DESIGN OF NATIONAL SEISMIC RISK MITIGATION PROGRAMME (NSRMP)

INCEPTION REPORT

Report # NDMA 01-001

Version 1.0

September 2019

Consultancy Project Implemented by Joint Venture of

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DDF-AKDN (JV)

For Designing National Seismic Risk Mitigation Programme (NSRMP)" by Project Management Unit (PMU) of National Disaster Management Authority (NDMA), Government of India (GoI).

Ref. No.L-DDF-AKDNJV-NDMA-19-001
Date: 11 Sept 2019

To,

Project Director,
National Cyclone Risk Mitigation Project (NCRMP),
National Disaster Management Authority (NDMA),
Ministry of Home Affairs, Govt. of India.
A-1, Safdarjung Enclave, NDMA Bhawan,
New Delhi-110029.

Subject - Submission of Inception Report (Deliverable # 1).

Project: Design of National Seismic Risk Mitigation Programme (NSRMP).

Reference – Contract # IN-NDMA-59365-CS-QCBS
Attachment - Inception Report (Report # NDMA 01-001)

Dear Sir,

It is our pleasure to submit the inception report, the first committed output towards the project implementation. The inception report details and confirms the approach, methods and modality to undertake the project as per the contract agreement. The inception report discusses briefly project outlines, hazard and risk profile of the states, recommendations for programme fund allocation, components design methodologies, proposed broad work plan, Monitoring and Evaluation (M&E) and reporting mechanism. We extend gratitude to NDMA to render active support and coordination with relevant stakeholders to move forward with our planning.

The report along with this letter is submitted for your appraisal and approval and further release first lot of instalment.

Thanking you,

With warm regards,

Dr. Amit Kumar
Team Lead
NSRMP-NDMA Project.

Enclosure: 3 Copies of the Inception Report.

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DESIGN OF NATIONAL SEISMIC RISK MITIGATION PROGRAMME (NSRMP)

INCEPTION REPORT

Contact No. IN-NDMA-59365-CS-QCBS
Report # NDMA 01-001

September 2019

Supported by

National Disaster Management Authority (NDMA)

Prepared by

A Joint Venture between DDF Consultants Private Limited (DDF) and Aga Khan Agency for Habitat India (AKDN) (DDF-AKDN JV)

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This report is prepared by DDF-AKDN JV (Joint Venture between DDF Consultants Private limited and Aga Khan Agency for Habitat India) in accordance with the terms and conditions of an assignment on "Consultancy Services for Designing National Seismic Risk Mitigation Programme (NSRMP)" awarded by National Disaster Management Authority (NDMA) to the consultant.

The data used in this report has been obtained from different agencies. Some data has also been collected by the consultant during preparation of the report.

Every care has been taken to ensure that the data is correct, consistent and complete as far as possible. However, the constraints of time and resources available, do not preclude the possibility of errors, omissions etc. in the data and consequently in the report preparation.

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The contents of this report are not to be used by any third party. The consultant will not be responsible for any use of or reliance on the contents of this report by any third party.

DOCUMENT CIRCULATION

Consultancy Details	Consultancy Services for Designing National Seismic Risk Mitigation Programme (NSRMP)
Report Version	Version One, Submitted on September 10, 2019
Client	Project Director National Cyclone Risk Mitigation Project (NCRMP) National Disaster Management Authority (NDMA) (Ministry of Home Affairs, Govt. of India) A-1, Safdarjung Enclave, New Delhi-110029
Period of Consultancy	12 months
Project Coordinator	Dr. Amit Kumar Team Leader
Consultant	DDF-AKDN JV A Joint Venture between DDF Consultants Private Limited (DDF) and Aga Khan Agency for Habitat India (AKDN) 501, B-09, ITL Twin Towers, Netaji Subhash Place, Pitampura New Delhi, India.

ACKNOWLEDGEMENT

The consultant would like to extend gratitude to the National Disaster Management Authority (NDMA) for extending overall management and coordination support to implement the project. The team appreciates the World Bank for their funding support. The project extends thanks to the SDMA State Project Officers for their active support and involvement.

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ACRONYMS

AKDN	Aga Khan Agency for Habitat India (An Agency of the Aga Khan Development Network)
ASDMA	Assam Disaster Management Authority
BIS	Bureau of Indian Standard
BMPTC	Building Material and Technology Promotion Council
BSNL	Bharat Sanchar Nigal Limited
cm	centimetre
CMS	Central Monitoring Station
CRORE	10^7
DDF	DDF Consultants Pvt. Ltd.
DHQ	District Headquarter
DPR	Detailed Project Report
DRI	Disaster Risk Index
DSC	Disaster Score Card
EEW	Earthquake Early Warning
EEWDS	Earthquake Early Warning Dissemination System
EEWS – ERS	Earthquake Early Warning System – ERS
ESA	Environment & Social Assessment
EWDS	Early Warning Dissemination System
EWS	Early Warning System
FCM	Fibrebase Cloud Messaging
GLOF	Glacial Lake Outburst Flood
GMT	Generic Mapping Tool
GoI	Government of India
GSDP	Gross State Domestic Product
HFT	Himalayan Frontal Thrust
IEC	Information Education and Communication
JV	Joint Venture
kg	kilogram
km	kilometre
m	metre
M&E	Monitoring and Evaluation
MBMS	Multimedia Broadcast and Multicast Services
MHA	Ministry of Home Affaire
MILLION	10^6
MTNL	Mahanagar Telephone Nigam Ltd.
NCPE	National Council of Professional Engineers
NCRMP	National Cyclone Risk Mitigation Project
NDMA	National Disaster Management Authority
NDT	Non Destructive Test
NEOC	National Emergency Operation Center
NIC	National Informatics Center
NICNET	National Informatics Centre Network
NSRMP	National Seismic Risk Mitigation Programme

NTP	Network Time Protocol
OFC	Optical Fibre Cable
OGD	Open Government Data
OGDP	Open Government Data Programme
PIU	Project Implementation Unit
PIU	Project Implementing Units
PMU	Project Monitoring Unit
PPSD	Project Procurement Strategy for Development
PPSD	Project Procurement Strategy for Development
QAQC	Quality Assurance and Quality Control
Rs.	Indian Rupees (INR)
RVS	Rapid Visual Screening
SCR	Social Corporate Responsibility
SDBR	Structural Design Based Report
SDMA	State Disaster Management Authority
SDRF	State Disaster Response Force
SDRF	State Disaster Response Fund
SEOC	State Emergency Operation Centre
SEOC	State Emergency Operations Center
SPIU	State Project Implementation Unit
SPIU	State Project Implementation Unit
sq.km	square kilometre
SWAN	State Wide Area Network
TDU	Technology Demonstration Units
TOR	Terms of Reference
UNDP	United Nations Development Programme
UT	Union Territory
VPN	Virtual Private Network

GLOSSARY

Avalanches	A mass of snow, ice, and rocks falling rapidly down a mountainside.
Capacity Building	Process by which individuals and organizations obtain, improve, and retain the skills, knowledge, tools, equipment and other resources needed to do their jobs competently.
Client	National Disaster Management Authority (NDMA)
Component	One of several parts that together make up a whole machine, system etc.
Consultant	DDF-AKDN JV (Joint Venture between DDF Consultants Private Limited and Aga Khan Agency for Habitat India (an agency of AKDN))
Disaster Resilience	Disaster resilience is the ability of individuals, communities, organisations and states to adapt to and recover from hazards, shocks or stresses without compromising long-term prospects for development.
Disaster Resilience Index	Disaster Resilience Index is calculated based on broadly seven weighted parameters such as Risk Assessment, Prevention and Mitigation and Governance and Disaster Preparedness, Relief and Rehabilitation, Response and Reconstruction
Disaster Risk Index (DRI)	The Disaster Risk Index is calculated using parameters such as Hazard Index, Vulnerability Index and Exposure Index. A scale of 0 to 10 for each of 14 hazards, 14 vulnerabilities and 2 exposures in each of 640 census districts of the country and the score of each state helps to perceive an idea of the present vulnerability of the State.
Dissemination	To spread or give out something, especially news, information, ideas etc., to a lot of people
Earthquake	An earthquake is a series of vibrations on the earth's surface caused by the generation of elastic (seismic) waves due to sudden rupture within the earth during release of accumulated strain energy.

EEWDS	Earthquake Early Warning Dissemination System is capable to issue public warning to a large region in case of major earthquake.
Environment and Social Management	An Environmental and Social Management System is a set of policies, procedures, tools and internal capacity to identify and manage a financial institution's exposure to the environmental and social risks of its clients/investees.
Evacuation	Temporary but rapid removal of people from building or disaster (or threatened) area as a rescue or precautionary measure
Evaluation	Evaluation is a systematic determination of a subject's merit, worth and significance, using criteria governed by a set of standards
Financial Management	Financial Management means planning, organizing, directing and controlling the financial activities such as procurement and utilization of funds of the enterprise.
Funding Agency	The World Bank
Geotechnical	Relating to the type of civil engineering that is concerned with rocks and soil
Hazard	A hazard is an agent which has the potential to cause harm to a vulnerable target.
Landslides	A collapse of a mass of earth or rock from a mountain or cliff.
Liquefaction	Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading.
Mainstream	The ideas, attitudes, or activities that are shared by most people and regarded as normal or conventional.
Methodology	*Methodology* is the systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge.

Mitigation	Measures aimed at reducing the risk, impact or effects of a disaster or threatening disaster situation.
Modules	One of a set of separate parts that, when combined, form a complete whole
Non-destructive Test	Non-destructive Test is a analysis technique used to evaluate the properties of a material, component, structure or system without causing damage.
Procurement Management	Procurement management is the project process that includes the processes necessary to get things and services needed for the project to run smoothly and achieve its objectives
Project	National Seismic Risk Mitigation Programme (NSRMP)
Regime	A particular government or a system or method of government
Retrofitting	*Retrofitting* refers to the addition of new technology or features to older systems to add on strength
Risk Assessment	The determination of the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods, and the environment.
Risk Management	The systematic process of using administrative decisions, organisation, operational skills, and capacities to implement policies, strategies, and coping capacity of the society and communities to lessen the impact of hazards.
Risk Mitigation	Risk mitigation is a strategy to prepare for and lessen the effects of threats faced by any disaster.
Scope	The opportunity or possibility to do or deal with something
Seismic Retrofitting	The structural modifications to upgrade the strength, ductility and energy dissipating ability of seismically deficient or earthquake-damaged structures.

Stakeholders	A group, corporate, organization, member, or system that affects or can be affected by an organization's actions.
Stringent	The process of judging something's quality, importance, or value, or a report that includes this information
Timelines	A graphical representation of a period of time, on which important events are marked
Tsunami	A tsunami is a series of waves caused by earthquakes or undersea volcanic eruptions.

EXECUTIVE SUMMARY

The Project

National Disaster Management Authority (NDMA) has awarded a consultancy project for Designing National Seismic Risk Mitigation Programme (NSRMP) under the National Cyclone Risk Mitigation Project, Phase-II under contact No. IN-NDMA-59365-CS-QCBS to DDF-AKDN JV, a Joint Venture between DDF Consultants Private Limited (DDF) and Aga Khan Agency for Habitat India (AKDN).

This inception report deals with the objectives, background components & deliverables and operation & management of the project.

Inception Report Objective

The inception report is the first project deliverable, which details and confirms the approach, methods and modality to undertake the project as per the contract agreement. The inception report discusses briefly project outlines, hazard and risk profile of eight states, recommendations for programme fund allocation, components design methodologies, proposed work plan, Monitoring and Evaluation (M&E) and reporting mechanism.

Project Background

The Consultancy Services for Designing National Seismic Risk Mitigation Programme (NSRMP) emanates from the National Cyclone Risk Mitigation Project, Phase-II outcomes. The project is being implemented under the aegis of National Disaster Management Authority, Government of India, under the financial support of the World Bank.

The aim of NSRMP is to reduce vulnerability of communities and their assets to earthquake disaster by taking appropriate mitigating measures and to strengthen the capacity of national and state entities to effectively plan for and respond to earthquakes. The overall objective of NSRMP is to improve preparedness for a potential earthquake through (a) enhancing the institutional and technical capacity for disaster management, (b) emergency response, (c) strengthening critical public facilities for earthquake resistance and (d) supporting measures for better enforcement of building codes. The specific objectives for the proposed project includes 1) supporting the Project Management Unit (PMU), NDMA in preparing and appraising the projects as outcome of various project components, 2) assist the state entities in formulating the investment program and preparing implementation ready proposals/projects with full detailing including social and environmental assessments and 3) provide technical assistance and training to states on technical, financial, environment, social management and fiduciary aspects. Major geographical areas of the select eight states i.e., Assam, Bihar, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Manipur, Tripura and Uttarakhand are located in seismic Zones V & IV.

Project Components and Deliverables

The consultancy project's key deliverables are divided into four components consisting of

1) Component A: subdivided into
   A1: Design Earthquake Early Warning Dissemination System and
   A2: Design Enhancing Emergency Response Capacity,
2) Component B: Detailed project report on Multi-Hazard Risk Mitigation of Infrastructure,
3) Component C: Design Technical Assistance to Improve Disaster Risk Management and
4) Component D: Develop Project Management, Monitor and Implementation Support.

The deliverables are envisioned to be developed in close consultation with national and state stakeholders, following the national prevailing systems, laws, guidelines and manuals.

Component A comprises of two major activities. First activity is to design earthquake early warning dissemination system (EEWDS) to recommend the design options for early detection of earthquake events, alert creation and dissemination to the community to reduce losses of life and property. Further, it provides detailed design and operational framework of EEWDS for eight states. Second activity under this component includes enhancing emergency response capacity by thorough review of state existing response functions, understand their requirements and identify the list of equipment and tools for effective emergency response along with capacity building manual for the first responders.

Component B primarily focuses on multi-hazard risk mitigation of infrastructure. The component is specific to earthquake vulnerability assessment based retrofitting design of critical emergency response buildings and infrastructure used during the disaster events for emergency evacuation. These infrastructures include critical buildings, bridges, helipads, fire stations etc. The vulnerability assessment based structural retrofitting design will be aligned to national building codes and guidelines.

Component C is pivoted around improving disaster risk reduction with specific emphasis on earthquake risk. This component will broadly develop draft bill for National Council of Professional Engineers (NCPE), recommending Centre of Excellence for earthquake research and development, Information, Communications and Education (ICE) material for earthquake risk mitigation and designing training modules for engineers/ architects/ masons etc.,

Component D deals with program implementation, monitoring and evaluation, staff capacity building and training, including preparation of training materials and manuals, project manuals, documentation, quality monitoring, project management support (including environmental and social monitoring) to the participating States and the Project Monitoring Unit (PMU), NDMA. This component integrates all three components discussed and enables PMU, NDMA and State Project Implementation Units (SPIUs) to use as instrument to monitor and manage. The topics covered under this head will involve Procurement Management, Financial Management, Environment & Social Management followed by developing a Management Information System.

Project Operation and Management

For effective operation of the consultancy project, organization setup is proposed which is coordinating with the client (NDMA), SPIUs, relevant stakeholders, along with the technical subject experts. The total size of NSRMP in the current phase is Rs. 5,000 crores for implementation of mitigation measures and capacity upgradation of all eight states under the program. Out of Rs. 5,000 crores to be spent under this phase of NSRMP, Rs. 1,300 crores is to be used for activities related to upgradation and capacity building components that fall under Component A and Component C of this project, whereas Rs. 3,700 crores is meant for risk mitigation measures in the identified 8 states under Component B. It is required to prepare and submit DPRs / Bid Documents for approximately Rs. 1,850 crores ($\pm$10%) whereas for the balance amount of Rs. 3,700 crores allocated under Component B, the respective State Governments are required to prepare DPRs / Bid Documents themselves. The report recommends various methods and options which will enable NDMA to finalize the fund allocation by each state for this ambitious project. Further, the report will recommend a set of qualifying key parameters for selection of buildings and infrastructure for detailed vulnerability assessment and retrofitting design as appropriate. As per the project, all components deliverables are expected to be completed within one year, provided all conditions are favourable as planned. The team is carefully planning and analysing all components and their

activities for effective and efficient planning. The project intends to have detailed and robust monitoring and evaluation and reporting mechanism.

Report Structure

Chapter 1 discusses consultancy project's overview and explains how it has emanated from the National Cyclone Risk Mitigation Project (NCRMP), Phase-II. The pilot States included under this project, rationale for their inclusion and project components are discussed in brief. Further, it elucidates expected project deliverables and working modalities at national and state levels, envisioned quality assurance and control system and perceived risk and mitigation approach. Finally, it enumerates expected support by the state authorities and proposes monitoring and evaluation system.

Chapter 2 emphasises on the basic demographic and geographical information with natural resources of the pilot States under the project. Further, each state is discussed with respective geophysical (earthquake, landslides etc.) and hydro-meteorological (floods, cyclone, high wind etc.), hazards, their social and physical vulnerability and consolidated risk. Furthermore, it summarises each state's capacity for disaster resilience.

Chapter 3 discusses rationale and proposed methods for budget allocation for various components. It proposes various methods for the budget allocation. "Parameter based Method" is used by the project team and is based on hazard, ratio of population by education and health, state GDP and road density. Further, weighted averaged budget allocation (%) is proposed considering all methods for NDMA to rationalize the allocation. All three methods are explained with illustration. Furthermore, chapter discusses the selection criteria for buildings and infrastructure for detailed vulnerability assessment and retrofitting designing. Following the criteria, proposed list of buildings and infrastructure are enumerated for further consideration.

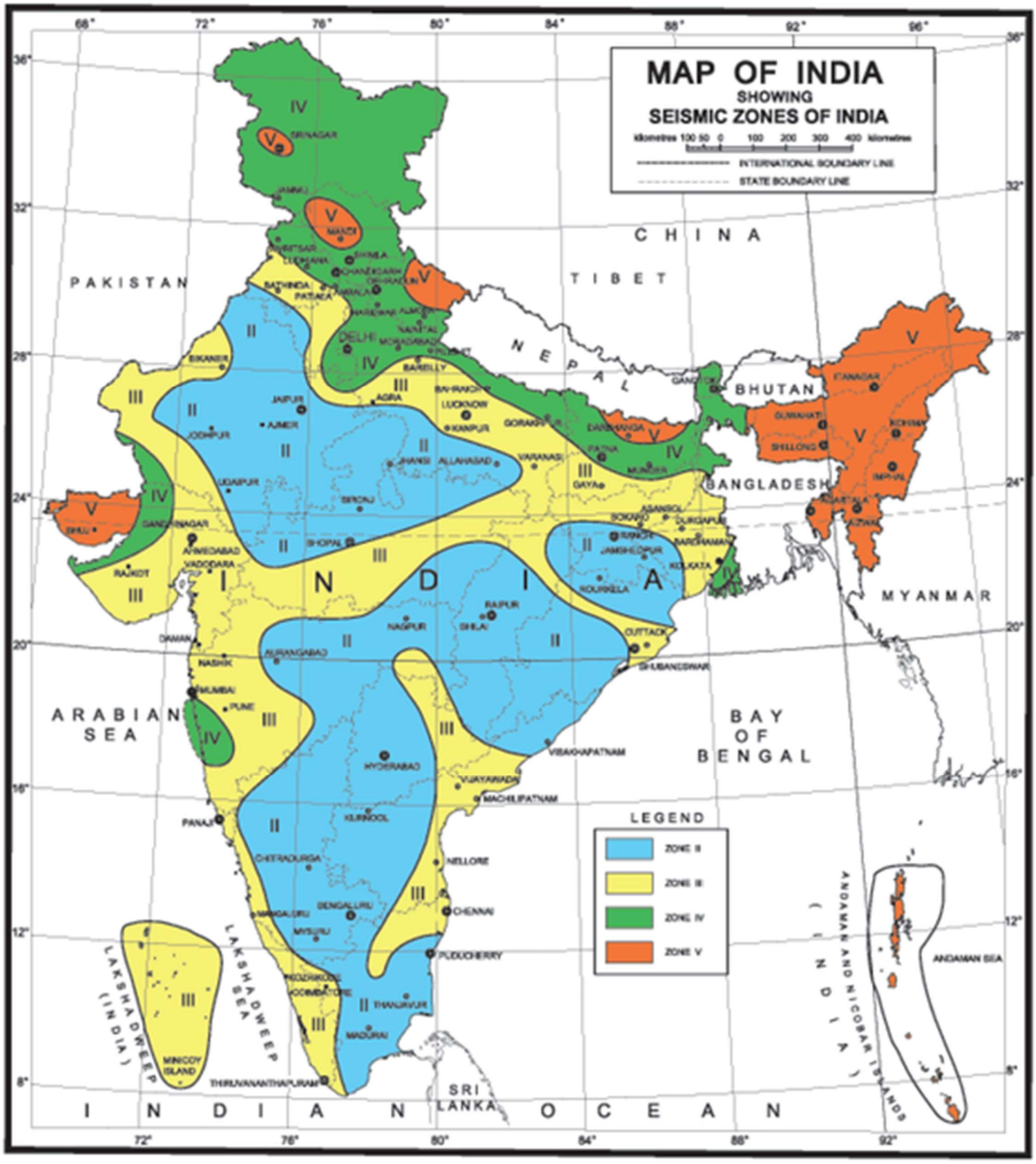
Chapter 4 discusses the project components' methodology. Each component methodology is supplemented with details of proposed technical processes, data collection proformas and expected outcomes. Further, the chapter discusses organization setup and working approach for project implementation. The concept is supported with flowcharts and explanation.

Chapter 5 discusses the project schedule, overall project deliverables with timelines in Gantt chart. Further, the chapter details out activities associated with project deliverables in a bar chart.

Chapter 6 explains the proposed monitoring & evaluation and reporting mechanism for effective and efficient project management.

Way Forward

- The Inception Report will be reviewed by the expert panel constituted by NDMA. Based on their feedback, the revised inception report will be submitted incorporating modifications (if necessary).
- The next deliverable is the Scoping Report, which will detail out the work plan for actual execution. This will set the rationale for the progress of the project and reported on routine basis.



01 INTRODUCTION & PROJECT OVERVIEW

Chapter 1 discusses consultancy project's overview and explains how it has emanated from the National Cyclone Risk Mitigation Project (NCRMP), Phase-II. The pilot States included under this project, rationale for their inclusion and project components are discussed in brief. Further, it elucidates expected project deliverables and working modalities at national and state levels, envisioned quality assurance and control system and perceived risk and mitigation approach. Finally, it enumerates expected support by the state authorities and proposes monitoring and evaluation system.

CHAPTER 1

INTRODUCTION & PROJECT OVERVIEW

1. INTRODUCTION

Designing National Seismic Risk Mitigation Programme (NSRMP) is a consultancy project awarded by National Disaster Management Authority under National Cyclone Risk Mitigation Project (NCRMP) Phase-II.

1.1. PROJECT OVERVIEW

1.1.1 PROJECT NAME

Consultancy Services for Designing National Seismic Risk Mitigation Programme (NSRMP)

1.1.2 FUNDING AGENCY – The World Bank

Credit No. IDA-5693-IN under National Cyclone Risk Mitigation Project (NCRMP) Phase-II

1.1.3 CONTRACT NUMBER

Contract No. IN-NDMA-59365-CS-QCBS

1.1.4 CONSULTANT - DDF – AKDN JV

Joint Venture between DDF Consultants Private Limited and Aga Khan Agency for Habitat India (an agency of AKDN).

Head Office address as mentioned below:

Table 1.1 Office Address

State Location	Address
Head Office, Delhi	501, B-09, ITL Twin Tower, Netaji Subhash Place, Pitampura. New Delhi – 110034.

1.2 PROJECT OVERVIEW AND BACKGROUND

The Indian sub-continent is frequently ravaged by multiple natural disasters such as cyclones (including wind), earthquakes, tsunamis, landslides, floods, droughts, avalanches, winds, fires etc. Disasters have enormous consequences on human development and economic growth. Due to severity and frequency of natural disasters, a burgeoning population and large-scale investments in development of infrastructure planned growth at the national level gets retarded.

In recent years human activity such as rapid and unplanned urbanisation, industrialisation, excessive exploitation of land resources, environmental degradation etc. has increased vulnerability to disasters manifold. For sustainable national development it is of prime concern that risk due to natural disasters be reduced for populations living in disaster prone areas. This necessitates effective management of risk due to a disaster as an integral part of sustainable development.

Building Material and Technology Promotion Council, (BMTPC), Government of India, has identified areas affected by different natural disasters and compiled several maps for India. Figure 1.1 shows earthquake hazard map which shows the epicentres with magnitude larger than or equal to 5. Figure 1.2 shows areas liable to flooding, figure 1.3 shows the landslide hazard map, figure 1.4 shows the cyclone hazard map; and figure 1.5 shows areas prone to wind hazard.

In 2011, Ministry of Home Affairs, Government of India, launched a National Cyclone Risk Mitigation programme (NCRMP) in Andhra Pradesh and Odisha with an objective to protect vulnerable coastal communities from frequent cyclones, and to minimize loss of lives and assets. Multiple mitigation measures were deployed like construction of cyclone shelters, installation of an early warning system, capacity-building programs, etc. This was the NCRMP-I program. Subsequent to the success of this program another program was launched in 2015. This was the NCRMP-II program, which was implemented in six more coastal states viz. Goa, Gujarat, Maharashtra, Karnataka, Kerala and West Bengal, with the same objectives.

All natural hazards are potential destroyers of human life, property and infrastructure and earthquakes are no different. It is pertinent to note that large magnitude earthquakes can sometimes trigger several other hazards such as surface faulting, topographic changes, surface distortions, regional warping of ground, uplift or submergence of coastlines, tsunamis, landslides, avalanches and liquefaction of ground. The built environment supported on this kind of damaged ground can be adversely affected. For this reason, it is pertinent to assess future earthquake hazards so that appropriate mitigation measures exist before the next disaster strikes and consequently risk can be considerably reduced.

Unpredictability of earthquake hazards, together with a vulnerable built environment leads to risk, both to life and property. Use of poor construction material and practices without the use of any earthquake resistant measures in the built environment increases vulnerability of structures and infrastructure. It is desirable if critical infrastructure and public buildings withstand earthquakes and remain available immediately after an earthquake, or any other disaster, for local emergency shelters. These structures may sometimes be seismically vulnerable and may require retrofitting and strengthening.

India experienced several catastrophic earthquakes, which caused immense destruction of life and property in very large geographical areas. These were the great earthquakes of Kutch in the year 1819, Assam, (now Meghalaya), in 1897; and again in 1950; (now Arunachal Pradesh); Kangra (Himachal Pradesh) in 1905; Bihar - Nepal region in 1934; the Bay of Bengal in 1941; and the Indian Ocean in 2004. The 2004 Sumatra earthquake also triggered a tsunami on the rim of the Indian Ocean and was catastrophic in vast geographically spread out coastal regions. These earthquakes are shown by a red dot in Figure 1.1. Some other very destructive earthquakes in India were the Bihar Earthquake of 1988, Uttarkashi earthquake of 1991, Latur earthquake of 1993, Jabalpur earthquake of 1997, Chamoli earthquake of 1999, Bhuj

earthquake of 2001, Kashmir earthquake of 2005, and Sikkim earthquake of 2011. As per NDMA, there were 23000 casualties between the years 1990 and 2006 due to 6 earthquakes alone, mostly due to collapse of buildings. However, during similar large magnitude earthquakes in the United States of America and Japan, casualty figures were far lower due to structural collapse, but cases were reported due to collateral hazards.

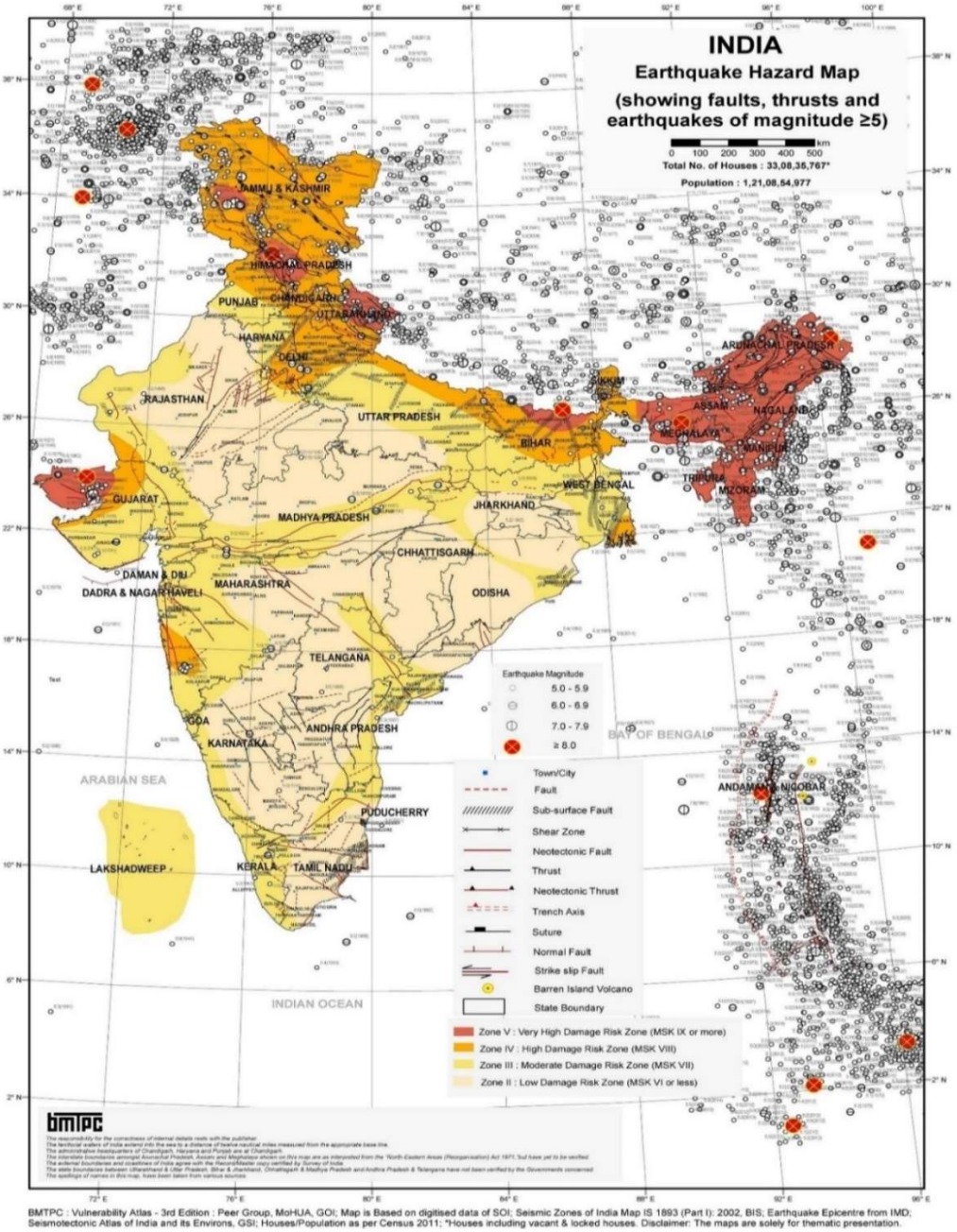


Figure 1.1: India Earthquake Hazard Map[1]

Source: [1] (BMTPC, 2019)

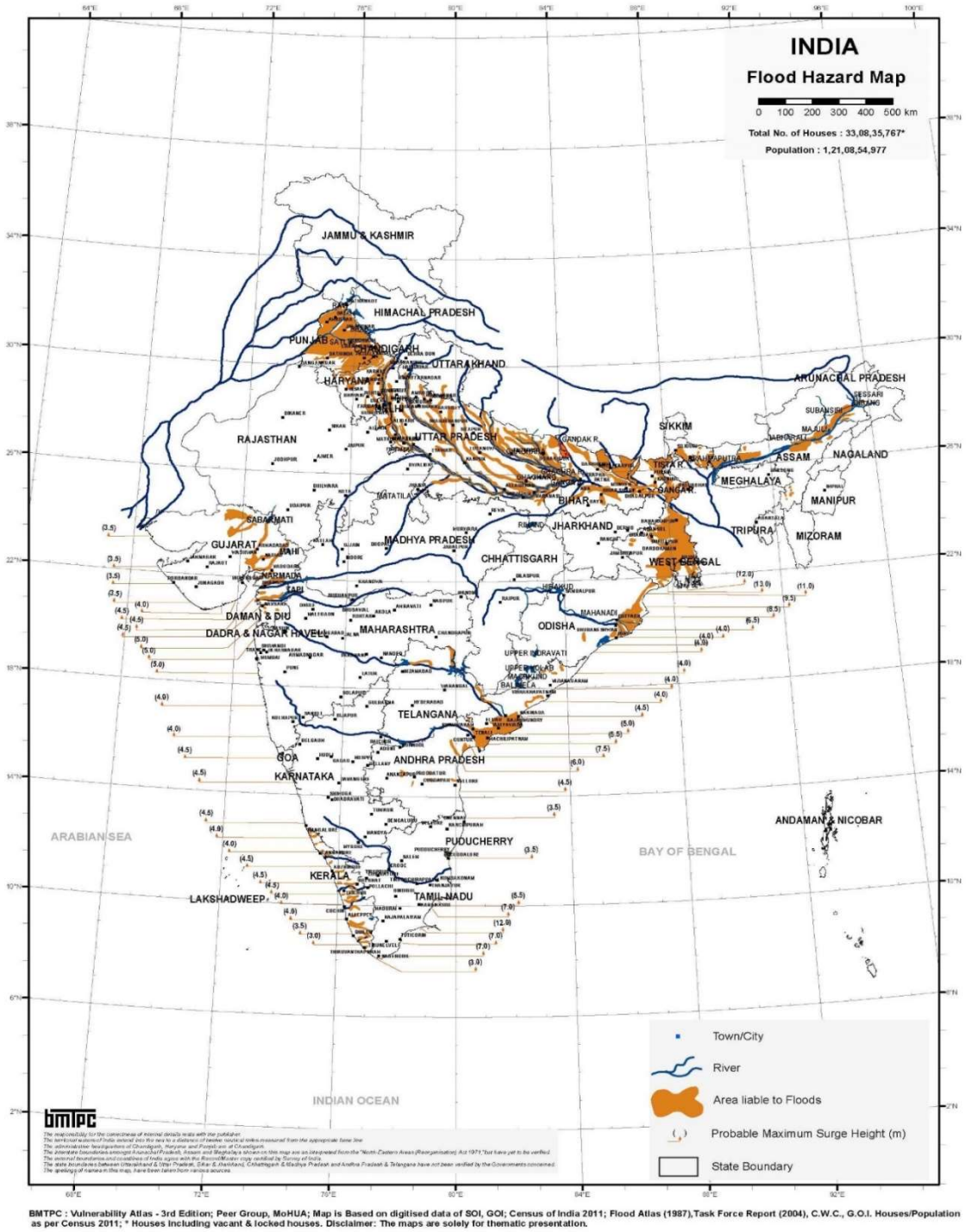
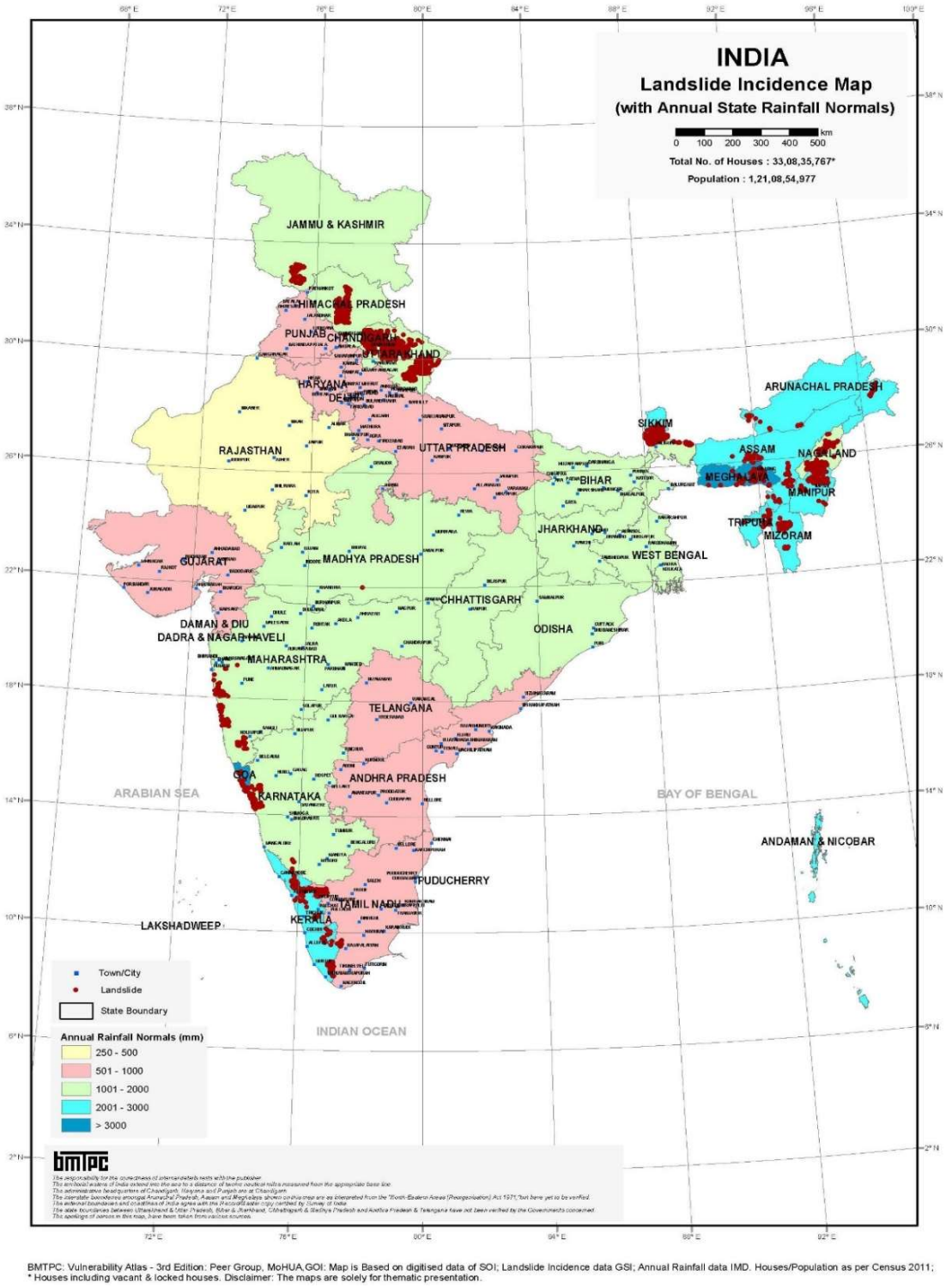


Figure 1.2: India Flood Hazard Map[2]

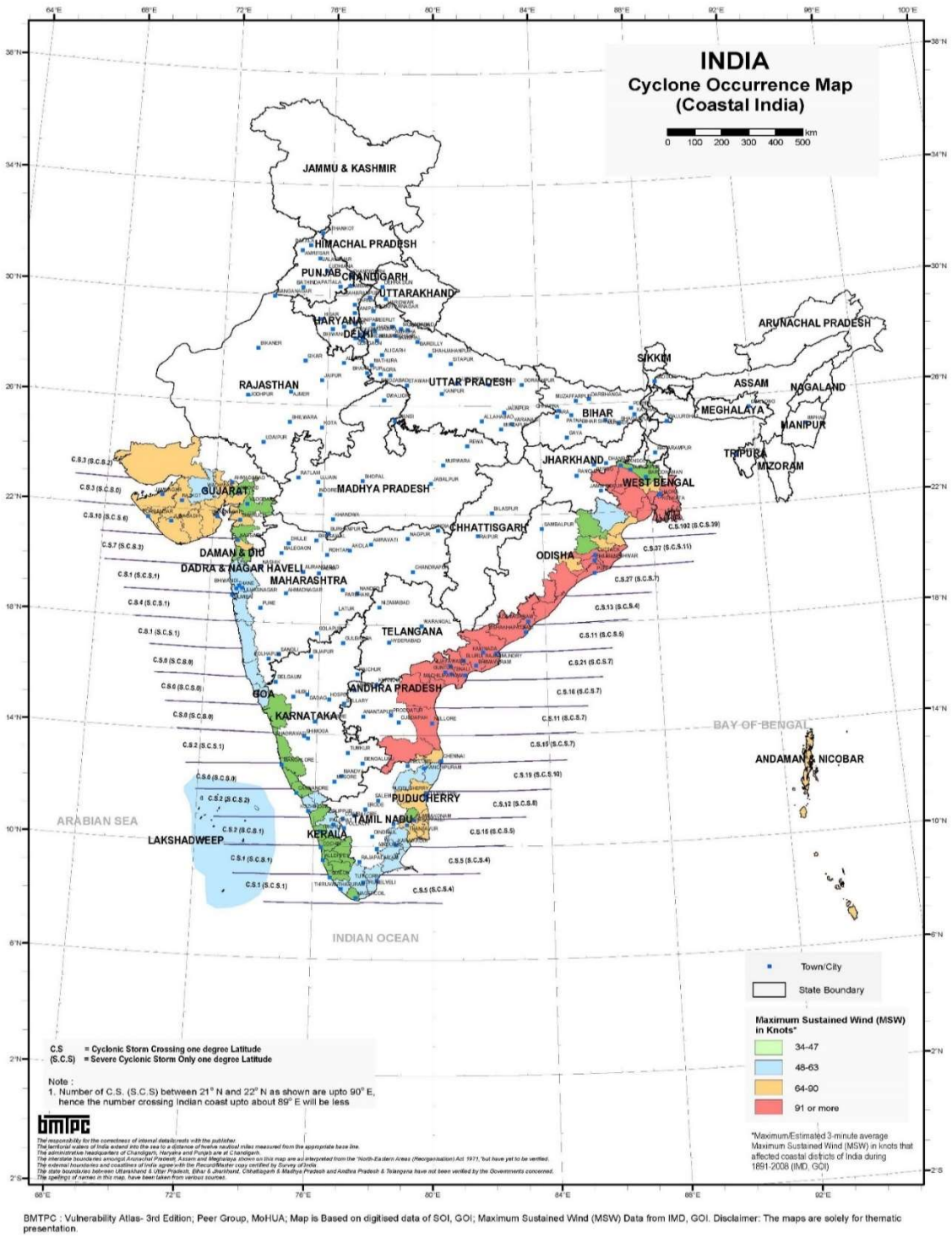
[2] (BMTPC., 2019)



BMTPC: Vulnerability Atlas - 3rd Edition: Peer Group, MoHUA,GOI: Map is Based on digitised data of SOI; Landslide Incidence data GSI; Annual Rainfall data IMD. Houses/Population as per Census 2011;
* Houses including vacant & locked houses. Disclaimer: The maps are solely for thematic presentation.

Figure 1.3: India Landslide Hazard Map[3]

[3] (BMTPC, 2019)



BMTPC : Vulnerability Atlas- 3rd Edition; Peer Group, MoHUA; Map is Based on digitised data of SOI, GOI; Maximum Sustained Wind (MSW) Data from IMD, GOI. Disclaimer: The maps are solely for thematic presentation.

Figure 1.4: India Cyclone Hazard Map[4]

[4] (BMTPC, 2019)

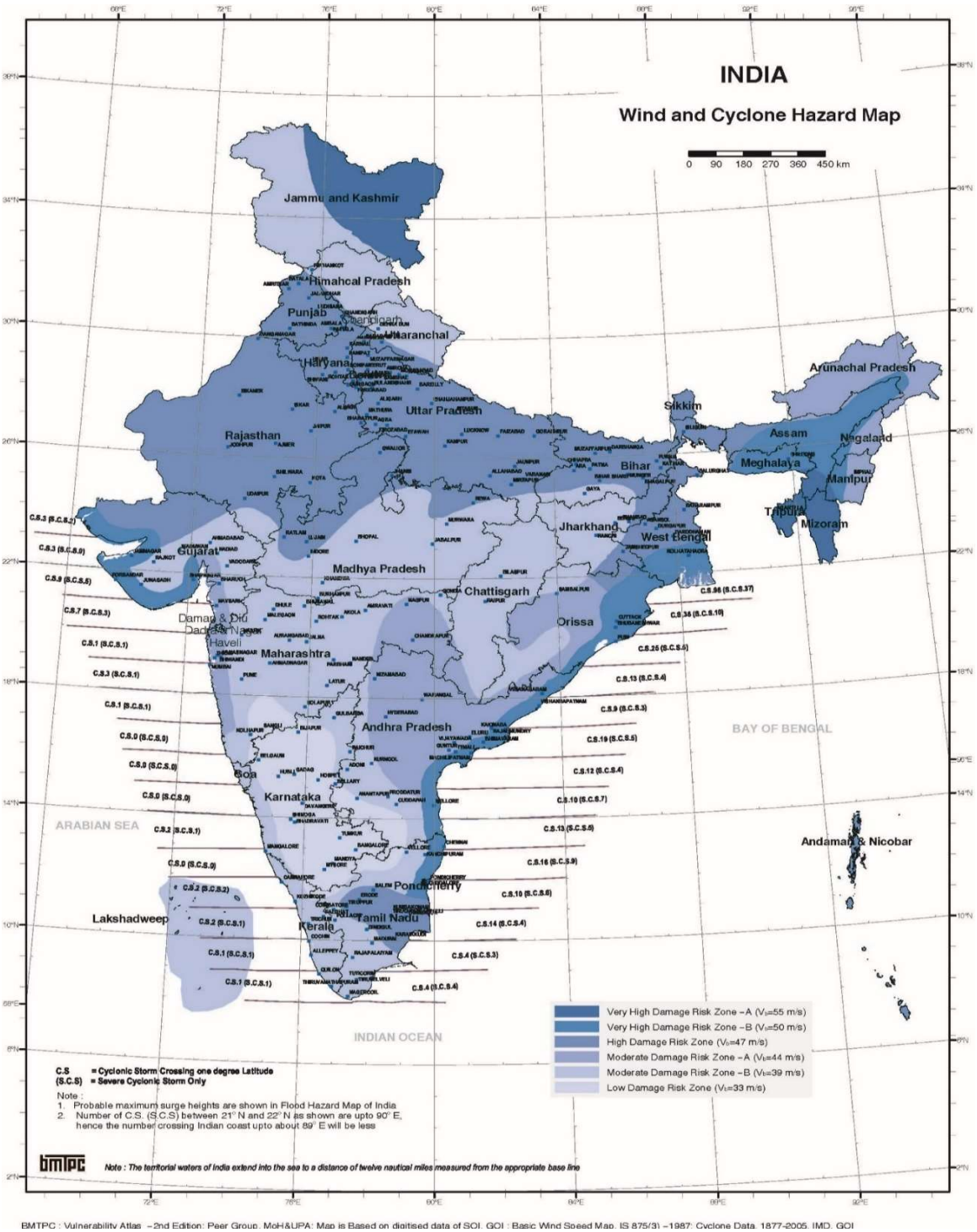


Figure 1.5: India Wind Hazard Map[5]

[5] BMTPC, 2019

The Bureau of Indian Standards, BIS, (2016), has divided India into four seismic zones, namely Zone II, III, IV and V, as shown in figure 1.6. In this hazard map these zones are broadly associated with MSK Intensity corresponding to VI (or less), VII, VIII and IX or above, respectively, and the corresponding zone factor is designated as 0.10g, 0.16g, 0.24g, and 0.36g, respectively. It is pertinent to note that almost 58.6 % of Indian Territory is prone to moderate to severe earthquake disasters, with 10.9% area in Zone V, 17.3% in Zone IV and 30.4% in Zone III, (NDMA, 2010).

To mitigate risk due to impending earthquake disasters NDMA designed and developed a consultancy project titled “Design of National Seismic Risk Mitigation Programme”, NSRMP, with a view to address earthquake risk in the country. It is part of the National Cyclone Risk Mitigation Project–II”. The project will lead to reduced vulnerability of communities and their assets due to earthquake hazard.

1.3 AIMS AND OBJECTIVES OF PROJECT

The overall objective of NSRMP is as follows
- To improve preparedness for a potential earthquake through enhancing institutional and technical capacity for disaster management
- Emergency response,
- Strengthening critical public facilities for earthquake resistance and supporting measures for better enforcement of building codes and land use plans.

The aim of NSRMP is
- To reduce vulnerability of communities and their assets to earthquake disasters by taking appropriate mitigation measures and
- To strengthen the capacity of national and state entities to effectively plan for and respond to earthquakes.

The specific objectives of the project are as follows
- To support the PMU NDMA in preparing and appraising projects as an outcome of various project components.
- To assist state entities in formulating investment plans and in preparing implementation ready proposals and projects, with full detailing, including social and environmental assessments.
- To provide technical assistance and training to states on technical, financial, environmental, social management and fiduciary aspects.

The National Seismic Risk Mitigation Programme is to be implemented in eight high to very high risk states of India, i.e. Assam, Bihar, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Tripura and Uttarakhand. These states are shown in figure 1.7. Figure 1.8 shows zone wise percentage of national area covered in this project, and also the remaining area that needs to be covered subsequently. Together these states cover approximately 14 % of geographical area of India and will impact almost 13% of the country’s demography. Figure 1.9 shows the distribution of area (%) and figure 1.10 shows population distribution (%) in states and country, respectively. These eight states encompass approximately 6.43% of area in Zone V, 6.28% in Zone IV and 0.76% in Zone III of Indian territory. Considering zone-wise percentage of area, 61.86% of Zone V, 37.49% of Zone IV and 2.56% of Zone III is covered in this project.

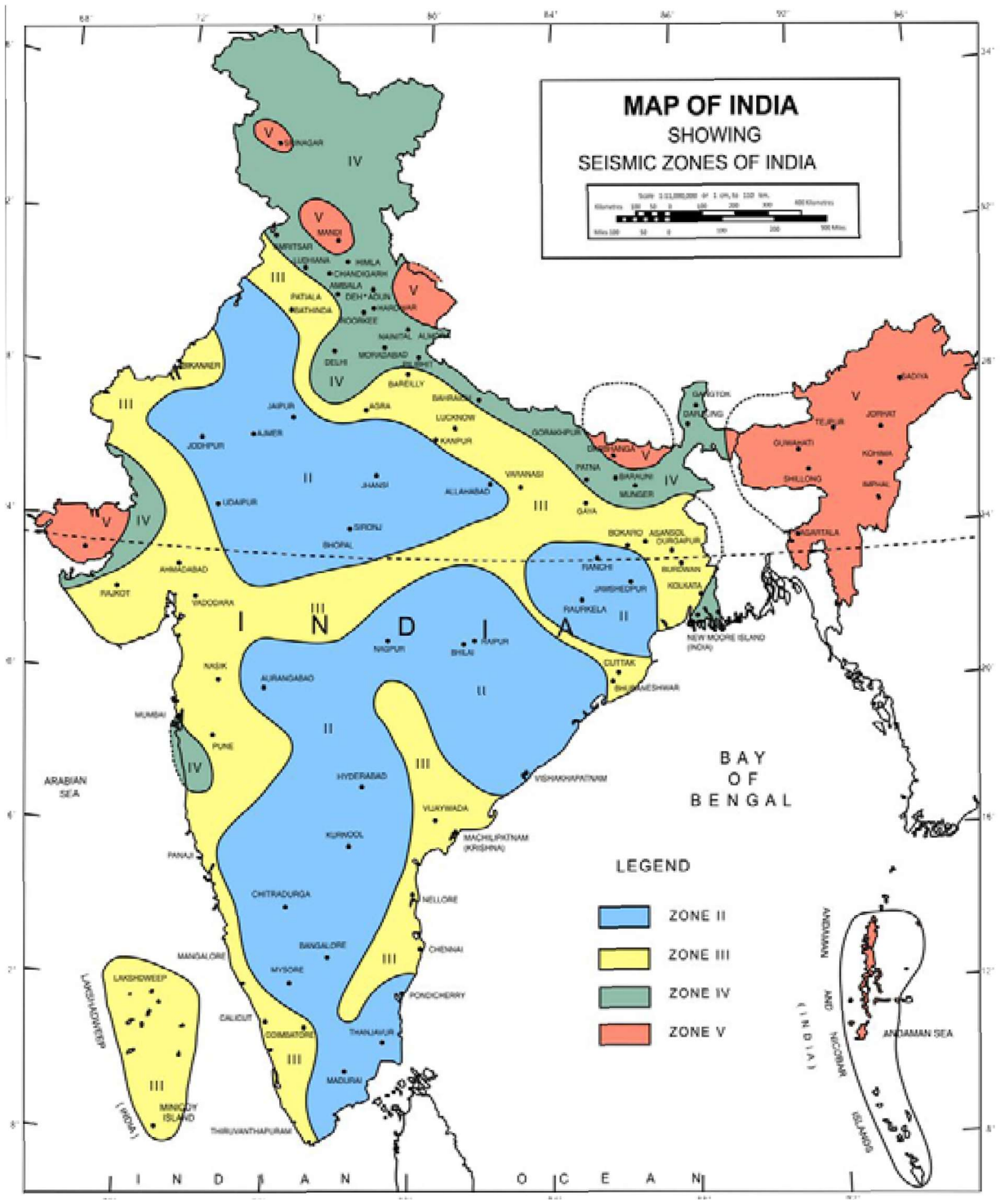


Figure 1.6: Seismic Zone Map of India[6]

[6] (BIS, 2016)

Risk profiles of each of the eight states in terms of hazards are discussed in detail in Chapter 2.

Risk reduction strategy in the project involves appropriate mitigation measures and capacity strengthening at national and state levels. Accordingly, Project Management Unit (PMU), NDMA is now in the process of preparing the following: investment proposals, detailed project reports, project appraisal document, etc. for earthquakes; formulating implementation arrangements and preparing necessary documentation such as environment and social assessment, operation manual, bidding documents etc. required for proposing potential financing from multilateral institutions particularly the World Bank.

1.4 SCOPE

To fulfil the above objectives, the work is divided into four components, each with specific objectives, tasks and scope

- It includes the design, development, deployment and use of results of an earthquake early warning system. This is expected to boost emergency response which will help minimise losses of assets and life.
- Another component deals with strengthening of infrastructure. This requires repair, modification and retrofitting of critical infrastructure and includes new construction where necessary.
- Also the response to the disaster of people in earthquake prone areas can be enhanced manifold by capacity building. (Education and research, IEC, understanding and encouraging traditional earthquake resistant)
- In house management of the project

As per the contract following are the components of the project:
Component A : Two parts-
: A1: Earthquake Early Warning Dissemination System
: A2: Enhancing Emergency Response Capacity
Component B : Multi-Hazard Risk Mitigation of Infrastructure
Component C : Technical Assistance to Improve Disaster Risk Management
Component D : Project Management, Monitor and Implementation Support

1.5 CONCEPT AND APPROACH OF WORK

The concept and approach of this work will be in compliance with the defined contract. All applicable rules, regulations, bye-laws, guidelines, national and international standard norms, National Building Codes, BIS, etc. will be followed in carrying out the project.

As per the contract, NDMA proposes to design a NSRMP for 8 states i.e. Assam, Bihar, Himachal Pradesh, Jammu and Kashmir, Manipur, Meghalaya, Tripura and Uttarakhand. Following is the brief risk profile of these states. As per draft report on Disaster Score Card of Disaster Management Division of Ministry of Home Affairs, Government of India, all states have been ranked based on their hazard profile and each state has been assigned a rank based on the score card. The same has been referred to in the following brief profile of each state.

1.5.1 ASSAM

Assam is prone to multiple hazards. It lies completely in Seismic Zone V i.e., the most critical seismic zone in the country. Apart from seismic hazard, major areas along the Brahmaputra river valley are prone to flooding and few localised areas are prone to landslide hazard. Lastly, most of Assam lies in Very High Damage Risk Zone (V_b=50m/s) as per the wind hazard map of India. Accordingly, Assam is ranked 7th amongst all states in India[7]. Accordingly, Assam State Disaster Management Authority (ASDMA) was formed in 2009 and today it is one of the pioneers in disaster management planning and since then ASDMA is involved in disaster management planning.

1.5.2 BIHAR

Bihar is prone to floods, droughts, fires and earthquakes. According to seismic zoning map, portion of Bihar under seismic zone V is concentrated along the Indo-Nepal border in the north followed by seismic zone IV in central Bihar and seismic zone III in south Bihar. Also due to its geographical and topographical locations, most of Bihar is prone to flooding. Bihar is India's most flood-prone State, with 76% of population in North Bihar living under the recurring threat of flood devastation. Almost 90% of Bihar lies in High Damage Risk Zone (V_b=47m/s) as depicted in the Wind Hazard Map of India. Bihar is ranked 10th amongst all states[8]. Accordingly, Bihar Disaster State Management Authority was formed in 2007, which is responsible for disaster management related activities in the state.

1.5.3 HIMACHAL PRADESH

The state of Himachal Pradesh falls in a region of high to very high seismic hazard. In the state the geologic hazards, namely, earthquakes and landslides are the most critical, the wind storm and flood hazards can also cause local damage. This state falls in seismic zones IV & V. Apart from earthquake hazard, Himachal Pradesh is also prone to landslide hazard in localised zones. It is ranked 22nd amongst the states in India as per the Disaster Score Card[9]. Himachal Pradesh State Disaster Management Authority was established in 2007, which is responsible for disaster management related activities within the state.

1.5.4 JAMMU & KASHMIR

The state of Jammu & Kashmir falls in a region of high to very high seismic hazard. As per the 2016 Bureau of Indian Standards (BIS) map, the state lies in Seismic Zones IV & V, respectively. Jammu & Kashmir is also prone to landslide hazard in localised pockets. Kashmir is prone to liquefaction due to water table being equal to ground level due to presence of flowing Sutlej River in the Kashmir Valley. Most of Leh, Ladakh and Kargil Districts in the state of Jammu & Kashmir is prone to Very High Damage Risk Zone (V_b=55m/s) as per the Wind Hazard Map of India. It ranks 25th amongst all states as per the Disaster Score Card. Jammu & Kashmir State Disaster Management Authority was established in 2007 to manage activities related to all disasters in the state.

[7] (Ministry of Home Affairs, 2018)
[8] (Ministry of Home Affairs, 2018)
[9] (Ministry of Home Affairs, 2018)

1.5.5 MANIPUR

The state of Manipur falls in a region of very high seismic hazard. As per the 2016 Bureau of Indian Standards (BIS) map, this state falls in Seismic Zone V. Areas in the state are also prone to landslide hazards. The areas near to the river basin are prone to flooding. Manipur state lies partially in Very High Damage Risk Zone (V_b=55m/s), Very High Damage Risk Zone (V_b=50m/s) and mostly in Moderate Damage Risk Zone (V_b=44m/s) as per the wind hazard map of India. It is ranked 17th amongst all states as per the Disaster Score Card[10] and to cater to disaster related activities, the Government of Manipur has set up a Department of Relief and Disaster Management.

1.5.6 MEGHALAYA

The state of Meghalaya falls in a region of very high seismic hazard. As per the 2016 Bureau of Indian Standards (BIS) map, this state falls in Seismic Zone V. Meghalaya is prone to landslide Hazards in localised pockets. Almost the entire state lies in Very High Damage Risk Zone (V_b=50m/s) with small portions in High Damage Risk Zone (V_b=47m/s) and Very High Damage Risk Zone (V_b=55m/s) as per the Wind hazard map of India. It is ranked 20th amongst all states in India as per the Disaster Score Card[11]. Meghalaya State Disaster Management Authority has been set up in 2005 to cater to all activities related to disaster management in the state.

1.5.7 TRIPURA

The state of Tripura falls in a region of very high seismic hazard. As per the 2016 Bureau of Indian Standards (BIS) map, this state falls in Zone V. As is observed in all other north-eastern states, Tripura too is prone to landslide hazard in localised pockets. However, the entire state falls in Very High Damage Risk Zone (V_b=55m/s) as per the Wind Hazard Map of India. It is ranked 18th amongst all states as per the Disaster Score Card and Tripura State Disaster Management Authority has been formed to look after all disaster related activities within the state.

