CITY RESILIENCE

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सत्यमेव जयते

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MULTI-HAZARD DISASTER RISK & RESILIENCE

SRINAGAR CITY

IIT Indore
Indian Institute of Technology Indore

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Resilient India - Disaster Free India

सत्यमेव जयते

MULTI-HAZARD DISASTER RISK AND RESILIENCE FOR

SRINAGAR CITY

nidm

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National Institute of Disaster Management

(Ministry of Home Affairs, Government of India)

Multi-Hazard Disaster Risk and Resilience for Srinagar City

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FOREWORD

Resilient India - Disaster Free India

सत्यमेव जयते

RAJENDRA RATNOO
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Disasters are highly unpredictable and instantaneous in nature and thus demand an immediate action. India has adopted a strategic approach towards disaster management which is focused on preparedness and mitigation so the rising numbers of disasters can be brought down significantly.

A significant reduction in losses and damages due to disasters in the country has been achieved with the enactment of the Disaster Management Act, 2005 and the implementation of the National Disaster Management Policy, 2009 and National Disaster Management Plan, 2016.

A study on "Disaster Risk and Resilience in States and Union Territories – An Analytical Study" was conducted in 2019 which analyzed and measured the disaster risk and resilience level of the States/UTs of India. This report on "Multi-hazard Risk and Resilience for Srinagar city" is a part of a broader study titled "Multi-hazard Disaster Risk & Resilience: Practical Learning and Step-by-Step Guide to Improve Disaster Resilience at City Levels". This report is a propagation of the aforementioned study to the next step i.e. at the level of cities and particularly for Srinagar city in Jammu and Kashmir. This study has been conducted by the Indian Institute of Technology, Indore, Madhya Pradesh under the aegis of National Institute of Disaster Management, Ministry of Home Affairs, Government of India in order to improve the overall resilience level of the cities/urban local bodies towards disaster risks.

The impacts and effects of disaster are more immediate and intense at the level of the cities/urban local bodies. This study is dedicated to evaluate the risk and resilience indices for the hazards specific to the city of Srinagar. Hence this study will prove to be remarkable in providing a more localized approach to the Srinagar city for understanding internal disaster risks and improving their preparedness and resilience thereby making them a self-sufficient paragon to deal with disasters.

(Rajendra Ratnoo)

PREFACE

Prof. Anil Kumar Gupta

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It's a matter of immense pleasure for me to present this study for "Multi-hazard Disaster Risk & Resilience for Srinagar City" developed in collaboration with Indian Institute of Technology, Indore as a part of the broader study on "Multi-hazard Disaster Risk & Resilience: Practical Learning and Step-by-Step Guide to Improve Disaster Resilience at City Levels". This report presents a scorecard to measure the level of disaster risks and resilience for the Srinagar city and has also been conducted as a pilot for three more cities of India viz. Guwahati, Vishakhapatnam and Jaipur representing a diverse range of geophysical characteristics. I strongly believe that this study is going to assist various line department officials in taking well-informed and precise decisions in case of the emergence of a disaster.

Climate-related extremes have more pronounced effects in cities because of the more complex urban infrastructure systems, rapid increase in urban populations and intensive economic activities. Cities are currently facing an over-burden due to the increased migration and thus are becoming sensitive and vulnerable to disasters and even unanticipated incidents like the sudden heat wave intensification in the United Kingdom in 2022. Thus, the cities specifically should be more and more focused on increasing their understanding of localized risks and developing resilience. A bottom-up approach may prove to be exceptional wherein the resilience at city levels can altogether build resilience at state and national levels.

This study is very detailed and is in the form of seven reports viz. a technical report which encompasses the development of risk and resilience scorecard for all four cities, four city-specific technical reports, a step-by-step disaster management guide to improve disaster resilience of Indian cities and a mayor's handbook. This particular report highlights the hazards and risks specific to the Srinagar city and its level of resilience in the form of preparedness and capacity building.

(Anil K Gupta)

ACKNOWLEDGEMENT

This study on “Multi-hazard Disaster Risk & Resilience: Practical Learning and Step-by-Step Guide to Improve Disaster Resilience at City Levels” has been carried out with a collaborative effort from the National Institute of Disaster Management (NIDM), New Delhi and the Indian Institute of Technology (IIT), Indore research teams.

Special thanks to the government authorities from the four cities i.e., Guwahati, Jaipur, Srinagar, and Visakhapatnam for providing valuable suggestions, feedback, and timely response for the required datasets in preparing disaster scorecards for risk and resilience of the selected cities.

The project team is grateful to Major General Manoj Kumar Bindal, then Executive Director, and also to Shri Taj Hassan, present Executive Director NIDM for their constant support and encouragement in performing this study and ensuring the effective functioning of the project. A number of consultation workshops were hosted which saw participation and suggestions from regional experts, scientific community, government organizations, and National Disaster Response Force (NDRF).

The support received from Shri Ghulam Hassan Mir, Shri Aamir Ali Khan, Dr. Vikash Sharma, Dr. Nitin Joshi, Dr. Pervez Ahmed, Mr. Aashiq Hussain and many more, for developing a consensus on the methodology and outcomes of the study, during assessment of risk and resilience for Srinagar city, is highly appreciable.

The contribution of principal investigator Professor Manish Kumar Goyal and his research team comprising Dr. Vikas Poonia (Former Research Scholar, IIT Indore), Mr. Vijay Jain, Mr. Shivukumar Rakkasagi, Mr. Shivam Singh and Mr. Kuldeep Singh Rautela (Research Scholars, IIT Indore) are acknowledged for joining hands with us in completion of this study for providing a technical assessment of natural and man-made hazards in the cities through collected data and in a compilation of the report. The study was supported with continuous support of the team from NIDM comprising of Dr. Kopal Verma (also acknowledged for the special efforts in designing the report), Dr. Uzma Parveen, Ms. Fatima Binte Amin, and Mr. Michael Islary for their overall coordination with all the cities authorities and collection of the datasets. The project team extends thanks to the library and the entire publication cell of NIDM for their support and publication of this report.

(Anil K Gupta)

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LIST OF ABBREVIATIONS

BPL	Below Poverty Line
BMTPC	Building Materials and Technology Promotion Council
CAW	Crime Against Women
CDRI	Composite Disaster Risk Index
CEPI	Comprehensive Environmental Pollution Index
CGWB	Central Ground Water Board
DM	Disaster Management
DRI	Disaster Risk Index
DRR	Disaster Risk Reduction
DRS	Disaster Resilience Score
FSI	Forest Survey of India
IMD	India Meteorological Department
IMR	Infant Mortality Rate
MAH	Maximum Accident Hazard
MDP	Master Development Plan
MHA	Ministry of Home Affairs
MHI	Maximum Hazard Industries
MoHUA	Ministry of Housing and Urban Affairs
MoUD	Ministry of Urban Development
MMR	Maternal Mortality Rate
MPIs	Maximum Polluting Industries
MSMEs	Micro, Small and Medium Enterprises
NCRB	National Crime Records Bureau
NDRF	National Disaster Response Force
NOAA	National Oceanic and Atmospheric Administration
OGD	Open Government Data

LIST OF ABBREVIATIONS

ORGI	Office of the Registrar General & Census Commissioner, India
OSM	Open Street Map
SDGs	Sustainable Development Goals
SEZs	Special Economic Zones
SFDRR	Sendai Framework for Disaster Risk Reduction
SPI	Standardized Precipitation Index
SSI	Standardized Soil Moisture Index
ULBs	Urban Local Bodies
UNDP	United Nations Development Programme
WHH	Women Headed Household

EXECUTIVE SUMMARY

India has taken a significant step towards developing an effective Disaster Management (DM) system, such as the endorsement of the DM Act 2005, the formulation of the National Policy on DM 2009, the publication of guidelines and the implementation of plans at the District, State and National level. Disaster Risk Reduction (DRR) refers to a policy goal or objective and the strategic & operational measures used to reduce exposure, hazard or vulnerability and improve resilience. The Sendai Framework for DRR (2015-2030), was the first key agreement of the post - 2015 development agenda and provided distinct actions to defend from disaster risk. Also, the United Nations Sustainable Development Goals (SDGs) contribute in reducing disaster risks and building resilience by endorsing education for sustainable development, such as SDG 4 (ensure inclusive and equitable quality education and promote lifelong learning opportunities for all), SDG 9 (Support domestic technology development, research and innovation in developing countries) and SDG 11 (Sustainable cities and communities). The establishment of the National Disaster Response Force (NDRF) in 2006, achieved vital milestones on the journey towards the country's DRR. Urban areas act as facilitators of economic growth, as they contribute significantly to the country's income, employment creation and productivity (GDP).

The city administrations in urban areas continue to lag in disaster risk reduction and have inadequate disaster management mechanisms, causing people's substandard quality of life. Therefore, the Government of India launched the 'Smart Cities Mission' in 2015 and selected 100 cities to accelerate financial growth and improve the living conditions of citizens through comprehensive work on social, economic and institutional pillars of the city. Srinagar city is one of the Smart Cities, which aims to leverage the city's heritage & tourism and improve the citizens' quality of life, with modern technology-based practices and inclusive solutions.

An increase in population and urban expansion intensifies vulnerability to disaster events for the population of disabled, children, below poverty line, etc. during the disasters. Srinagar is the 32nd most populous city in India, with a population of around 1.24 million as per 2011 census record and is spread over an approximate area of 232.35 sq. km., with population density of 5337 persons per sq. km. Taking into consideration, the increasing urban population and haphazard encroachment in the vicinity of water bodies. However, the city is susceptible to natural and man-made disasters such as Flood, Coastal Erosion, Heat Wave, Fire Accident etc.

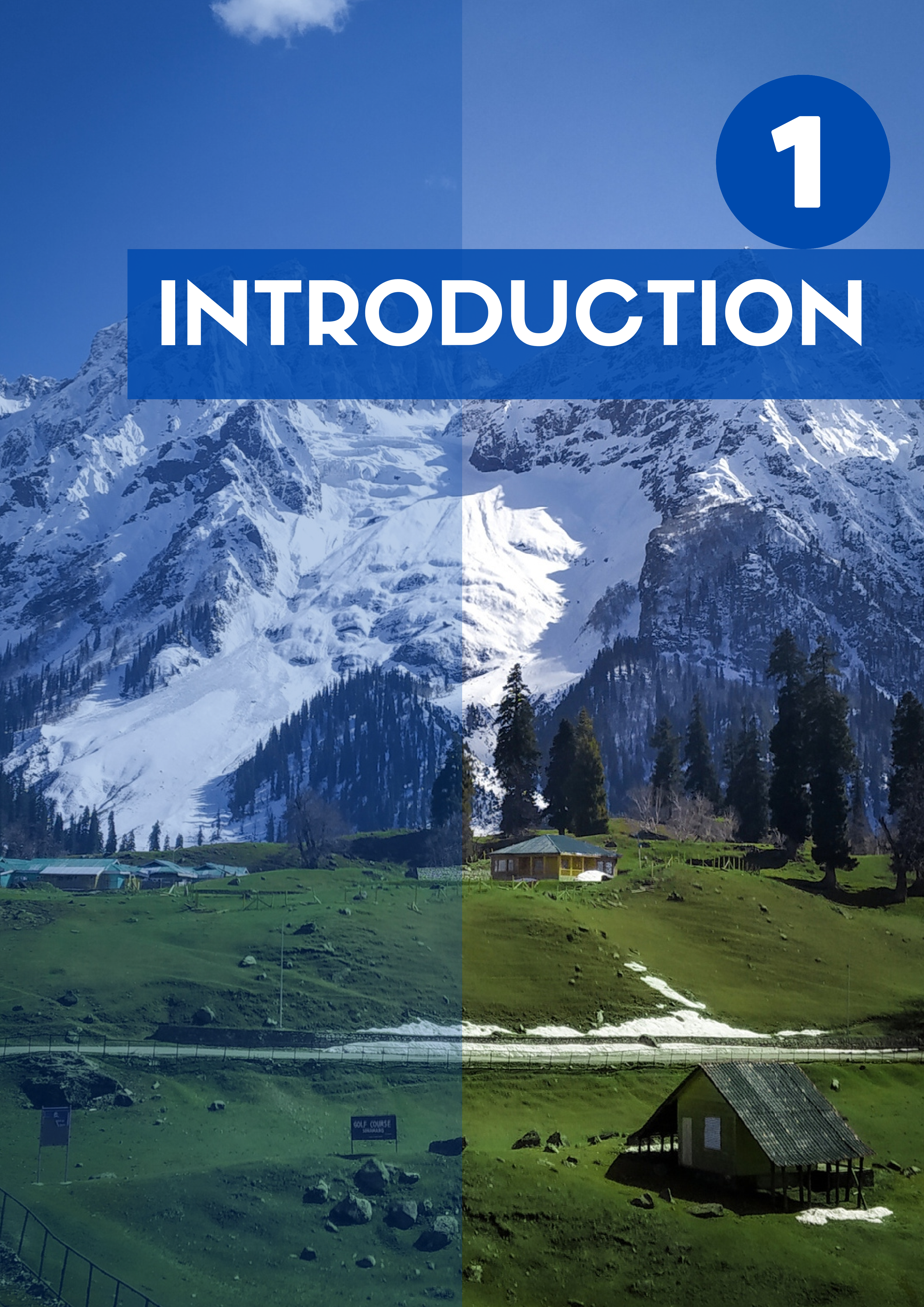
The city is classified as seismic disturbance Zone-V, making it more vulnerable to earthquakes. This adds more risk to the region which is prone for landslide and snow-avalanche hazards. Therefore, there is an immediate requirement for assessing the city's disaster risk and resilience and based on it, implement the disaster management plan.

In this study, hazard, vulnerability and exposure indices for Srinagar city have been computed using several indicators (as per the MHA-UNDP 2019 report). The study showed that Srinagar city is more prone to Earthquake, Cold Wave, Urban Floods, Heat Wave and Drought followed by Industrial hazard, Avalanche and Fire.

Similarly, Srinagar city is more vulnerable to disasters in terms of depletion of forest cover, Livestock, Elderly People, and Water Stress followed by Women, Social and Physical infrastructure, Children, Poverty, Unsafe buildings, Disabled Population, and Industries. The study also revealed that the population of Srinagar has a high hazard specific exposure index for natural disasters like Earthquake, Cold Waves, and Floods, that may lead to an economic loss for the city. This research can be expanded to other cities in India. The risk and resilience indices will aid in evaluating disaster risks at the city level and can play an essential role for their disaster resilience.

1

INTRODUCTION



In a rapidly urbanizing world, It is estimated that by 2050, two-thirds of the world's population will reside in cities and every year for the next 30 years, about 70 million people will relocate to cities(CDP, 2022). The interactions between rapid urbanization, changes in land use, vulnerable and exposed population, will enhance the future climate change risks and associated impacts on cities (IPCC, 2022). Rapid urbanization intensifies the human induced warning, climate change and extreme events, like severe heatwaves, heavy precipitation, etc. For example, flooding will become more likely in coastal cities due to the rise in the sea level and the more frequent occurrence of extreme rainfall events (IPCC, 2021).

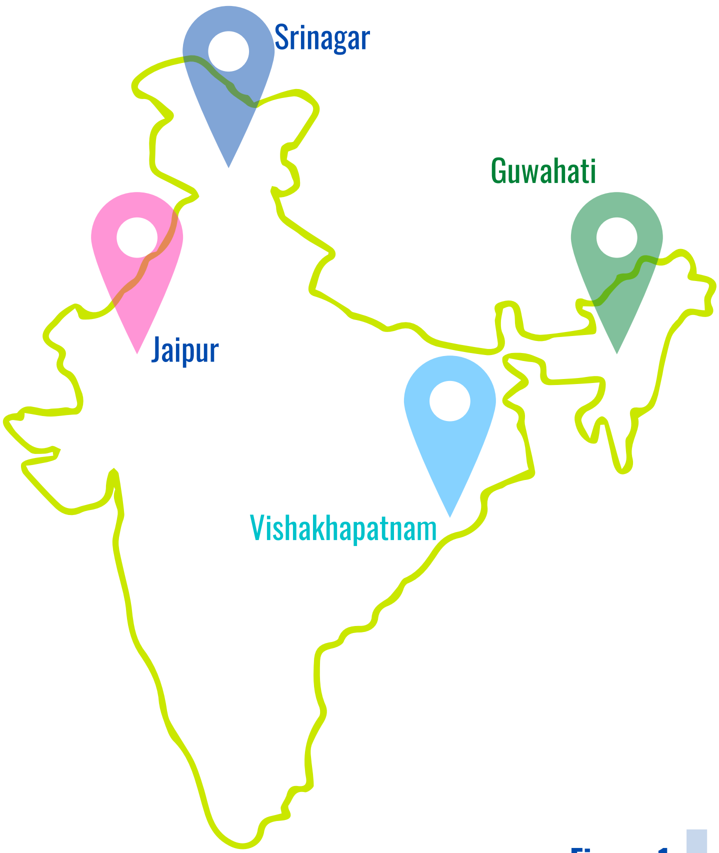


Figure 1

Selected cities for the study: Guwahati, Jaipur, Srinagar, and Visakhapatnam

An increase in population and urban expansion intensifies vulnerability to disaster events and a lack of basic amenities; the population below the poverty line is highly vulnerable during disasters (ESCAP, 2021). Climate change is becoming more closely associated with urban issues, since it is anticipated to increase the hazards of underdeveloped infrastructure and resource - deficient urban areas (Gupta et al., 2019). The pillars of making any city robust to a changing environment, are disaster risk reduction and climate change adaptation (WMO Report, 2022). The use of indigenous knowledge, alongside scientific understanding in disaster risk reduction (DRR), is becoming increasingly popular to lessen community susceptibility to environmental risks (UNICEF, 2022).

The public-private involvement, strong governance and institutional framework, including disaster resilience, adaptability, environment and sustainability are crucial. The necessary step-change in urban risk management, may be realized by combined action through these technological and developmental frameworks, i.e., the Sendai Framework for Disaster Risk Reduction (SFDRR) and Sustainable Development Goals (SDGs) (consisting of Goal 11 of making the cities and human settlements inclusive, safe, resilient and sustainable), (Stanton-Geddes & Vun, 2019).

The cumulative consequences of different programmes may be seen in sophisticated early warning systems, coordinated responses to disasters and approaching disasters, dramatic reductions in disaster fatalities and a general improvement in disaster awareness at all levels, such as national, state and district levels.

