (December-January) falls below 0°C. The weather in Shimla is predominantly cool during in winters and moderately cool in summers. The average temperature during winter is between -1°C and 10°C and between 19°C and 28°C in summer. The historical climate monthly averages of Shimla City can be referred to as Figure 2.2.1.

Winters in Shimla are chilling. December, January and February are the months when Shimla experiences heavy chilling cold, with chilly winds coming from Himalayan snow peaks. During winters, the temperature goes below freezing point and nights are bone chilling. Snowfall is also very common. Maximum temperature during winters is 8 -10 degree Celsius.

¹ (Shimla Municipal Corporation at a Glance n.d.)

² (DM Cell, SMC 2012)

³ (Bhan, et al. 2011, 3)

⁴ (Bhan, et al. 2011, 3)

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Summer is the season when Shimla offers respite to people, from severe heat and heat waves of the plains. The summer season starts from April and lasts until June. During this season temperature, fluctuates between 15 °C to 28°C.

The average total annual precipitation of the city is 1520 mm. The snowfall in Shimla drives tourists to the city in its chilly winters. Snowfall, which used to be in the month of December in Shimla has lately shifted to January or even February (since last 20-25 years).

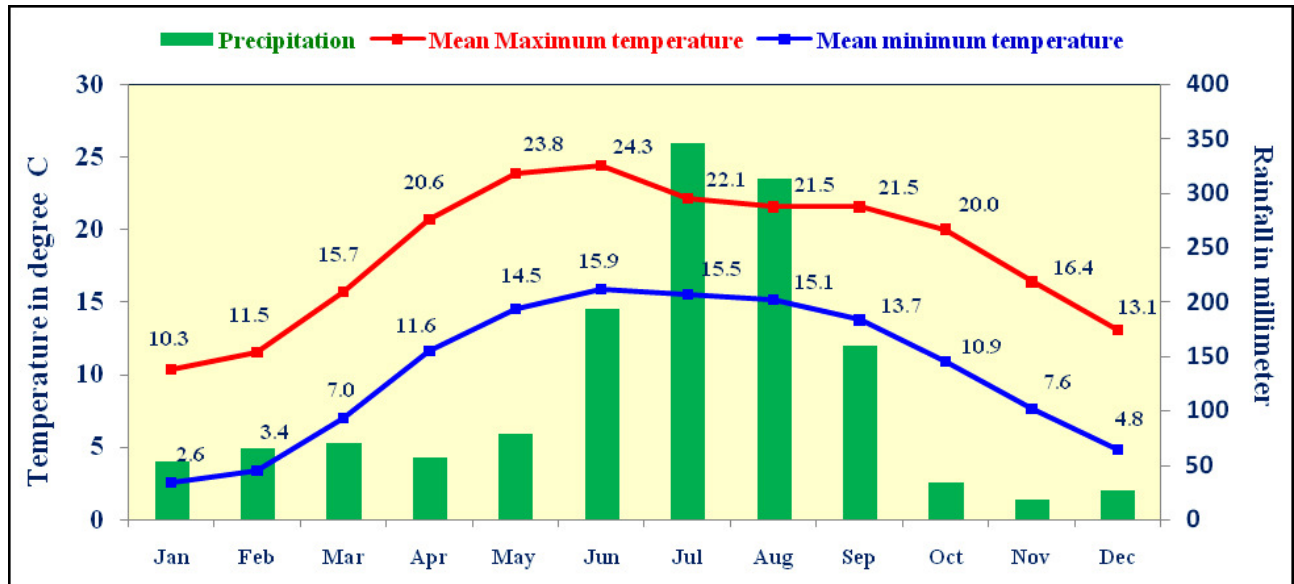


Figure 2.2.1: Monthly Normal Maximum & Minimum Temperatures and total Rainfall⁵

2.3 Geology⁶

Shimla town is situated on the rocks of Jutogh Group and Shimla Group. Jutogh group occupies main Shimla area and extends from Annadale-Chura Bazar-Prospect Hill-Jakhoo-US Club and highland area. Shimla Group comprising of earlier Chail Formation and Shimla Series represented by shale, slate, quartzite greywacke and local conglomerate is well exposed in Sanjauli-Dhalli area.

2.4 Population, growth trend and population density of the City

As per provisional reports of Census India, population of Shimla Municipal Corporation Area in 2011 is 1,69,578. The break-up of the population statistics is given in Table 2.4.1. Shimla Planning Area (SPA, Figure 2.6.1), the only Class I city in the Himachal Pradesh, has a population of 1,74,789 persons (2001 census), which accounts for 24% population of the Shimla district. The population of SPA has increased from 1,29,827 persons in 1991 to 1,74,789 in 2001, recording a decadal growth rate of 34.63 percent. During the past few decades, the city's population has grown at a faster pace than the corresponding state average. Figure 2.6.3 gives an idea about the density of population in different wards within the Shimla Municipal Corporation Area.

⁵ (Bhan, et al. 2011, 5)

⁶ (MoUD, Gol 2010, 29)

⁷ (Census of India 2011)

Table 2.4.1: Status of the Population in Shimla Municipal Corporation

Demographics⁸	
Total Population	1,69,578
Male	93,152
Female	76,426
F/M ratio (per 1000)	818
Household size	5
Number of Households	37,756
Population Density	4197 per sq. km
Slum population ⁹	11,874
Literacy¹⁰	
Average literacy rate	84%
Male literacy rate	85.7%
Female literacy rate	86.7%
Employment¹¹	
Employment rates	41.33%
Main worker population	62,083
Marginal worker population	8,011
Nature of occupation	The economy is mainly dependent on government and tourism. The government jobs account for almost 47% of the employment of the city
Occupational pattern	Primary – 1.1%
	Secondary – 0.9%
	Tertiary – 98 %

2.5 Socio-economic Features¹²

Industries in Shimla are mainly centred around the small scale industries. Since Shimla is a hill resort, so the construction of big industries is quite impossible in Shimla due to number of valid reasons like the unavailability of adequate human resource and uneven terrain. Shimla being an ideal place for a getaway, the tourism industry in Shimla has emerged as a booming one. The tourism industry has been a major source of income for the people of Shimla. The overall scenic beauty of Shimla with the rolling hills and salubrious climate draws domestic as well as foreign tourists.

Employment is largely driven by the government and tourism. Being the administrative capital of the state of Himachal Pradesh, the city houses several central and state government offices. Government jobs account for almost half (47%) of the working population. Direct hospitality industry personnel such as tour guides, hotel and restaurant employees, etc., are few (10%). Individual crafts and small scale industries, such as tourist souvenir production and horticultural produce processing, comprise most of the remainder. In addition to being the local hub of transportation and trade, Shimla is the area's healthcare centre, hosting a medical college and four major hospitals. The city's

⁸ (Census of India 2011)

⁹ (MoUD, GoI 2010, 208)

¹⁰ (Census of India 2011)

¹¹ (MoUD, GoI 2010)

¹² (DM Cell, SMC 2012, 5 & 11)

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development plan aims to make Shimla an attractive health tourism spot. The unemployment rate in the city had come down from 36% in 1992 to 22.6% in 2006. This drop is attributed to recent industrialization, the growth of service industries, and knowledge development.

2.6 Administrative Jurisdiction

Shimla Planning Area (Figure 2.6.1) is the region delineated by the Town and Country Planning (TCP), which had been considered for the preparation of the City Development Plan (CDP) of Shimla City. With the passing of the Himachal Pradesh Municipal Corporation Act, 1994¹³ the government delineated the Shimla Municipal Corporation Area into 21 wards with 9.55 Sq km and further in 2001 into 25 wards with 13.67 sq km¹⁴ (Figure 2.6.2). The SPA represents an area of potential urbanization, comprising the core urban area of Shimla, its peri-urban fringe and the rural hinterland that is expected to urbanize in due course, with the development of the urban core.

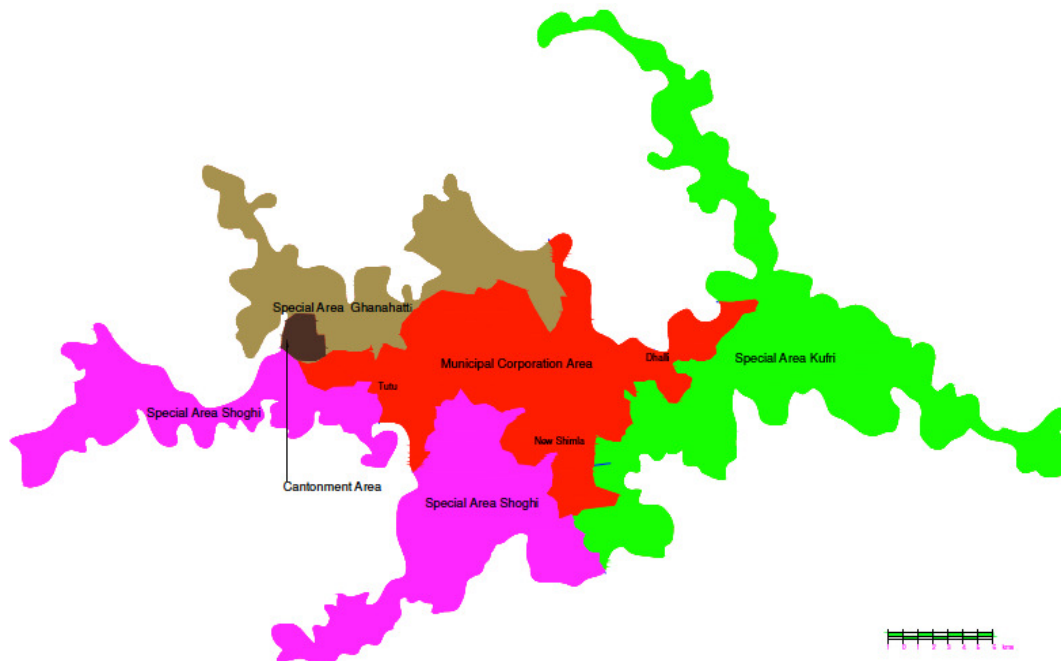


Figure 2.6.1: Administrative Jurisdiction of Shimla Planning Area (SPA) which includes Shimla Municipal Corporation Area and the neighboring Shimla Development Authority Areas (SADAs)

¹³ (Govt. of Himachal Pradesh 1994)

¹⁴ (TCPO, MoUD n.d.)