1.5.8 UTTARAKHAND

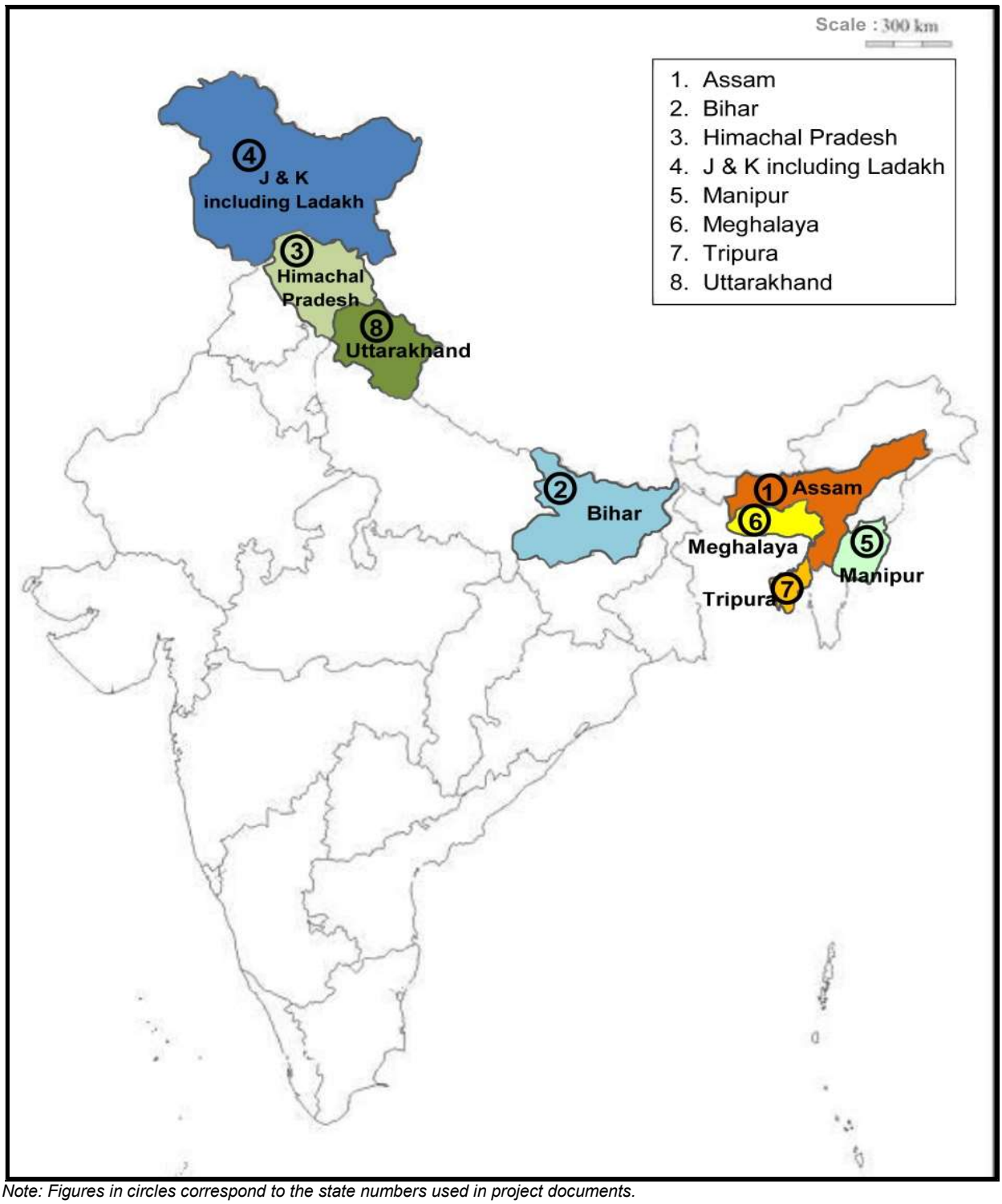
The state of Uttarakhand falls in a region of high to very high seismic hazard. As per the 2016 Bureau of Indian Standards (BIS) map, Uttarakhand falls in seismic zones IV & V. The topographical features of Uttarakhand make it prone to landslide hazard in most areas. Almost the entire state, barring Udham Singh Nagar and parts of Haridwar and Nainital Districts which lie in very high damage risk Zone (V_b=50m/s), lie in Moderate Damage Risk Zone (V_b=39m/s) as per Wind Hazard Map of India. It is ranked 15th amongst the states as per the Disaster Score Card[21] and Department of Disaster Management in the state was established in 2000 and Uttarakhand Disaster Management Authority was established 2006 to look after all disaster related activities within the state.

[10] (Ministry of Home Affairs, 2018)
[11] (Ministry of Home Affairs, 2018)

1.6 DELIVERABLES

Based on the objectives, the scope can be broadly listed as below:

1. Inception report.
2. Scoping report
3. Detailed Investment plans for all components.
4. Outline and detailed implementation arrangement structure and TOR for specific positions.
5. Detailed project reports for identified investments.
6. Procurement manual in line with World Bank's Procurement Regulations 2016 for the proposed investments and consultancies.
7. Project Procurement Strategy for Development (PPSD) and initial procurement plan.
8. Financial Management Manual.
9. Environmental and Social Management Instruments:
   a. An Environmental and Social Commitment Plan.
   b. Environment and Social Management Framework.
   c. Environment and Social Assessment Reports for sub-projects.
   d. Environment and Social Management Plans for sub-projects.
10. Results Framework.
11. Project Management and MIS tool.
12. Project Operation Manual.
13. Project Appraisal Document.
14. Consultations and participation of key stake holders in formulation of plans, designs and documentation.
15. IEC and Communication strategy and package.
16. Information Disclosure of environment and social instruments.



Note: Figures in circles correspond to the state numbers used in project documents.

Figure 1.7: States Covered - NSRMP[12]

[12] (Pinterest , 2019)

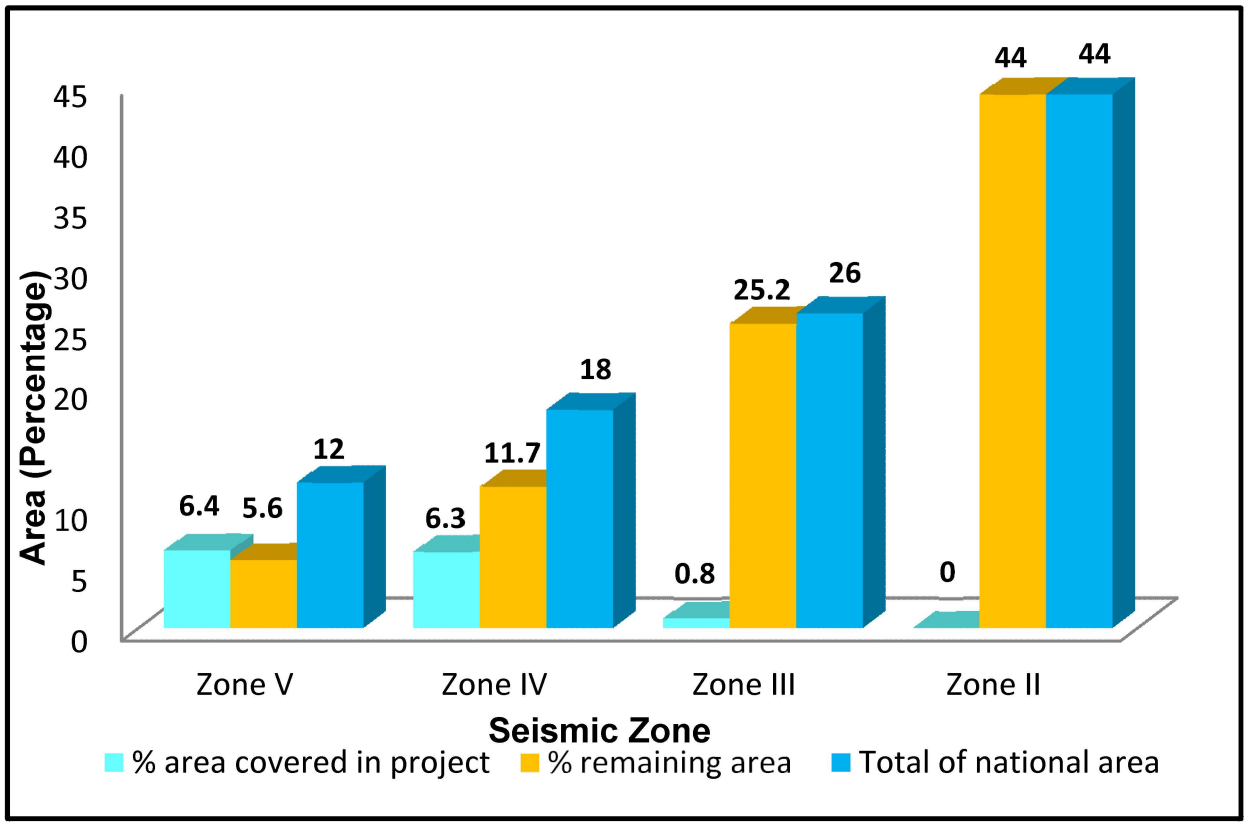


Figure 1.8: Zone wise percentage of area covered in present programme

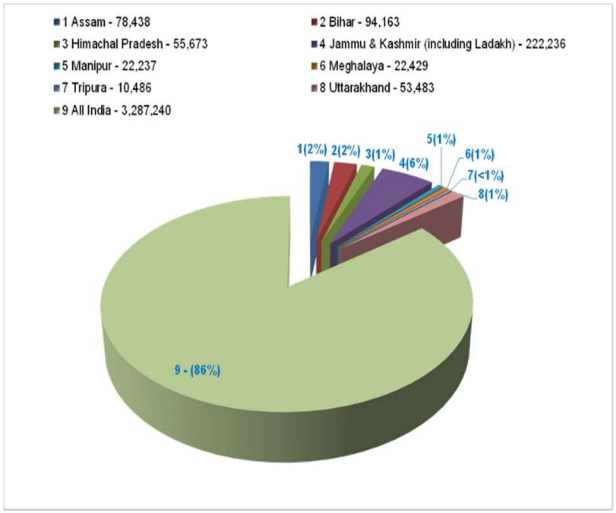


Figure 1.9 Distribution of area (Sqkm) in project states and India (Census 2011)

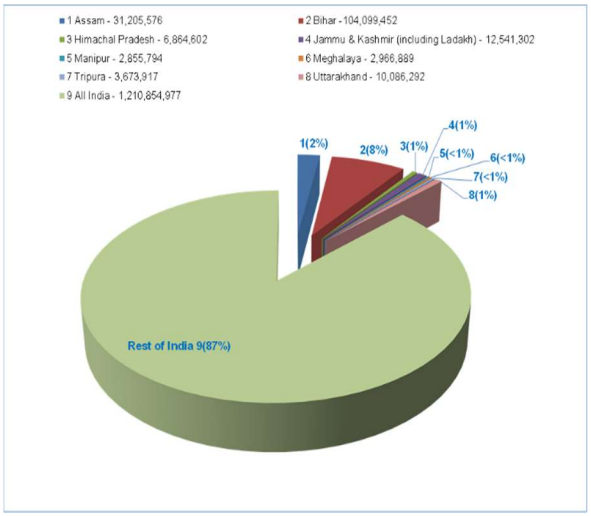


Figure 1.10 Distribution of population in project states and India (Census 2011)

1.7 WORKING MODALITIES

This is a large scale national level project involving eight defined states and national Authorities. Each state further comprises multiple line departments and associated multiple activities. Hence, overall working modality of the project has been proposed as shown in figure 1.11. Project Management Unit (PMU) is established at NDMA to monitor the design of NSRMP and project implementation. Each state will establish a State Project Implementation Unit (SPIU) to extend desired help in designing NSRMP and implementing the project in their states. Further at state level SPIU will coordinate with other stakeholders at state level and with the help of technical support group as shown in figure 1.12.

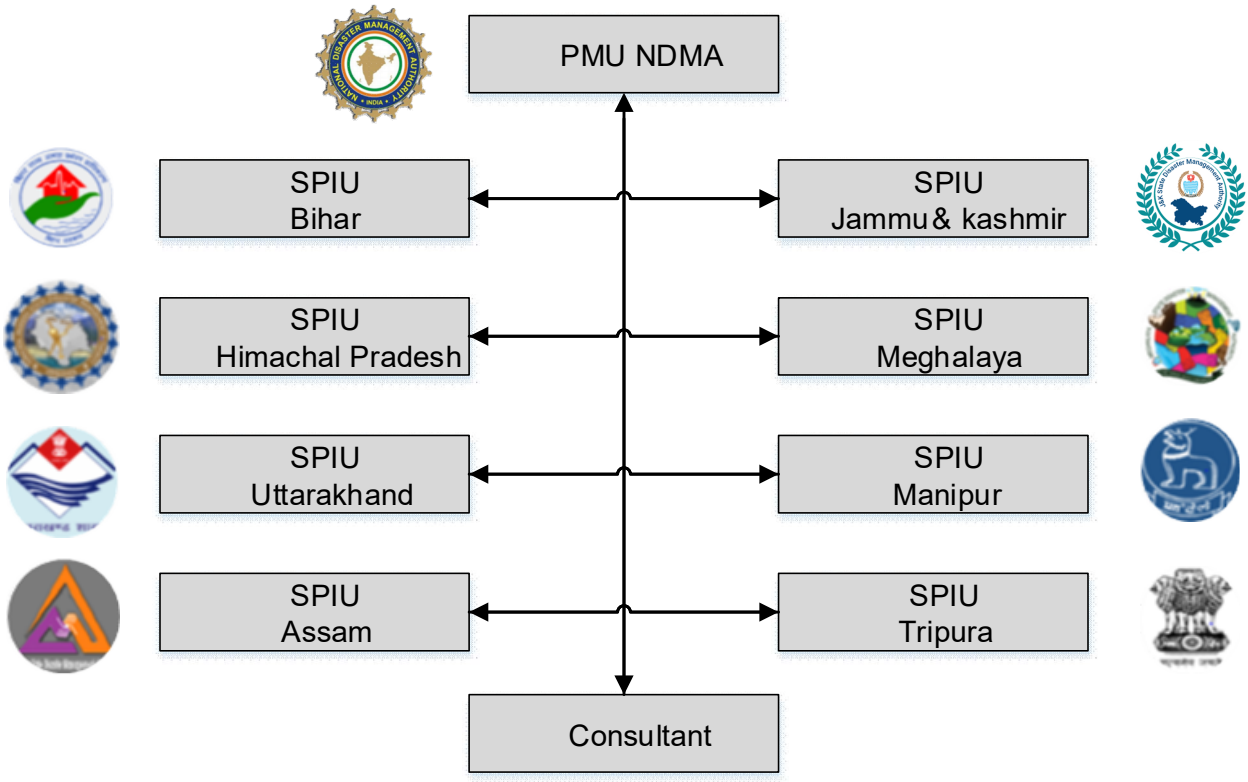


Figure 1.11: Overall Working Modality of the Project

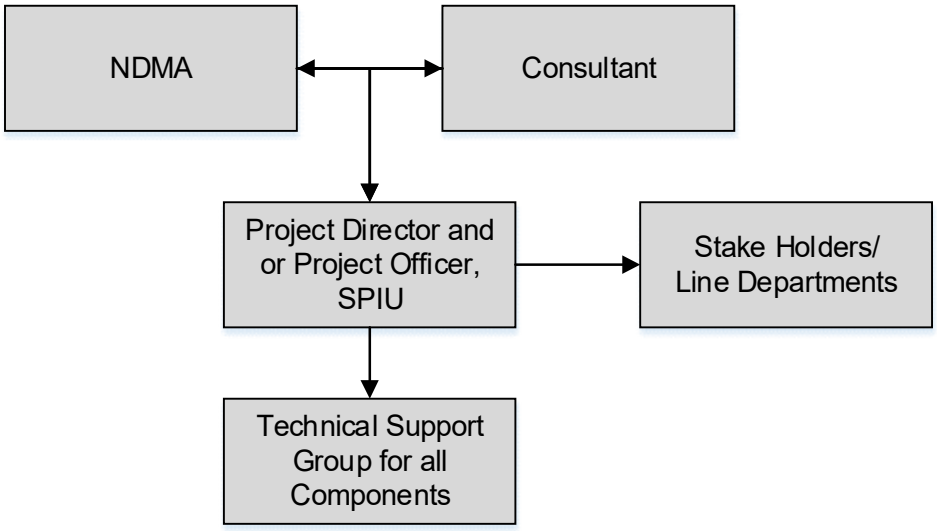


Figure 1.12: State Level Project Working Modality

1.8 QUALITY ASSURANCE AND CONTROL SYSTEM

The project planning, implementation and monitoring process underlines the importance of quality assurance and control (QAQC) throughout the project management cycle. The emphasis is more to the quality assurance than quality control, in view of the given project timeline and multiple experts engagement. The project management system proposes the QAQC system, which starts from the field operations to the central project management unit (PMU). The following flowchart (Figure 1.13) shows the approach and process for the proposed QAQC.

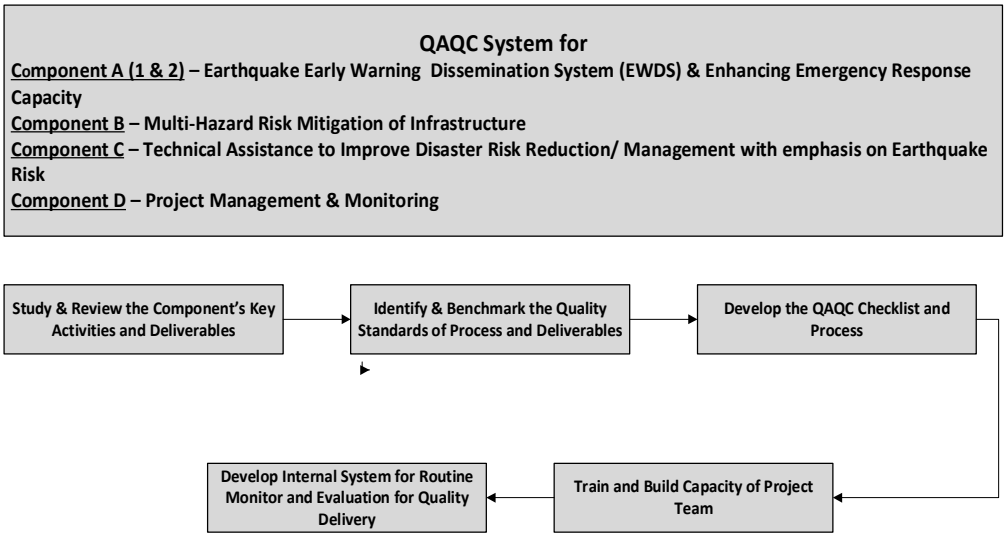


Figure 1.13: Flowchart showing the quality assurance and control during project execution

1.9 RISK ANTICIPATION AND MITIGATION STRATEGY

For seamless operation and robust planning, each project component is thoroughly analysed and all anticipated risk is mapped out. Further, a strategy is prepared to mitigate the risk in close consultation with various relevant stakeholders. Table 1.2 shows the anticipated risk and mitigation planning.

1.10 ENVISIONED ROLE AND RESPONSIBILITY OF CLIENT

GENERAL

1. Provide details of Project Implementation Units of each state and coordinating officials of the state about the project.
2. Provide necessary authority letters for relevant departments/organisations.
3. Provide list of agencies with co-ordinating officials and their phone numbers to be contacted for arranging visits to buildings / facilities at the time of survey.
4. Provide desired digital maps as per needs and availability.
5. Facilitate the consultant for any other confidential data needed for the project from National/State agencies.
6. Provide logistic help as needed especially in difficult terrains and restricted areas.
7. Grant timely approvals to expedite work.

COMPONENT A-1 (EEWS-ERS)

1. Facilitate the consultant to receive status of present Early Warning System if available in State.
2. Provide list of district headquarters (with Lat., Long.) where NICNET is available in all the states.
3. Provide list of districts, tehsils, blocks and villages (with Lat., Long.) where SWAN connectivity is operational in all the states.
4. Provide list (with latitude and longitude) of mobile phone towers and their types (detachable base room or base room having floor which is monolith with ground) of BSNL and other mobile phone service providers.
5. Provide information about mode of travel to reach those mobile towers which are located in difficult terrain.
6. Facilitate permission from NIC to install sensors in their premises at different district headquarters (DHQ).
7. Facilitate permission from NIC to use their UPS power supply (24x7) for sensors at each DHQ. Power requirement is less than 10 watts.
8. Facilitate permission from NIC to use NICNET at each DHQ and provide support for communication of data from each DHQ to CMS.
9. Facilitate permission from state governments of J&K, Himachal Pradesh, Uttarakhand, Bihar, Meghalaya, Manipur and Tripura to install sensors in their premises at each SWAN stations of their state.
10. Facilitate permission from state governments of in all the states to use their UPS power supply (24x7) for sensors at each DHQ. Power requirement is less than 10 watts.
11. Facilitate from state governments in all the states to use their network at each SWAN station and provide support for communication of data from each SWAN station to CMS.

12. Facilitate from mobile phone service providers for installation of sensors in base rooms of the designated mobile towers.
13. Facilitate from mobile phone service providers to use their battery bank (24x7) at each mobile tower to provide power to sensors and network equipment. Power requirement will be less than 10 watt.
14. Facilitate from each mobile phone service provider for making a VPN of installed sensors in their broadband network and provide support to transmit data from each installation to CMS. Data transfer through OFC only is recommended. It is expected that mobile phone service providers will provide this service through their social corporate responsibility (SCR) without any charges.
15. Provide list of locations with longitude and latitude of villages, localities, in all the states where sirens for issue of earthquake early warning is required to be installed.
16. Facilitate administrative permissions of relevant authorities to install sirens at locations mentioned above.

COMPONENT A-2 (Emergency Response)

1. Arrange letters for meetings with officials of the first responders

COMPONENT B (RETROFITTING)

2. Facilitate so that the custodian of facility should remain present in the facility and provides access to the desired data.
3. Provide the State wise finalised list of new buildings/infrastructure to be built including demonstration units, their locations along with names of the line departments and coordinating persons.
4. Facilitate the state wise finalised list of buildings/infrastructure to be retrofitted along with their location, name of the line departments and coordinating persons.
5. Facilitate provision of Architectural and Structural Drawings as available of the identified buildings and other infrastructure to be retrofitted.
6. Facilitate provision of permission for data collection and sample collection from infrastructure.
7. In case of Hospitals one Medical person to help in preparing list of equipments if any to be retrofitted.
8. Provide Design Reports, Geotechnical Investigation reports of various sites identified for retrofitting if available.
9. Provide permissions for carrying out Non-Destructive Testing (NDT / Collection of samples of Structural materials including exposing parts of structure and non-structural member as needed.
10. Facilitate permission to expose part of outer side foundation as required.
11. Provide space to keep instruments / equipment’s in facilities where testing will be done.
12. Arrange water and electricity during testing.

COMPONENT C (CAPACITY BUILDING)

1. Provide all available reports, maps, policies, existing State Disaster Management Plans, digitalized maps, etc.
2. Facilitate consultant to access to all available IEC / Education Awareness aides developed by NDMA and State Agencies for Capacity building earlier.

3. Permission to user (with due acknowledgement / reference/ source) existing material related with IEC / training etc. developed by National/ state agencies, academic institutions and other agencies.
4. Provide details of course content of Training programme/module developed earlier by NDMA/State agencies for Engineers, Architects, Masons and other Stake Holders or other emergency response agencies.
5. Provide list of officials of SDRF and other first responders to be contacted for getting equipment details and other data required for capacity enhancement as needed for component A2.

COMPONENT D (PROJECT MANAGEMENT AND MONITORING)

1. Provide process, policies and guidelines of Environment and Social Management Framework (ESMF) at national and state level for development projects.
2. Facilitate access to the sites for Environment and Social impact assessment.
3. Ensure engagement of relevant stakeholders during the assessment
4. Support the consultant to design the training and capacity building related to project management
5. Support the consultant to access to procurement and financial management practices, guidelines and systems at national and state level and review the manuals/ guidelines and support in finalize.
6. Support and engage relevant stakeholders in developing appropriate Management Information System (MIS), testing the system, provide feedback and finalize for the end usage.

1.11 MONITORING AND REPORTING PROCESS

The project management plan envisions stringent monitoring system, which will enable to complete the project on proposed timeline with high quality. The system for monitoring, evaluation and reporting structure will be finalized in close consultation with respective stakeholders. The M&E outline is being discussed in Chapter 6.

Table 1.2 Anticipated risk and mitigation planning

Risk Type	Risk Description	Risk Owner	Occurrence Probability (Regular/ Sometime / Rare)	Mitigation measures
Data Availability	Unavailable data for required modelling and system development	NDMA + Consultants to develop alternative options, as required	Regular	• Meticulous planning for developing the deliverables • Subject experts to list out data requirement. In case data not available, devise alternative parameters for computation
Data confidentiality	Confidential data if any,	NDMA + Government	Sometimes	• In case of confidential / classified data, Check with

Risk Type	Risk Description	Risk Owner	Occurrence Probability (Regular/ Sometime / Rare)	Mitigation measures
	agency may find difficult to share with the consultant	Depts.		NDMA for their special permission or facilitation with the department to release the data
Data precision	Chances of erroneous data or less precise data	All Stakeholders	Sometimes	• Engage the subject experts to develop the precise computation system with data requirements
				• Develop the system for quality assurance for data accuracy and system for regular assurance and control
				• If procured from other department/agency, the consultant team should carry out due diligence before procurement
Data sharing with consultant	Delays in data sharing	NDMA + Consultants	Regular	• Map the data requirement, procurement source, resource requirement, procurement permissions, data generation and schedule of procurement
				• Procurement planning in advance with resources
				• Keep NDMA in cognizance about procurement
Decision delays from Clientele	Delays in decision giving by the Client	NDMA + Govt. Depts.	Regular	• Delays Registration and communication with the client
				• Facilitate the client to enable decision making
				• If decision not given, reschedule the plan with due client intimation
Client project management system	Hierarchy of the system may delay information flow	NDMA + Govt. Depts.	Sometimes	• More robust structure for reporting and responsibility
				• Develop the responsibility matrix, communicate and follow up

Risk Type	Risk Description	Risk Owner	Occurrence Probability (Regular/ Sometime / Rare)	Mitigation measures
Changes in needs and requirements	Sudden changes in consultancy requirements	NDMA + Govt. Depts.	Rare	• Client agreement on the deliverables and restrict unnecessary changes / modification
				• Allow modification, in case the issue is judicious and genuine, based on mutual agreement. Request for additional resources as required
Client satisfaction	Service are not matching to the client expectations	NDMA + Govt. Depts. + Consultant	Sometimes	• Explain Client- the components' methodology and outcomes in details and how the outcomes will look like in advance.
				• Good Communication and regular reporting
Project Management	Lack of resource, time and human resource management	Consultant	Sometimes	• Better anticipation of challenges and threats, develop mitigation planning
				• Meticulous planning, review and updating
Structured Documentation formats	Improper Report structure for outputs	NDMA + Consultants	Sometimes	• For each deliverables, plan for the report structure and confirmed with the Client and sensitize the clientele
				• Special attention for professional writing and formatting
Communication mechanism	Poor System communication of (verbal /written etc.)	NDMA + Consultants	Sometimes	• Define and get client confirmation on channel and schedule of report submission
Disputes between stakeholders	Any contract related disputes	NDMA + Consultants	Rare	• Avoid any disputes by discussion, meeting and arbitration
				• In case, it fails, follow the contract document for necessary guidance
Cash Inflow & outflow	Delays in payment from	NDMA + Consultants	Sometimes	• Structure better communication system

Risk Type	Risk Description	Risk Owner	Occurrence Probability (Regular/ Sometime / Rare)	Mitigation measures
	client			• Set up communication and reporting system
				• Schedule a cash inflow and outflow plan, the cash flow schedule is agreed between client and Consultants
				• Develop alternative funds arrangements to manage the funds crisis

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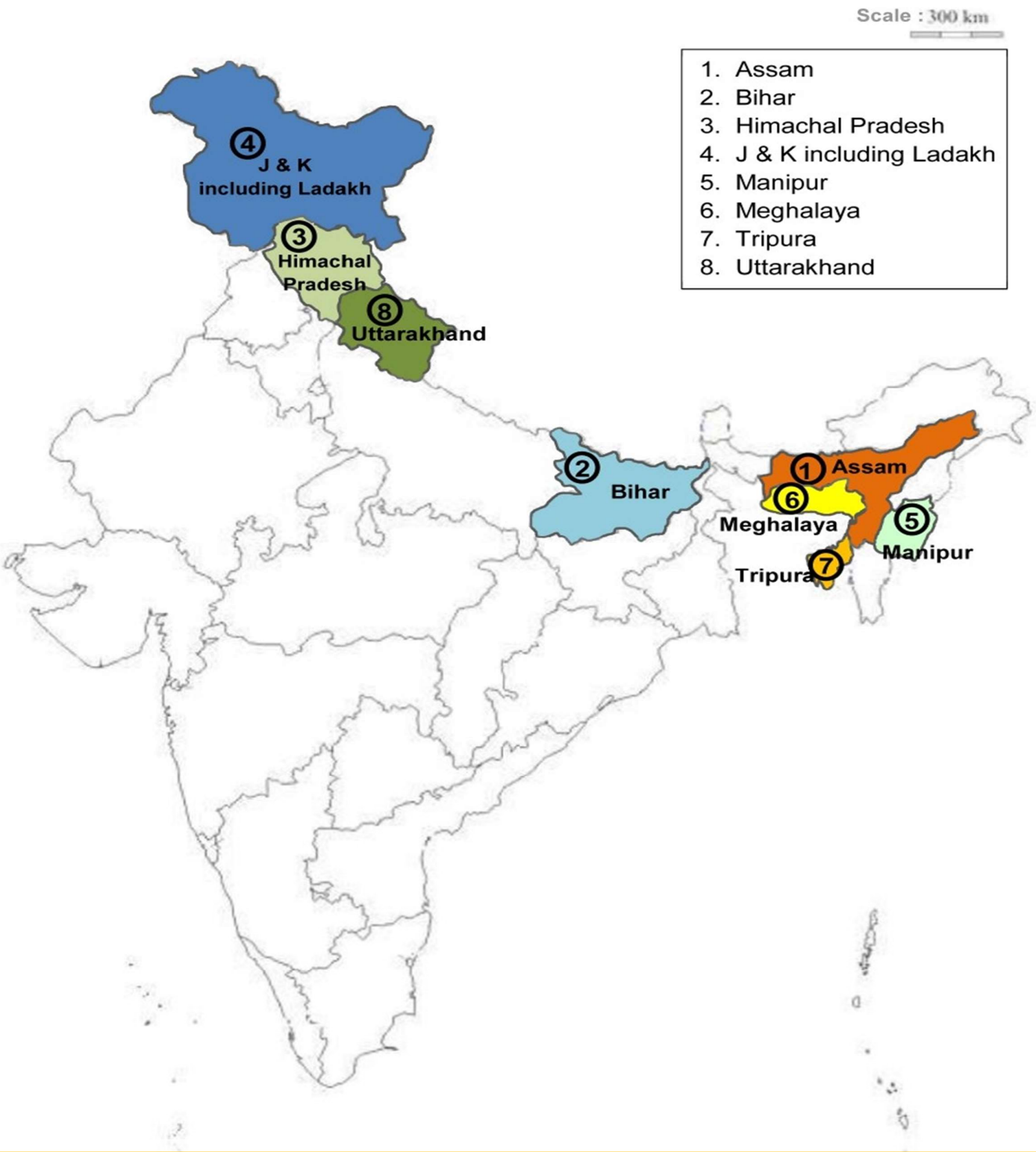

02 PROFILE OF STATES

Chapter 2 emphasises on the basic demographic and geographical information with natural resources of the pilot states under the project. Further, each state is discussed with respective geophysical (earthquake, landslides etc.) and hydro-meteorological (floods, cyclone, high wind etc.), hazards, their social and physical vulnerability and consolidated risk. Further, it summarises each state's capacity for disaster resilience.

CHAPTER 2

PROFILE OF STATES

2.1. BACKGROUND

As mentioned in previous chapter, eight states comprising of three states in the northern part of India and five states located in north-eastern part of India have been considered under the National Seismic Risk Mitigation Program (NSRMP). It is important to brief each states in terms of their political, geographical, demographical, economical aspects, etc. and also the different types of hazards likely to affect the state. It is important to know the current capability of each state in their preparedness for dealing effectively with the hazards likely to occur in their state with major focus on earthquake. The frequent and recurring natural disasters occurring in the states have been discussed.

The Disaster Management Division of Ministry of Home Affairs, Government of India have prepared a draft report on Disaster Score Card (DSC) for States and Union Territories with the overarching three objectives:[1]

"a) To develop benchmarks for various activities to be taken up for disaster risk management, namely risk assessment, risk prevention, risk mitigation and risk governance; and disaster preparedness, disaster response, disaster recovery and disaster reconstruction.

b) To quantify the risks of disasters of the States and Union Territories of India on the basis of uniform datasets on common set of indicators on disaster risks, and generate scorecards on Disaster Risk Index.

c) To quantify the level of resilience achieved by the States and Union Territories of India on the basis of uniform datasets on common set of indicators on disaster resilience and generate scorecards on Disaster Resilience Index."

The Disaster Risk Index (DRI) has been developed in a scale of 0 to 10 for each of 14 hazards, 14 vulnerabilities and 2 exposures in each of 640 census districts of the country[1] and the score of each state helps to perceive an idea of the present vulnerability of the State.

2.2. ASSAM

Assam is a state located in north-eastern part of India, situated south of the eastern part of the Himalayas along the Brahmaputra River and Barak River valleys. Assam covers an area of 79,410 sqkm.[2] The state is bordered by Bhutan and Arunachal Pradesh to the north, Nagaland and Manipur to the east, Meghalaya, Tripura, Mizoram and the country of Bangladesh to the south, and West Bengal to the west via the Siliguri Corridor, a 22 kilometres strip of land that connects the state to the rest of India. The state has a population of 2.9 crore.[3]

1 https://www.ndmindia.nic.in/images/gallery/scorecard1.pdf (NDMA , 2019)
[2] Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
[3] Summation of district population of the state from District Census Handbook 2011 (Census of India, 2011)

Assam is famous for its wildlife diversity and tea plantations. It is a major contributor to the GDP of the nation because of its tea plantations and hence disaster resilience extremely important for the state. The Gross State Domestic Product (GSDP) is Rupees 2,24,233 crore for the financial year of 2015-2016.[4]

According to Open Government Data Platform (OGD) India, incorporating life expectancy, education and per capita income, Human Development Index of Assam is 0.605.[5] The state has 5,687[6] indispensable Health Infrastructures and 50,178[7] vital Educational infrastructures which are vulnerable and hence their performance should be enhanced to immediate occupancy during any disasters. These facilities are an integral part for disaster resilience of the state also.

2.2.1. HAZARDS

Assam is a multi-hazard state prone to floods, earthquake, storms and landslide besides man-made disasters. Also the state faces acute flood and land erosion problem. Assam has a history of disasters ranging from large earthquakes to severe floods. Huge urban population combined with bad quality infrastructure, bad quality building stock, and lower resistance of the highly populated society increases the risks to earthquakes in the urban centres.[8]

The state is affected by several disasters and the most frequent ones are discussed.

2.2.1.1. EARTHQUAKE [8,9]

Assam suffers from earthquakes, with quite a high frequency of occurrence. The earthquakes of M>5.0 have a repeat frequency of just about 6 months within and close to the state boundary. The state of Assam lies in a region with high to very high seismic hazard. As per the 2016 Bureau of Indian Standards (BIS) map, this state also falls in Zone V. (refer to Figure 2.1: **Earthquake Hazard Zoning Map of Assam**. Historically, parts of this state have experienced seismic activity greater than M6.0. Much of Assam lies in the Brahmaputra River Valley, except for a few southern districts. The northern and eastern parts of this valley are bounded by the Himalayan Frontal Thrust (HFT). In the eastern parts along with the HFT, there is the Lohit and Naga Thrusts. Among the large earthquakes in this region were the events in 1869 and 1897. The 1897 earthquake is well known for the dramatic accounts of violent upthrow during the shock. As per BMTPC Earthquake Hazard Zoning Atlas (2016) present day Assam-Meghalaya border area has been the seat of the Great Assam earthquake of 1897 which in fact laid the foundation of seismology in India. This earthquake of giant Magnitude of 8.7 is almost unsurpassed up-to now. This earthquake was responsible for the death of 1542 persons, and almost total destruction of all brick and stone buildings in all the principal towns of Shillong, Sylhet, Goalpara, Gauhati, Dhubri and Tura. The destruction spread over an area of 370,000 sq.km (equal to circle of 340 km radius), and the shock wave was felt over an area of 4.5 million sq. km (circle of 1,200 km radius). The intensity of the shock was so great within the epicentre tract that ground waves were visible at Shillong, and Nalban Magadai. Estimates of the horizontal ground acceleration were: 0.42g at Shillong, Sylhet and Goalpara, 0.30g at Cherapunji, 0.27g at Dhubri and 0.12g at Silchar. On the slopes of Khasi hills, a number of embedded rounded small blocks of granite were thrown from their places and projected to other

[4] https://data.gov.in/keywords/gross-state-domestic-product (Government of India; GSDP, 2019)
[5] https://data.gov.in/search/site?query=human+development+index (Government of India; HDI, 2019)
[6] https://data.gov.in/search/site?query=hospitals (Government of India; Hosp., 2019)
[7] http://udise.schooleduinfo.in/ and https://www.ugc.ac.in/ (UDISE, 2019) (UGC, 2019)
[8] Assam State Disaster Management Plan (ASDMA)
[9] Assam Earthquake Hazard Zoning Atlas (BMTPC)

places showing that the vertical acceleration exceeded gravity there. (Refer - Figure 2.1: Earthquake Hazard Zoning Map of Assam).

Another earthquake of giant size occurred near the tri junction of Tibet, Burma and India in 1950 having a Magnitude of 8.6 which lifted up the bed of River Lohit and other streams causing flood conditions downstream. Although the epicentre was in uninhabited region, it caused great destruction in north eastern Assam particularly in North Lakhimpur, Dibrugarh, Jorhat, Sibsagar and in Arunachal Pradesh. Road and rail communications in the affected areas got completely disrupted due to ground subsidence as well numerous fissures. The bed of Brahmaputra rose and gave rise to unprecedented floods downstream. An area of nearly 4600 sq. km in Assam suffered extensive damage. The felt area must have exceeded 2.9 million sq.km. (960 km radius). The total seismic energy released indicates that a block of rock 200 km x 100 km x 100 km must have been subjected to breaking stress.

The area is so earthquake prone that, on an average the following Magnitudes are likely to recur,

- M > 5.0 to less than 5.6 once in about 12 months
- M > 5.5 to less than 6.6 once in about 18 months
- M > 6.5 to less than 7.6 once in about 8 years
- M > 7.5 once in about 48 years

As a result of the high seismicity, the whole state is classified in IS: Zone V referred as Very High Damage Risk Zone (MSK IX or More) in the Atlas, requiring great care in earthquake resistant design and construction of buildings and structures.

House Types in Assam and Risk of Earthquake Damage - Housing situation from view point of wall types' as per 2011 Census in the state as a whole can be summarised as below:

Total housing units in state = 87,56,707 (excluding vacant and locked houses)

- Category A (clay mud, unburnt bricks = 3,33,717 (3.81%) or random stone laid in mud)
- Category B (Burnt brick walls) = 19,45,461 (22.21%)
- Category C (concrete walls/frames, well = 4,21,244 (4.81%) built wooden/Ikra houses)
- Category X (metal sheets, bamboo, thatch = 6,056,285 (69.16%) etc.

It means that Category A and B housing accounting for 26% of all buildings in the state have very high vulnerability to destruction in an Intensity IX earthquake. A very high percentage of X type units is indicative of the poverty of the people.

In case of a repeat of Great Assam Earthquake of 1897, the damage will be massive in various districts.

Existing priority life-line structures are to be identified and retrofitted immediately. Beside this other actions like regulations and code enforcement, enhancement of capacity of various emergency response agencies, education, awareness, development of earthquake early warning dissemination system etc. are needed for reducing the Disaster Risk.

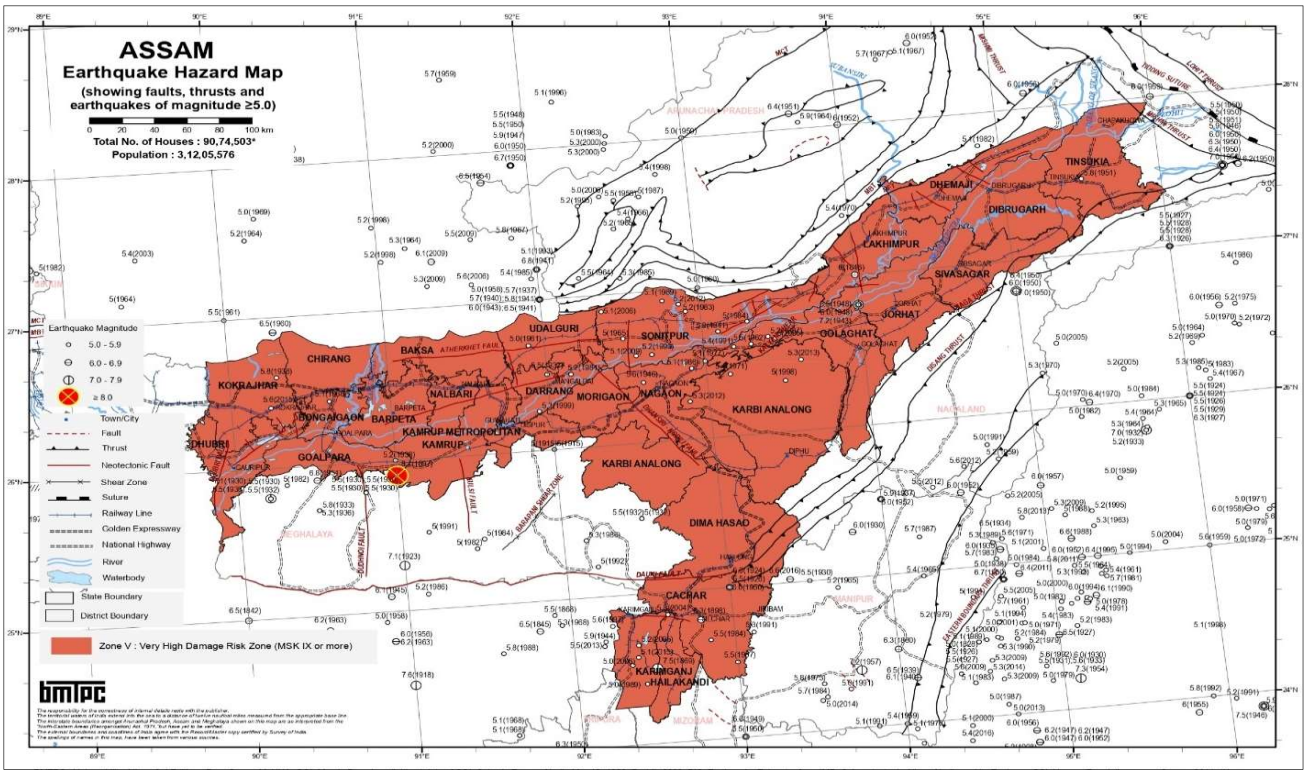

Figure 2.1: Earthquake Hazard Zoning Map of Assam

2.2.1.2. FLOOD [10, 11]

The state is frequently ravaged by the River Brahmaputra and its tributaries causing massive devastations. Assam gets an overabundance of rain throughout the year. The Brahmaputra originates in Mansarovar in Tibet and passes through the Centre of the state from east to west, more or less the entire span of the state. The 2,900 km long river and its numerous tributaries such as, Subansiri, Manas, Gadadhar, Sonkosh, Dhansiri, etc. gets flooded and overflow their banks flooding major areas of the state during the monsoon. The increased level of river beds due to constant deposition of silt has been also a major cause of flood in the state. The floods happen at regular intervals rendering hundreds of villages along the river Brahmaputra and its tributaries submerged in water. Properties and utilities worth crores of rupees gets destroyed. Standing crops, cattle and other valuable goods are washed away. 23,823 sqkm area of the state is flood ravaged on a regular basis along the river. (Refer - Figure 2.2**:** Flood Hazard Map of Assam).

The districts that are severely flood affected are Darrang, Morigaon, Barpeta, Lakhimpur, Dhemaji, Jorhat, Nalbari, Nagaon and Sibsagar. More than 50% of the area of these districts are flooded leading to huge socio-economic losses for the districts.

The reliability and effectiveness of the embankments from the Brahmaputra flooding are generally insufficient because of structural deterioration and ongoing riverbank erosion. River erosion is resultant issue of the floods and which leads to severe land loss.

10 Assam State Disaster Management Plan (ASDMA)
11 Vulnerability Atlas of India 2016 (BMTPC, 2016)

"The average bank-line shift of the north bank towards the north is estimated to be 227.5 m/year on average, 331.6 m/year from the north bank towards the south, 137.2 m/year from the south bank towards the south and 225 m/year from the south bank towards the north (Sarma, 2005)."

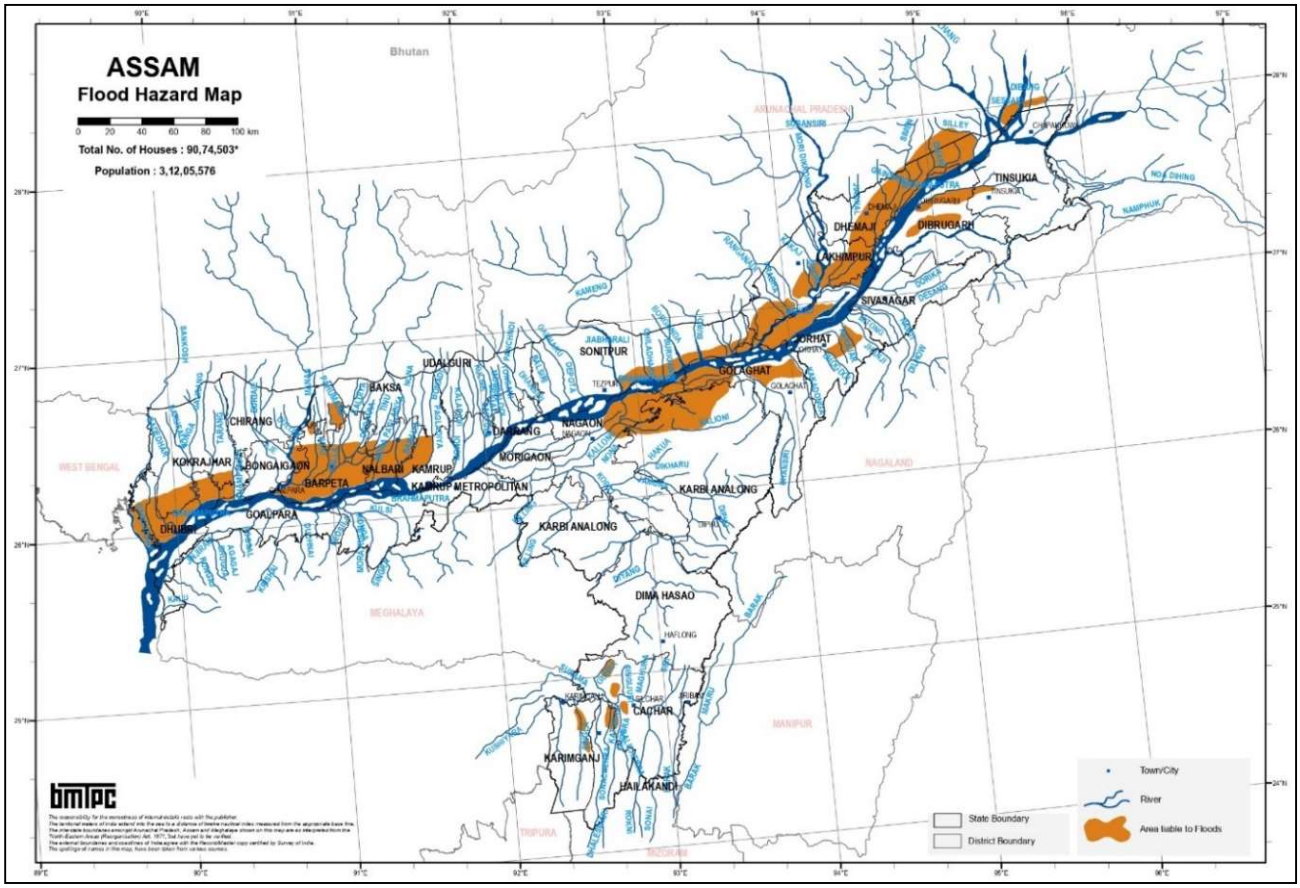

Figure 2.2: Flood Hazard Map of Assam

2.2.1.3. LANDSLIDE[12], [13]

Along with heavy rainfall, deforestation along the slopes and unauthorized rapid growth of settlement on the hills are the major causes of landslides in the state, especially when the slopes turn into unstable slopes. With the increase of settlement, the frequency of landslides have increased. Most of the landslides since 1990 have occurred because of rampant encroachment. 18,351 sqkm of the state is affected by landslides. (refer to Figure 2.3: Landslide Incidence Map of Assa).

The state is located on the Himalayas, and the mountains being seismically active results in frequent earthquakes which are usually accompanied by damaging landslides in the region. However, most of the minor landslides go unnoticed many major events have taken place in the recent past, and torrential rainfall are the most common cause for the events.

12 Vulnerability Atlas of India 2016 (BMTPC, 2016)
13 Assam State Disaster Management Plan (ASDMA)

The major districts affected by landslides are Kamrup Metropolitan and Dima Hasao. Extensive parts of these two districts are severely affected by landslides at a regular interval. Other districts affected are Cachar, Karimganj and Lakhimpur.

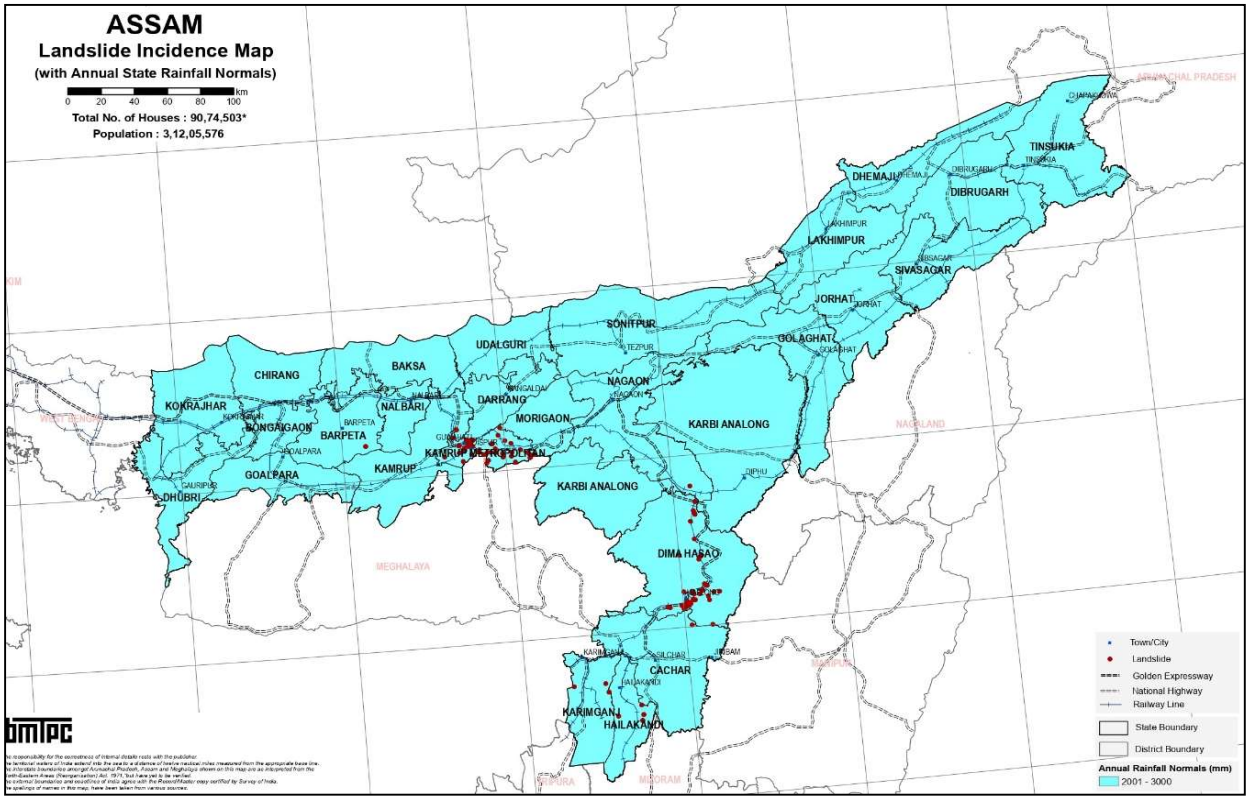

Figure 2.3: Landslide Incidence Map of Assam

2.2.2. DISASTER RISK

The state is affected by several natural hazards amongst which Earthquake, Flood and Landslide are the most prominent and recurs frequently. A study has been conducted and the data has been compiled in the following table pertaining information about the districts that are affected by the hazards.

Table 2.1 Disaster Risk Profile of the Districts of Assam[14] [15]

Districts	Area (sqkm)	Earthquake Hazard Zone V (sqkm)	Flood Hazard (✓ Flood prone / × Not prone to Flood)	Landslide (LS) Hazard (✓ LS prone / × Not prone to LS)	Wind Hazard Zone
Baksa	2,457	2,457	✓	×	VHDRZ-B
Barpeta	2,282	2,282	✓	✓	VHDRZ-B
Bongaigaon	1,519	1,519	✓	×	HDRZ

14 Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
15 Vulnerability Atlas of India 2016 (BMTPC, 2016)

Districts	Area (sqkm)	Earthquake Hazard Zone V (sqkm)	Flood Hazard (✓ Flood prone / × Not prone to Flood)	Landslide (LS) Hazard (✓ LS prone / × Not prone to LS)	Wind Hazard Zone
Cachar	3,786	3,786	✓	✓	VHDRZ-A
Chirang	1,923	1,923	×	×	HDRZ
Darrang	1,585	1,585	×	×	VHDRZ-B
Dhemaji	3,237	3,237	✓	×	VHDRZ-B
Dhubri	2,176	2,176	✓	×	HDRZ
Dibrugarh	3,381	3,381	✓	×	VHDRZ-B
Dima Hasao	4,888	4,888	×	✓	VHDRZ-B
Goalpara	1,824	1,824	✓	×	VHDRZ-B
Golaghat	3,502	3,502	✓	×	VHDRZ-B
Hailakandi	1,327	1,327	×	✓	VHDRZ-A
Jorhat	2,851	2,851	✓	×	VHDRZ-B
Kamrup(M)	1527	1,527	×	✓	VHDRZ-B
Kamrup	3,105	3,105	✓	✓	VHDRZ-B
Karbi Anglong	10,434	10,434	×	×	VHDRZ-B
Karimganj	1,809	1,809	✓	✓	VHDRZ-A
Kokrajhar	3,296	3,296	✓	×	HDRZ
Lakhimpur	2,277	2,277	✓	×	VHDRZ-B
Morigaon	1,525	1,525	×	×	VHDRZ-B
Nagaon	3,973	3,973	✓	✓	VHDRZ-B
Nalbari	1,052	1,052	✓	×	VHDRZ-B
Sivasagar	2,668	2,668	×	×	VHDRZ-B
Sonitpur	5,204	5,204	✓	×	VHDRZ-B
Tinsukia	3,790	3,790	✓	×	VHDRZ-B
Udalguri	2,012	2,012	×	×	VHDRZ-B

VHDRZ-A	Very High Damage Risk Zone - A (Vb= 55 m/s)
VHDRZ-B	Very High Damage Risk Zone - B (Vb= 50 m/s)
HDRZ	High Damage Risk Zone (Vb= 47 m/s)

It can be observed from the above mentioned table on depicting the hazards of the Assam state, entire state comes under the most severe earthquake zone i.e., zone V making the entire state most vulnerable to earthquakes, amongst twenty-seven districts of the state eighteen district areas are liable to flooding, eight districts are Landslide-prone and two districts comes predominantly under very high damage risk zone experiencing wind velocity of 55 m/s, twenty districts experiencing a wind speed of 50 m/s and rest comes under high damage risk zone with the wind speed of 47 m/s. It can be clearly concluded that Assam is a state prone to sever hazards and requires preparedness against disasters.

2.2.3. DISASTER RESILIENCE [16]

The state has formed its own State Disaster Management Authority (SDMA) to mitigate the risks arising due to the hazards. An analysis into the different areas of work by the SDMAs was

16 https://www.ndmindia.nic.in/images/gallery/scorecard1.pdf and http://sdmassam.nic.in/ (NDMA , 2019) (ASDMA, 2019)

conducted and the following table has been compiled to effectively detail out the various work of the state towards Disaster Resilience.

Table 2.2 Functional Areas of Disaster Resilience of Assam

Areas of Work	Work Statement
State Disaster Management Authority	Assam State Disaster Management Authority (ASDMA)
State Disaster Management Plan	Assam State Disaster Management Plan
State Disaster Response Force	No information is available.
Publications	• Acts and Policy. • Newsletters. • Annual Reports. • Compendium on Innovative Tools.
Drills and Public Awareness Programmes	• Great Assam School Shake Out. • Assam Secretariat Mock Drill. • Emergency Management Exercises. • Mega Mock Exercise. • Guwahati Emergency Management Exercise. • Aapda Mitra Scheme. • Workshops. • Street Plays on Earthquake Safety. • Workshop on Mainstreaming Media into Disaster Risk Reduction.
Capacity Building	• Integration of Emergency Helpline Number. • GIS Mapping of Amenities and Buildings. • Installation of Flood Early Warning Systems (FLEWS). • Status Survey of Hospitals and School Buildings in Guwahati and Retrofitting. • Flood and Erosion Risk Mitigation Planning. • Critical Analysis of Existing Seismic Micro-Zonation - Study of Guwahati City. • Operationalization of District Disaster Response and Information Centre. • Revenue Circle Level Disaster Information and Response Teams Formation of State Disaster Rescue Force (SDRF). • Apartment Society Sensitization Programme. • Involvement of NGO with ASDMA. • Incident Response System (IRS) in Assam, etc.
MIS Search and Rescue Equipment	Equipped with more than 28000 equipment.
NGO's	NGO Enrolment facility is provided.
Contact Address	Govt. of Assam, Assam Secretariat, Dispur Work: +91- 361- 2237221 Fax: +91- 361- 2237010 e-mail: asdmaghy@gmail.com and statedmcontrolroomassam@gmail.com

2.3. BIHAR

Bihar is a state in the eastern part of India bordering Nepal, with an area of 94,069 sqkm[17]. The third-largest state by population, it is continuous with Uttar Pradesh to its west, the country of Nepal to the north, the northern part of West Bengal to the east, with Jharkhand to the south. The river Ganges which flows from west to east bifurcates the state in two halves and often floods its fertile plains. It has a population of 10.4 crores.[18]

Bihar is famous for being the place where Lord Buddha attained his enlightenment. It has quite a number of Buddhist and Hindu shrines and happens to host one of the ancient seat of learning- Nalanda. Apart from tourism, agriculture contributes most to the Gross State Domestic Product (GSDP) of the state which is Rupees 413503 crores for the financial year of 2015-2016.[19]

According to Open Government Data Platform (OGD) India, incorporating life expectancy, education and per capita income, Human Development Index of Bihar is 0.566.[20] The state has 11,705[21] indispensable Health Infrastructures and 71,637[22] vital Educational infrastructures which are vulnerable and hence their performance should be enhanced to immediate occupancy during any disaster. These facilities are an integral part for disaster resilience of the state also.

2.3.1. HAZARDS

The State of Bihar, a multi-disaster prone state, is predominantly rural in character. The geo-climatic conditions of Bihar make it vulnerable to many hazards. The lives and livelihood of millions of the people residing in Bihar gets affected by various disasters from time to time. The state witnesses various types of natural and human induced disasters, like Floods, Drought, Earthquake, Fire, and Cyclone.[23]

2.3.1.1. EARTHQUAKE [23, 24]

The state of Bihar being located on the boundary of the tectonic plate joining the Himalayan tectonic plate an lies in a region with moderate, low and high seismic hazard zone. The state has six sub-surface fault lines penetrating through its Gangetic planes in four directions, and is vulnerable to the worst kind of disaster caused by earthquake of near maximum intensity.

As per the 2016 Bureau of Indian Standards (BIS) map, this state also falls in Zones III, IV and V. Historically, this region has experienced earthquake in the M5.0-7.0 range. (refer to Figure 2.4**:** Earthquake Hazard Zoning Map of Bihar). It has a repeat frequency of just about 3 years within and close to the boundary of northern part of the state.

The earthquake hazard situation in Bihar is very peculiar, whereas the northern parts of the state abutting Nepal have the highest seismic intensity zone V, the southern districts lie in the intensity zone III.

[17] Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
[18] Summation of district population of the state from District Census Handbook 2011 (Census of India, 2011)
[19] https://data.gov.in/keywords/gross-state-domestic-product (Government of India; GSDP, 2019)
[20] https://data.gov.in/search/site?query=human+development+index (Government of India; HDI, 2019)
[21] https://data.gov.in/search/site?query=hospitals (Government of India; Hosp., 2019)
[22] http://udise.schooleduinfo.in/ and https://www.ugc.ac.in/ (UDISE, 2019) (UGC, 2019)
[23] Bihar State Disaster Management Plan (BSDMA)
24 Bihar Earthquake Hazard Zoning Atlas (BMTPC)

North Bihar was subjected to one of the most violent giant earthquakes in India and Nepal with M 8.3 in 1934 on the open ended Richter scale, with its epicentre in Nepal close to the Indian border. It caused large scale damage in both countries, including the whole area from Kathmandu in Nepal to Munger in India. More than 7,000 persons lost their lives in India and 8,500 in Nepal. Bhatgaon in Nepal and Munger in Bihar were ruined completely and large parts of Patna and Kathmandu in Nepal and Motihari, Muzaffarpur and Darbhanga were also destroyed along with innumerable villages in between. Large tracts in the present named districts of East Champaran, Sitamarhi, Madhubani, Supaul, Saharsa, Modhepura and Araria in a length of about 300 km and average width of about 50 km slumped due to liquefaction of sandy soils and at many places sand fountains and sand boils occurred on a large scale. In these districts, houses had greatly tilted and sunk into the ground. The highest intensity observed was Modified Mercalli (or MSK) X. The isoseismal IX enclosed an area of about 36000 sq.km with a length of about 300 km.

In the same area, an earthquake of M 6.6 occurred on Aug. 20, 1988 in the monsoon season when the area was under flooding. This resulted in 282 dead, 3,766 injured in India and 721 dead and 7,300 injured in Nepal, loss of 1,50,000 houses in India and 1,00,000 in Nepal. Maximum intensity reached was MSK VIII.

The latest series of earthquakes in 2015, with the epicentres ranging in between Tibet to Nepal had a little impact on the state.

As per seismic zoning map in IS: 1893(Part-I)-2016 (see Earthquake Hazard Map of the state in this Atlas), 15.2% of area of Bihar is placed in Zone V referred as Very High Damage Risk Zone (MSK IX or more). This covers eight districts at present. The next lower intensity zone IV referred as High Damage Risk zone (MSK VIII) covers 63.7% area. The remaining 21.7% area is placed in zone III (MSK VII) thus whole of state of Bihar is liable to the seismic damaging intensities.