The consequences are less noticeable in city-level disaster risk assessment, risk prevention & mitigation and disaster risk reduction mainstreaming across multiple development sectors (NDMA, 2019). Therefore, a critical evaluation of risk and resilience is required with an assessment and technical capacity development by Urban Local Bodies (ULBs) (Jain & Bashir Bazaz, 2016).

In India's federal system of governance, state governments are primarily responsible for disaster management, with the central government playing a supporting role. The regional and local governments frequently deal with disasters, but there is a lack of scientific studies and tools availability for benchmarking the performance or assessing the progress of cities during various phases of disaster management (NDMA, 2019). The cities selected for the study, i.e., Guwahati, Jaipur, Srinagar and Visakhapatnam, in this project are part of the 'Smart Cities Mission' of India which was launched in 2015(MoHUA, 2022).

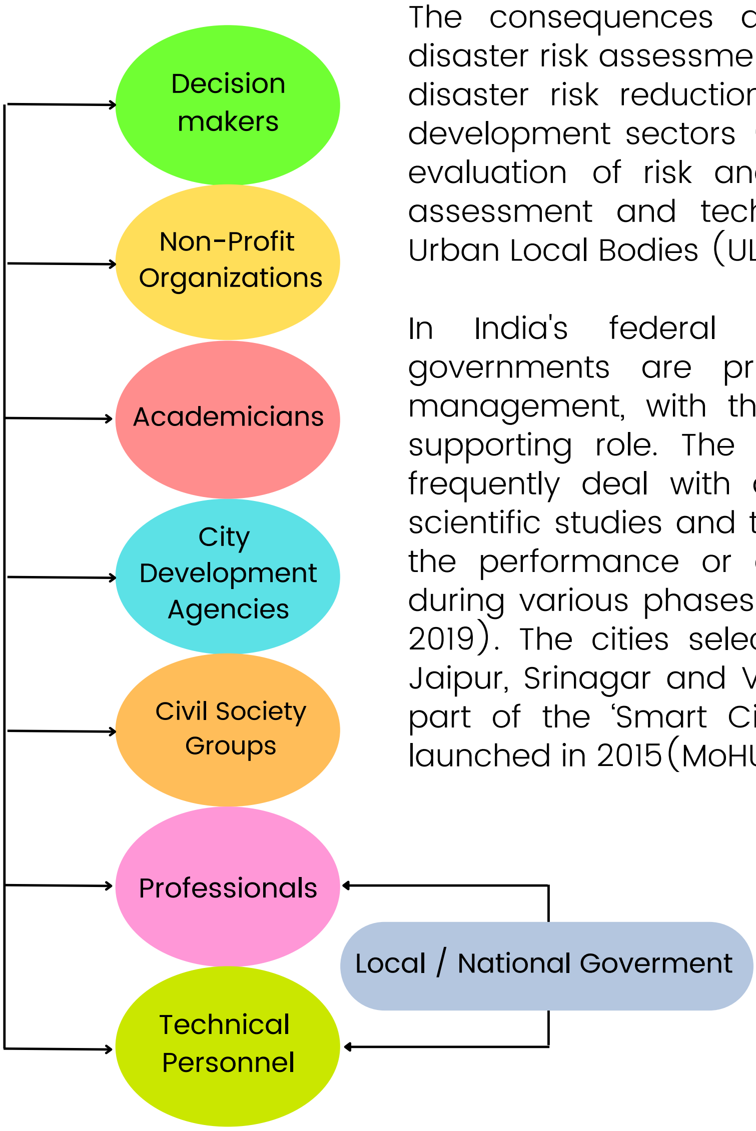


Figure 2

Technical Report's primary audience

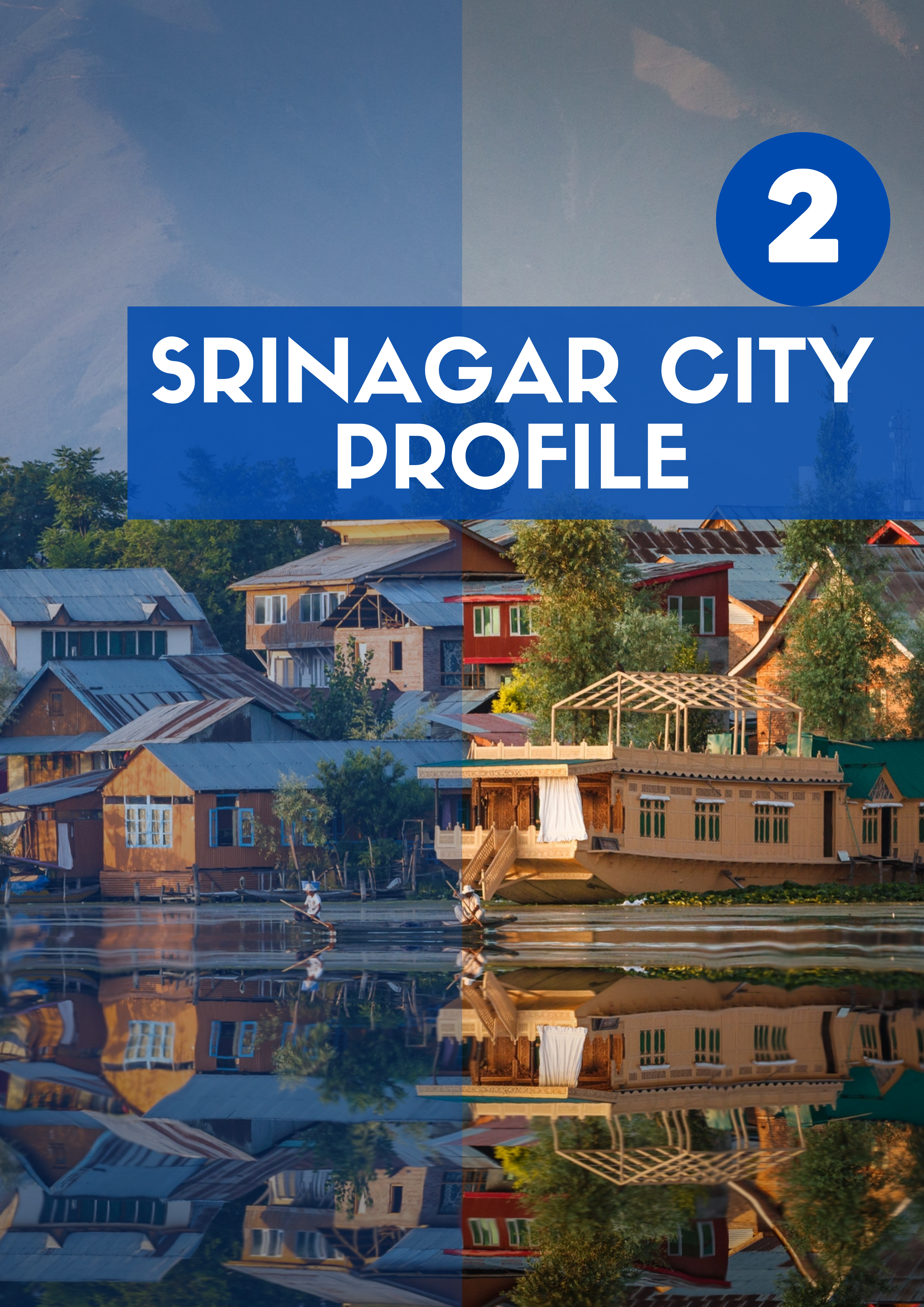
The project aims to understand the perceptions & contexts for city risk resilience and provides helpful guidance to city administrators & policy makers, on actions required to form resilience to disasters. The 4 Indian cities of the study, exhibit a broad range of geographical variances in terms of climate, terrain, vegetation, hydrology and habitation pattern, creating a patchwork of practically every natural hazard.

As India is yet to build a solid and robust database of hazards, vulnerabilities, risks and resilience, the 'model' theoretical framework on indicators, is greatly hampered by lack of data at the city level, to monitor indicators' progress.

Thus, to make Srinagar city resilient, the regional population should react to disasters with the logic of urgency and strategically reduce human, land/property and ecological loss by evolving a complete, practical, multi-disaster and technology-focused approach for Disaster Management (DM). Therefore, this is the first study of its kind at the city level, on multi-hazard disaster risk & resilience to develop a risk and resilience scorecard. This study can be extended to other cities in India to evaluate the disaster risks and to plan for disaster resilience. This Technical Report's primary audience consists of decision-makers, professionals and technical personnel from local to national governments, city development agencies, non-profit organizations and civil society groups. The report is also essential to academicians and various other stakeholders for further research.

2

SRINAGAR CITY PROFILE



Srinagar, the summer capital of Jammu and Kashmir union territory (UT), is geographically located in the center of the Valley of Kashmir, at an altitude of 1585 m above the mean sea level, with latitude and longitude coordinates of 34.08 N and 74.79 E respectively, as shown in Figure 1,(Tokyo Climate Center (WMO), 2022). The name of the city has been interpreted by scholars as, 'Surya Nagar': the city of Sun, 'Shri Nagar'; the city of Goddess Lakshmi (M. S. Khan, 2011), and 'The land of Kashyap' (Gariyali, 2021). The city is one of the prime tourist centers in India and is famous for its picturesque sites, sweet water lakes, pleasant gardens, mountains views and tourist places(Dalrymple, 2008). It lies in the Kashmir Valley on the banks of the river Jhelum (Vyeth & Vitasta), a tributary of the Dal, Indus and Aanchar lakes (Dalrymple, 2008). Srinagar was the 32nd most populous cities of India, with population of around 1.24 million as per 2011 census records and is spread over an area of 232.35 sq. km., with population density of 5337 persons per sq. km(District Srinagar, 2022). The city has a comparatively lower average literacy rate of 70% and sex ratio of 888 compared to the national literacy rate of 74.04% and sex ratio of 940 (Census of India, 2011b 2011a).

Srinagar has a humid subtropical climate and it experiences longer, warmer and clearer summers and shorter, colder and cloudy winters(IMD, 2015). The average daily mean temperature of the city has been observed 5.07°C and 21.7°C, with average minimum and maximum temperatures of -4.35°C and 32.9°C in winters and summers respectively (IMD, 2015, 2016). The city experiences on average 720 mm of rainfall annually (IMD, 2016).

Srinagar smart city project got approval to transform the city into an ecofriendly, disaster resilient and socio-economically vibrant city by the Ministry of Urban Development in round 3 challenge held in 2017. The Srinagar Municipal Corporation is actively working in the field to ensure scientific solid waste management for the city. The average per capita waste generation is about 0.4- 0.6 kg, out of which 30 50% of waste is biodegradable (District Srinagar: Official Website, 2022). The city has gained remarkable boost from 357th (2019) to 36th rank (2020) under Swachh Survekshan 2020, however, it slipped slightly to 50th rank in 2021(ANI, 2021; Excelsior, 2020). It has also ranked 12th in 'Safai Mitra Suraksha Challenge'(Excelsior, 2020). Due to certain regional instability, it has been ranked last in 'The Ease of Living Index' in the list of 49 cities in 2020 (Hindustan Times, 2021). In 2019, then J&K State stood 21st among 36 states and UTs in the 'Ease of Doing Business' index (People, 2020). In spite of comparatively poor performances in Ease of Living and Ease of Doing Business indices, the city attracts large numbers of national and international tourists, for its natural environment, gardens, waterfronts and houseboats. The city is also globally famous for its' traditional Kashmiri handicrafts and dried fruits.

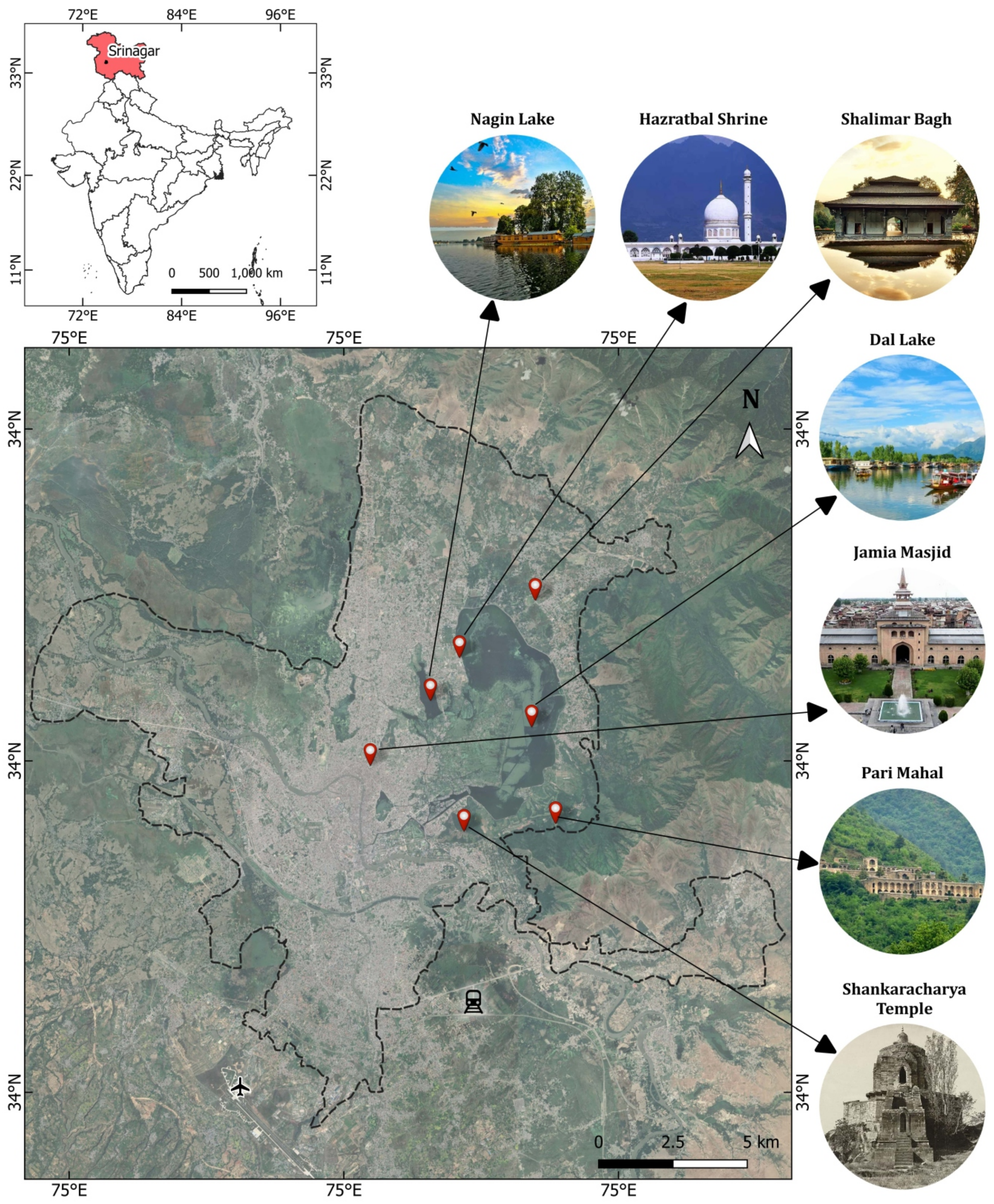


Figure 3
Location map of Srinagar city

Population

1.24 million

Population Density

5337 person per sq.km

Annual Growth Rate

1.76%

Safai Mitra Suraksha Challenge

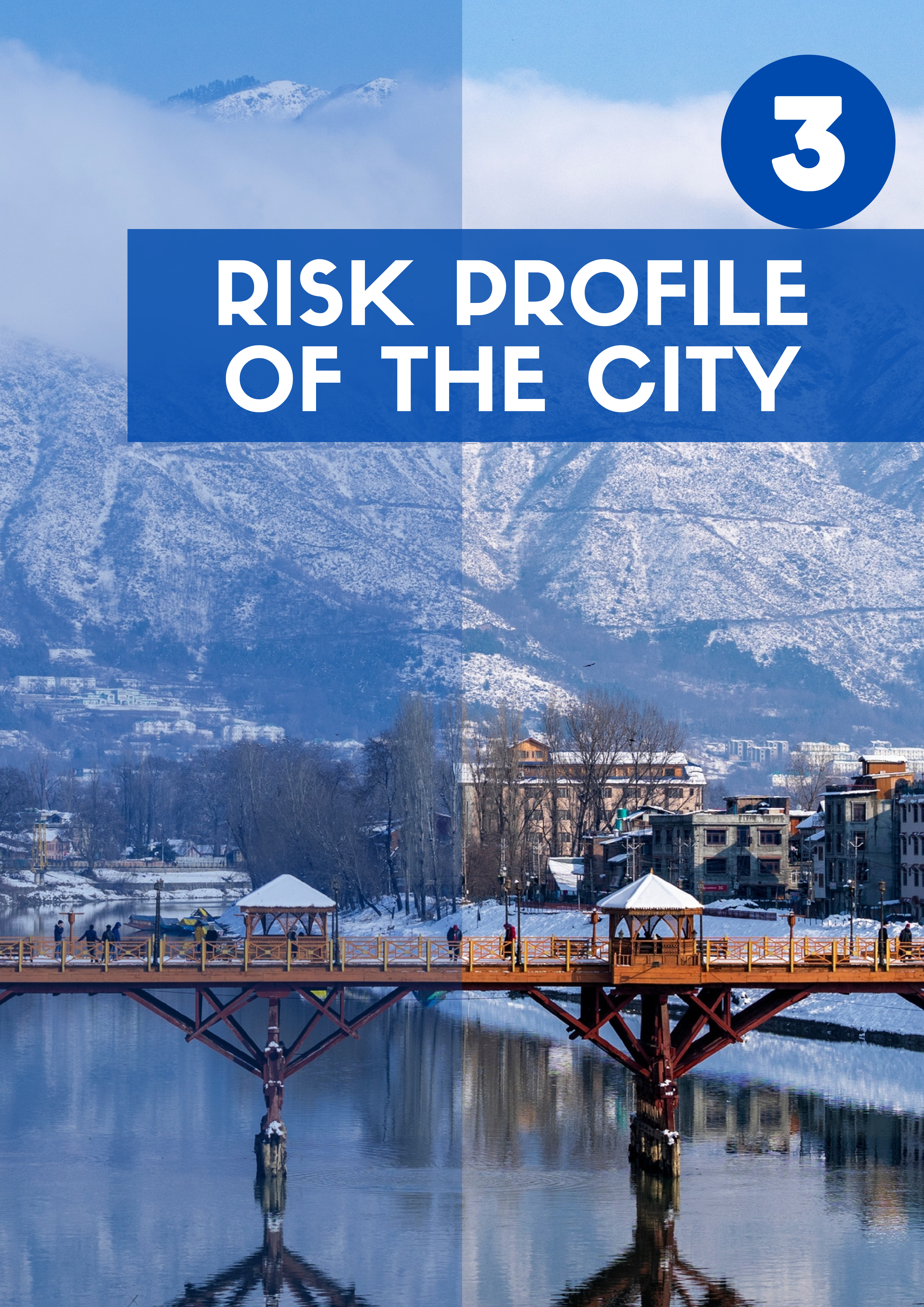
Rank 12

Smart Cities Mission (Round 4)

Rank 10

3

RISK PROFILE OF THE CITY



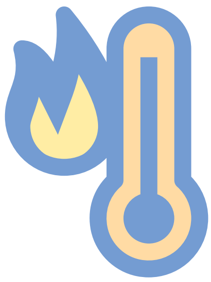
The risk profile and disasters triggered in the past in Srinagar city are as follows:

According to a seismic zoning map, issued by the Bureau of Indian Standards (BIS), Srinagar city lies in the very severe intensity zone or zone V, the highest risk earthquake zone (India Spend, 2015). The city has experienced many earthquakes in the past. Some of the recent earthquakes are, earthquake hitting the city with 4.8 magnitude (Richter scale) on Dec 27, 2021(NDTV, 2021), 5.7 magnitude on Feb 5, 2022 (Times of India, 2022) and 5.2 magnitude on Mar 17, 2022(The Print, 2022).