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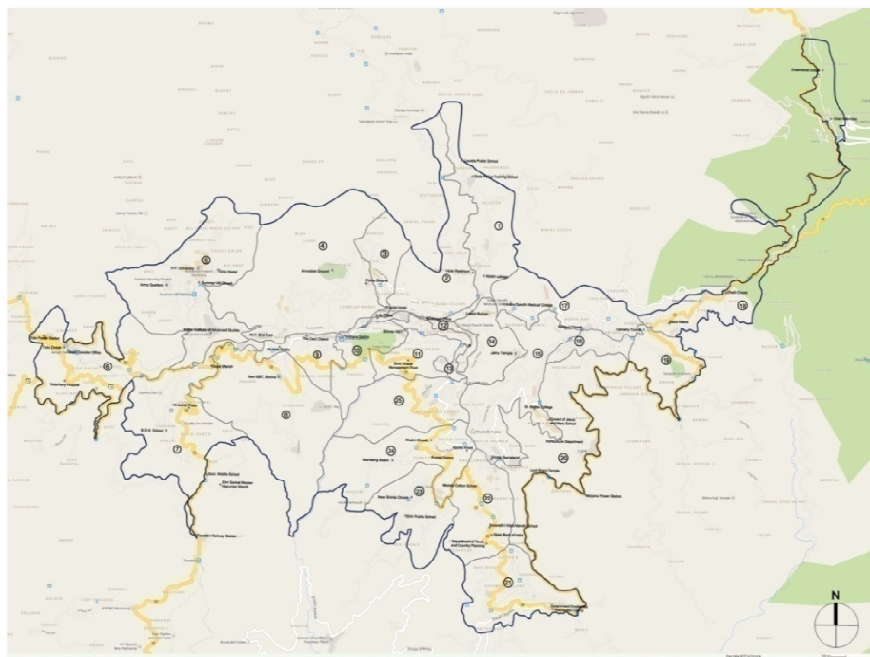


Figure 2.6.2: Shimla Municipal Corporation Area with Ward Boundaries

Index of Ward Numbers of Shimla Municipal Corporation (SMC & GIZ 2011)				
1. Bharari	6. Totu	11. Krishnanagar	16. Engineghar	21. Kasumpati
2. Raladubhatta	7. Boileuganj	12. Rambazaar	17. Sanjauli	22. Chotta Shimla
3. Kaithu	8. Tutikandi	13. Lower Bazaar	18. Dhalli	23. Pateyog
4. Annadale	9. Nabha	14. Jakhoo	19. Chamyana	24. Khalini
5. Summer Hill	10. Phagli	15. Banmore	20. Malyana	25. Kanlog

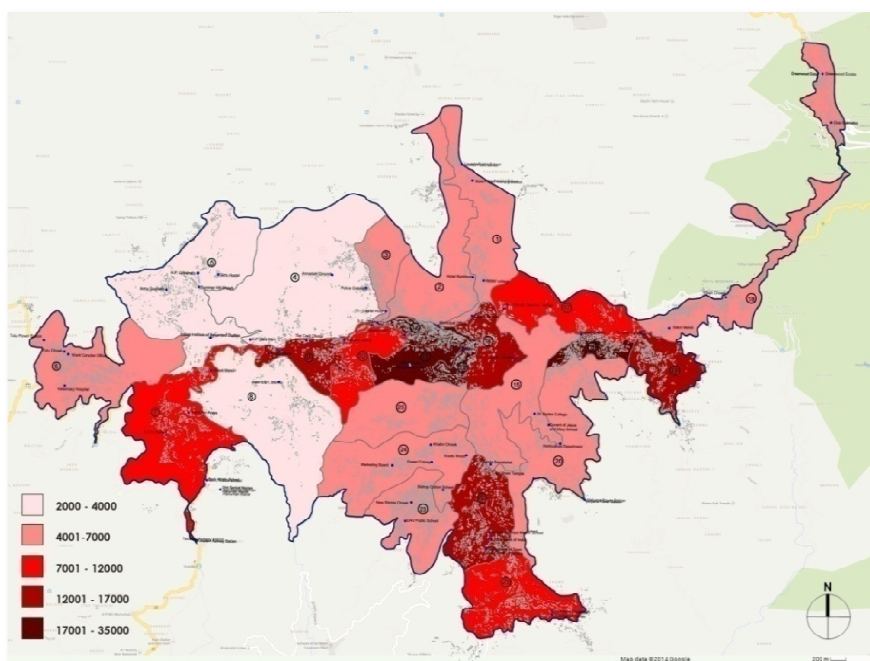


Figure 2.6.3: Ward-wise Density of Population within Shimla Municipal Corporation Area¹⁵

¹⁵ (SMC & GIZ 2011)

3 Situational analysis

3.1 City Scoping

According to a city scoping exercise carried out for the city, the city is mainly impacted by two climatic hazards – increase of temperature, and increase in precipitation. These hazards impact several sectors in the city.

Further, shortage of water has been identified as a key issue in the city. Water supply is handled by Shimla Municipal Corporation and Irrigation and Public Health Department (I&PH). 90% of the community has access to safe-drinking water.

Shortage of water supply is a common problem in the city. During the summer monsoon season the problem becomes worse. Due to existing shortage of water supply following key social, economic and environmental impacts are being faced by the city:

- Loss in number of working days
- Decrease in productivity
- Depletion of the water table
- Increase in water pollution

Shimla Municipal Corporation (SMC) has been taking a number of measures for improved water supply and other sectors, which directly or indirectly help the city in adapting to climate change. Some of these measures have been mentioned below:

Water Supply	<ul style="list-style-type: none"> •In the process of implementing 24×7 water supply •Extension of water supply pipelines to uncovered areas
Solid Waste Management	<ul style="list-style-type: none"> •Waste composting plant is under trial run •Engineered landfill to be constructed soon •Door to door collection of solid waste is being carried out •Use of non biodegradable polythene carry bags has been banned •Carrying out a zero waste management project
Environment and DRR	<ul style="list-style-type: none"> •Awareness raising campaigns regarding DRR •Hazard, Risk and Vulnerability Assessment of urban areas •Community risk assessment and preparation of community response and preparedness plans •Integration of disaster risk reduction features in urban planning •Training and capacity building of engineers, architects, masons on safe construction practices •Strengthening of compliance mechanism to ensure structural safety. Creation of DM cells in MC •School safety and awareness programme

Following is a list of the main plans and policies for Shimla integrating social, environmental and economic elements:

- City Development Plan
- Solar City Master Plan
- City Sanitation Plan
- City Mobility Plan (to be developed)
- City Environment Plan (under development)
- City Disaster Management Plan
- City Climate Change Policy (under development)

3.2 Potential Hazards for Shimla city and some past disaster events

Shimla city, due to its geological features and location is exposed to various natural and Human induced hazards. They may include, but are not limited to the following:

- Natural Hazards: Earthquake, Landslide, Land Sinking, Hailstorm, Severe Storms, including lightning and high winds (Thunderstorms), Flash Flood/cloud Burst, Heavy Snow Falls
- Human Induced Hazards: Accidents (Train, Road, Air), Monkey Menace, Traffic Jams, Tree Falling, Fires (Household, Forest), Lift Disorder, Stampede, Utilities Failure such as Energy, Telecommunication, Water and Sewerage System

The hazardous events faced by the city over the last few decades were studied to assess the likely hazards whose impacts could be exacerbated due to climate change impacts.

Earthquakes: The North-Western fringe of Himalayas is bounded by two major thrusts namely Main Central Thrust and Main Boundary Fault running parallel to the axis. Himachal State therefore, falls in most active seismic zones-IV and V. Shimla city and the region have experienced various earthquakes causing damage to the city infrastructure and further leading to other disasters like landslides and fire.

Landslides: Landslide is the most common disaster in Himachal Pradesh and Shimla, which causes immense loss of infrastructure, property and life. The fragile nature of rocks forming the mountains along with the sub-tropical highland climate and various anthropogenic activities has made the city vulnerable to the landslides.

Storms: Severe Storms, including lightning & high winds (Thunderstorms): Every year severe storms, lightning and high winds cause huge loss to the economy of Shimla City. It results in uprooting of trees, damage to electricity supply wires, telephone cables, street lights, etc. Uprooting of trees causes loss to life, buildings or vehicles¹⁶.

Flash floods: Shimla district has faced numerous flash floods in the past. These floods have resulted in major losses in the area. They cut the communication channels of the area to the outside world. They resulted in loss of infrastructure, life and livelihood, caused various health issues and left the people in a state of horror. Some of the major floods that have affected the area in the past are August 1997 flood and July 2005 flood¹⁷.

¹⁶ (DM Cell, SMC 2012)

¹⁷ (Sharma 2006)

4 Climate scenario in the city

4.1 Past climatic trends for Shimla City and the region

Climatic data trend analysis and projections at City level are rarely available. Hence, in order to better understand the past trends in temperature and precipitation for Shimla city, preliminary analysis of climatological parameters was undertaken based on regional assessment report published by Indian Network for Climate Change Assessment (INCCA), recent reports published by India Meteorological Department (IMD) and State Strategy & Action Plan on Climate Change, Himachal Pradesh (HPSSAPCC).

All the above mentioned resources were referred to, which provides climatological assessment for north-western Himalayan region and also in some case for Shimla City to assess the past trends and preliminary trend assessment for future. Assessments for more than 100 years as well as the recent past were used for this purpose. The analysis has been done for two key parameters: Temperature and Rainfall.