House Types in Bihar and Risk of Earthquake Damage - Based on Census 2011 will bring out the poor quality of the constructions.

It will be seen that 18.71% of the housing belongs to

- Category A (Mud or Stone walls).
- Category B (Burned Brick walls which are mostly built using mud mortar) account for 48.62%.

Category- A houses are liable to total collapse in zone V and have risk of very severe damage with partial collapse in zone IV. Even in MSK VII, these could sustain wide cracking and few collapses. On the other hand.

Category B houses which are not built with cement mortar, but with mud mortar, will also be liable to severe damage including collapses in zone V and heavy damage in zone IV. The better Category C houses account for only 1.2% of total housing units in the state.

Existing priority life-line structures are to be identified and retrofitted immediately. Beside this other actions like regulations and code enforcement, enhancement of capacity of various emergency response agencies, education, awareness, development of earthquake early warning dissemination system etc. are needed for reducing the Disaster Risk.

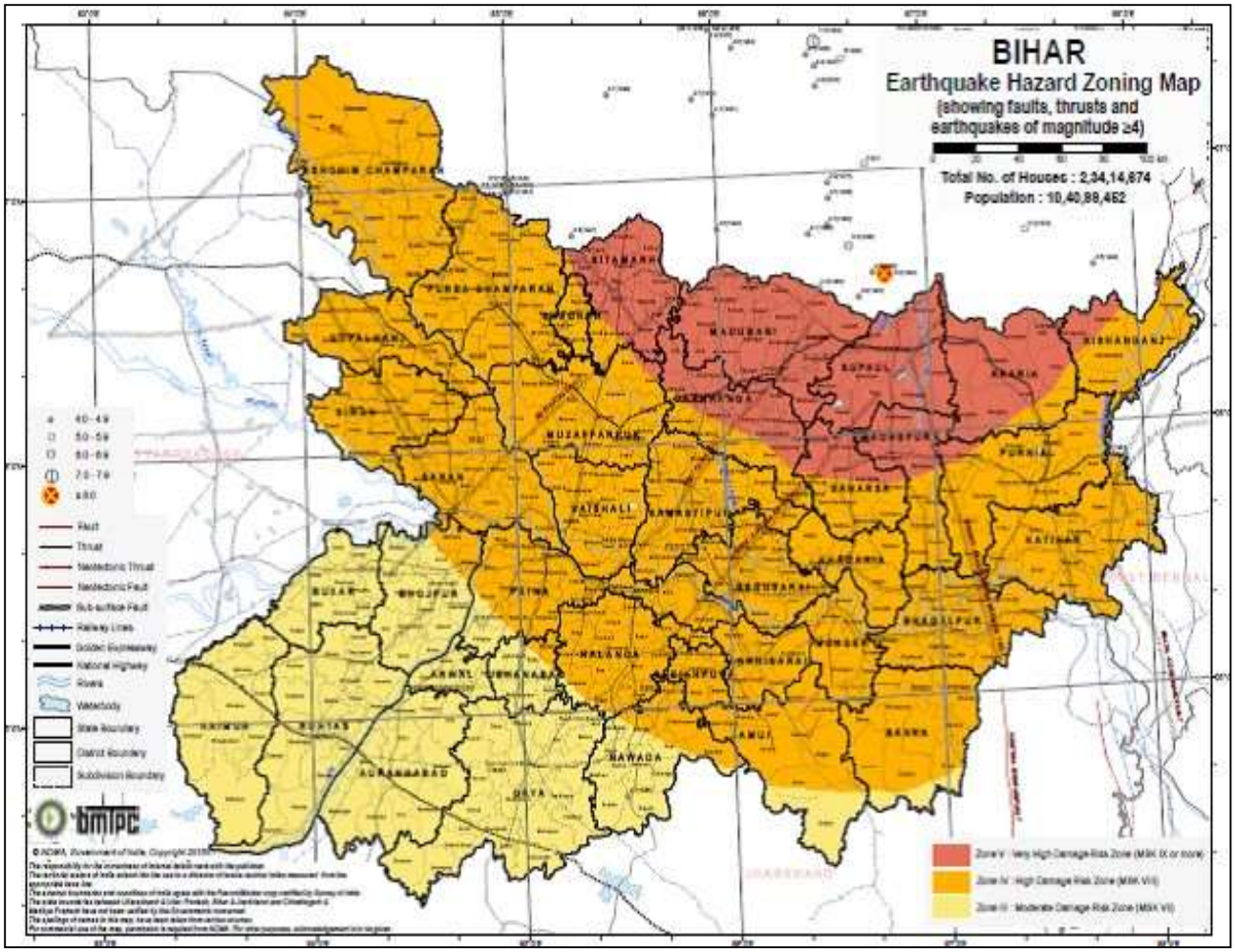

Figure 2.4: Earthquake Hazard Zoning Map of Bihar

2.3.1.2. FLOOD [25, 26]

Several rivers pass through the state of Bihar like the Ganga, Sone, Punpun, Falgu, Karmanasa, Durgavati, Kosi, Gandak and the Ghaghara, to name a few. It receives heavy rainfall all through June to October and the state accounts for almost half of India's average annual flood losses. Historically the state faces floods on a regular interval. The frequency of floods has become high in recent years. Several people have lost their lives and their homes and there has been infrastructural losses worth crores of rupees. 68,800 sqkm of the state is flooded on a regular basis leading to massive destruction, which tantamount to 73% of the area of the state. (refer to Figure 2.5: Flood Hazard Map of Bihar.

Every year, approximately 28 districts get flooded causing severe socio-economic losses. Out of the 28 districts, Sitamarhi, Supaul and Kishanganj are 90% affected by flood, Bhagalpur, Darbhanga, Khagaria, Madhepura, Saharsa get around 70% affected and in the rest of the districts, the flood affected areas vary from 55% to 25%. In all 56% of the total area of Bihar is affected by flood.

25 Vulnerability Atlas of India 2016 (BMTPC, 2016)
26 Bihar Disaster Management Plan (BSDMA)

It is a great irony that, the state is also affected by drought. During the summer months, the southern part of the state is hit by heat waves prevailing the northern part of India, and groundwater reaches to a drastic low level leading to recurrent droughts. Reducing forest lands and unscientific agricultural methods along with rapid groundwater extraction is accelerating the drought and drought-like conditions in the state.

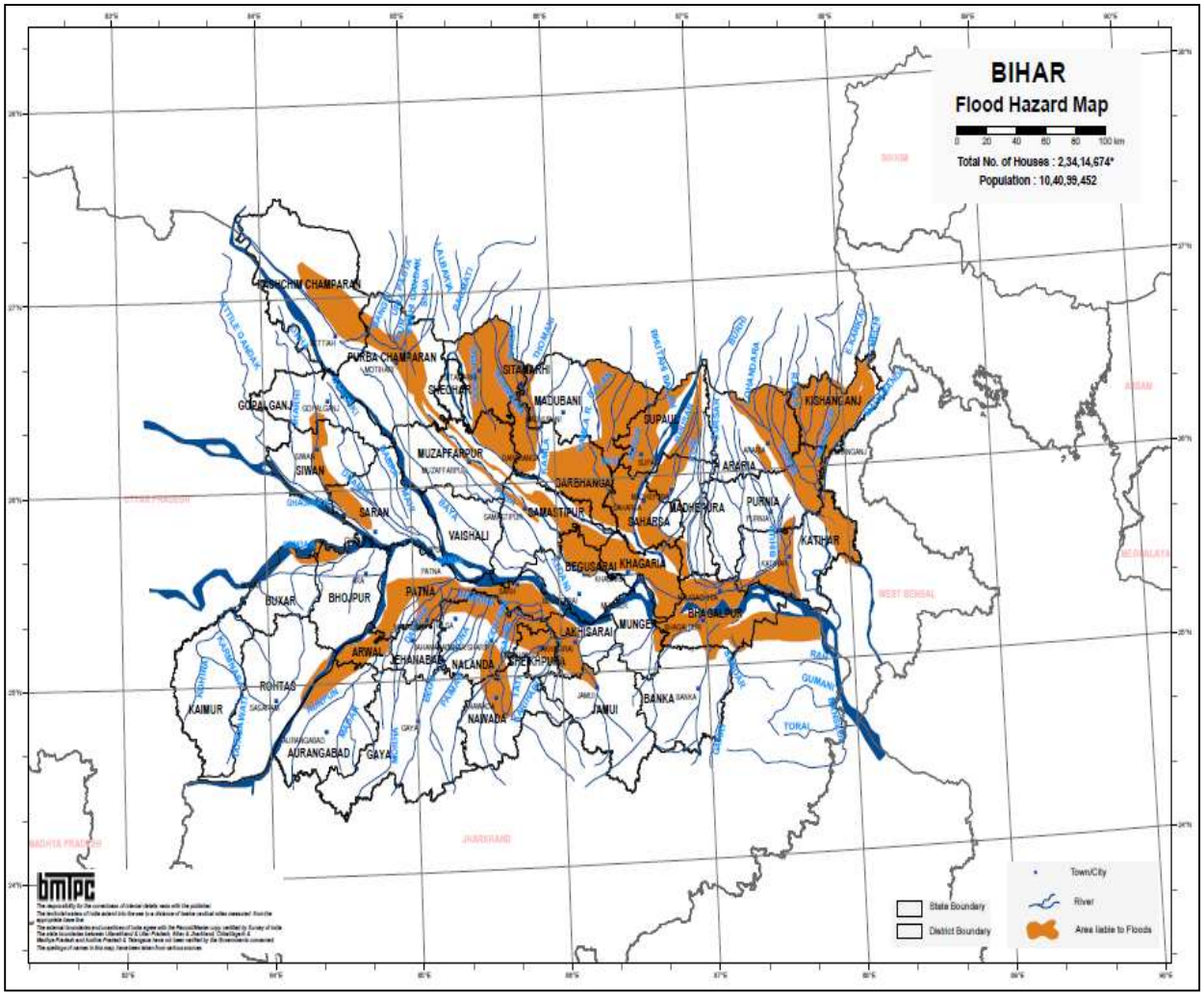

Figure 2.5: Flood Hazard Map of Bihar

2.3.1.3. CYCLONE [27, 28]

With each passing year, and the erratic monsoon in the country, the state is having floods and droughts at the same time due to lack of water conservation techniques and methods. During the summer months, hot winds have become a common phenomenon over the state. The monsoon and post monsoon season have become completely unpredictable in the state, and tropical cyclones hits the state on a frequent basis. The loss of life and damage to infrastructure and crops are quite severe.

27 Bihar Disaster Management Plan (BSDMA)
28 Vulnerability Atlas of India 2016 (BMTPC, 2016)

"In the state, out of 38 districts, 27 districts are completely affected by high speed winds of 47 m/s intensity. The area of districts - Banka, Jehanabad, Arwal and Nalanda is nearly 90% affected. Other districts of South Bihar except Nawada are partly affected by high speed winds of 44 m/s. Nawada is, however, 100% affected by high speed winds of this intensity." (refer to Figure 2.6**:** Wind Hazard Map of Bihar).

Electrocution and collapsing of old structures are one of the major causes of human life loss in the cyclones. Waterlogging in the urban areas due to failing infrastructure have become a common sight in current times, leading to crippling of the basic public services.

Among other related disasters, Railway/road/boat accidents are growing at an alarming rate in the state. The large proportion of population living below poverty line in unhygienic conditions and the rapid increase in vehicular traffic without having proper road infrastructure is leading to more issues.

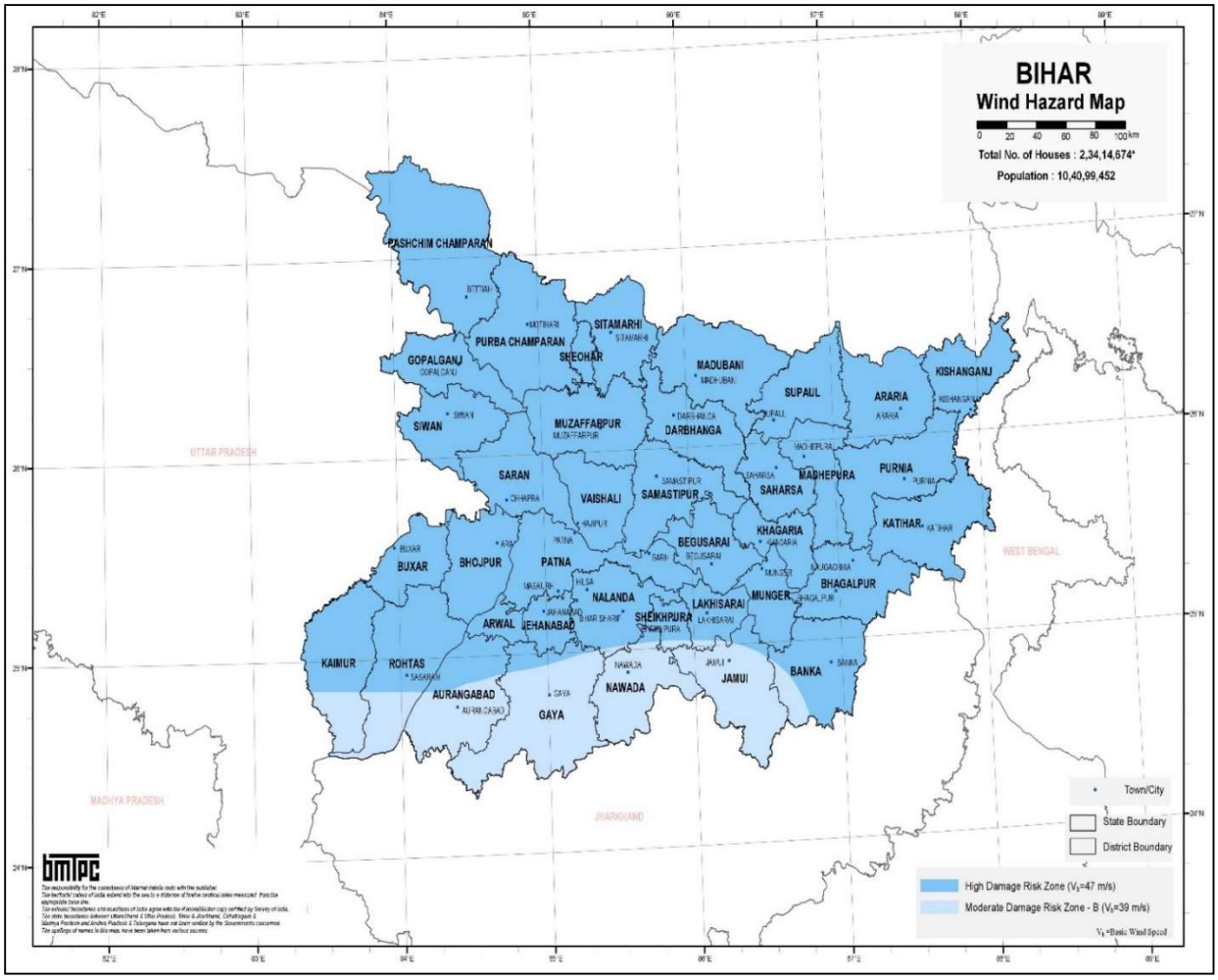

Figure 2.6: Wind Hazard Map of Bihar

2.3.2. DISASTER RISK

The state is affected by several natural hazards amongst which Earthquake, Flood and Cyclone are the most prominent and recur frequently. A study has been conducted and the data has

been compiled in the following table pertaining information about the districts that are affected by the hazards.

Table 2.3 Disaster Risk Profile of the Districts of Bihar [29] [30]

Districts	Area (sqkm)	Earthquake Hazard ZoneV(sqkm)	Earthquake Hazard ZoneIV(sqkm)	Earthquake Hazard ZoneIII(sqkm)	Flood Hazard (✓ Flood prone / × Not prone to Flood)	Wind Hazard Zone
Araria	2,830	2,462	368	0	✓	HDRZ
Arwal	638	0	0	638	✓	HDRZ
Aurangabad	3,305	0	0	3,305	×	MDRZ
Banka	3,020	0	2,476	544	×	HDRZ
Begusarai	1,918	0	1,918	0	✓	HDRZ
Bhagalpur	2,569	0	2,569	0	✓	HDRZ
Bhojpur	2,395	0	357	2,038	✓	HDRZ
Buxar	1,703	0	0	1,703	✓	HDRZ
Darbhanga	2,279	1,345	934	0	✓	HDRZ
Champaran (E)	3,968	0	3,968	0	✓	HDRZ
Gaya	4,976	0	0	4,976	×	MDRZ
Gopalganj	2,033	0	2,033	0	✓	HDRZ
Jamui	3,098	0	2,293	805	×	MDRZ
Jehanabad	931	0	184	747	×	HDRZ
Khagaria	1,486	0	1,486	0	✓	HDRZ
Kishanganj	1,884	273	1,611	0	✓	HDRZ
Kaimur	3,332	0	0	3,332	×	HDRZ
Katihar	3,057	0	3,057	0	✓	HDRZ
Lakhisarai	1,228	0	1,228	0	✓	HDRZ
Madhubani	3,501	3,501	0	0	✓	HDRZ
Munger	1,419	0	1,419	0	✓	HDRZ
Madhepura	1,788	1,051	737	0	×	HDRZ
Muzaffarpur	3,172	190	2,982	0	✓	HDRZ
Nalanda	2,355	0	2,002	353	✓	HDRZ
Nawada	2,494	0	923	1,571	✓	HDRZ
Patna	3,202	0	2,770	432	✓	MDRZ
Purnia	3,229	355	2,874	0	✓	HDRZ
Rohtas	3,881	0	0	3,881	×	HDRZ
Saharsa	1,687	658	1,029	0	✓	HDRZ
Samastipur	2,904	0	2,904	0	✓	HDRZ
Sheohar	349	38	311	0	×	HDRZ
Sheikhpura	689	0	689	0	✓	HDRZ
Saran	2,641	0	2,641	0	✓	HDRZ
Sitamarhi	2,200	1,958	242	0	✓	HDRZ
Supaul	2,425	2,425	0	0	✓	HDRZ
Siwan	2,219	0	2,041	178	✓	HDRZ
Vaishali	2,036	0	2,036	0	×	HDRZ
Champaran (W)	5,228	0	5,228	0	✓	HDRZ

29 Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
30 Vulnerability Atlas of India 2016 (BMTPC, 2016)

Districts	Area (sqkm)	Earthquake Hazard ZoneV(sqkm)	Earthquake Hazard ZoneIV(sqkm)	Earthquake Hazard ZoneIII(sqkm)	Flood Hazard (✓ Flood prone / × Not prone to Flood)	Wind Hazard Zone
	HDRZ	High Damage Risk Zone (Vb= 47 m/s)				
	MDRZ	Moderate Damage Risk Zone (Vb= 39 m/s)				

It can be observed from the above mentioned table on depicting the hazards of the Bihar state, entire state comprises of three sever earthquake zones i.e., zone V, zone IV and zone III, making the entire state vulnerable to earthquakes, amongst thirty eight districts of the state twenty-eight district areas are liable to flooding and thirty-four districts comes predominantly under high damage risk zone experiencing wind velocity of 47 m/s and remaining districts experiencing a wind speed of 39 m/s. It can be clearly concluded that Bihar is a state prone to sever hazards and requires preparedness against disasters.

2.3.3. DISASTER RESILIENCE [31]

The state has formed its own State Disaster Management Authority (SDMA) to mitigate the risks arising due to the hazards. An analysis into the different areas of work by the SDMAs was conducted and the following table has been compiled to effectively detail out the various work of the state towards Disaster Resilience.

Table 2.4 Functional Areas of Disaster Resilience of Bihar

Areas of Work	Work Statement
State Disaster Management Authority	Bihar Disaster Management Authority (BSDMA)
State Disaster Management Plan	Bihar State Disaster Management Plan
State Disaster Response Force	No information is available.
Publications	• Acts and Policy. • Newsletters. • Annual Reports.
Drills and Public Awareness Programmes	• Trainings. • Mukhyamantri School Safety Programme. • National School Safety Programme. • Aapda Mitra Scheme. • Safety Weeks. • Road Safety Awareness, etc.
Capacity Building	• Collaboration with National Institute of Technology (NIT), Patna on research and development of earthquake resistant structures. • Collaboration with International Centre for Integrated Mountain Development (ICIMOD, Kathmandu (Nepal) to reduce disaster risk in the Kosi river basin.
MIS Search and Rescue Equipment	No information is available.
NGO's	No information is available.
Contact Address	2nd Floor, Pant Bhavan, Bailey Road, Patna, Bihar-800001

31 https://www.ndmindia.nic.in/images/gallery/scorecard1.pdf (NDMA , 2019)

Areas of Work	Work Statement
	Phone No: 0612-2522032,Fax: 0612-2532311 Email id-info@bsdma.org

2.4 HIMACHAL PRADESH

Himachal Pradesh is a state in the northern part of India. Situated in the Western Himalayas, it is bordered by states of Jammu and Kashmir on the north, Punjab on the west, Haryana on the southwest, Uttarakhand on the southeast, and Tibet on the east. At its southernmost point, it also touches the state of Uttar Pradesh. It covers an area of 55,679 sqkm[32] and has a population of 68.64 lakhs.[33]

Himachal Pradesh is situated in a region of scenic splendour in the Himalayas, offering a multi-textured display of majestic snow-clad mountains, deep gorges, thickly forested valleys, large lakes, terraced fields, and cascading streams. It is home to beautiful mountain towns and resorts like Dharmashala, Shimla, Manali, etc. The state also hosts the Dalai Lama, and possess a strong Tibetan presence which is reflected in its Buddhist temples and monasteries, as well as its vibrant Tibetan celebrations. There are several religious sanctums all over the state, leading to a steady economy generation from tourism.

Agriculture accounts up to nearly 45% of the GSDP, and along with it, with liberal state policies and strategic location to the national capital and other key locations, it is rapidly becoming industrial hub. Several electronic complexes have been established at Solan, Mandi, Hamirpur, Shogi, Raga-Ka-Bagh, Chamba, Ambi, Taliwala and Keylong. Baddi, Barotiwal and Nalagarh Industrial area is hosts many major industries of the country. Due to presence of several rivers which are in the upper course in the state, the power of the water flow has been harnessed by several dams and hydro-power plants along the rivers. All these and tourism constitutes the Gross State Domestic Product which had amounted to Rupees 1,04,368 crore in the financial year of 2015-2016.[34]

According to Open Government Data Platform (OGD) India, incorporating life expectancy, education and per capita income, Human Development Index of Himachal Pradesh is 0.72.[35] The state has 2,596 [36] indispensable Health Infrastructures and 15,495 [37] vital Educational infrastructures which are vulnerable and hence their performance should be enhanced to immediate occupancy during any disaster. These facilities are an integral part for disaster resilience of the state also.

2.4.1. HAZARDS

Himachal Pradesh is exposed to various disasters. Frequent natural disasters of various intensity and their impact on society and land is one of such problems, which hamper the development of the state. Earthquakes, landslides, cloudbursts, flash floods, avalanches, forest fires, droughts, etc. have caused tremendous loss to the state. The state of Himachal Pradesh falls in a region of high to very high seismic hazard. In the state of Himachal Pradesh, the

[32] Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
[33] Summation of district population of the state from District Census Handbook 2011 (Census of India, 2011)
[34] https://data.gov.in/keywords/gross-state-domestic-product (Government of India; GSDP, 2019)
[35] https://data.gov.in/search/site?query=human+development+index (Government of India; HDI, 2019)
[36] https://data.gov.in/search/site?query=hospitals (Government of India; Hosp., 2019)
37 http://udise.schooleduinfo.in/ and https://www.ugc.ac.in/ (UDISE, 2019) (UGC, 2019)

geologic hazards, namely, earthquakes and landslides are the most critical, the wind storm and flood hazards could also occur but cause damage locally only.[38]

2.4.1.1. EARTHQUAKE [38, 39]

The state of Himachal Pradesh falls in a region of high to very high seismic hazard. In the state of Himachal Pradesh, the geologic hazards, namely, earthquakes and landslides are the most critical, the wind storm and flood hazards could also occur but cause damage locally only.

As per the 2016 Bureau of Indian Standards (BIS) map, this state also falls in Zones IV and V. (refer to Figure 2.7: Earthquake Hazard Zoning Map of Himachal Pradesh). Historically, parts of this state have experienced seismic activity in the M7.0 range. As per latest hazard Atlas 2019, the whole state is prone to severe earthquake hazard. It has been subjected in 1905 to one of the giant earthquakes of the recorded seismic history of India having a Magnitude of 8.0 on the open ended Richter Scale in which 20000 persons had lost their lives, the towns of Kangra and Dharmsala were razed to the ground and no Government functionary there was left alive even to report the happenings to the higher authorities. It had shaken an area of more than 416000 sq. km in and around the present Himachal Pradesh. A maximum Intensity X on Rossi-Forel Scale was observed in the epicentral area which when interpreted on the now current Modified Mercalli Scale would be between X and XI. There are 248 earthquakes of Magnitude between 4.0 and 5.0 and 78 with Magnitude 5.0 or more, which have rocked the state of Himachal Pradesh and adjoining areas of Jammu and Kashmir or U.P. in the last about 100 years. The Kinnaur earthquake of Jan. 19, 1975 (M=6.7) and Dharmsala earthquake of April 26, 1986 (M=5.7) are well recorded in respect of damages caused and losses incurred.

It is also seen that according to seismic zoning map of the state in the Vulnerability Atlas of India 2016 (2006), five districts, namely Chamba (57.8%) Hamirpur (100%), Kangra (97.8%), Kullu (67.4%), Mandi (96.3%) have their area liable to the severest design Intensity of MSK IX or more, the remaining area of these districts being liable to the next severe Intensity VIII. Two districts, Bilaspur (49.0%) and Una (54.4%) also have substantial area in MSK IX and rest in MSK VIII. The remaining districts also are liable to Intensity VIII.

The 1905 Kangra earthquake occurred in Himachal Pradesh in India on 4 April 1905. The earthquake measured 7.8 on the surface wave magnitude scale and killed more than 20,000 people. Apart from this, most buildings in the towns of Kangra, Mcleodganj and Dharamshala were destructed.

There are frequent earthquakes of low to moderate intensity across the state, with its epicentre nearby. Though there are no or low loss of life and property, due to these low intensity earthquakes, any major disaster can happen any time.

Existing priority life-line structures are to be identified and retrofitted immediately. Beside this other actions like regulations and code enforcement, enhancement of capacity of various emergency response agencies, education, awareness, development of earthquake early warning dissemination system etc. are needed for reducing the Disaster Risk.

38 Himachal Pradesh State Disaster Management Plan (HPSDMA)
39 (BMTPC, Himachal Pradesh Earthquake Hazard Zoning Atlas)

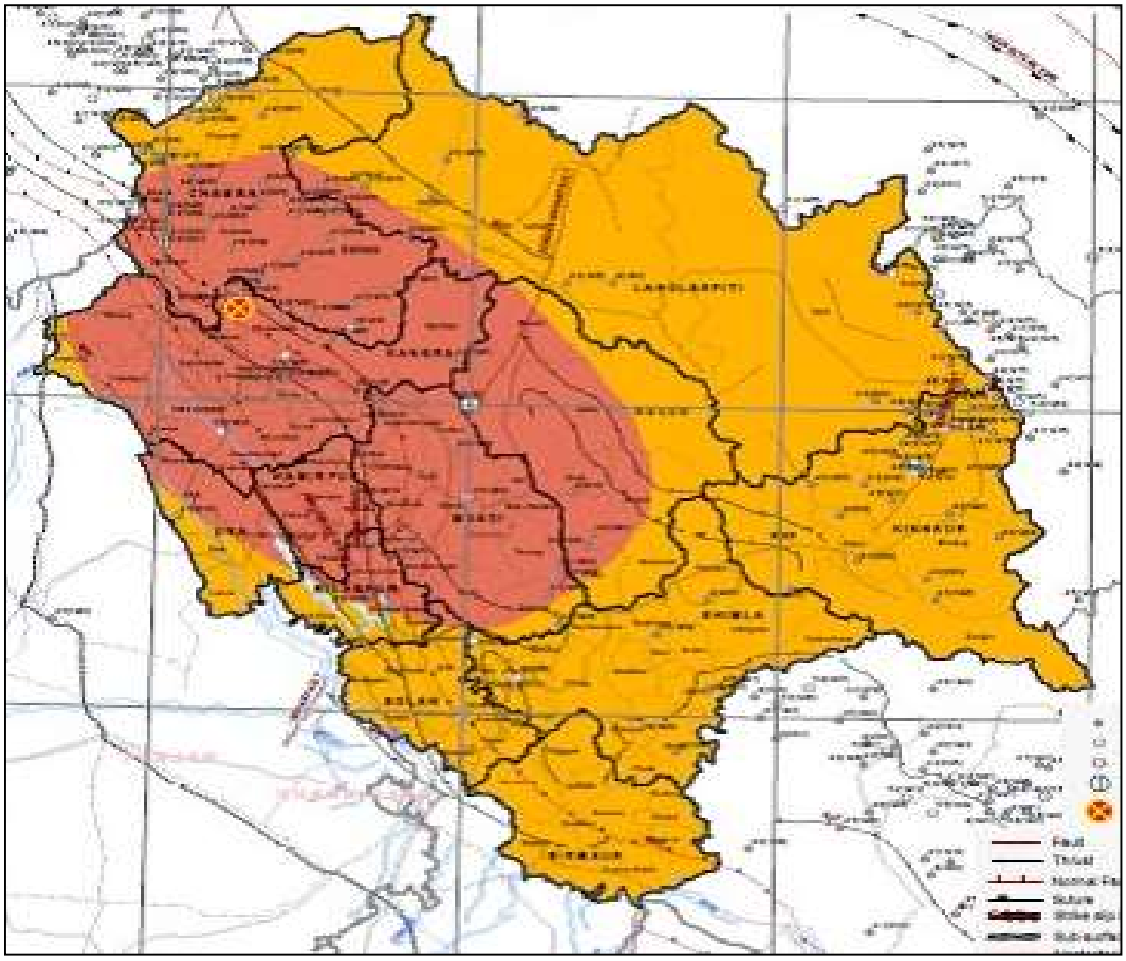

Figure 2.7: Earthquake Hazard Zoning Map of Himachal Pradesh

2.4.1.2. LANDSLIDE [40, 41]

Landslide is the one of the most regular hazard in Himachal Pradesh. Approximately each year the state is ravaged by major landslides causing loss of life and damage to houses, agricultural fields, roads and infrastructure. Everyday lives are severely affected, disrupting movement of people, goods and services, with adverse impact on the economy.

Landslides are triggered by both natural and man-made factors. Among the natural factors, the common causes are due to earthquakes, steep slopes, torrential rains, melting snow. The man-made factors include deforestation, unscientific construction of roads, unscientific agricultural practices, and encroachment on hill slopes etc.

Most of the state is well connected by roadways. Many major state and national highways are at risk of landslides, and in many cases damage to the road network means partial or complete blockage of access to parts of the state, as a result most of the tourist places face problems if the routes are compromised. Amongst the National Highways, 993.29 kms are in high vulnerable zone, 516.46 kms fall in moderate risk zone and 10.96 kms are in extreme

40 Himachal Pradesh State Disaster Management Plan (HPSDMA)
41 Vulnerability Atlas of India 2016 (BMTPC, 2016)

vulnerable zone. On the basis of visual and GIS interpretation, it has been found that most of the built-up areas of 866.14 sq. km. in the state fall under the landslide risk zones.

Many reservoirs, dams, hydro-power plants are at constant risk from landslides. In the following Figure 2.8**: Landslide Incidence Map of Himachal Pradesh**, the red zones demarcate high hazard zones, the orange demarcates medium and the yellow demarcates low hazard zones due to Landslide in the state.

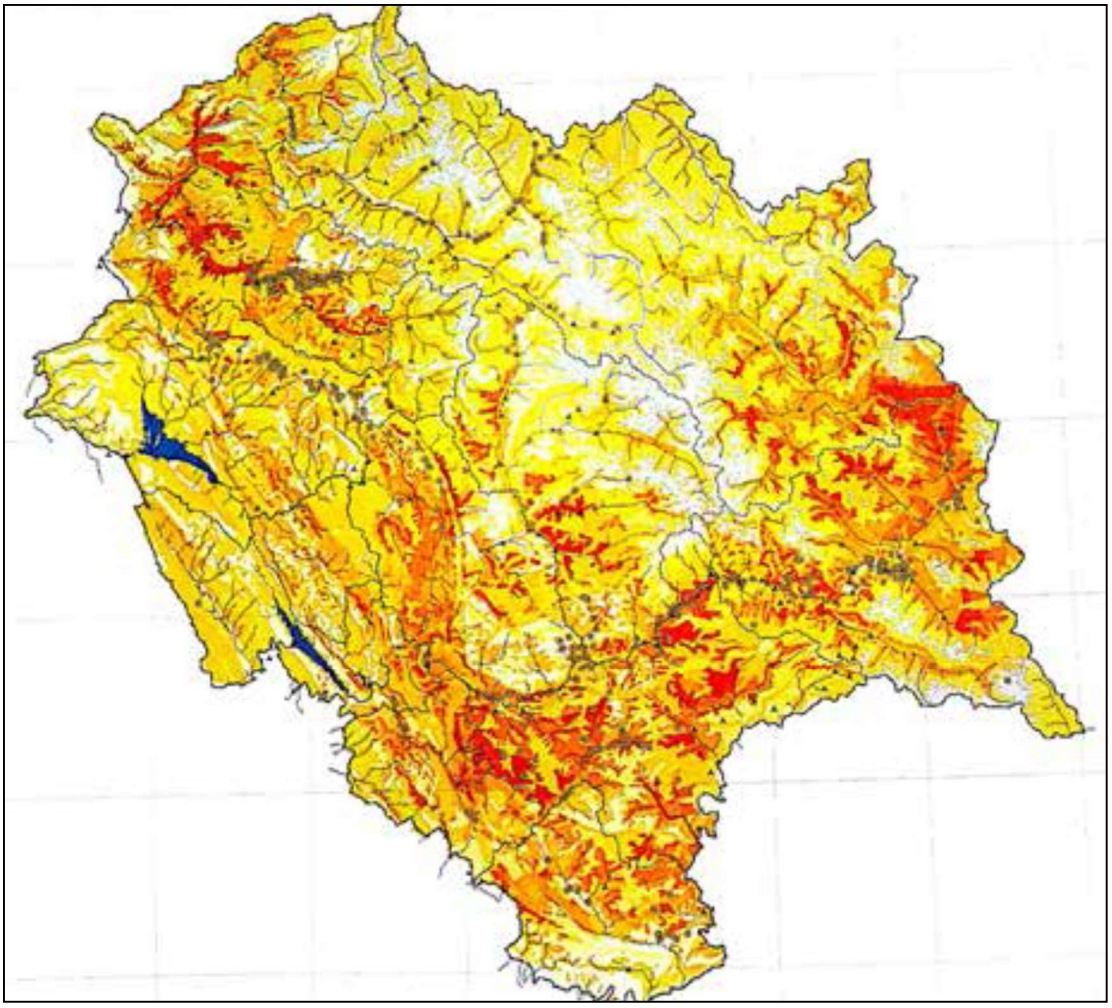

Figure 2.8: Landslide Incidence Map of Himachal Pradesh

2.4.1.3. FLOOD [42, 43]

Himachal Pradesh having a several rivers flowing through it is at constant risk from hydrological hazards as well. Riverine floods, Flash floods and Glacial Lake Outburst Floods are the most common types of floods which affect the state.

During the monsoon, due to torrential rainfall and as a result due to sudden increase in amount of water in the hilly rivers, they tend to overflow their banks and the dams have a safe capacity

42 Himachal Pradesh State Disaster Management Plan (HPSDMA)
43 Vulnerability Atlas of India 2016 (BMTPC, 2016)

beyond which, the dams also have to release the water causing floods downstream. River Sutlej and Beas are flooded every year causing severe damages socio-economically.

Out of the 12 districts of the state, 8 are at severe risk from floods. (refer to Figure 2.9: Flood prone River Section Map of Himachal Pradesh).

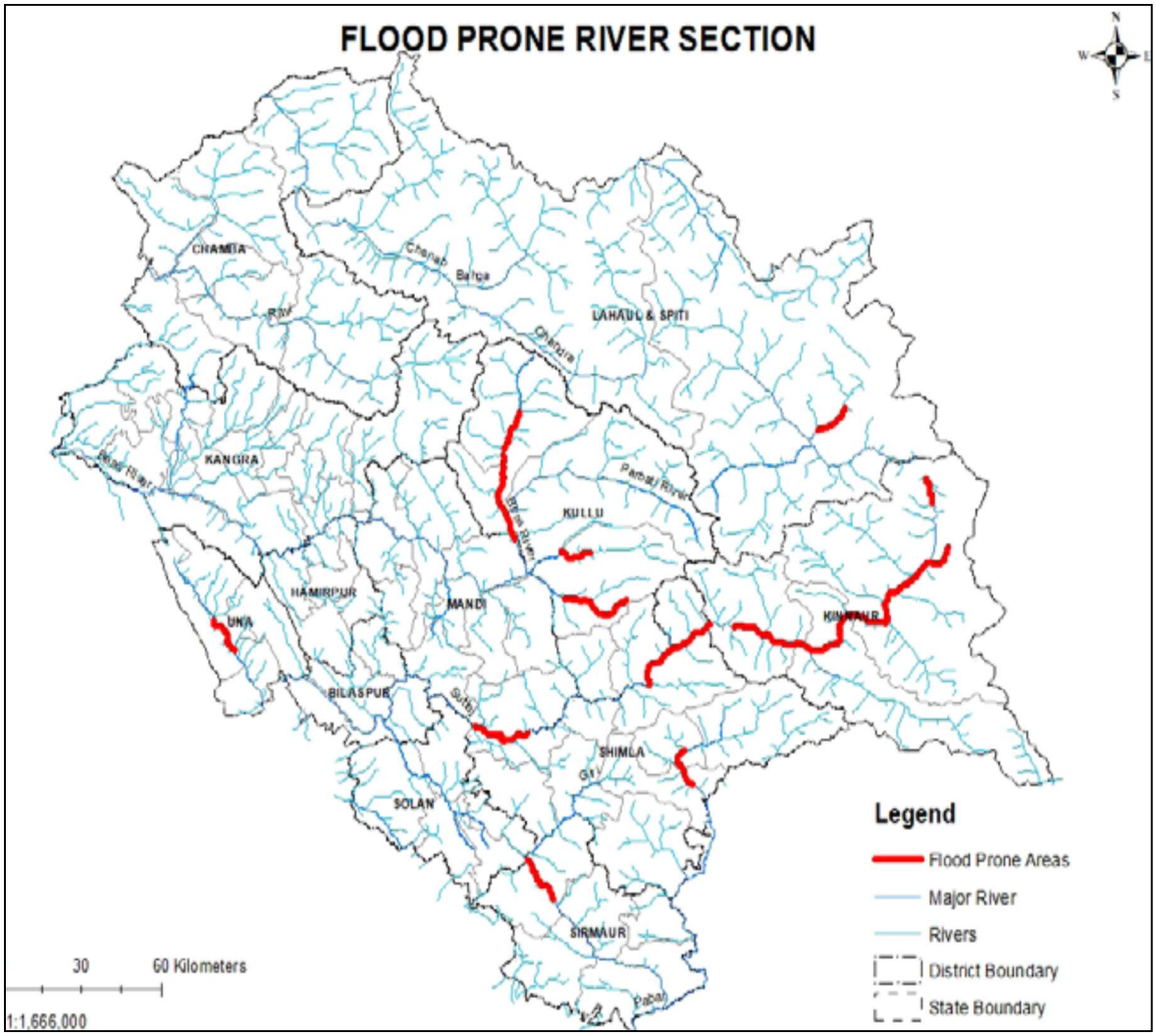

Figure 2.9: Flood prone River Section Map of Himachal Pradesh

Flash floods occur in the state at frequent rate than the riverine floods. The causes of flash floods can vary from excessive rainfall to cloud bursts to disturbances in the upper catchment area of the rivers, etc. The most alarming nature of flash floods is that it occurs without any prior or no warning causing huge damage to life and property.

There have been several incidents of flash floods in the past. In August 1994, the Manimahesh flash flood left over 50 people dead, 2000 injured. It resulted in economic losses of over Rupees 450 crores to the state.

In June 2000, a flash flood affecting 12,400 sqkm area of the state in the adjoining areas of the River Sutlej near Kullu, Mandi, Kinnaur, Rampur, left 140 dead along with 400 displaced.

Recurrent flash floods in 2001, 2003, 2004 left several people dead and more than 15000 sqkm affected.

In the recent history, the Parechu flood in 2005 was the most damaging in terms of economy of the state as well as the livelihood of the people. The cause of the flood was a major landslide in the Parechu region in Tibet resulting in blockage of the water flow of the river and formation of a massive lake. Pre-emptive measures in form of continuous monitoring through satellite imageries helped in averting a major disaster. Swift evacuation of people from the low-lying areas along the river banks prevented loss of lives but damages to houses, livelihood and infrastructure could not be prevented. Overall, the flash flood damaged 5 major bridges and completely submerged 50 houses. Another resultant of the event was interruption of generation and supply of electricity leading to severe issues to the places where the electricity is distributed.

The entire Himalayan region is spread with several glaciers, and due to the constant rate of global warming, these glaciers are eventually becoming unstable and which may lead to sudden discharge of water. This type of flood is known as Glacial Lake Outburst Flood (GLOF). This type of flood leads to devastation on a cataclysmic level. Himachal Pradesh has 2554 glaciers with 229 glacial lakes and 22 of them are potentially dangerous.

2.4.2. DISASTER RISK

The state is affected by several natural hazards amongst which Earthquake, Flood and Landslide are the most prominent and recurs frequently. A study has been conducted and the data has been compiled in the following table pertaining information about the districts that are affected by the hazards.

Table 2.5 Disaster Risk Profile of the Districts of Himachal Pradesh[44, 45]

Districts	Area (sqkm)	Earthquake Hazard Zone V (sqkm)	Earthquake Hazard Zone IV (sqkm)	Landslide (LS) Hazard (✓ LS prone / × Not prone to LS)	Wind Hazard Zone
Bilaspur	1,167	495	672	✓	MDRZ
Chamba	6,528	3,571	2,957	×	MDRZ
Hamirpur	1,118	1,118	0	×	MDRZ
Kangra	5,739	5,337	402	✓	MDRZ
Kinnaur	6,401	5,953	448	×	MDRZ
Kullu	5,503	3,247	2,256	✓	MDRZ
Lahaul and Spiti	13,841	747	13,094	✓	MDRZ
Mandi	3,950	3,595	356	✓	MDRZ
Shimla	5,131	5,131	0	✓	MDRZ
Sirmaur	2,825	2,825	0	✓	MDRZ
Solan	1,936	33	1,903	✓	MDRZ
Una	1,540	627	913	×	MDRZ
	MDRZ	Moderate Damage Risk Zone (Vb= 39 m/s)			

44 Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
45 Vulnerability Atlas of India 2016 (BMTPC, 2016)

As it can be observed from the above mentioned table on depicting the hazards of the Himachal Pradesh state, entire state comprises of two sever earthquake zones i.e., zone V and zone IV, making the entire state vulnerable to earthquakes, amongst twelve districts of the state, eight district areas are Landslide-prone and all the districts comes predominantly under moderate damage risk zone experiencing wind velocity of 39 m/s. It can be clearly concluded Himachal Pradesh is a state prone to sever hazards and requires preparedness against disasters.

2.4.3. DISASTER RESILIENCE [46]

The state has formed its own State Disaster Management Authority (SDMA) to mitigate the risks arising due to the hazards. An analysis into the different areas of work by the SDMAs was conducted and the following table has been compiled to effectively detail out the various work of the state towards Disaster Resilience.

Table 2.6 Functional Areas of Disaster Resilience of Himachal Pradesh

Areas of Work	Work Statement
State Disaster Management Authority	Himachal Pradesh State Disaster Management Authority (HPSDMA)
State Disaster Management Plan	Himachal Pradesh State Disaster Management Plan
State Disaster Response Force	No information is available.
Publications	• Acts and Policy. • Activity Report. • Study Report. • Exposure Visit Report. • Guidelines.
Drills and Public Awareness Programmes	• Formulation of Safety Tips for Citizens. • IEC Materials. • Earthquake Repository.
Capacity Building	• Himachal Pradesh School Safety Preparedness Drill. • Samarth which is flagship mass awareness and capacity building campaign. • Regular training of officials.
MIS Search and Rescue Equipment	No information is available.
NGO's	No information is available.
Contact Address	H.P. State Disaster Management Authority Disaster Management Cell, H.P. Secretariat, Shimla - 171002 Phone - 0177 2880331, 2880320 Fax No - 0177 2621154 E-mail - sdma-hp@nic.in

46 https://www.ndmindia.nic.in/images/gallery/scorecard1.pdf (NDMA , 2019)

2.5. JAMMU AND KASHMIR

Jammu and Kashmir comprises of three regions: Jammu, Kashmir Valley and Ladakh.

"Jammu and Kashmir covers the northern most extremity of India. The state occupies a strategic position in India with borders touching Pakistan in the west, China and Tibet in the north and east and in the south Indian States of Punjab and Himachal Pradesh. The state has a geographical area of 2,22,236 sq. km comprising 6.93% of the total area of the Indian territory, which includes 78,114 sq. km under illegal occupation of Pakistan and 5180 sq. km illegally handed over by Pakistan to China and 37, 555 sq. km under illegal occupation of China in Ladakh. Physically the state comprises of three distinct regions which correspond with its three administrative Divisions. Of the three divisions, Ladakh alone covers about 70% of the total area of the state, Jammu accounts for 19% and the valley of Kashmir accounts for the remaining 11%."[47]

With several valleys in the state, the state is home to a population of 1.25 crores.[48] Due to its diverse biogeography the state has lush green meadows, lakes nested in valleys, dense forests, snow clad mountains, pine forests along with several rivers criss-crossing the state. Due to the picturesque nature of the state, tourism is one of the key economy generators of the state. Moreover, the state has numerous shrines of different religions across the state, increasing religious tourism. The apple orchards, walnut farms, other agricultural products, along with the famous Kashmir willow bats are also major economy generators. All these constitute the Gross State Domestic Product which had amounted to Rupees 118387 crore in the financial year of 2015-2016.[49]

According to Open Government Data Platform (OGD) India, incorporating life expectancy, education and per capita income, Human Development Index of Jammu and Kashmir is 0.684.[50] The state has 2,409[51] indispensable Health Infrastructures and 23,358[52] vital Educational infrastructures which are vulnerable and hence their performance should be enhanced to immediate occupancy during any disaster. These facilities are an integral part for disaster resilience of the state also.

2.5.1. HAZARDS

The State of Jammu and Kashmir has witnessed a long history of natural disasters, ranging from catastrophic earthquakes to destructive floods, snow blizzards to avalanches, landslides to wind storms; all owing to its peculiar topography, rugged terrain, extreme weather conditions, and unique geographical and geo-climatic settings. Most of the population is at constant risk from natural disasters.

[47] http://jkfcr.nic.in/pdf/Master_Plan_Version_IV.pdf (JKFCR, 2019)
[48] Summation of district population of the state from District Census Handbook 2011 (Census of India, 2011)
[49] https://data.gov.in/keywords/gross-state-domestic-product (Government of India; GSDP, 2019)
[50] https://data.gov.in/search/site?query=human+development+index (Government of India; HDI, 2019)
[51] https://data.gov.in/search/site?query=hospitals (Government of India; HDI, 2019)
[52] http://udise.schooleduinfo.in/ and https://www.ugc.ac.in/ (UDISE, 2019) (UGC, 2019)

2.5.1.1. EARTHQUAKE [53, 54]

The State of Jammu and Kashmir falls in a region of high to very high seismic hazard. As per the 2016 Bureau of Indian Standards (BIS) map, this state also falls in Zones IV and V. Historically, parts of this state have experienced seismic activity in the M6.0-7.0 range. As per hazard Atlas, Jammu and Kashmir is a large state measuring about 500 km N S and 700 km W E lying in the Great Himalayan seismic belt.

Large number of earthquakes having M ≥ 5.0 are known to have occurred within or close to the boundary of the state. Between 1885 and 2010 A.D., 250 earthquakes are listed indicating an average return period of about 7 months for one such earthquake. The city of Srinagar was destroyed by two earthquakes of M 7.0 and 6.5 in 1885 and damaged again by earthquakes of M 5.3 in 1963. Anantnag has seen shaken or damaged by two earthquakes of M 5.0 and 5.5 in 1967. Accordingly, the whole state lies in Seismic Zone IV with an elliptical area containing Baramula and Srinagar in Zone V of IS: 1893. These zones are referred to respectively, as Zones of High Damage Risk Zone of MSK VIII and Very High Damage Risk Zone of MSK IX. (refer to Figure 2.10: Earthquake Hazard Zoning Map of Jammu and Kashmir).

Jammu and Kashmir experiences seismic activities frequently but one of the most severe earthquake Jammu and Kashmir experienced was the 2005 Kashmir earthquake occurred on 8 October. It was centred near the city of Muzaffarabad, and affected the Indian-administered Jammu and Kashmir. It was of magnitude 7.6. The severity of the damage caused by the earthquake is attributed to severe up thrust. It is considered to be the deadliest earthquake to hit South Asia since the 1935 Quetta earthquake. “As per official records of the Ministry of Home Affairs, 385 male and 334 female populations died in the earthquake that struck the state, contributing to 62.1% share to total deaths due to the natural hazards in the country in the year 2005. The tremors that struck the state in the following December recorded a magnitude of Mw 6.8”

Due to high seismicity, historically, an indigenous construction technology called “Dhajji Diwari” was developed as seen in Jammu and Kashmir, Himachal Pradesh and Afghanistan. In this construction, timber runners are used at various levels in brick or stone walls going across the corners and junctions of walls. Recent earthquake observations have shown their stability in seismic intensities up-to MSK VIII. Wooden frames with brick nogging were also used and found effectively safe even in MSK IX. In the recent few decades, however, these practices have been lost due to modernization, high cost or non-availability of wood, etc. and thick stone walls have been used instead, which, however, gave way easily even in MSK VII. It is, therefore, necessary now to adopt the safer modern construction technology, eliminating use of timber and using reinforced concrete bands etc. in place of timber runners. In view of high seismic risk, the earthquake resisting measures need to be adopted in all new constructions and seismic retrofitting of existing unsafe buildings has to be adopted as a preventive measure.

Existing priority life-line structures are to be identified and retrofitted immediately. Beside this other actions like regulations and code enforcement, enhancement of capacity of various emergency response agencies, education, awareness, development of earthquake early warning dissemination system etc. are needed for reducing the Disaster Risk.

53 Jammu and Kashmir State Disaster Management Plan (JKSDMA)
54 Jammu and Kashmir Earthquake Hazard Zoning Atlas (BMTPC)

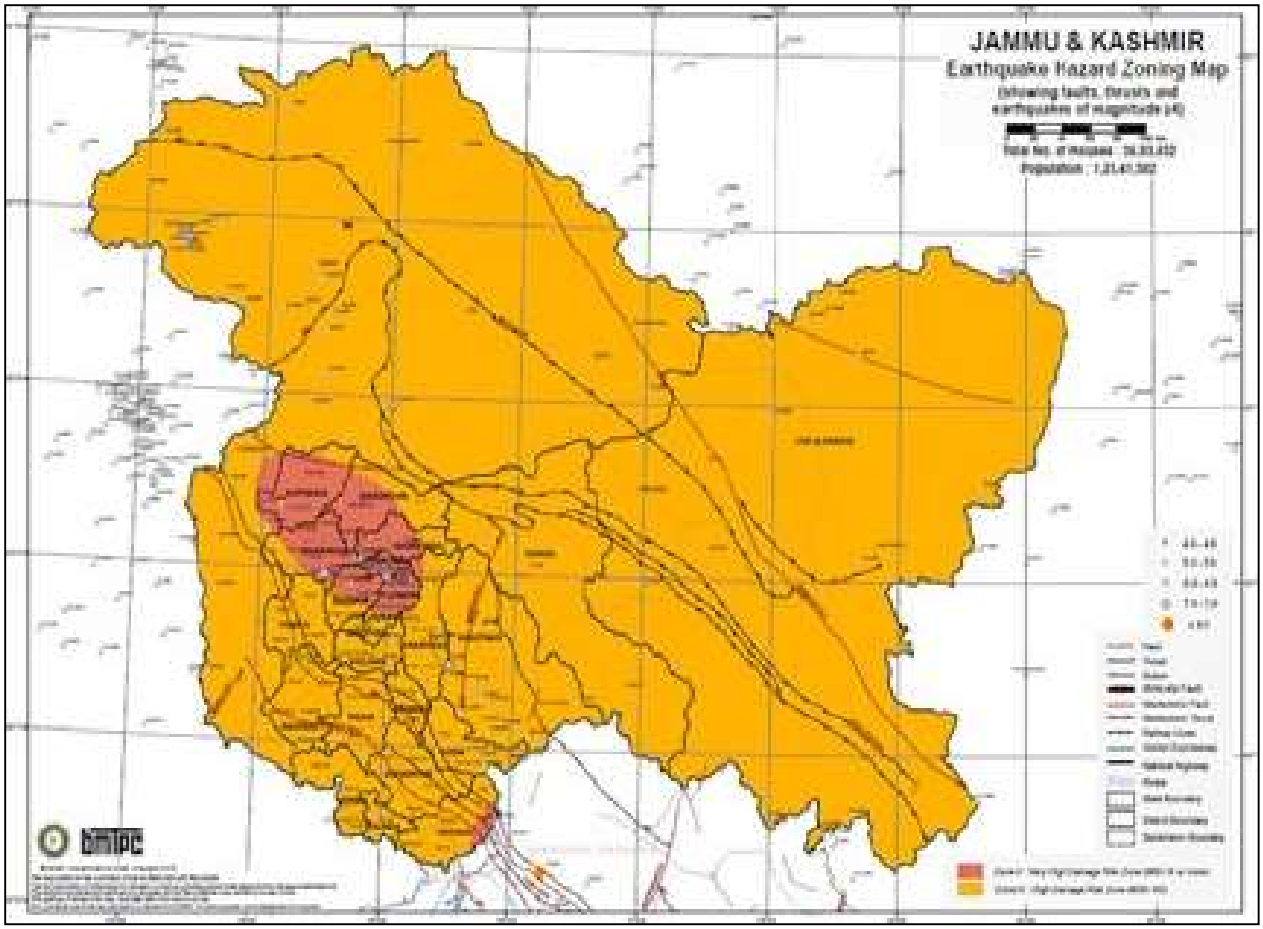

Figure 2.10: Earthquake Hazard Zoning Map of Jammu and Kashmir

2.5.1.2. LANDSLIDE [55, 56]

Jammu and Kashmir has a unique topography, most of the state is covered in mountainous terrain with rivers crisscrossing it at regular intervals. With the heavy rainfall each monsoon there are regular landslides across the state blocking major access ways and causing severe damages to the infrastructure and other assets.

Every year landslides severely affects everyday lives, disrupting movement of people, goods and services, with adverse impact on the economy. Landslides are triggered by natural and man-made factors. Among the natural factors, the common causes are due to earthquakes, steep slopes, torrential rains, melting snow. The man-made factors include deforestation, unscientific construction of roads, unscientific agricultural practices, and encroachment on hill slopes etc.

In Figure 2.11, it can be observed that parts of Bandipora, Kargil, Anantang, Kishtwar, Pulwama and Shopian districts are very high hazard risk areas. Whereas parts of Kupwara, Baramulla, Budgam, Shopian, Anantnag, Kulgam, Srinagar and Ganderbal are very low hazard areas.

55 Jammu and Kashmir State Disaster Management Plan (JKSDMA)
56 Vulnerability Atlas of India 2016 (BMTPC, 2016)

Every year there has been an average death of 15 people in landslides across the state with several more injured and severe loss of economy of the state. Earthquakes and floods causes landslides along the unstable slopes of the hills.

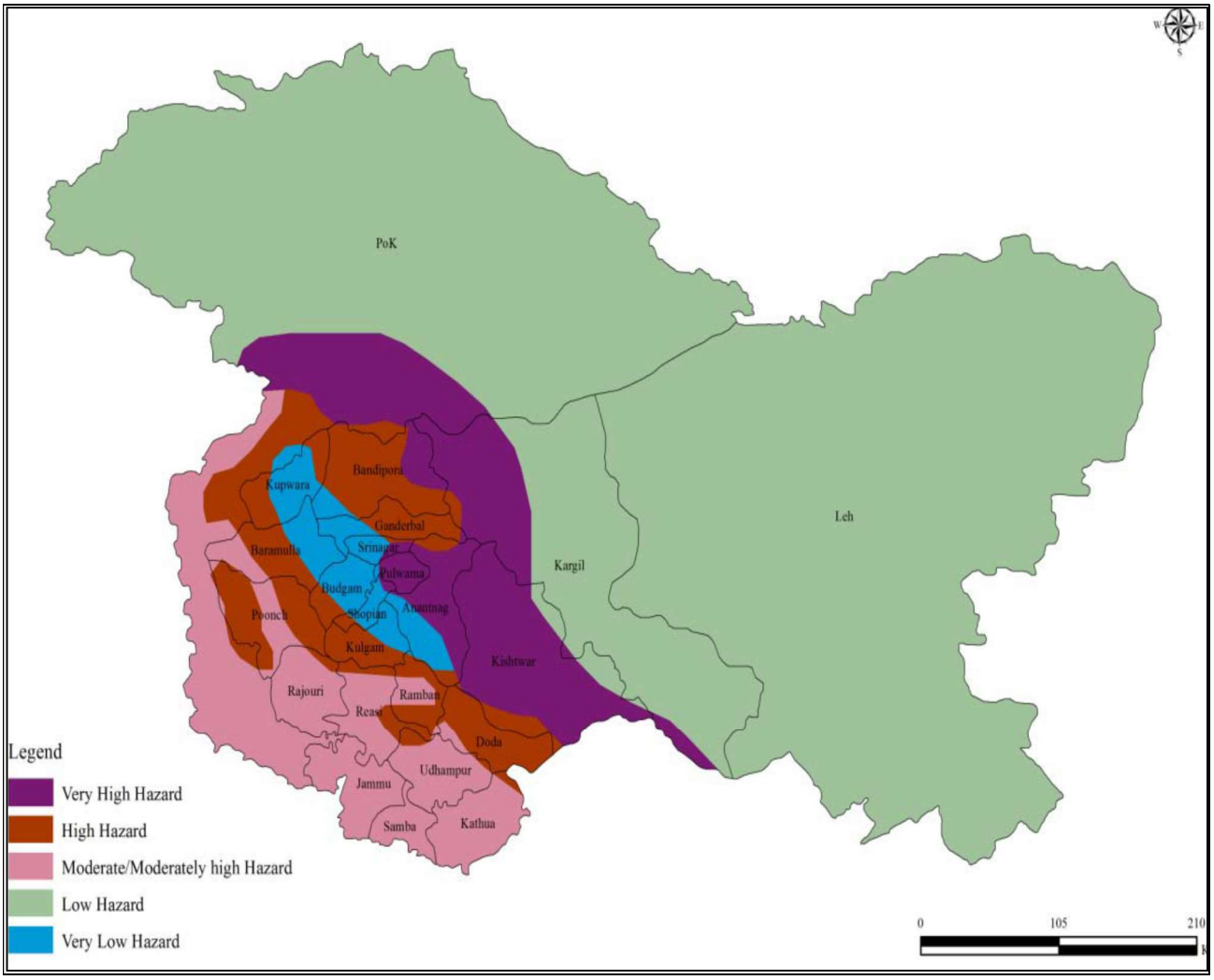

Figure 2.11: Landslide Hazard Map of Jammu and Kashmir

2.5.1.3. FLOOD[57]

Jammu and Kashmir has several rivers flowing through it, and putting it at constant risk from hydrological hazards. Flash floods as a result of cloud burst are the most common nature of floods occurring in the state. “The hilly terrain of the state favours the formation of cumulonimbus cloud. This leads to the shedding of larger droplets of water at a higher rate, resulting in higher impact on the ground.”

During the monsoon, due to torrential rainfall and as a result due to sudden increase in amount of water in the hilly rivers, they tend to overflow their banks and the dams have a safe capacity beyond which, the dams also have to release the water causing floods downstream. River are flooded every year causing severe damages socio-economically. During summers also melting

57 Vulnerability Atlas of India 2016 (BMTPC, 2016)

of the glaciers causes floods. In 2010 as a result of the floods, more than 255 people were killed. (refer to Figure 2.12: Weekly sum of rainfall for the period Sept 2 to Sept 8, 2014 of IMD stations).

Unauthorised constructions along the slopes and constricted natural drainage paths leading to choking of flow of storm and excess water result in frequent flooding. The extreme flooding in September 2014, claimed more than 250 lives and stranded thousands of people which included tourists. In this disaster, the southern part of the state received more than 200mm rainfall, which the state was not infrastructurally equipped to deal with and the districts were also densely populated.

The high impact areas in Jammu and Kashmir due to flood and cloudburst are Budgam, Leh, Udhampur, Ramban, Doda, Reasi, Bandipora, Kulgam, Rajouri, and Srinagar districts.