Srinagar city is one of the most susceptible locations in India to landslide hazards(Martha et al., 2021). Jammu-Srinagar national highway (NH-44) experiences frequent blocking in the monsoon and winter seasons, due to landslides (Fayaz & Khader, 2020). Extreme rainfall has led to landslides on many occasions in the region (Kumar 2017). Some recent incidents of landslides, noticed in the city this year are, landslide hitting NH 44 on June 17, 2022, (NDTV, 2022a), June 22, 2022, (The Statesman, 2022) and July 21, 2022, (NDTV, 2022b).

The roadways infrastructure of the city also experiences snow avalanches, which results in the loss of lives and properties and blocking of roadways. These kinds of disasters paralyze the life of the communities living in hilly terrain by creating a shortage of essential commodities, which also results in economic losses, due to the impact on tourism (Patel et al., 2020; Goyal & Surampalli, 2018). This year again, Srinagar-Leh NH has been hit twice by massive avalanches on Jan 11, 2022 (Hindustan Times, 2022), and April 27, 2022, (Kashmir, 2022).

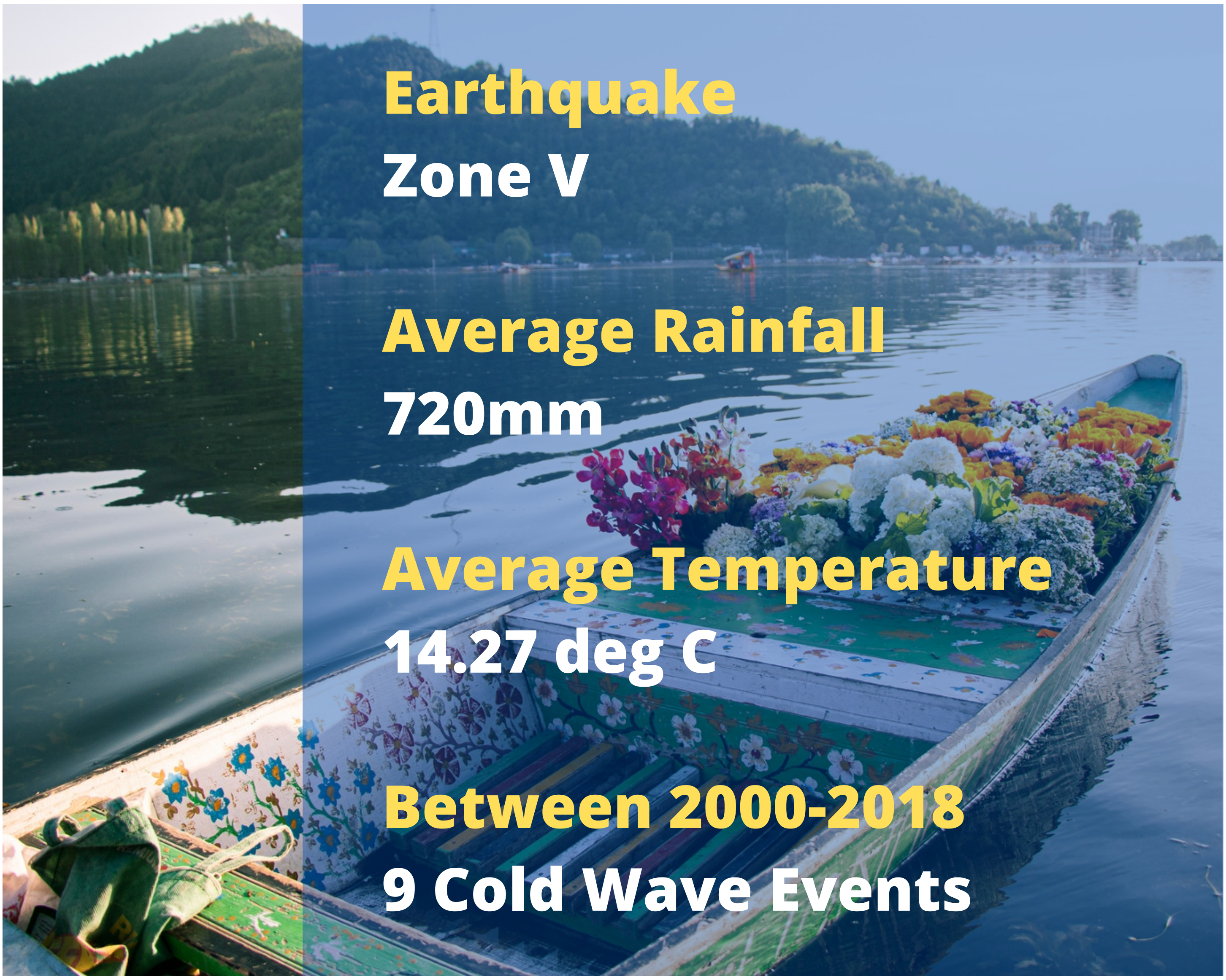
Due to large variations in average mean minimum and maximum temperature, -4.35°C and 32.9°C in winters and summers respectively, throughout the year, the city experiences cold waves as well as heat waves (IMD, 2016). As per the results carried out of the research, in an average 9 days in a year, city experienced a temperature below -4°C, whereas 2 heat waves were observed with maximum length of 8 days. For instance, last year, on Dec 20, 2021, Srinagar city recorded -6°C temperature, during a cold wave (India Today, 2021), whereas this year, on June 14, 2022, the temperature went up to 32.2°C, during a heat wave (India Today, 2022).



Fire is one of the most destructive manmade disasters of all time. Srinagar city has also witnessed some of fire accidents every year. For instance, this year on March 31, 2022, (Times of India, 2022) and April 06, 2022, (Rising Kashmir, 2022), city experienced devastating fire incidents causing huge property loss.

The successive infringement of building bye laws and unplanned construction had altered the natural landscape of the city and made it prone to urban floods (Ahmad et al., 2019). In September 2014, the city experienced a disastrous flood, due to heavy precipitation caused by western disturbances which impacted lots of the inhabitants and assets in the entire valley including the city (Goyal et al., 2022; Sharma & Goyal, 2020; Ahmad et al., 2019). In recent times also, this year Jammu-Srinagar National Highway got washed away due to a flash flood, triggered by the heavy rains on June 22, 2022 (The Economic Times, 2022), and the Srinagar-Leh highway got blocked due to flash floods on July 5, 2022 (Greater Kashmir, 2022).

In case of Srinagar city, drought, cyclones, tsunamis, forest fire, coastal hazards, industrial hazards and lightning hazards are not significant, due to its geographical and topographical features. Therefore, it is essential to invest in enhancing urban resilience and undertaking risk-reducing measures, for sustainable urban development of Srinagar city.



Earthquake
Zone V

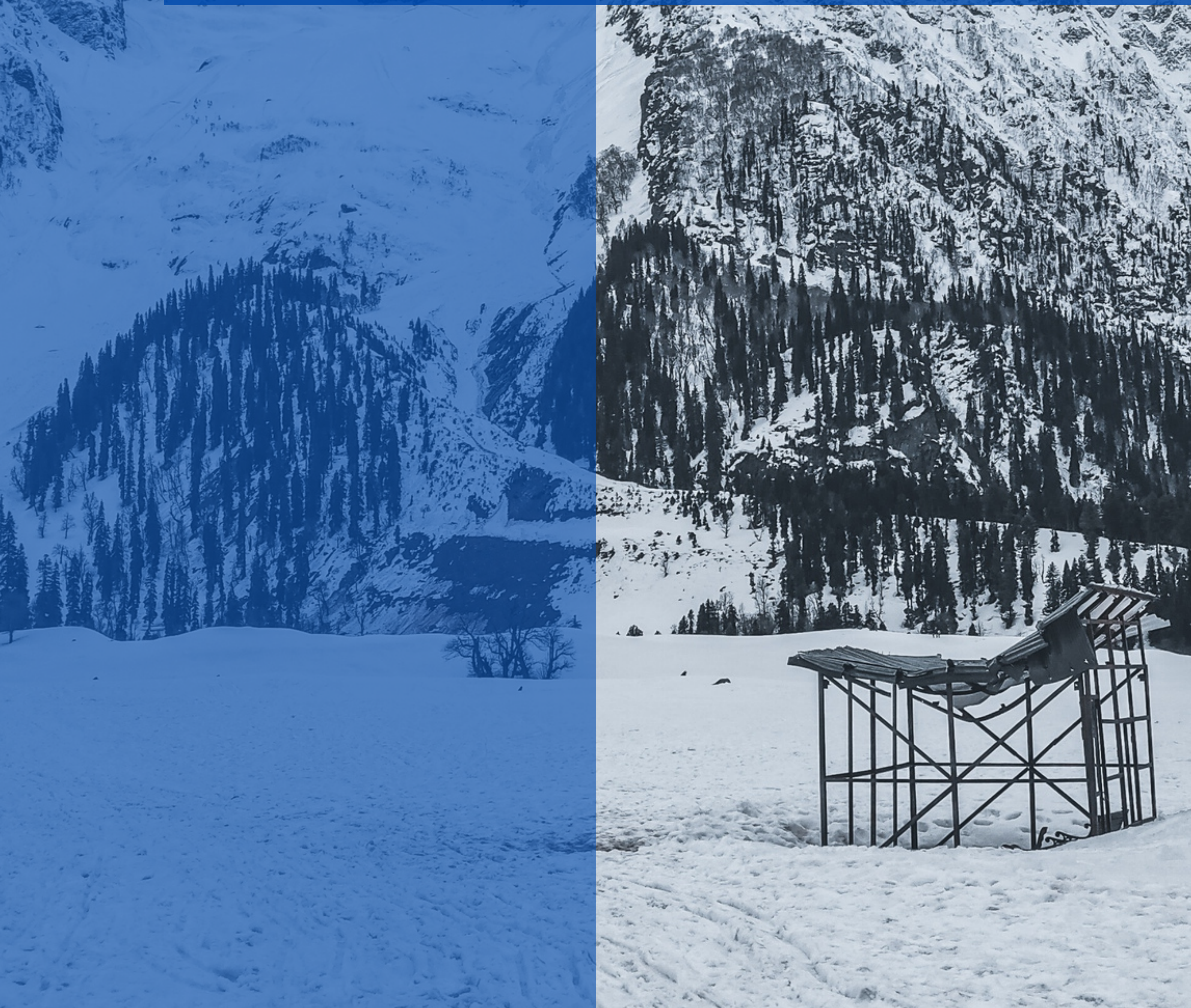
Average Rainfall
720mm

Average Temperature
14.27 deg C

Between 2000-2018
9 Cold Wave Events

4

STUDY OF MULTI-HAZARD DISASTERS



In this study, a multi-hazard disaster risk matrix has been developed by collecting primary and secondary data, at the urban level as per the Ministry of Home Affairs (MHA) and the United Nations Development Programme (UNDP) report "Disaster Risks and Resilience in India: An Analytical Study 2019" (UNDP, 2019). The datasets have been collected and generated for several parameters, chosen to compute exposures, vulnerabilities and hazards indices. Based on the importance of the parameters, specific weightage has been given to the parameters, according to the Risk and Resilience matrix, developed by the MHA-UNDP 2019 report (Page no.: 35) (UNDP, 2019). The methodology of the Disaster Risk Index (DRI) considered 14 indicators of hazards (12 for natural hazards and 2 for man-made hazards), 14 indicators of vulnerabilities and 2 indicators of exposures (Refer to Table 1). The parameters and their relative weightage were identified and taken from MHA-UNDP Report, 2019 (UNDP, 2019).

The disaster resilience score (DRS) has been computed by summing up the scores achieved by Srinagar city on each of 7 indicators (based on the quantitative norms) such as i) assessment of risk, ii) prevention and mitigation of risk, iii) governance of risk, iv) preparedness, v) response, vi) relief and rehabilitation and vii) reconstruction of a disaster. Such scores are rescaled to 100 to compute resilience, enable comparison and thereby DRS. Based on guidelines and contents provided under the DM Act 2005 and DM Policy 2009 of the country, a set of questions were used for the performance assessment of Srinagar city. As per the MHA-UNDP Report (2019), responses (received from the city's administration) assessment on the Questionnaire has been computed in quantitative terms. The risk and resilience score card methodology has been explained and presented sequentially in Figure 2.

i) What constitutes risks of disasters

Risks are measured using equation (i) (IPCC, 2014)

$$R = \{(h \times v) \times e\} \div c \qquad \text{------------- (i)}$$

Where,

R = disaster risk;
h = hazard (the possibility of an occurrence of an event which causes loss);
v = vulnerability, factors increasing the vulnerability of an area or public to the impacts of hazard;
e = exposure of vulnerable people and assets to hazards
c = capacity or resources that could decrease the risk level or the impacts of disasters.

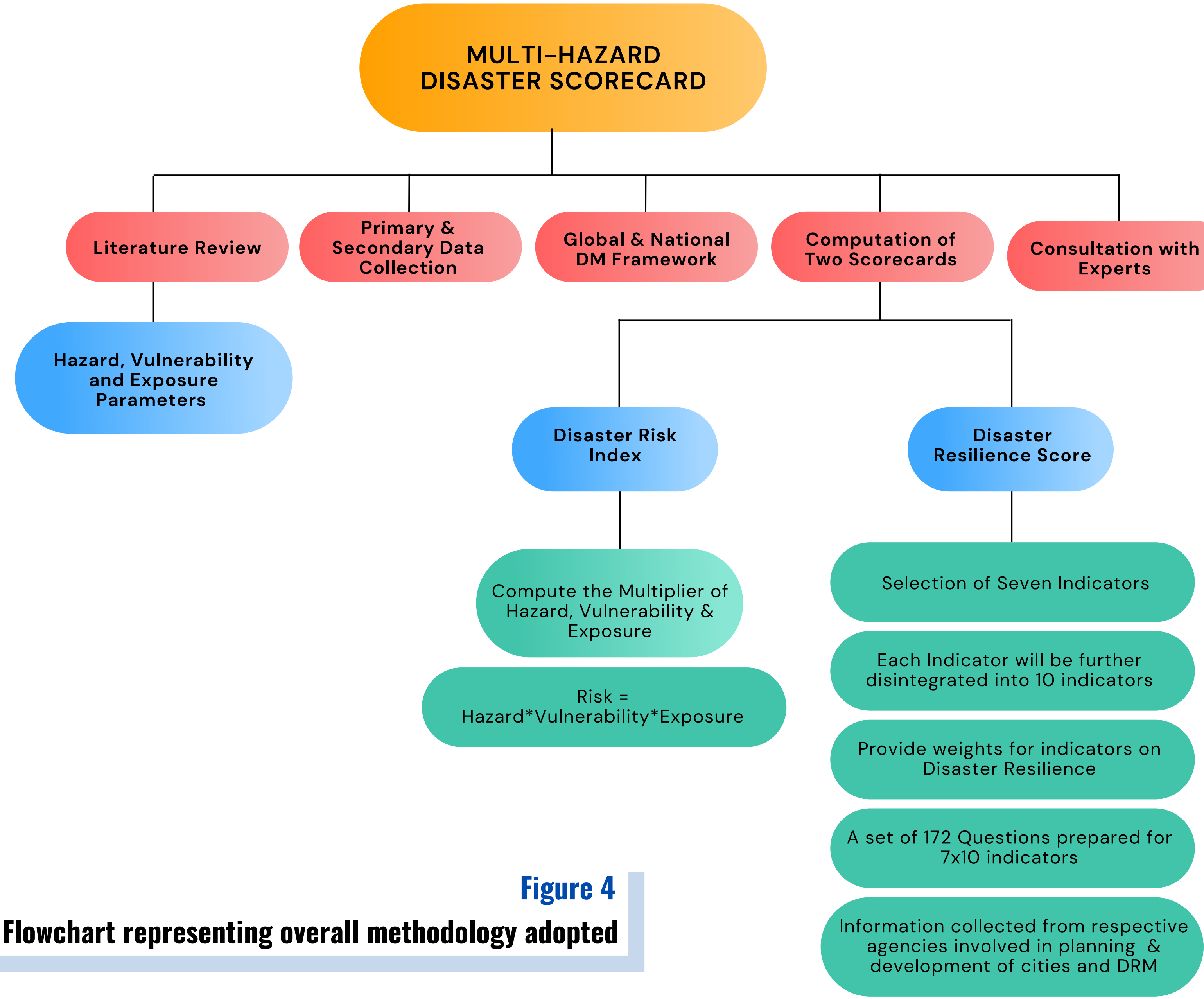


Figure 4

Flowchart representing overall methodology adopted

ii) Selection of indicators for hazard, vulnerability and exposure

The indicators of hazards, vulnerabilities and exposures have been chosen on their importance and the data accessibility, uniformly across the city (Refer Figure 3). Although specific datasets for some indicators, like livestock, forest fire, agriculture etc., are available at the district level and hence they were chosen and the best use of datasets was made based on the existing datasets.