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Table 4.1.1: Summary of the Past Trends

Changing Climate Condition	Assessments	Amount of Expected Change (include baseline and planning horizon years)	Geographical Area	Extent of Variability	Level of Confidence	Source(s)
Precipitation change	Regional Assessments	<i>The annual, winter and monsoon precipitation clearly shows a decreasing trend¹⁸ (also see Table 4.1.1). Though the results of trend analysis of annual, winter and monsoon precipitation in Shimla, Solan & Sirmour in Himachal Pradesh show a significantly decreasing trend, district wise variation of annual rain fall trends in few districts (Kinnaur, Chamba, Lahual & Spiti) show a significantly increasing trend¹⁹.</i>	<i>Western Himalayas constituting of Jammu and Kashmir, Uttarakhand and Himachal Pradesh²⁰.</i>		<i>High</i>	INCCA. Nov 2010. <i>Climate Change and India: A 4X4 Assessment, A Sectoral and Regional Analysis for 2030s. MoEF, Gol.</i>
	Supplementary Local Assessments	<i>Results of trend analysis of annual, winter and monsoon precipitation in Shimla show a significantly decreasing trend. There has been about 40% reduction in rainfall over the last 25 years (1987-2009)²¹. About 17% decrease in rain fall was observed from 1996 onwards. The decreasing trend of seasonal snowfall has been observed since 1990 and was lowest in 2009²².</i>			<i>High</i>	
Temperature change	Regional Assessments	<i>Past trend of 100 years indicate that there has been an increase at a rate of 0.86 °C/ 100 yrs in temperature in the region. However, during 1970 to 2000 the temperature has increased at a rate of 0.46 °C/ 10 yrs, which is quite alarming (See Figure 4.1.2). Figure 4.1.3 also</i>	<i>Western Himalayas constituting of Jammu and Kashmir, Uttarakhand and Himachal Pradesh²⁴.</i>		<i>High</i>	INCCA. Nov 2010. <i>Climate Change and India: A 4X4 Assessment, A Sectoral and</i>

¹⁸ (Govt. of HP 2012, 33, table - 10)

¹⁹ (Govt. of HP 2012, 33)

²⁰ (INCCA, Nov 2010, p. 28)

²¹ (Govt. of HP 2012, 34)

²² (Govt. of HP 2012, 11)

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Changing Climate Condition	Assessments	Amount of Expected Change (include baseline and planning horizon years)	Geographical Area	Extent of Variability	Level of Confidence	Source(s)
		<i>indicate that there is a warming trend in general in the region. Snow fall also show a decreasing trend in the region²³, which further confirms the increase in temperature.</i>				Regional Analysis for 2030s. MoEF, Gol.
	Supplementary Local Assessments	<i>The mean average winter temperature has increased by 1.8 °C during the period 1901-2002²⁵. Also see Figure 4.1.4 for variations in temperature in mean winter, monsoon and annual temperature. Warming of Shimla was higher during the period 1991-2002 as compared to other decades²⁶. The mean average winter temperature has increased by 2.4 °C during this period²⁷.</i>				
Extreme events (please specify the event)	Regional Assessments	<i>Frequency of cold days show a significant decreasing trend of 2.1 days per decade. It is also observed that pre-monsoon maximum temperatures in the region have increased significantly²⁸. There is a certain increase in winter mean air temperature in Himachal Pradesh²⁹.</i>	<i>Western Himalayas constituting of Jammu and Kashmir, Uttarakhand and Himachal Pradesh³⁰.</i>			INCCA. Nov 2010. Climate Change and India: A 4X4 Assessment, A Sectoral and Regional Analysis for 2030s. MoEF, Gol.
	Supplement	<i>Change in rainfall patterns with increased</i>	The State of			State

²⁴ (INCCA, Nov 2010, p. 28)

²³ (Govt. of HP 2012, 32)

²⁵ (Govt. of HP 2012, 32)

²⁶ (Govt. of HP 2012, 11)

²⁷ (Govt. of HP 2012, 31)

²⁸ (INCCA, Nov 2010, p. 32)

²⁹ (Govt. of HP 2012, 31)

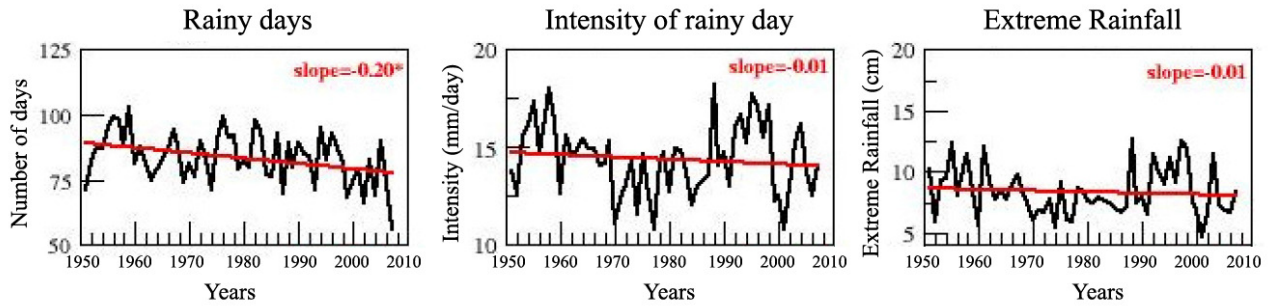
³⁰ (INCCA, Nov 2010, p. 28)

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Changing Climate Condition	Assessments	Amount of Expected Change (include baseline and planning horizon years)	Geographical Area	Extent of Variability	Level of Confidence	Source(s)
	ary Local Assessments	<p>variability in future in south-eastern parts of the State of Himachal Pradesh may be experiencing less rainfall. Drought like conditions may prevail in given projections.</p> <p>Projected increase in temperature, rainfall, rainfall variations and intensities in the State may lead to accelerated summer flows leading to situations like floods/ flash floods in North-western parts of the State.</p> <p>Health risks are also associated indirectly with extreme events in sub mountain, low hills and sub-humid agro climatic zones of the State³¹.</p>	Himachal Pradesh			Strategy & Action Plan on Climate Change, Himachal Pradesh, 2012

³¹ (Govt. of HP 2012, 41)

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Red line indicates the linear trend

Figure 4.1.1: Long term trends in frequency, intensity of rainy days and extreme rainfall over Western Himalayan Region (1950-2010)³²

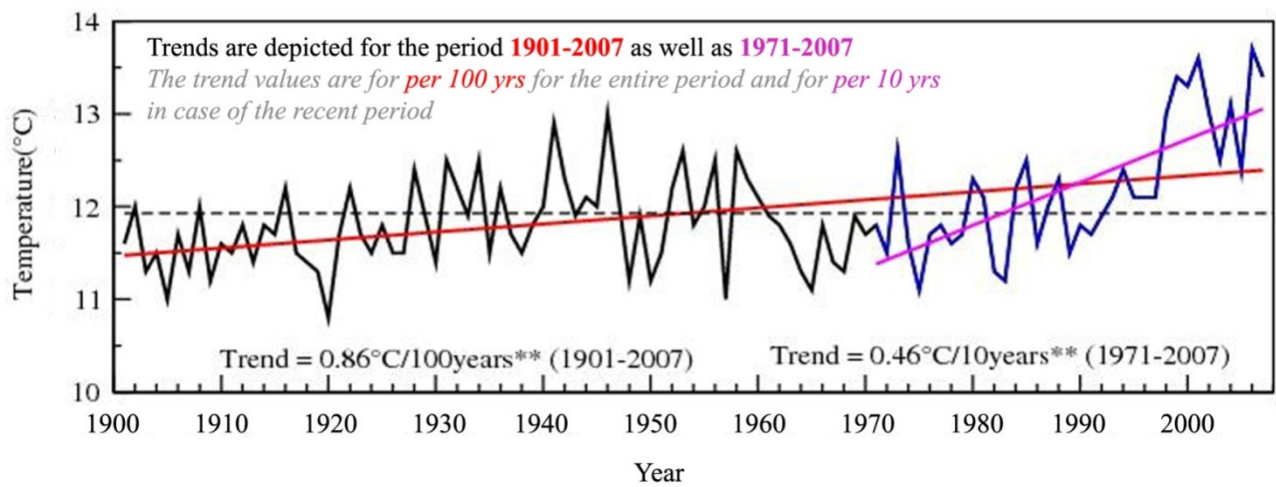


Figure 4.1.2: Annual temperature time series for Western Himalayan region (1901-2007)³³

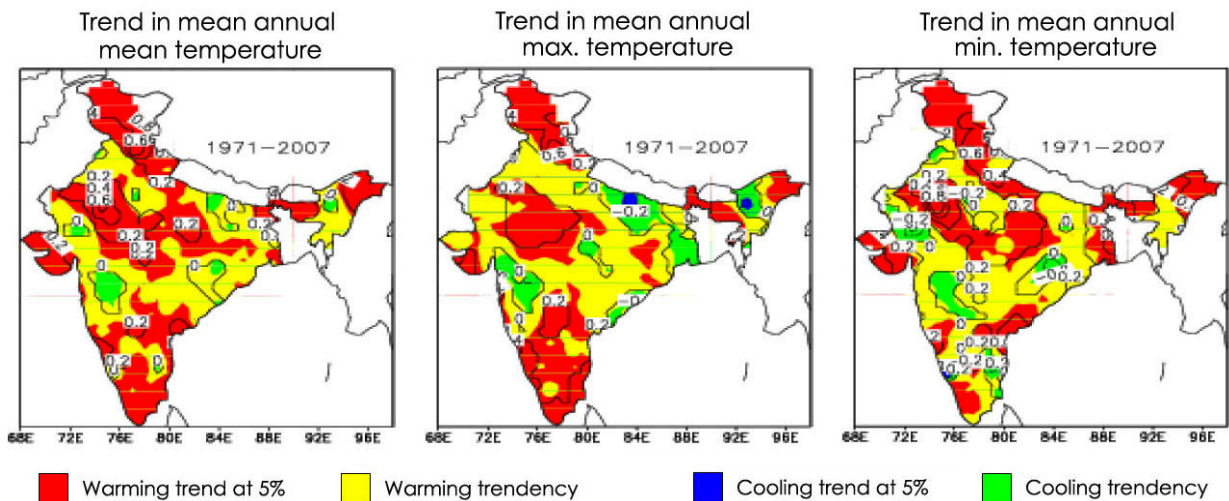


Figure 4.1.3: Observed trends in air temperature³⁴

³² (INCCA, Nov 2010)

³³ (INCCA, Nov 2010)

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Table 4.1.2: Summary of projected Climate Data

Changing Climate Condition	Assessments	Amount of Expected Change (include baseline and planning horizon years)	Geographical Area	Greenhouse Gas Emissions Scenario	Extent of Variability	Level of Confidence	Source(s)
Precipitation change	Regional Assessments	Projected mean annual rainfall is varying from 1268±225.2 mm to 1604±175.2 mm, which show a net increase in 2030's with respect to the simulated rainfall of 1970's in the region by 60 to 206 mm. The rise in precipitation with respect to 1970's is by 5% to 13% ³⁶ .	Western Himalayas constituting of Jammu and Kashmir, Uttarakhand and Himachal Pradesh ³⁷ .	A1B socio-economic scenarios of the IPCC that assumes significant innovations in energy technologies, which improve energy efficiency and reduce the cost of energy supply ³⁸ .	All seasons in the region indicate an increase in rainfall, with the monsoon months of June, July, August and September showing the maximum increase in rainfall by 12 mm. The winter rain in the months of January and February are also projected to increase by 5mm in 2030's with respect to 1970's, with minimum increase in October, November and December ³⁹ .	High	INCCA. Nov 2010. Climate Change and India: A 4X4 Assessment, A Sectoral and Regional Analysis for 2030s. MoEF, Gol.