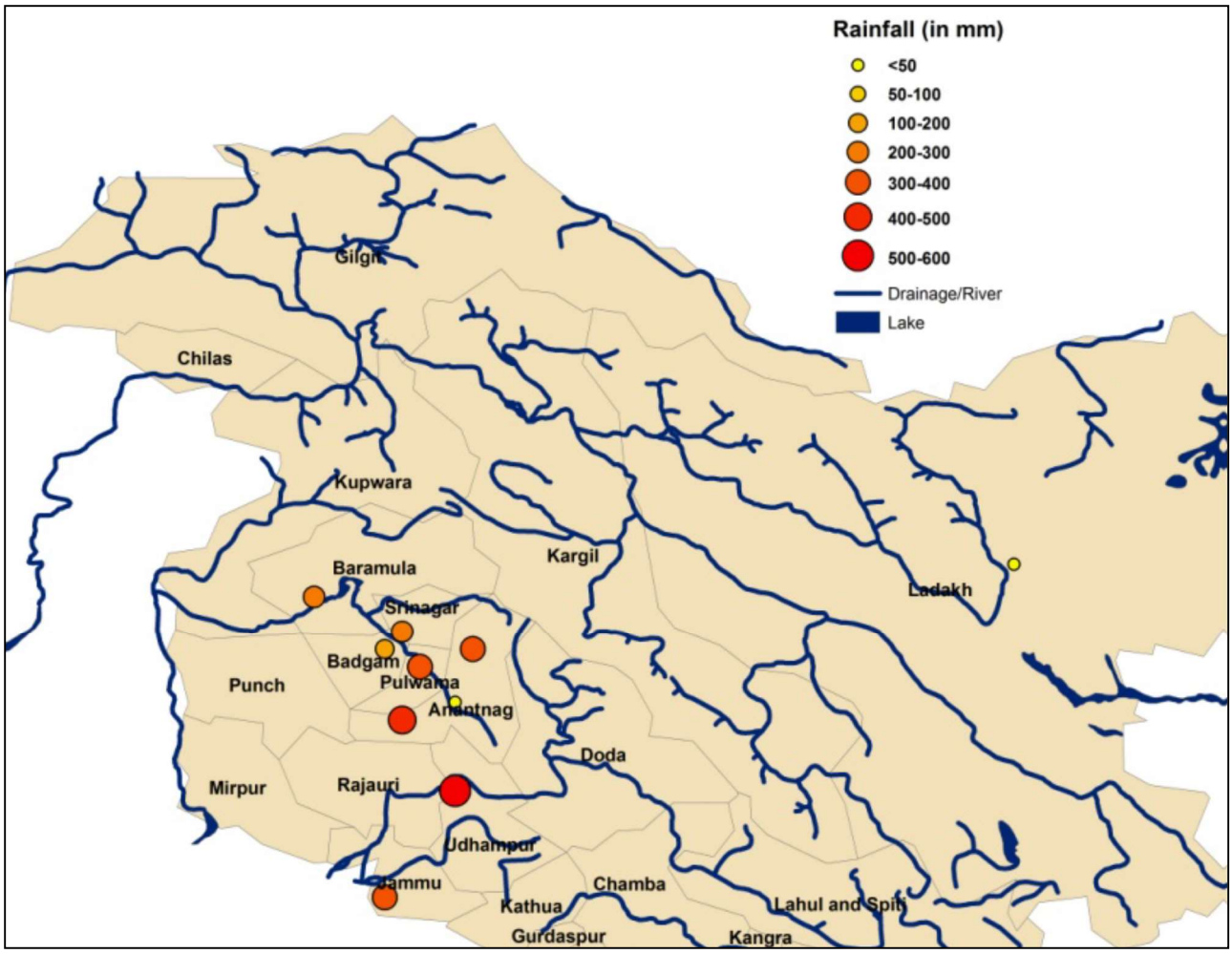

Figure 2.12: Weekly sum of rainfall for the period Sept 2 to Sept 8, 2014 of IMD stations

2.5.2. DISASTER RISK

The state is affected by several natural hazards amongst which Earthquake, Flood and Landslide are the most prominent and recurs frequently. A study has been conducted and the data has been compiled in the following table pertaining information about the districts that are affected by the hazards.

Table 2.7 Disaster Risk Profile of the Districts of Jammu and Kashmir [58] [59]

Districts	Area (sqkm)	Earthquake Hazard ZoneV(sqkm)	Earthquake Hazard ZoneIV(sqkm)	Landslide (LS) Hazard (✓ LS prone / × Not prone to LS)	Wind Hazard Zone
Anantnag	3,574	150	3,424	×	MDRZ
Badgam	1,371	795	576	×	MDRZ
Bandipora	345	176	169	×	MDRZ
Baramulla	4,243	3,186	1,057	×	MDRZ
Doda	8,912	0	8,912	✓	MDRZ
Ganderbal	1,045	736	309	×	MDRZ
Jammu	2,342	0	2,342	×	MDRZ
Kargil	14,036	0	14,036	×	VHDRZ-A
Kathua	2,502	418	2,084	✓	MDRZ
Kishtwar	1,644	0	1,644	×	MDRZ
Kulgam	404	1	403	×	MDRZ
Kupwara	2,379	2,005	374	×	MDRZ
Leh	45,110	0	45,110	×	VHDRZ-A
Poonch	1,674	1	1,673	×	MDRZ
Pulwama	1,398	1,153	245	×	MDRZ
Rajouri	2,630	0	2,630	×	MDRZ
Ramban	1,346	0	1,346	✓	MDRZ
Reasi	1,719	0	1,719	✓	MDRZ
Samba	904	0	904	✓	MDRZ
Shopian	307	1	307	×	MDRZ
Srinagar	1,979	1,979	0	×	MDRZ
Udhampur	2,637	0	2,637	✓	MDRZ
	VHDRZ-A	Very High Damage Risk Zone - A (Vb= 55 m/s)			
	MDRZ	Moderate Damage Risk Zone (Vb= 39 m/s)			

As it can be observed from the above table on depicting the hazards of the Jammu and Kashmir state, entire state comprises of two severe earthquake zones i.e., zone V and zone IV, making the entire state vulnerable to earthquakes, amongst twenty-two districts of the state, six district areas are Landslide-prone and two districts comes predominantly under very high damage risk zone experiencing wind velocity of 55 m/s and remaining districts experiencing a wind speed of 39 m/s. It can be clearly concluded that Jammu and Kashmir is a state prone to sever hazards and requires preparedness against disasters.

58 Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
59 Vulnerability Atlas of India 2016 (BMTPC, 2016)

2.5.3. DISASTER RESILIENCE [60]

The state has formed its own State Disaster Management Authority (SDMA) to mitigate the risks arising due to the hazards. An analysis into the different areas of work by the SDMAs was conducted and the following table has been compiled to effectively detail out the various work of the state towards Disaster Resilience.

Table 2.8 Functional Areas of Disaster Resilience of Jammu and Kashmir

Areas of Work	Work Statement
State Disaster Management Authority	Jammu and Kashmir State Disaster Management Authority (JKSDMA)
State Disaster Management Plan	Jammu and Kashmir State Disaster Management Plan
State Disaster Response Force	No information is available.
Publications	• Acts and Policy. • Activity Report. • Study Report. • Exposure Visit Report. • Guidelines.
Drills and Public Awareness Programmes	• Mock Drill. • Emergency Management Exercises. • Mega Mock Exercise. • Workshops for public. • Water Rescue Training Awareness. • Disaster Preparedness Awareness Camp for community. • Disaster Risk Reduction program.
Capacity Building	• Conclave by Indian Air Force. • Workshops for the officials. • Establishment of Emergency Operations Centre. • Training Programs.
MIS Search and Rescue Equipment	No information is available.
NGO's	No information is available.
Contact Address	Emergency Operation Centre: 1070 Email:dirdm@jksdma.org, jksdma@gmail.com.

2.6 MANIPUR

Manipur is a state in north eastern part of India, bounded by Nagaland to the north, Mizoram to the south, and Assam to the west and Myanmar to its east. The state has a geographical area of 22,327 sqkm [61] with a population of 28.55 lakhs.[62] The state has eight rivers flowing through it namely, Manipur, Imphal, Iril, Nambul, Sekmai, Chakpi, Thoubal and Khuga, all of the rivers originate from the surrounding hills. Manipur has two distinct physical regions, an outlying area of rugged hills and narrow valleys, and the inner area of flat plain. These two areas are distinct in physical features. The valley region has hills and mounds rising above the flat surface. The Loktak Lake is an important feature of the central plain. The total area occupied by all the lakes

60 https://www.ndmindia.nic.in/images/gallery/scorecard1.pdf (NDMA , 2019)
[61] Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
[62] Summation of district population of the state from District Census Handbook 2011 (Census of India, 2011)

is about 600 sqkm. The altitude ranges from 40 m at Jiribam to 2,994 m at Mt. Iso peak near Mao Songsong.[63]

Manipur has conditions favourable for several cash crops like walnut, peach, plum, etc along with bamboo. It has more than 3,000 sqkm bamboo forest area. The fast flowing rivers has facilitated the generation of hydro-electric power. Unique flora and fauna along with picturesque locations in the state has made it a hotspot for eco-tourism over the years. All these sources are the major economy generators of the state. The Gross State Domestic Product which had amounted to Rupees 18,042 crore in the financial year of 2015-2016.[64]

According to Open Government Data Platform (OGD) India, incorporating life expectancy, education and per capita income, Human Development Index of Manipur is 0.684.[65] The state has 524[66] indispensable Health Infrastructures and 3,311[67] vital Educational infrastructures which are vulnerable and hence their performance should be enhanced to immediate occupancy during any disaster. These facilities are an integral part for disaster resilience of the state also.

2.6.1. HAZARDS

Manipur is exposed to various disasters due to its geo-climatic, geological and physical features, Manipur is vulnerable to all natural disasters of various intensity and their impact on society and land, is one of such problems, which hamper the development of the state. Earthquakes, landslides, floods, avalanches, forest fires, etc. have caused tremendous loss to the state. The state of Manipur falls in a region of high to very high seismic hazard. In the state of Manipur, the geologic hazards, namely, earthquakes and landslides are the most critical.

2.6.1.1. EARTHQUAKE [68, 69]

The state of Manipur falls in a region of very high seismic hazard. As per the 2016 Bureau of Indian Standards (BIS) map, this state also falls in Zone V. Historically, parts of this state have experienced seismic activity greater than M6.0-7.0.

The state forms part of the most severe seismic zone in the country, namely, Zone V of Seismic Zoning Map of India, (vide IS: 1893 Part-1 2016), that is, referred as Very High Damage Risk Zone (MSK IX or more) in the Vulnerability Atlas of India 2016 (First Revision), 2006. A large number of moderate to large Magnitude earthquakes have occurred within the state boundary as well as within 100 km distance around it. An earthquake of M 7.2 occurred in 1957 with its epicentre within 15 km of the district town of Churachandpur, causing MSK IX in the epicentral area. (refer to Figure 2.13: Earthquake Hazard Zoning Map of Manipur).

The 2016 Imphal earthquake which struck Manipur on January 4 had magnitude of 6.7. At least ten people were killed, 200 others were injured and many buildings were damaged. The earthquake was also strongly felt in Bangladesh. It was also extensively felt in north-eastern India. The earthquake, which hit on 4 January was Centred in an isolated area.

[63] Manipur State Disaster Management Plan (MSDMA)
[64] https://data.gov.in/keywords/gross-state-domestic-product (Government of India; GSDP, 2019)
[65] https://data.gov.in/search/site?query=human+development+index (Government of India; HDI, 2019)
[66] https://data.gov.in/search/site?query=hospitals (Government of India; HDI, 2019)
[67] http://udise.schooleduinfo.in/ and https://www.ugc.ac.in/ (UDISE, 2019) (UGC, 2019)
68 Manipur State Disaster Management Plan (MSDMA)
69 Manipur Earthquake Hazard Zoning Atlas (BMTPC)

The house types in the state, as whole, numbering 6,00,635, as per the 2011 Census, consist of 52.7% Kutcha (clay mud walls) and 13.5% Pucca brick walls. These are classified as Category A (clay and stone walls) and Category B (brick walls).

These two category houses are vulnerable to receive severe damage including collapse in MSK IX. The concrete and wood frame houses, placed in Category C account for 11.4% and behave much better with only a few collapses in MSK IX. The others consisting of thatch/metal sheet huts account for 22.2%. These suffer very little damage in earthquakes, and do not pose threat to life as the Category A and B housing.

Hence special attention of the state is called for taking pre earthquake preventive and preparedness measure for mitigating the possible disastrous consequences.

House Types in Manipur and Risk of Earthquake Damage: The house types in the state, as whole, numbering 6,00,635, as per the 2011 Census, consist of 52.7% Kutcha (clay mud walls) and 13.5% Pucca brick walls. These are classified as Category A (clay and stone walls) and Category B (brick walls).

These two category houses are vulnerable to receive severe damage including collapse in MSK IX. The concrete and wood frame houses, placed in Category C account for 11.4% and behave much better with only a few collapses in MSK IX. The others consisting of thatch/metal sheet huts account for 22.2%. These suffer very little damage in earthquakes, and do not pose threat to life as the Category A and B housing.

Hence special attention of the state is called for taking pre earthquake preventive and preparedness measure for mitigating the possible disastrous consequences. The existing priority life-line structures are to be identified and retrofitted immediately. Beside this other actions like regulations and code enforcement, enhancement of capacity of various emergency response agencies, education, awareness, development of earthquake early warning dissemination system etc. are needed for reducing the Disaster Risk.

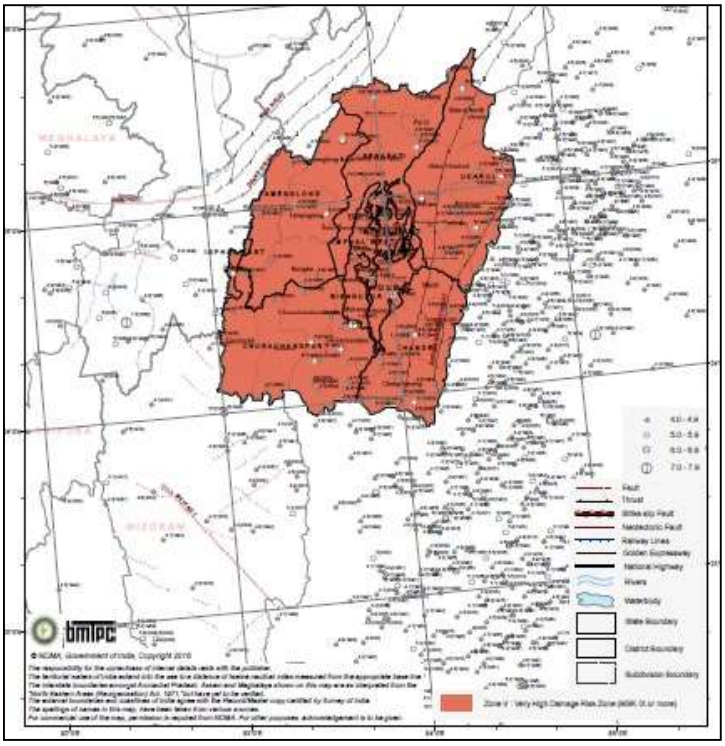

Figure 2.13: Earthquake Hazard Zoning Map of Manipur

2.6.1.2. FLOOD [70] [71]

With eight rivers criss-crossing the state, floods are a common occurrence in Manipur causing a major human life loss as well as infrastructural damages to the state amounting to crores of rupees. It occurs due to high rainfall or river bank breaching which may be due to vegetation removal leading to soil and river bank erosion and sedimentation in the river channel affecting the runoff.

Approximately, 2/3rd of the total population of Manipur resides in the Manipur Valley which covers only 8.2% area of the total area of the state, making it a densely populated area of the state. River flooding and flash floods occurs at regular intervals. Moreover, drainage failures and increased surface run-offs results in urban flooding. (refer to Figure 2.14: Flood Hazard Zoning Map of Manipur).

Heavy rainfall in the upper catchment area is one of the major causes of flooding. Steep slopes along with degraded land enhancing soil erosion and surface run off, blocking of the water drainage routes adds up to the flooding. Proper maintenance of the riverbanks along with more tree plantation and might ease out the situation.[72]

70 Manipur State Disaster Management Plan (MSDMA)
71 Vulnerability Atlas of India 2016 (BMTPC, 2016)
[72] Manipur Earthquake Hazard Zoning Atlas (BMTPC)

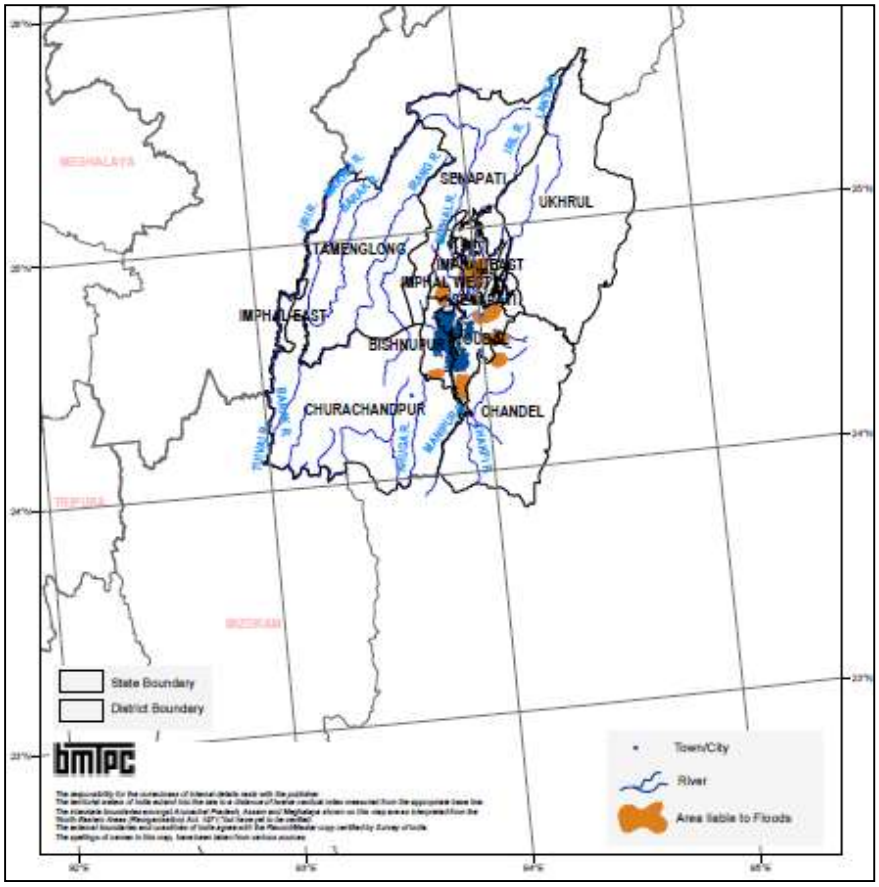

Figure 2.14: Flood Hazard Zoning Map of Manipur

2.6.1.3. LANDSLIDE

Manipur being a mountainous state, landslides are a recurrent event disrupting movement of people, goods and services, with adverse impact on the economy.

Landslides are triggered by both natural and man-made factors. Among the natural factors, the common causes are due to earthquakes, steep slopes, and torrential rains. The man-made factors include deforestation, unscientific construction of roads, unscientific agricultural practices, and encroachment on hill slopes etc.

Over the years, due to increase in populations as well as their properties in the hilly terrains along the National and State Highways, the incidences of landslides have shown a disturbing and damaging trend of occurrence with higher damage to life and property. Hill districts of Manipur i.e., Churachandpur, Tamenglong, Senapati, Ukhrul and Chandel are most vulnerable to Landslides.

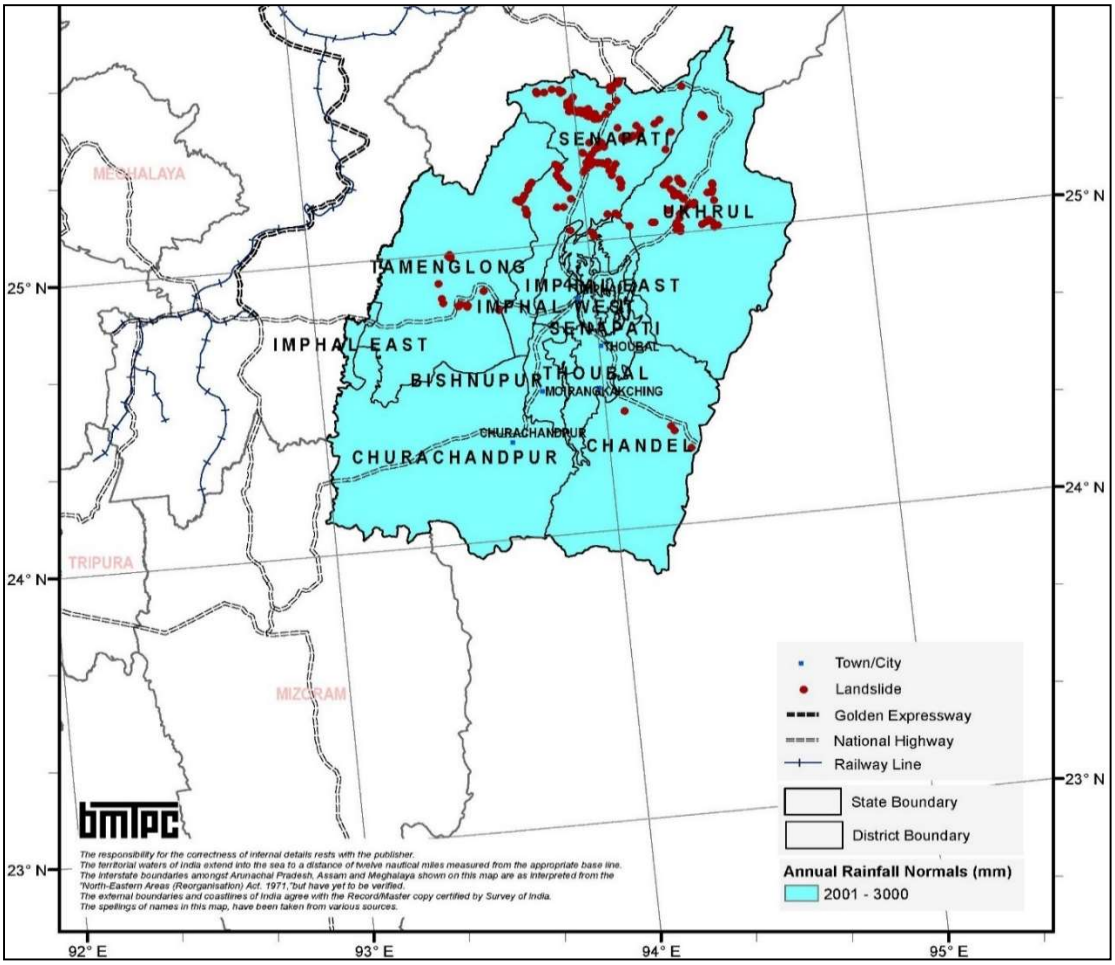

Figure 2.15: Landslide Incidence Map of Manipur

2.6.2. DISASTER RISK

The state is affected by several natural hazards amongst which Earthquake, Flood and Landslide are the most prominent and recurs frequently. A study has been conducted and the data has been compiled in the following table pertaining information about the districts that are affected by the hazards.

Table 2.9 Disaster Risk Profile of the Districts of Manipur [73] [74]

Districts	Area (sqkm)	Earthquake Hazard Zone V (sqkm)	Landslide (LS) Hazard (✓ LS prone / × Not prone to LS)	Wind Hazard Zone
Bishnupur	496	496	✓	MDRZ
Thoubal	514	514	✓	MDRZ
Imphal East	709	709	✓	VHDRZ(A)

73 Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
74 Vulnerability Atlas of India 2016 (BMTPC, 2016)

Imphal West	519	519	✓	MDRZ
Senapati	3,271	3,271	✓	MDRZ
Ukhrul	4,544	4,544	×	MDRZ
Chandel	3,313	3,313	✓	MDRZ
Churachanpur	4,570	4,570	×	VHDRZ(A)
Tamenglong	4,391	4,391	×	VHDRZ(B)
	VHDRZ-A	Very High Damage Risk Zone - A (Vb= 55 m/s)		
	VHDRZ-B	Very High Damage Risk Zone - B (Vb= 50 m/s)		
	MDRZ	Moderate Damage Risk Zone (Vb= 39 m/s)		

As it can be observed from the above mentioned table on depicting the hazards of the Manipur state, entire state comes under the most severe earthquake zone i.e., zone V making the entire state most vulnerable to earthquakes, amongst nine districts of the state six district areas are Landslide-prone and two districts comes predominantly under very high damage risk zone experiencing wind velocity of 55 m/s, one district experiencing a wind speed of 50 m/s and rest comes under moderate damage risk zone with the wind speed of 39 m/s. It can be clearly concluded that Manipur is a state prone to sever hazards and requires preparedness against disasters.

2.6.3. DISASTER RESILIENCE [75]

The state has formed its own State Disaster Management Authority (SDMA) to mitigate the risks arising due to the hazards. An analysis into the different areas of work by the SDMAs was conducted and the following table has been compiled to effectively detail out the various work of the state towards Disaster Resilience.

Table 2.10 Functional Areas of Disaster Resilience of Manipur

Areas of Work	Work Statement
State Disaster Management Authority	Department of Relief and Disaster Management - Government of Manipur
State Disaster Management Plan	Manipur State Disaster Management Plan, Volume I and II
State Disaster Response Force	No information is available.
Publications	• Acts and Policy. • Activity Report. • First Aid Manuals. • Emergency Education. • Gender Mainstreaming in Disaster Management. • Study Report. • Exposure Visit Report. • Guidelines.
Drills and Public Awareness Programmes	• Study on Seismic vulnerability assessment of school. • Site Characterization and Seismic Vulnerability Studies. • USAID Supported Developing Resilient Cities through Disaster Risk Reduction. • National Disaster Management Services (NDMS). • Aapda Mitra Program.

75 https://www.ndmindia.nic.in/images/gallery/scorecard1.pdf and http://sdmassam.nic.in/

Areas of Work	Work Statement
	• Mock Drill.
Capacity Building	• Workshops for the officials. • Establishment of Emergency Operations Centre. • Training Programs.
MIS Search and Rescue Equipment	No information is available.
NGO's	No information is available.
Contact Address	No information is available.

2.7 MEGHALAYA

The name Meghalaya means "the abode of clouds" in Sanskrit. The state is bounded to the south by the Bangladesh divisions of Mymensingh and Sylhet, to the west by the Bangladesh division of Rangpur, and to the north and east by Assam. The capital of Meghalaya is Shillong has been nicknamed as the "Scotland of the East" due to its striking similarity between landscapes, climate by the Britishers. Meghalaya was previously part of Assam, in 1972, the districts of Khasi, Garo and Jaintia hills were joined to form the new state of Meghalaya.

The state of Meghalaya spreads over an area of 22,429 sqkm[76] with a population of 29.66 lakhs.[77] Several perennial and seasonal rivers flow through the state creating deep gorges and splendid waterfalls. Some of the important rivers are, Ganol, Daring, Sanda, Bandra, Bugai, Dareng, Simsang, Nitai, Bhupai in the Garo Hills Region and Khri, Umtrew, Digaru, Barapani, Kynshi, Umngi, Mawpa, Umiam Khwan, Umngot, Umkhen, Myntdu, Myntang in the central and eastern sections of the plateau. With a distinct, climate having average high rainfall, it is one of the wettest place in the planet. Due to the favourable climate, major portion of the state is covered with dense subtropical forests, hosting a wide unique array of floral and faunal biodiversity. Interestingly, the state is inhabited by several tribal communities who worship these forests leading to creation of “sacred groves” which are pockets of the forests which are centuries old.

Uniquely, Meghalaya follows a matrilineal system where the lineage and inheritance are traced through women, the youngest daughter inherits all wealth of the family and she also takes care of her parents.

The state comprises of mainly agrarian economy with the Gross State Domestic Product amounting up to Rupees 29566 crore in the financial year of 2015-2016.[78]

According to Open Government Data Platform (OGD) India, incorporating life expectancy, education and per capita income, Human Development Index of Meghalaya is 0.65.[79] The state has 553[80] indispensable Health Infrastructures and 5,197[81] vital Educational infrastructures which are vulnerable and hence their performance should be enhanced to immediate occupancy during any disaster. These facilities are an integral part for disaster resilience of the state also.

[76] Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
[77] Summation of district population of the state from District Census Handbook 2011 (Census of India, 2011)
[78] https://data.gov.in/keywords/gross-state-domestic-product (Government of India; GSDP, 2019)
[79] https://data.gov.in/search/site?query=human+development+index (Government of India; HDI, 2019)
[80] https://data.gov.in/search/site?query=hospitals (Government of India; Hosp., 2019)
[81] http://udise.schooleduinfo.in/ and https://www.ugc.ac.in/ (UDISE, 2019) (UGC, 2019)

2.7.1. HAZARDS

Meghalaya is a multi-hazard prone state prone to earthquakes, floods, cyclonic storms, etc. It has witnessed several devastating earthquakes and floods in the recent years which has led to hug loss of lives and properties. This due to its peculiar topography, rugged terrain, extreme weather conditions, unique geographical and geo-climatic settings.

2.7.1.1. EARTHQUAKE [82, 83]

The state of Meghalaya falls in a region of very high seismic hazard. As per the 2016 Bureau of Indian Standards (BIS) map, this state also falls in Zone V. Historically, parts of this state have experienced seismic activity greater than M6.0 including an M8.1 in 1897.

As per hazard Atlas, the State of Meghalaya forms part of the most severe seismic zone in the country, namely, Zone V of Seismic Zoning Map of India, (vide IS: 1893-Part- 1 2016), that is, referred as Very High Damage Risk Zone (MSK IX or more) in the Vulnerability Atlas of India 20162016(First Revision) 2006. A large number of moderate to large Magnitude earthquakes have occurred within the state boundary as well as within 100 km distance around it. Present day Assam Meghalaya border area has been the seat of the Great Assam earthquake of 1897 which in-fact laid the foundation of seismology in India. This earthquake of giant Magnitude of 8.7 is almost unsurpassed up-to now, and was responsible for the death of 1542 persons, and almost total destruction of all brick and stone buildings in all the principal towns of Shillong, Sylhet, Goalpara, Gauhati, Dhubri and Tura. The destruction spread over an area of 3,70,000 sq.km (equal to circle of 340 km radius) in Meghalaya and Assam, and the shock wave was felt over an area of 4.5 million sq. km (circle of 1,200 km radius). The intensity of the shock was so great within the epicentral tract that ground waves were visible at Shillong, and Nalban Magadai. Estimates of the horizontal ground acceleration were: 0.42g at Shillong, Sylhet and Goalpara, 0.30g at Cherapunji, 0.27g at Dhubri and 0.12g at Silchar. On the slopes of Khasi hills, a number of embedded rounded small blocks of granite were thrown from their places and projected to other places showing that the vertical acceleration exceeded gravity there. Two other large earthquakes of M 7.1 have occurred within the state, one in 1923 in Western Khasi Hills and the other in West Garo Hills in 1930 both causing MSK IX in these districts. The State of Meghalaya could be termed as the most earthquake prone. (refer to Figure 2.16: Earthquake Hazard Zoning Map of Meghalaya).

The house types in the state, as whole, numbering 680,597, as per the 2011 Census, consist of 8.04% Kutcha (clay mud walls stone walls laid in mud) and 14.6% Pucca brick walls. These are classified as Category A (clay and stone walls) and Category B (brick walls). These two category houses are vulnerable to receive severe damage including collapse in MSK IX and VIII. The concrete and wood frame houses, placed in Category C account for 32.6% and behave much better with only a few collapses in MSK IX. The others consisting of thatch/metal sheet huts account for 44.6% the housing. These suffer very little damage in earthquakes, and do not pose threat to life as the Category A and Category B housing.

Hence special attention of the state is needed for taking pre earthquake preventive and preparedness measure for mitigating the possible disastrous consequences. Existing priority life-line structures are to be identified and retrofitted immediately. Beside this other actions like regulations and code enforcement, enhancement of capacity of various emergency response

82 Meghalaya State Disaster Management Plan (MSDMA)
83 Meghalaya Earthquake Hazard Zoning Atlas (BMTPC)

agencies, education, awareness, development of earthquake early warning dissemination system etc. are needed for reducing the Disaster Risk.

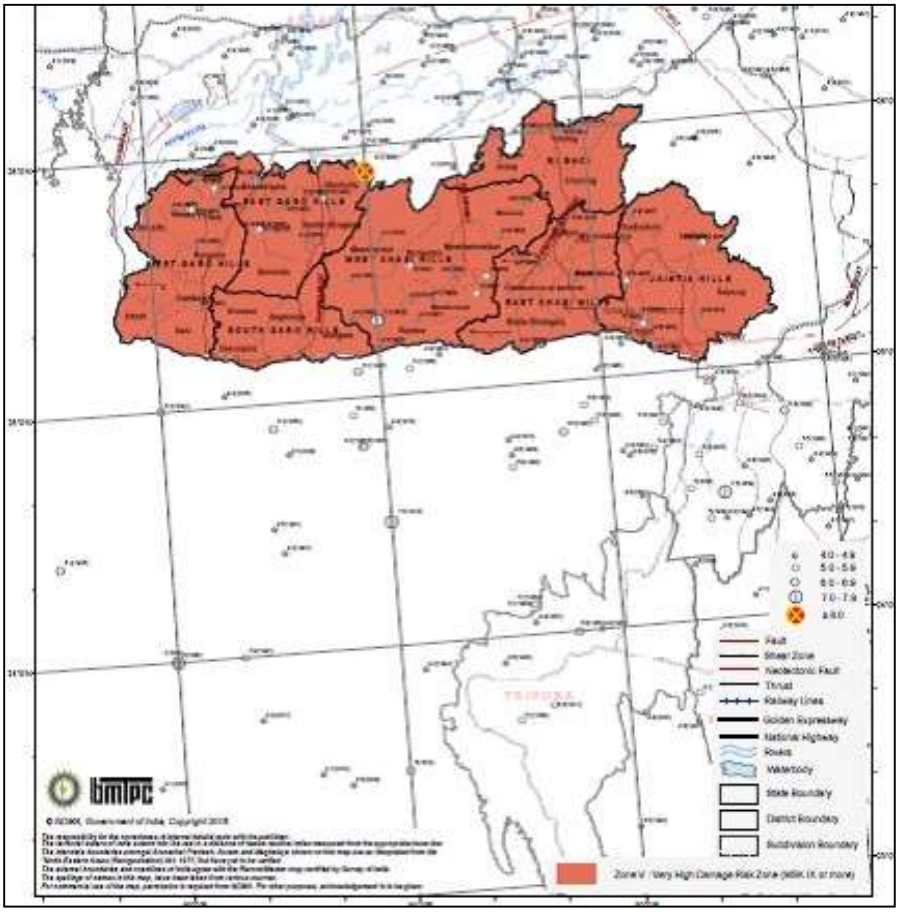

Figure 2.16: Earthquake Hazard Zoning Map of Meghalaya

2.7.1.2. LANDSLIDE [84, 85]

The state is one of the highest rain fall receiving state of India. In recent times, with rampant urbanisation and construction in the state, slopes of the hilly terrains are getting stripped of soil binding vegetation and as a result incidences of landslides have increased. It causes destruction of infrastructure worth lakhs in the state. Each year several landslides are reported from various localities. These causes huge loss of life and properties, communication network disruption. During the months of June to October when the state is lashed by heavy rains, major landslides occur.

The southern part of the state is more Landslide-prone than the northern part. Stretches of the National Highways like Bajengdoba-Tura-Dalu, Damra-Siju-Baghmara, Guwahati-Shillong-Tamabil, and Shillong- Jowai- Badarpur are highly Landslide-prone. Urban areas of Shillong and Tura, Jowai are also Landslide-prone due to the faulty construction of houses and rapid unchecked urbanization. (refer to Figure 2.17: Landslide Incidence Map of).

84 Meghalaya State Disaster Management Plan (MSDMA)
85 Vulnerability Atlas of India 2016 (BMTPC, 2016)

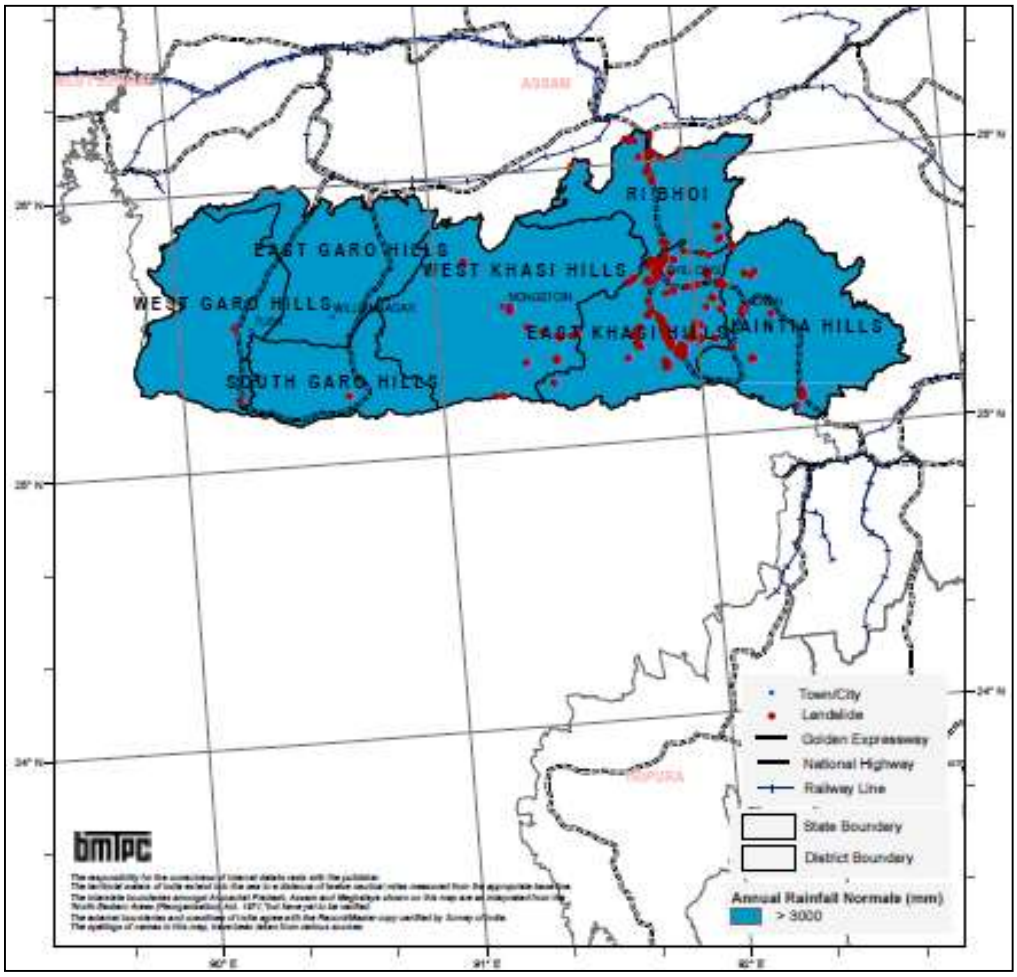

Figure 2.17: Landslide Incidence Map of Meghalaya

2.7.1.3. FLOOD [86, 87]

Though the state does not suffer from any major flood incidents in the past, in the recent years, due to encroachments on the flood plains sometimes flash floods occurs resulting in major inconveniences to the state. The heavy rains leads to river bank erosion causing flash floods and also often when the flow exceeds the capacity of the river it floods the neighbouring settlements. Floods usually occur in between June to October and there have been 37 deaths due to floods in the state in the past 10 years.

The flood prone areas of the state are the western part of the state like Tikrikilla, Phulbari, Rajabala, Garobadha, Hallidaygunj, Bhaitbari, Fersakandi, Magurmari, Silkata, Mahendraganj etc. Even the plain areas near Bangladesh like Baghmara, Balat, Shella, Dawki etc face flooding. Areas of Shillong, Williamnagar, Tura are often affected by urban flooding. Localised areas of West Khasi Hills, South West Khasi Hills, East Khasi Hills Jaintia Hills and Ri-Bhoi Districts are the most flood affected areas. (refer to

[86] Meghalaya State Disaster Management Plan (MSDMA)
[87] Vulnerability Atlas of India 2016 (BMTPC, 2016)

Figure 2.18: Meghalaya Drainage **Map**).

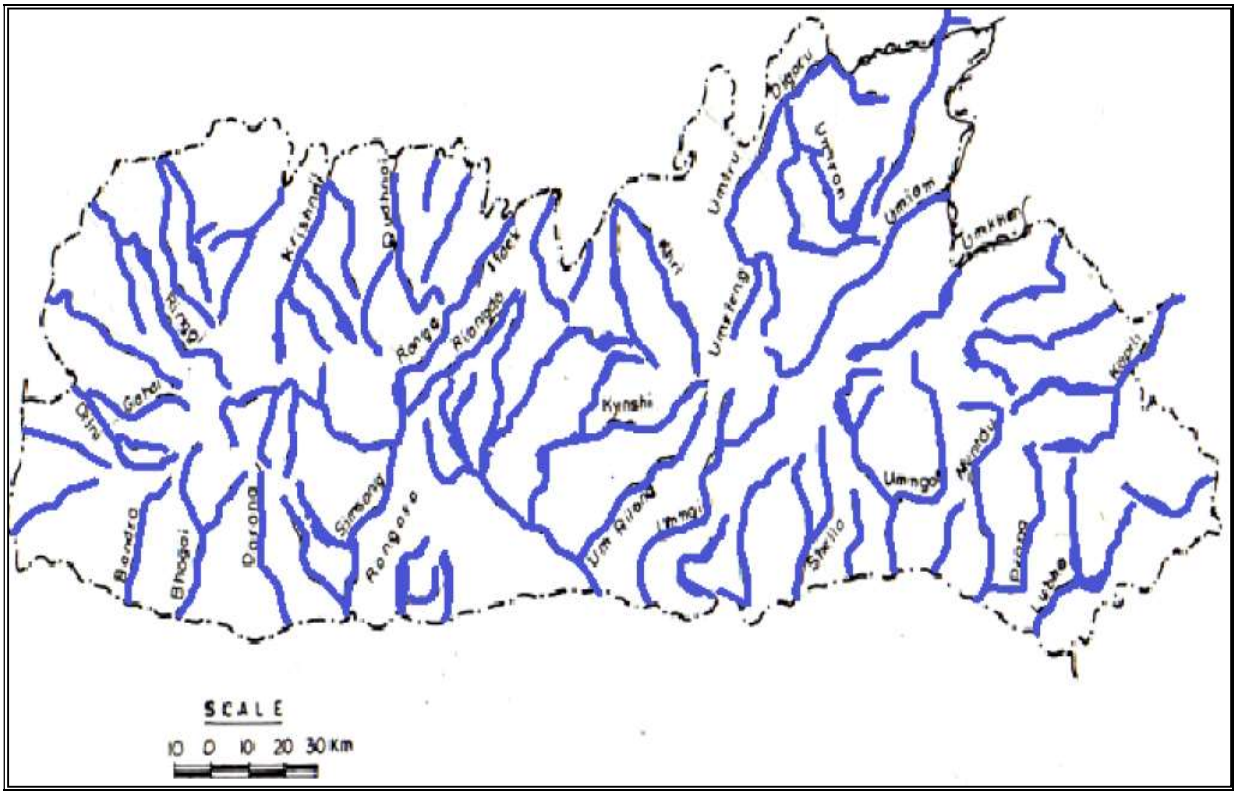

Figure 2.18: Meghalaya Drainage Map

2.7.2. DISASTER RISK

The state is affected by several natural hazards amongst which Earthquake, Flood and Landslide are the most prominent and recurs frequently. A study has been conducted and the data has been compiled in the following table pertaining information about the districts that are affected by the hazards.

Table 2.11 Disaster Risk Profile of the Districts of Meghalaya [88] [89]

Districts	Area (sqkm)	Earthquake Hazard Zone V (sqkm)	Landslide (LS) Hazard (✓ LS prone / × Not prone to LS)	Wind Hazard Zone
East Garo Hills	2,603	2,603	×	VHDRZ-B
East Khasi Hills	2,748	2,748	✓	VHDRZ-B
Jaintia Hills	3,819	3,819	✓	VHDRZ-A
Ribhoi	2,448	2,448	✓	VHDRZ-B
South Garo Hills	1,887	1,887	✓	VHDRZ-B
West Garo Hills	3,677	3,677	✓	VHDRZ-B
West Khasi Hills	5,247	5,247	✓	VHDRZ-B

[88] Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
[89] Vulnerability Atlas of India 2016 (BMTPC, 2016)

	VHDRZ-A	Very High Damage Risk Zone - A (Vb= 55 m/s)
	VHDRZ-B	Very High Damage Risk Zone - B (Vb= 50 m/s)

As it can be observed from the above mentioned table on depicting the hazards of the Meghalaya state, entire state comes under the most severe earthquake zone i.e., zone V making the entire state most vulnerable to earthquakes, amongst all the seven districts of the state six districts are Landslide-prone, six districts comes predominantly under very high damage risk zone experiencing wind velocity of 50 m/s and one district experiencing a wind speed of 55 m/s. It can be clearly concluded that Meghalaya is a state prone to sever hazards and requires preparedness against disasters.

2.7.3. DISASTER RESILIENCE [90]

The state has formed its own State Disaster Management Authority (SDMA) to mitigate the risks arising due to the hazards. An analysis into the different areas of work by the SDMAs was conducted and the following table has been compiled to effectively detail out the various work of the state towards Disaster Resilience.

Table 2.12 Functional Areas of Disaster Resilience of Meghalaya

Areas of Work	Work Statement
State Disaster Management Authority	Meghalaya State Disaster Management Authority
State Disaster Management Plan	Meghalaya State Disaster Management Plan, Volume I and II and Annexure
State Disaster Response Force	No information is available.
Publications	• Acts and Policy. • Activity Report. • First Aid Manuals. • Emergency Education. • Gender Mainstreaming in Disaster Management. • Study Report. • Exposure Visit Report. • Guidelines.
Drills and Public Awareness Programmes	• Study on Seismic vulnerability assessment of school. • Site Characterization and Seismic Vulnerability Studies. • USAID Supported Developing Resilient Cities through Disaster Risk Reduction. • National Disaster Management Services (NDMS). • Aapda Mitra Program. • Mock Drill.
Capacity Building	• School Safety Preparedness Drill. • Regular training of officials. • Workshops for the officials. • Training Programs.
MIS Search and Rescue Equipment	No information is available.
NGO's	No information is available.

[90] https://www.ndmindia.nic.in/images/gallery/scorecard1.pdf (NDMA , 2019)

Areas of Work	Work Statement
Contact Address	Revenue and Disaster Management Authority, Government of Meghalaya. Email: eo.sdma@gmail.com, sdmadeptt007@gmail.com

2.8 TRIPURA

The state of Tripura covers a geographical area of 10,486 sqkm[91] having a population of 36.73 lakhs.[92] After Goa and Sikkim, it he third smallest state in the country. The state is bordered by Bangladesh to the north, south and west, and the states of Assam and Mizoram to the east. It majorly consists of hilly terrains, and has six ranges from north to south along with plain lands in between the hills. The state has six major rivers running through it and has a major portion covered in tropical forests which is rich in flora and fauna. It hosts several endangered species. It is majorly an agrarian state with most of the population dependant on agriculture and its allied activities and the GDP of the state is Rupees 29666 crores for the financial year of 2015-2016, which is relatively lower amongst the seven north-eastern states.[93]

According to Open Government Data Platform (OGD) India, incorporating life expectancy, education and per capita income, Human Development Index of Tripura is 0.655.[94] The state has 735 [95] indispensable Health Infrastructures and 2,496[96] vital Educational infrastructures which are vulnerable and hence their performance should be enhanced to immediate occupancy during any disaster. These facilities are an integral part for disaster resilience of the state also.

2.8.1. HAZARDS

Tripura is prone to various natural disasters, particular to Earthquake. The state is situated in the most vulnerable earthquake prone Zone-V of India. It has been frequently struck with earthquakes of low to moderate intensities. Apart from earthquakes, the state is troubled by floods at regular intervals and there are landslides at some places.

2.8.1.1. EARTHQUAKE [97] [98]

Tripura falls in a region of high to very high hazard. As per the 2016 Bureau of Indian Standards (BIS) map, both states fall in Zone V. Historically, parts of these states have experienced seismic activity greater than M6.0. Approximate locations of selected towns and basic political state boundaries are displayed.

Earthquake activity in Tripura is mainly shallow. The Dauki earthquake fault line which follows the international border of India and Bangladesh in Meghalaya passes through northern sections of Tripura. The other major threat is from the Madhupur Fault in Bangladesh. However, it must be stated that proximity to faults does not necessarily translate into a higher hazard as compared to areas located further away, as damage from earthquakes depends on numerous factor such as subsurface geology as well as adherence to the building codes.

[91] Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
[92] Summation of district population of the state from District Census Handbook 2011 (Census of India, 2011)
[93] https://data.gov.in/keywords/gross-state-domestic-product (Government of India; GSDP, 2019)
[94] https://data.gov.in/search/site?query=human+development+index (Government of India; HDI, 2019)
[95] https://data.gov.in/search/site?query=hospitals (Government of India; Hosp., 2019)
[96] http://udise.schooleduinfo.in/ and https://www.ugc.ac.in/ (UDISE, 2019) (UGC, 2019)
[97] Tripura State Disaster Management Plan (TSDMA)
[98] Tripura Earthquake Hazard Zoning Atlas (BMTPC)

The state forms part of the most severe seismic zone in the country, namely, Zone V of Seismic Zoning Map of India, (vide IS 1893:2016), that is, referred as Very High Damage Risk Zone (MSK IX or more) in the Vulnerability Atlas of India. A large number of moderate to large Magnitude earthquakes have occurred within the state boundary as well as within 100 km distance around it. An earthquake of M 6.3 occurred within North Tripura district in 1950 causing MSK VIII and another of M 7.5 occurred in 1869 with its epiCentre within 18 km of the district town of Dharmanagar, causing MSK IX in the epicentral area. (refer to Figure 2.19: Earthquake Hazard Zoning Map of Tripura).

The house types in the state, as whole, numbering 10,22,646, as per the 2011 Census, consist of 44.6% Kutcha (clay mud walls and stone walls laid in mud) and 16.5% Pucca brick walls. These are classified as Category A (clay and stone walls), and Category B (brick walls). These two category houses are vulnerable to receive severe damage including collapse in MSK IX. The concrete and wood frame houses, placed in Category C account for 0.90% only and behave much better with only a few collapses in MSK IX. The others consisting of thatch/metal sheet huts account for 37.8% of housing units. These suffer very little damage in earthquakes, and do not pose threat to life as the Category A and B housing.

Hence special attention of the state is called for taking pre earthquake preventive and preparedness measure for mitigating the possible disastrous consequences. Existing priority life-line structures are to be identified and retrofitted immediately. Beside this other actions like regulations and code enforcement, enhancement of capacity of various emergency response agencies, education, awareness, development of earthquake early warning dissemination system etc. are needed for reducing the Disaster Risk.

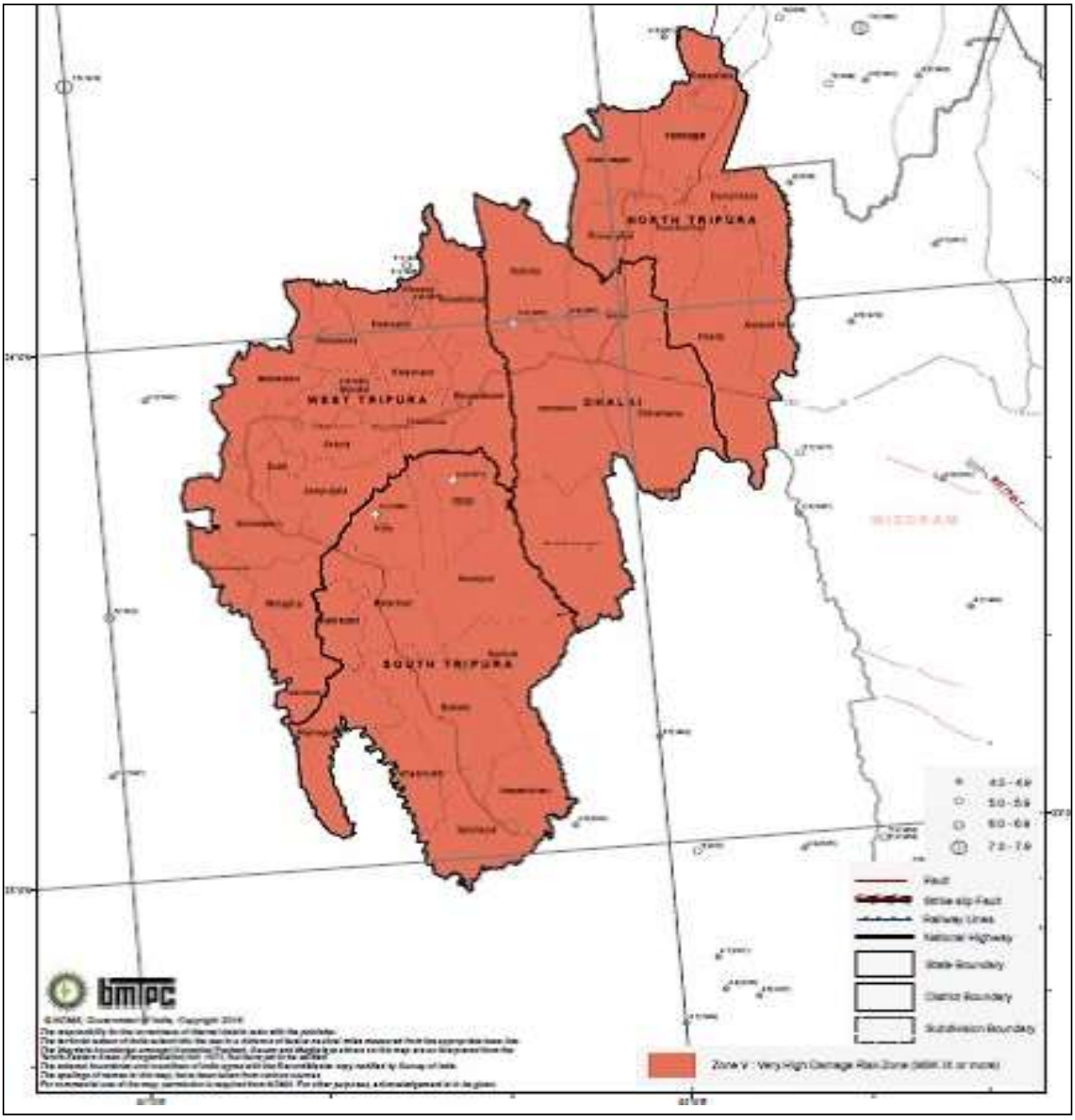

Figure 2.19: Earthquake Hazard Zoning Map of Tripura

2.8.1.2. LANDSLIDE [99,100]

Landslides are a common incidence in the hilly terrains of the state. During the monsoon, heavy rains causes landslides with the earth/rocks in the hill ranges of Tripura, which usually affects the NH-44, the life line of the state. Each year during the monsoons, parts of the neighbouring state is affected by landslides, which in turn affects parts of Tripura, often cutting off the state as there is no other means of road transportation except the roads and NH-44 running through the

[99] Tripura State Disaster Management Plan (TSDMA)
[100] Vulnerability Atlas of India 2016 (BMTPC, 2016)

landslide affected areas. During 2010 in September a deep depression in the hill in between the road from Tainani to Debipur caused severe congestion and disruption. The NH44 along North Tripura, Unakoti and Dhalai Districts face recurrent landslides cause disruption of surface communication particularly during monsoon. (refer to Figure 2.20).

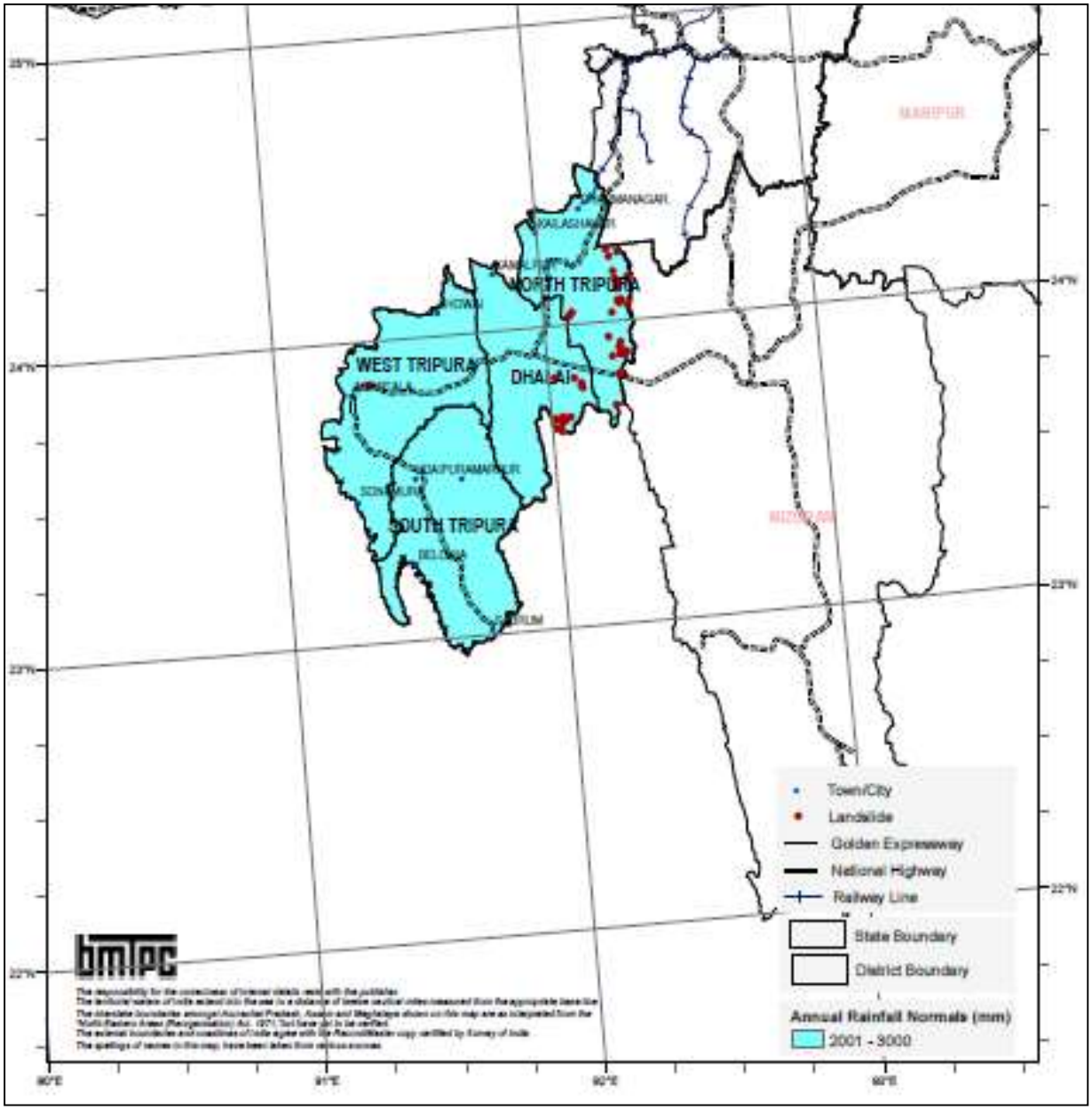

Figure 2.20: Landslide Incidence Map of Tripura

2.8.2. DISASTER RISK

The state is affected by several natural hazards amongst which Earthquake, Flood and Landslide are the most prominent and recurs frequently. A study has been conducted and the data has been compiled in the following table pertaining information about the districts that are affected by the hazards.

Table 2.13 Disaster Risk Profile of the Districts of Tripura [101] [102]

Districts	Area (sqkm)	Earthquake Hazard Zone V (sqkm)	Landslide Hazard	Wind Hazard Zone
Dhalai	2,400	2,400	Landslide-prone	VHDRZ(A)
North Tripura	2,036	2,036	Landslide-prone	VHDRZ(A)
South Tripura	3,057	3,057	Not Landslide-prone	VHDRZ(A)
West Tripura	2,993	2,993	Landslide-prone	VHDRZ(A)
	VHDRZ-A	Very High Damage Risk Zone - A (Vb= 55 m/s)		

As it can be observed from the above mentioned table on depicting the hazards of the Tripura state, entire state comes under the most severe earthquake zone i.e., zone V making the entire state most vulnerable to earthquakes, amongst four districts of the state three district areas are Landslide-prone and all the districts comes predominantly under very high damage risk zone experiencing wind velocity of 55 m/s. It can be clearly concluded that Tripura is a state prone to sever hazards and requires preparedness against disasters.

2.8.3. DISASTER RESILIENCE [103]

The state has formed its own State Disaster Management Authority (SDMA) to mitigate the risks arising due to the hazards. An analysis into the different areas of work by the SDMAs was conducted and the following table has been compiled to effectively detail out the various work of the state towards Disaster Resilience.