Figure 5

Indicators selected for hazards, vulnerabilities, and exposures

iii) Parameters on indicators and their weights

Each of these 14 hazards, 14 vulnerabilities and 2 exposure indices has various parameters. These parameters (Refer Table 1) were chosen for the computation of indices on hazards, vulnerabilities and exposure, based on available datasets of the city. The weights were assigned to the parameters (Refer Table 2), following the MHA-UNDP Report, 2019.

iv) For exposures, (a) population and (b) GDP are selected. The 50% of equal weights are given to both parameters.

v) Hazard-specific vulnerabilities

Each indicator of vulnerability is not related to each hazard. For instance, the susceptible buildings and infrastructure are exceptionally related to earthquakes and landslides, but not associated with a heatwave. Similarly, the susceptible forest and mangrove cover are significantly related to forest cover, but not related to industrial hazards. Thus, based on their significance, hazard-specific vulnerabilities were factored in to measure risks in an individual instance.

vi) Comparative weights on indicators of hazards, vulnerabilities, and exposures

Each hazard and vulnerability indicator will not generate an identical extent of risks. For instance, the risks of disasters from an earthquake are much higher than from forest fire or landslides. Similarly, each vulnerability cannot develop similar quantity of damages and losses. For instance, the vulnerability of buildings and infrastructure can cause severe deaths, damages and economic losses than exposed human conditions of poverty or gender bias. The datasets of past disasters have been used to develop relative weights (Refer Table 3).

viii) Comparative weights on hazards, vulnerabilities, and exposures

The risk level for the city of Srinagar, which has a high population density of 5337 person per km^2 and GDP, is overestimated when hazards, vulnerabilities and exposures are given equal weightage. It was agreed that the relative weights of H (hazard), V (vulnerability), and E (exposure) should be stated in the ratio of 4:2:1 because hazards are the main factors that increase the risk of disasters (MHA-UNDP Report, 2019).

Table 1
List of hazards, parameters, and their relative weights
(as per MHA-UNDP Report, 2019, Page No: 33)

Hazards	Parameters on Hazard	Weights on parameters
Earthquake	Seismic hazard zonation: Zone-V, IV, III, and II	Zone-V: 10, Zone-IV: 6, Zone-III: 4, Zone-II: 2
Landslide	Landslide hazard zonation: Zone- IV, III, II, and I	Zone-IV: 10, Zone-III: 8, Zone-II: 4, Zone-I: 0
Avalanche	Avalanche hazard zonation: Zone- V, IV, III, II, and I	Zone-V: 10, Zone-IV: 8, Zone-III: 6, Zone-II: 4, Zone-I: 0
Drought	a) Drought-prone area, b) Number of drought years, c) Moisture index, d) Frequency of SSI (Standardized Soil Moisture Index), e) Frequency of SPI (Standardized Precipitation Index).	Equal Weights
Urban Flood	a) Average annual flooding, b) Maximum annual flooding, c) Year of maximum flooding, d) Average flooded area (%), e) Maximum flooded area (%)	Equal Weights
Heat Wave	a) Average Heat Index based on National Oceanic and Atmospheric Administration (NOAA) methodology b) Number of days with a heat index above 54 c) Number of a heat wave (temperature above 40°C for 5+ days) d) Longest duration of a heat wave	Equal Weights
Cold Wave	When the temperature goes below 4°C in plain areas and below - 4°C in hilly areas	Equal Weights

Hazards	Parameters on Hazard	Weights on parameters
Cyclone	a) Number of cyclones b) Number of severe cyclones c) Probable maximum wind speed d) Probable maximum precipitation e) Probable maximum rainfall f) Maximum Storm Surge	Equal weights of 15% for (a) and (c) to (f) and 25% weights for (b)
Tsunami	a) Length of coastline b) Population living within 0.5 km of coasts c) Average height of tsunami wave	a) 25% b) 25% c) 50%
Fire	Normalized fire index of Srinagar city based on average annual. a) Number of accidents of fire b) Number of deaths c) Number of injuries	Equal weights
Forest Fire	Forest fire zonation in very dense, dense and open forests a) High risk zone-very dense b) Moderate risk zone- dense c) No risk zone- open forests	Values of 10, 5 and 0 for 3 risk zones with weights of 50%, 30% and 20% on 3 types of forests
Coastal Erosion	a) Length of coastline b) Coastal length (km) under erosion c) Coastal area (sq km) under erosion	Equal weights
Industrial Hazard	a) MAH industries b) MPI industries c) CEPI index	a) 50% b) 25% (c) 25%
Lightning	Normalized annual average lightning mortality in Jaipur city	Mortality index scaled 0 to 10

MAH: Maximum Accident Hazard
MPIs: Maximum Polluting Industries
CEPI: Comprehensive Environmental Pollution Index

Table 2

Parameters and weights on vulnerabilities

(as per MHA-UNDP Report, 2019, Page No: 34)

Vulnerabilities	Parameters on Vulnerabilities	Weights on parameters
Unsafe Buildings	Number of buildings constructed predominantly with materials used for construction of roofs and walls and classified as Very High (VH), High (H), Moderate (M), Low (L) and Very Low (VL) risk in earthquake, landslide, flood, and cyclone	VH:10, H:8, M: 6, L:4, VL: 2
Social infrastructure	Number of educational and health institutions in the city	a) 40% weights on primary educational institutions b) 10% weights on higher educational institutions c) 25% weights on primary health institutions d) 25% weights on hospitals
Physical infrastructure	a) Length of roadways b) Length of railways c) Number of airports and seaports	Equal weights on each parameter and further equal weights on sub-parameters within each parameter
Livestock Population	Number of livestock in the city a) Bovine animals b) Other animals	a) 80% b) 20%
Vulnerable Women	a) Sex ratio b) Illiteracy (%) c) MMR d) WHH (%) e) CAW f) Dependent (%)	Equal weights
Vulnerable Children	a) Age group 0-6 and 7-18 b) Non-school going children c) Working children d) IMR	Equal weights
Aged People	a) Age group 60+ b) Age group 80+ c) Dependency Ratio	Equal weights

Hazards	Parameters on Hazard	Weights on parameters
Disabled People	Types of disability a) Visual b) Hearing c) Speech d) Physical e) Mental f) Any other	Equal weights
Net Cropped Area	a) Cropped area b) Irrigated area	a) 80% b) 20%
Industries	a) Number of MSME in Srinagar city b) Number of industrial clusters c) Number of SEZ	a) 40% b) 40% c) 20%
Rural/Urban Poor	a) BPL population (rural and urban) b) Homeless population	Equal weights on both, with further equal weights on rural and urban BPL and Homeless
Deforestation	Change of forest cover (positive, negative, overall) during 2001-2015 a) Dense forests b) Open forests	Equal Weights
Depletion of Mangroves	Change of mangrove cover (positive, negative, overall) during 2000-2021 a) Dense mangrove b) Open mangrove	Equal weights
Water Stress	a) Terrestrial water as captured in moisture index b) Surface water as captured in area under irrigation c) Sub-surface area as reflected in Central Ground Water Board (CWGB) data	Equal Weights

MMR: Maternal Mortality Rate per 1,00,000 child births
CAW: Crime Against Women (cases registered per 1,00,000 women)
IMR: Infant Mortality Rate
MSMEs: Micro, Small and Medium Enterprises
SEZs: Special Economic Zones.
BPL: Below Poverty Line

Table 3

Comparative weights on hazards, vulnerabilities, and exposures
(as per MHA-UNDP scorecard report, 2019, Page No: 36)

HAZARDS		VULNERABILITIES		EXPOSURES	
Indicator	Weight%	Indicator	Weight%	Indicator	Weight%
Earthquake	15	Buildings*	15	Population	50
Landslide	7	Agriculture*	10	Economy	50
Avalanche	3	Poverty*	10		
Drought	15	Women*	8		
Urban Flood	15	Children*	8		
Heat Wave	6	Disability	6		
Cold Wave	6	Aged	6		
Cyclone	15	Livestock*	6		
Tsunami	3	Industries	6		
Fire	3	Physical Infrastructure	5		
Forest Fire*	3	Social Infrastructure*	5		
Coastal Erosion	3	Deforestation	5		
Industrial Hazard	3	Depletion of Mangrove	5		
Lightning	3	Water Stress*	5		

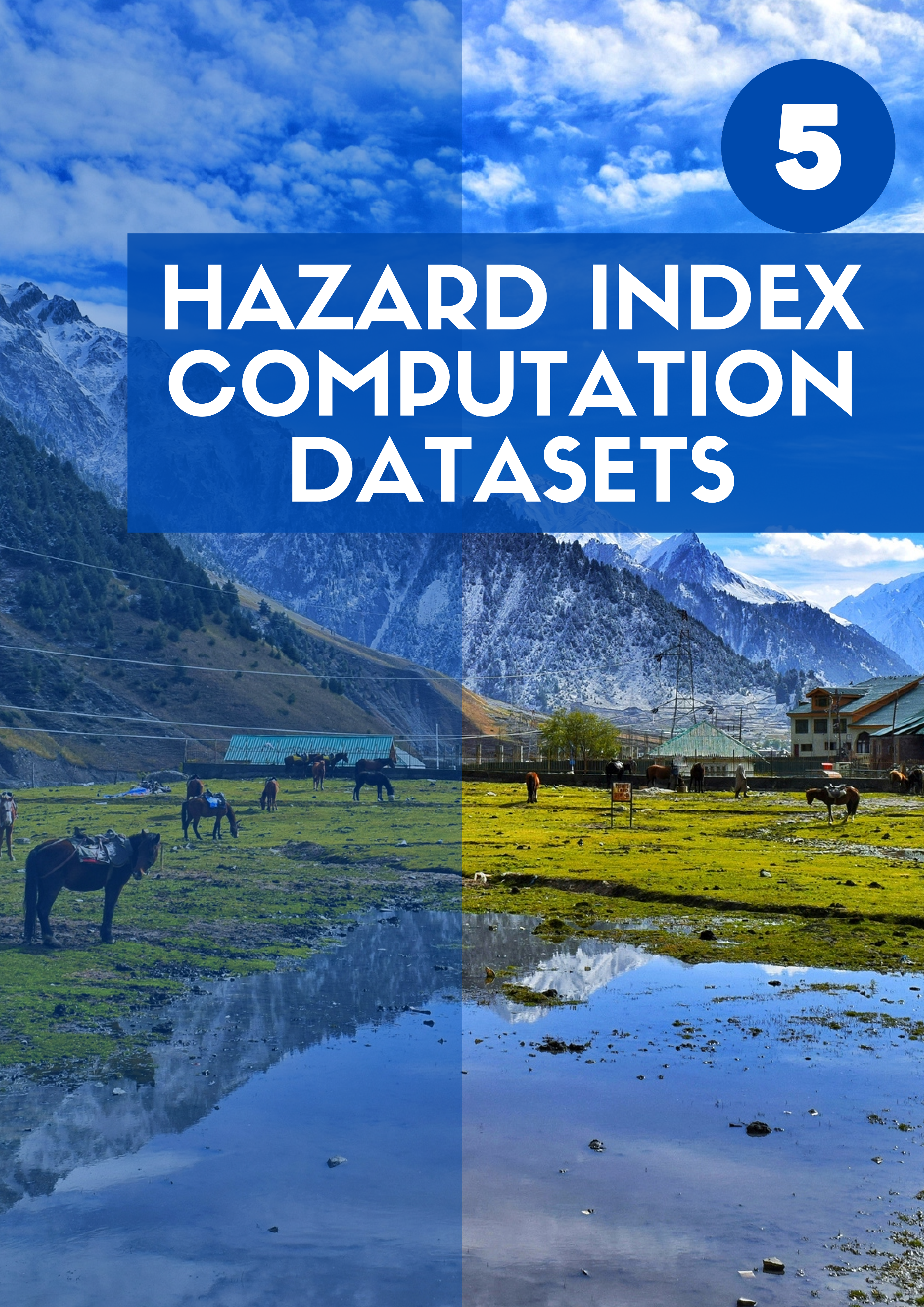
*In the absence of city-level data, the district-level data have been considered for these indicators in the entire study.

Note:

1. As per the MHA-UNDP 2019 report, the total hazard indicators in the list are 14. However, Srinagar city is not prone to Cyclone, Tsunami and Coastal Erosion, due to the geographical and topographical features of the city.

2. Likewise, all the vulnerable indicators in the list of the MHA-UNDP 2019 report have been considered for Srinagar city, except Depletion of Mangrove (13 vulnerable indicators have been considered out of 14), as there is no mangrove in the city.

3. The present study has been carried out comparatively over Guwahati, Jaipur, Srinagar and Visakhapatnam cities. The risk index profiling of these cities has been computed comparatively for different hazards, vulnerabilities and exposure parameters. Therefore, various indices in this report for Srinagar city have been compared to the other three cities should not to be seen in isolation.



5

HAZARD INDEX COMPUTATION DATASETS

1. Earthquake

The earthquake data of the city has been derived from Open Government Data (OGD) Platform India (data.gov.in), as per the National Building Code 2005 (Ministry of Home Affairs). The values on a scale of 0 to 10, have been adopted for various seismic zones. Accordingly, the hazard index of the city has been worked out: Zone-V (Very High Risk): 10, Zone-IV (High Risk): 6, Zone-III (Moderate Risk): 4, Zone-II (Low Risk): 2, through Earthquake Hazard Zoning Atlas of India of 2016 (Table 4).

Table 4 **Earthquake hazard index**

City Area (km^2)	Area (km^2) in Earthquake Hazard Zones								Earthquake Hazard Index (Out of 10)
	ZONE II (Low Risk)		ZONE III (Moderate Risk)		ZONE IV (High Risk)		ZONE V (Very High Risk)		
	Area	%	Area	%	Area	%	Area	%	
232.35	0.00	0.00	0.00	0.00	0.00	0.00	232.35	100.00	10.00

Since whole of Srinagar city lies in Zone V (for which the weight is 10), the area falling in the earthquake hazard zone is considered the city's area, i.e., 232.35 km^2. It means the whole city is susceptible to earthquake events in a Very High - Risk zone.

2. Landslide

As per the Landslide Hazard Zonation Atlas of India (2003), the entire landmass of India has been classified into 4 landslide hazard zones: Zone-IV (Very High), Zone-III (High), Zone-II (Moderate to Low) and Zone-I (Unlikely). Based on this area analysis, the landslide hazard index has been worked out, based on the following values ascribed to each zone, on a scale of 0 to 10: Zone-IV: 10, Zone-III: 8, Zone-II: 4, Zone-I: 0 (Table 5).

Table 5 **Landslide hazard index**

City Area (km^2)	Area (km^2) in Landslide Hazard Zones								Landslide Hazard Index (Out of 10)
	ZONE I (Unlikely)		ZONE II (Moderate Risk)		ZONE III (High Risk)		ZONE IV (Very High Risk)		
	Area	%	Area	%	Area	%	Area	%	
232.35	216.13	100	0.00	0.00	0.00	0.00	16.22	6.98	0.70

Since Srinagar city lies partly in Zone I and IV (for which the weightage are 0 and 10 respectively), the area falling in the landslide hazard zone has been considered the city's area, i.e., 232.35 km^2. It means, the city has approximately 6.98 % region i.e., 16.22 km^2 area, which is very highly susceptible to landslide events.

3. Drought

No agency has carried out drought hazard zonation of the city. In the absence of such zonation, parameters of drought, have been captured through 5 parameters: (a) drought-prone area, (b) number of drought years,(c) moisture index, (d) frequencies of SSI (Standardized Soil Moisture Index) and (e) SPI(Standardized Precipitation Index). An equal weightage of 20% has been given on each parameter (Table 6). The data sources for these parameters have been provided in the annexure section at the end of the report(Annexure 1).

Table 6 Drought Index

Drought Prone Area (km^2)	No. of Drought Years	Moisture Index	Frequency		Normalized				Drought Index (Out of 10)
			SSI	SPI	Drought Years	Moisture Index	SSI	SPI	
0	3	-0..276	17	33	2.31	10	6.54	7.50	5.27

Srinagar city observed maximum decline in moisture index with 3 drought years, during 2000 to 2016. Therefore, Srinagar is experiencing increased water scarcity and reduced drinking water sources, due to the soil moisture and meteorological drought, significantly.

4. Urban Flood

The urban flood index has been calculated using the BMTPC (2006) map and literature. Urban floods have been captured through 5 parameters: (a) average annual flooding, (b) maximum annual flooding, (c) year of maximum flooding, (d) average flooded area (%), and (e) maximum flooded area (%). Equal weightage has been given to all the parameters (Table 7). The data sources for these parameters have been provided in the annexure section at the end of the report (Annexure 1).

Table 7 **Flood Hazard Index**

City Area (km^2)	Flood Affected Area (km^2)					Flood Hazard Index (Out of 10)
	Average Annual Flooding	Maximum Annual Flooding	Year of Maximum Flooding	Average Flooded Area (%)	Maximum Flooded Area (%)	
232.35	97.30	116.76	2014	35.00	42.00	7.00

In the 232.35 km^2 total area of the city, the observed area of maximum flooding, was 42% in 2014, during 2000 to 2020 and the average flooded area, was about 35%.

5. Heat Wave

Heatwaves have been captured through 4 parameters: (a) the number of days with a heat index above 54, (b) the average number of the heat wave (temperature above 40°C for 5+ days), (c) the average longest duration of the heat wave and (d) average Heat Index based on National Oceanic and Atmospheric Administration (NOAA) methodology (Table 8). Equal weightage has been given to each parameter.

Table 8 **Heat Wave Index**

Heat Waves				Heat Wave Index (Out of 10)
No of days with a Heat Index (HI) above 54 (Annual Average)	Average number of Heat Waves (5 days +)	Average longest Heat Wave (No of Days)	Average Index of Heat Waves	
3	2	8	0.55	6.13

2 average heatwave events (5 days+), with temperatures above 40°C or above, occurred between 2000 to 2018, over the city each year. The number of days with HI above 54, was 3 days and the average longest heat wave, was 8 days.

6. Cold Wave

Cold Wave Hazard Index has been worked out following the Indian Meteorological Department (IMD) Weather Forecast, which defines a day as cold when the temperature goes below 4°C in plain areas and below - 4°C in hilly areas. The percentage of days, with cold wave conditions, in 3 different temperature brackets in the city, has been worked out with equal weightage to calculate the Cold Wave hazard index on a scale of 0 to 10 in other indices (Table 9).