³⁶ (INCCA, Nov 2010, p. 36)

³⁷ (INCCA, Nov 2010, p. 28)

³⁸ (INCCA, Nov 2010, p. 36)

³⁹ (INCCA, Nov 2010, p. 36)

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Changing Climate Condition	Assessments	Amount of Expected Change (include baseline and planning horizon years)	Geographical Area	Greenhouse Gas Emissions Scenario	Extent of Variability	Level of Confidence	Source(s)
	Supplementary Local Assessments	<i>There is no projections available at the local level.</i>				High	
Temperature change	Regional Assessments	<i>The annual temperature is projected to increase from 0.9±0.6 °C to 2.6±0.7°C in 2030's. The rise in temperature with respect to 1970's is ranging from 1.7°C to 2.2°C⁴⁰.</i>	<i>Western Himalayas constituting of Jammu and Kashmir, Uttarakhand and Himachal Pradesh⁴¹.</i>	<i>A1B socio-economic scenarios of the IPCC that assumes significant innovations in energy technologies, which improve energy efficiency and reduce the cost of energy supply⁴².</i>	<i>Seasonal air temperatures show rise in all seasons. However, winter temperatures during October, November and December show a decrease by 2.6°C in 2030's with respect to 1970's⁴³.</i>	High	INCCA. Nov 2010. <i>Climate Change and India: A 4X4 Assessment, A Sectoral and Regional Analysis for 2030s. MoEF, Gol.</i>
	Supplementary Local Assessments						
Extreme events (please specify the)	Regional Assessments	<i><u>Extreme Temperature</u>: Minimum temperatures are projected to rise by 1 to 4.5°C, and the maximum temperatures may rise by 0.5 to 2.5°C⁴⁴.</i> <i><u>Extreme Precipitation</u>: Number of</i>	<i>Western Himalayas constituting of Jammu and Kashmir, Uttarakhand and</i>	<i>A1B socio-economic scenarios of the IPCC that assumes significant</i>			INCCA. Nov 2010. <i>Climate Change and India: A 4X4</i>

⁴⁰ (INCCA, Nov 2010, p. 39 & 41)

⁴¹ (INCCA, Nov 2010, p. 28)

⁴² (INCCA, Nov 2010, p. 36)

⁴³ (INCCA, Nov 2010, p. 41)

⁴⁴ (INCCA, Nov 2010, p. 131)

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Changing Climate Condition	Assessments	Amount of Expected Change (include baseline and planning horizon years)	Geographical Area	Greenhouse Gas Emissions Scenario	Extent of Variability	Level of Confidence	Source(s)
event)		<p>rainy days is likely to increase by 5-10 days on an average. The intensity of rainfall in the region is likely to increase by 1-2mm/day⁴⁵. The frequency as well as intensity of rain days is also projected to increase in this region⁴⁶.</p> <p><u>Impact on Human Health:</u> The increase in temperatures may lead to increasing morbidity due to heat stress. Flash floods due to glacial lake outburst floods (GLOF) may lead to large scale landslides and affect food security and hence nutritional health. Projections of malaria transmission windows for the 2030s, based on temperature, reveal the introduction of new foci in Jammu and Kashmir and an increase in the opening of more transmission months in districts of the region. The transmission windows in Jammu and Kashmir, however, still remain open only for 0–2 months in the 2030s⁴⁷.</p>	Himachal Pradesh ⁴⁸ .	innovations in energy technologies, which improve energy efficiency and reduce the cost of energy supply ⁴⁹ .			Assessment, A Sectoral and Regional Analysis for 2030s. MoEF, Gol.

⁴⁵ (INCCA, Nov 2010, p. 132)

⁴⁶ (INCCA, Nov 2010, pp. 42 - figure 3.8 - a & b)

⁴⁷ (INCCA, Nov 2010, p. 137 & 138)

⁴⁸ (INCCA, Nov 2010, p. 28)

⁴⁹ (INCCA, Nov 2010, p. 36)

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Changing Climate Condition	Assessments	Amount of Expected Change (include baseline and planning horizon years)	Geographical Area	Greenhouse Gas Emissions Scenario	Extent of Variability	Level of Confidence	Source(s)
	Supplementary Local Assessments						

4.2 Climate Scenario Statement

There is a 'high' level of confidence of a 5 to 13 % of expected change in the precipitation and a 1.7 to 2.2 °C of expected change in the temperature in the North Western Himalayan region in India by the year 2030.

Table 4.2.1: Climate Scenario Statement

Changing Climate Conditions	Assessments	Climate Scenario Summary Statements
Precipitation change	Regional Assessments (4x4 Assessment report by GoI)	<i>Projected mean annual rainfall is varying from 1268±225.2 mm to 1604±175.2 mm, which show a net increase in 2030's with respect to the simulated rainfall of 1970's in the region by 60 to 206 mm. The rise in precipitation with respect to 1970's is by 5% to 13%⁵⁰.</i>
	Supplementary Local Assessments	
Temperature change	Regional Assessments	<i>The annual temperature is projected to increase from 0.9±0.6 °C to 2.6±0.7°C in 2030's. The rise in temperature with respect to 1970's is ranging from 1.7°C to 2.2°C⁵¹.</i>
	Supplementary Local Assessments	<i>The temperature is likely to increase in future</i>
Extreme events (please specify the event)	Regional Assessments	<i><u>Extreme Temperature</u>: Minimum temperatures are projected to rise by 1 to 4.5°C, and the maximum temperatures may rise by 0.5 to 2.5°C⁵². <u>Extreme Precipitation</u>: Number of rainy days is likely to increase by 5-10 days on an average. The intensity of rainfall in the region is likely to increase by 1-2mm/ day⁵³. The frequency as well as intensity of rain days is also projected to increase in this region⁵⁴.</i>

⁵⁰ (INCCA, Nov 2010, p. 36)

⁵¹ (INCCA, Nov 2010, p. 39 & 41)

⁵² (INCCA, Nov 2010, p. 131)

⁵³ (INCCA, Nov 2010, p. 132)

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Changing Climate Conditions	Assessments	Climate Scenario Summary Statements
		<p><i>Impact on Human Health:</i> The increase in temperatures may lead to increasing morbidity due to heat stress. Flash floods due to glacial lake outburst floods (GLOF) may lead to large scale landslides and affect food security and hence nutritional health. Projections of malaria transmission windows for the 2030s, based on temperature, reveal the introduction of new foci in Jammu and Kashmir and an increase in the opening of more transmission months in districts of the region. The transmission windows in Jammu and Kashmir, however, still remain open only for 0–2 months in the 2030s⁵⁵.</p>
	Supplementary Local Assessments	
	Regional Assessments	
Sea Level Rise	Supplementary Local Assessments	N/A (Shimla is situated at an average altitude of 2,202 mt, so there is no likelihood that it will be affected by sea level rise)

⁵⁴ (INCCA, Nov 2010, pp. 42 - figure 3.8 - a & b)

⁵⁵ (INCCA, Nov 2010, p. 137 & 138)

4.3 Urban systems analysis

In the previous section we saw the impact of climate change on Shimla city. This section focuses on the management and functioning of the urban systems. It tries to benchmark the condition of the urban systems in the city and determines their fragility. It therefore, helps in identifying the urban systems, which are critical for the city, and also explains the reasons for this. The critical urban systems are then analyzed against the climatic impact identified in the previous section. Further, the risk associated with the fragility of these systems is calculated through a risk assessment exercise.

The urban system analysis carried out for Shimla identified the following urban systems as fragile:

Water Supply: The city of Shimla is situated at an elevation. It draws water from the nearby streams. Surface water from rivulets is pumped and supplied at varying elevations. The water supply system of Shimla dates back to 1875. The authorities responsible for water supply in Shimla are the Irrigation and Public Health (I&PH) department and the Shimla Municipal Corporation (SMC). The I&PH looks after bulk supply and treatment of water while the SMC is concerned with distribution and pumping, metering and billing of potable water to domestic and commercial connections. Since the water supply infrastructure is very old it is not capable of supporting the current population. The current water losses are very high. At times of shortage of water, tankers are used to supply water. This is a money intensive process and involves increased diesel consumption. The identified possible climatic changes in Shimla would exacerbate the problem. Increased precipitation (snow) can disrupt/ damage water supply infrastructure. It can also cause the water in the pipelines to freeze. Increased temperatures will lead to increased demand for water. This would put additional stress on the supply system.

Transport: Traffic congestion is a major problem in the city. A single road connects the city to nearby areas. The city has many major bottleneck points, which cause traffic jams for several hours. Many roads are extremely narrow and due to road encroachment their usage is further limited. There is a major shortage of parking facility. Further, the road infrastructure is impacted severely due to the inflow of tourists and landslides. The roads need significant maintenance and repair. Increased precipitation can disrupt/damage the road and transport infrastructure leading to increased traffic congestion. It can cut off the city from rest of the area leading to shortage of food supply etc.

Tourism: Shimla is a famous tourist attraction of North India. Increased temperature in neighbouring areas can lead to an increased influx of tourists to Shimla. This would lead to additional stress on the urban services of the city.

4.4 Risk assessment

Having identified the fragile systems and the impact of climate change on them, now we prioritize them based on an assessment of the degree of risk that each impact poses for the systems. In this report risk is defined as a combination of the likelihood of an event to occur and the consequences faced if the event does occur.

Risk = Likelihood × Consequence

The idea behind this assessment is to identify the fragile systems facing a higher risk to the changing climate. This would help in the prioritization of the most fragile urban systems. This

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assessment provides a variety of combinations for likelihood and consequence. The approach helps in determining a risk score for each fragile urban system.

The assessment is carried out through a scoring mechanism. In terms of the likelihood of an event to occur the scoring is done on a scale of 1-5 with 1 being 'rare' and 5 being 'almost certain'. Similarly, for the consequence of that event the scoring is done on a scale of 1-5 with 1 being 'insignificant' and 5 being 'catastrophic'. The consequence of the event is evaluated on the system as well as on the city government. Based on the final risk score generated for each fragile statement they are categorized as extreme, high, medium and low risk. The detailed process is available at Annex 1: Risk Assessment for further reference.