Table 2.14 Functional Areas of Disaster Resilience of Tripura

Areas of Work	Work Statement
State Disaster Management Authority	Tripura State Disaster Management Authority
State Disaster Management Plan	Tripura State Disaster Management Plan
State Disaster Response Force	No information is available.
Publications	• Acts and Policy. • Activity Report. • Flood Reports. • Memorandums. • Development of Action Plan on Capacity Building.
Drills and Public Awareness Programmes	• Aapda Mitra Program. • Mock Drill.
Capacity Building	• Workshops for the officials. • Training Programs. • Establishment of nodal training institution for imparting theoretical training on Disaster Risk Reduction. • Development of Action Plan on Capacity Building for

[101] Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
[102] Vulnerability Atlas of India 2016 (BMTPC, 2016)
[103] https://www.ndmindia.nic.in/images/gallery/scorecard1.pdf (NDMA , 2019)

Areas of Work	Work Statement
	School Safety on Disaster Management.
MIS Search and Rescue Equipment	No information is available.
NGO's	No information is available.
Contact Address	Revenue Department. First Floor, New Capital Complex, Secretariat, Agartala-799001. Phone-0381-2415385/241-8053/241-6045

2.9 UTTARAKHAND

Uttarakhand which was earlier known as Uttaranchal is one of the newly formed state in the northern part of the country, being carved out of the Himalayan regions of the state of Uttar Pradesh. The state is usually known as “Dev Bhoomi” owing to the fact that the state hosts a large number of hindu pilgrimage sites. The north of the state is bordered by Tibet, to the east Nepal, Uttar Pradesh to the south and Himachal Pradesh to the west and north-west. Most of the state has mountainous terrain densely covered with snow and ice or forests. Two of the most important rivers, the Ganges and the Yamuna flow from the glaciers located in the state. There are also several other lakes and streams in the region. The state is divided into two parts, the western half known as Garhwal and the eastern region as Kumaon.[104] The state covers an area of 53484 sqkm[105] and has a population of 1.0086 crore.[106]

The state is famous of its majestic snow-clad mountains, deep gorges, thickly forested valleys, large lakes, terraced fields, and cascading streams. It is home to beautiful mountain towns and resorts like Mussoorie, Nainital, Bhimtal, etc. It is home to rare species of flora and fauna, many of which are protected by sanctuaries and reserves which include the Jim Corbett National, and Valley of Flowers National Park - Nanda Devi National Park, which together are a UNESCO World Heritage Site.

Agriculture like most of the other states is the major economy generator with wheat, apple, oranges and other food crops being the major agricultural products. Apart from agriculture, other industries which contribute a significant amount to the state economy are tourism and hydropower. Post 2005, several Industrial Estates have been established in public-private partnership in the state. The Gross State Domestic Product had amounted to Rupees 184091 crore in the financial year of 2015-2016.[107]

According to Open Government Data Platform (OGD) India, incorporating life expectancy, education and per capita income, Human Development Index of Himachal Pradesh is 0.677.[108] The state has 2097[109] indispensable Health Infrastructures and 17526[110] vital Educational infrastructures which are vulnerable and hence their performance should be enhanced to

[104] Uttarakhand State Disaster Management Plan (USDMA)
[105] Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
[106] Summation of district population of the state from District Census Handbook 2011 (Census of India, 2011)
[107] https://data.gov.in/keywords/gross-state-domestic-product (Government of India; GSDP, 2019)
[108] https://data.gov.in/search/site?query=human+development+index (Government of India; HDI, 2019)
[109] https://data.gov.in/search/site?query=hospitals (Government of India; Hosp., 2019)
[110] http://udise.schooleduinfo.in/ and https://www.ugc.ac.in/ (UDISE, 2019) (UGC, 2019)

immediate occupancy during any disaster. These facilities are an integral part for disaster resilience of the state also.

2.9.1. HAZARDS

The state being nested in the Himalayan ranges, is majorly prone earthquakes and landslides. But, on some occasions it is also affected by floods also. The state falls in the highest seismic risk zones of the country i.e., Zone V and IV. These disasters have caused immense loss of property, natural wealth, and human lives. Remoteness and difficult accessibility in the rural areas along with lack of awareness on disaster risk reduction and preparedness have also contributed to increase in risk of the state's population.

2.9.1.1. EARTHQUAKE [111, 112]

Uttarakhand state is among the states which are most seismically active in India. It falls in a region of high to very high seismic hazard. As per the 2016 Bureau of Indian Standards (BIS) map, Uttarakhand also fallfalls in Zones IV and V. Historically, parts of this region have experienced seismic activity in the M6.0-7.0 range. Many events of M5.5 or above have been recorded in the region since 1900. (refer to Figure 2.21: Earthquake Hazard Zoning Map of Uttarakhand).

In the recent past, the largest earthquake experienced by Uttarakhand was on 19 October 1991 in the area of Pilang-Bhatwari, having a magnitude of M6.8. It resulted in the death of 768 people and nearly 5,000 were injured. Approximately, 18,000 buildings were destroyed in the Uttarkashi-Chamoli region and it also resulted in landslides in the Gharwal Hills. Tremors were felt over a wide area of northern India, western Nepal and Pakistan. Minor damage was also reported from New Delhi and Chandigarh.

It is seen that the following building types are predominant:

- Category A with the stone walls, in the hill districts = 18.02%
- Category B with burnt brick walls = 76.14%

These house types will have high risk in future earthquakes of different intensities, since most of the existing housing stock does not have the earthquake resisting features built in them. Existing priority life-line structures are to be identified and retrofitted immediately. Beside this other actions like regulations and code enforcement, enhancement of capacity of various emergency response agencies, education, awareness, development of earthquake early warning dissemination system etc. are needed for reducing the Disaster Risk.

[111] Uttarakhand Earthquake Hazard Zoning Atlas (BMTPC)
[112] Vulnerability Atlas of India 2016 (BMTPC, 2016)

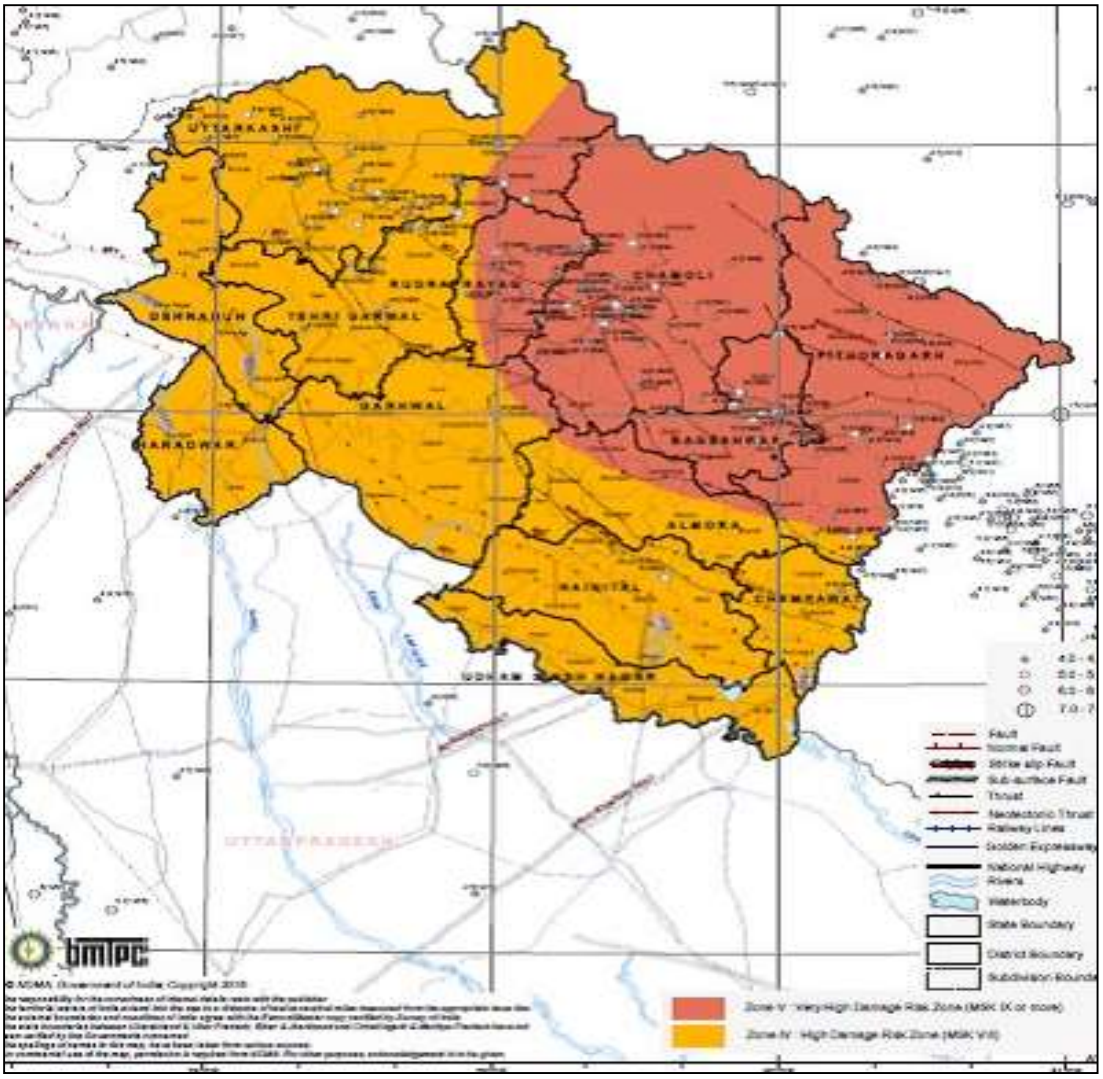

Figure 2.21: Earthquake Hazard Zoning Map of Uttarakhand

2.9.1.2. LANDSLIDE [113, 114]

The entire state has large portions of area falling under the mountainous terrains, and as a result it is Landslide-prone. Landslides are triggered by both natural and man-made factors. Among the natural factors, the common causes are due to earthquakes, steep slopes, torrential rains, melting snow. The man-made factors include deforestation, unscientific construction of roads, unscientific agricultural practices, and encroachment on hill slopes etc.

Almost every year the state is affected by one or more major landslides affecting the society in many ways. Loss of life, damage of houses, roads, means of communication, agricultural land, are some of the major consequences of landslides in Uttarakhand. For this, the state is affected as because there is no other means of transport except roads.

113 Uttarakhand State Disaster Management Plan (USDMA)
114 Vulnerability Atlas of India 2016 (BMTPC, 2016)

Over the past 40 years, more than 600 lives have been lost in landslides, along with severe damages to properties and infrastructures. The eastern and western part of the state is majorly affected. (refer to Figure 2.22: Landslide Incidence Map of Uttarakhand).

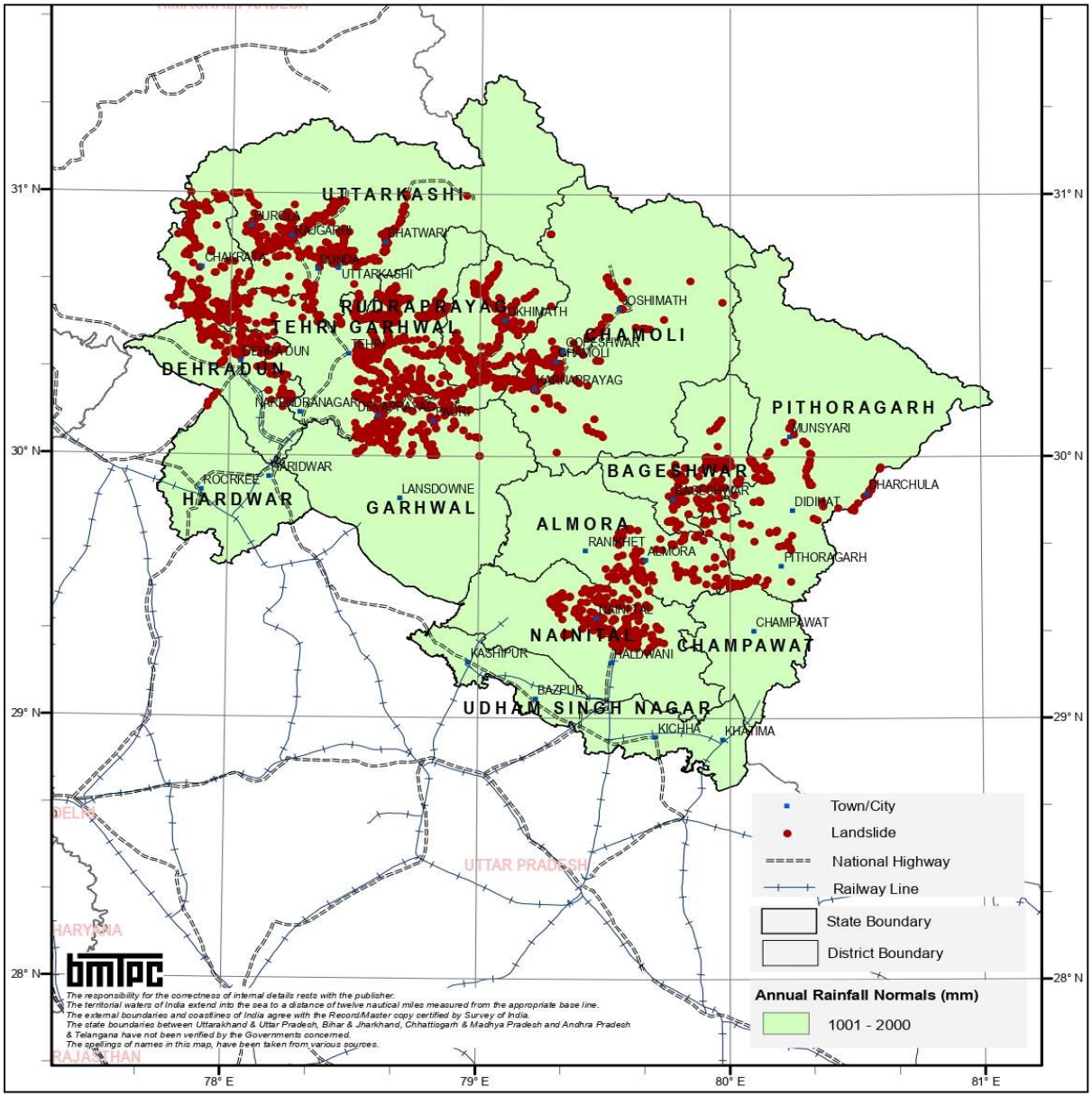

Figure 2.22: Landslide Incidence Map of Uttarakhand

2.9.1.3. FLOOD [115, 116]

The state has relatively high average annual rainfall. Mostly it rains from April to September, and heavy rainfall occurring during this period causes floods in low lying areas and erosion of land throughout the state has become a common phenomenon. Deforestation has increased the

115 Uttarakhand State Disaster Management Plan (USDMA)
116 Vulnerability Atlas of India 2016 (BMTPC, 2016)

severity of floods and reduced steam flows. The increase of soil erosion has reduced the water carrying capacity of the rivers resulting into swallowing of riverbeds leading to floods in the plains.

The unmanaged growth of tourism accompanied with rapid construction of road and housing in ecologically fragile areas. Along with this, cloud bursts and glacier lake bursts add to the flood issue in the state. From 2002 onwards there has been more than 150 deaths due to flash floods resulting from cloudbursts. (refer to Figure 2.23: Flood Hazard Zoning Map of Uttarakhand).

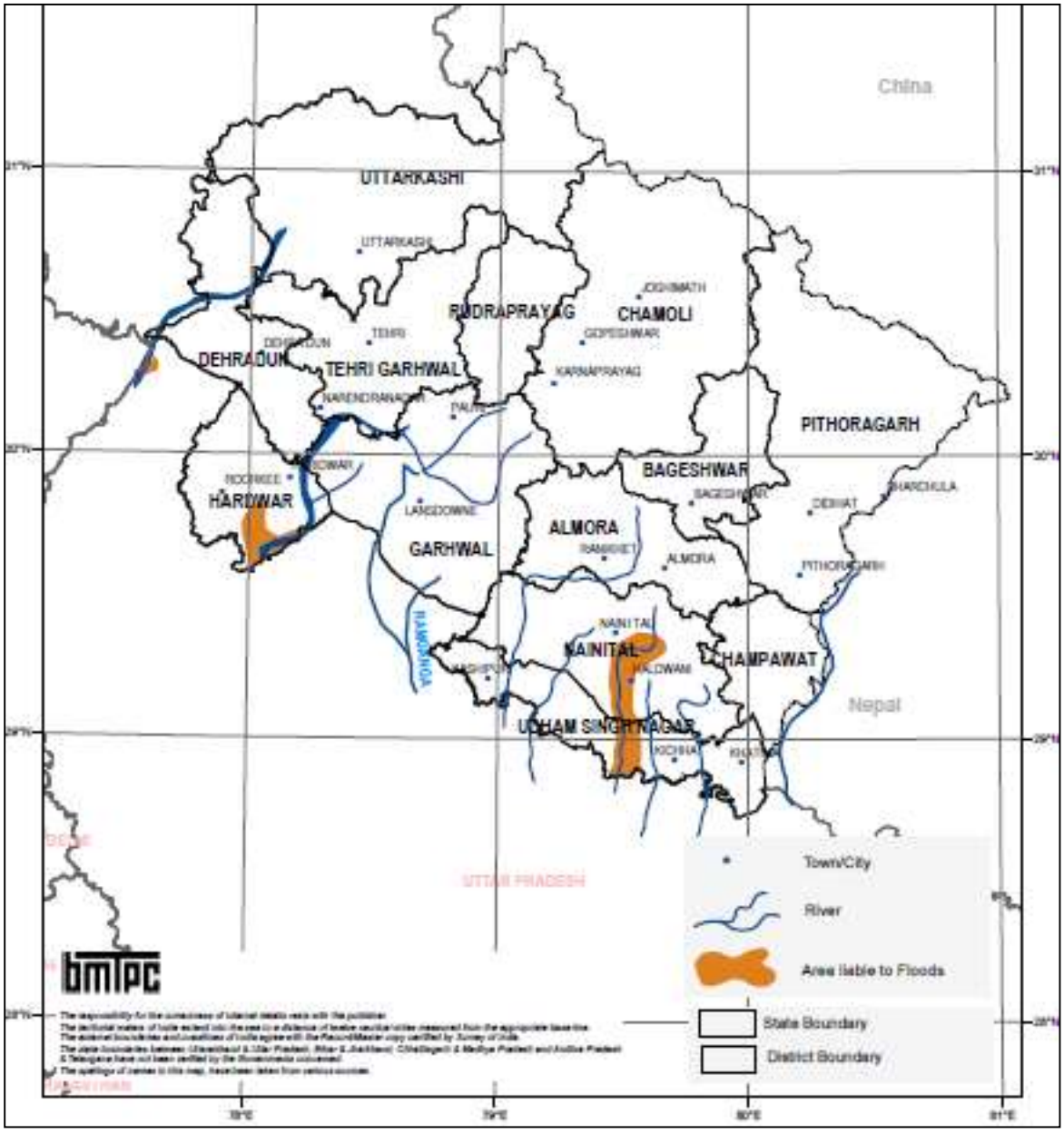

Figure 2.23: Flood Hazard Zoning Map of Uttarakhand

2.9.2. DISASTER RISK

The state is affected by several natural hazards amongst which Earthquake, Flood and Landslide are the most prominent and recurs frequently. A study has been conducted and the data has been compiled in the following table pertaining information about the districts that are affected by the hazards.

Table 2.15 Disaster Risk Profile of the Districts of Uttarakhand [117] [118]

Districts	Area (sqkm)	Earthquake Hazard Zone V (sqkm)	Earthquake Hazard Zone IV (sqkm)	Flood Hazard (✓ Flood prone / × Not prone to Flood)	Landslide (LS) Hazard (✓ LS prone / × Not prone LS)	Wind Hazard Zone
Almora	3,144	805	2,339	×	✓	MDRZ
Bageshwar	2,241	2,241	0	×	✓	MDRZ
Chamoli	8,030	8,030	0	×	✓	MDRZ
Champawat	1,766	0	1,766	×	✓	MDRZ
Dehradun	3,088	0	3,088	×	✓	MDRZ
Garhwal	5,329	320	5,009	×	✓	MDRZ
Haridwar	2,360	0	2,360	✓	✓	VHDRZ (B)
Nainital	4,251	0	4,251	✓	✓	MDRZ
Pithoragarh	7,090	6,764	326	×	✓	MDRZ
Rudraprayag	1,984	1,685	300	×	✓	MDRZ
Tehri Garhwal	3,642	109	3,533	×	✓	MDRZ
Udham Nagar	2,542	0	2,542	✓	✓	VHDRZ (B)
Uttarkashi	8,016	1,154	6,862	×	✓	MDRZ
	VHDRZ-B		Very High Damage Risk Zone - B (Vb= 50 m/s)			
	MDRZ		Moderate Damage Risk Zone (Vb= 39 m/s)			

It can be observed from the above mentioned table on depicting the hazards of the Uttarakhand state, entire state comprises of two sever earthquake zones i.e., zone V and zone IV, making the entire state vulnerable to earthquakes, amongst thirteen districts of the state, three district areas are liable to flooding, ten district areas are Landslide-prone and two district areas comes predominantly under very high damage risk zone experiencing wind velocity of 50 m/s. Rest of the districts comes under the wind velocity of 39m/s i.e., moderate damage risk zone of wind hazard. It can be clearly concluded that Uttarakhand is a state prone to sever hazards and requires preparedness against disasters.

2.9.3. DISASTER RESILIENCE [119]

The state has formed its own State Disaster Management Authority (SDMA) to mitigate the risks arising due to the hazards. An analysis into the different areas of work by the SDMAs was conducted and the following table has been compiled to effectively detail out the various work of the state towards Disaster Resilience.

117 Summation of district area of the state from District Census Handbook 2011 (Census of India, 2011)
118 Vulnerability Atlas of India 2016 (BMTPC, 2016)
119 https://www.ndmindia.nic.in/images/gallery/scorecard1.pdf (NDMA , 2019)

Table 2.16 Functional Areas of Disaster Resilience of Uttarakhand

Areas of Work	Work Statement
State Disaster Management Authority	Uttarakhand State Disaster Management Authority
State Disaster Management Plan	Uttarakhand State Disaster Management Plan
State Disaster Response Force	No information is available.
Publication	• Acts and Policy. • Activity Report. • Flood Reports. • Memorandums. • Guidelines.
Drills and Public Awareness Programmes	• National Disaster Management Services (NDMS) Pilot Project. • Early warning system for flood. • Sustainable Reduction in Disaster Risk (SRDR). • Aapda Mitra Program. • Mock Drill. • Search and Rescue Training. • Mason Training.
Capacity Building	• Workshops for the officials. • Training Programs. • IEC Material Development. • Retrofitting of the key buildings.
MIS Search and Rescue Equipment	No information is available.
NGO's	No information is available.
Contact Address	USDMA, Secretariat Campus, 4-B, Subhash Road, Dehradun Uttarakhand Secretariat. Phone: 0135-2710233 Email: usdmauttarakhand@gmail.com

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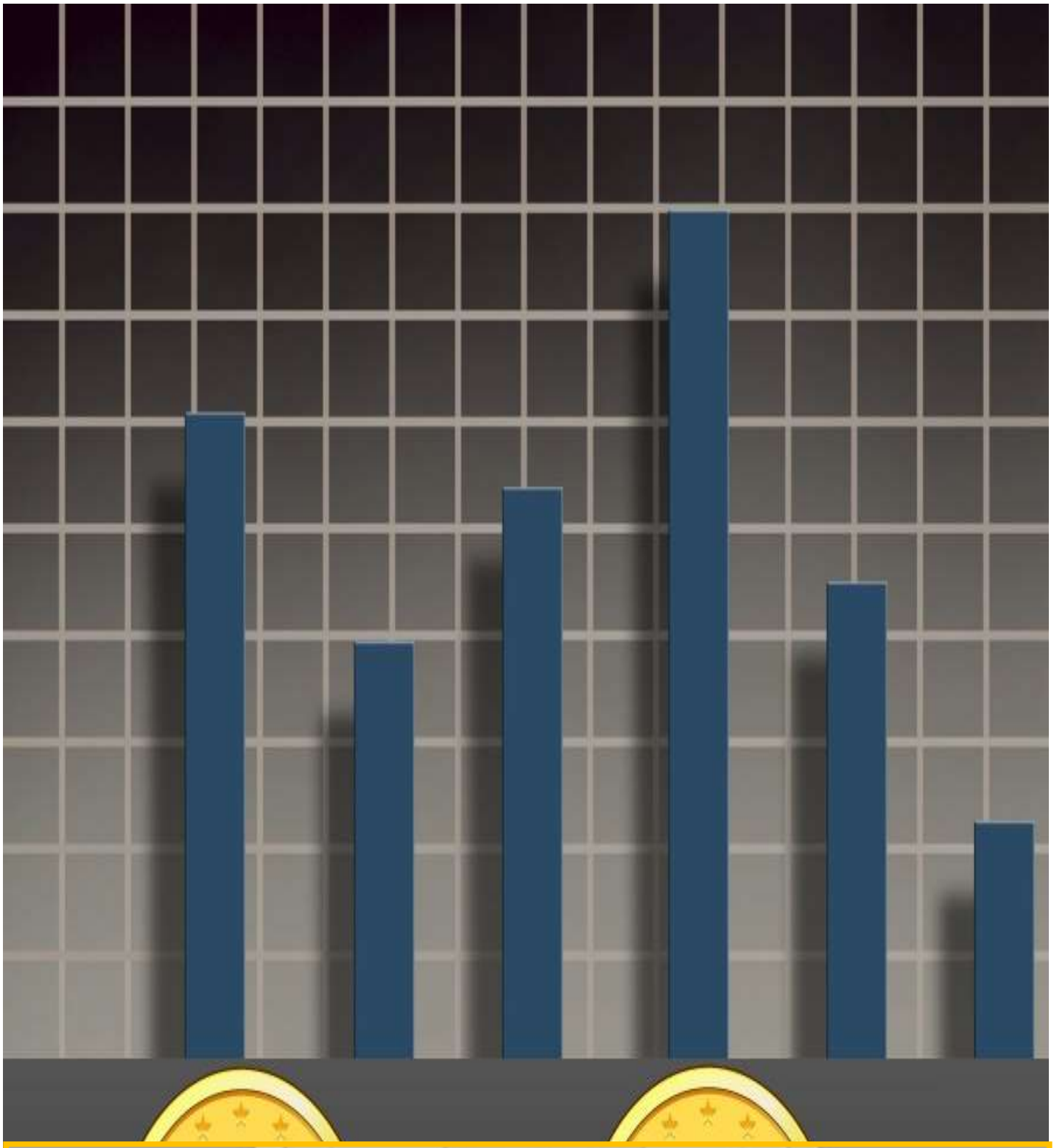


03 BUDGET ALLOCATION & INFRASTRUCTURE SELECTION

Chapter 3 discusses rationale and proposed methods for budget allocation for various components. It proposes various methods for the budget allocation. "Parameter based Method", is used by the project team and is based on hazard, ratio of population by education and health, state GDP and road density. Further, weighted averaged budget allocation (%) is proposed considering all methods for NDMA to rationalize the allocation. All three methods are explained with illustration. Furthermore, chapter discusses the selection criteria for buildings and infrastructure for detailed vulnerability assessment and retrofitting designing. Following the criteria, proposed list of buildings and infrastructure are enumerated for further consideration.

CHAPTER 3

BUDGET ALLOCATION AND INFRASTRUCTURE SELECTION

3.1. INTRODUCTION

As mentioned in Chapter 1, around 58.6% (10.9% in Zone V, 17.3% in Zone IV, 30.40% in Zone III) of Indian land mass is susceptible to moderate to severe earthquakes. During the last decade and half, disaster management of India has demonstrated paradigm shift from post-disaster relief and rehabilitation of victims to pre-disaster management. This is enhanced by emergency response system, using mitigation measures to reduce risk of vulnerable infrastructure and capacity building by creating community awareness and educating professionals for better design. These steps were guided by the Disaster Management Act 2005 through national disaster management authorities at national, state and district levels and were guided by the National Policy on Disaster Management 2009. Accordingly, the Government of India (GoI) through NDMA is designing a programme funded by the World Bank for enhancing the emergency response, mitigation measures and capacity building for reducing earthquake hazards risks under the National Cyclone Risk Mitigation Programme Phase II (NCRMP-II). The programme is named as National Seismic Risk Mitigation Programme (NCRMP).

The total size of NSRMP in the current phase is Rs. 5,000 crores for implementation of mitigation measures and capacity upgradation of each state under the program. Out of Rs. 5,000 crores to be spent under this phase of NSRMP, Rs. 1,300 crores is to be used for activities related to upgradation and capacity building components that fall under Component A and Component C of this project whereas Rs. 3,700 crores is meant for risk mitigation measures in the identified 8 states under Component B. The Consultant is required to prepare and submit DPRs / Bid Documents for approximately Rs. 1,850 crores ($\pm$10%) whereas for the balance amount in the Rs. 3,700 crores allocated under Component-B, the respective State Governments are required to prepare DPRs / Bid Documents themselves. Hence, there is a need to find the share / portion of funding for each state.

To fulfil this need a detailed study of Government of India published document(s) related to this topic were studied. The list of documents are detailed out in the chapter reference section. Three methods based on multiple criteria have been developed and proposed. A comparative statement of all three methods are presented to enable NDMA to distribute the total budget in eight states.

3.2. METHOD 1 - DISASTER SCORE CARD METHOD[1]

Ministry of Home Affairs (MHA) in collaboration with the United Nations Development Programme (UNDP) and support of State Governments, has come up with the draft report “Indian Disaster Score card” using the Sendai Framework for Disaster Risk Reduction, slightly changed to suit the priorities of the country. In this document, two Indices: (i) Disaster Risk Index; and (ii) Disaster

[1] (Ministry of Home Affairs, 2018)

Resilience Index have been quantified on the basis of uniform datasets on common set of indicators on disaster risks and level of resilience of States and Union Territories.

The Disaster Risk Index is calculated using parameters such as Hazard Index, Vulnerability Index and Exposure Index. Hazard Index and Vulnerability Index are calculated considering fourteen weighted parameters each, whereas Exposure Index is based on two weighted parameters. Table 3.1 below lists each parameter under the respective sub-heads i.e., Hazard, Vulnerability and Exposure.

Table 3.1: Parameters considered under Hazard, Vulnerability and Exposure

S.No.	Hazards	Vulnerabilities	Exposures
1.	Earthquake	Unsafe Buildings	Population
2.	Cyclone	Social Infrastructure	GDP
3.	Flood	Physical Infrastructure	
4.	Drought	Net Cropped Area	
5.	Landslide	Livestock Population	
6.	Tsunami	Industries	
7.	Avalanche	Vulnerable Women	
8.	Heat Wave	Vulnerable Children	
9.	Cold Wave	Disabled People	
10.	Coastal Erosion	Aged People	
11.	Lightning	Rural/Urban Poor	
12.	Forest fire	Deforestation	
13.	Fire	Depletion of Mangrove	
14.	Industrial Hazard	Water Stress	

The Disaster Resilience Index is calculated based on broadly seven weighted parameters (listed in Table 3.2 below) which are further calculated considering ten independent sub-parameters. For example, for assessing the Risk Assessment, the ten sub-parameters are: (i) Hazard Vulnerability risk assessment; (ii) Digital risk mapping in Public domain; (iii) Real time data on Risks and Disasters; (iv) Micro zonation of earthquake risks; (v) Flood risk assessment; (vi) Drought risk assessment; (vii) Dissemination of risk information to people; (viii) Assessing Traditional and local knowledge; (ix) Assessing patterns of Emerging risks; and (x) Developing database of disasters.

Table 3.2: Parameters considered under Resilience Index

S.No.	Resilience Parameters
1.	Risk Assessment
2.	Risk Prevention and Mitigation
3.	Risk Governance
4.	Disaster Preparedness
5.	Disaster Response
6.	Disaster Relief and Rehabilitation
7.	Disaster Reconstruction

Thereafter, the hazard, vulnerability and exposure indices of each state were multiplied together and the result obtained was divided by the resilience index of the state to obtain the Disaster

Score Card for that state. This process was carried out for each State and UT across India to rank them in order of most vulnerable to least vulnerable State / UT across the country.

Using parameters based on above Disaster Score Card, the budget allocation can be decided for each state. The Disaster Score Card of the eight states are converted into percentages on the basis of the severity of risk score. The outcome is depicted in the bar chart shown under figure 3.1 below.

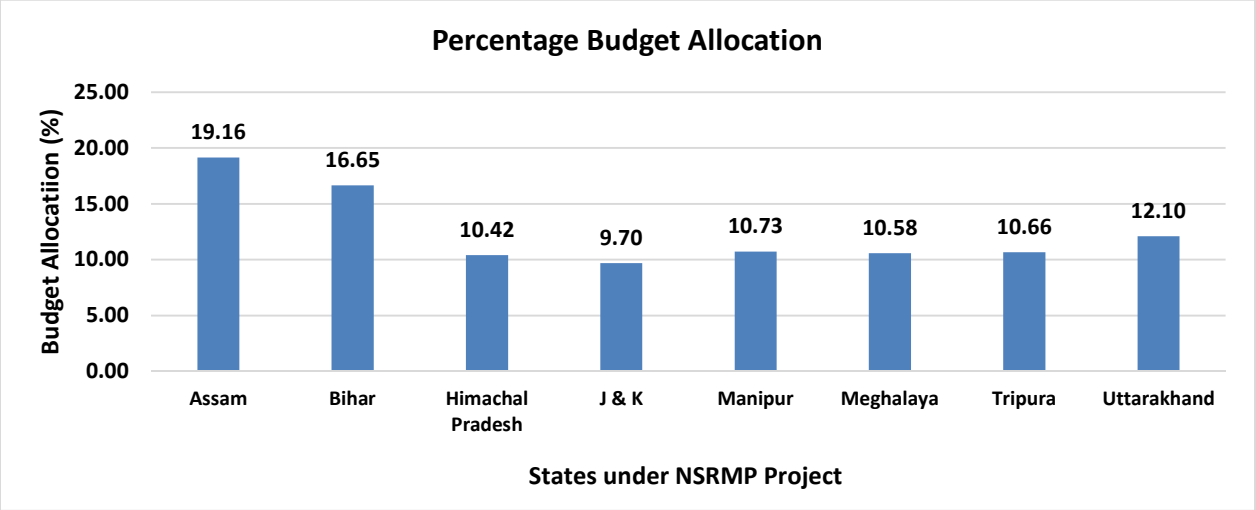


Figure 3.1: Percentage Allocation of Eight States

As can be seen from the above bar chart, Assam should get the maximum share of 19.16% of the total budget whereas Jammu & Kashmir should get the least i.e., 9.70% of the total budget share.

3.3. METHOD 2 – "STRENGTHENING DISASTER MANAGEMENT IN INDIA" [2]

Another document titled "Strengthening Disaster Management in India" which is an initiative by the Ministry of Home Affairs, Government of India in collaboration with the support under GoI-UNDP Disaster Risk Reduction Programme (2009-2012) shares Government of India's initiatives taken in disaster risk reduction program and also provides an insight in the funds allocated under various schemes.

Funds were released by the Central Government of India to the State Governments under Schemes (Plan and Non- Plan) and Centrally Sponsored and through external aids. By the proposal of the Thirteenth Finance Commission, the Ministry of Finance, Government of India has assigned funds for improving disaster management institutions, capacity building and response mechanisms under broadly three heads :-

- State-wise Allocation of State Disaster Response Fund
- State-wise Grant Allocation for Capacity Building for Disaster Response
- State-wise Grant Allocation for Revamping of Fire Services

[2] (Strengthening Disaster Management in India, an initiative by the Ministry of Home Affairs. Government of India in collaboration with UNDP)

3.3.1. STATE DISASTER RESPONSE FUND

The 13th Finance Commission, Ministry of Finance, Government of India has allocated funds for states under State Disaster Response Fund for Financial Year 2010-2011, 2011-2012, 2012-2013, 2013-2014 and 2014-2015, respectively. Total Annual allocation of funds allocated (INR Crores) for 8 states Assam, Bihar, Himachal Pradesh, Jammu and Kashmir, Manipur, Meghalaya, Tripura and Uttarakhand are 1457.51, 1848.25, 722.56, 952.93, 39.9, 80.95, 106.7 and 650.15 respectively. As per document, Government of India has contributed 75% of the total annual allocation for states belonging to the general category (Bihar) and 90% for states belonging to the special category (rest of 7 Project States) in the form of a Non-Plan grant based on the receipt of confirmation of accounting procedures as mentioned in the guidelines issued in the gazette. Considering that each state has received full amount, the accumulated funds (in INR Crores) received by each state under this head is calculated and represented in a bar chart under figure 3.2 below.

As can be seen from the bar chart below, Bihar has received maximum funding under this head to the tune of Rs. 1,386 crores whereas Manipur has received only Rs. 36 crores in the five financial years as per data released by the GoI.

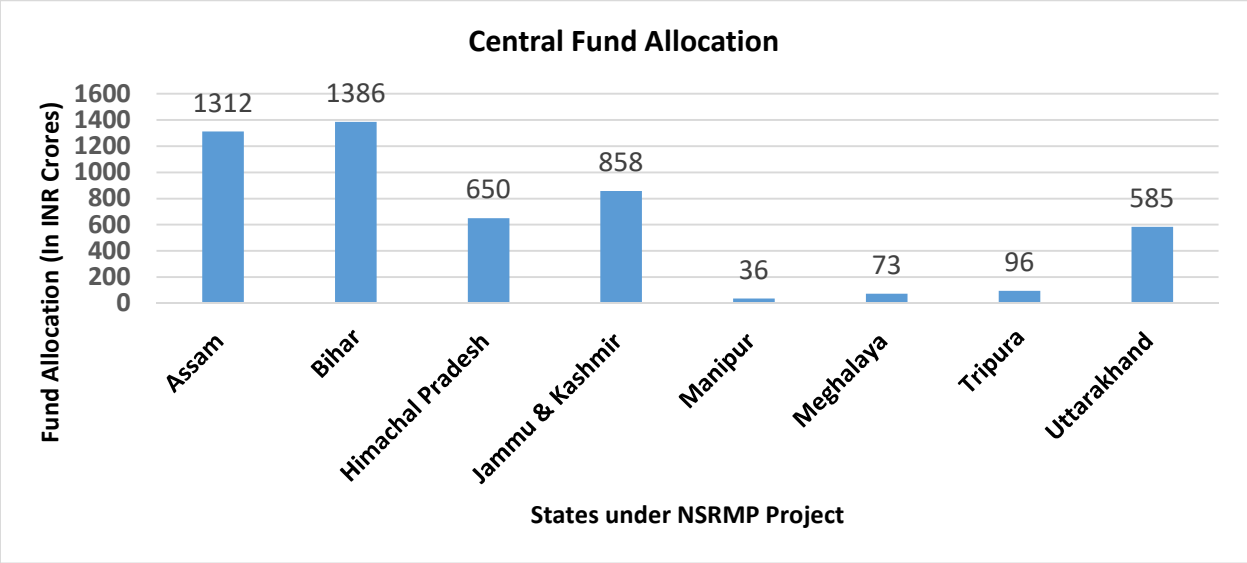


Figure 3.2: Total accumulated fund for State Disaster Response development from Government of India (2010-2015)

3.3.2. CAPACITY BUILDING FOR DISASTER RESPONSE

The Thirteenth Finance Commission has approved an endorsement of Rs. 525 crores for capacity building within the administrative system for better execution of disaster response and for preparedness of District and State level disaster management plans as planned under the Disaster Management Act, 2005. The grant is credited for helping the states in providing important trainings and supporting capacity building of life, capital and property, readiness of Disaster Management Plans based on hazard, risk and vulnerability analysis, and setting up / strengthening of Emergency Operation Centres (EOCs). Hereto, the funds (in crores) have been allocated to the States and UTs from Financial Year 2010-2011, 2011-2012, 2012-2013, 2013-

2014 and 2014-2015, respectively. Assuming full funding is to be provided, the bar chart shown under figure 3.3, shows the total fund allocated to the states under this grant from 2010-2015.

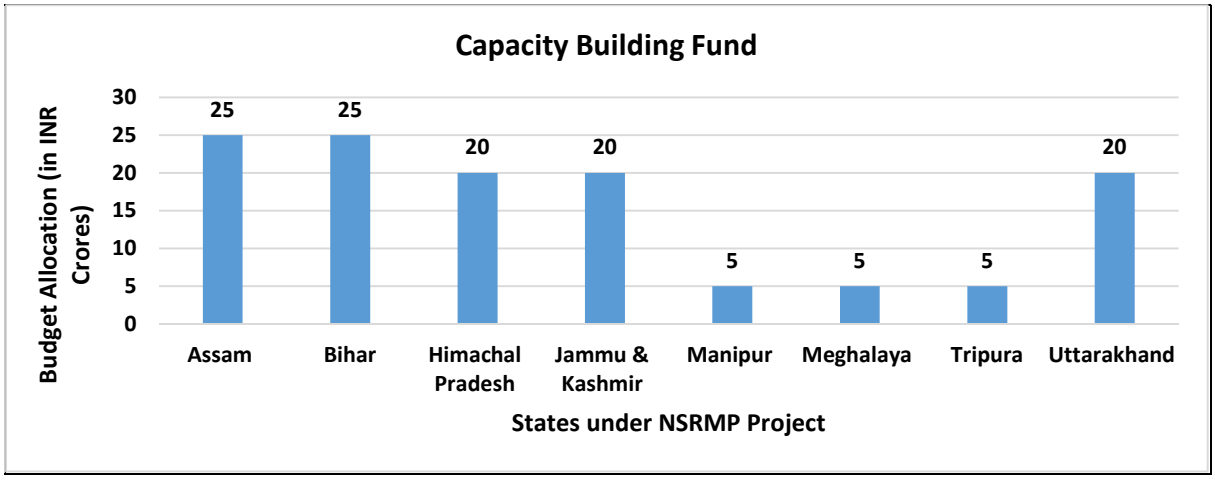


Figure 3.3: Total accumulated fund for State Capacity Building (2010-2015)

As seen from the above bar chart, Assam and Bihar have been allotted maximum funding of Rs. 25 crores in the 5 financial years whereas Manipur, Meghalaya and Tripura have been allotted only 5 crores in same period.

3.3.3. REVAMPING OF FIRE SERVICES

As per recommendations of the Thirteenth Finance Commission Report, a budget allocation of Rs. 87,519 crores is assigned to Urban Local Bodies, a portion of which is available for improvement of fire resistance services within their respective jurisdiction. The states are eligible to draw their share from the grant only if they comply with the conditions i.e., all municipal corporations with a population of more than one million (2011 census) must put in place fire hazard response and mitigation plan for their respective areas. An additional fund of Rs. 472 crores has been allocated to seven states. Amongst them the states considered in the NSRMP (National Seismic Risk Mitigation Programme), only Tripura got funds for the improvement of services to resist fire. As per available data in the report mentioned above only Tripura has received Rs. 15 crores under this head.

3.3.4. AID SCHEMES

Further grants under two plan schemes were allocated by the GoI to the respective States and UTs. They have been discussed separately in ensuing paragraphs.

(a) Strengthening of Fire and Emergency Setup

With an overall objective to strengthen the fire and emergency services in the country and transform fire services into a multi-hazard response force to act as a first responder in all types of emergency situation, the GoI launched a Program for the Improvement of Fire and Emergency Service in 2009 with an initial budget of Rs. 200 crores. Within the Eleventh five year period, the program is being implemented as a Centrally Funded Program in ratio between Central:State as 75:25 and for North-Eastern States as 90:10. The implementing agency for this program has been assigned to the Office of Director Ge

neral, National Disaster Resource Fund & CD, GoI. The programme is regularly reviewed by a High Level Empowered Committee regulated under the chairmanship of Secretary (Border Management), MHA. A bar chart shown under figure 3.4 below shows the Central allocated funds (in crores) to each state under this scheme.

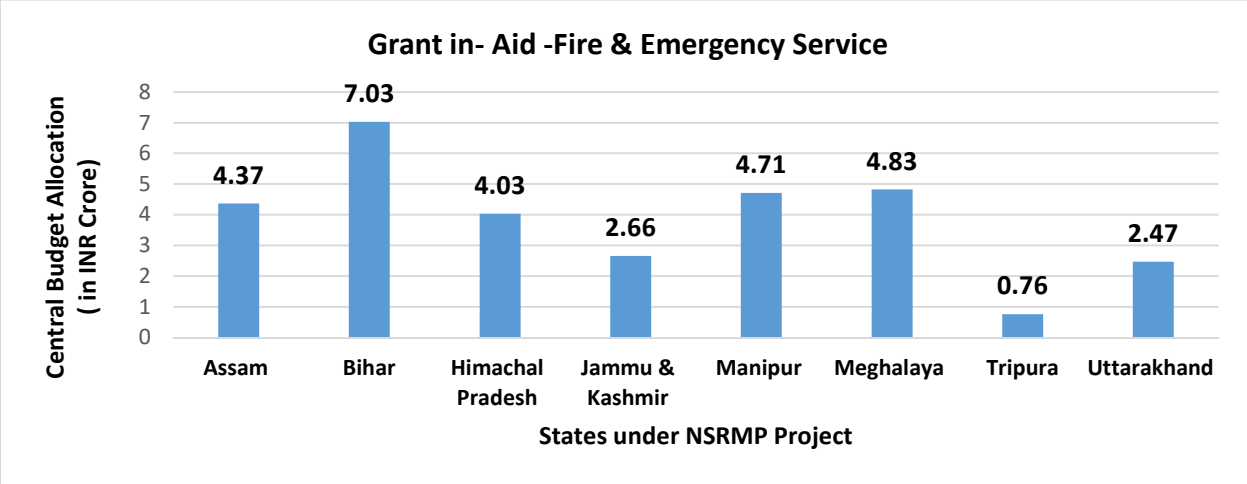


Figure 3.4: Central Budget Allocated under Aid Schemes for Strengthening of Fire and Emergency Setup (2010-2015)

(b) Revamping of Civil Defence Setup

Similarly, to strengthen the Civil Defence setup in the country to play a significant role in disaster management, Government of India has launched a Centrally Funded Programme in April 2009 with an initial budget of 100 crores during the Eleventh Five Year Plan. The implementing agency for this scheme has been assigned to the Office of Director General, National Disaster Resource Fund & CD, Government of India while the reviewing authority is assigned under the chairmanship of Secretary (Border Management), MHA. The bar chart shown under figure 3.5 below shares the Central Allocation (in crores) to each state under this scheme.

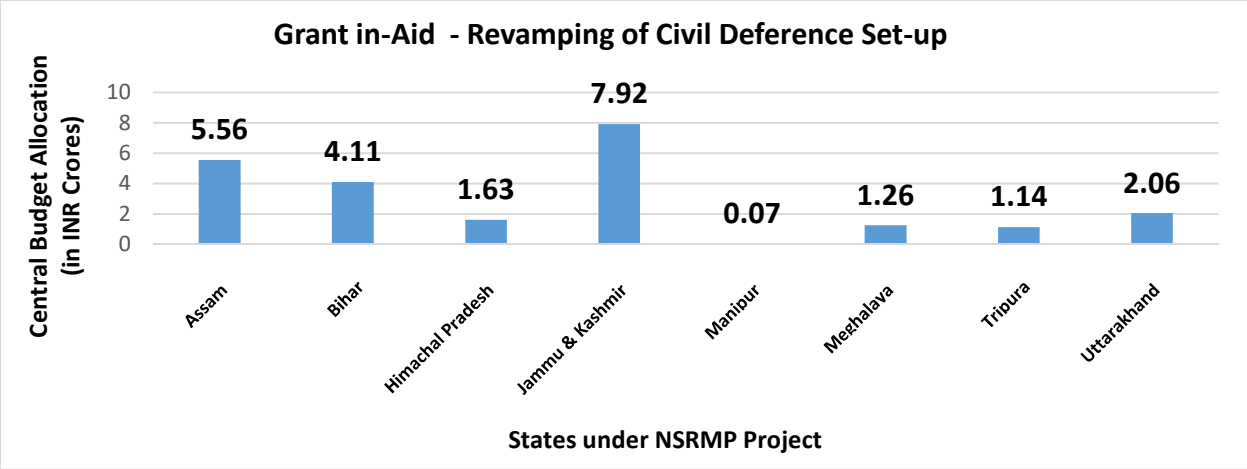


Figure 3.5: Central Budget Allocated under Aid Schemes for Revamping of Civil Defence Set-up (2010-2015)

Figure 3.6 shows the component wise budget allocation for project states. The bar chart shown under figure 3.7 shows the total funding allocated to each state provided under the three heads and two aid schemes by the Central Government. Upon expressing the same in terms of percentage (shown in bar chart figure 3.8), we can observe that almost 27.40% of the total allocated budget goes to Bihar whereas only 0.88 % of the total budget is allocated to Manipur.

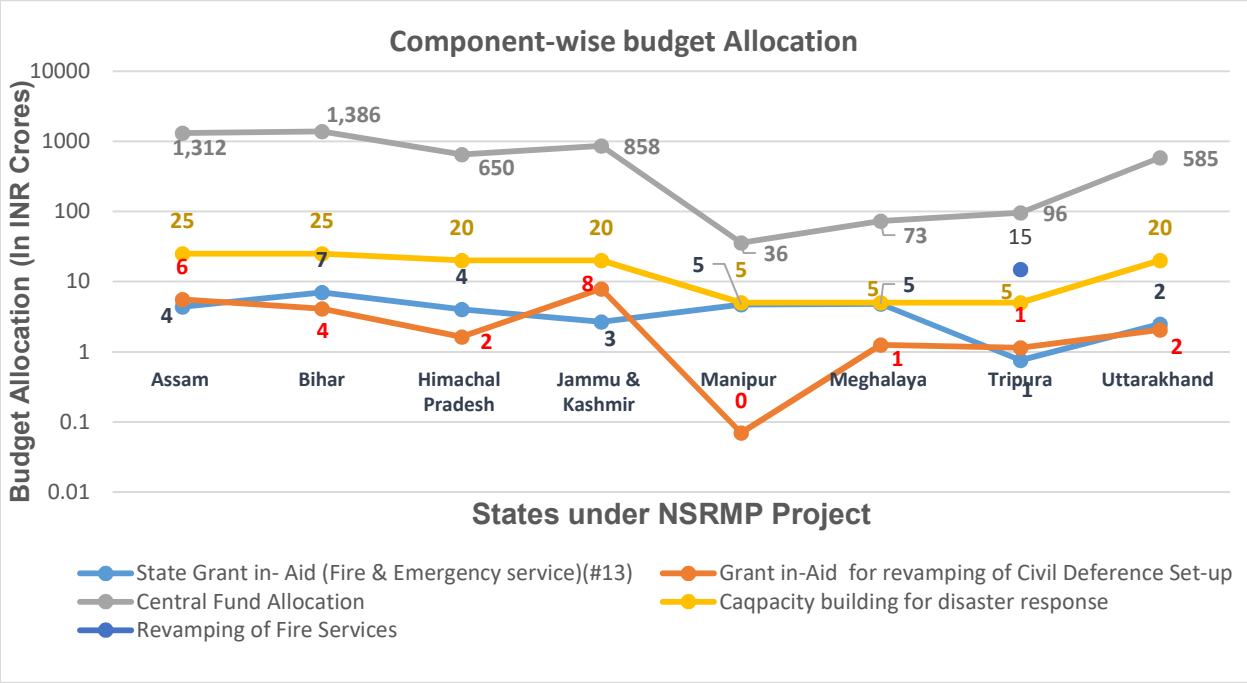


Figure 3.6: Central Funds Allocated under all Heads and Schemes (INR Crores) (2010-2015)

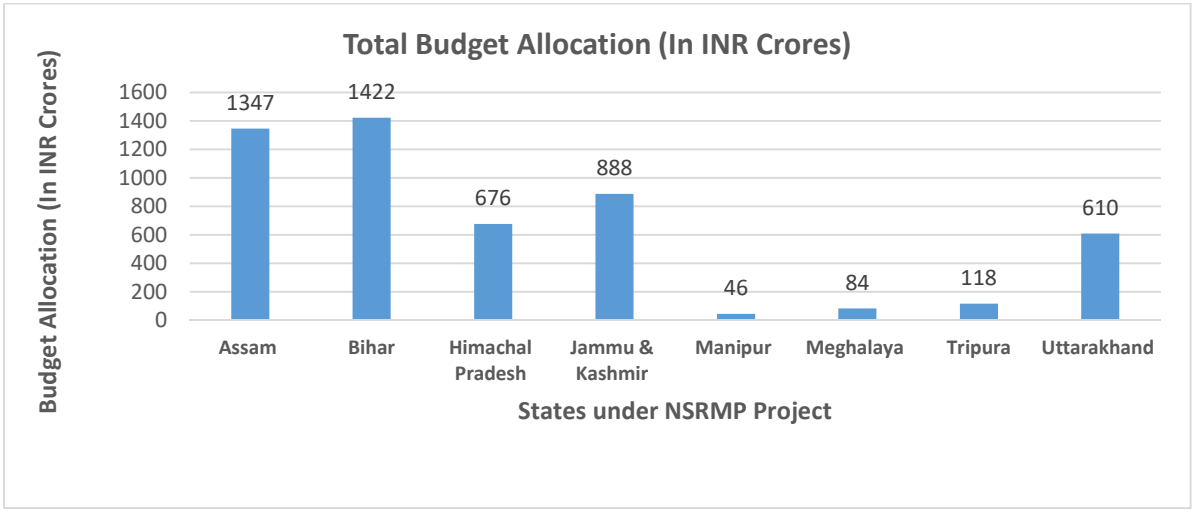


Figure 3.7: Total Central Funds Allocated to States under NSRMP (2010-2015)

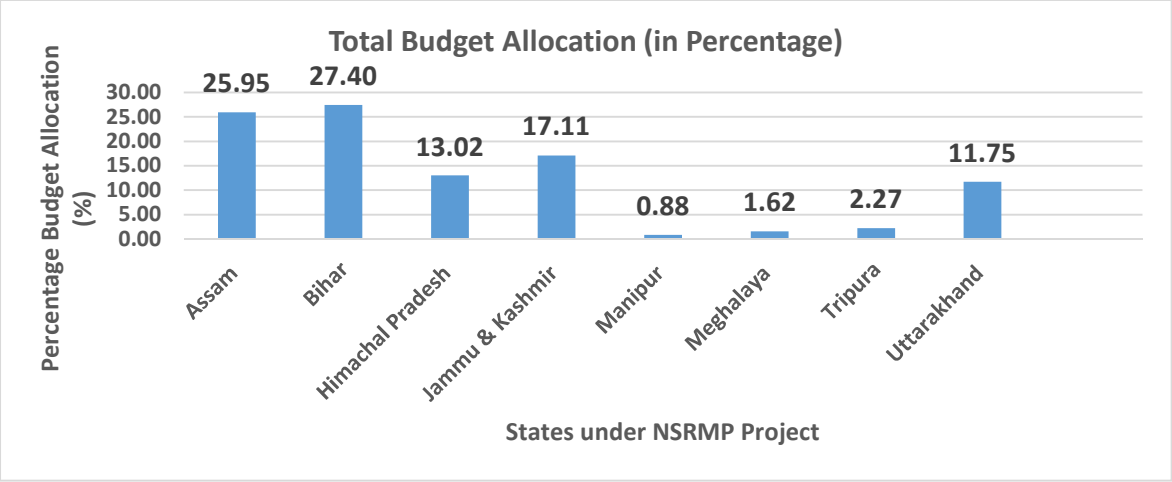


Figure 3.8: Total Central Funds Allocated to States under NSRMP (Percentage) (2010-2015)

3.4 METHOD 3 – PARAMETER BASED METHOD

The above methods considered all disasters in general. However, the specific need under this project is seismic hazard. Hence, a method based on parameters affected by seismic hazard has been proposed and percentage budget allocation for each state is worked out. The reasoning and method to achieve the same has been explained below.

During seismic events, losses can be classified broadly under two heads, namely: (1) Loss of Life; and (2) Economic Loss. Hence, when considering seismic events, it becomes important to consider loss as discussed above. Various criterion have been considered, as listed and the rationale for their inclusion has been further explained in detail below.

- Hazard Score,
- Population Exposure per Education Infrastructure,
- Population Exposure per Health Infrastructure,
- Gross State Domestic Product (GSDP),
- Road Density Exposure.

3.4.1. HAZARD SCORE

As mentioned above, four out of the eight states namely, Assam, Manipur, Meghalaya and Tripura lie in Zone V whereas three states - Jammu & Kashmir, Himachal Pradesh and Uttarakhand are spread over Zone IV and V and Bihar is spread over Zone III, IV and V, respectively.

Looking at seismic maps of the project states, it is observed that Himachal Pradesh, Jammu & Kashmir and Uttarakhand are lying in seismic zones IV and V while Bihar is spread across seismic zones III, IV and V. Within each state, it is further seen that few districts are lying in a single seismic zone while remaining districts are spread over various seismic zones. Hence, the approximate areas under each seismic zone was calculated. Columns (2) and (3) in Table 3.3 shows the areas lying in seismic zone IV and V, respectively.

For each state, the weighted sum of hazardous area was calculated. The weight for each seismic zone was considered as the respective zone factor (z) value as mentioned in IS 1893 (Part

1):2016. Hazard Score for each state was obtained by dividing the weighted sum i.e. Hazard Index of respective State by the lowest Hazard Index amongst all states. Sample calculation procedure for the hazard score has been depicted for the state of Himachal Pradesh under Table 3.3.

Table 3.3: Hazard Score Calculation for Himachal Pradesh

Name of District	Total District Area (km²)	Seismic Zone IV Approx. Area (km²)	Seismic Zone V Area (km²)
	(1)	(2)	(3)
Bilaspur	1,167	672	495
Chamba	6,528	2,957	3,571
Hamirpur	1,118	0	1,118
Kangra	5,739	402	5,337
Kinnaur	6,401	448	5,953
Kullu	5,503	2,256	3,247
Lahaul and Spiti	13,835	13,088	747
Mandi	3,950	356	3,595
Shimla	5,131	0	5,131
Sirmaur	2,825	0	2,825
Solan	1,936	1,903	33
Una	1,540	913	627
Total Areas	55,673	22,995	32,678
Factored Areas		5518.83	11,764.04
Hazard Index			28805
Hazard Score			**2.75**

Following steps have been followed to calculate the Hazard Score.

- Sum up the total area under respective seismic zones for all district to get zone-wise total area in the state.
- The summed up area of each seismic zone is multiplied by the zone factor (IS 1893:2016) of the respective zone to get the factored areas.
- Weighted average is obtained by dividing the sum of factored areas by the sum of weights i.e. summation of the zone factors.
- Similar calculations have been performed for the remaining project states.
- Hazard Score of each state is calculated by dividing each state hazard index by the lowest hazard index amongst all eight states.

3.4.2. POPULATION EXPOSURE PER EDUCATION INFRASTRUCTURE

Population for each state (district level breakup) was obtained from District Census Handbook 2011 compiled by the Census of India whereas the Education Infrastructure was obtained from the websites[3,4]. To include the loss of life, population ranging between 5 years to 25 years which

[3] (Census of India, 2019)
[4] (University Grants Commission, India)

is generally considered to be education oriented was obtained from the total population for each district.

Based on the area covered under each earthquake zone, the number of Education Infrastructure in each district was obtained with respect to the earthquake zone. For example:
(i.) Area of a district = A
(ii.) Area of district in zone V, 25% of A = 0.25 A
(iii.) Number of Education Infrastructure in district = 100
(iv.) Number of Education Infrastructure in zone V = 100 X 0.25 = 25

Based on the explained sample calculation (mentioned above), the number of institutions lying in each seismic zone in each district was computed and consolidated.

Similar exercise was carried out for education oriented population to arrive at the numbers. First the filtered population with respect to respective earthquake zone in the district was calculated. This is followed by obtaining approximate education oriented population for different seismic zones within each district. The education oriented population is then divided by the number of education infrastructure in that zone to obtain population exposure per education infrastructure for respective seismic zones.

Summation of population being served per education infrastructure in seismic zone V was calculated. Similar process was followed for other seismic zones. Weighted sum of population exposure per education infrastructure was obtained by multiplying with weights. The weight for each seismic zone was considered as the respective zone factor (z) value as mentioned in IS 1893(Part 1):2016. Population Exposure per Education Infrastructure of a state is calculated by dividing the weighted sum for each state by the lowest weighted sum obtained amongst all project states. Sample calculation procedure for the Population Exposure per Education Infrastructure has been depicted for Himachal Pradesh under Table 3.4.

Table 3.4: Population Exposure per Education Infrastructure

HIMACHAL PRADESH						
Name of District	**No. of Institutes**	**Population**	**Zone V**		Zone IV	
		2011 Census (5-25 yrs)	**No. of Institutes**	**Population (5- 25 yrs)**	**No. of Institutes**	**Population (5- 25 yrs)**
Bilaspur	852	144,319	361	61,191	491	83,128
Chamba	1652	233,753	904	127,863	748	105,890
Hamirpur	770	169,976	770	169,976	0	0
Kangra	2547	576,282	2,369	535,942	178	40,340
Kinnaur	272	30,954	253	28,787	19	2,167
Kullu	1028	186,170	607	109,840	421	76,330
Lahaul & Spiti	270	11,923	15	644	255	11,279
Mandi	2463	395,835	2,241	360,210	222	35,625
Shimla	2332	322,967	2,332	322,967	0	0
Sirmaur	1454	245,550	1,454	245,550	0	0
Solan	1090	239,940	19	4,079	1,071	235,861
Una	765	207,352	311	84,392	454	122,960
	15,495	2,765,021	11,635	2,051,442	3,860	713,579
Avg. Population served per Institute				176		185
Factored population served per Institute				63		44
Weighted Sum						180
Population Exposure per Education Infrastructure						**1.70**

Following steps are followed to calculate the parameter:

- Sum up the total Education Infrastructure under respective zones for all districts to get zone-wise Education Infrastructure.
- Sum up the population ranging between 5-25 years under respective zones for all districts to get zone-wise population.
- Calculate average population served per Education Infrastructure by dividing the total population of the zone by the number of Education Infrastructure in that zone.
- Weighted average of population served per education infrastructure for the state is obtained by dividing the sum of factored population served per education infrastructure for each seismic zone by the sum of weights i.e. summation of the zone factors.
- Similar exercise is carried out for remaining seven project states.
- Finally, the Population Exposure per Education Infrastructure Score is obtained by dividing with the lowest figure amongst all project states.