Table 9 **Cold Wave Index**

Plain Areas (temperature <4 0C)	Cold Wave Index (Out of 10)
9	10.00

There were 9 numbers of cold wave events observed, as the temperature less than -4°C (the sudden decrease of temperature less than the usual minimum level and the prolongation of the event for a few days), between 2000 to 2018 over the city. Srinagar city, in the hilly regions, thus observes high cold wave risk index as compared to the other cities.

7. Fire

The Directorate General of National Disaster Response Force (NDRF) and Civil Defence commissioned a study on fire hazard and risk analysis in the country, for revamping fire services in the States. The study did not cover fire risks in the districts or did not compile data on city fires. In the absence of any city-level database on fire, the National Crime Records Bureau (NCRB) State-level database has been relied upon, to assess (a) the number of cases of fire accidents registered, (b) the number of deaths and (c) number of injuries during 2001-2015 (Table 10). Data has been normalized at the city level, based on population. The fire hazard index has been worked out, based on equal weightage of 33.33% on these 3 parameters.

Table 10 **Fire Hazard Index**

Accidents of Fire			Fire Hazard Index (Out of 10)
Cases	Deaths	Injured	
2	2	0	0.22

The city had 2 cases, 2 deaths and no injuries, that occurred due to fire accidents, between 2001 to 2015. The data sources for these parameters have been given in the annexure section, at the end of the report (Annexure 1).

Fire incident at a commercial building in Srinagar. January 27, 2022 (Source: INDIA TV)

Srinagar city suffered disastrous floods in 2014: The year of tragedy. December 31, 2014 (Source: The Indian Express)

8. Forest Fire

The study on 'Vulnerability of India's Forests to Fire' published in 2019 by the Forest Survey of India (FSI), is the basis for data on forest fires (Table 11). The study has classified Srinagar district (lack of city-level data), in terms of 3 types of forest fire: high, moderate and no risk. This has been supplemented with data on types of forests in the cities- very dense (50%), dense (30%) and open forests (20%), as brought out in the Annual India State of Forest Report 2019. The assigned weightages are multiplied with the risk zone multiplier, to get the value of the hazard index for the desired city region.

Table 11 **Forest Fire Index**

Total Area-City (km²)	Total Area-District (km²)	Forest Area (km²)						Forest Fire Index (Out of 10)
		Very Dense	Dense	Open	Total	% of Total	Risk Zonation	
232.35	2,228	139	292.57	273.86	704.14	4.57%	0.00	0.00

The total forest area in the Srinagar district is about 704.14 km². It has been found that, there is no risk zone for forest fire in the city.

9. Industrial Hazard

The datasets have been obtained from several sources like the Central Pollution Control Board, the City Municipal Corporation etc. (Table 12). The weightage assigned for Maximum Hazard Industries (MHI), Maximum Polluting Industries (MPI) and Comprehensive Environmental Pollution Index (CEPI) are 50%, 25% and 25% respectively.

Table 12 **Industrial Hazard Index**

Parameters of Industrial Hazards			Industrial Hazard Index (Out of 10)
Maximum Hazard Industries (MHI)	Maximum Polluting Industries (MPI)	Average CEPI of major Industrial Clusters	
11	11	40	4.74

The CEPI calculates the pollution level of air, water, and soil due to the industrial clusters in the city. The average CEPI of major clusters is about 40 in Srinagar city. The city shows a high score on the industrial hazard index, about 4.74, which means that, there is a moderate risk, that contributes to trigger the hazards, which may lead to disasters.

10. Lightning

Lightning accounts for significant mortalities during disasters in several cities in India. Although, there is lack of scientific studies, assessing the lightning impact on the country's population. The datasets of lightning mortalities have been obtained through National Crime Records Bureau (NCRB) database, at a city level. The lightning mortality index has been worked out on a scale of 0 to 10 (Table 13).

Table 13 **Lightning Hazard Index**

Accidents of Fire		Lightning Hazard Index (Out of 10)
Total Lightning Mortalities	Lightning Mortalities Average Annual	
0	0	0

In Srinagar city, there have been no mortalities due to lightning events in the past 15 years (2000-2015). It is challenging to say the risk of lightning occurrence here, as it is a natural phenomenon, but the hazard index shows that the city is experiencing an unlikely or no risk of lightning hazards.

11. Avalanche

Avalanche-prone cities are classified into 5 zones: Zone-V(Very High Risk), Zone-IV(High Risk), Zone-III (Moderate Risk), Zone-II (Low Risk), and Zone-I (No Risk). Areas falling in each zone, have been calculated city-wise and the percentage of the area falling in each zone, has been worked out accordingly. Based on this area analysis, the avalanche hazard index of relevant cities has been worked with the following values: Zone-V: 10, Zone-IV: 8, Zone-III:6, Zone-II: 4, Zone-I: 0 (Table 16). The avalanche hazard is prominent in Srinagar city only, while its risk is completely nonexistent in other cities (Table 14).

Table 14 Avalanche hazard index

City Area (km²)	Area (km²) in Avalanche Hazard Zones										Avalanche Hazard Index (Out of 10)
	ZONE I (No Risk)		ZONE II (Low Risk)		ZONE III (Moderate)		ZONE IV (High)		ZONE V (Very High)		
	Area	%	Area	%	Area	%	Area	%	Area	%	
232.35	88.43	38.06	13.27	5.71	0.00	0.00	130.84	56.31	0.00	0.00	4.73

Since Srinagar city lies partly in Zone I, II and IV (for which the weight is 0 and 10 respectively), the area falling in the Avalanche hazard zone is considered as the city's area, i.e., 232.35 km². It means, the city has approximately 56.31 % region i.e., 130.84 km² area, which is very highly susceptible to Avalanche events.

Summary of Hazard Indicators:

- As per the MHA-UNDP 2019 report, 11 hazard indicators, relevant to Srinagar city, based on the geographical and topographical features of the city, have been considered.
- The methodology and weightage adopted to compute the hazard indices are as per the MHA and the UNDP report, "Disaster Risks and Resilience in India: An Analytical Study 2019".
- The hazard indices have been computed for different hazard parameters, at the city level, except for Forest Fire (for which the data was available at the district level) for Srinagar city.
- Srinagar city is more prone to Cold Waves, Earthquakes, Urban floods, Heat waves, Drought, Industrial Hazards and Avalanches, compared to other hazard indicators.

6

VULNERABILITY INDEX COMPUTATION DATASETS

1. Buildings

a. Walls

The source of datasets of building walls is the 'Office of the Registrar General & Census Commissioner, India (ORGI)' used in this study (Table 15). Hazard zones are Zone V: Very High Damage Risk Zone, Zone IV: High Damage Risk Zone, Zone III: Moderate Damage Risk Zone, Zone II: Low Damage Risk Zone, and Zone I: No Risk Zone. Vulnerable buildings weights are VH= Very High (damage potential 100%); H= High (50%); M=Medium (25%); L=Low (10%); VL= Very Low (5%).

Table 15 **Vulnerability index of walls**

Grass, Thatch, Bamboo	Plastic Polythene	Mud Unburnt bricks	Wood	Stone not packed with mortar	Stone packed with mortar	GI, Metal Asbestos	Burnt Bricks	Concrete	Any other material	**Vulnerability Index of Walls (Out of 10)**
324	413	10,795	3,040	2,552	945	1,096	13,63,05	9,781	2,197	1.86

The vulnerability index of walls is about 1.86, computed based on the different building materials. It is observed that the building walls constructed with burnt bricks are more in number compared to other building materials. Srinagar is vulnerable to hazards like earthquake and urban flood, which damages the building walls. Therefore, the resistant designs and specifications should be incorporated into the materials, used for the construction of walls to tackle these disasters.

b. Roofs

The source of datasets of building walls is the 'Office of the Registrar General & Census Commissioner, India (ORGI)' used in this study (Table 16). Hazard zones are Zone V: Very High Damage Risk Zone, Zone IV: High Damage Risk Zone, Zone III: Moderate Damage Risk Zone, Zone II: Low Damage Risk Zone, and Zone I: No Risk Zone. Vulnerable buildings weights are VH= Very High (damage potential 100%); H= High (50%); M=Medium (25%); L=Low (10%); VL= Very Low (5%).

Table 16 Vulnerability index of roofs

Grass, Thatch, Bamboo	Plastic Polythene	Hand-made tiles	Machine-made tiles	Burnt Bricks	Stone Slates	GI, Metal Asbestos	Concrete	Any other material	Vulnerability Index of Roofs (Out of 10)
2,852	643	1,775	170	356	2,211	14,88,03	8,377	2,261	1.81

The vulnerability index of roofs is about 1.81, computed based on the different building materials. It is observed that, the building roofs constructed with GI and Metal Asbestos, are more in number, compared to other building materials. Srinagar city is vulnerable to hazards like Earthquakes and Avalanches, which impact the building roofs. Therefore, the resistant designs and material specifications should be considered for constructing roofs to resist such disasters.

2. Agriculture

The Crop Vulnerability Index has been worked out based on 2 parameters: cropped area and irrigated area (Table 17). District-wise data on the area under crops and irrigation has been collected from the Directorate of Economics and Statistics, Ministry of Agriculture, Cooperation and Farmers Welfare, GoI, through the Indiastatdistricts.com website. However, these 2 parameters have been included, due to their associated impact on the urban population in the city. Considering the relative importance of crops and irrigation, 80% of weightage has been given to areas under crops and 20% to irrigated areas.

Table 17 Crop Vulnerability Index

Total area of district (hectare)	Area Under Agriculture (hectare)				Flood Hazard Index (Out of 10)
	Cropped Area		Irrigated Area		
	Area	%Area	Area	%Area	
11,16,149	11,354.59	1.01%	7,798	0.69%	0.04

The vulnerability index of the crop is 0.04, which is computed based on the area under agriculture in the Srinagar district. The cropped area is about 0.90% of the total area under agriculture, as compared to the irrigated area. The crop vulnerability index shows that Srinagar's agricultural area is less susceptible to disasters.

3. Poverty

For the poverty data, Census 2011 data on the homeless population, has been adopted in this study at district level (Table 18). The parameters BPL (Below Poverty Line) and Homeless Population, have 2 sub-parameters for rural and urban areas. An equal weightage of 25% has been given to each of these 4 sub-parameters for working out the poverty vulnerability index.

Table 18 Poverty Vulnerability Index

BPL Population (in Lakhs)			Homeless Population (in Lakhs)			Poverty Vulnerability Index (Out of 10)
Rural	Urban	Total	Rural	Urban	Total	
10.51	24.71	35.52	8,199	10,848	19,047	1.53

The poverty vulnerability index for Srinagar city is 1.53, which means that the people who live below the poverty line and are homeless in Srinagar city, are more susceptible to disasters because they are more exposed to hazards and have lower coping capacities against disasters.

4. Women

Gender Vulnerability Index has been worked out based on 6 parameters: sex ratio (women per 1,000 men), illiteracy (%), WHH (Women Headed Household in %), MMR (Maternal Mortality Rate per 1,00,000 childbirths), CAW (Crime Against Women cases registered per 1,00,000 women) and dependent (%). District-wise data on all 6 parameters were compiled from Census 2011 (Table 19). Equal weightage has been given to each of these 6 parameters.

Table 19 Gender Vulnerability Index

Total Female Population	Sex Ratio	Illiteracy (%)	WHH (%)	MMR	CAW	Dependent (%)	Gender Vulnerability Index (Out of 10)
31,57,671	888	55%	8.06%	200	421	89.63%	2.46

Greater the vulnerability, there is more severity in the impact of hazards. The 8.06% WHH is an indicator of strength in the city. The MMR per 1,00,000 childbirths, is about 200 and the average number of CAW is 421. The dependent parameter shows 89.63%, showing non-working women in the city. The gender vulnerability index for the region is 2.42, which indicates that, women have low vulnerability for disasters. Although, there is relatively low sex ratio and higher dependent or non-working women.

5. Children

The child vulnerability index has been worked out, based on 4 parameters: age group, children not going to school, children working and IMR (Infant Mortality Rate). District-wise data of all parameters have been compiled from Census 2011 (Table 20). Each parameter has been given an equal weightage of 25%. In contrast, 2 sub-parameters in children age groups of 0 to 6 and 7 to 18, have been given differential weightage in a 60:40 ratio, as younger children are more vulnerable during disasters.

Table 20 **Child Vulnerability Index Computation**

Age Group of Children (Years)						Not Going to School		Working Children		Child Vulnerability Index (Out of 10)
0-18 (Numbers)	0-6 (%)	0-6 (Numbers)	7-18 (%)	7-18 (Numbers)	IMR	(%)	Numbers	(%)	Numbers	
4,29,001	36.89%	1,58,300	63.10%	2,70,701	51	5.99%	25,700	5.99%	25,700	1.94

The index of child vulnerability has been computed based on 3 parameters for Srinagar city: age group of children of different ages, children not attending school and children working. The IMR in the city is 51, which is a childcare factor. The index of child vulnerability is 1.94, which indicates that children are susceptible to disasters. For example, the children die due to the building collapse, as they will usually be inside the building and would be unaware of what to do to survive in earthquakes. The IMR is significantly higher in the city.

6. Disability

The disability vulnerability index has been worked out based on 6 parameters: visual, hearing, speech, physical, mental and other disabilities. The data on all these parameters have been compiled from Census 2011 (Table 21). Each parameter has been given equal weightage.

Table 21 Disability Vulnerability Index

Total Population	Disabled		Visual		Hearing		Speech		Physical		Mental		Any other		Disability Vulnerability Index (Out of 10)
	Population	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	
12,40,000	26,000	2.10	5,307	20.41	6,602	25.39	1,270	4.88	2,703	10.40	3,028	11.65	5,034	19.36	1.38

We know that disasters can increase the number of disabled persons and worsen the situation of those, who are already impaired. The disability vulnerable index of Srinagar city is 1.38, computed based on the population with different aspects of disabilities. The share of the population with a disability is about 2.10% of the city's total population. Among various disabilities, hearing disability is the highest at approximately 25.39 %, which means the hearing disabled population in Srinagar is more susceptible to disasters.

7. Aged

The elderly vulnerability index has been worked out based on 3 parameters: population in 60+ age group, population in 80+ age group and dependency ratio (ratio of population in 60+ age group over working population in 19-59 age group). City-wise data on all 3 parameters have been compiled from Census 2011 (Table 22). Each parameter has been given an equal weightage of 33.3%.

Table 22 Elderly Vulnerability Index

Total Population	60-90 Age Group		80+ Age Group		Dependency Ratio	Elderly Vulnerability Index (Out of 10)
	Number	%	Number	%		
12,40,000	72,363	5.85	6,994	0.57	26.60%	3.45

In disasters, the aged people suffer disproportionately. The elderly vulnerability index of Srinagar city is 3.45, computed using different age groups and dependency ratios. It has been found that the age group of 60-79, is more susceptible to disasters, as it has 5.85% population ratio as compared to the 80+ age group which has only 0.57%. The dependency ratio is about 26.60% in Srinagar city, which is the ratio of population in 60+ age group, over working population in 19-59 age group.

8. Livestock

Livestock data has been compiled from Livestock Census 2012 (Table 23). The livestock vulnerability index has been worked out, based on 2 parameters, (a) number of bovine animals and (b) other animals, with 75:25 weightage ratio between the 2 parameters.

Table 23 **Livestock Vulnerability Index**

Livestock (Numbers)			Industrial Hazard Index (Out of 10)
Bovine Animals	Other Animals	Total Animals	
43,199	62,547	1,05,746	4.54

The vulnerability index of livestock is 4.54, which has been computed based on the number of different animals in Srinagar. The number of other animals is more in total livestock compared to the bovine animals. The index of livestock vulnerability shows that the number of livestock in Srinagar is moderately susceptible to disasters.

9. Industries

City-wise data on industries has been collected from multiple sources on 3 parameters: the number of Micro, Small and Medium Enterprises (MSMEs), industrial clusters and Special Economic Zones (SEZs). Data on MSMEs have been collected from the database of the Development Commissioner (MSMEs), while data on Industrial Clusters and SEZs in cities, have been collected from several sources (Table 24). The industrial vulnerability index has been worked out, based on differential weights of 40% on MSMEs, 40% on Industrial Clusters and 20% on SEZs.

Table 24 **Industries Vulnerability Index**

Livestock (Numbers)			Industrial Vulnerability Index (Out of 10)
MSME Industries (Numbers)	Industrial Clusters (Numbers)	Special Economic Zones (SEZ) (Numbers)	
1,000	1	0	0.76

The industrial vulnerability index of Srinagar is 0.76, which shows that, the industries are unlikely or low vulnerable indicators in the city. It is observed that there are 1000 MSME industries and 1 industrial cluster in the city. Therefore, there is a need to formulate guidelines, norms and regulations, to ensure safety for hazardous industries and to reduce the probability of disaster events.

10. Physical Infrastructure

Data on 6 types of physical infrastructure- roadways, railways, airports and seaports have been collected from multiple sources. Each city's total length of roadways and railways has been compiled using Open Street Map (OSM) data in the QGIS software. The Airport Authority of India has collected data on the city's airports. In contrast, data on seaports has been compiled from Basic Port Statistics (Table 25). Equal weightage has been given to each of the parameters, with sub-parameters within the parameters, in calculating the Physical Vulnerability Index.

Table 25 **Physical Infrastructure Vulnerability Index**

Road Length (km)	Railway Length (km)	Sea Port (Numbers)		Airport (Numbers)		Physical Infrastructure Vulnerability Index (Out of 10)
		Major	Minor	Int. + Dom.	Domestic	
2,213	4	0	0	1	0	2.07

The index of the physical infrastructure of Srinagar is 2.07, computed using the elements of physical infrastructures, such as roads and bridges, railway lines, seaports and airports. Road length is more than railway length, indicating that, roadways are more vulnerable and typically damaged during disasters, such as floods in Srinagar. The factors, such as quality of construction, standards of maintenance, age of the structure etc., make the physical infrastructures vulnerable to hazards.

11. Social Infrastructure

Social infrastructure data has been limited to health and educational institutions, as these are considered critical lifeline infrastructure during any significant disaster. Data on the number of health and educational institutions have been compiled from the database of Census 2011 at the district level (Table 26). The social vulnerability index has been worked out with equal weightage on these 2 parameters.