Table 4.4.1: Risk Assessment

Urban system	Impacts of climate change	Likelihood	Consequence	Risk score	Risk status
Water supply	Increased precipitation disrupts/ damages water supply infrastructure	4	4	16	High
	Increased precipitation can cause water to freeze in the pipelines	4	4	16	High
	Increased temperatures will lead to increased demand for water thereby posing additional stress on the supply system	3	3	9	Medium
Transport	Increased precipitation can disrupt/damage the road and transport infrastructure	4	4	16	High
	Increased precipitation can lead to increased traffic congestion	4	4	16	High
	Increased temperature can cut off the city from rest of the area leading to shortage of food supply etc.	2	2	4	Low
Tourism	Increased temperature can lead to an increase in tourism industry causing additional stress on city services	4	3	12	High

This step helps in prioritizing the urban systems on the basis of their fragility. These systems may fall (completely or partially) or may not fall under the purview of the city government. As observed from the assessment, the additional stress on water supply system, transport of the city has the highest risk.

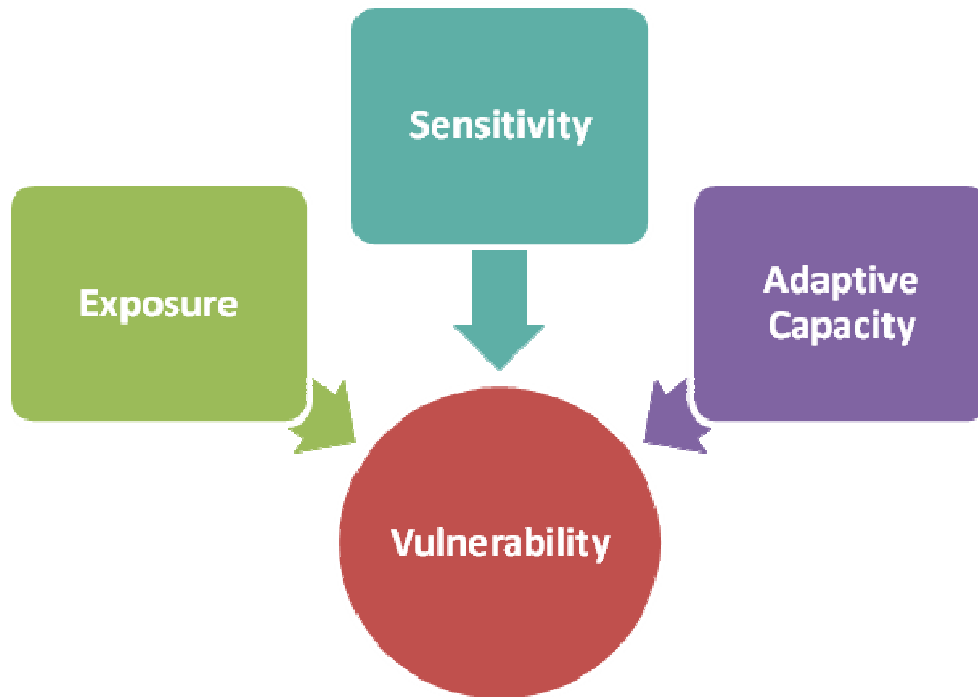
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- Disrupted/ damaged water supply infrastructure due to increased precipitation
- Frozen water in the pipelines due to increased precipitation
- Disrupted/damaged road and transport infrastructure due to increased precipitation
- Increased traffic congestion due to increased precipitation

It is interesting to notice here that increased precipitation is perceived to have more severe impacts than increased temperature. These fragile urban systems may further impact other urban systems thereby increasing the city's vulnerability to climate change. These secondary impacts have been identified in the next section. The urban systems with a high or medium risk have been considered for further assessment.

5 Vulnerabilities assessment

Intergovernmental Panel on Climate Change defines vulnerability as a function of three parameters of the character, magnitude, and rate of climate variation to which a system is exposed - in other words, the exposure of the system to climatic variation, its sensitivity, and its adaptive capacity⁵⁶.



Exposure: The nature and degree to which a system may be exposed to climate events, such as temperature increases, rainfall variability and change (including extremes), or changes in the frequency or intensity of tropical cyclones and storms.

Sensitivity: The degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. It is often measured by the system's response to what has happened to past events.

Adaptive Capacity: The ability of a system to adjust to climate - including climate variability and extremes, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

To build a resilient set up there is a need to know to what extent are the cities susceptible to the climate change. This susceptibility will vary from city to city depending on their geographical location, demographic condition, infrastructure, socio economic condition etc. Hence we need to have a robust analysis of all these parameters in order to assess the overall susceptibility of a city. This can be done in the form of vulnerability assessment. This section tries to capture all these components of vulnerability. It takes into account both the current and the future vulnerability of the city. This assessment identifies the vulnerable areas, relevant actors and the adaptive capacity of the urban systems. The actors have been scored on a resilience score from 1-27 with 1 being least resilient and 27 being the highest. These scores have been calculated on the basis of three parameters namely, responsiveness, resourcefulness and capacity to learn. The adaptive capacity of

⁵⁶ (IPCC 2007)

the urban systems has been assessed on the basis of five parameters economic capacity, technological/infrastructural capacity, governance, societal capacity and ecosystem services.

For each fragile urban system the vulnerable areas have been mapped for the city. Further, the vulnerability of each ward of the city has been identified in order to find the vulnerable hotspots of the city. The overall process followed is available at Annex 2: Analysis of Vulnerable Areas & Urban Actors for further reference.

5.1 Water supply

Secondary Impacts: The damaged water supply infrastructure can hamper the functioning of sewerage management. This would degrade the quality of sanitation in the city, creating health issues. It would cause shortage of potable water supply leading to usage of water from open sources of questionable quality, which impacts the health adversely. Damaged water supply system infrastructure would impact the road systems would in turn cause traffic congestion. Landslides due to downstream impacts of water may affect infrastructure thereby leading to a decrease in tourism and hence impacting the economy. Freezing of water in the pipelines would cause disruption of water supply and will therefore have an adverse impact on the tourism and economy. Wear and tear of existing water supply infrastructure due to additional stress on urban services would pose financial stress on Municipal Corporation.

Vulnerable areas: The vulnerable wards in terms of the water supply system for the city have been highlighted in the following figures (Figure 5.1.1 & Figure 5.1.2).

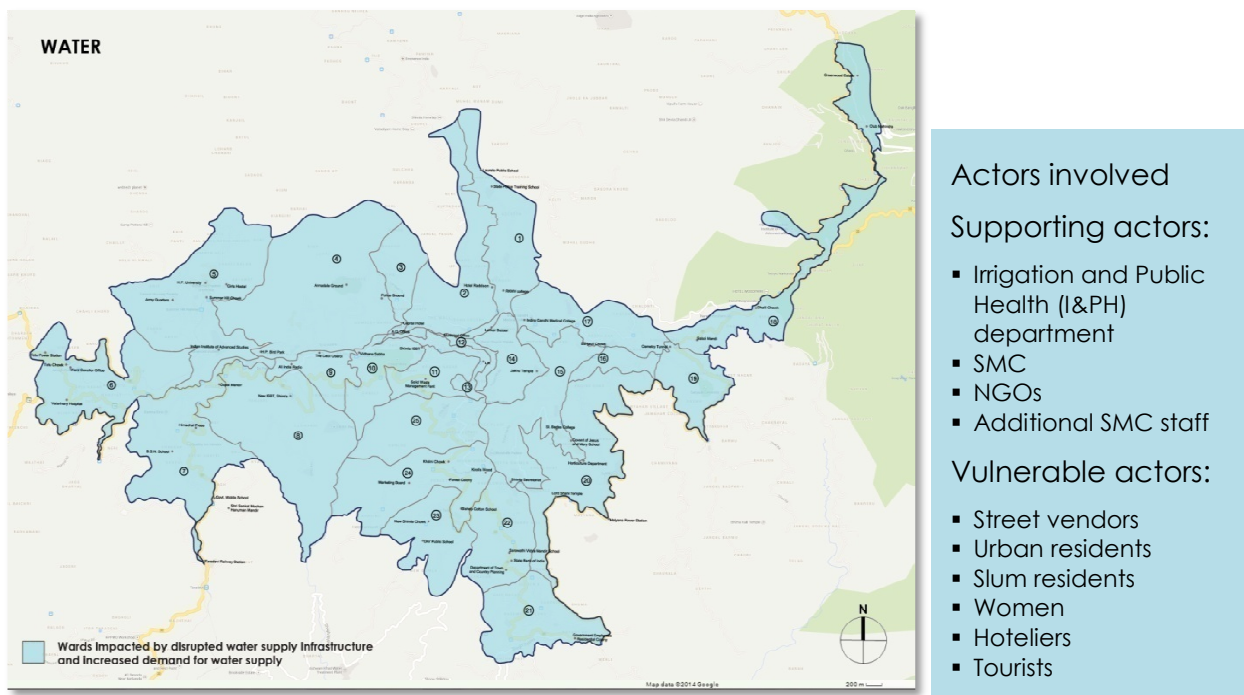
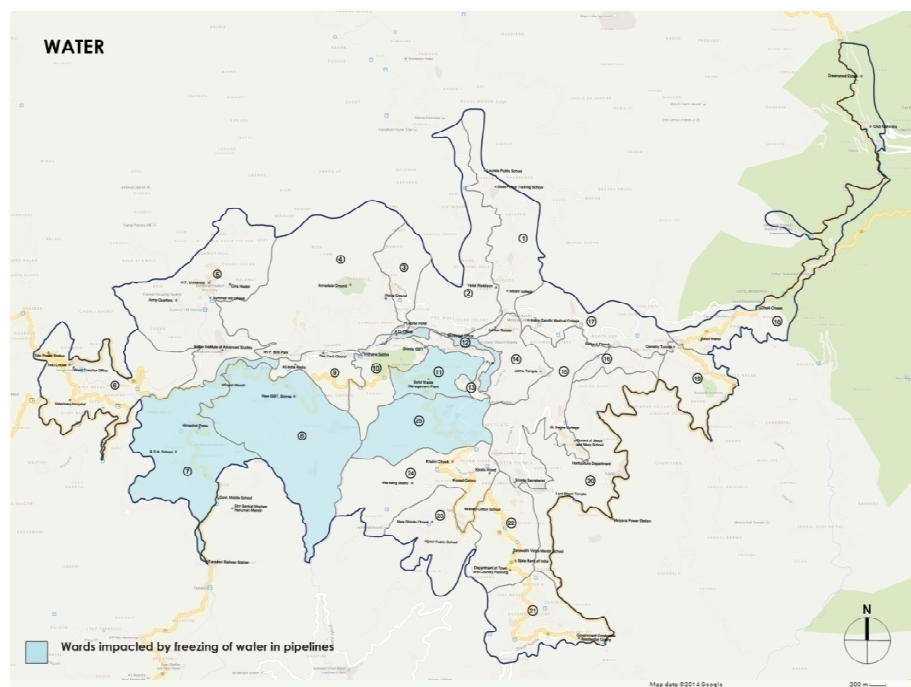


Figure 5.1.1: Wards impacted by disrupted water supply infrastructure and increased demand for water supply

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Actors involved

Supporting actors:






- Irrigation and Public Health (I&PH) department
- SMC
- NGOs
- Additional SMC staff

Vulnerable actors:

- Street vendors
- Urban residents
- Slum residents
- Women
- Hoteliers
- Tourists

Figure 5.1.2: Wards impacted by freezing of water in pipelines

Adaptive capacity:

	Low	Medium	High
 Economic			
 Technological/ Infrastructural			
 Governance			
 Societal			
 Ecosystem services			

The water supply system has been found to have a high economic, infrastructural, ecosystem services and governance capacity. However, the societal adaptive capacity of the system is medium.