3.4.3. POPULATION EXPOSURE PER HEALTH INFRASTRUCTURE

After any seismic event, Health Infrastructure would be the most sought to treat the injured. Hence, the list of Health Infrastructure was obtained from Open Government Data Platform (OGD) India and population was obtained from District Census Handbook 2011 compiled by the Census of India for each district in each state.

Similar process as carried out above i.e. for population exposure per education infrastructure was followed to calculate the vulnerable population at risk per Health Infrastructure. Only difference maintained from the above method was that in this case, the total district population was considered. In order to calculate the vulnerable population at risk per health infrastructure, the total district population was considered as entire population irrespective of age would be using the Health Infrastructure during hour of need.

Using the similar method, normalised value of Vulnerable Population at risk per health infrastructure was obtained for each state. Weighted sum of population exposure per health infrastructure was obtained by multiplying with weights. The weight for each seismic zone was considered as the respective zone value as mentioned in IS 1893(Part 1):2016. Population Exposure per Health Infrastructure of a state is calculated by dividing the weighted sum for each state by the lowest weighted sum obtained amongst all project states. Sample calculation procedure for the health infrastructure component has been depicted for Himachal Pradesh under the Table 3.5. Similar calculations have been performed for the remaining project states.

Table 3.5: Population Exposure per Health Infrastructure

HIMACHAL PRADESH						
Name of District	**No. of Hospitals**	**Population**	**Zone V**		**Zone IV**	
		2011 Census	**No. of Hospitals**	**Population**	**No. of Hospitals**	**Population**
Bilaspur	150	381,956	64	161,949	86	220,007
Chamba	219	519,080	120	283,937	99	235,143
Hamirpur	182	454,768	182	454,768	0	0
Kangra	525	1,510,075	488	1,404,370	37	105,705
Kinnaur	57	84,121	53	78,233	4	5,888
Kullu	123	437,903	73	258,363	50	179,540
Lahaul & Spiti	55	31,564	3	1,704	52	29,860
Mandi	385	999,777	350	909,797	35	89,980
Shimla	344	814,010	344	814,010	0	0
Sirmaur	187	529,855	187	529,855	0	0
Solan	214	580,320	4	9,865	210	570,455
Una	155	521,173	63	212,117	92	309,056
	2,596	6,864,602	1,930	5,118,969	666	1,745,633
Avg. Population served per Hospital				2,652		2,622
Factored pop. served per Hospital				955		629
Weighted Sum				2640		
Population Exposure per Health Infrastructure				1.44		

Following steps are followed to calculate the parameter:

- Sum up the total Health Infrastructure under respective seismic zones for all districts to get zone-wise Health Infrastructure.
- Sum up the population under respective zones for all districts to get zone-wise population.

- Calculate average population served per health infrastructure by dividing the total population of the seismic zone by the number of health infrastructure in that zone.
- Weighted average of population served per health infrastructure for the state is obtained by dividing the sum of factored population served per health infrastructure for each seismic zone by the sum of weights i.e. summation of the zone factors.
- Similar exercise is carried out for remaining seven project states.
- Finally, the Population Exposure per Health Infrastructure Score is obtained by dividing with the lowest figure amongst all project states.

3.4.4. GROSS DOMESTIC PRODUCT OF STATE

Gross State Domestic Product (GSDP) current price in crores for year 2014-2015 was obtained for respective states from Government of India website[5] and is an important criteria that represents the states' total economic activity. It represents the monetary value of all goods and services produced within a state's geographic borders over a specified period of time. Hence, higher GSDP states occupy higher rating in terms of requirement to be saved.

The GSDP of these eight states was normalised with respect to each other like other indices so that they could be used directly for arriving at the percentage for budget allocation within these eight states.

3.4.5. ROAD DENSITY EXPOSURE

The length of National Highways and State Highways was obtained from Basic Road Statistics of India 2015-16[6]. Since these figures were obtained for each state, but the bifurcation was required for each district as was carried out in above cases. Assuming that the road density was uniform throughout the state, the approximate road density was obtained for each seismic zone in each district. This is followed by summing the road density for each seismic zone to get the zone wise road density for each state. Sample calculation procedure for the Road Density Exposure has been depicted for the state of Himachal Pradesh under the Table 3.6. Similar calculations have been performed for the remaining project states.

[5] (National Informatics Centre (NIC), Ministry of Electronics & Information Technology, Government of India)

[6] (Highways, Mi. of R.T. and Basic road statics of India 2015-16. Transp.Highw.Transp. Res. Wing, New Delhi 1-68 (2015))

Table 3.6: Road Density Exposure for Himachal Pradesh

HIMACHAL PRADESH						
			Zone V		Zone IV	
District	Area (km²)	Road Length (National & State Highways) (km)	Area (km²)	Highway Length (km)	Area (km²)	Highway Length (km)
Bilaspur	1,167	86	495	37	672	50
Chamba	6,528	482	3,571	263	2,957	218
Hamirpur	1,118	82	1,118	82	0	0
Kangra	5,739	423	5,337	394	402	30
Kinnaur	6,401	472	5,953	439	448	33
Kullu	5,503	406	3,247	240	2,256	166
Lahaul & Spiti	13,841	1021	747	55	13,094	966
Mandi	3,950	291	3,595	265	356	26
Shimla	5,131	379	5,131	379	0	0
Sirmaur	2,825	208	2,825	208	0	0
Solan	1,936	143	33	2	1,903	140
Una	1,540	114	627	46	913	67
	55,679	4,108	32,678	2,411	23,001	1,697
Avg. Road Density				0.074		0.074
Factored Road Density				0.027		0.018
Weighted Avg. Road Density		0.074				
Road Density Exposure Index		**2.77**				

Following steps are followed to calculate the parameter:

- Sum up the road length under respective zones for all districts to get zone-wise road length for the state.
- Sum up the area under respective zones for all districts to get zone-wise area.
- Calculate average road length per unit area by dividing the total road length in a particular seismic zone by the area of that zone.
- Weighted average road length density is obtained by dividing the sum of factored road length density in all seismic zones by the sum of weights i.e. seismic zone factors given in IS 1893:2016.
- Similar exercise is carried out for remaining 7 project states.
- Finally the Road Density Exposure per unit area is obtained by dividing by the lowest figure amongst all project states.

Once the respective Hazard Score and Exposure Score was obtained for all cases described above, they were used to compute the risk by multiplying the hazard index with the exposure score. These values were directly converted into corresponding percentages to obtain the budget allocation for each state. The summarised table with respective index figures and percentage

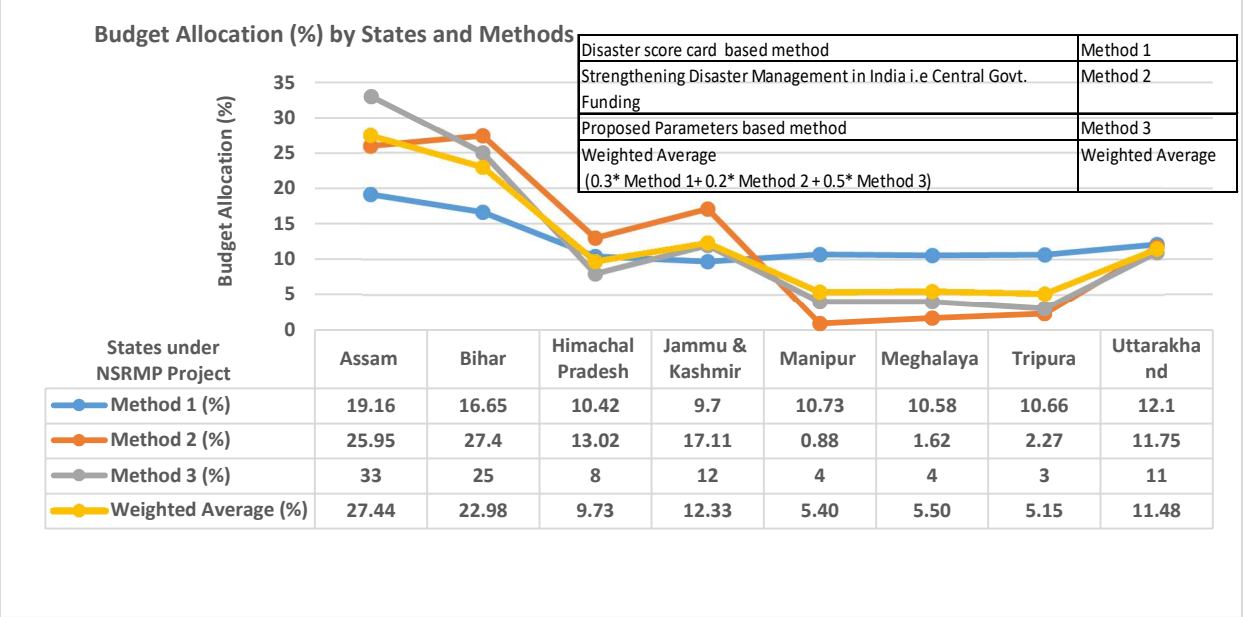
allocation for each state obtained from detailed calculations as per methodology explained above under different heads is shown under Table 3.7 below.

Table 3.7: Percentage Allocation of Budget for Each State

	Hazard Score	Exposure Score				Total Hazard (H)	Total Exposure (E)	Risk (H x E)	Percentage Allocation
State	Hazard Score	Pop. Exposure / Edu. Infra.	Pop. Exposure / Health Infra.	Gross Domestic Product of State	Road Density Exposure				
	(1)	(2)	(3)	(4)	(5)	(6)=(1)	(7)= (2)+(3)+(4)+(5)	(8)	(9)
Assam	7.57	3.29	1.00	10.98	3.00	7.57	18.27	138.35	**33**
Bihar	2.93	7.20	5.04	20.72	3.63	2.93	36.59	107.38	**25**
Himachal Pradesh	2.75	1.70	1.44	5.78	2.77	2.75	11.69	32.12	**8**
Jammu & Kashmir	4.14	2.69	3.21	5.56	1.00	4.14	12.46	51.56	**12**
Manipur	2.13	1.34	2.96	1.00	3.32	2.13	8.62	18.35	**4**
Meghalaya	2.14	1.00	2.92	1.35	3.30	2.14	8.57	18.34	**4**
Tripura	1.00	2.14	2.72	1.64	4.04	1.00	10.54	10.54	**3**
Uttarakhand	2.46	1.98	2.14	8.98	5.08	2.46	18.18	44.69	**11**
									100

3.4.6 SUGGESTED BUDGET ALLOCATION

Based on the RFP and consultant's understanding about the project, the proposed budget allocation has been calculated considering three methods as mentioned above. Based on the project understanding, the weighted average percentage by each state using weights - 30%, 20% and 50% for method 1, method 2 and method 3 respectively are calculated and proposed. However, some other key parameters could have been missed out, which NDMA would like to consider to arrive at the final budget allocation. NDMA may consider these suggested approaches while finalizing the confirmed budget allocation. The comparison has been shown graphically under figure 3.9.



States under NSRMP Project	Assam	Bihar	Himachal Pradesh	Jammu & Kashmir	Manipur	Meghalaya	Tripura	Uttarakhand
Method 1 (%)	19.16	16.65	10.42	9.7	10.73	10.58	10.66	12.1
Method 2 (%)	25.95	27.4	13.02	17.11	0.88	1.62	2.27	11.75
Method 3 (%)	33	25	8	12	4	4	3	11
Weighted Average (%)	27.44	22.98	9.73	12.33	5.40	5.50	5.15	11.48

Figure 3.9: Budget Comparison in Percentage

Percentage budget allocation out of weighted average is further divided to cater to the three sub-components of Component B.

(I.) 10% of the percentage budget allocated to each state is suggested to be utilised for constructing small technology demonstration units of critical infrastructures such as schools, hospitals, etc.

(II.) 10% is proposed to be sanctioned for retrofitting and / or constructing evacuation roads, bridges, landing strips and helipads, and multi-hazard shelters

(III.) 80% of the percentage budget allocation to each state is proposed to utilise for multi-hazard risk mitigation of infrastructure.

Table 3.8 shows the breakup of the budget allocation for each sub-component for each project state.

Table 3.8: Sub-component percentage breakup of allocated budget for project states

	Component B (%)	**(I) = 10% (%)**	**(II) = 10% (%)**	**(III) = 80% (%)**
Assam	27.44	2.744	2.744	21.952
Bihar	22.98	2.298	2.298	18.384
Himachal Pradesh	9.73	0.973	0.973	7.784
Jammu & Kashmir	12.33	1.233	1.233	9.864
Manipur	5.40	0.54	0.54	4.32
Meghalaya	5.50	0.55	0.55	4.4
Tripura	5.15	0.515	0.515	4.12
Uttarakhand	11.48	1.148	1.148	9.184

This programme has been envisaged as a pilot study to be implemented in the project states which shall be extended to other states in second phase. Limited funds corresponding to (III) – 80% of the total percentage budget allocation are available for retrofitting of critical buildings. Though each state is most likely to have many vulnerable buildings however only a few buildings can be taken up in this pilot study. Hence, a judicious decision has to be made to incorporate various types of structures within this budget. The following section i.e., Infrastructure selection is explained with rationale and parameters for considering for finalising the list of buildings for retrofitting.

3.5 INFRASTRUCTURE SELECTION & PRIORITISATION PARAMETERS

Followed by budget allocation, infrastructure selection shall be taken up for purpose of seismic retrofitting using the allocated budget. Varying rationale is applicable for different infrastructure. For buildings, rationale is different as compared to bridges and other facilities.
In general list of buildings and other structure has to be finalized by the State Government based on their use, their strategic importance and consequences of the failure of infrastructure.

3.5.1. SELECTION & PRIORITISATION OF BUILDINGS

NDMA has in the past published many documents for building selection and their categorisation. Three such NDMA published documents are reviewed and compared for an insight into understanding some parameters for building identification and selection for seismic retrofitting. The three documents considered have been mentioned below whereas comparison has been tabulated and shown below in Table 3.9 below.

(i) “Seismic Retrofitting of Deficient Buildings and Structures” by NDMA, June-2014. This document has been prepared to share the importance for carrying out the structural safety audit of existing lifeline structures and other critical structures in earthquake-prone areas followed by carrying out selective seismic strengthening and retrofitting of the vulnerable structures.
(ii) “On Ensuring Disaster Resilient Construction of Buildings and Infrastructure financed through Banks and Other Lending Institution” by NDMA, September-2010. This document has been prepared specifically in view to help banks and other lending institutions to know prior to lending whether the structure is safe or vulnerable as one of the prerequisites before sanctioning of the loan to secure their assets.
(iii) “Management of Earthquakes” by NDMA, April-2007. Through this document, NDMA has tried to create awareness by studying the current state of the country to assess the risk due to seismic events. They have further suggested priority listing of important structures that need to be checked for their respective vulnerabilities and based on the existing vulnerabilities, designing of seismic retrofitting / intervention that is required for each structure adopting suitable methods has been emphasized.

Table 3.9: Critical Review of Criteria of selection of buildings/ infrastructure for Seismic Retrofitting in India

Management of Earthquakes (April'2007)	On Ensuring Disaster Resilient Construction of Buildings & Infrastructure financed through Banks & Other Lending Institutions (Sept'2010)	Seismic Retrofitting of Deficient Buildings & Structures (June'2014)
• Buildings of national importance like Rashtrapati Bhavan, Parliament House, the Supreme Court of India, Raj Bhavans, Legislatures, High Courts, Central and State Secretariats, historical monuments, museums, heritage buildings, strategic assets and vital installations such as power plants, and water works. • Lifeline buildings, structures and critical facilities like schools, colleges and academic institutions; hospitals and health facilities, tertiary care Centres and all hospitals designated as major hospitals. • Public utility structures like reservoirs and dams; bridges and flyovers; ports and harbours; airports, railway stations and bus station complexes. • Important buildings that ensure governance and business continuity like offices of the district collector and superintendent of police in districts; buildings of financial institutions like the Reserve Bank of India and the stock exchanges. • Multi-storeyed buildings with five or more floors in residential apartments,	• Buildings can be sub-divided into different groups based on *function of use*, *material of construction* and *total height above ground*. • Based on the function of use, three further sub-groups can be identified, namely *Residential*, *Non-Residential* and *Critical Lifeline* Buildings. • Based on material of construction, four sub-groups can be identified, namely *Reinforced Concrete (RC)*, *Steel*, *Masonry* and *Other Materials*. • Based on total height of the building above ground level, three sub-groups are identified, namely less than 15m tall, between 15m and 45m tall, and taller than 45m. Most masonry buildings in India are less than 15m tall. • *Non-buildings* include all other structures including industrial structures, civic amenities, and infrastructure projects.	• High grade *critical lifeline buildings* that serve as nerve centres to host public congregations or large number of persons, and as important functions and services required in the aftermath of earthquakes towards ensuring *governance and business continuity*. Some examples of this set of structures are: District Magistrate's office and residence, office of Superintendent of Police, fire stations, food stocking and distribution centres, shopping centres, banks (including *Reserve Bank of India* and headquarters of all banks), telecommunication facilities (including all buildings that host telecommunication towers at the top), commercial centres, and sport stadia/arenas. • Lifeline structures and critical facilities, namely telecommunication systems, transportation systems including highway systems (e.g., Golden Quadrilateral System, and North-South and East-West Corridors) airport control towers and railway station buildings, fire services, and pipelines carrying water, oil and gas from large distances (both buried and surface pipes)

Management of Earthquakes (April'2007)	On Ensuring Disaster Resilient Construction of Buildings & Infrastructure financed through Banks & Other Lending Institutions (Sept'2010)	Seismic Retrofitting of Deficient Buildings & Structures (June'2014)
office and commercial complexes.		along with LPG distribution networks for consumers. • Buildings and structures of hospitals and health facilities, designated as critical medical facilities by the city / district / block National defence and security-related most critical facilities, strategic assets and choke points. • National, prestigious and historic buildings and monuments • Important buildings of government that ensure governance continuity in the aftermath of earthquakes, including offices of NDMA, State DMAs, District DMAs, and EOCs • Buildings and structures of schools and academic institutes/universities, including those designated to be used for post-earthquake temporary rehabilitation of affected persons and operations • Panchayat Office and Post Office buildings in villages • Critical industries that have bearing in the post-earthquake management activities

As can be seen from above table, building selection criteria is classified under various heads such as buildings of national importance, lifeline buildings, public utility structures, important buildings, and multi-storied buildings as per document "Management of Earthquakes" whereas as per document titled "On Ensuring Disaster Resilient Construction of Buildings and Infrastructure financed through Banks and Other Lending Institutions" the building selection is based on functional use, material of construction and total height above ground of the building. The three

parameters have been further sub-divided. Under functional use, categorization of buildings has been done based on residential building, non-residential building and critical lifeline buildings. Similarly, under material of construction, categorization has been made into four sub-heads i.e., reinforced concrete (RC), steel, masonry and other materials while the third parameter has been sub-divided into three groups' i.e., buildings less than 15m tall, between 15m and 45m tall, and taller than 45m. In the third document titled "Seismic Retrofitting of Deficient Buildings and Structures" the buildings have been prioritized based on critical lifeline buildings, lifeline and critical facilities, buildings and structures of hospital and health facilities, national, prestigious and historic buildings and monuments, important government buildings, education related buildings, village buildings and lastly critical infrastructure that is important from the point of view of post-earthquake activities.

Based on categorization parameters specified in above documents, a table has been prepared wherein parameters for selection and number and type of building to be considered with their logical reasoning has been proposed for helping the state governments to identify buildings owned and operated by them that require seismic retrofitting. Table 3.10 depicts the sample list of buildings to be identified for the above purpose.

Table 3.10: Identification and Selection of Critical Buildings

S.No.	Building Typology	Numbers	Rationale for selection
1.	General Hospitals such as District Hospitals - •Required immediately after a seismic hazard, •24 hrs. Working hours and hence more critical as compared to other types of buildings.	7	a. Larger serving population districts should be given preference, b. Old & very old buildings should be given less preference, as they would have less residual service life and require more cost to upgrade to desired performance level, c. Buildings being affected due to its location i.e., a building located on weak soil or in liquefaction potential area should be avoided as compared to a building on firm soil, d. Economically and Strategically important buildings for State Government should be given higher preference.
2.	State Emergency Operation Centres (SEOC) / Fire Station / Disaster Management Offices / State Disaster Response Centres / etc. •Required for controlling after-effects of seismic activity.	5	
3.	District Magistrate Office & Residence / Important Admin Buildings such as Police Stations / etc. •Required for effective management and communication after seismic activity. •Will be operational 24 hrs. in case of emergency service after earthquake.	5	
4.	Education Facilities – Schools / Colleges / Universities / etc. •Can be used as multi-hazard shelters after a seismic hazard, • Last on list as working hours is generally 8 hours and hence less critical as compared to other types of buildings.	5	
5.	Other Important Critical Buildings as deemed fit by State Authorities	3	
	Total Buildings	25	

Note:
(i.) For states where seismic zone IV and V exist, buildings should be spread across districts in both seismic zones.
(ii.) Most popular typologies of buildings should be considered in this pilot programme for referring in future.

3.5.2. SELECTION & PRIORITISATION OF EVACUATION ROUTES AND PLANS

Similarly, for selecting and prioritising of infrastructure under evacuation of routes and plans such as bridges, landing strips & helipads and multi-hazard shelters, etc., few parameters have been discussed for consideration which are mentioned below:

3.5.2.1. SELECTION & PRIORITISATION OF BRIDGES

For bridges following parameters may be used for selection:

(a.) Critical Linkage with settlements For Emergency Response and Evacuation – if the bridges are linking major urban / rural settlements, which are crucial for emergency response resource supplies and evaluation, may be considered as priority facilities for further assessment.

(b.) Span: Large span bridges are more susceptible to local and/or global failures and they require more time and cost for reconstructing as compared to smaller span bridges.

(c.) Age: bridges are designed for a service life and for a designed load. Bridges falling on important evacuation routes should be identified which have service life more than 75% can be selected and retrofitted.

(d.) Type: Bridges based on the type of road i.e., National / State / District / Village as per importance can be prioritised for retrofitting.

3.5.2.2. SELECTION & PRIORITISATION OF LANDING STRIPS & HELIPADS

For Landing Strips and Helipads, the parameters are suggested as below:

(a.) Government Priority: Based on state government key disaster management criterion, the sites could be selected.

(b.) Economic & Strategical Location: Economic and strategic factors identified by the state could be considered for the site identification.

(c.) Disaster Response Criteria: As per the disaster response plan of the state, the helipads and landing strips that cater to maximum vulnerable population in can be selected

The above parameters are suggestions with rationale for selecting and prioritising the infrastructure for assessment and retrofitting. However, the states may consider other criterion which may not be stated but still are important from their disaster management point of view. However, under this project only Government owned and operated public government buildings and infrastructure are considered though in times of disaster, private public infrastructure such as cinema halls and marriage Centres can also play an important role in acting as multi-hazard shelters post a disaster. Hence, priority in this phase is limited to government owned and operated

public buildings only, but it should be extended in future phases to private owned public buildings also.

3.5.2.3. SMALL DEMONSTRATION UNITS

State may provide a list of places along with identified land where small earthquake resistant building has to be built for showcasing the technology.

Referring to the Section 3.5 parameters, the list of proposed critical buildings and infrastructure are identified and compiled in Table 3.12.

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Table 3.11 - Proposed List of Buildings and Infrastructure by Project States and Districts

State	District	EQ Zone V (%) Zone Area/ Tot Area	EQ Zone IV (%) Zone Area/ Tot Area	EQ Zone III (%) Zone Area/ Tot Area	Population Density Zone V @ 2011 PPSQKM	Population Density Zone IV @ 2011 PPSQKM	Population Density Zone III @ 2011 PPSQKM	Health Facility	Education Facility	DM Office & residence	Disatser Management Authority facility	Fire Station	Power Stations	Police Station	State Disaster Response Force Facilities	Bridges	Helipads	Others	Total Number of faciltiies
Assam	Dhubri	2.74	0.00	0.00	896	0	0	1	1					1					**3**
Assam	Kamrup Metropolitan*	1.92	0.00	0.00	821	0	0	1	1	1	1	1		1	1	1	1		**9**
Assam	Barpeta	2.87	0.00	0.00	742	0	0	1	1					1					**3**
Assam	Nalbari	1.32	0.00	0.00	733	0	0	1	1					1					**3**
Assam	Nagaon	5.00	0.00	0.00	711	0	0	1	1					1					**3**
Assam	Karimganj	2.28	0.00	0.00	679	0	0												**0**
Assam	Morigaon	1.92	0.00	0.00	628	0	0												**0**
Assam	Darrang	2.00	0.00	0.00	586	0	0												**0**
Assam	Goalpara	2.30	0.00	0.00	553	0	0												**0**
Assam	Hailakandi	1.67	0.00	0.00	497	0	0												**0**
Assam	Kamrup	3.91	0.00	0.00	489	0	0												**0**
Assam	Bongaigaon	1.91	0.00	0.00	486	0	0												**0**
Assam	Cachar	4.77	0.00	0.00	459	0	0												**0**
Assam	Udalguri	2.53	0.00	0.00	413	0	0												**0**
Assam	Sivasagar	3.36	0.00	0.00	394	0	0												**0**
Assam	Baksa	3.09	0.00	0.00	387	0	0												**0**
Assam	Jorhat	3.59	0.00	0.00	383	0	0												**0**
Assam	Sonitpur	6.55	0.00	0.00	370	0	0	1		1				1					**3**
Assam	Tinsukia	4.77	0.00	0.00	350	0	0												**0**
Assam	Golaghat	4.41	0.00	0.00	305	0	0												**0**
Assam	Kokrajhar	4.15	0.00	0.00	269	0	0												**0**
Assam	Chirang	2.42	0.00	0.00	251	0	0												**0**
Assam	Dhemaji	4.08	0.00	0.00	212	0	0												**0**
Assam	Karbi Anglong	13.14	0.00	0.00	93	0	0	1		1				1		1			**4**
Assam	Lakhimpur	2.87	0.00	0.00	67	0	0												**0**
Assam	Dima Hasao	6.16	0.00	0.00	44	0	0	1		1									**2**
Assam	Dibrugarh	4.26	0.00	0.00	41	0	0												**0**
																			30
Bihar	West Champaran	0.00	5.52	0.00	0	753	0												**0**
Bihar	East Champaran	0.00	4.19	0.00	0	1285	0												**0**
Bihar	Katihar	0.00	3.22	0.00	897	897	0	1	1										**2**
Bihar	Muzaffarpur	0.20	3.15	0.00	1514	1514	0	1	1										**2**
Bihar	Samastipur	0.00	3.06	0.00	0	1467	0												**0**
Bihar	Purnia	0.37	3.03	0.00	1011	1011	0	1	1										**2**
Bihar	Patna	0.00	2.92	0.46	0	1823	1823	1	1	1	1	1	1	1	1	1	1	1	**11**
Bihar	Saran	0.00	2.79	0.00	1880	1880	0	1	1										**2**
Bihar	Bhagalpur	0.00	2.71	0.00	0	1182	0												**0**
Bihar	Banka	0.00	2.61	0.57	0	674	674												**0**
Bihar	Jamui	0.00	2.42	0.85	0	568	568												**0**
Bihar	Siwan	0.00	2.15	0.00	919	0	0	1	1										**2**
Bihar	Vaishali	0.00	2.15	0.00	0	1717	0												**0**
Bihar	Gopalganj	0.00	2.14	0.00	0	1260	0												**0**
Bihar	Nalanda	0.00	2.11	0.37	0	1222	1222												**0**
Bihar	Begusarai	0.00	2.02	0.00	0	1549	0												**0**
Bihar	Kishanganj	0.29	1.70	0.00	0	1005	0												**0**
Bihar	Khagaria	0.00	1.57	0.00	0	0	488												**0**
Bihar	Munger	0.00	1.50	0.00	1120	1120	0	1	1										**2**
Bihar	Lakhisarai	0.00	1.30	0.00	0	815	0												**0**
Bihar	Saharsa	0.70	1.10	0.00	1127	1127	0	1	1										**2**
Bihar	Darbhanga	1.42	0.99	0.00	1728	1728	0	1	1										**2**
Bihar	Nawada	0.00	0.97	1.66	0	890	890												**0**
Bihar	Madhepura	1.11	0.78	0.00	1282	0	0	1	1										**2**
Bihar	Sheikhpura	0.00	0.73	0.00	0	924	0												**0**
Bihar	Sheohar	0.05	0.42	0.00	0	1496	0												**0**
Bihar	Bhojpur	0.00	0.39	2.22	0	1139	1139												**0**
Bihar	Araria	2.60	0.39	0.00	993	993	0	1	1										**2**
Bihar	Jehanabad	0.00	0.33	1.33	0	1209	1209												**0**
Bihar	Sitamarhi	2.06	0.26	0.00	1556	1556	0	1	1										**2**
Bihar	Arwal	0.00	0.00	0.67	0	0	1099												**0**
Bihar	Aurangabad	0.00	0.00	3.48	0	0	769												**0**
Bihar	Buxar	0.00	0.00	1.71	0	0	1002												**0**
Bihar	Gaya	0.00	0.00	5.25	0	0	883												**0**
Bihar	Kaimur	0.00	0.00	3.55	0	1122	0												**0**
Bihar	Madhubani	3.69	0.00	0.00	0	964	0												**0**
Bihar	Rohtas	0.00	0.00	4.06	0	0	763												**0**
Bihar	Supaul	2.54	0.00	0.00	0	1501	1501												**0**
Grand Total																			**33**
Himachal Pradesh	Hamirpur	2.01	0.00	0.00	407	0	0	1	1										**2**
Himachal Pradesh	Una	1.13	1.64	0.00	338	338	0												**0**
Himachal Pradesh	Bilaspur	0.89	1.21	0.00	327	327	0												**0**
Himachal Pradesh	Solan	0.06	3.42	0.00	300	300	0												**0**
Himachal Pradesh	Kangra	9.59	0.72	0.00	263	263	0	1	1										**2**
Himachal Pradesh	Mandi	6.46	0.64	0.00	253	253	0												**0**
Himachal Pradesh	Sirmaur	5.07	0.00	0.00	188	0	0												**0**
Himachal Pradesh	Shimla	9.22	0.00	0.00	159	0	0	1	1	1	1	1	1	1	1	1	1		**10**
Himachal Pradesh	Kullu	5.83	4.05	0.00	80	80	0												**0**
Himachal Pradesh	Chamba	6.41	5.31	0.00	80	80	0												**0**
Himachal Pradesh	Kinnaur	10.69	0.80	0.00	13	13	0												**0**
Himachal Pradesh	Lahaul and Spiti	1.34	23.51	0.00	2	2	0												**0**
																			14
Jammu and Kashmir	Kathua	0.43	2.12	0.00	1137	1137	0	1	1										**2**
Jammu and Kashmir	Anantnag	0.16	3.67	0.00	1051	1051	0	1	1										**2**

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State	District	EQ Zone V (%) Zone Area/ Tot Area	EQ Zone IV (%) Zone Area/ Tot Area	EQ Zone III (%) Zone Area/ Tot Area	Population Density Zone V @ 2011 PPSQKM	Population Density Zone IV @ 2011 PPSQKM	Population Density Zone III @ 2011 PPSQKM	Health Facility	Education Facility	DM Office & residence	Disatser Management Authority facility	Fire Station	Power Stations	Police Station	State Disaster Response Force Facilities	Bridges	Helipads	Others	Total Number of faciltiies
Jammu and Kashmir	Srinagar	0.28	0.00	0.00	866	866	0	1	1										**2**
Jammu and Kashmir	Kargil	0.00	13.48	0.00	625	0	0												**0**
Jammu and Kashmir	Jammu	0.00	2.98	0.00	550	550	0	1	1	1	1	1	1	1	1	1	1	1	**11**
Jammu and Kashmir	Ganderbal	0.18	0.07	0.00	401	401	0												**0**
Jammu and Kashmir	Bandipora	0.19	0.19	0.00	366	366	0												**0**
Jammu and Kashmir	Doda	0.00	2.22	0.00	302	302	0												**0**
Jammu and Kashmir	Budgam	0.76	0.55	0.00	285	285	0												**0**
Jammu and Kashmir	Rajouri	0.00	2.53	0.00	285	285	0												**0**
Jammu and Kashmir	Samba	0.00	0.87	0.00	246	246	0												**0**
Jammu and Kashmir	Kishtwar	0.00	7.43	0.00	238	238	0												**0**
Jammu and Kashmir	Poonch	0.00	1.61	0.00	0	46	0												**0**
Jammu and Kashmir	Ramban	0.00	1.28	0.00	0	653	0												**0**
Jammu and Kashmir	Reasi	0.00	1.65	0.00	0	10	0												**0**
Jammu and Kashmir	Udhampur	0.00	4.37	0.00	0	140	0												**0**
Jammu and Kashmir	Baramulla	3.31	1.10	0.00	0	3	0												**0**
Jammu and Kashmir	Kulgam	0.00	1.02	0.00	0	244	0												**0**
Jammu and Kashmir	Kupwara	1.93	0.36	0.00	0	211	0												**0**
Jammu and Kashmir	Pulwama	1.11	0.24	0.00	0	183	0												**0**
Jammu and Kashmir	Shopian	0.00	0.59	0.00	0	353	0												**0**
Jammu and Kashmir	Leh	0.00	43.34	0.00	0	210	0												**0**
																			17
Manipur	Imphal West	2.32	0.00	0.00	998	0	0	1	1	1	1	1	1	1	1	1	1	1	**11**
Manipur	Thoubal	2.30	0.00	0.00	821	0	0												**0**
Manipur	Imphal East	3.18	0.00	0.00	643	0	0												**0**
Manipur	Bishnupur	2.22	0.00	0.00	479	0	0												**0**
Manipur	Senapati	14.65	0.00	0.00	146	0	0												**0**
Manipur	Churachanpur	20.47	0.00	0.00	60	0	0												**0**
Manipur	Chandel	14.84	0.00	0.00	44	0	0												**0**
Manipur	Ukhrul	20.35	0.00	0.00	40	0	0												**0**
Manipur	Tamenglong	19.67	0.00	0.00	32	0	0												**0**
																			11
Meghalaya	East Khasi Hills	12.25	0.00	0.00	301	0	0	1	1	1	1	1	1	1	1	1	1	1	**11**
Meghalaya	West Garo Hills	16.39	0.00	0.00	175	0	0												**0**
Meghalaya	East Garo Hills	11.61	0.00	0.00	122	0	0												**0**
Meghalaya	Ribhoi	10.91	0.00	0.00	106	0	0												**0**
Meghalaya	Jaintia Hills	17.03	0.00	0.00	103	0	0												**0**
Meghalaya	South Garo Hills	8.41	0.00	0.00	75	0	0												**0**
Meghalaya	West Khasi Hills	23.39	0.00	0.00	73	0	0												**0**
																			11
Tripura	West Tripura	28.54	0.00	0.00	577	0	0	1	1	1	1	1	1	1	1	1	1	1	**11**
Tripura	North Tripura	19.42	0.00	0.00	341	0	0												**0**
Tripura	South Tripura	29.15	0.00	0.00	287	0	0												**0**
Tripura	Dhalai	22.89	0.00	0.00	158	0	0												**0**
																			11
Uttarakhand	Almora	1.46	4.26	0.00	198	198	0	1	1										**2**
Uttarakhand	Tehri Garhwal	0.23	7.34	0.00	170	170	0	1	1										**2**
Uttarakhand	Pauri District	0.60	9.42	0.00	129	129	0												**0**
Uttarakhand	Rudraprayag	2.98	0.53	0.00	122	122	0												**0**
Uttarakhand	Bageshwar	4.27	0.00	0.00	116	0	0												**0**
Uttarakhand	Pithoragarh	12.57	0.61	0.00	68	68	0												**0**
Uttarakhand	Chamoli	14.90	0.00	0.00	49	0	0												**0**
Uttarakhand	Uttarkashi	2.14	12.73	0.00	41	41	0												**0**
Uttarakhand	Champawat	0.00	3.30	0.00	0	147	0												**0**
Uttarakhand	Dehradun	0.00	5.73	0.00	0	549	0	1	1	1	1	1	1	1	1	1	1	1	**11**
Uttarakhand	Haridwar	0.00	4.38	0.00	0	801	0												**0**
Uttarakhand	Nainital	0.00	7.16	0.00	0	225	0												**0**
Uttarakhand	Udham Singh Nagar	0.00	5.40	0.00	0	649	0												**0**
																			15

04 METHODOLOGY

Chapter 4 discusses the project components' methodology. Each component methodology is supplemented with details of proposed technical processes, data collection proformas and expected outcomes. Further, the chapter discusses organization setup and working approach for project implementation. The concept is supported with flowcharts and explanation.

CHAPTER 4

METHODOLOGY

4.1 GENERAL

NDMA intends to design a National Seismic Risk Mitigation Programme (NSRMP) for 8 States i.e., Assam, Bihar, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Tripura and Uttarakhand.

4.2 COMPONENTS IN BRIEF

The project is divided into different components. Each component has been mentioned and briefly described below:

- Component A-1: Earthquake Early Warning Dissemination System.
- Component A-2: Enhancing Emergency Response Capacity.
- Component B: Multi-hazard Risk Mitigation Infrastructure.
- Component C: Technical Assistance to Improve Disaster Risk Management.
- Component D: Project Management & Monitoring.

4.2.1. COMPONENT A

4.2.1.1. COMPONENT A-1: EARTHQUAKE EARLY WARNING DISSEMINATION SYSTEM

Design / Development of an Earthquake Early Warning Dissemination System (EEWDS), involves the following:

- Recommend Technology Option consisting of detailed design for early detection of earthquake, alert creation and dissemination to the community to reduce loss of life and property.
- Provide detailed design and operational framework of EWS for 8 states.
- Design / Suggest intervention with already existing national network of EEWDS, if any, taking account of compatibility issues, wherever possible.

4.2.1.2. COMPONENT A-2: ENHANCING EMERGENCY RESPONSE CAPACITY

For Enhancing Emergency Response Capacity of States following is required:

- Relevant/available data about search and rescue equipment will be collected from State Disaster Response Force (SDRF), Fire and Emergency Services and other emergency / first responders. For this purpose, the Consultant will co-ordinate with the concerned State Government Agency/ Department for obtaining data in the required format. NDMA will be facilitating procurement of data from Govt. sources.
- The existing search and rescue equipment will be reviewed and latest upgraded list of Search & Rescue equipment taking into account the existing inventory will be prepared.

- Refer Annexure A at the end of the report for detailed process and methodology.
- Further, a manual for training and capacity building will be prepared to impart training to emergency / first responders with regards to EEWDS.
- Further literature in form of pamphlets and videos shall be prepared to augment the disaster risk management capacities of the communities pertaining to the EEWDS.

4.2.2. COMPONENT B - MULTI HAZARD RISK MITIGATION OF INFRASTRUCTURE

This component will concentrate on reducing the structural risk of critical infrastructure and public buildings to protect communities, assets and emergency response capabilities. The risk mitigation infrastructure under this programme will be Seismic specific; however, such infrastructure must be resistant to multi hazards prevailing in the regional and local levels which are prevalent in the State.
Retrofitting of selected critical infrastructure is to be carried out as following:

- Lifeline buildings, structures and critical facilities like schools, colleges and academic institutions; hospitals and health facilities, tertiary care centres, community centres.
- Important buildings that ensure governance and business continuity like offices of the district collector and superintendent of police in districts; Fire stations, communication buildings, Panchayat Office and Post Office buildings structures designated to be used for post, earthquake temporary rehabilitation of affected persons and operations.
- Buildings of national importance like Secretariats, historical monuments, museums, heritage buildings, strategic assets and vital installations.
- Any other structures as deemed fit to be worked as lifeline by State Government such as critical links- bridges.

First step in this would involve the Consultant to assist SPIU and other concerned State Departments and help them to identify the critical infrastructure. SPIU/State Govt. will be providing relevant available data as available to the Consultant. Other required drawings, data, maps, design reports etc. will be prepared by the Consultant. While preparing DPR for identified work corresponding to 50% of funds allocated to State, the Consultant may consult relevant Line Departments of State Govt. through SPIU.

The scope of retrofitting would include Structural Design Based Report (SDBR) after detailed survey, conditional assessment and Non-destructive testing along with detailed analysis. The performance level of the retrofitted structures is to be ensured based on the utilization/ importance factor of the structures and needs of the concerned State Governments. Retrofitting should adhere to the National Building Codes/BIS/NDMA Guidelines and consistent with the international best practices. Wherever applicable, International Codes may be adopted for design and construction.

It may also involve retrofitting and/or constructing important links like: bridges, landing strips and helipads and multi-hazard shelters on evacuation routes.

The work in Component B also involves construction of Technology Demonstration Units (TDU) of critical infrastructure such as schools, hospitals, etc. TDU will be identified by the state. The size and location of TDUs will be decided in consultation with state authorities. Consultant will develop design (new/retrofit) and construction drawings, prepare DPR and Bid Documents for these investments.

Refer Annexure B at the end of the report for detailed process and methodology.

4.2.3. COMPONENT C – IMPROVE DISASTER RISK REDUCTION WITH EMPHASIS ON EARTHQUAKE RISK

This component will deal specifically to improve the capacity of states to manage the risks associated with their risk profile. The associated work of this component consists of the following:

- Existing material/draft bill for National Council of Professional Engineers is to be critically reviewed and suggestions are to be made to improve the structure and content of bill from the perspective of seismic risk mitigation/ disaster risk reduction.
- Various activities listed in TOR like strengthening of seismic research and development programme, setting up a centre of excellence, curriculum revision, formulation and implementation of techno-legal regime, improving and encouraging traditional earthquake resistant construction will lead to enhancement in capacity.
- The work involves mapping and assessment of these activities at National and State level. The Objective is to identify key challenges, gaps, roles and responsibilities of key institutions, entry points for implementation. This will lead to needed activities their scope and implementation plans with appropriate strategy. Outcome will be relevant TOR, Procurement Documents, and Work Plans etc.
- Development of standardized information, education and communication (IEC) material where not available including audio visuals and print materials from existing materials or new material is to be developed for awareness/sensitization programmes of communities.
- Mapping and Critical review of existing training modules for engineers/architects/ masons/State & Municipal bodies and prepare TOR for consulting services for formation of new/modified training modules along with implementation plans etc.
- Refer Annexure C at the end of the report for detailed process and methodology.

4.2.4. COMPONENT D – PROJECT MANAGEMENT, MONITORING AND IMPLEMENTATION SUPPORT

The last component of the project deals with the program implementation, monitoring and evaluation, staff capacity building and training, including preparation of training materials and manuals, project manuals, documentation, quality monitoring, project management support (including environmental and social monitoring) to the participating states and the PMU, NDMA. This component integrates all three components discussed and enables PMU, NDMA and SPIUs to use as instrument to monitor and manage the project and sub projects of this designed NSRP.

The topics covered under this head will involve Procurement Management, Financial Management, Environment & Social Management followed by developing a Management Information System.

Procurement Management will be carried out by developing Procurement Manual in line with the Procurement Regulations 2016 of World Bank including Project Procurement Strategy for Development (PPSD) as per World Bank Guidelines. Training and support to implement the procurement functions at national and state level shall be imparted. Technical / capacity building assistance for implementing the project will be given to the Project Implementing Units (PIU) to finalise the procurement documents.

Financial Management includes designing financial management system and flow of funds. Consultant will frame detail monitoring and reporting mechanism and auditing requirements. The Financial management System will be integrated with the MIS of the entire project. An overall investment plan shall be prepared by developing a financial management manual and providing training and support to implementing units of Financial Management functions.

Environment & Social Management framework shall be prepared and Environment & Social Assessment (ESA) for sub-projects identified for investment under the proposed project made will be conducted. Environment & Social Plans shall be made for these sub-projects after consulting the participation of key stakeholders in formulation of plans and designs, including systematic documentation of the same. Further key / summary documents shall be translated into the local vernacular and communication and dissemination system strategy devised. Training material shall be prepared and imparted to Project Implementation Unit (PMU), NDMA and State Project Implementation Units (SPIUs) of each state including concerned line departments on application and implementation of environment and social management instruments. Training on each manual in each state for 02 days and 01 day at PMU, NDMA shall be done. The same shall be integrated appropriately in the Procurement Plan and operations manual.

Management Information System (MIS) shall be incorporated by designing internet based MIS system / software and mobile application based on an open source platform for the project after duly consulting with experts (Procurement Specialist, Financial Management Specialist, Project Management Specialist, Monitoring and Evaluation Specialist, Safeguards Specialist, etc.). Consultant will propose specification and configurations of the hardware that will be required for the efficient functioning of the MIS software. Training modules and imparting training on each manual for 02 days to Officials of all SPIUs in each state and for 01 day to officials of PMU, NDMA shall be conducted by the Consultant. Technical specifications and procurement documents for MIS hardware / software shall be prepared and submitted.

Refer Annexure D at the end of the report for detailed process and methodology.

4.3 ORGANIZATIONAL SETUP FOR DESIGNING NATIONAL SEISMIC RISK MITIGATION PROGRAMME

NDMA is the nodal agency, who will manage the implementation and monitoring of the programme. PMU under NDMA has been created which will oversee the design of NSRMP and later implementation of the project. State Level Project Implementation Unit will implement the project in respective states after NSRMP is designed.

The performance and quality of design of NSRPM work will be reviewed by a Review Committee set by PMU, NDMA including representatives from participating states. The organizational setup for providing consultancy services for designing NSRMP is shown in figure 4.1.

The consultant will interact at both the levels i.e., at the Central as well as the state level for designing NSRMP. The Consultant will also support the PMU, NDMA in preparing and appraising the Projects and will assist the state representatives in formulating the investment program and preparing implementation ready proposals / projects with full detailing including social and environmental assessments.

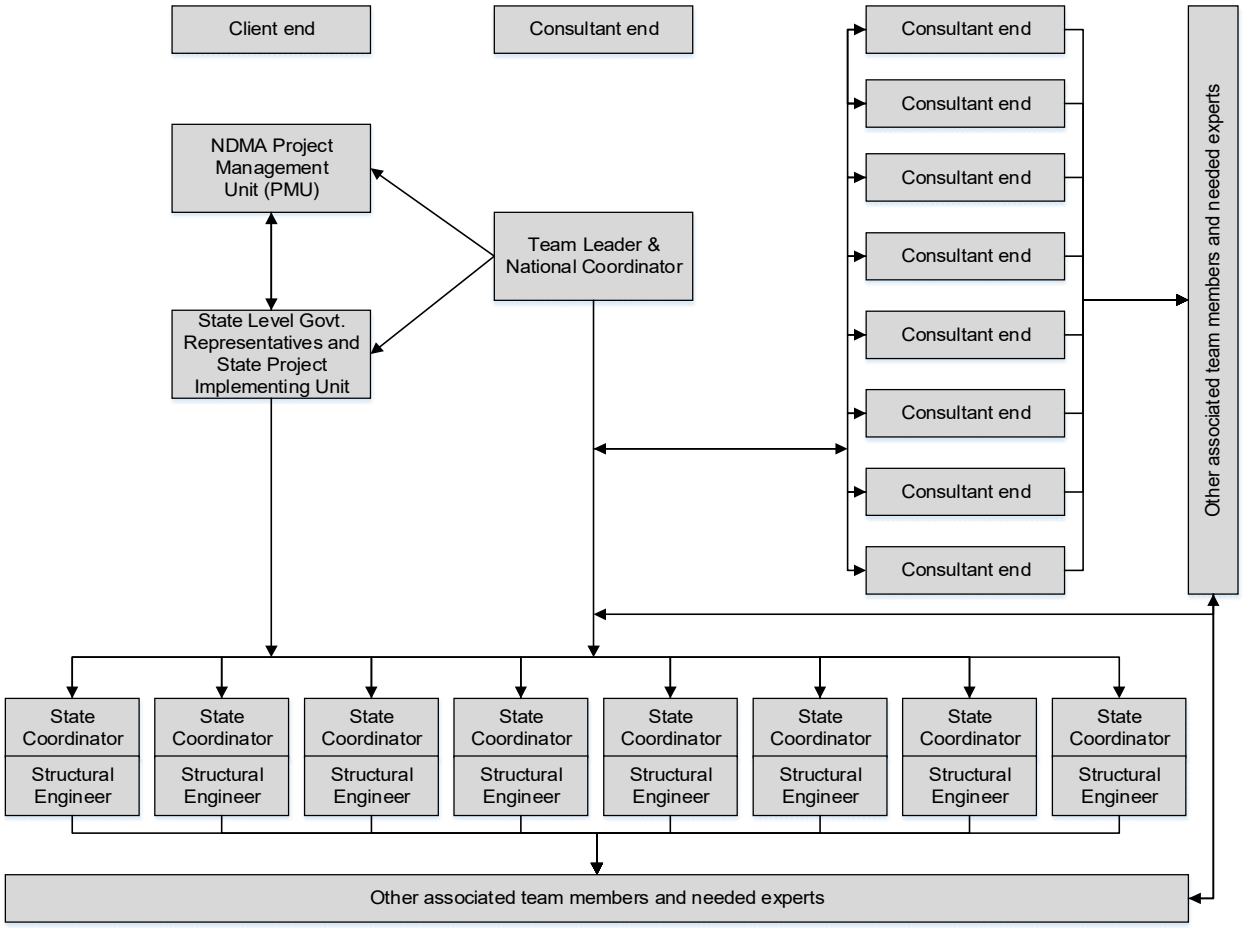


Figure 4.1: Organizational Setup Methodology Diagram

4.4 WORKING METHODOLOGY FOR DESIGNING NSRMP

The overall methodology of the project includes various deliverables which are at both National and the state level. These deliverables comprises of the Component A, B and C. The consultancy will be initiated with an introductory meeting where all the stakeholders will be identified and will be briefed about project in detail. This will enhance participation of stakeholders in designing and implementation of NSRMP. The details of overall methodology is explained in the following table with various steps to arrive at various deliverables like – Inception Report, Initial project scoping report, project investment plan, Draft ESMF, DPRs, Draft EIASs, Draft Environmental and Social Commitment Plan Document, Project appraisal document, Web Based Project MIS, Project Operation Manual.

Following Table 4.1 lists the process and its outcome in form of deliverable required as part of the RFP.

Table 4.1: Process & Outcome of Project

Step	Process	Deliverable
1	Start and Mobilization of Team	
2	Introductory Meeting • Identification of the stakeholders • Stakeholders understanding about the work to be done. • Views of stakeholders about the project and identification of the local stakeholders or custodians of data. • Primary discussion with the officials	
3	Preparation Phase • Understanding of the objectives. • Finalization of the methodology. • Finalisation of Work plan. • Methodology for taking approvals at various stages. • Review of existing available documents on seismic risk mitigation (BIS Codes, NDMA guidelines, vulnerability Atlas, State Disaster Management Plan, World Bank Guidelines, Local building Bye Laws, Disaster Act and Regulations followed by the respective states). • Present risk profile of each state. • Strategy for budget allocation. • Strategy for verification of infrastructure.	Inception Report
4	Initial Project Scoping Report • Stakeholders meeting at Central as well as the state level. • Elaboration of scope of work according to the four components such as: • Component A- • A-1:Earthquake Early Warning Dissemination System & • A-2:Enhancing Emergency Response Capacity • Component B- Multi-Hazard Risk Mitigation of Infrastructure • Component C- Technical Assistance to Improve Disaster Risk Management. • Component D- Project Management, Monitoring and Implementation Support. • Identification of critical buildings to be retrofitted. • Identification of critical infrastructure to be retrofitted. • Proposal for new small technology demonstration units to be constructed. • Assessment and review of the existing status of various components. • Discussion of scope of work at state level and finalization and approval at the Central level. • Conduct meeting with respective State Govt. to identify site for constructing demonstration units. Also discuss size and other relevant requirements of the small technology demonstration units.	Detailed Scope of Work • At Central Level • At State Level (Workshops and Discussion with various stakeholders) State Wise Preliminary Cost Estimation with Agreed Project Scope along with the Sub Projects.

Step	Process	Deliverable
	• Conduct formal consultations and ensure participation of key stakeholders in formulation of plans and designs, including systematic documentation of the same.	
5	Project Investment Plan • Project Investment Plan will be prepared for all the components i.e., A, B and C. • Design and Development of Alert System/EWDS for Earthquakes in India and recommend technology options and feasibility of the options for both regional and local earthquake alert system. • Specification for Procurement of Sensors. • Design of Central Server based on Capacity, Capability, latest equipment, area reqd., etc. • Earthquake risk mitigation and preparedness measures Upgradation requirements (human resources, equipment, and training needs) of SDRF, and the State/City level Fire & Emergency Services to meet search and rescue standards. • Cost for Training and capacity building programme for emergency/first responders. • Augment the disaster risk management capacities of the communities. • Cost of Retrofitting of selected critical infrastructure such as: schools, offices, hospitals, transport terminals, data centres, emergency installations, etc. • Investment cost of Retrofitting and/or constructing evacuation roads, bridges, landing strips and helipads and multi-hazard shelters. • Cost of constructing small Technology Demonstration Units of critical infrastructure such as schools, hospitals etc.	State Wise Preliminary Cost Estimation With Agreed Project Scope Along with the Sub Projects.
6	Draft Environment and Social Management Framework • Conduct Environment and Social Assessments for sub-projects that are identified for investment under the proposed project. • Preparation of Environment and Social Management Plans for sub-projects that are identified for investment under the proposed project. • Conduct formal consultations and ensure participation of key stakeholders in formulation of plans and designs, including systematic. • Facilitate disclosure of information of the project as well as environment and social management instruments prepared for the project. • Develop training material and provide training to Project Implementation Units/States on application and implementation of environment and social management instruments. • Translate key/summary documents in vernacular language related with environmental and social aspects.	Preparation of Draft Environmental and Social Commitment Plan. Prepare Communication and Information Dissemination Strategy. Procurement Plan and Operations Manual.
7	Detail Project Report	DPR for Identified 50% of Risk

Step	Process	Deliverable
	• Preparation of DPR for identified risk mitigation measures with complete environment and social assessment, impact assessment and other required documents corresponding to 50% of allocated Budget. • DPR for Retrofitting of selected critical lifeline buildings such as: schools, offices, hospitals, transport terminals, data centres, emergency installations, etc. • DPR for Retrofitting and/or constructing evacuation roads, bridges, landing strips and helipads and multi-hazard shelters. • DPR of constructing small Technology Demonstration Units of critical infrastructure such as schools, hospitals etc. • DPR for Design/Development of Earthquake Early Warning Dissemination System (EWDS) based on latest technology, allowing people and systems to take actions to protect lives and property and also to alert the Emergency Response System. • DPR for Upgrading existing and providing additional search and rescue equipment for: State Disaster Response Forces, Fire & Emergency Services and other emergency/first responders. • ToR for Training and capacity building programme for emergency/first responders.	Mitigation Measures with Complete Environmental and Social Assessment, Impact Assessment and Other Required Documents.
8	Draft EIAS/SIAS/EMPS/RAPS • Evaluation of all Components and projects in 8 States based on environment and social impact.	Draft Environment Impact Assessment. Draft Social Impact Assessment.
9	Draft Environmental and Social Commitment Plan Document • Environment and Social Commitment Plan for prepared DPRs	Environmental and Social Commitment Plan.
10	Project Appraisal Document	Project Appraisal Report.
11	Web Based Project MIS • Designing internet based/electronic MIS System/ software/mobile application for implementing the projects of NSRMP in consultation with subject experts (Procurement Specialist, Financial Management Specialist, Project Management Specialist, Monitoring and Evaluation Specialist, Safeguards Specialist etc.) • Identifying human resources and IT equipment resources for PMU, NDMA and PIUs.	Prepare Technical Specifications and Procurement Documents for MIS Hardware/Software. Manual for Use of MIS.
12	Finalise and Disclose all Environment and Social Management Instruments/Documents	Disclosure Document.
13	Project Operation Manual • Project Operation Manual to be prepared for the entire project including the 8 States and guidelines to be prepared at the central level. • Approval to be taken at Centre level.	Project Operation Manual at Centre Level and for 8 States and Relevant Guidelines.
14	Capacity Development Plan, Training and Complete Set of TOR/RFPS/Bidding Documents	TOR of consultancy Services Procurement

Step	Process	Deliverable
	• Review of existing draft bill for National Council of Professional Engineers (NCPE) • Preparation of TOR for consultancy to suggest changes on Strengthening/Establishing Seismic research and development program across country. • Preparation of TOR for consultancy services Curriculum revision for introduction of Earthquake Engineering topics in Engineering, and Architecture education. • Preparation of TOR Formulation and implementation of Techno-legal Regime for structural design reviews, implementation monitoring and licensing of professionals. • Standardized IEC material for, improving and encouraging and for sensitization programme Traditional Earthquake Resistant Construction. • Preparation of TOR for consulting services on Training & Capacity Building for Engineers, Architects and Masons; and Municipal and State bodies.	Documents Action plans Standardized IEC Material.

The working methodology of consultancy of designing NSRMP described above is shown as flow chart in figure 4.2

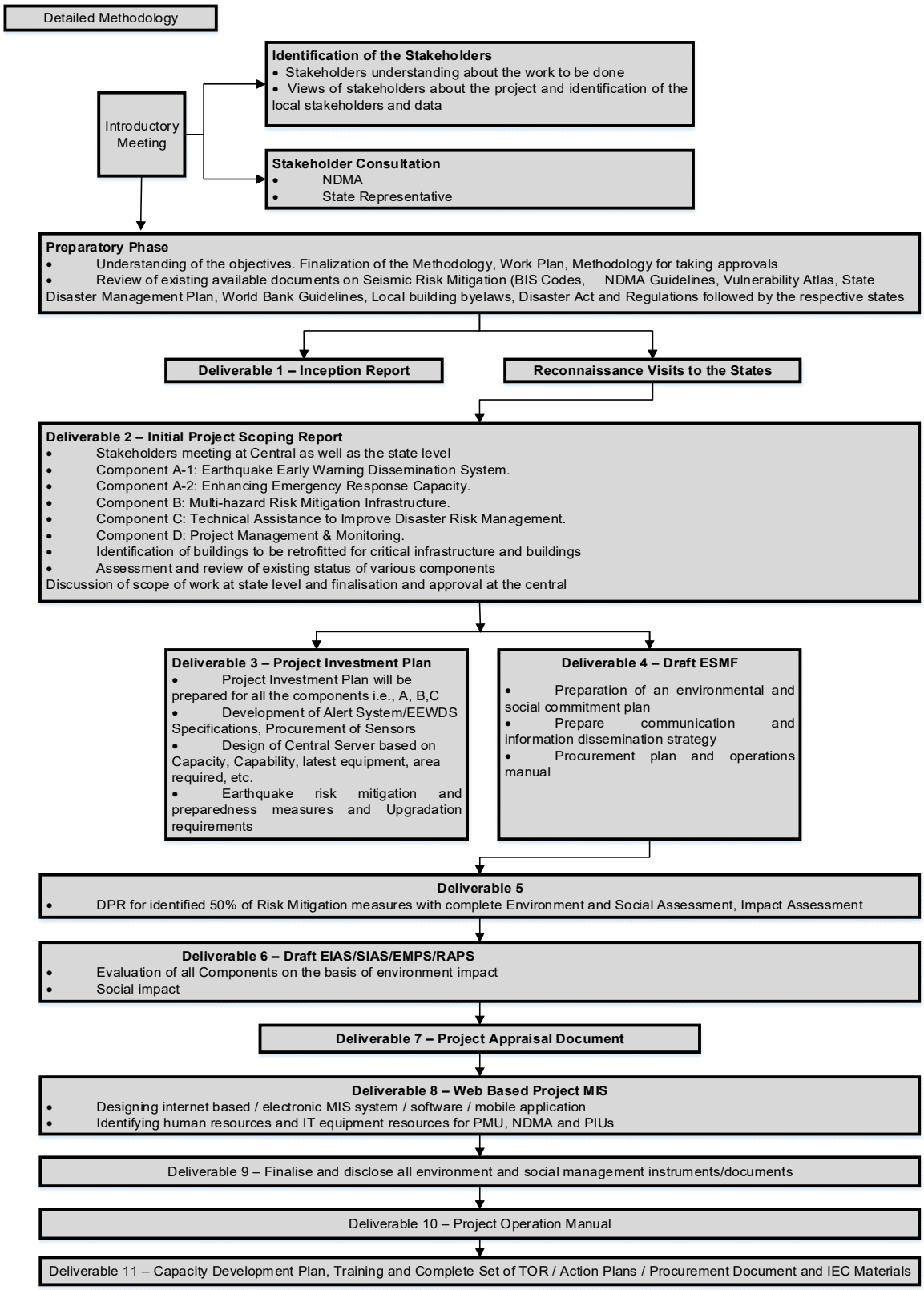


Figure 4.2: Project Methodology

4.5 COMPONENT WORKING METHODOLOGIES

4.5.1. COMPONENT A: TECHNICAL APPROACH AND METHODOLOGY FOR DESIGN AND DEVELOPMENT OF EEWDS (REGIONAL & ON-SITE LEVEL) & ENHANCING EMERGENCY RESPONSE SYSTEM

More than 50% land area of India is prone to big earthquakes and several prominent seismologists from India and abroad through their technical papers and presentations have concluded that tectonic movement between Indian and Eurasian plates may result into large earthquakes (greater than M 7) in Himalayas. Scientists have also concluded that the risk of such earthquakes striking soon in central Himalayas (Uttarakhand and part of Himachal Pradesh) is quite high because stresses in this part of Himalayas have not released for last several centuries.

It may be mentioned that Tarai region adjoin to Himalayas (Punjab, Haryana, Delhi, western UP, Eastern UP) are most vulnerable due to earthquakes striking in Himalayas as large part of this region is sitting on soft soil where the ground motion gets amplified by several fold. Unfortunately, most dwellings of this region do not have earthquake resistant features (as per 2008 census carried out by BMTPC) and are likely to face total collapse in the event of M 7 and above earthquake having epicentre in Himalayas. There may be more than two crore houses in this region, which are vulnerable to have total collapse. Thus, earthquakes in Himalayas have well established risk of having a casualty number which may be more than any other curse to the humanity in the known history.