Table 26 **Social Infrastructure Vulnerability Index**

Number of Educational Institutions							Number of Health Institutions			Social Infrastructure Vulnerability Index (Out of 10)
School Education		Higher Education				Polytechnic (Number)	Primary Healthcare			
Primary	Secondary	College	University	Engineering	Medical		Dispensaries	FW Centres	Hospitals/ Med. Schools	
261	296	86	2	3	2	4	9	34	3	2.37

Social infrastructure includes structures and other related physical facilities, that provide community services in the Srinagar district (lack of data at the city level). The index of the social infrastructure of Srinagar is 2.37, computed using the number of educational and health institutions. These social infrastructure facilities are certainly damaged during Srinagar's severe earthquake and urban floods. The factors like structural design, materials quality, maintenance standards, design age etc., make the social infrastructures more vulnerable to hazards.

12. Deforestation

Changes in the district's forest cover (lack of data at the city level) have been captured on 2 parameters: dense forests and open forests from 2000 to 2015 (Table 27). Equal weightages have been given to both the parameters, while calculating the index.

Table 27 Forest Cover Depletion Index

Total Area of District (km^2)	Changes in Forest Cover (km^2)			Forest Cover Depletion Index (Out of 10)
	Dense	Open	Total	
13,418.77	5.28	-44.20	-38.92	5

The depletion index of forest cover is 5, which has been computed using the total area and change in forest cover of the Srinagar district. The negative value shows, the decrease in forest cover change and the positive value shows, the increase in forest cover change. The depletion is an indication, for quantifying the environmental vulnerability of forests, in the Srinagar district.

13. Water Stress

The extent of water stress in the district (lack of data at the city level) has been captured through 3 parameters: surface, terrestrial and sub-surface water, from the website of the Central Ground Water Board (CGWB), Ministry of Jal Shakti (Table 28). Equal weightage has been given to each parameter, for calculating the water stress index. Sub-surface water has 4 sub-parameters: over-exploited, critical, sub-critical and safe. This is distributed as follows: 50% has been given to over-exploited, 30% to critical and 20% to sub-critical components.

Table 28 Water Stress Index

Surface Water (km^2)			Terrestrial	Subsurface Water (Number)				Water Stress Index (Out of 10)
Total Area	Non-irrigated Area	%	Moisture Index (MI)	Over Exploited	Critical	Subcritical	Safe	
11,16,149	11,08,351	0.99	-0.275	0	0	0	1	3.15

The water stress index is 3.15, computed using Srinagar's terrestrial, surface and sub-surface water. The stress on terrestrial and surface water sources has been captured in Moisture Index (MI), and areas of non-irrigated as used in estimating the indices of drought hazard and agricultural vulnerability.

Summary of Vulnerability Indicators:

- As per the MHA-UNDP 2019 report, 13 vulnerability indicators, relevant to Srinagar city, based on the geographical and topographical features of the city have been considered, except depletion of mangroves.
- The methodology and weightage, adopted to compute the vulnerability indices, are as per the MHA and the UNDP report "Disaster Risks and Resilience in India: An Analytical Study 2019".
- The vulnerability indices have been computed for different vulnerability parameters, at the city level except for, Buildings, Agriculture, Livestock, Social infrastructure, Deforestation Women, Children, Poverty, and Water stress (for which the data was available at the district level) for Srinagar city.
- Srinagar city is more vulnerable to disasters in terms of Deforestation, Livestock, Elderly, people and Water Stress compared to other vulnerability indicators.

The scale of classification based on index values: The classification is based on a scale of 0 to 10 as per Table 29.

Table 29 **Scale of Classification based on index values**

Class	Range
Very High	Equal to 10
High	7 - 10
Moderate	3 - 7
Low	0 - 3
Unlikely	Equal to 0

Classification of computed hazard indicators for Srinagar city based on the scale: The classes of the different hazard indicators based on the index values are presented in Table 30.

Table 30 **Classification of hazards based on the index**

HAZARDS		
Indicator	**Index**	**Class**
Earthquake	10.00	Very High
Landslide	0.70	Low
Drought	5.27	Modeatre
Urban Flood	7.00	High
Heat Wave	6.13	Moderate
Cold Wave	10.00	Very High
Fire	0.22	Low
Forest Fire	0.00	Unlikely
Industrial Hazard	4.74	Moderate
Lightning	0.00	Unlikely
Avalanche	4.73	Moderate

Classification of computed vulnerability indicators for Jaipur city based on the scale: The classes of the different vulnerable indicators based on the index values are presented in Table 31.

Table 31 Classification of vulnerability indicators based on the index

VULNERABILITIES		
Indicator	**Weight%**	**Class**
Buildings (Walls & Roof)	1.84	Low
Agriculture	0.04	Low
Poverty	1.53	Low
Women	2.46	Low
Children	1.94	Low
Disability	1.38	Low
Aged	3.45	Moderate
Livestock	4.54	Moderate
Industries	0.76	Low
Physical Infrastructure	2.07	Low
Social Infrastructure	2.37	Low
Deforestation	5.00	Moderate
Water Stress*	3.15	Moderate

7

EXPOSURE INDEX COMPUTATION DATASETS

Data on exposures has been collected on 2 parameters: exposure of population and exposure of economy, as reflected in district GDP. While data on exposure of population is compiled from Census 2011, exposure of city GDP has been derived from the newspaper article (The Times of India dated Mar 24, 2019). 2 parameters have been considered for calculating the Exposure Index. These are: (a) population density (=Population / Area in km^2), and (b) per capita GDP (=GDP (in Cr. Rs.) / Population) of a city (Table 32). Both parameters have been normalized by dividing with the maximum value and multiplying by 10, to put them on a scale of 0 to 10. Then, a simple average of these parameters has been taken, since equal weightage has been given on both.

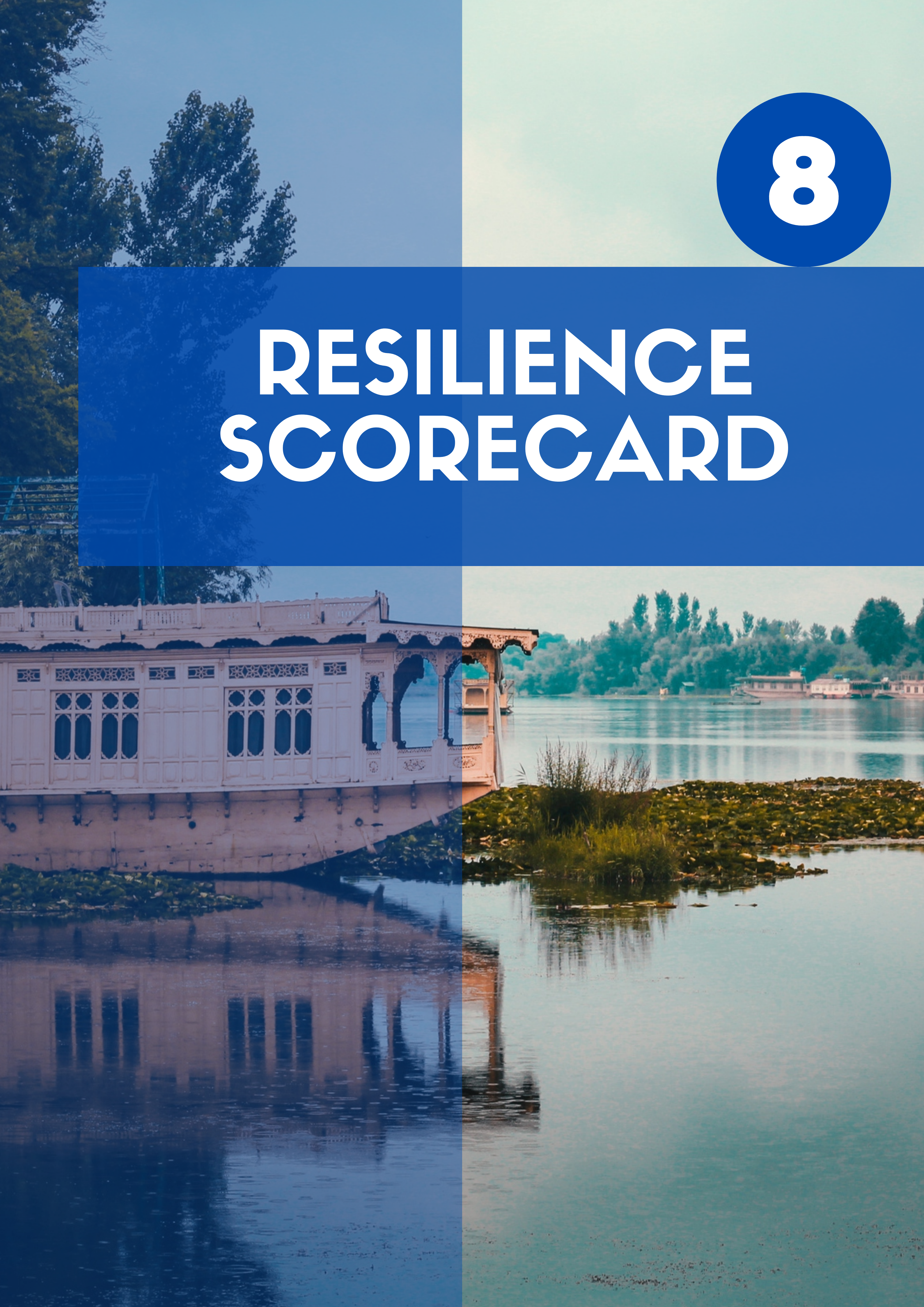
Table 32 **Average Exposure Index**

Area (km^2)	Population		City GDP		Average Exposure Index (Out of 10)
	Total	Density	Total (Rs. Cr.)	Per Capita (Rs.)	
232.35	12,40,000	5,337	45,39,945	37,533	5.42

The average exposure index is 5.42 for Srinagar city, which has been computed by estimating the district's population density and per capita income and assigning equal weightage to both indicators, on a scale of 10. The index shows that the population of Srinagar is more exposed to disasters.

8

RESILIENCE SCORECARD



The Disaster Resilience Score (DRS) is based on the information collected from the cities on 7x10 indicators, through a questionnaire comprising of 172 questions (as per Figure 2). The Resilience scorecard is computed discretely for Srinagar city, based on the 7 parameters, on the scale of 100: Risk Assessment, Risk Prevention & Mitigation, Risk Governance, Disaster Preparedness, Disaster Response, Disaster Relief & Rehabilitation and Disaster Reconstruction, as shown in Table 33 and Figure 4.

Table 33 Weights of Indicators on Disaster Resilience
(MHA-UNDP Report, 2019)

S.No.	Aggregate Indicators	Weights	Values for Srinagar City
1	Risk Assessment	10%	**37**
2	Risk Prevention and Mitigation	20%	**36**
3	Risk Governance	20%	**44**
4	Disaster Preparedness	20%	**50**
5	Disaster Response	10%	**64**
6	Disaster Relief and Rehabilitation	15%	**71**
7	Disaster Reconstruction	5%	**47**
	Disaster Resilience Score	**49.10 on a scale of 100** (Through weighted aggregate of seven parameters)	

Based on the following values and their associated weightage as per the MHA-UNDP Report 2019, The DRS value of 49.10 obtained for the Srinagar city on the scale of 100. Therefore, although the risk associated with Srinagar city comparatively least with minimum number of hazards occurrence, but city is moderately resilient based on its resilience score. Thus, city administration should enhance efforts for making the city highly resilient to the natural and man-made disasters.

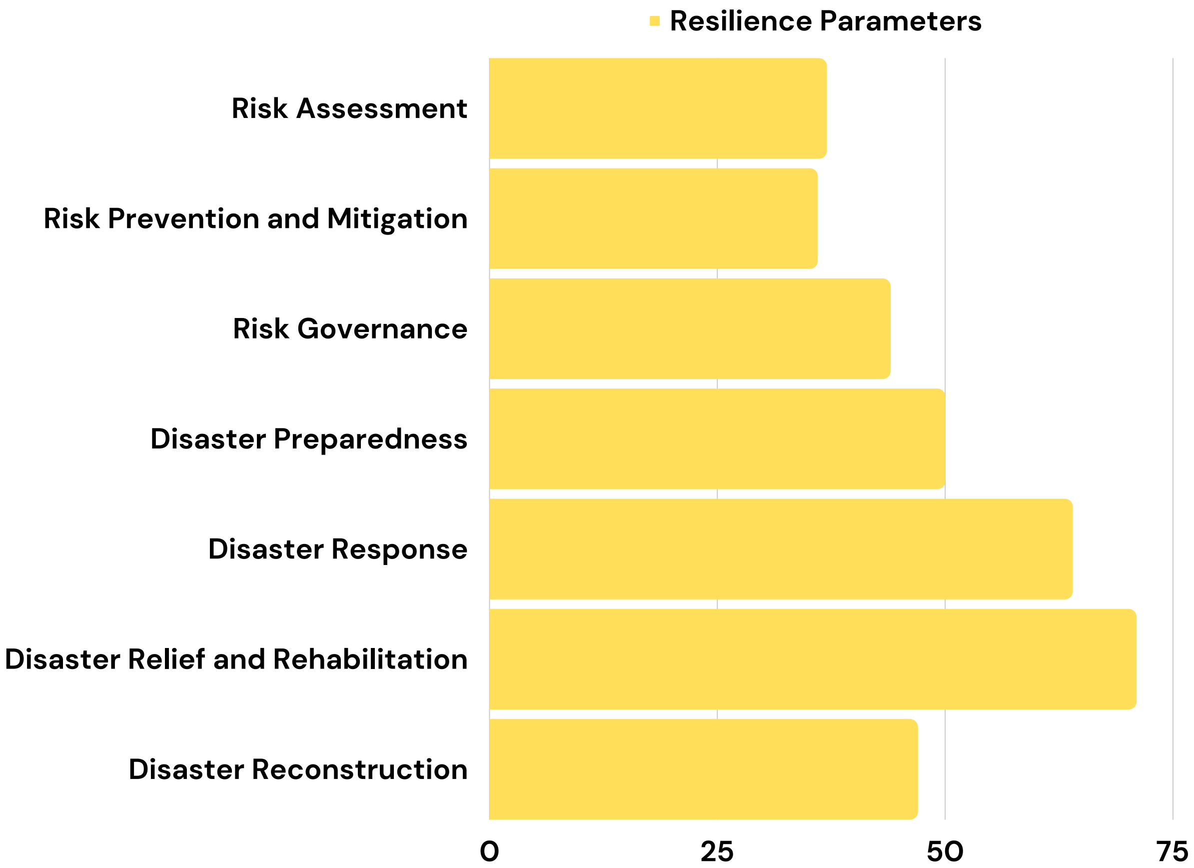


Figure 6
Disaster Resilience Scorecard for Srinagar City

9

CONCLUSION

The study showed that Srinagar city is more prone to Cold Waves, Earthquakes, Urban floods, Heat Waves, Drought, Industrial Hazards and Avalanches. Similarly, Srinagar city is more vulnerable to disasters in terms of Deforestation, Livestock, Elderly people and Water Stress. The study also revealed that the population of Srinagar have high exposure index for natural disasters such as Avalanche, Earthquake and Urban Floods, that may lead to an economic loss for the city.

The resilience score of the city is 49.10 on the scale of 100 make city is moderately resilient to the hazards occurred in the region due to the municipal, government and regional population combined efforts. Srinagar city performs best in terms of Disaster Relief and Rehabilitation and Disaster Response. While the city is in the last position out of all four cities in terms of 2 indicators out of 7 indicators of the disaster resilience score i.e., Risk Assessment, Risk Prevention and Mitigation. It is noteworthy to mention that Srinagar city is not susceptible to Cyclones, Tsunamis and Coastal Erosion events, due to its geographical and topographical features.

Srinagar city has highest risk occurrence for Earthquake, Cold Wave and Avalanche, among all the cities. Population density with 5337 persons per sq. km increases risks associated with hazards and makes city highly vulnerable for livestock, children, disabled, below poverty line, homeless, aged and women population. Deforestation, social and physical infrastructure are highly vulnerable to hazards in the city. The Srinagar city is less resilient scoreompratively due to low scores and least effort has been made in Risk assessment, Risk Prevention and Mitigation, Risk Governance, and Disaster Reconstruction. Therefore, city administration should enhance efforts to decrease risks associated with vulnerable population, infrastructure and provide improvement in policy making for disaster management plan to make the city risk resilient against multi-hazard disasters.

10

COMPARATIVE DISASTER RISK & RESILIENCE ASSESSMENT

The present study provides Multi-Hazard Disaster Risk and Resilience at the city level with a comparative analysis of Guwahati, Jaipur, Srinagar and Visakhapatnam cities. The risk index profiling of these cities is computed comparatively for different hazards, vulnerabilities and exposure parameters. In the statistical assessment for calculating the Disaster Risk Index (DRI), all the hazard indicators have been computed comparatively for all the cities.

All the vulnerability and exposure parameters except Buildings, Agriculture, Livestock, Social infrastructure, Deforestation, Women, Children, Poverty and Water stress have been computed comparatively for the cities. Thus, based on this assessment, Srinagar is at a higher risk for Cold Waves, Earthquakes, and Urban floods, while it is highly vulnerable to Deforestation, Livestock, Elderly people and Water Stress as compared to the other cities. For all 4 cities, hazard-specific risk indices for each of 14 hazards, have been aggregated with weights to work out the DRI, as shown in Figure 5.

The Disaster Resilience Score (DRS) computed exclusively for each city, based on the responses assessment, received by the city administration for the questionnaire regarding disaster management at city levels. The DRS for all the cities have been shown in Figure 6 and responses for questionnaire have been mentioned in Annexure 3. This study shows that the level of resilience to disasters in cities, is comparatively low and requires considerable improvement. Most of the existing level of resilience has been developed, during the past decade and a half, and it may be expected that the impacts of these initiatives will be felt in the years to come.