5.2 Transport

Secondary Impacts: Impact on road systems due to increased precipitation would in turn cause traffic congestion and increase the chances of road accidents and can cause loss of life and livelihood. Increased travel time caused due to traffic congestion leads to loss

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of productive hours and thereby impacts the economy. Increased precipitation can cut off the city from rest of the area leading to shortage of food supply. This can lead to malnutrition of the citizens specially the poor.

Vulnerable areas: The vulnerable wards in terms of the transport system for the city have been highlighted in Figure 5.2.1 & Figure 5.2.2.

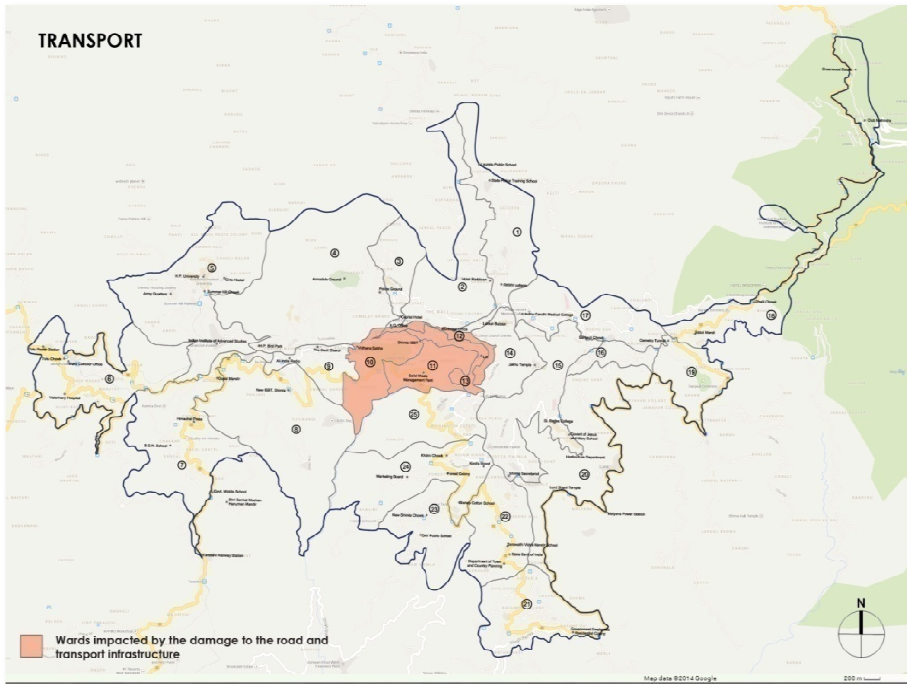


Figure 5.2.1: Wards affected by disrupted road infrastructure

Actors involved

Supporting actors:

- SMC
- Traffic police
- State Pollution Control Board (SPCB)
- Himachal Road Transport Corporation (HRTC)
- Himachal Pradesh Public Works Department (HPPWD)

Vulnerable actors:

- Urban residents
- Tourists
- Slum residents
- Street vendors
- Institutions
- Students
- Commercial organisations

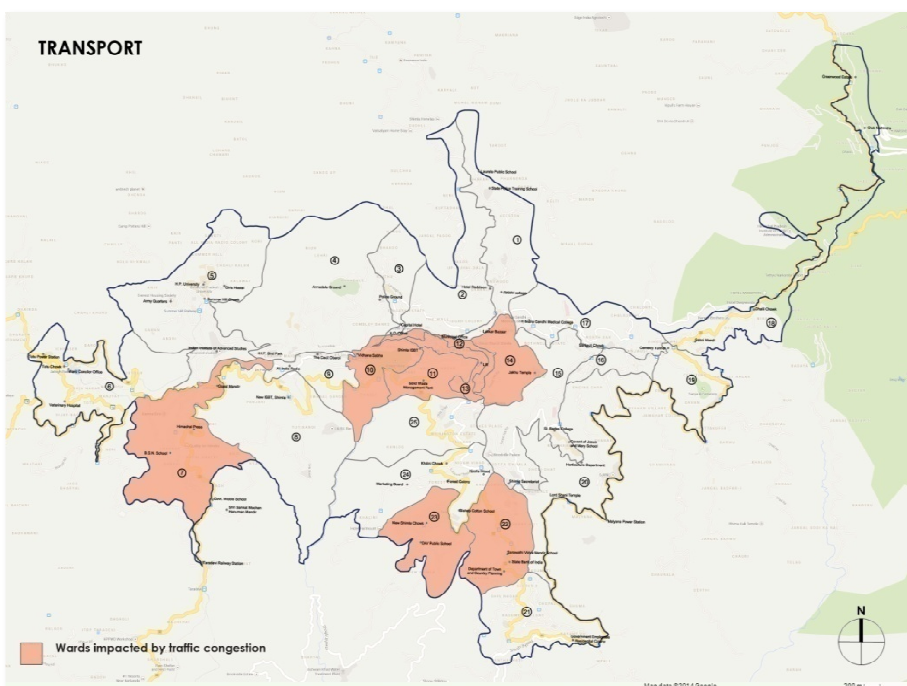


Figure 5.2.2: Wards affected by increased traffic congestion

Actors involved

Supporting actors:

- SMC
- Traffic police
- State Pollution Control Board (SPCB)
- Himachal Road Transport Corporation (HRTC)
- Himachal Pradesh Public Works Department (HPPWD)

Vulnerable actors:

- Urban residents
- Tourists
- Slum residents
- Street vendors
- Institutions
- Students
- Commercial organisations

Adaptive capacity:

	Low	Medium	High
 Economic			
 Technological/ Infrastructural			
 Governance			
 Societal			
 Ecosystem services			

Transport in the city has been found to have a low economic and societal capacity. However, the technological/ infrastructural capacity is said to be high. Further, the adaptive capacity in terms of the governance is medium.

5.3 Tourism

Secondary impacts: Increase in temperature in other parts of India is leading to increased tourism in Shimla due to its cooler climate, causing stress on its urban services. This would further increase the demand for water, parking spaces and more efficient urban services. It would cause financial burden on the municipal corporation in order to keep up with the increasing demand on satisfactory performance.

Vulnerable areas: The vulnerable wards in terms of the tourism for the city have been highlighted in Figure 5.3.1.

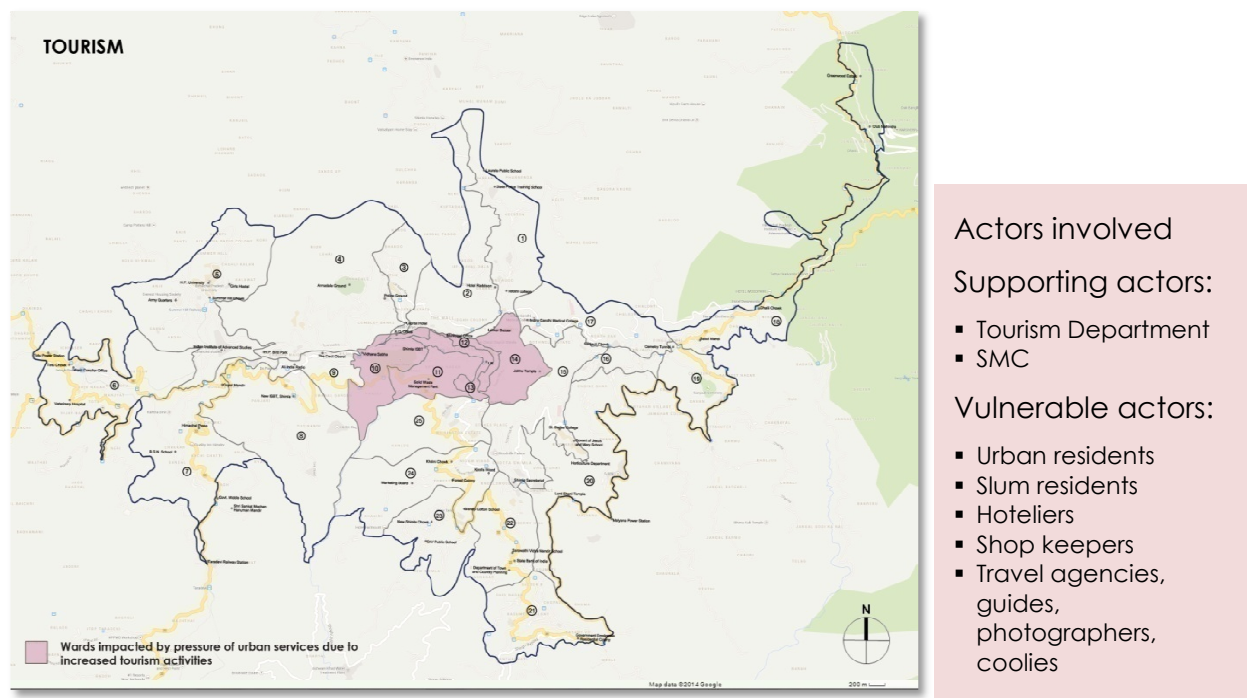


Figure 5.3.1: Wards facing additional stress on systems due increase in tourism

Adaptive capacity:

	Low	Medium	High
 Economic			
 Technological/ Infrastructural			
 Governance			
 Societal			
 Ecosystem services			

The tourism sector has been found to have low economic, technological/infrastructural, governance, and ecosystem services capacity. However, the societal capacity was found to be medium.