Using EEWDS, people living in ground and first floors at more than 100 km from epicentre, can be provided sufficient warning time to save their life. Those living in higher floors can safeguard themselves from the falling material and debris.

Such systems are in operation in Japan, Mexico, Taiwan, Turkey and are under development at USA and few European countries. There are several success stories of these systems and success of such system will be heard more frequently in future due to fast advancements in communication technology. However, it is important to understand that usefulness, relevance and possibility of getting full advantage of EEW system is much more in India, in comparison to any other place in world.

An EEWD system can provide 30 seconds or more warning to the populated region. In fact, Delhi can get as much as 70 seconds of warning time for earthquakes originating from central Himalayas. Today every city, town and village of this region has mobile connectivity and soon every village will have broadband connectivity. Almost all houses in rural areas and very large number of houses in urban areas are single or two storied houses. Thus, the entire region can get the benefit of EEWD system. It is, therefore, apparent that a successful EEWD system in the event of M 7+ earthquake in Central Himalayas has potential to save millions of lives.

Overall goal of this component is establishment of regional earthquake early warning and dissemination (EEWD) system for our country. Also, recommendations for onsite warning systems for shut down of gas pipelines, power plant, machineries etc. are included. The project proposes detailed site specific sensors in all pilot states. To ensure design of holistic network, the report will recommend number of sensors in other neighbouring states.

Methodology of this component has been described in detail in Annexure A. Regional and On-site Earthquake Early Warning System, Training and capacity building with respect to EEWD is also described under A.1.1 and A.1.2 in Annexure-A of this document.

4.5.2. COMPONENT B: TECHNICAL APPROACH AND METHODOLOGY FOR MULTI-HAZARD RISK MITIGATION OF INFRASTRUCTURE

This component will concentrate on reducing the multi-hazard structural risk of critical infrastructure. It is further divided in sub-parts which is mentioned below. First part covers methodology for retrofitting of critical buildings in detail. The critical buildings are,

- Lifeline buildings structures and critical facilities like schools, colleges and academic institutions; hospitals and health facilities, tertiary care centres, community centres,
- Important buildings that ensure governance and business continuity like offices of the district collector and superintendent of police in districts; Fire stations, communication buildings, Panchayat Office and Post Office buildings structures designated to be used for post, earthquake temporary rehabilitation of affected persons and operations,
- Buildings of national importance like Secretariats, historical monuments, museums, heritage buildings, strategic assets and vital installations,

The detailed methodology to achieve the objective is given in Annexure-B1.

In second part, evacuation roads, bridges, landing strips and helipads and multi-hazard shelters have been considered for retrofitting. The detailed methodology to achieve this objective is given under Annexure-B2.

In third and last sub-part of this component, constructing small Technology Demonstration Units of critical infrastructure such as schools, hospitals etc. have been suggested. The detailed methodology to achieve this objective is given under Annexure-B3.

4.5.3. COMPONENT C: TECHNICAL APPROACH AND METHODOLOGY FOR TECHNICAL ASSISTANCE TO IMPROVE DISASTER RISK REDUCTION/ MANAGEMENT WITH EMPHASIS ON EARTHQUAKE RISK

The objective of this component is to improve the capacity of states to manage the risks associated with their risk profile. It would include development of a policy and platform to share and use information for risk management, detailed vulnerability assessment, setting up of accreditation programmes for engineers, architects, mason and construction workers etc.

The detailed methodology to achieve this component objective is given under Annexure-C.

4.5.4. COMPONENT D: TECHNICAL APPROACH AND METHODOLOGY FOR PROJECT MANAGEMENT AND MONITORING OF COMPONENT A, B & C INCLUDING PREPARATION OF MANUALS AND IMPARTING TRAINING

The objective of this component is for quality project implementation and monitoring through progressive evaluation of the Components A, B & C. Staff capacity training through training programs in all states and at national level shall be made. To meet the said objectives, a comprehensive Management Information System (MIS) will be developed. Requisite training and

project manuals on technical, financial, environmental and social framework including fiduciary shall be prepared and documented. Quality controlled project management support is envisaged through quality monitoring of all components at various levels. In brief, the Consultant will support and help implement the NSRMP to the States and at National Level. They will prepare appraisal documents, assist state entities in formulating investment program and also prepare implementation ready proposals for projects with full detailing including social and environmental framework.

The detailed breakup of Component D is given under Annexure D of this document.

05 DELIVERABLES AND TIMELINES

Chapter 5 discusses the project schedule, overall project deliverables with timelines in Gantt chart. Further, the chapter details out activities associated with project deliverables in a bar chart.

CHAPTER 5

DELIVERABLES AND TIMELINES

5.1 PROJECT SCHEDULE

As per RFP, the following Table 5.1 shares the timeline with respect to the deliverables of the Consultancy Project.

Table 5.1: Project Deliverables & Timeline

S.No.	**Deliverables**	**Timeline (Months)**
1.	Inception Report	D + 0.5
2.	Initial Project Scoping Report	D + 1
3.	Project Investment Plan – component wise and state wise and with agreed Project Scope (sub project listing)	D + 2
4.	Draft ESMF	D + 4
5.	Draft EIAs/SIAs/EMPs/RAPs	D + 7
6.	DPR for identified 50% of risk mitigation measures with complete environment and social assessment, impact assessment and other required documents.	D + 8
7.	Draft ESCP Document	D + 8
8.	Project Appraisal Document	D + 9
9.	Web based Project MIS	D + 10
10.	Finalise and disclose all environment and social management instruments / documents	D + 10
11.	Project Operation Manual	D + 12
12.	Capacity development plan, training and complete set of TORs / RFPs / Bidding Documents.	D + 12

Note: D – 29.8.2019 i.e., 29th of August'2019

The timeline and deliverables have been expressed in terms of various activities in the form of a bar chart showing the project schedule which is shown under figure 5.1. The table 5.2 shares the detailed list of activities to achieve each deliverable and is detailed for a better understanding of the various activities.

Table 5.1: Overall Project Deliverables and Timeline

	Date of Project to Start	29th August,2019																					
	Time line ----------	September		October		November		December		January		February		March		April		May		June		July		August	
S.No	Deliverables																								
1	Inception Report																								
2	Initial Project Scoping Report																								
3	Project Investment Plan																								
4	Draft ESMF																								
5	Draft EIAs/SIAs/EMPs/RAPs																								
6	DPRs for50% of risk mitigation measures with complete Environment and social impact report																								
7	Draft ESCP Report																								
8	Project Appraisal Document																								
9	Web Based MIS																								
10	Finalisation of all Social and environment instruments documents																								
11	Project Operation Manual																								
12	Capacity Development plan, training and complete set of TOPs/ RFPs/ Bidding Documents																								

Table 5.2: Detailed Identified Activities for Achieving Project Deliverables & Timeline

Activity Code	TASK	TIMELINE IN MONTHS																							DELIVERABLES
		0.50	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	
D-1	Inception Report																									D+15
D- 1.1	Organize meetings with client.																									
D- 1.2	Gear up of DDF offices# 8 States																									
D- 1.3	Organize meetings with State officials #8 States																									
D- 1.4	Review- existing status of activities with Work scope																									
D- 1.5	Review existing Statuary documents, guidelines related to work																									
D- 1.6	Finalize project working methodology																									
D- 1.7	Finalize methodology/strategy for Component A-																									
	A1: Earthquake Early Warning Dissemination System &																									
	A-2: Enhancing Emergency Response Capacity																									
D- 1.8	Finalize methodology-Multi-Haz Risk Mitig Infrastructure(B)																									
D- 1.9	Finalize methodology Tech Assist for Disaster Risk Mgt (C)																									
D- 1.10	Prepare buildings selection retrofitting criteria																									
D- 1.11	Prepare criteria- evacuation transp modes, shelters for retrofit &/or constructed																									
D- 1.12	Prepare criteria for small tech Demo units of critical infra to built																									
D- 1.13	Prepare of Draft Inception report																									
D- 1.14	Present inception report to stakeholders & seek their comments																									
D- 1.15	Present Inception Report at Center for comments and advice																									
D- 1.16	Submit revised Inception Report																									
Task under D1 may continue in D2 as they are dependent on the response of stakeholders at different levels																										
D-2	Initial Project Scoping Report																									1. Preparation of Initial Project Scoping Report & 2 Monthly progress report
D-2.1	Meeting stakeholders at Central states																									
D-2.2	Expand scope of work of all components with PMU, SPIU NDMA,																									
D-2.3	Discuss scope of work at State level and finalize																									
D-2.3.1	Identify Region and # sensors with specs for Regional EEWS																									
D-2.3.2	Finalize transmission between Sensors & Monitoring stations																									
D-2.3.3	Select decision making software & strategy to use																									
D-2.3.4	Develop strategy to mainstream existing EEWD system, if any																									
D-2.3.5	Develop draft strategy & tech for dissemination of Warning																									
D-2.3.6	Identify technology & strategy to install on site EEWS																									
D-2.3.7	Develop list of needed rescue and relief equipment																									
D-2.4	Finalize list of critical infrastructure (buildings) for Component B																									
D-2.5	Finalize evacuation trp modes list & multi-hazard shelters-retrofitted/constructed																									
D-2.6	Finalize list of small Tech Demo units - critical infrastructure																									
D-2.7	Assess and list Capacity building related works/programs																									
D-2.7.1	Review, listing and status of existing documents/draft bill-NCPE																									
D-2.7.2	Review of existing status & system of Curriculum Dev EQ Engg																									

Activity Code	TASK	TIMELINE IN MONTHS																							DELIVERABLES
		0.50	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	
D-2.7.3	Review of status of Techno-legal regime at National and States																									
D-2.7.4	Review of existing status of encouragement of EQ resistant Construction																									
D-2.7.5	Review status existing IEC material & need assess IEC Material																									
D-2.7.6	Review existing trg Modules for Eng, Arch, & need assessment																									
D-2.7.7	Review, listing status of EQ Res. Dev Prg & Centre of Excellence.																									
D-2.8	Develop Strategy & framework - PM & Monitoring System.																									
D-2.9	Presnet Initial Project Scoping Report with all stakeholders																									
D-2.10	Present draft Project Scoping Report at stand Stake holders.																									
D-2.11	Revise report & final submission of draft Project Scoping Report																									
D-3	Project Investment Plan – by Component, state & Project Scope																									1. Project Investment Plan – component wise and state wise and with agreed Project Scope (subproject listing),2. Monthly Progress report
D-3.1	Investment Plan for Component A1																									
D-3.2	Develop preliminary cost estimation of Component A for onsite EEWS																									
D-3.3	Develop preliminary cost estimation of Component B - Bldg retrofit																									
D-3.4	Develop preliminary cost estimation of Component B - Infra retrofit																									
D-3.5	Develop Preliminary cost estimation of Component B - constructing small tech Demo unit of critical buildings																									
D-3.6	Develop Preliminary cost estimation of Component C, Trg resource material, Centre of Excellence																									
D-3.7	Draft Project Investment Plan for each state with agreed scope of work.																									
D-3.8	Meeting with SPIU in states to seek their comments about Investment Plan.																									
D-3.9	Meeting with PMU, NDMA for finalization of state wise Investment Plan.																									
D-4	Prepare draft environmental and Social Management Framework (ESMF)																									1. Draft Environmental and Social Management Framework report, 2. Monthly Progress Report
D-4.1	Prepare communication & Information dissemination strategy ESMF																									
D-4.2	Scehedule Stakeholder Meetings in all states																									
D-4.3	Prepare draft document for all states																									
D- 4.4	Present ESMF report to stakeholders in States and seek comments																									
D- 4.5	Present ESMF report at Center to seek their review comments																									
D-5	Develop DPR for identified 50% of risk mitigation measures																									Preparation of :1. DPR of 50% of risk mitigation measures,2. Complete environment and social impact assessment report for various projects, 3. Procurement Manual, 4. Monthly Progress Report
D-5.1	Prepare DPR - Retrofitting of selected critical infra. (buildings)																									

Activity Code	TASK	TIMELINE IN MONTHS																							DELIVERABLES
		0.50	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	
D-5.1.1	Conduct condition assessment, data collection, measurements, NDT, soil investigation, lab testing of samples																									
D-5.1.2	Prepare architectural drawings, structural system drawings																									
D-5.1.3	Conduct analysis and vulnerability assessment																									
D-5.1.4	Conduct design of retrofitting scheme - vulnerabilities & analysis - retrofitted model																									
D-5.1.5	Finalize retrofitting option																									
D-5.1.6	Design support system for non-structural elements																									
D-5.1.7	Prepare DPR- retrofitting of evacuation trp modes and multi-hazard shelters																									
D-5.2.A	Design retrofitting of evacuation trp modes and multi-hazard shelters																									
D-5.2.A.1	Conduct condition assessment survey, collection of data, measurements, NDT, soil investigation,																									
D-5.2.A.2	Prepare arch drawings, structural system drawings, other details on the basis of 5.2.A.1																									
D-5.2.A.3	Conduct analysis and vulnerability assessment																									
D-5.2.A.4	Design of retrofitting scheme for local/global vulnerabilities & analysis of retrofitted model																									
D-5.2.A.5	Finalize of retrofitting option																									
D-5.2.A.6	Preparation of DPR.																									
D-5.2.B	Develop new construction evacuation trp modes and multi-hazard shelters																									
D-5.2.B.1	Finalize planned evacuation trp modes & multi-hazard shelters.																									
D-5.2.B.2	Finalize layouts/architectural design and preparation of drawings.																									
D-5.2.B.3	Geotechnical Investigation.																									
D-5.2.B.4	Structural Design and design of services																									
D-5.2.B.5	Preparation of DPR.																									
D-5.3	Construct small Techn Demo Units of critical infras																									
D-5.3.1	Preparation of architectural plans and drawings.																									
D-5.3.2	Approval of architectural plans and drawings.																									
D-5.3.3	Geotechnical Investigation of proposed site.																									
D-5.3.4	Preparation of structural design and drawings.																									
D-5.3.5	Preparation of DPR.																									
D-5.4	Carry out env & social assess, impact assess in compliance to D6.																									
D-5.5	Prepare Procurement Manuals.																									
D-6	Draft EIAs/SIAs/EMPs/RAPs reports																									1. Draft EIAs /SIAs / EMPs / RAPs, 2. Monthly Progress reports
D-6.1	Prepare location maps of projects/ sub project sites identified																									
D-6.2	Prepare site screening for potential env and social impact & identifying specific impacts																									
D-6.3	Prepare environmental and management plan of projects/sub project																									
D-6.4	Integrate Env & management plan with overall project procedures																									

Activity Code	TASK	TIMELINE IN MONTHS																							DELIVERABLES
		0.50	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	
D-7	Draft ESCP document																									1. Draft ESCP document,2. Monthly Progress Reports
D-7.1	Design of Training Module.																									
D-7.2	Development of ESCP Framework Training Manual.																									
D-8	Project Appraisal Document																									1. Project Appraisal Document,2. Monthly Progress Reports
D-8.1	Review-Project Scoping Report & progress of product developed																									
D-8.2	Identify status of milestones and timeline.																									
D-8.3	Identify risks and strategies for risk reduction.																									
D-8.4	Finalize document report in consultation with PMU, NDMA.																									
D-9	Web based Project MIS																									Web based Project MIS
D-9.1	Develop MIS software in consultation with subject experts																									
D-9.2	Finalize of specs & configuration of hardware to be procured.																									
D-9.3	Develop training Module for PMU, NDMA and SPIU's.																									
D-9.4	Training programs in eight states and at Centre.																									
D-9.5	Framework and manpower identification for PMU, NDMA & SPIU's																									
D-9.6	Develop procurement documents.																									
D-10	Finalize and disclose all environment and social management instruments/documents																									Disclosure documents of all environment and social management issues
D-11	Project Operation Manual																									Project Operation Manual, 1. Capacity development plan, 2. Training Module Design, 3. Complete set of TORs / RFPs / Bidding Documents
D-12	Develop capacity development plan, training and complete set of TORs / RFPs / Bidding Documents																									
D-12.1	Develop Capacity Development Plan for stakeholders.																									
D-12.2	Training Design and Schedule.																									
D-12.3	TOR / RFP / Bidding Documents for all DPR's with capacity building																									

06 MONITORING, EVALUATION AND REPORTING SYSTEM

Chapter 6 explains the proposed monitoring & evaluation and reporting mechanism for effective and efficient project management.

CHAPTER 6

MONITORING, EVALUATION AND REPORTING SYSTEM

6.1 INTRODUCTION TO THE MONITORING AND EVALUATION FRAMEWORK

The project planning and implementation carefully envisions stringent framework which encompasses review and study of the project objectives, scopes, outputs, outcomes and impact. Based on the above factors, it proposes evaluation criteria and measuring indicators. The indicators broadly include time, resource, quality, process and performance. These indicators are integrated in project planning, design and implementation. While the project in implemented as per the plan, these indicators are evaluated, measures and reported to the respective stakeholders. The feedback by each indictor is further incorporated in the project planning process. The steps are detailed below and further illustrated in the flowchart.

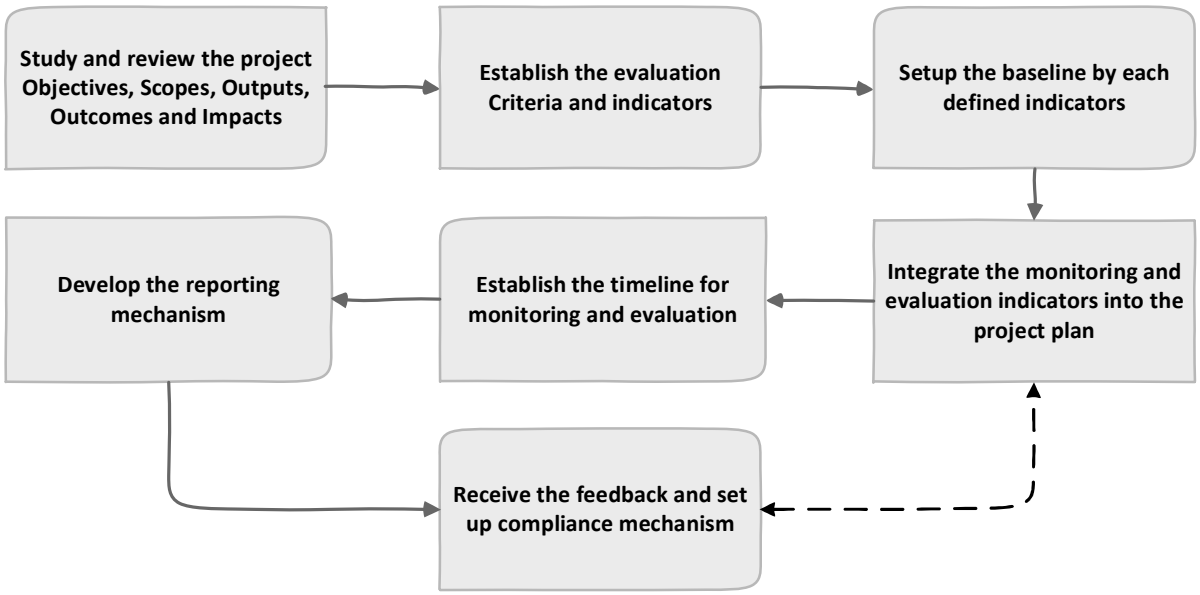


Figure 6.1: Steps for Project Monitoring and Evaluation

6.2 STEPS FOR THE PROJECT MONITORING AND EVALUATION

1. Study and review the project Objectives, Scopes, Outputs, Outcomes and Impacts.
2. Establish the evaluation Criteria and indicators
3. Setup the baseline by each defined indicators
4. Integrate the monitoring and evaluation indicators into the project plan
5. Establish the timeline for monitoring and evaluation
6. Develop the reporting mechanism
7. Receive the feedback and set up compliance mechanism

6.3 REPORTING MECHANISM

The M&E will be carried out by Project Implementation Team of DDF-AKDN JV. However, NDMA, the client will carry out M&E based on their institutional setup, which is not included in this section. The reporting format and reporting scheduled will be detailed out in scoping report.

ANNEXURES

A. COMPONENT A

A.1. COMPONENT A-1: DESIGN AND DEVELOPMENT OF EEWDS

A.1.1 INTRODUCTION

More than 50% land area of India is prone to big earthquakes and several prominent seismologists from India and abroad through their technical papers and presentations have concluded that tectonic movement between Indian and Eurasian plates may result into large earthquakes (greater than M 7) in Himalayas. Scientists have also concluded that the risk of such earthquakes striking soon in central Himalayas (Uttarakhand and part of Himachal Pradesh) is quite high because stresses in this part of Himalayas have not released for last several centuries.

It may be mentioned that tarai region adjoin to Himalayas (Punjab, Haryana, Delhi, western UP, Eastern UP) are most vulnerable due to earthquakes striking in Himalayas as large part of this region is sitting on soft soil where the ground motion gets amplified by several fold. Unfortunately, most dwellings of this region do not have earthquake resistant features (as per 2008 census carried out by BMTPC) and are likely to face total collapse in the event of M 7 and above earthquake having epicenter in Himalayas. There may be more than two crore houses in this region, which are vulnerable to have total collapse. Thus, earthquakes in Hiamalayas have well established risk of having a casualty number which may be more than any other curse to the humanity in the known history.

Using earthquake early warning and dissemination (EEWD) system, people living in ground and first floors at more than 100 km from epicentre, can be provided sufficient warning time to save their life. Those living in higher floors can safeguard themselves from the falling material and debris.

Such systems are in operation in Japan, Mexico, Taiwan, Turkey and are under development at USA and few European countries. There are several success stories of these systems and success of such system will be heard more frequently in future due to fast advancements in communication technology. However, it is important to understand that usefulness, relevance and possibility of getting full advantage of EEW system is much more in India, in comparison to any other place in world.

An EEWD system can provide 30 seconds or more warning to the populated region. In fact, Delhi can get as much as 70 seconds of warning time for earthquakes originating from central Himalayas. Today every city, town and village of this region has mobile connectivity and soon every village will have broadband connectivity. Almost all houses in rural areas and very large number of houses in urban areas are single or two storied houses. Thus, the entire region can get the benefit of EEWD system. It is, therefore, apparent that a successful EEWD system in the event of M 7+ earthquake in Central Himalayas has potential to save millions of lives.

A.1.2 BROAD ROADMAP FOR IMPLEMENTATION

Overall goal of project is establishment of regional earthquake early warning and dissemination (EEWD) system for our country for earthquakes originating from Himalayas and give recommendations for onsite warning systems for shut down of gas pipelines, power plant, machineries etc.

A.1.2.1 STAKE HOLDER ORGANISATIONS

National Disaster Management Authority (NDMA) will have overall control of EEWD system and an officer of the rank of Joint Secretary will be in-charge of the developed EEWD system. However, for successful operation of the system, support of Bharat Sanchar Nigam Ltd. (BSNL), Mahanagar Telephone Nigam Ltd. (MTNL), National Informatics Centre (NIC) will be taken for real time transmission of data and for issue of warning. (State disaster management authority (SDMA) of states of J&K, HP, Uttarakhand, UP, Bihar, Sikkim, West Bengal, Assam, Arunachal Pradesh, Meghalaya, Nagaland, Manipur, Mizoram, Tripura, Punjab, Haryana, Rajasthan and Delhi will be responsible to manage the warning signal and train the population for optimum response in the event of warning signal.) Service providers of mobile phone and television channels will also be used for dissemination of warning. A block diagram given in Figure A.1 depicts the control structure of methodology.

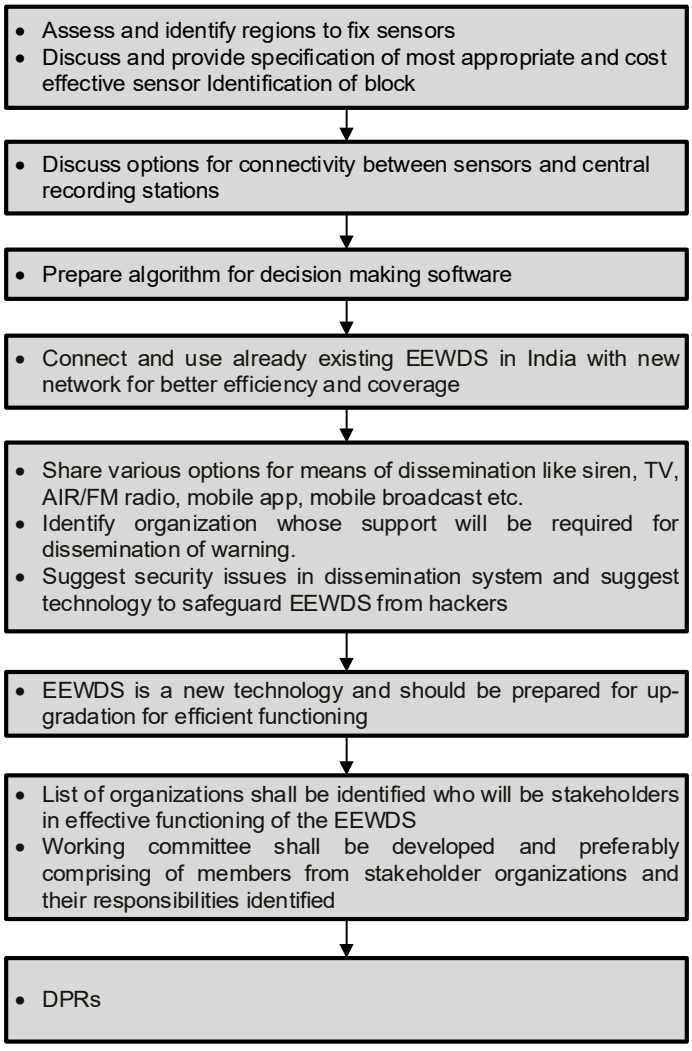


Figure A.1: Technical Approach & methodology Flowchart for Regional Level EEDWS

In this regard, following information and administrative permissions will be sought:

(SDMA) of states Assam, Bihar, Jammu and Kashmir, Himachal Pradesh, Manipur Meghalaya, Uttarakhand and Tripura will be responsible for to manage the warning signal and train the population for optimum response in the event of a warning signal.

Additional States (Not part of contract) who have to work on response system are Uttar Pradesh, Punjab, Haryana, Rajasthan, Delhi, Arunachal Pradesh, Mizoram, Sikkim, Nagaland and West Bengal. These states are beyond the scope of work.

INFORMATION

1. List of district headquarters (with Lat. Long.) where NICNET is available in the states of Assam, Bihar, Himachal Pradesh, J&K, Manipur, Meghalaya, Tripura and Uttarakhand.
2. List of districts, tehsils, blocks and villages (with Lat. Long.) where SWAN connectivity is operational in the states of Assam, Bihar, Himachal Pradesh, J&K, Manipur, Meghalaya, Tripura and Uttarakhand.
3. List (with latitude and longitude) of mobile phone towers and their types (detachable base room or base room having floor which is monolith with ground) of BSNL and other mobile phone service providers.
4. Information about mode of travel to reach those mobile towers that are located in difficult terrain.
5. Other pertinent information about accessibility to all locations mentioned in items 1 to 4 above.

ADMINISTRATIVE PERMISSIONS

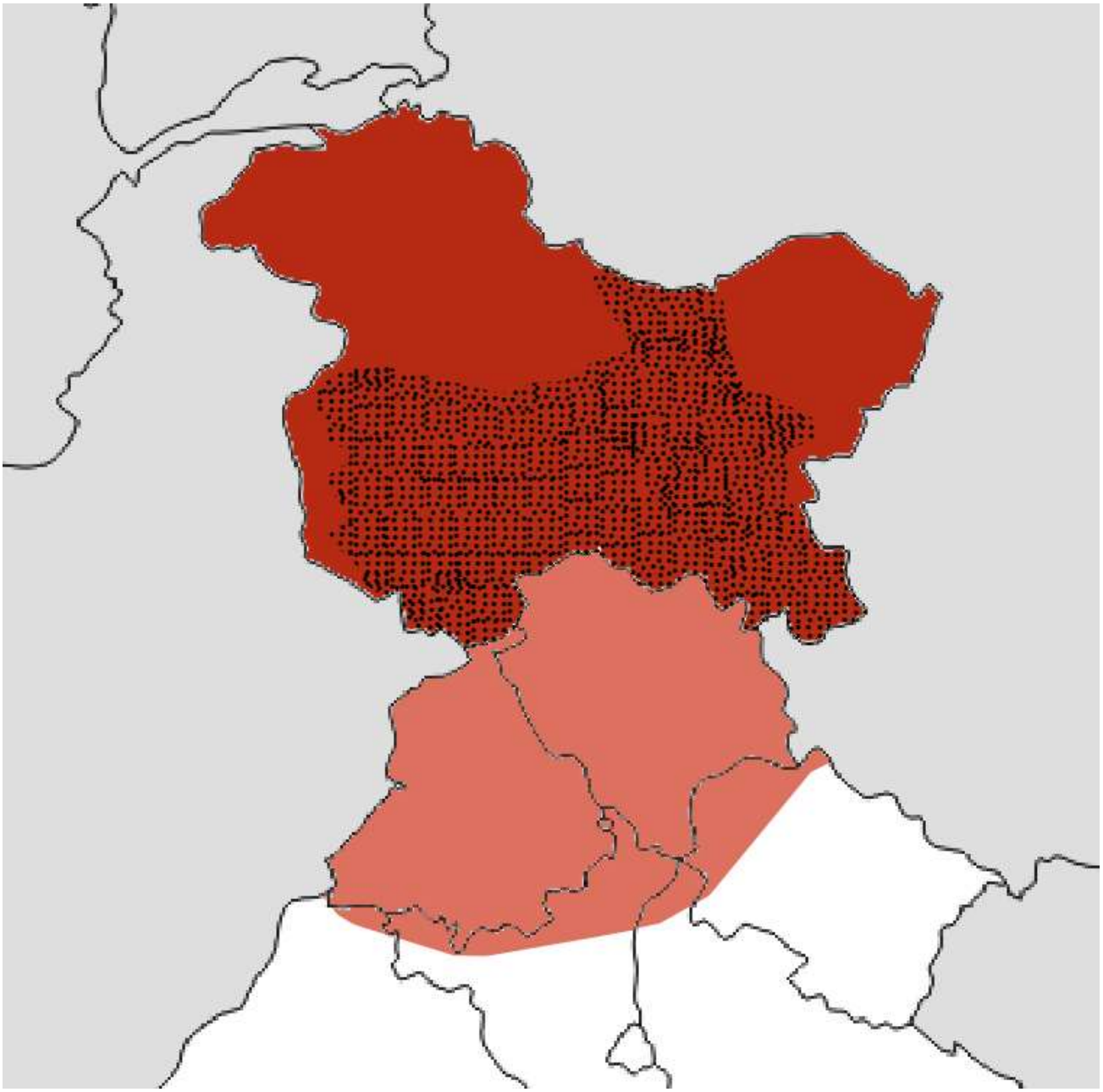
1. Permission from NIC to install sensors in their premises at different district headquarters (DHQ).
2. Permission from NIC to use their UPS power supply (24x7) for sensors at each DHQ. Power requirement is less than 10 watts.
3. Permission from NIC to use NICNET at each DHQ and provide support for communication of data from each DHQ to CMS.
4. Permission from state governments of Assam, Bihar, Himachal Pradesh, J&K, Manipur, Meghalaya, Tripura and Uttarakhand to install sensors in their premises at each SWAN stations of their state.
5. Permission from state governments of Assam, Bihar, Himachal Pradesh, J&K, Manipur, Meghalaya, Tripura and Uttarakhand to use their UPS power supply (24x7) for sensors at each DHQ. Power requirement is less than 10 watts.
6. Permission from state governments of Assam, Bihar, Himachal Pradesh, J&K, Manipur, Meghalaya, Tripura and Uttarakhand to use their network at each SWAN station and provide support for communication of data from each SWAN station to CMS.

A.1.2.2 IDENTIFICATION OF REGIONS

As Himalayas cover a distance of more than 2000 Km in India, it is apparent that more than one EEWDS for entire Himalayas will be required, as earthquakes, originating from one part of Himalayas will not require issue of warning in entire North and NE India. In this project, five arrays of accelerometers, which will be part of five independent EEWDs will be developed. These arrays will be named as Kashmir array, Central array, Bihar array, NE-1 array and NE-2 array.

(a) Kashmir Array

A large sized earthquake originating in Kashmir part of Himalayas will have damaging effect in states of Jammu & Kashmir, HP and Punjab but may have little or no impact in Uttarakhand, Haryana, U.P. and other states. Thus, one array of sensors will be installed in Kashmir part of Indian Himalayas covering an area of approximately 400 km X 100 Km as shown in Figure A.2. Sensor to sensor distance of 10 Km is required for a successful EEWDS thus about 450 sensors will be installed in this array. A central monitoring station (CMS) will be established at state emergency operation centre (SEOC) at Srinagar and all sensors of this array will be connected to this CMS. However early warning alert system will be designed only for states under consideration of present NSRMP.



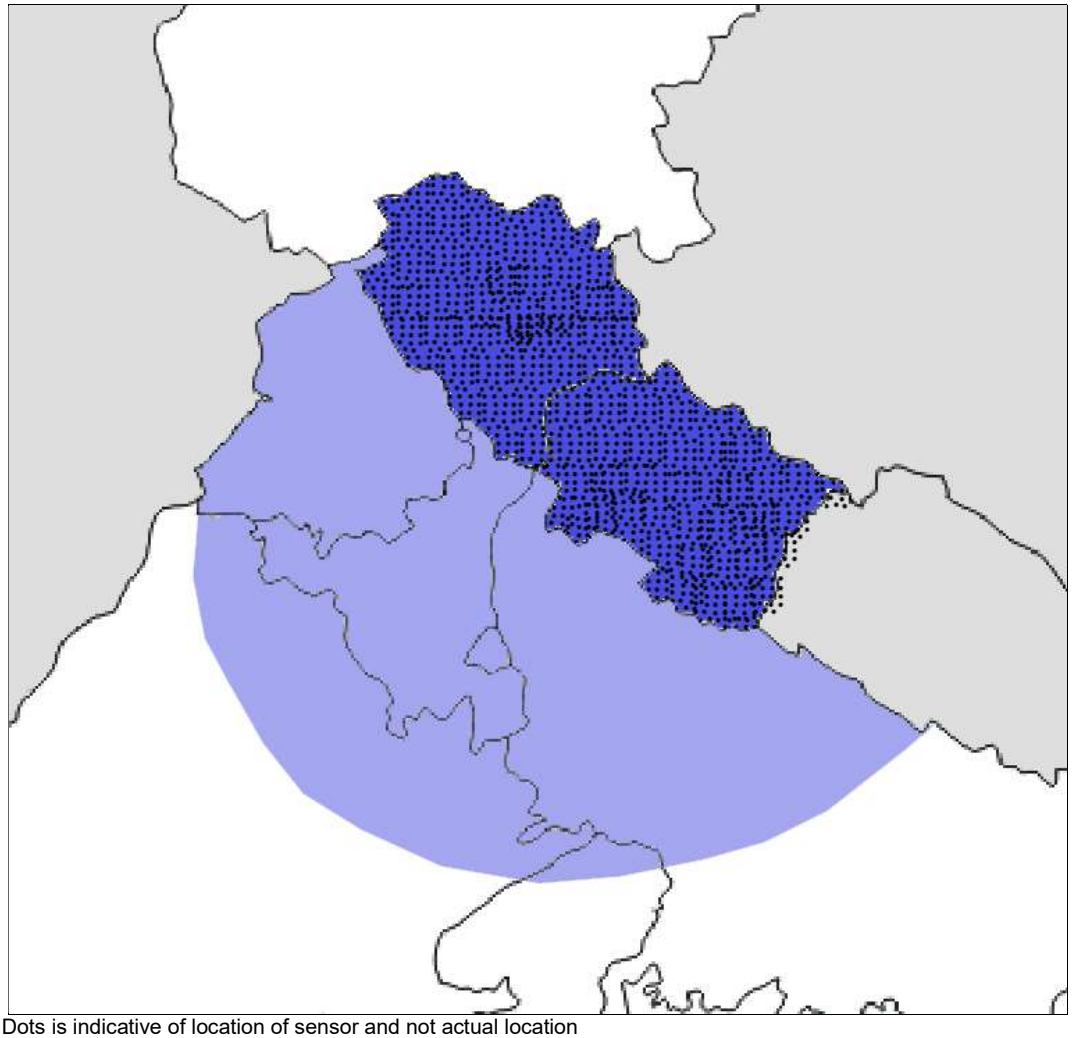
Note: (i) Dots is indicative of location of sensor and not actual location
(ii) Dark Shaded area is area where sensors will be installed
(iii) Light shaded area shows area which will be benefitted from fixed sensors

Figure A.2: Kashmir Array

(b) Central Array

The most crucial and important segment of Himalayas for this project is central Himalaya covering states of Himachal Pradesh and Uttarakhand. As discussed earlier, several scientists have concluded that a large sized earthquake is expected to occur soon from this region. An array of

sensors will be installed in a window of approx. 600 Km X 200 Km covering entire HP and Uttarakhand and for required instrumental density (sensor to sensor distance of 10 Km) approximately 1300 sensors will be required to cover this window as depicted in Figure A.3. An existing operative earthquake early warning system network of IIT Roorkee has already installed 160 sensors in Uttarakhand. Thus, additional 1140 sensors will be installed in this array. All 1300 sensors will stream data to CMS, which will be established at national emergency operation centre (NEOC) at New Delhi. In case of a large sized earthquake in this region, warning may be issued in HP, Uttarakhand, Delhi, western UP, central UP, eastern UP, Haryana, Punjab and parts of Rajasthan. However early warning alert system will be designed only for states under consideration of present NSRMP.

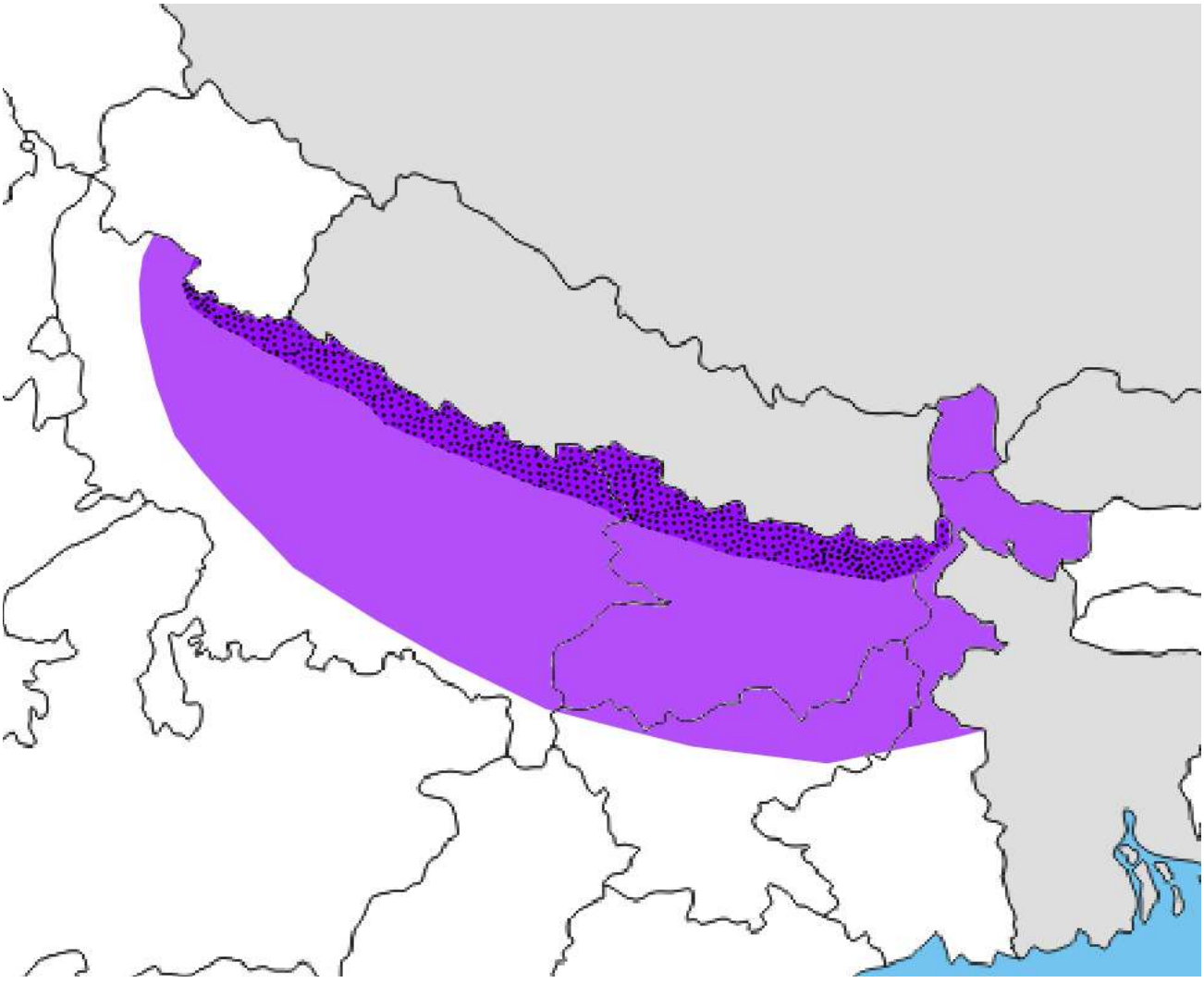


Note: (i) Dots is indicative of location of sensor and not actual location
(ii) Dark Shaded area is area where sensors will be installed
(iii)Light shaded area shows area which will be benefitted from fixed sensors

Figure A.3: Central Array

(c) Bihar Array

Third array of sensors will be installed in the boundary of Nepal and Bihar (Bihar array), which may be extended to boundary of Nepal / East UP in second phase. This array will warn state of Bihar, Eastern and central UP, Sikkim and parts West Bengal for earthquakes originating from Nepal part of Himalayas. A window of about 700 Km X 40 Km covering boundary of Bihar/ East UP with Nepal will be instrumented with an array of about 300 sensors (Figure A.4). CMS for this array will be established at SEOC at Patna. In case of large sized earthquake in the region, warning may be issued to Bihar, West Bengal, Eastern UP and Sikkim. In present work earthquake early warning alert system will be designed only for the states under consideration of present NSRMP.

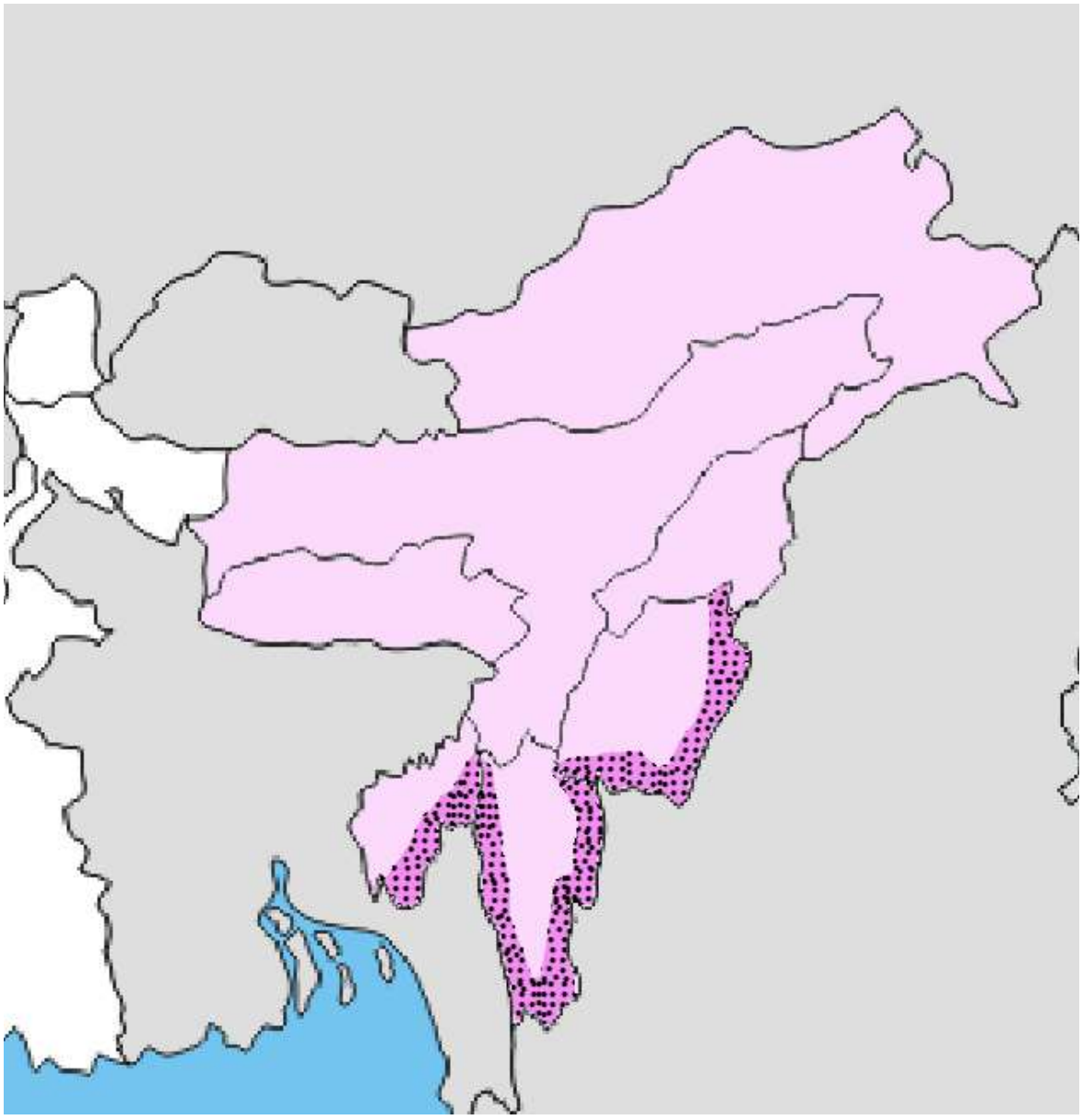


Note: (i) Dots is indicative of location of sensor and not actual location
(ii) Dark Shaded area is area where sensors will be installed
(iii)Light shaded area shows area which will be benefitted from fixed sensors

Figure A.4: Bihar Array

(d) NE-1 Array

Fourth array of sensors along Indo Burma border covering a linear distance of about 500 Km will be installed. In this array about 50 sensors will be installed (Figure A.5). A large sized earthquake in Indo Burma border may be damaging to all seven states of NE India. CMS for this array will be at Shillong, along with CMS of NE-2 array described below. Alert system will be designed only for states under present NSRMP.

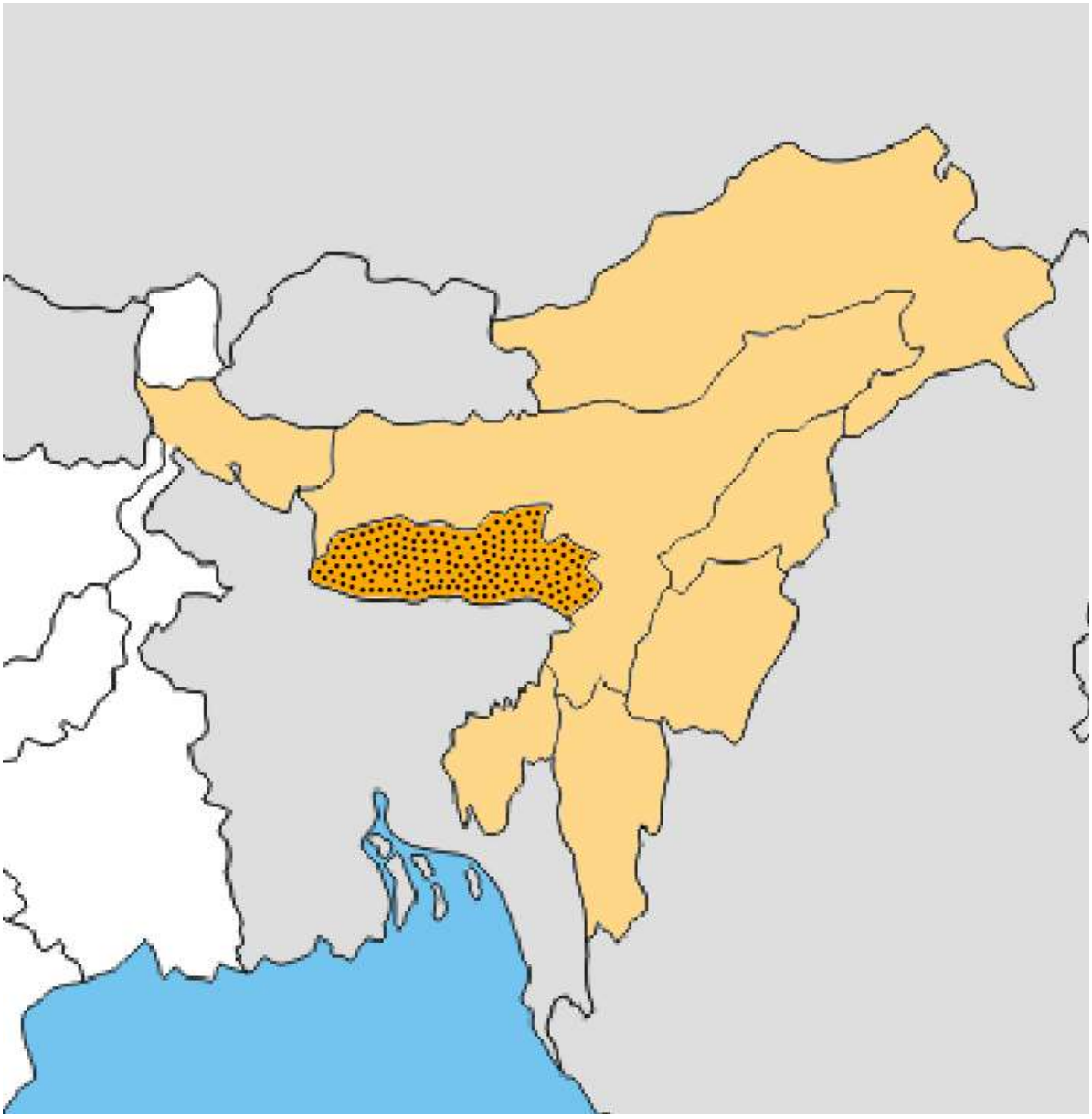


Note: (i) Dots is indicative of location of sensor and not actual location
(ii) Dark Shaded area is area where sensors will be installed
(iii)Light shaded area shows area which will be benefitted from fixed sensors

Figure A.5: NE-1 Array

(e) NE-2 Array

Fifth array of sensors will cover Meghalaya and have a window of about 200 Km x 100 Km, thus, will require about 200 sensors (Figure A.6). A large sized earthquake in this region will have damaging effects in all the seven states of NE India. These sensors will stream data to CMS which will be established at Shillong. Alert system will be designed only for states under consideration.



Note: (i) Dots is indicative of location of sensor and not actual location
(ii) Dark Shaded area is area where sensors will be installed
(iii)Light shaded area shows area which will be benefitted from fixed sensors

Figure A.6: NE-2 Array

A.1.2.3 SENSORS AND INSTALLATION

As described in previous section, about 2300 sensors are required in Himalayas to have effective EEWDS. It is very important that specification of sensors should be drawn in optimum manner so that at minimum cost, EEWDS performs accurately and in robust manner. It is experienced that accelerometers having dynamic range of about 100 dB are good enough to accurately calculate all parameters of EEWDs. MEMS accelerometers having dynamic range of 100 dB or more are most suitable for regional EEWDS in view of its performance and cost. Table-A.1 gives tentative specifications of sensors, which may be procured for EEWDS.

Table A.1 TENTATIVE SPECIFICATIONS OF SENSORS

PREAMBLE	The field units should operate through 9 volt to 30 Volt DC and should have power consumption of less than 5 watt. The sensor should have water proof rating of IP67 or better
Accelerometer and Digitizer	1. Type: Tri-axial MEMS 2. Full scale +/- 2g 3. Frequency response: Flat displacement response from 0.075Hz to 20 Hz 4. ADC Resolution: 24 Bit 5. Dynamic range of sensor: 100 dB or more 6. STA and LTA Setting Range: 0.1~100 seconds 7. Pre Event and Post Event Time: 5-200 seconds 8. Data storage 8 GB or more 9. Inbuilt battery for power back
Capabilities for Onsite Warning	1. Supporting Algorithms: P_d, Threshold Acceleration, Threshold Displacement, STA / LTA. 2. Relay type: Normally open 3. Capacity of Relay: More than 0.5 Amp DC 4. Provision for voice warning
Capabilities for Regional Warning	1. Communication through RS 485 with selectable IP address and automatically connecting with at least 2 servers. 2. Baud rate: At least 19200 3. Reaction time: Less than 50 m sec 4. Communication Parameters: Three channels of acceleration @ 100 SPS, menu selectable seismic event information. 5. Timing calibration through NTP protocol 6. Should be able to operate the relay through warning sent by central recording station also. 7. Computer programme at central recording station to fetch real time data from unlimited number of stations

Following are the three logistic requirements at site for installation of sensors

a) Sensors require availability of reliable power supply. Most sensors operate on +/- 15 volt DC. Thus, at the site, a UPS with good battery back-up or a battery bank which gives DC output with a generator back-up (in case of shut down of mains) is required. If required, site can also be provided with solar cell back-up.

b) Sensors require ready access for connectivity with a network for sending data to CMS.
c) Installation should be safe against vagaries of weather and vandalism.

Government of India through National Informatics Centre has networked all district headquarters with NICNET. Also, this network has further been branched to the level of Tehsils and blocks through state wide area network (SWAN) of each state. Thus, sensors will be installed in NIC / SWAN office of each block, Tehsil and district, which comes within region of all the five sensor arrays. These offices satisfy all three logistic requirements mentioned above for installation of sensors.

However, number of blocks, Tehsils and districts will not meet the requirement of density of array (ie. sensors at about every 10 Km). Thus, it is essential to install sensors up to village level. Best location to install sensors at these places is on the base room of mobile towers, which have come up in very large numbers. Mobile towers satisfy all three logistic requirements for installation of sensors. BSNL is the biggest owner of mobile towers in remote locations of Himalayas. However, other mobile phone service providers have also come up with their mobile towers in the region of our array. Thus, suitable mobile towers of BSNL or any other service provider are to be chosen for installation of sensors. It may be mentioned that several sensors of EEW system of IIT Roorkee have been installed in mobile towers of BSNL.

A.1.2.4 COMMUNICATION BETWEEN SENSORS AND CMS

Transmission between sensor and CMS is most crucial as it is the backbone of the EEWDS. As far as sensors installed in NICNET / SWAN are considered, there are no issues as the network, which is entirely based on OFC cable, is available. However, decision for connectivity is required for sensors, which are not installed at NIC / SWAN. Options for modes of communication available are VSAT, mobile technology, leased line and virtual private network. Experience of IIT Roorkee, which is based on several experiments conclude that VPN on broadband is most suitable for this purpose. VSAT was ruled out due to displacement of antenna during strong shaking of earthquake, which will disconnect the antenna with the satellite. Also, VSAT takes more than 1 second for data to reach CMS from sensor. Mobile phone technology (using SIM card based modem for each sensor) was experimentally found to have very large amount of data drop. Leased line between each station and CMS is too costly. Whereas, VPN on broadband was found to have very little or no data drop, takes less than 100 milli-second for data to reach CMS from sensors, it is entirely on OFC cable and OFC cable is available at mobile towers. Therefore, all sensors installed at mobile towers will be connected to CMS using VPN of service provider. Figure A.7 given below depicts flow chart of transmission between sensor and CMS used by IIT R using VPNoBB.

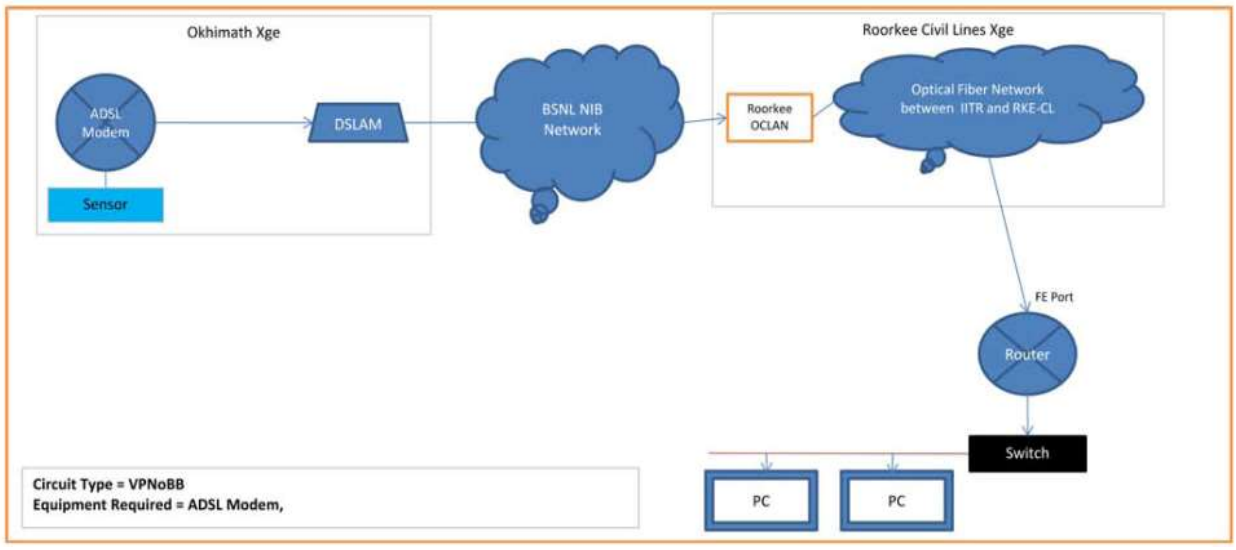


Figure A.7: Flow Chart of Transmission of Data from Sensor to CMS

A.1.2.5 CENTRAL MONITORING STATION (CMS)

Central monitoring stations are the control rooms of EEWDS where computers, 24 X 7, receive real-time data from all the sensors of the array and take decision to issue or not to issue warning. As has been mentioned above, five arrays namely Kashmir array, Central array, Bihar array, NE-1 array and NE-2 array will be deployed. For Kashmir array, CMS will be made at SEOC Srinagar, for central array CMS will be at NEOC Delhi, for Bihar array CMS will be at SEOC Patna and for NE-1 and NE-2 arrays CMS will be at Shillong. Thus, four CMS will be developed in this project.

A space of about 60 feet X 60 feet (about 325 square meter) it is to be made available by NDMA / SDMA for each CMS. In addition to high performance computers and servers, CMS will have advanced networking hardware. There will be sufficient redundancy in power supply, computers, servers and networking hardware so to achieve zero second failure of CMS. CMS will have a meeting room having a capacity of about 20 persons and the meeting room will have good quality video conferencing facility. DPR will include all aspects in detail. Details of working framework will be worked out in detail and will be finalized in consultation with client.

Each CMS will have a team comprising of at least 2 experts of seismic instrumentation having experience of EEW system, 2 networking engineers and 6 scientists in addition to other staff. One of the team members will be made group leader who should report to in-charge of national EEW system.

A.1.2.6 DECISION MAKING SOFTWARE

It is important that decision making should be based on an open source platform so that it remains transparent and open to be checked, modified, retrieved or corrected in future by permitted authorities. Earthworm is a commonly used open source platform for seismological applications and data processing. It has a strong user base, which is well networked for discussions on fault diagnostic and other problems and the members of the group are mostly quite open minded. Several modules of earthquake early warning system are also available in internet but require

changes / modifications due to varying conditions of noise, networking etc. Individuals can easily build modules for their own requirements and easily plug-in the module in the platform.

As part of a government project, IIT Roorkee has already developed software for complete earthquake early warning system on Earthworm platform. Developed system consists of number of modules, which are well integrated. Each module does a particular job like data acquisition, phase picking, parameter determination etc. Modules communicate by broadcasting and receiving various messages such as packets of trace data, phase picks, etc. The message passing scheme is analogous to radio communications. It consists of a message-carrying 'medium' and a set of standard routines, which can be considered as multi-frequency two-way radios operating in this medium. Modules can thus use routines to broadcast message to the shared memory. The same can be utilized using appropriate procedure/permissions as per Government policies and rules.

Data from all sensors are streamed into earthworm using TCP/IP protocol through BSNL leased line and NIC SWAN network. All the data is stored in shared memory location by the module specifically written to get data from installed sensors. PICK_EW, standard earthworm module keeps scanning shared memory and as soon as it founds any earthquake wave it transfers the channel to another shared memory or ring. Another module is always scanning the PICK_RING and as soon as it found waveform data in shared memory it starts estimating the EEW parameters and creates a report file based upon information stored in the configuration file for the module. Geiger's method of inversion is used to find the location of hypocenter of the earthquake. Once earthquake is picked, EEW parameters P_d and Tau_c for first three seconds of the record are calculated. Then regression models between magnitude vs P_d / Tau_c and distance are used to estimate magnitude from these parameters. Decision for issuing warning is taken only when weighted estimated magnitude from at least four sensors exceed preset threshold magnitude (which is at present set at 6). As of now magnitude estimates based on regression model using P_d is being used. Figure 8 below gives a flow chart of software used for decision making by IIT Roorkee for existing EEWD system.

Accuracy of time is another important requirement of EEW system. It is also mandatory that all the sensors and central server must be in sync in terms of time. Since sensors have functionality to update time, a NTP server within Earthworm installation is used. To achieve this, NTP has been installed at server side. The daemon NTP is very subtle and accurate NTP server program. It calculates the drift of system clock and continuously adjusts it, so there are no large corrections that could lead to inconsistent logs. The cost is a little processing power and memory, but for a modern server this is negligible. The server clock is always updated with NTP daemon and all sensors updates its time every 10 min from the server.
In this project, software developed at IIT Roorkee will be used. Necessary formalities in this regard should not have any road-blocks as this development has been done under a government funded project.