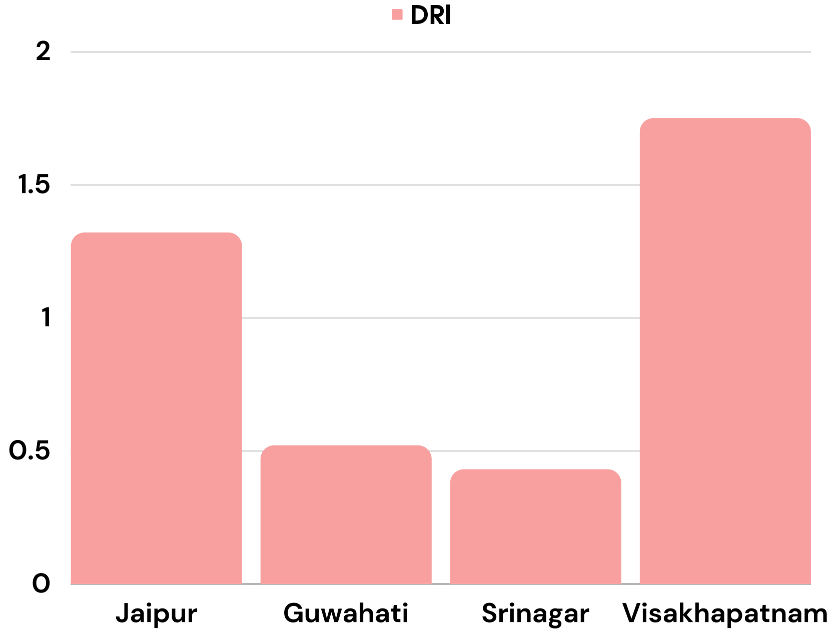


Figure 7
Disaster Risk Index

Based on DRI, the order of cities at risk is
Visakhapatnam > Jaipur > Guwahati > Srinagar

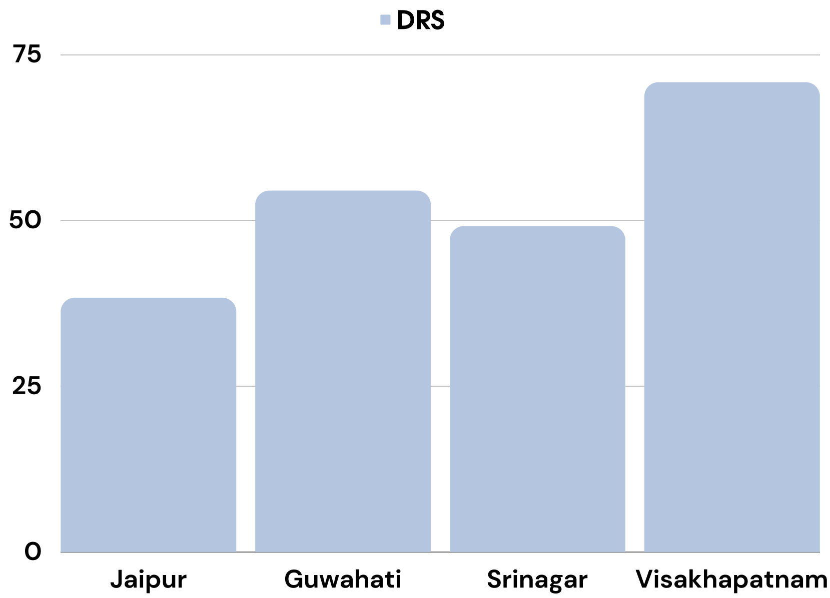
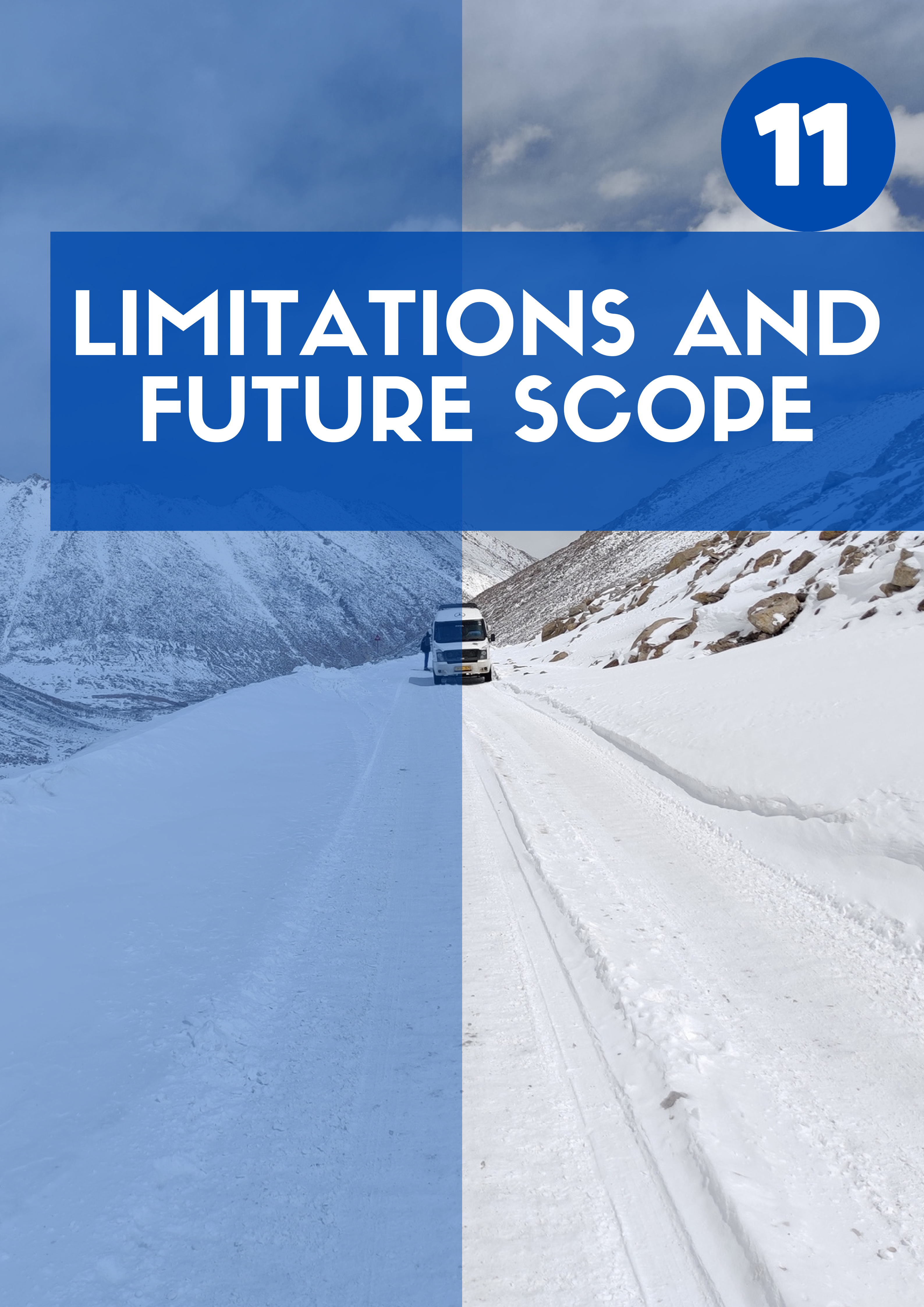


Figure 8
Disaster Resilience Score

Based on DRS, the order of cities at resilience is
Visakhapatnam > Guwahati > Srinagar > Jaipur

11

LIMITATIONS AND FUTURE SCOPE



The limitations are as follows:

- The city-level datasets for certain hazard, vulnerability and exposure indicators, are unavailable. Thus, district-level datasets are considered for 1 hazard indicator (Forest Fire) and 6 vulnerability indicators (Buildings, Agriculture, Livestock, Social infrastructure, Deforestation and Water stress) in the present study.

- Specific hazard datasets, like Landslide, Avalanche and Coastal erosion, were obtained from the national susceptible zone maps for respective hazard data, in the absence of data at the city levels.

- The risk analysis of the vulnerability of buildings is limited to significant materials, used for building walls and roofs. In contrast, other parameters, such as foundation designs, structural designs and quality & maintenance of structures have not been considered, as it is challenging to get datasets at a city scale.

The future scope can include:

- This study can be further extended at the town, municipality and village level to improve the mitigation measures and resiliency, against potential risks, at a micro-scale.

- This study uses 2 scorecards (Disaster Risk and Disaster Resilience Scorecard), as per the MHA-UNDP 2019, for 4 Indian cities. However, in the future, this study can be expanded to include all Indian cities. Disaster risk and resilience scorecards at the city level will undoubtedly play an essential role, in enhancing disaster resilience.

- This study can be further extended to impact assessment and representation of the impacts of disasters, by developing dashboards, interactive maps etc., to improve community awareness and preparedness for emergencies.

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ANNEXURE 1

Sources of Hazard, Vulnerability and Exposure Datasets

Table 34: Hazard datasets and their sources

S.No.	Parameter	Value	Sources
1	Area (Sq. Km)	232.35	https://iihs.co.in/
2	Earthquake Zone (Area)	II (232.35)	https://data.gov.in/resources/list-and-zone-factors-important-cities-towns-high-risk-earthquake-zone-and-moderate-risk; https://bmtpc.org/DataFiles/CMS/file/VAI2019/MAP/eqmap/EQ_JPG/EQ_INDIA.jpg
3	Landslide Zone (Area)	I (216.13), V (16.22)	https://bmtpc.org/topics.aspx?mid=56&Mid1=186
4	Heat Wave	Average Heat Index: 0.55; No. of HWs: 8; Length of Longest HW: 2; No. of Days with Heat Index > 54: 3	https://zenodo.org/record/3987736#.YfJvnP5BzIV
5	Cold Wave	9 (Less than – 4° Celsius)	Computed using Minimum temperature (Minimum temperature is derived from Indian Meteorological Department)
6	Forest Fire (District)	2228,139,292.571,273.86,704.14 Total area, very dense forest area, Dense Forest area, Open Forest area, Total Forest area in sq. km	https://www.fsi.nic.in/forest-report-2019
7	Lightning (Average)	0	https://ncrb.gov.in/en/accidental-deaths-suicides-in-india?field_adsi_year_value%5Bvalue%5D%5Byear%5D=2000&field_accidental_deaths_suicides_value=1&items_per_page=10
8	Industrial Hazards	11, 11, 40 (MAH industries, MPI industries, CEPI index)	https://cpcb.nic.in/displaypdf.php?id=Q1BBL05ld0l0ZW1fMTUyX0ZpbmFsLUJvb2tfMi5wZGY= (Refer page 26-28 for CEPI Score 2009)
9	Fire	2; 0; 2 (No. of cases; Injured; Died)	https://ncrb.gov.in/en/accidental-deaths-suicides-in-india?field_adsi_year_value%5Bvalue%5D%5Byear%5D=2000&field_accidental_deaths_suicides_value=1&items_per_page=10
10	Drought	0, 3, -0.276, 17, 33 (Drought-prone area, number of drought years, moisture index, frequencies of SSI, and SPI)	https://www.indiastatdistricts.com/, Drought computed for SSI, SPI and Moisture Index based on temperature, rainfall, and soil moisture data
11	Avalanche	I (88.43), II (13.27), IV (130.84)	https://link.springer.com/article/10.1007/s10346-006-0036-1

Table 35: Vulnerability datasets and their sources

S.No.	Vulnerability	Data Parameter	Values	Sources
1	Agriculture	Total area hectares, Cropped area, Irrigated area	1116149, 11354.60, 7798	http://ecostatjk.nic.in/Digest1314/6%20irrigation.pdf(Refer Page no:6)
2	Livestock	Total Animals, Bovine Animals, Other Animals	105746, 43199, 62547	https://dahd.nic.in/documents/statistics/livestock-census
3	Deforestation	Change in Dense Forest cover, Change in Open Forest cover (2001-2019) (in %)	5.277, -44.204	https://www.fsi.nic.in/forest-report-2019
4	Women	Sex Ratio, Illiteracy, WHH, MMR, CAW, Dependent	888, 55%, 8.06%, 200, 421, 89.63%	https://srinagar.nic.in/demography (Sex ratio), https://censusindia.gov.in/nada/index.php/catalog/2308 (Illiteracy) https://censusindia.gov.in/nada/index.php/catalog/2902 (WHH); https://www.nhm.gov.in/images/pdf/nrhm-in-state/state-wise-information/jammu-kashmir/jnk-report.pdf (Refer Page no:16 for MMR) https://ncrb.gov.in/sites/default/files/crime_in_india_table_additional_table_chapter_reports/Table%203B.1_4.pdf (CAW)
5	Children	Children population (0-6 years), (7-18 years), IMR, Non-school going children, Working children	158300, 270701, 51, 25700, 25700	https://censusindia.gov.in/census.website/data/population-finder (Common source for 0-6 and 7-18), https://www.nhm.gov.in/images/pdf/nrhm-in-state/state-wise-information/jammu-kashmir/jnk-report.pdf(Refer Page no: 16 for IMR) https://censusindia.gov.in/nada/index.php/catalog/16952 (number of children attending school)
6	Aged	Age group 60+, Age group 80+, Dependency Ratio	72363, 6994, 26.60%	https://censusindia.gov.in/nada/index.php/catalog/2308
7	Disabled	Visual, Hearing, Speech, Physical, Mental Disabled and Any other Disability	5307, 6602, 1270, 2703, 3028, 5034	https://censusindia.gov.in/nada/index.php/catalog/42520

S.No.	Vulnerability	Data Parameter	Values	Sources
8	Industries	Micro, Small and Medium Enterprises (MSME), Industrial clusters, Special Economic Zones (SEZ)	1000, 1, 0	http://dcmsme.gov.in/old/dips/DPS%20Srinagar.pdf(MSME, Page no. 6) http://www.jkslbc.com/pdf/guidlines/Lending%20to%20Micro,%20Small%20and%20Medium%20Enterprises%20Sector-28092018.PDF(Refer page no: 20 for cluster), http://sezindia.nic.in/upload/uploadfiles/files/n.pdf (For SEZs)
9	Depletion of mangroves	Change of mangrove cover during 2001-2020, Dense mangrove, Open mangrove	0	https://fsi.nic.in/isfr19/vol1/chapter3.pdf
10	Poverty	Rural, Urban BPL Population, Rural and Urban Homeless population (Lakhs)	10.51, 2.47, 8199, 10,848	https://censusindia.gov.in/nada/index.php/catalog/7239
11	Water stress	Surface Water (%), Moisture Index, Sub-Surface Water (Over-Exploited, Critical, Sub-critical, Safe)	0.99%, -0.275, (0,0,0,1)	http://cgwb.gov.in/gwresource.html

12. Physical Infrastructure

City	Length of roadways	Length of railways	No. of airports (Int+Domestic)	No. of airports (Domestic)	No. of seaports (Major)	No. of seaports (Minor)
Srinagar	2213	4	1	0	0	0

Source: https://www.indiastatdistricts.com/, http://ecostatjk.nic.in/Digest1314/17%20road%20and%20buildings.pdf

13. Social Infrastructure

City	Primary School	Secondary School	College	University	Engineering	Medical	Polytechnique	Dispensaries/ Health Centers	FW Centers	Hospital/Med-ical Schools
Srinagar	261	296	86	2	3	2	4	9	34	3

Source: https://censusindia.gov.in/census.website/data/handbooks

14 a. Material of Roof (% of buildings as per prominent materials used for roofs)									
City	Grass/ Thatch/ Bamboo / Wood/Mud etc.	Plastic/ Polythene	Handmade Tiles	Machine made Tiles	Burnt Brick	Stone/ Slate	G.I./Metal/ Asbestos sheets	Concrete	Any other material
Srinagar	1.7	0.4	1.1	0.1	0.2	1.3	88.9	4.9	1.4
Source: https://censusindia.gov.in/nada/index.php/catalog/9309									

14 b. Material of Wall (% of buildings as per prominent materials used for walls)										
City	Grass/ Thatch/ Bamboo etc.	Plastic/ Polythene	Mud/ Unburnt brick	Wood	Burnt Brick	Stone not packed with mortar	Stone packed with mortar	G.I./Metal/ Asbestos sheets	Concrete	Any other material
Srinagar	0.2	0.3	6.5	1.9	81.6	1.4	0.6	0.7	5.7	1.3
Source: https://censusindia.gov.in/nada/index.php/catalog/9309										

Table 36: Exposure datasets and their sources

12. Physical Infrastructure						
City	Population	Area in sq.km	Population Density	GDP in Cr.Rs.	Per Capita GDP	Remarks
Srinagar	30,70,000	232.35	5337	4,539,945	37533	https://censusindia.gov.in/census.website/data/population-finder

ANNEXURE 2

Statistical Note on Methodology

HAZARD INDEX COMPUTATION

1. Earthquake

Earthquake Hazard Index has been calculated as the weighted average of the prescribed values of the seismic hazard zones, where the weights are the percentage of the area, falling within a particular zone. Here X2= 2, X3= 4, X4= 6, X5= 10 is the intensity of the ith hazard zone, wi's are the percentage area of the city in the ith hazard zone, i = 2, 3, 4, and 5 in equation (i).

$$I = \frac{\sum_{i=2}^{5} w_i \times X_i}{\sum w_i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (i)$$

2. Landslide

Landslide Hazard Index has been calculated as the weighted average of the prescribed values of the landslide hazard zones, where the weightages are the percentage of the area falling within a particular zone. Here X1= 0, X2= 4, X3= 8, X4= 10 is the intensity of the ith hazard zone, wi's are the percentage of the area of the city in the ith hazard zone in equation (i).

$$I = \frac{\sum_{i=1}^{4} w_i \times X_i}{\sum w_i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (i)$$

3. Drought

The drought Hazard Index has been calculated as the average of the normalized scores of the parameters. For X1 (drought-prone area) and X2 (drought years), moisture index, X3 frequency of SSI and X4 frequency of SPI, have been normalized by dividing by the maximum value and multiplying by 10 to put on a scale of 0 to 10 using equation (i) (MHA-UNDP Report, 2019). Then, an average of all these parameters was taken, since equal weightage had been pre-specified.

$$X_i^* = 10 \times (X_i) / (\max (X_i)) \ldots\ldots\ldots\ldots\ldots\ldots (i)$$

$$I = \text{mean}\,(X_i^*)$$

4. Urban Flood

The urban flood index has been calculated, as the weighted average of the 3 prescribed indicators, which are the values of the percentage of flood-prone area, according to the mapping by BMTPC (2006)(BMTPC, 2011), using equation (i) and standardized by equation (ii), where w denotes the percentage of flood area in the risk zone and Y denotes the pre-specified score of the zones, as well as total number of flood-prone cities in the district, with a population greater than 1 Million and 10 Million, standardized by equation (iii), where the equal weightage had been pre-specified to every parameter.