5.4 Vulnerability Hotspots

Many areas in the city are impacted by more than one fragile urban system. These areas relatively need more attention as they pose threat from multiple fragile urban systems. Such areas are called the vulnerability hotspots. Figure 5.4.1 identifies the vulnerability hotspots for Shimla city in terms of their degrees of vulnerability.

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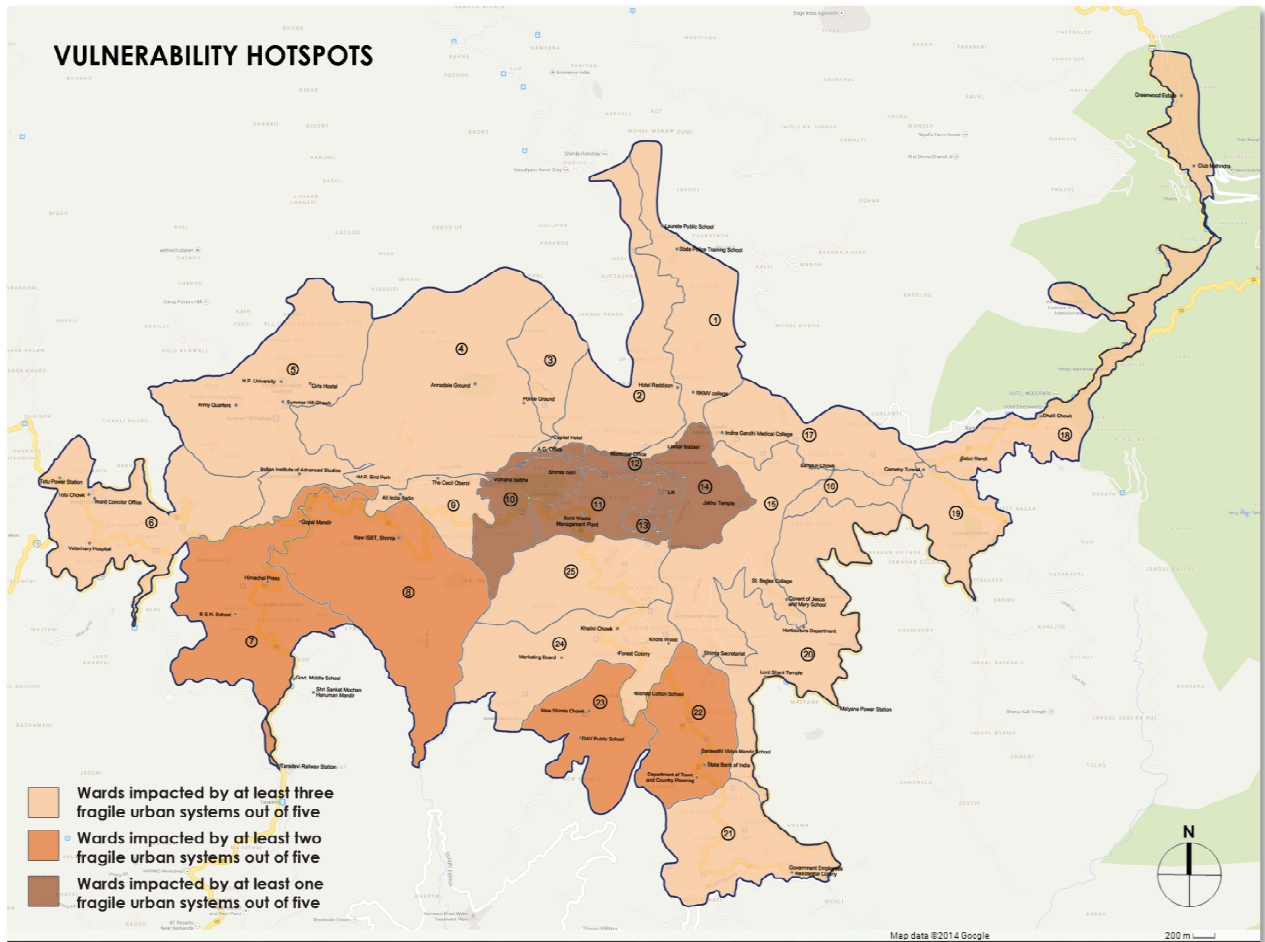


Figure 5.4.1: Vulnerability hotspots

It is interesting to note here that the highly vulnerable areas are the ones where the tourist influx is the maximum in the city (Mall road area). This floating population can be one of the reasons for the stressed resources in this area.

6 Resilience interventions

In the previous section the vulnerable areas affected by the four critical urban systems, and the vulnerable population groups have been identified. In order to minimize the impacts of changing climate on these systems the key relevant resilience interventions have been identified.

In this section the identified climate resilience actions have been evaluated in terms of their resilience (redundancy, flexibility/robustness, responsiveness/re-organisation, capacity to learn), feasibility (technical, political, cost), and benefits of the action (short term/medium term/long term). On the basis of these criteria their applicability for the city has been identified.

In total 30 resilience interventions have been identified for the three vulnerable sectors – water supply, transportation, and tourism.

Following table assesses the identified resilience interventions on the basis of the resilience indicators:

Table 5.4.1: Resilience Interventions assessed on the basis of resilience indicators

Urban System	Potential Climate Resilience Interventions	Redun-dancy	Flexibility/ Robustness	Responsiveness/ Reorganization	Capacity to learn
Water Supply	Multiplicity of command needs to be unified. E.g. IPH, MC and Electricity department (To be outsourced in PPP mode)	No	Yes	Yes	Yes
	Extensive early warning systems for increased precipitation	Yes	No	Yes	Yes
	Extensive patrolling of area to take immediate action on freezing of water pipes	No	No	Yes	No
	Developing and implementing rain water harvesting strategy	Yes	Yes	Yes	Yes
	Encourage recycling and conservation of water	Yes	Yes	Yes	Yes
	Channelization of existing nallahs and natural drainage system	No	Yes	Yes	No
	Construction of more public toilets with subsidised user charges	No	Yes	No	No
	Proper maintenance of sewerage lines - connectivity of the missing links	No	Yes	Yes	No
	Septage and STP's Sludge management	No	Yes	Yes	No
	Decentralized wastewater treatment options	Yes	Yes	Yes	Yes
	Ferro cement water storage tanks for households/ clusters	No	Yes	Yes	No
	Use of composite pipes instead of conventional galvanised iron pipes	No	Yes	Yes	No

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Urban System	Potential Climate Resilience Interventions	Redun- dancy	Flexibility/ Robustness	Responsiveness/ Reorganization	Capacity to learn
	Reviving traditional water sources	Yes	Yes	Yes	Yes
Transport	Implementation of the city mobility plan	Yes	Yes	Yes	Yes
	Urban planning to keep important buildings which attract traffic in outskirts	No	Yes	Yes	Yes
	Preparation and implementation of by-laws for road usage/ regulation	No	Yes	Yes	Yes
	Integration of existing bus service with regional bus service and HRTC taxi service	No	Yes	Yes	Yes
	Parking provisions in new construction/ new Parking provisions/ Byelaws on Hotel's parking provisions	Yes	Yes	Yes	Yes
	Augmentation of existing public transport - bus service	Yes	Yes	Yes	No
	Mass transport systems to be developed – buses, trains, rope rail, escalators	Yes	Yes	Yes	Yes
	Snow clearance/ cutters on road	No	Yes	Yes	No
	Development of anti-skid pathways	No	No	Yes	No
	Tourism	Development of legal provisions and their strict implementation	No	No	Yes
Preparation and implementation of bye laws on tourism to address water shortage, traffic congestion		Yes	Yes	Yes	Yes
Green tax for cars from outside Himachal Pradesh		No	No	Yes	Yes
Construction of trams, mini deluxe buses (Dhali to regal building, Secretariat to lift, Advanced studies institute to CTO)		Yes	Yes	Yes	Yes
Construction of more lifts and escalators (Old ISBT to DC office)		Yes	Yes	Yes	Yes
Construction of sky buses (on the circular road linked to mall road through flyover)		Yes	Yes	Yes	Yes
Construction of multi storied parking		Yes	Yes	Yes	Yes
Urban forestry Initiatives to be undertaken		No	No	Yes	No

These interventions have further been assessed on the basis of feasibility indicators and long/medium and short term impact. A combination of these assessments helps in

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determining the applicability of the interventions as high/medium/low. 23 Interventions have been categorized as highly applicable measures for the city of Shimla.

Table 5.4.2: Applicability of the resilience interventions

Urban Systems	Potential Climate Resilience Interventions	Feasibility			Impact Short/ medium/ long term	Applicability High/ medium/ low
		Technical	Political	Cost		
Water Supply	Rain water harvesting strategy for the city	High	High	High	Short	High
	Reviving traditional water sources	High	High	High	Long	High
	Extensive early warning systems for increased precipitation	High	High	High	Short	High
	Use of composite pipes instead of conventional galvanised iron pipes	High	High	High	Med-long	High
	Extensive patrolling of area to take immediate action on water freezing	High	High	High	Short	High
	Multiplicity of command needs to be unified. E.g. IPH, MC and Electricity department	High	Medium	High	Long	High
	Ferro cement water storage tanks for households/ clusters	High	High	High	Short	High
	Channelization of existing nallahs and natural drainage system	High	High	Med-low	Long	High
	Proper maintenance of sewerage line- Connectivity of the missing links	High	High	Medium	Long	High
	Septage and STP's Sludge management	Medium	High	Medium	Long	High
	Construction of more public toilets and subsidising user charges	High	High	Medium	Short	High
	Decentralized wastewater treatment options	High	High	Medium	Long	High
	Encourage recycling and conservation of water	High	High	High	Med-long	High
Transport	Implementation of the city mobility plan	High	High	Low	Long	High
	Mass transport systems to be developed – buses, trains, rope rail, escalators	High	High	Medium	Medium	High
	Integration of existing bus service with regional bus service	High	High	High	Short	High

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Urban Systems	Potential Climate Resilience Interventions	Feasibility			Impact	Applicability
		Technical	Political	Cost	Short/ medium/ long term	High/ medium/ low
	and HRTC taxi service					
	Augmentation of existing public transport - bus service	High	High	Medium	Short	Medium
	Preparation and implementation of by-laws for road usage/ regulation	High	Medium	High	Medium	High
	Parking provisions in new construction/ new Parking provisions/ Byelaws on Hotel's parking provisions	High	High	Low	Long	High
	Snow clearance/ cutters on road	High	High	High	Short	High
	Development of anti-skid pathways	High	High	Low	Medium	Medium
	Urban planning to keep important buildings which attract traffic in outskirts	High	Medium	Low	Medium	Medium
Tourism	Development of legal provisions and their strict implementation	High	Medium	High	Long	High
	Construction of more lifts and escalators (Old ISBT to DC office)	High	High	Medium	Long	High
	Green tax for cars from outside Himachal Pradesh	High	High	High	Long	High
	Construction of trams, mini deluxe buses (Dhalli to regal building, Secretariat to lift, Advanced studies institute to CTO)	High	Medium	Low	Long	Medium
	Construction of sky buses (on the circular road linked to mall road through flyover)	High	Medium	Low	Long	Medium
	Construction of multi storied parking	High	Medium	Low	Long	Medium
	Preparation and implementation of bye laws on tourism to address water shortage, traffic congestion	High	Low	High	Long	High
	Urban forestry Initiatives to be undertaken	High	Medium	Low	Long	Medium

7 Conclusion

The City Resilience Strategy for Shimla Municipal Corporation, developed using the ICLEI ACCCRN Process, has helped to identify 2 major impacts of climate change –increase in precipitation and increase in temperature, that will be faced in future by the city of Shimla. The primary urban services, which will most severely face these climate impacts, are water supply services, transport and tourism as identified by the core team of the Shimla Municipal Corporation through the ICLEI ACCCRN Process. Notably, for these fragile urban systems, most of the concerns are due to increased precipitation, rather than for increased temperatures.

The process then went on to identify the different risks to these fragile urban systems due to the climate impacts and helped the core team to identify the most vulnerable areas likely to face these risks and the most vulnerable actors, as well as the adaptive capacity of the fragile systems. On the basis of these vulnerable urban systems, areas, and actors, resilience actions have been identified by the core team to counter the climate impacts on these systems.

The resilience strategies identified have been assessed in terms of their technical, political and financial feasibility and their impact potential. Apart from the structural strategies to counter the climate impacts of these fragile urban systems, the process also recognized the importance of developing and implementing plans for these urban services keeping in mind the possible future impacts. Another important aspect that evolved from the discussions of the core team members was the need for better coordination among different government agencies. Since some of the urban services are under the control of different government agencies (for instance, water supply is handled both by the Irrigation and Public Health Department and the Municipal Corporation), it is necessary for the different government bodies to coordinate their activities so as not to work at cross purposes. Stricter implementation of regulatory provisions for conservation of water, traffic control and tourism management could also help the municipal corporation to reduce the impacts of sudden disruption to services because of climate impacts.

A good number of government schemes are ongoing in the city of Shimla for development purpose, such as the JNNURM Schemes, Parking Project, City Sanitation Plan, and so on. The JnNURM scheme provides a huge amount of funds for the improvement of transport, drinking water supply system, sewerage system and promotion of tourism in the city. It is upto the city government to utilise the funds under these schemes to their best possible benefit, keeping in mind possible future impacts of climate change on their urban service

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Annex 1: Risk Assessment

A Risk Assessment is undertaken in order to identify high, medium and low risk impacts, prioritize them and therefore enable the prioritization of adaptation actions. For all the impacts/ vulnerabilities that have been identified a *likelihood* and *consequence* score needs to be collectively allocated.

Step 1: Refer to the 'Likelihood Rating and Scoring' table and assess the likelihood of occurrence of each of the impacts / vulnerabilities and assign the corresponding scores as indicated i.e. Almost certain = 5; Likely = 4 etc.

Likelihood Rating and Scoring

Likelihood rating	Description	Score
Almost certain	Could occur several times per year – likelihood probably greater than 50%	5
Likely	May arise once per year – 50/50 chance	4
Possible	May arise once in 10 years – probability less than 50% but still quite high	3
Unlikely	May arise once in 10 to 25 years - Unlikely but should still be considered – probability significantly greater than zero	2
Rare	Unlikely in foreseeable future – negligible probability	1

Step 2: Similarly, use the 'Consequence Rating & Scoring' table to assess the potential consequences of each of the identified impacts / vulnerabilities and assign the corresponding scores as indicated.

Consequence Rating and Scoring

Consequence Rating	Impact on System	Impact on City Government	Score
Catastrophic	System fails completely and is unable to deliver critical services, may lead to failure of other connected systems	Widespread loss of confidence and criticism in City Government for failing to manage the crisis situation adequately	5
Major	Serious impact on the system's ability to deliver critical services, however not complete system failure	Loss of confidence and criticism in City Government, ability to achieve City vision and mission seriously affected	4
Moderate	System experiences significant problems, but still able to deliver some degree of service	City Government's reputation may be affected, possibly some political implications	3
Minor	Some minor problems experienced, reducing effective service delivery, possibly affecting certain other systems or groups	Minor impact on City Government's reputation, no major problems with achieving vision and mission	2
Insignificant	Minimal impact on system –	Minimal impact on	1

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	may require some review or repair, but still able to function	reputation of City Government, may present opportunity to review and improve system	
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Step 3: Having assigned a 'Likelihood' and 'Consequence' score to each of the identified fragile systems, now **multiply** both these values to arrive at the 'Risk Score' for each of the identified impacts / vulnerabilities.

Step 4: Finally, for each of the impacts / vulnerabilities, assess their 'Risk Status' based on their respective Risk Scores. Please refer to the 'Summary of Risk Matrix' for assessing the risk status.

Summary of a Risk Matrix

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Medium (RS* = 5)	Medium (RS = 10)	High (RS = 15)	Extreme (RS = 20)	Extreme (RS = 25)
Likely	Low (RS = 4)	Medium (RS = 8)	High (RS = 12)	High (RS = 16)	Extreme (RS = 20)
Possible	Low (RS = 3)	Medium (RS = 6)	Medium (RS = 9)	High (RS = 12)	High (RS = 15)
Unlikely	Low (RS = 2)	Low (RS = 4)	Medium (RS = 6)	Medium (RS = 8)	Medium (RS = 10)
Rare	Low (RS = 1)	Low (RS = 2)	Low (RS = 2)	Low (RS = 4)	Medium (RS = 5)

Step 5: List all the 'Extreme' and 'High' risk impacts (in some cases where there may not be 'high' risk impacts, 'medium' risk impacts can also be considered).

It is suggested that the risk assessment exercise is undertaken group wise and then discussed collectively to ensure maximum participation and a collective agreement on the prioritization of the impacts based on perceived risks.

Annex 2: Analysis of Vulnerable Areas & Urban Actors

Mapping Vulnerable Areas

In this exercise, the vulnerable areas of each of the *impacts/ vulnerabilities* in the city are identified. This can be done using hard copies of the city ward map and different colors representing different impacts. This will help having a fair idea of the wards/ areas where the identified impacts are most critical.

Further the steps below may be followed for guidance

Step 1: Select the impacts which have been identified to have extreme or high risk in the risk assessment carried out earlier. Assign a colour to each of the impacts.

Step 2: Next, for each of the impact, identify the area/ward of your city that has been impacted the most. Mark the area/ward affected by the on the map with the help of the colour assigned to it.

Step 3: Repeat step 3 for each impact on separate maps.

Step 4: Overlay the wards/areas of your city on a single map. E.g. assume that the city has identified 5 key impacts and the areas affected by them. Overlay all these areas to identify the wards/ areas affected by the maximum number of 'impacts'. The areas that are affected by the highest number of impacts would be the '*vulnerability hotspots*' in the city.

Urban Actor Analysis

This exercise is to identify the specific key actors in the identified vulnerable area. In the above exercise we have identified the vulnerable areas/wards for each of the impacts identified. Here for each of the identified impacts and respective vulnerable ward we identify the specific key actors.

The Actors analysis can be used to identify:

1. How different classes of actors relate to different systems (who, what, where, why)
2. What categories of actors may be missing

Groups of actors that may be disempowered, lacking in capacities or otherwise marginalized

Please follow the steps below to complete the Exercise 2.

Step 1: For each the impacts, note the key actors involved – those affected by, and those who have control over, the system. Refer to the broad categories of actors mentioned above, but be specific in terms of the actors themselves e.g. in the case of Government actors it should be Department of Water Resources / Environment / Transport, as may be appropriate.

Step 2: Rate the actors against the criteria of Capacity to Respond, Resources, and Access to Information based on the scoring mentioned in the Actors' Capacities Rating and Scoring table below. For each of the criteria you need to determine whether the capacity of a particular actor is – Low, Medium or High, and accordingly assign the corresponding score as indicated in the table.

Actors' Capacities Rating and Scoring

Key Capacities of Actors	Score
Responsiveness	
Low capacity to organize and re-organize in response to threat or disruption	1
Medium capacity to organize and re-organize in response to threat or disruption	2
High capacity to organize and re-organize in response to threat or disruption	3
Resourcefulness	
Low capacity to identify and anticipate problems, establish priorities and mobilize resources for action	1
Medium capacity to identify and anticipate problems, establish priorities and mobilize resources for action	2
High capacity to identify and anticipate problems, establish priorities and mobilize resources for action	3
Capacity to Learn	
Low capacity to avoid repeated failures, and innovate to improve performance	1
Medium capacity to avoid repeated failures, and innovate to improve performance	2
High capacity to avoid repeated failures, and innovate to improve performance	3

Step 3: Finally, for each actor (for a particular fragile system) arrive at their 'Adaptive Capacity Score' by multiplying the scores allocated to each characteristic.

Step 4: Based on the Adaptive Capacity Scores of each of the actors, for a particular impact, you can determine which actors have a High, Medium and Low resilience. Refer to the *Levels of Adaptive Capacity* table to help assess the adaptive capacity of each of the actors.

Example: Levels of Adaptive Capacity

Resilience Score	Level of Resilience
1 – 3	Low
4 – 8	Medium
9 – 27	High

Actors having a '**Low**' level of adaptive capacity would be those that would need to be **specifically targeted** in the actions (or resilience strategies) that are undertaken to reduce the fragility of the identified urban system.

Actors with a '**High**' level of adaptive capacity can be engaged in the proposed actions as they have the capacity to effectively respond to the impacts of the fragile systems. Similarly, those falling in the '**Medium**' category can also be engaged in the proposed actions as they some capacities to respond.