$$X_i^* = (X_i)/10 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (i)$$

$$X_2^* = \frac{\sum_{i=1}^{5} w_i \times Y_i}{\sum w_i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (ii)$$

$$X_3^* = 10\times(X_3)/\ (\max\ (X_3)) \quad \ldots\ldots\ldots\ldots \quad (iii)$$

$$I = \frac{\sum_{i=1}^{3} w_i \times X_i^*}{\sum w_i}$$

5. Heat Wave

The first 3 parameters (annual average of the number of hot days, number of heat waves and length of longest heat wave), have been normalized by dividing by the maximum value and multiplying by 10, to put on a scale of 0 to 10 to equation (i). The average heat index, during the heat waves, has been normalized, according to equation (ii). Then, a simple average of all these parameters had been taken, to get the index, since equal weightage had been pre-specified.

$$X_i^* = 10\times(X_i)/\ (\max\ (X_i)) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (i)$$

$$X_4^* = 10\times(X_4\text{-}54)/\ (\max\ (X_4)\text{-}54) \quad \ldots\ldots\ldots\ldots\ldots \quad (ii)$$

$$I = \text{mean}\ (X_i^*)$$

6. Cold Wave

As per the India Meteorological Department (IMD, Pune) criteria, a cold wave is defined based on the actual minimum temperature of a station. Cold Wave is considered, when the minimum temperature of a station is, 4 degree Celcius or less for plains and -4°C or less for hilly regions. The cold wave index for days with cold wave events has been computed with equal weightage on a scale of 0 to 10, using equation (i). A simple average had been taken to get the index since equal weightage had been pre-specified.

$$X_i^* = 10\times(X_i)/(\max\ (X_i)) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (i)$$

$$I = \text{mean}\ (X_i^*)$$

7. Fire

The parameters, such as cases, deaths and injuries due to fire accidents, have been normalized by dividing with the maximum value and multiplying by 10, to put it on a scale of 0 to 10, using equation (i). Then, a simple average of all these parameters was taken, since equal weightage had been pre-specified. Since the data has been compiled at the city level, an assumption has been made that, the incidence is equally likely across all areas; hence, the areas with more population would be at a higher risk.

$$X_i^* = 10 \times (X_i) / (\max (X_i)) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. \ (i)$$

$$I = \text{mean} (X_i^*)$$

8. Forest Fire

We obtained a multiplier, which has been defined as the weighted average of proportions of "very dense", "dense" and "open" forest cover, in the district (area of forest category in the district divided by total forest cover in the district), where the weightage had been pre-specified. The multiplier is strictly between 0 and 1 using equation (i). Then, this multiplier is multiplied with the pre-assigned score associated with the risk category of the district, to get the hazard index.

$$X_i^* = 10 \times (X_i) / (\max (X_i)) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. \ (i)$$

$$I = \text{mean} (X_i^*)$$

9. Industrial Hazard

The first 2 parameters (i.e., Maximum Hazard Industries and Maximum Polluting Industries) have been normalized by dividing with the maximum value and multiplying with 10, to put on a scale of 0 to 10 using equation (i). The CEPI (Comprehensive Environmental Pollution Index) has been rescaled on a scale of 10, which is 10 for CEPI>80, 8 for CEPI>70, 60 for CEPI>60, and 4 for CEPI>50, 2 for CEPI<50. Then, a weighted average of all these parameters was taken, where the weights had been pre-specified as 50%:25%:25%.

$$X_i^* = 10 \times (X_i) / (\max (X_i)) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. \ (i)$$

$$I = \frac{\sum_{i=1}^{3} w_i \times X_i^*}{\sum w_i}$$

10. Lightning

The average annual deaths have been normalized by dividing with the maximum value and multiplying with 10, to put it on a scale of 0 to 10 using equation (i). Since the data has been compiled at the district level, an assumption has been made that, the incidence is equally likely across the city; hence the city with more population would be at a higher risk.

$$X_i^* = 10 \times (X_i) / (\max(X_i)) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ldots. \quad (i)$$

$$I = \text{mean}\,(X_i^*)$$

11. Avalanche

Avalanche Hazard Index has been calculated as the weighted average of the prescribed values of the seismic hazard zones, where the weightage are the percentage of area falling within a particular zone. Here X1= 0, X2= 4, X3= 6, X4= 8, X5=10 is the intensity of the ith hazard zone and wi's are percentage of area of city in the ith hazard zone as shown in equation (i).

$$I = \frac{\sum_{i=1}^{5} w_i \times X_i}{\sum w_i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (i)$$

VULNERABILITY INDEX COMPUTATION

1. Buildings

a. Walls

In order to capture the effect, each particular hazard has, on each specific type of wall, the following coding has been used: X: {VH = 10, H = 8, M = 6, L = 4, VL = 2} and each hazard index has been categorized according to 5 risk zones. A weighted average of these, have been taken, where the weightages are the proportion of a particular wall type in all houses of the district.

b. Roofs

In order to capture the effect, each particular hazard has, on each specific type of roof, the following coding has been used: X: {VH = 10, H = 8, M = 6, L = 4, VL = 2} and each hazard index has been categorized, according to 5 risk zones. A weighted average of these have been taken, where the weightages are the proportion of a particular roof type in all houses of the district.

2. Agriculture

For agriculture, the net non-irrigated cropped area (total cropped area–irrigated area) and irrigated area, have been normalized by dividing with the district's total area and multiplying with 10, to put on a scale of 0 to 10, using equation (i). Then, a weighted average of all these parameters was taken, where the weightage had been pre-specified as 80% on the former and 20% on latter. (: Cropped area, : Irrigated area, : Total area)

$$I_a = 0.8 \times (X_c - X_i)/X_t + 0.2 \times X_i/X_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (i)$$

3. Poverty

All parameters (rural and urban BPL and Homeless population) have been normalized by dividing with the maximum value and multiplying with 10, on a scale of 0 to 10 using equation (i). Then, a simple average of all these parameters was taken, since equal weightage had been pre-specified.

$$X_i^* = 10 \times (X_i) / (\max(X_i)) \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (i)$$

$$I = \text{mean}\,(X_i^*)$$

4. Women

All parameters have been normalized by dividing with the maximum value and multiplying with 10, to put them on a scale of 0 to 10, according to equation (i). Then, a simple average of all these parameters was taken, since equal weightage had been pre-specified.

$$X_i^* = 10\times(X_i - \min(X_i))/(\max(X_i)-\min(X_i)) \ldots\ldots\ldots\ldots \quad (i)$$

$$I = \text{mean}(X_i^*)$$

5. Children

All parameters have been normalized by dividing with the maximum value and multiplying with 10, to put them on a scale of 0 to 10, according to equation (i). Then, an average of groups of these parameters was taken, since equal weightage had been pre-specified. Within each group, a weighted average of each of the parameters in the group has been taken, where the weightage had been pre-specified. This has been done twice, once with absolute numbers and once with percentages. Then, a geometric mean of both these indices was taken to obtain the final index.

$$X_1^* = 10\times(X_i - \min(X_i))/(\max(X_i)-\min(X_i)) \ldots\ldots\ldots\ldots \quad (i)$$

$$I_1 = \text{mean}(X_i^*)$$

$$I_2 = \text{mean}(X_i^*)$$

$$I = \text{geo mean}(I_1, I_2)$$

6. Disability

All parameters have been normalized by dividing with the maximum value and multiplying with 10, to put them on a scale of 0 to 10, according to equation (i). Then, a simple average of all these parameters was taken, since equal weightage had been pre-specified. This has been done twice, once with absolute numbers and once with percentages. Then, a geometric mean of both these indices was taken to represent the final index.

$$X_1^* = 10\times(X_i - \min(X_i))/(\max(X_i)-\min(X_i)) \ldots\ldots\ldots\ldots \quad (i)$$

$$I_1 = \text{mean}(X_i^*)$$

$$I_2 = \text{mean}(X_i^*)$$

$$I = \text{geomean}(I_1, I_2)$$

7. Aged

All parameters have been normalized by dividing with the maximum value and multiplying with 10, to put them on a scale of 0 to 10, according to equation (i). Then, a simple average of all these parameters was taken, since equal weightage had been pre-specified. This has been done twice, once using absolute numbers and once using percentages. Then, a geometric mean of both these indexes was taken to represent the final index.

$$X_1^* = 10\times(X_i - \min(X_i))/(\max(X_i) - \min(X_i)) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (i)$$

$$I_1 = \text{mean}\ (X_i^*)$$

$$I_2 = \text{mean}\ (X_i^*)$$

$$I = \text{geo mean}\ (I_1, I_2)$$

8. Livestock

For livestock, the number of bovine animals and other animals, has been normalized by dividing with the total number of the district and multiplying with 10, to put it on a scale of 0 to 10, using equation (i). Then, a weighted average of all these parameters was taken, where the weightage had been pre-specified as 75% on the former and 25% on the latter.

(X_b : No. of bovine animals, X_o : No. of other animals, X_t : Total No. of animals)

$$I_a = 0.75 \times (X_b)/X_t + 0.2\times X_o/X_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (i)$$

9. Industries

The total number of industries, industrial clusters, and SEZs, has been normalized by dividing with the maximum value and multiplying with 10, to put on a scale of 0 to 10, equation (i). Then, a weighted average of all these parameters was taken, where the weightage had been pre-specified as 40%:40%:20%.

$$X_i^* = 10\times(X_i)/(\max(X_i)) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (i)$$

$$I = \frac{\sum_{i=1}^{3} w_i \times X_i^*}{\sum w_i}$$

10. Physical Infrastructure

All parameters have been normalized by dividing with the maximum value and multiplying with 10, to put on a scale of 0 to 10, using equation (i). Then, a simple average of groups of these parameters (Road & Rail Connectivity, Sea and Air Connectivity) was taken, since equal weightage had been pre-specified using equation (ii). Within each group, a simple average of each of the parameters in the group has been taken.

$$X_i^* = 10 \times (X_i) / (\max(X_i)) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{(i)}$$

$$Y_j = \text{mean}\ (X_i : X_i \in j^{th}\ \text{group}) \ldots\ldots\ldots\ldots\ldots\ldots \textit{(ii)}$$

$$I = \text{mean}\ (Y_j)$$

11. Social Infrastructure

All parameters have been normalized by dividing with the maximum value and multiplying with 10, to put on a scale of 0 to 10, using equation (i). Then, a simple average of groups of sub-groups of these parameters (Educational Institutions and Health Institutions), was taken, since equal weightage had been pre-specified using equation (ii). Within each group, a simple average of each of the sub-group of parameters has been taken. Within each sub-group, a simple average of each of the parameters, in the sub-group has been taken.

$$Y_j = \text{mean}\ (X_i : X_i \in j^{th}\ \text{subgroup}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{(i)}$$

$$Z_j = \text{mean}\ (Y_i : Y_i \in j^{th}\ \text{group}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{(ii)}$$

$$I = \text{mean}\ (Z_j)$$

12. Deforestation

All parameters of change (dense & open) have been normalized by dividing with the maximum value and multiplying with 10, to put it on a scale of 0 to 10, according to equation (i). Then, a simple average of all these parameters was taken, since equal weightage had been pre-specified.

$$X_1^* = 10 \times (X_i - \min(X_i)) / (\max(X_i) - \min(X_i)) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{(i)}$$

$$I = \text{mean}\ (X_i^*)$$

13. Water Stress

All parameters of change have been on a scale of 0 to 10 according to equations (i), (ii), and (iii). Then, a simple average of all these parameters was taken, since equal weightage had been pre-specified.

$$X_1^* = 10\times(\max(X_1) - X_1)/\ (\max(X_1)\text{-}\min(X_1)) \ldots\ldots\ldots\ldots\ldots \quad (i)$$

$$X_2^* = (100 - X_2)/\ (100) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (ii)$$

$$X_3^* = \left(\frac{\sum_i^3 w_i \times X_i}{\sum w_i}\right) \ldots\ldots\ldots\ldots\ldots\ldots \quad (iii)$$

$$I = \text{mean}\ (X_i^*)$$

EXPOSURE INDEX COMPUTATION

Two parameters have been considered for calculating the Exposure Index. These are

(a) population density (=Population /Area in km^2) and

(b) per capita GDP (=GDP (in Cr. Rs.) / Population) of a city.

Both parameters have been normalized by dividing with the maximum value and multiplying with 10, to put them on a scale of 0 to 10, according to equation (i).

Then, a simple average of these parameters was taken, since equal weightage has been given on both the parameters.

$$X_i^* = 10\times(X_i)/\ (\max\ (X_i)) \ldots\ldots\ldots\ldots\ldots\ldots \quad (i)$$

$$I = \text{mean}\ (X_i)$$

ANNEXURE 3

Disaster Resilience Questionnaire Responses

1. Risk Assessment (Weights 10%)

	Indicators/Questions	Aggregate Points	Points Assigned
1.1	Hazard Vulnerability Risk Assessment	10	6
1.2	Digital Risk Mapping in Public Domain	5	1
1.3	Real Time Data on Risks and Disasters	5	1
1.4	Micro Zonation of Earthquake Risks	3	0.5
1.5	Flood Risk Assessment	3	2
1.6	Drought Risk Assessment	5	0
1.7	Dissemination of Risk Information to People	3	1
1.8	Assessing Traditional and Local Knowledge	3	2.5
1.9	Assessing Patterns of Emerging Risks	3	1
1.10	Developing Database on Disasters	5	1
	Others	5	2.5

2. Risk Prevention & Mitigation (Weights 20%)

	Indicators/Questions	Aggregate Points	Points Assigned
2.1	Disaster Risk Mitigation Projects	8	4
2.2	Mainstreaming DRR in Development	3	1
2.3	State and Disaster Risk Mitigation Fund	3	2
2.4	Safety standards for constructions and land use	7	2
2.5	Safety audit/ retrofitting of lifeline infrastructure/ buildings	8	3
2.6	Construction of cyclone/ flood shelters	3	0.5
2.7	Eco System Approach for Disaster Risk reduction	3	1
2.8	Social Safety Net for Poor and Vulnerable	5	1.5
2.9	Mitigation of risks of heritage	2	0.5
2.10	Integration of climate change adaptation with DRR	3	0.5
	Others	5	2

3. Risk Governance (Weights 20%)		Indicators/Questions	Aggregate Points	Points Assigned
	3.1	Institutional mechanisms for risk governance	6	2
	3.2	Disaster Management Policy and Plans	10	6
	3.3	Disaster Management Manuals and Procedures	2	0.5
	3.4	Decentralization and Devolution of Functions	2	0.5
	3.5	Training and Capacity Development	10	7
	3.6	Multi-Stakeholder Platform	2	0.5
	3.7	Community Involvement and Participation	5	2
	3.8	Enforcement and Compliance	4	0.5
	3.9	Monitoring and Evaluation	2	0.25
	3.10	Transparency and Accountability	2	0.25
		Others	5	2.5

4. Disaster Preparedness (Weights 20%)		Indicators/Questions	Aggregate Points	Points Assigned
	4.1	End-to-End Early Warning Systems	5	2
	4.2	Emergency Operation Centers	5	3
	4.3	Disaster Communication System	5	2
	4.4	Emergency Medical Preparedness	5	3
	4.5	Scenario Building, Simulation and Mock Drills	5	3
	4.6	Contingency Plans, SOPs, Manuals	5	2
	4.7	Community Based Disaster Preparedness	5	3
	4.8	Awareness Generation	5	3
	4.9	Resource Inventory	3	1.5
	4.10	Media Partnership	2	0.5
		Others	5	2

5. Disaster Response (Weights 10%)		Indicators/Questions	Aggregate Points	Points Assigned
	5.1	State Agencies for Disaster Response	10	8
	5.2	Incident Response System	4	1
	5.3	Coordination with GOI, NDRF Armed, Forces	2	2
	5.4	Evacuation, Search and Rescue	7	5
	5.5	Emergency Medical Response	5	3
	5.6	Emergency Support Functions	5	2
	5.7	Protection of vulnerable women and children	5	2
	5.8	Disposal of dead bodies	3	3
	5.9	Disposal of Animal Carcasses	2	2
	5.10	Disposal of Debris	2	1
		Others	5	3

6. Disaster Relief & Rehabilitation (Weights 15%)		Indicators/Questions	Aggregate Points	Points Assigned
	6.1	Minimum Standard of Relief	2	1.5
	6.2	Ex-gratia Relief	1	1
	6.3	Relief Logistics and Supply Chain Management	7	5
	6.4	Food and Essential Supplies	7	5
	6.5	Drinking Water, Dewatering and Sanitation	7	6
	6.6	Health and Mental Health Care	7	5
	6.7	Management of Relief Camps	5	4
	6.8	Veterinary Care	3	2
	6.9	Relief Employment	3	1
	6.10	Temporary and Intermediary Shelters	3	2
		Others	5	3

7. Disaster Reconstruction (Weights 5%)		Indicators/Questions	Aggregate Points	Points Assigned
	7.1	Damage and Loss Assessment	5	4
	7.2	Post Disaster Needs Assessment	5	3
	7.3	Financing Reconstruction	5	2.5
	7.4	Institutional Mechanisms for Reconstruction	5	2
	7.5	Building Back Better	5	2
	7.6	Reconstruction of Houses	5	2
	7.7	Reconstruction of Infrastructure	5	2
	7.8	Livelihood Reconstruction	5	1.5
	7.9	Regeneration of Ecology and Environment	3	1
	7.10	Learning from Reconstruction and Recovery	2	0.5
		Others	5	3

CITY RESILIENCE

About the Institute

National Institute of Disaster Management (NIDM) was constituted under an Act of Parliament with a vision to play the role of a premier institute for capacity development in India and the region. The efforts in this direction that began with the formation of the National Centre for Disaster Management (NCDM) in 1995 gained impetus with its redesignation as the National Institute of Disaster Management (NIDM) for training and capacity development. Under the Disaster Management Act 2005, NIDM has been assigned nodal responsibilities for human resource development, capacity building, training, research, documentation and policy advocacy in the field of disaster management.

NIDM is proud to have a multi-disciplinary core team of professionals working in various aspects of disaster management. In its endeavour to facilitate training and capacity development, the Institute has state-of-the-art facilities like class rooms, seminar hall and video-conferencing facilities etc. The Institute has a well-stocked library exclusively on the theme of disaster management and mitigation. The Institute provides training in face-to-face, on-line and self-learning mode as well as satellite based training. In-house and off-campus face-to-face training to the officials of the state governments is provided free of charge including modest boarding and lodging facilities.

NIDM provides Capacity Building support to various National and State level agencies in the field of Disaster Management & Disaster Risk Reduction. The Institute's vision is to create a Disaster Resilient India by building the capacity at all levels for disaster prevention and preparedness.

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Resilient India - Disaster Free India

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