A.1.2.7 MERGING THE EXISTING EEWD SYSTEM

As mentioned earlier, IIT Roorkee is at present operating an array of about 160 sensors in Uttarakhand and will be installing another about 30 sensors soon. This installation was initially done under a project funded in 2013 by Ministry of Earth Science, Government of India and subsequently in June 2017 Government of Uttarakhand provided funds for its operation and up-gradation. This project is working in research mode under faculty members of IIT Roorkee and is being established and operated by few research scholars, project technical staff and faculty. Some of these research scholars have become experts in this field.

As per the objective of this project this existing EEWD system may be merged with newly designed EEWD System.

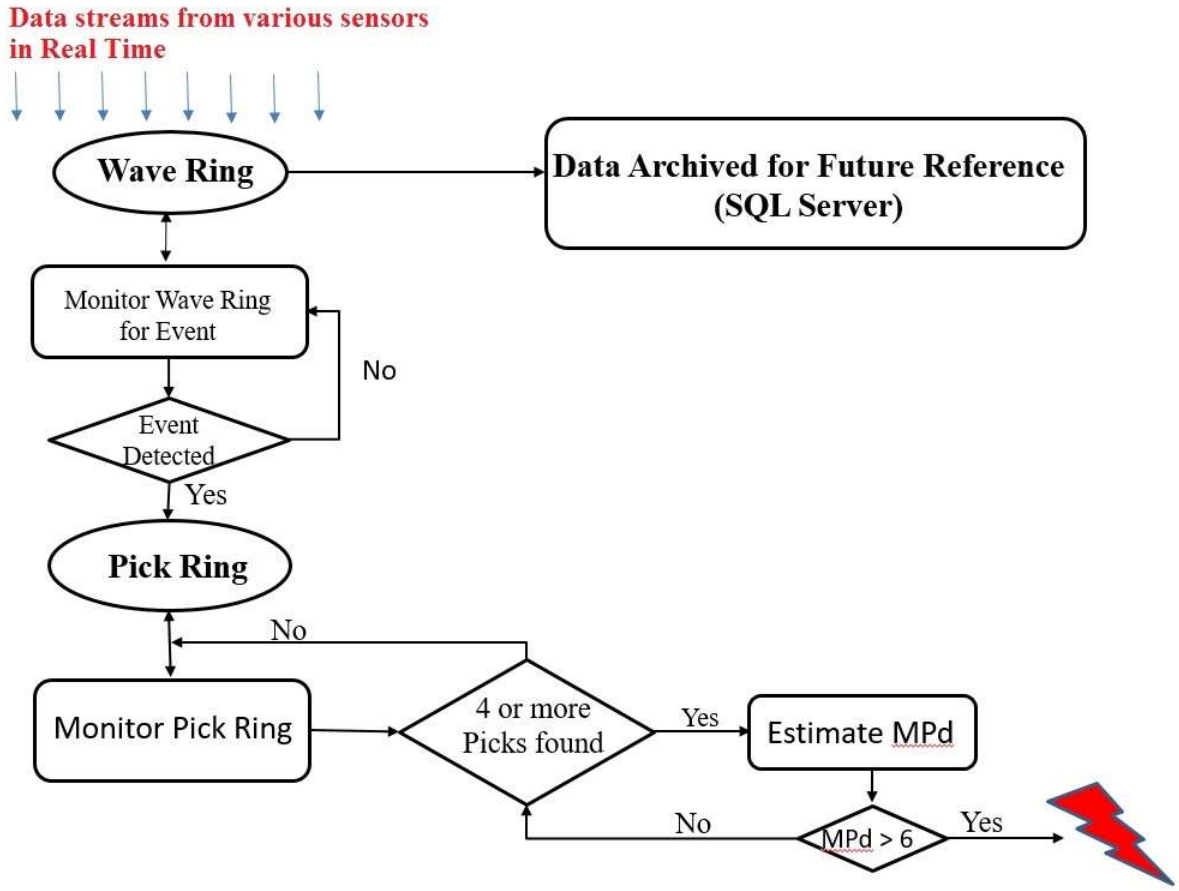


Figure A.8: Flowchart showing steps involved in decision making using EARTHWORM

A.1.2.8 DISSEMINATION OF WARNING

Once warning is issued by decision making software then it needs to be communicated to public in shortest possible time. There can be several ways, through which public can be alerted but it should be ensured that no hacker or unknown device or unauthorised person should be able to hack the dissemination system. It is, therefore, essential that whichever mode for dissemination is used, it should provide adequate safety and using dynamically encrypted warning message. This implies that the receiving end (siren, radio, TV, mobile broadcasts etc) should also have an intelligent device (like a micro computer) which should activate the alert on receiving the coded message. In this project dynamically encrypted messages will be used between decision making computer and siren/TV/mobile broadcast etc for issue of warning. Technology in this regard has already been developed.

Earthquake early warning will be disseminated to public using public sirens through client-Server TCP/IP communication protocol. Internet, NICNET, SWAN, Intranet of organizations etc. will be used to connect sirens. A similar system has been developed which use raspberry pi as a

controlling board to control the siren. As mentioned earlier, warning messages are dynamically encrypted to protect the dissemination system against hacking. Warning messages are kept small enough to reduce the load on network and avoid network congestion. Authenticity of each message is checked at siren end and siren is blown on an authentic message only. Specific sound for siren is also created to differentiate it from others sound. Health of these sirens is checked periodically and an auto generated email is sent on failure of any siren.

Warning messages will also be disseminated through mobile Apps. One such App for Android phones has been developed at IIT Roorkee which uses Google's Firebase Cloud Messaging (FCM) service. FCM is used for sending instant messages to users without any cost with a payload of up to 4KB. When a user installs the app, a unique user identification id is generated by FCM for that phone, which is forwarded to IIT R server by this app. After this, unique id is stored in user information database. A secure application programming interface (API) is developed for sending warning message to user through FCM. On receiving a warning message app is programmed to produce a specific sound to alert users. App also contains information about the steps needed to be followed on occurrence of an earthquake as well as information about how to make and find safe places in a house for hiding during occurrence of earthquake. Android Studio is used to develop this app, which is the official integrated development environment for Google's Android operating system.

Another method of issuing warning is to use radio and TV. Alert will be provided to All India Radio and all FM channels to broadcast automatically a pre-recorded message of earthquake alert. All TV stations will be fed with earthquake alert and a predesigned message with a specific sound will automatically overlap over the transmitted program. Again, safe-guarding the system from hacking will be ensured. Action will be taken to instruct all TV and radio channels for upgrading their ends for such broadcast.

Another method to issue alert will be through Multimedia Broadcast and Multicast Services (MBMS) of mobile phone service providers. All service providers have facility to broadcast a message to all their users instantly. A ready to use text will be automatically broadcasted to all its users by the service provider of mobile phones on receiving the alert. Action will be taken to instruct all mobile phone service providers for upgrading their ends for such broadcast.

In this project, in addition to issuing warning, online preparation shake map will also be developed immediately after the earthquake is over. This shake map will provide important information about ground motion shaking in the region during the earthquake. This information can be used by disaster management authorities for rescue and relief immediately after earthquake. A method developed by IIT Roorkee for shake map is described below.

Central server records complete acceleration time histories of all active stations. This data is processed for removal of noise and integrated to get velocity and displacement time histories. Peak ground acceleration, velocity, displacement and intensity at each station is then picked up. Any earthquake may not provide time histories at sufficient number of locations for generation of a good quality shake map (few thousand points are required). Various spatial interpolation techniques are examined for getting PGA/ PGV/ PGD /Intensity at all points of a dense grid (say 1 Km X 1Km) and most suitable one was implemented to get the best shake map. To create the shake map, a platform called Generic Mapping Tool (GMT) is used. GMT produces a map document and this document file can be visualise by ghost script. This map is uploaded automatically on the website and any disaster management authority can use this shake map for its search, rescue and response operations. A typical shake map developed for an earthquake is shown in Figure A.9 below.

A.1.2.9 RESEARCH AND ADVANCEMENTS FOR FUTURE

As mentioned earlier, EEWD is an upcoming field in which, at present, lot of research is going on and new innovations are coming. It is, therefore, important that the developed system (which will base on presently available technology) should remain prepared for its up-gradation. For last six to seven years, substantial amount of research has been done at IIT Roorkee in this field. Scientists of other organisations like ISR Gujarat and IIT Gandhinagar have also shown their keen interest in this field. For future, this project will generate big thrust and scientists from several other institutes will surely show interest in this field. For future upgradation it is important that appropriate research / academic institute having maximum contribution and capabilities in the field of EEW should be made active stake holder at the implementation stage of this programme.
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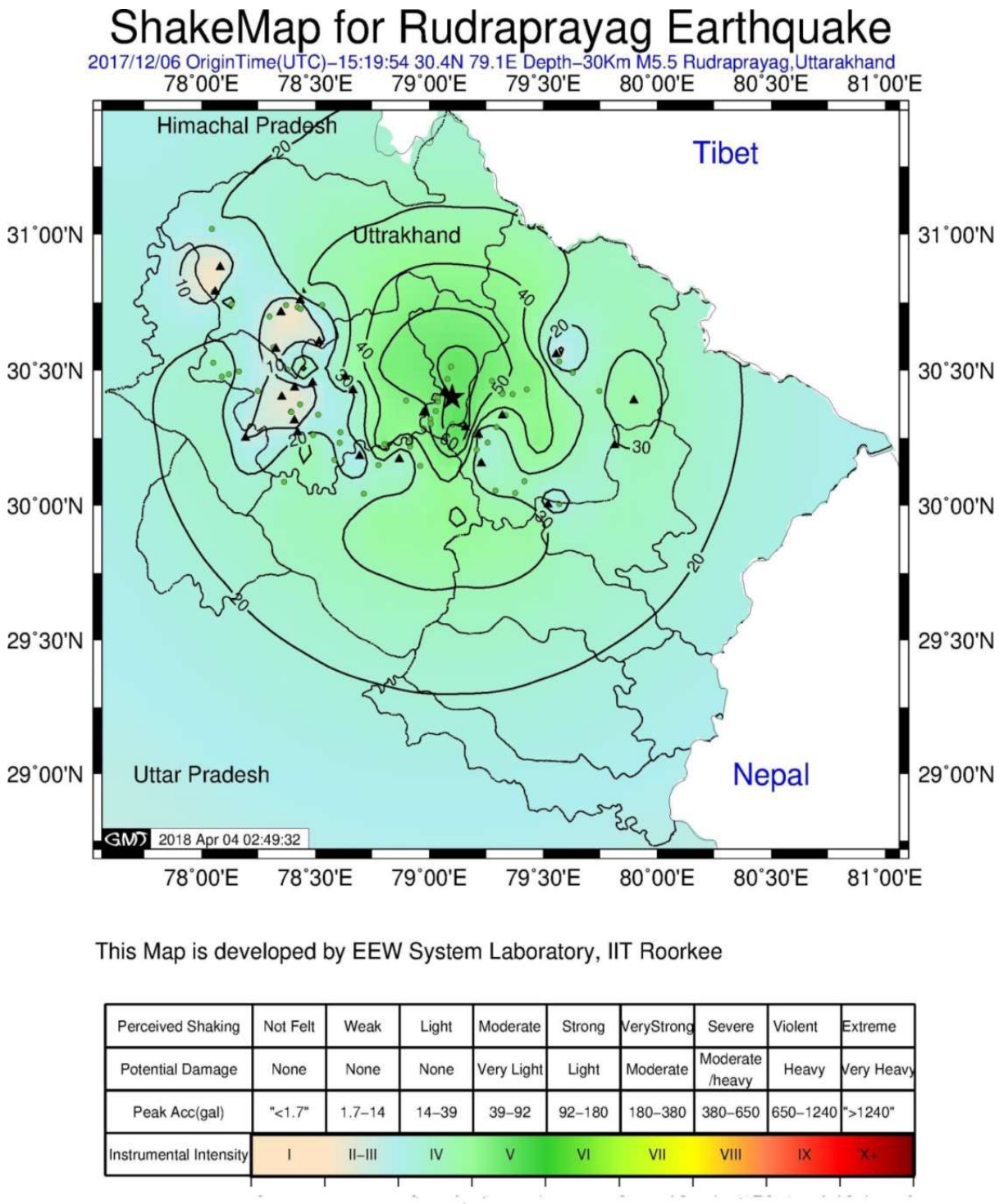


Figure A.9: Developed Shake Map for a Recorded Earthquake

A.1.3 TENTATIVE LIST OF PARTICIPATING ORGANISATIONS AND THEIR SUGGESTED RESPONSIBILITIES

For establishment of EEWD system, key participating organizations having important responsibilities will be NDMA, BSNL, NIC, SDMA of states (Assam, Bihar, Jammu and Kashmir, Himachal Pradesh, Manipur Meghalaya, Uttarakhand and Tripura) and some active research /academic institutes. Dissemination of warning (other than radio, TV and mobile broadcast) should be outsourced to one or more private player(s). Additional states may be involved in next phase of NSRMP. Important responsibilities of each organisation are given below.

A.1.3.1 PROPOSED RESPONSIBILITIES OF NDMA / NEOC /SEOC

- A senior officer of NDMA (as appropriate) will be in-charge of national earthquake early warning system comprising of all five arrays of the country.
- A team comprising of at least2 experts of seismic instrumentation having experience of EEW system, 2 networking engineers and 6 scientists will be made at NEOC at Delhi and similar teams will be made at SEOCs at Srinagar, Patna and Shillong. One of the team members of NEOC and each SEOC be made group leader who should report to in-charge of national EEW system. In addition supporting staff will be required
- A space of about 60 feet X 60 feet (about 325 square meter) will be have to be allotted by NEOC and each SEOC for central monitoring station (CMS). Further details are to be worked out.
- All sensors of arrays will stream data in real time to servers installed at respective CMS.
- At least 2 persons of CMS will be remain on duty at CMS 24 X 7.
- Group of personnel at each CMS will be responsible for ensuring connectivity between sensors and CMS. In case of non-connectivity of any sensor, person/s at CMS should take immediate action to warn the service provider (BSNL / NIC) for taking corrective action.
- Group of personnel at each CMS will ensure that the software and system is working properly and will take action as per standard operating procedure in case of malfunction.

A.1.3.2 PROPOSED RESPONSIBILITIES OF BSNL / OTHER MOBILE SERVICE PROVIDERS AND NIC

- BSNL / service provider and NIC will be responsible to host sensor installations, its upkeep (safety and physical connectivity) and streaming from all the sensors to CMS.
- At BSNL / service provider, sensors will be installed inside base room of their mobile towers.
- VPN facility of BSNL / service provider for networking of sensors will be used for EEW system. However, in case a technologically better networking plan is available with BSNL / service provider then it can be used. But it should give superior results in regard to data drop and transmission time.
- NIC / SWAN will host sensors at all the pops in DHQ, THQ and blocks falling in the region of arrays. These sensors will become part of NICNET / SWAN.
- One senior level person of BSNL and one senior level person of NIC from each state should be given the responsibility of ensuring the working of the setup.

A.1.3.3 PROPOSED RESPONSIBILITIES OF RESEARCH / ACADEMIC INSTITUTE

- Institute will have a very important task of keeping abreast with the latest development in all aspects of EEW system.
- Institute will be a key player in capacity building in the field of EEW system.
- Institute should host a parallel computational system and all the sensors will stream data at two different servers – one placed at CMS (hosted at NEOC and three SEOCs) and other placed at Research/Academic Institute.
- Major responsibility of the institute will be to closely monitor the characteristics of time history of each station for improving the decision making of the software.
- Institute will perform basic research on EEW system on topics, some of which are given below
    - Improvements in the existing decision-making software using characteristics of the streamed data.
    - Study different attributes for issue of warning and simulate the same on the streamed data.
    - Study local site effects on the streamed data and its implications in EEW.
    - Research and development on warning dissemination including mobile apps.
    - Any other topic dealing with the subject.
- Due to some emergency and if required, parallel computational system at the institute may be developed as CMS.

A.1.3.4 PROPOSED RESPONSIBILITIES OF OUTSOURCED ORGANISATIONS

- Such organizations will prepare modalities to transmit warning through siren, mobile apps and trigger for industry.
- They should clearly demonstrate the technology that they will use for dissemination of warning including security against hacking.
- They should also demonstrate diagnostic tests of siren systems, keeping records of status of sirens and repair with minimum downtime.
- They should submit the projected cost on which they will sell siren systems to various government and non-government organizations. The cost should include recurring cost of internet or any other communication method.
- They will have the right to sell the warning to industry as per market force.
- They will also have the right to prepare a mobile app and sell it to mobile users as per market force.
- Their performance (readiness) will be monitored by concerned SDMA.

A.1.3.5 PROPOSED RESPONSIBILITIES OF VARIOUS SDMAs

- SDMAs of concerned states will be responsible for training public in regard to do’s and dont s’ in the event of EEW warning.

- Promote pamphlets, posters and any other means to educate people about how best to respond in the event of EEW warning.
- Lot of literature on Dos and dont's in the event of an earthquake warning is available and Figures A.10 below show a typical poster prepared by IIT Roorkee, which have been prominently displayed at student hostels and other places in the institute.
- They will suggest and advice installation of sirens at various government and non-government setup. Sirens must be installed in each village and every mohalla of cities of the effected region described in earlier sections. Typically one siren can cover an area of approximately 3 square km.
- They will be responsible to monitor proper functioning of dissemination systems outsourced to private players, which are being installed in their respective states.

All India Radio, FM broadcasters, DD, other TV channels and service providers of mobile phone as well as NDRF / SDRF will have to be brought in loop for dissemination of warning and for propagating do's and dont's on issue of EEW warning. Role and responsibilities are to be finalised in consultation with client as per Government Policy

Figure A.10: Poster for Do's and Don'ts inside Class Room in the event of an earthquake warning

A.1.4 WORKING AND MONITORING COMMITTEE

A.1.4.1 PROPOSED WORKING COMMITTEE

A system for working and monitoring committee has to be worked out in detail. Tentative system is proposed below:

- The following will the formal working committee
  - Officer in-charge of the national EEW system: Chairman
  - Group leaders of all CMS: Member
  - In-charge of EEW system of the designated research / academic institute: Member
  - Officer in charge of BSNL and NIC of respective states: Member
  - Officer in charge of SDMAs of respective states: Member
  - Senior most technical officer (s) of outsourced agencies: Member
  - Group leader of CMS NEOC: Convener
- Formal working committee meetings will be held once in a month (say first Friday of every month). In this meeting, as far as possible, all members or their representatives should attend.
- All those scientists and officers who are directly participating in the project will also be encouraged to attend working committee meetings.
- If required informal meetings of working committee will be held more frequently. During these meetings, it will not be necessary that all members may be called.
- All meetings will fully utilize the services of video conferencing so as to avoid time lost in travel etc.
- These meetings will deliberate upon problems and bottlenecks in execution of the work and will attempt to get the most optimum solutions.
- Recorded minutes of all meetings (formal and informal) will include attendance, problems discussed and solutions arrived. These minutes will become important technical document for future diagnosis.
- Planning of work for the next month, fine tuning of individual responsibilities and problems & their solutions will be the main agenda of monthly meetings. Free open discussions and arriving at best solutions, irrespective of individual egos, will be the goal of all working committee meetings. However such detasils are to be finalized by NDMA

A.1.4.2 PROPOSED MONITORING COMMITTEE

- It will be the apex committee which will send its report to government about performance of national EEW system
- This committee will also act as advisory committee of the project.
- The committee will comprise of following
  - Vice Chairman / Secretary NDMA: Chairman
  - Two eminent seismologists: Member
  - One eminent network technologist: Member
  - One eminent EEW expert: Member
  - Member Technology, Telecom Commission of India or his representative: Member

- Director General NIC or his representative: Member
- Head of the institute of designated research / academic institute or his representative: Member
- All members of NDMA: Member
- Officer in-charge national EEW system: Convener

Details are to be worked out by NDMA when project is implemented.

A.1.5 Budgetary Assessment

As per detailed requirements given in above sections, budgetary requirements will be worked out. Budget will be prepared taking into account approximate cost of sensors, present salary structure, prevailing government rates for civil, electric work etc, communication, computers, servers, networking equipment, air conditioning etc.

A.1.6 ONSITE EARTHQUAKE EARLY WARNING SYSTEM

Regional EEWDS described above is capable to issue public warning to a large region in case of major earthquake occurs with epicentre in the instrumented region. However, medium and small intra-plate earthquakes may originate in regions where instrumentation has not been done. For example earthquakes having magnitudes between 5 and 6 can originate from Moradabad fault, Gurgaon and other seismogenic features around Delhi. These earthquakes are capable create damage to several infrastructure projects. Also, large size earthquakes occurring in Pakistan or Afghanistan may cause damage to infrastructure in parts of India. For such situations onsite earthquake early warning systems will be deployed. In onsite early warning system, warning / alert is issued at the same place where sensor is deployed. It is capable to issue warning on arrival of P phase of earthquake and will provide warning time till damaging S phase arrives. In most cases it is capable to issue warning of few seconds to about 15 seconds for damaging intensities. Its application is very important to safe guard important infrastructure facilities. Few manufacturer (mostly outside India) are manufacturing and selling this product.

Onsite EEW system should be capable to alarm people and shut off all running applications during primary wave phase, before the destructive secondary wave of a severe earthquake strikes and thus minimize the losses. System should be capable to identify the incoming intensities of an earthquake on the arrival of primary waves and should have inbuilt relays as well as optical and acoustic sirens which should activate when ground intensity exceeds threshold value.

All critical projects / infrastructure facilities which are expected to malfunction during earthquake shaking or which can be shutdown to reduce / prevent its damage due to earthquake should use onsite earthquake early warning systems. Facilities / infrastructure projects recommended to have onsite earthquake early warning systems are

Service providers of Gas pipelines

Applications of gas pipe lines

Metro lines at approximately every five kms

High speed train corridors at about every five kms in seismic zones IV and V as well as at about every 20 kms in seismic zones II and III.

Airport control towers

Nuclear Power Projects

All other power projects

Hospitals

Manufacturers using vibration sensitive machines

Other setups / units / facilities which needs shutting during earthquakes

Table 2 Tentative Specifications of Onsite Earthquake Early Warning System

1	**Conditions**	a) System Capable of working on Power supply of 12V DC/24V DC/230V AC b) The product capable to generate SMS or Email alerts. c) The product should be capable to trigger on the primary wave of the earthquake (threshold level 0.015g -0.4g) and triggering on different threshold levels. d) The product should have proven record of triggering of early warning of earthquake at any place of installation. e) The product must have sensor test facility 24x7, in case of a sensor problem via LED and RELAY to BMS. f) The product should have proven test reports from two or more different reputed scientific institutions or universities.
2	**Specifications of System Sensors**	a) Electronic sensor (3-Axis), Analysis method- 3 Analog devices sensors, installed in the system in 3 directions (X,Y and Z axis) making 3 axis capable of analyzing the acceleration of the ground motion from all directions. b) Operating Range: DC - 40 Hz c) Noise: ~0.01m/s2
3	**Features/Components of Master Detector**	a) Relay controlled connections for Sirens. b) Relay connections for the commissioning of warning / shut down. c) Master System Installed in Protected Weatherproof case.
4	**Earthquake detector Sub Master**	Sub Master connecting to Master system via bus cable, compulsory for redundant configuration capable of running on power supply of 12V DC/24 V DC/230V AC supported by:

		a) Battery back up to avoids voltage fluctuations/ power failure. b) Relay connections for Sirens. c) Relay connection for the commissioning of warning / shut down. d) Sub Master System Installed in Protected Weatherproof case. e) Capable of displaying on the system helping user's as guide.
5	**Installation including cabling and other Services like**	a) Training of technical staff in the earthquake early warning. b) Training in earthquake. c) Training in behavioural measures. General Advice in earthquake

Details will be worked out in DPR.

A.2. COMPONENT A-2: ENHANCING EMERGENCY RESPONSE CAPACITY

An EEWDS system may be in place but it has to be supported by desired response system. This response system will be worked out and relevant literature/videos/leaflet/mock drills mechanism etc. related to EEWDS will be developed Training of officials at center in PMB and in State PIVs will be conducted as desired.

However, this particular component has major focus upon the following three major criteria's:

- Upgrading existing and providing additional search and rescue equipment for: State Disaster Response Forces, Fire & Emergency Services and other emergency /first responders.
- Training and capacity building programme for emergency/first responders.
- Augment the disaster risk management capacities of the communities.

These three are described below:

Upgrading existing and providing additional search and rescue equipment

The major priority issues to be addressed under this heading are:

1. Assess
   1.1 the stakeholders involved in emergency response and preparedness
   1.2 the responsibility overlaps and gaps
   1.3 the current capacity and their up-gradation plan and resource allocated
2. Lessons learnt from disaster reports / past experience
3. Work out feasible measures for effective response
4. Recommend list of new equipment and tools with technical specs and procurement ToR

By addressing the priority issues listed above and through need assessment additional search and rescue equipment for emergency/first responders.

Training and capacity building programme

The major priority issues to be addressed are as follows:

1. Follow training design process to develop the training and capacity building program manual.
2. Strategy to mainstream newly developed training modules in identified departmental annual training calendar with adequate support for Sustainability and Resource allocation support to various department.
3. Design strategy for Monitoring and Evaluation (M&E) and Impact assessment system so as to enable stakeholders to revise training modules as appropriate.

Augment the disaster risk management capacities of communities

The major priority issues to be addressed under this heading are:
1. Understand the social –economic and behavioural aspects of target community, their Disaster Risk Reduction (DRR) priorities, study and analyse available awareness initiatives.
2. Work on best options with due consultation of the stakeholders to develop implementation plan, as needed
3. Design required tools for awareness and education
4. Recommend measures to link tools with existing state run development programmes if any
5. Develop Impact assessment measures for the education and awareness.

To assess existing emergency response capacity a questionnaire (Form A2) is developed and is placed at end of Annexure A. This may be filled by SPIU authorities and essential data may be shared.

A.2.4 COMPLIANCE TO ENVIRONMENTAL AND SOCIAL MANAGEMENT FRAMEWORK (ESMF)

For above components A-1 & A-2 desired studies will be carried out, if essential, in compliance to the ESMF and related reports/documents/ disclosures will be prepared based on relevant parameters of these components and DPR of this part.

A.2.5 FORMS/ QUESTIONNAIRE RELATED TO COMPONENT A

The following forms will be used for collecting the data for Component A from State Disaster Management Authorities and other stakeholders as needed

Form A1**:** Earthquake Early Warning Dissemination System
Form A2: Enhancing Emergency Response Capacity

FORM A1: Earthquake Early Warning Dissemination System

Location:

Date:

Name of Respondent:

Position of Respondent:

Name of Surveyor:

1.a.	Presence of existing Disaster Warning System	Yes	No
1.b	Details of the System (please provide a list of the existing system)		
1.b.	Type of Disasters the Warning System caters to		
1.c.	Compliance of Environmental regulations of the Warnings System	Yes	No
1.d.	Any EIA done for the existing Warning System (please provide a copy of the same)	Yes	No
1.e.	Real Time Data Collection	Yes	No
1.f.	Global Navigation Satellite System is attached	Yes	No
1.e.	Systems are ISO Compliant	Yes	No
2.a.	Details of Technology Provider (please provide a list of the same)		
2.b.	Data collection and record generation	Yes	No
2.c.	Data collection and record generation of previous five years (please provide a copy of the same)		

2.d.	Data Monitoring Office Details (please provide a list of the same)		
2.e.	Data Storage location (please provide a list of the same)		
2.f.	Data Storage Record Keeper (please provide a list of the same)		
3.a.	Training provided to the Personnel	Yes	No
3.b.	Training Manual (please provide a copy of the same)		
3.c.	System Operating Manual (please provide a copy of the same)	Yes	No
3.d.	Details of the System (please provide related document)		
3.e.	Frequency of Maintenance of the System		
4.a.	Any failures of the Warning System in past five years	Yes	No
4.b.	Type of failures		
4.c.	Mitigation of the issue		
4.d.	Requirement of more Warning System	Yes	No

Note* Enclose all details (hard copy and /or soft copy)

Seal and Signature of the Responding Officer on behalf of the State

Form A2: Enhancing Emergency Response Capacity

Location:

Date:

Name of Respondent:

Position of Respondent:

Name of Surveyor:

1.	Collapsed Structure Search and Rescue Equipment			Nos.
1.1.	Portable Generator	Yes	No	
1.2.	Angle cutter (electric)	Yes	No	
1.3.	Diamond tipped blade for angle cutter	Yes	No	
1.4.	Composite Blade Network for angle cutter	Yes	No	
1.5.	Circular Saw (Electric) with Carbide Tipped Blade	Yes	No	
1.6.	Circular Saw carbide tip blade	Yes	No	
1.7.	Electric drill set	Yes	No	
1.8.	Fire extinguisher (dry chemical type)	Yes	No	
1.9.	Portable Oxygen Breathing Unit Set	Yes	No	
1.10.	Carbide tipped chain saw	Yes	No	
1.11.	Distress signal Unit	Yes	No	
1.12.	Inflatable lighting Tower (Emergency Lighting System)	Yes	No	
1.13.	Cordless Hammer Drill	Yes	No	
1.14.	Gas Cutter (Heavy duty)	Yes	No	
1.15.	Rubber Pipe Duplon Type	Yes	No	
1.16.	Air lifting bag set with air cylinder	Yes	No	
1.17.	Combination Cutter with Spreader Power Unit	Yes	No	
1.18.	Diamond chain saw	Yes	No	
1.19.	Floating Pump	Yes	No	
1.20.	Hammer drill concrete	Yes	No	
1.21.	Portable Generator set 10.5 KVA(Silent Type Diesel & Water Cooling)	Yes	No	
1.22.	Victim location unit (with breaching system)	Yes	No	

1.23.	Breaching system	Yes	No	
1.24.	Leak tester for testing respiratory eqpts	Yes	No	
1.25.	Life Detector TYPE - I	Yes	No	
1.26.	Life Detector TYPE – II	Yes	No	
1.27.	Head Light Pelican	Yes	No	
1.28.	Reflective Jackets	Yes	No	
1.29.	Self-Contained Positive Pressure & Open Circuit Type Breathing Apparatus	Yes	No	
1.30.	Ventilator & Air Tube	Yes	No	
1.31.	Safety Torch	Yes	No	
1.32.	Hand held gas detector	Yes	No	
1.33.	Thermal Imaging Camera	Yes	No	
1.34.	Multi Gas Detector	Yes	No	
1.35.	Specialised evacuation equipment for Air Evacuation	Yes	No	
1.36.	Helipad marking equipment for summer and winter	Yes	No	
1.37.	Handheld communication equipment	Yes	No	
1.38.	Specialised canine (K9) unit for post disaster search	Yes	No	
1.39.	Remotely Operated Vehicles (ROVs)	Yes	No	
1.40.	Drone / Quad Copter	Yes	No	
1.41.	Recue line launcher	Yes	No	
2.1.	List of First Responder(s)	Yes	No	
2.2.	State Emergency Response System is in place	Yes	No	
2.2.a.	If Yes, copy of the system details regarding list of first responders (with contact details like name, telephone numbers, email addresses etc.) year wise training programmes conducted			
2.2.b.	Details of training programmes conducted (year wise)			
2.2.c.	Case studies / experiences / lessons learned / reports with years and copies of documents (if available)			
2.3.	Existing alternative contact system exist	Yes	No	
2.3.a.	If Yes, copy of the system details regarding list of first responders (with contact details like name, telephone numbers, email addresses etc.) year wise training programmes conducted			
2.3.b.	Details of training programmes conducted (year wise)			
2.3.c.	Case studies / experiences / lessons learned / reports with years and copies of documents (if available)			
2.4.	Capacity building of the First Responders and refresher training	Yes	No	
2.5.	Community awareness training (year wise)	Yes	No	
2.6.	Report of Community Training	Yes	No	

Note* Enclose all details (hard copy and /or soft copy)

Seal and Signature of the Responding Officer on behalf of the State

State:

Note: Provide list / Data as separable Attachments.

ANNEXURE B

B. COMPONENT B

B.1. RETROFITTING OF BUILDINGS

To achieve the risk reduction objective by retrofitting / new construction, an overall methodology mentioning the activities to be performed, outcome of these activities and deliverables is shown in a tabular format in Table B.1 below:

Table B.1 Building Retrofitting Methodology Chart

Step No.	Activity	Outcome	Deliverables
Step 1	• Meeting respective SPIUs and other relevant State Departments to identify and prepare an initial list of buildings covering various typologies, type of occupancy and use. • Assessment of Initial List of buildings on basis of data available and codal provisions	• Grouping of buildings as per their typology / occupancy / use in three heads such as Critical, Semi Critical and Least Critical to arrive at tentative list of buildings to be retrofitted will be useful to fix priority.	Progress Report
Step 2	• Discussion / project planning meeting with client • Finalisation of Methodology for carrying out Detailed vulnerability Assessment (DVA) • Finalisation of Performance level and associated criteria for safety.	• Planning for detailed survey, type of tests and action plan. • Final Methodology including Method of Analysis like Linear Static Analysis, Linear Dynamic Analysis, Non-Linear Static Analysis and Non-Linear Dynamic Analysis. • Final Performance Level and associated criteria.	Part of Inception Report / Progress Report
Step 3	• Visit sites for Data Collection • Carry out Visual Survey for condition assessment • Perform NDT tests as per need • Carry out Geotechnical Investigation, if needed • Carrying out Laboratory tests on samples collected during site visit • Collect Information pertaining to Social & Environment Impact	• Information of – Building with photographs, – material condition, – material properties, – geometric properties, – existing construction defects – List of non-structural appendages, elements and equipment – Soil properties such as 'N' value, etc. – Data on Social & Environmental Impact	Progress Report

Step 4	• Analysis of collected information • Preparation of drawings • Quick assessment from irregularities to finalise mathematical model • Grouping of Non-Structural Appendages and elements based on their type	• As built drawings • Structural system drawings • Material & geometric properties • List of irregularities in both directions i.e. plan and vertical and other configuration defects • List of vulnerable non-structural elements in respective groups such as vertical/horizontal appendage, critical equipment in hospitals, etc.	Progress Report
Step 5	• Finalisation of structural model as per irregularities present • Perform Detailed Vulnerability Assessment	• Location of local / global failing / deficient structural members • Structural component strength is sufficient or not • Drift limitations are satisfied or not • Performance Level is achieved or not	Progress Report
Step 6	• Suggest retrofitting options at local / global level • Perform Analysis of retrofitted building	• Check for all deficiencies mentioned above in Step 5 • Repeat this step by enhancing / implementing different retrofitting schemes until building is found safe for desired performance level	Progress Report
Step 7	• Design of supporting system for appendages and critical equipment in critical facilities	• Check as per Indian codes/guidelines	Progress Report
Step 8	• Performing Social & Environmental Impact Assessment and preparation of reports / documents under ESMF • Preparation of DPR	• Reports in compliance to documents under ESMF • DPR (Cost, Specification, BOQ, etc.)	ESMF Documents Reports & DPR of retrofitted buildings

The flowchart depicting the overall methodology for retrofitting of the buildings to be finalised after due consultation with PMU and SPIUs is shown below under figure B.1 below.

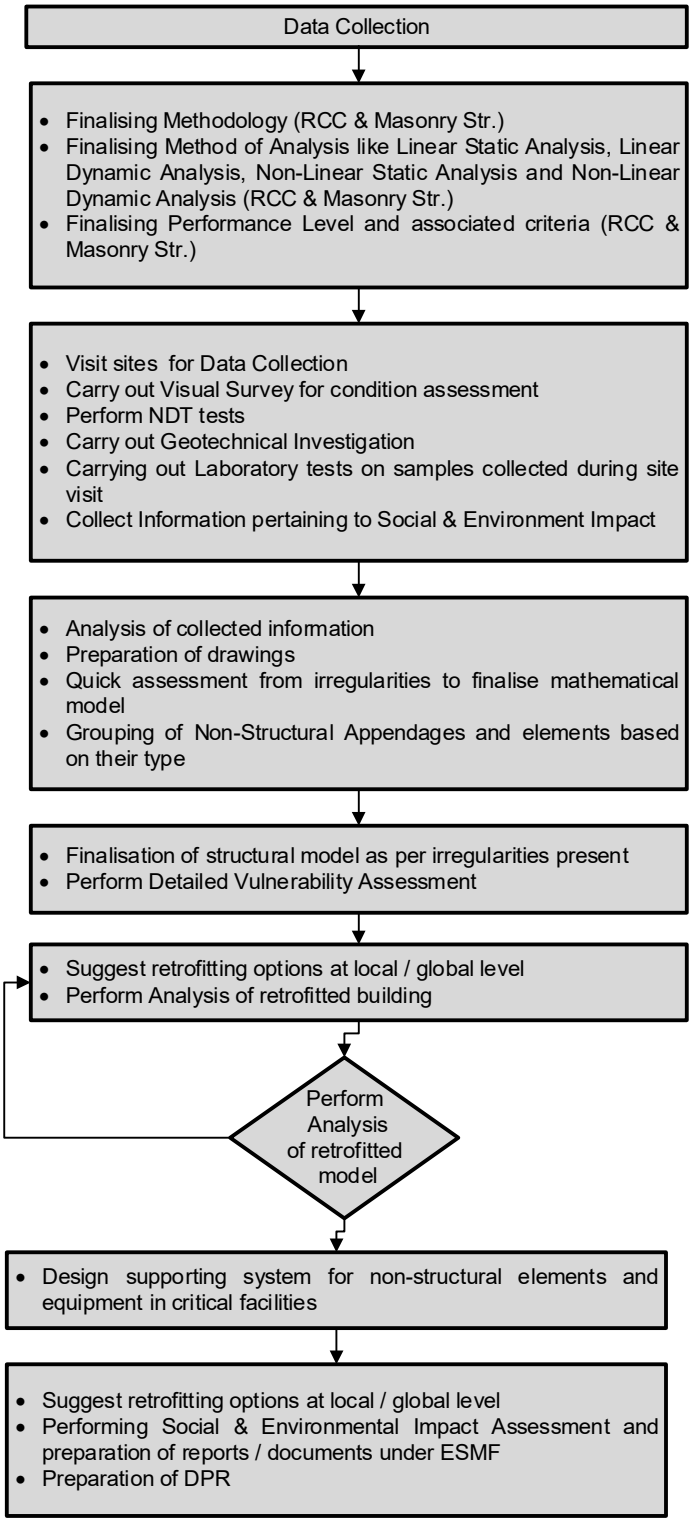


Figure B.1: Flowchart depicting the overall methodology for retrofitting of Buildings

The broadly specified activities in the flow chart above comprises of number of sub-activities to achieve the task at hand. Accordingly, the detailed methodology showing the different sub-activities under each activity is given below:

Step1: Collection of List of Buildings for Retrofitting

(a.) A kick-off meeting with the Centre followed by respective SPIU Units and related Government Officials will be conducted.
(b.) During these meetings, the respective State Governments will be requested to share their list of buildings / structures which they want to undertake for retrofitting.
(c.) Further, any previous data that the State Government may have collected / prepared in past of these buildings may be provided
(d.) The list may be provided in format given in Form B1 at end of Annexure B.

Step 2: Building Prioritising Criteria

A detailed yet simple method shall be used to categorise the various buildings into three heads i.e. Critical, Sub-Critical and Least Critical before identifying, which buildings are to be selected for retrofitting and up to which Performance Level. The selection of buildings shall be finalised by considering most popular typologies of the buildings so that sample typologies get covered for setting an example for the future.

The outcome of this step will be a finalised list of buildings for which retrofitting DPRs are to be prepared.

Step 3: Finalisation of Methodology, Method of Analysis, Performance level and its Criteria

(a.) Based on finalised buildings to be retrofitted as per exercise carried out above, a calendar will be prepared to visit the screened sites for detailed survey.
(b.) Permission letters / Official permissions shall be applied to respective state Project Implementation Units for un-obstructive building and site survey and carrying out NDT and geotechnical investigation and collection of material samples for further testing in accredited laboratory.
(c.) Based on typology of the building, the Data Collection, Non-Destructive Tests, Geotechnical Investigation, Performance Level, Method of Analysis, etc. shall be considered differently. The same have been mentioned in brief in following sections for masonry and RCC Buildings separately.
(d.) Meetings shall be held with client to finalise the methodology, methods of analysis and performance levels and their respective criteria for various typologies.
(e.) Higher performance level opted for a building, will result in higher cost of retrofitting as retrofitting measure will be greater and hence, it may not be practicable to retrofit all buildings for the highest level. Also the fact that many buildings may be very old and have lived most of its life, hence, retrofitting of such buildings to achieve the highest Performance Level may not work out to be a practical solution.
(f.) It may not be possible to obtain Immediate Occupancy Performance Level for masonry buildings and impractical to obtain the same for very old RCC Buildings. Hence, performance levels for such buildings may be limited to Life Safety performance level whereas relatively newer RCC buildings where possibility of code compliance exists can be retrofitted for immediate occupancy performance level. Hence based on mutual decision, the performance level shall be finalised for the buildings.

Step 4: Data Collection (As per format in Sample Forms)

(a) Calendar will be prepared to visit all sites within stipulated time as per contract to carry out detailed site survey.

(b) Before moving to site, all existing drawings of the selected infrastructure shall be collected from respective SPIUs, if available.

(c) To collect more information other than drawings, etc. detailed questionnaires on topics such as General Building Data, Architectural Building Data, Structural Building Data, MEP and Fire Fighting related Data, Non-Structural Appendages and Elements Data, Non-Destructive Testing & Geotechnical Investigation Data, etc. have been prepared. The questionnaires are prepared in general format to cover all types of buildings such as Load Bearing Structures and Frame Structures, etc. Based on the typology, they follow a set pattern which also guide with respect to the type of NDT tests to be carried out for a specific typology structure. Samples of these Forms (tentative) are shown as Forms B1A to B1G at end of Annexure B.

(i) Form B1B has been made to collect General Building Data, information pertaining to the name of building, type of building, age of building, general occupation of building, etc. will be collected and mentioned.

(ii) Form B1C has been generated to collect Architectural Data such as dimensional details, sectional sizes, layout of MEP and firefighting services, if required footing dimensions, etc. that will be measured and drawn or checked with existing drawings. Figure B.2 show measurement being taken in a Hospital Buildings.

Figure B.2: Measurement being carried out on site for preparing As-Built Drawings

(iii) Form B1D has been generated to collect Structural Data, visual condition survey with pictures showing the damage and structural distress, if any. Pictures shown under figure B.3 below show two types of distress observed during site visits.

Figure B.3: Structural Distress observed during Visual Survey

(iv) Form B1E has been generated to collect data about Non-Structural Appendages and equipment (only for health infrastructure) and listed in tabular format.

(v) Form B1F and B1G has been generated to share result output of NDT & Geotechnical Testing, three type of tests shall be conducted on site, followed by laboratory testing of samples. The three type of tests performed on the site will be Semi-Destructive Tests & Non-Destructive Tests (NDT) and limited Geotechnical Investigation. For Masonry Buildings, brief description of different tasks that will be performed under each type of test is given below:

Semi-Destructive Tests (Masonry Buildings):

- Samples of masonry units and mortar shall be collected for each building. Minimum three to four samples shall be collected for each storey spanning across the entire floor in a random manner to get average material properties for every storey. Pictures of samples being collected from sites are shown under figure B.4.
- Earthquake Strengthening Measures shall be identified as per IS 4326:2013.

Figure B.4: Masonry Unit & Mortar Samples being collected from site

Non-Destructive Testing (Masonry Buildings):

- Rebound Hammer test shall be carried out on concrete beams, slabs and lintel beams to get the grade of concrete. Rebound Hammer test shall be carried out on the building as per guidelines mentioned in IS 13311(Part 2):1992.
- Ultra-sonic Pulse Velocity test shall be carried out on concrete beams and slabs to get an idea about the quality of concrete. UPV test shall be performed on site as per IS 13311(Part 1):1992.

Picture showing direct Ultrasonic pulse velocity test being conducted on a roof beam and rebound hammer test being conducted on a RCC roof slab is shown under figure B.5.

Figure B.5: USPV & Rebound Hammer Test being conducted in Masonry Building

Geotechnical Investigation (Masonry Buildings):

- Trial Pit(s) shall be excavated at base of an external wall on outside of the building to get details such as type of footing, material of construction of footing and most importantly, the dimensions of the footing. Pictures shown below under figure B.6 show two buildings with trial pits showing respective footings.

Figure B.6: Trial Pits excavated to expose footing for taking measurement and testing

- Dynamic Cone Penetration Test shall be carried out to get the soil properties by relating the number of blows with the resistance offered by the soil. IS 4968(Part 1) shall be followed to conduct the Dynamic Cone Penetration Test. This shall be done at existing base of the footing.
- Standard Penetration Test shall be carried out to obtain the safe bearing capacity of soil from the 'N' value and soil sample collected to be tested later in laboratory for getting soil properties. The procedure mentioned in IS2131:1981 shall be followed to perform the SPT. This shall be done at existing base of the footing.
- Liquefaction Potential of soil, as per site applicability shall be ascertained as per Clause 3.12 and 6.3.5.3 following the guidelines under Annex F of IS 1893 (Part 1):2016

Pictures showing SPT and DCPT being carried out on site is shown under figure B.7 below.

Figure B.7: SPT & DCPT being carried out on site

Laboratory Testing (Masonry Buildings):

The samples that shall be collected during the site testing / investigation will be further subjected to testing in laboratory. The tests and code that shall be followed for testing of the samples are mentioned below:

(i) Masonry Unit Samples
- Dimensions of the masonry units shall be measured and noted as per procedure mentioned in IS 1077:1992.
- Water absorption test shall be performed on all samples as per procedure mentioned in IS 3495 (Part 2):1992.
- The masonry units shall be put under Universal Testing Machine to get their compressive strength as per procedure mentioned in IS 3495 (Part 1):1992.

(ii) Mortar Samples
- Mortar samples shall be subject to chemical analysis. The procedure as mentioned in ASTM C-1084-97 was followed to arrive at the mix ratio of the mortar.

(iii) Soil Samples
- Soil samples shall be subjected to multiple tests to obtain various properties such as shear strength parameters of soil i.e. 'c' and 'Ø', liquid and plastic limit, density and specific gravity, etc.

Pictures showing few samples being tested in the laboratory is shown under figure B.8 below.

Figure B.8: Samples Subjected to Testing in Laboratory

Similarly, for RCC Frame Buildings, brief description of different tasks that will be performed under each type of test is given below:

Semi-Destructive Tests (RCC Buildings):

- Samples of masonry units and mortar shall be collected. Minimum three to four samples shall be collected for each storey spanning across the entire floor in a random manner to get average material properties for every storey.
- Core Samples shall be collected from columns, beams and footings (as per site circumstances) to test for the material properties in laboratory in due course. Picture showing coring to collect core sample is shown in pictures under figure B.9 below.

Figure B.9: Core Samples being collected for testing in laboratory

Non-Destructive Testing (RCC Buildings):

- Rebound Hammer test shall be carried out on columns, beams and footing to get the grade of concrete. Rebound hammer test shall be carried out on the building as per guidelines mentioned in IS 13311(Part 2):1992.

- Ultra-sonic Pulse Velocity test shall be carried out on few columns, beams and footings (as per site circumstances and requirement) to get an idea about the quality of concrete. UPV test shall be performed on site as per IS 13311(Part 1):1992.
- Rebar Locator test shall be carried out on columns, beams and footings (as per site circumstances and requirement) to obtain concrete cover, probable diameter and spacing of reinforcement.

Pictures showing Rebound Hammer, Ultrasonic Pulse Velocity and Rebar Location Tests being conducted on various sites is shown under figure B.10 below.

Figure B.10: Rebound Hammer, Ultrasonic Pulse Velocity and Rebar locator Tests being conducted on sites

Geotechnical Investigation (RCC Buildings):

- Trial Pit shall be excavated at base of a column(s) (preferably outer peripheral / corner column) to get details such as type, material of construction and the dimensions of the footing. Pictures showing the trial pits are shown under figure B.11.

Figure B.11: Trial Pits at Base of Corner Columns

For buildings where pile foundation exits, it will be presumed that foundation failure will not occur and only vulnerable superstructure will be analysed for seismic retrofitting.

- Dynamic Cone Penetration Test shall be carried out to get the soil properties by relating the number of blows with the resistance offered by the soil. IS 4968(Part 1) shall be followed to conduct the Dynamic Cone Penetration Test. This test shall be performed at base of the existing footing.
- Standard Penetration Test shall be carried out to obtain the safe bearing capacity of soil from the 'N' value and soil sample shall be collected to be tested later in laboratory for getting soil properties. The procedure mentioned in IS2131:1981 shall be followed to perform the SPT. This test shall be performed at existing base of the footing.
- Liquefaction potential of soil, as per the site applicability shall be ascertained as per clause 3.12and 6.3.5.3 following the guidelines under Annex-F of IS 1893 (Part I):2016.

Laboratory Testing (RCC Buildings):

The samples that will be collected during the site testing / investigation shall be further subjected to testing in laboratory. The tests and respective codes followed for testing of the samples are mentioned below:

(i) Masonry Unit Samples
- Dimensions of the masonry units shall be measured and noted as per procedure mentioned in IS 1077:1992.
- Water absorption test shall be performed on all samples as per procedure mentioned in IS 3495 (Part 2):1992.
- The masonry units shall be put under Universal Testing Machine to get their compressive strength as per procedure mentioned in IS 3495 (Part 1):1992.

(ii) Mortar Samples
- Mortar samples shall be subject to chemical analysis. The procedure as mentioned in ASTM C-1084-97 will be followed to arrive at the mix ratio of the mortar.

(iii) Core Samples
- Concrete Core samples collected from site shall be subjected to tests to obtain the Compressive strength of concrete to relate with the compressive strength obtained from Rebound Hammer Test results.

(iv) Soil Samples
- Soil samples shall be subjected to multiple tests to obtain various properties such as shear strength parameters of soil i.e. 'c' and 'Ø', liquid and plastic limit, density and specific gravity, etc. at the depth of footing.

Figure B.12 shows a flow chart wherein the different activities that shall be performed under data collection process are mentioned for better understanding.

The plan will ensure checking the quality assurance and checks of data from the site and labs before it comes for compilation. Further the team will ensure quality of data and computation in all steps in the following sections.

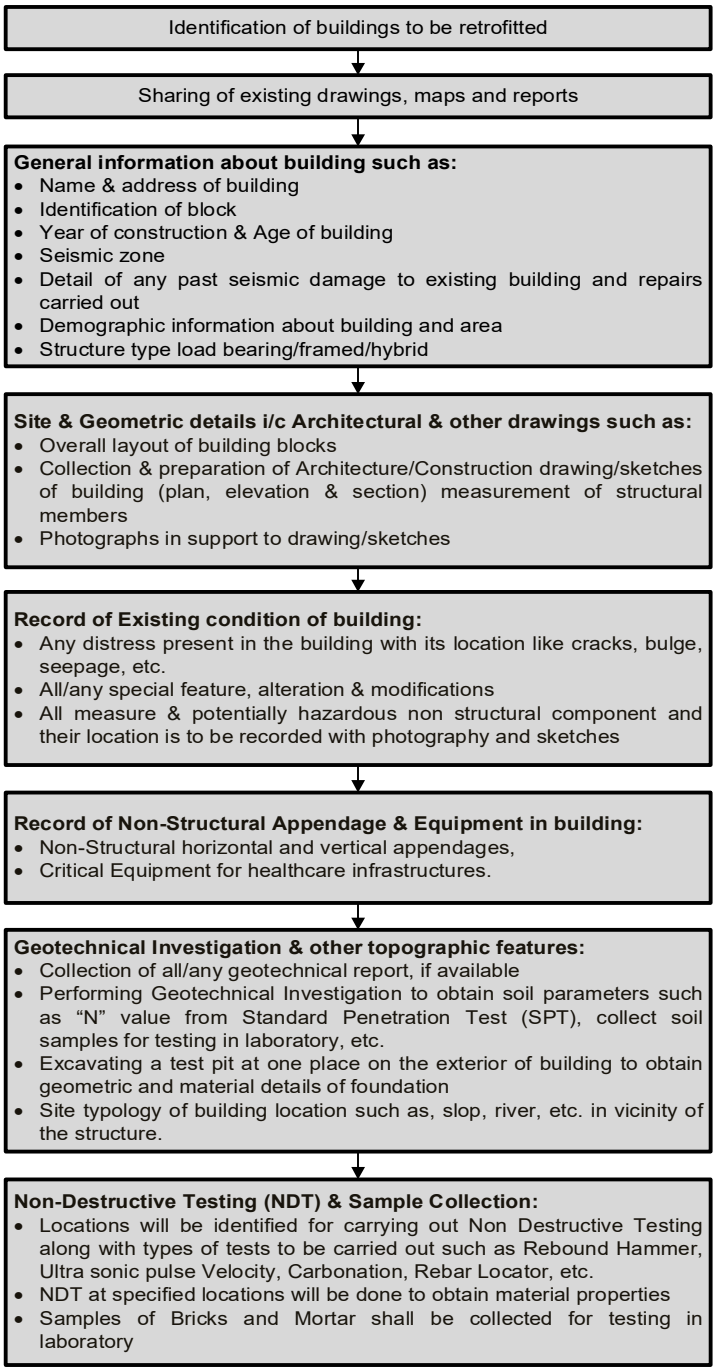


Figure B. 12: Flowchart showing steps involved in Data Collection

Step 5: Compilation of Collected Data

The collected data will be compiled and converted into desired format to use it in mathematical modelling and analysis of structure. Details of this step are given in figure B.13.

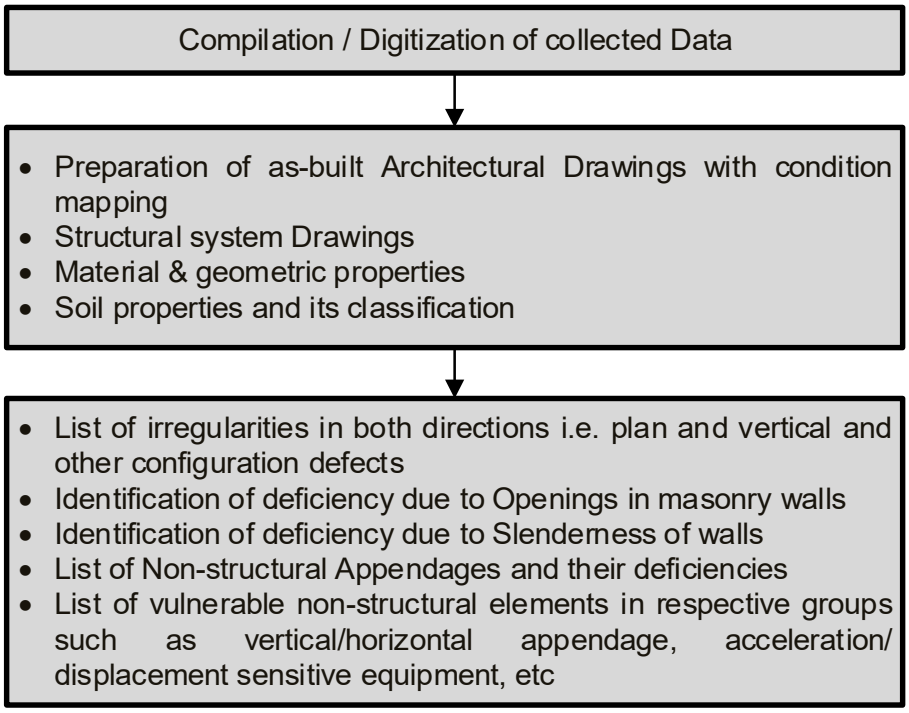


Figure B.13: Synthesis of Collected Data

5a: Preparation of Drawings

Pictures showing sample architectural drawings in form of site plan, plan, elevations, section, are shown below under figures B.14, B.15, B.16 and B.17, respectively.

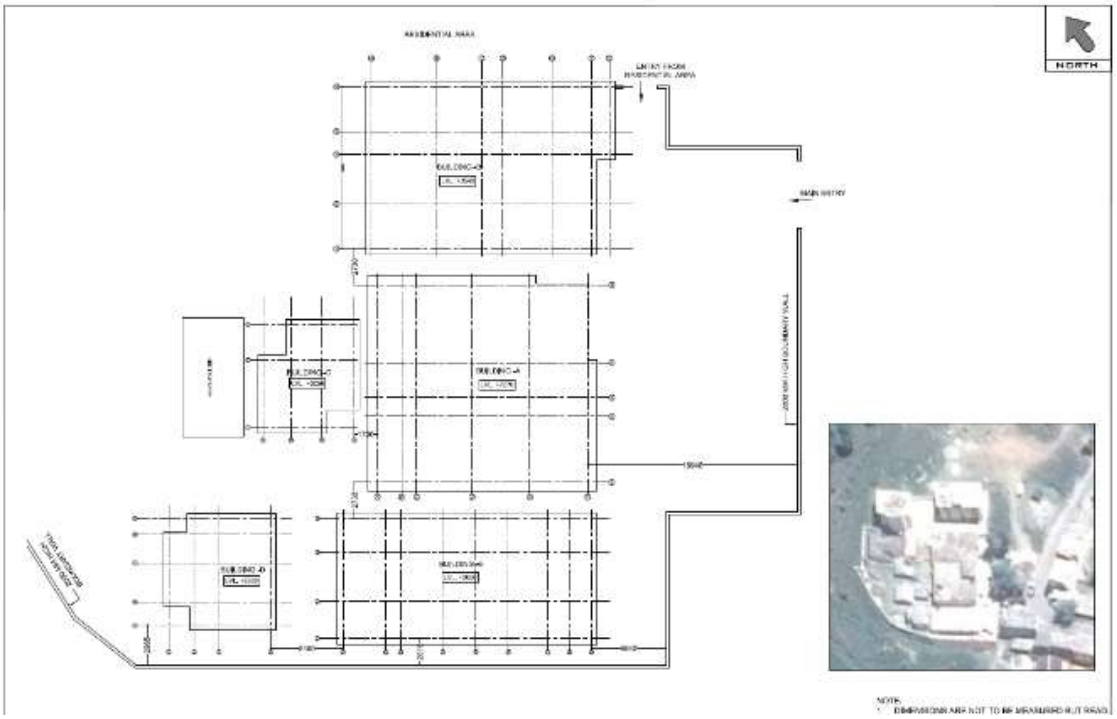


Figure B.14: Typical Site Plan

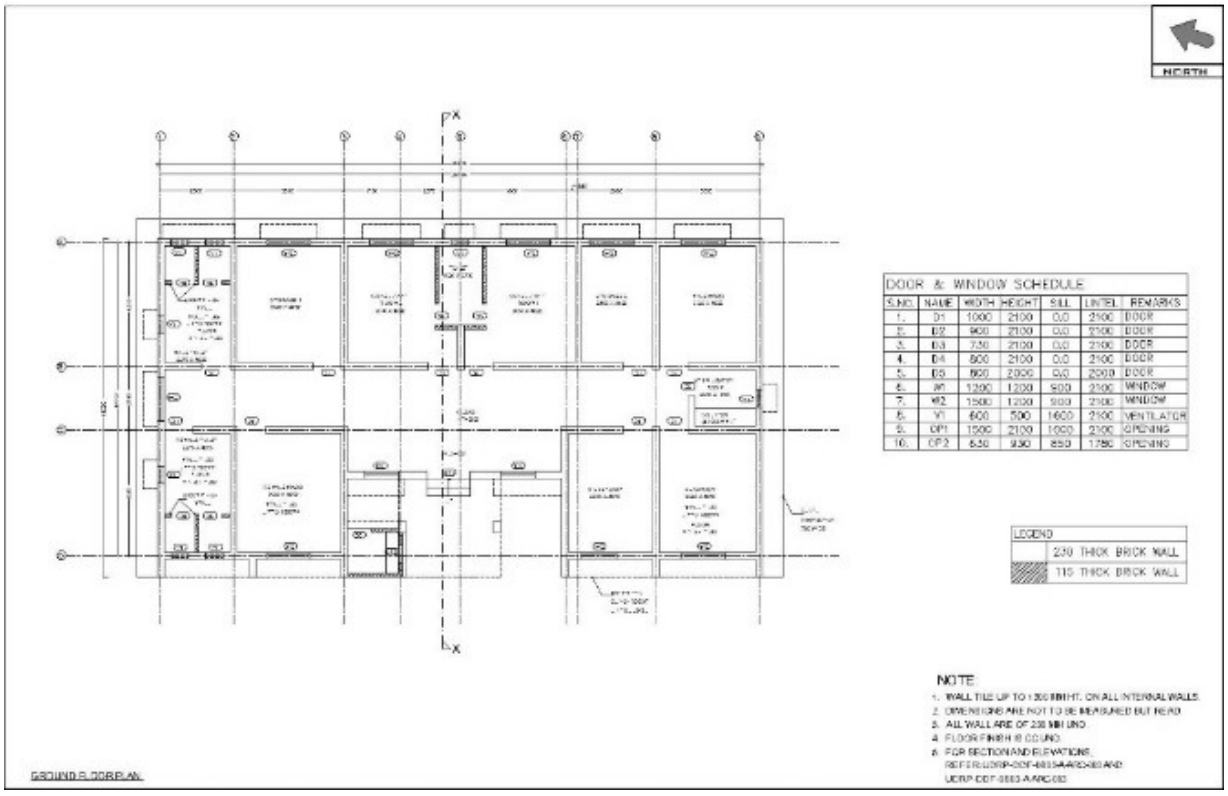


Figure B.15: Typical Plan

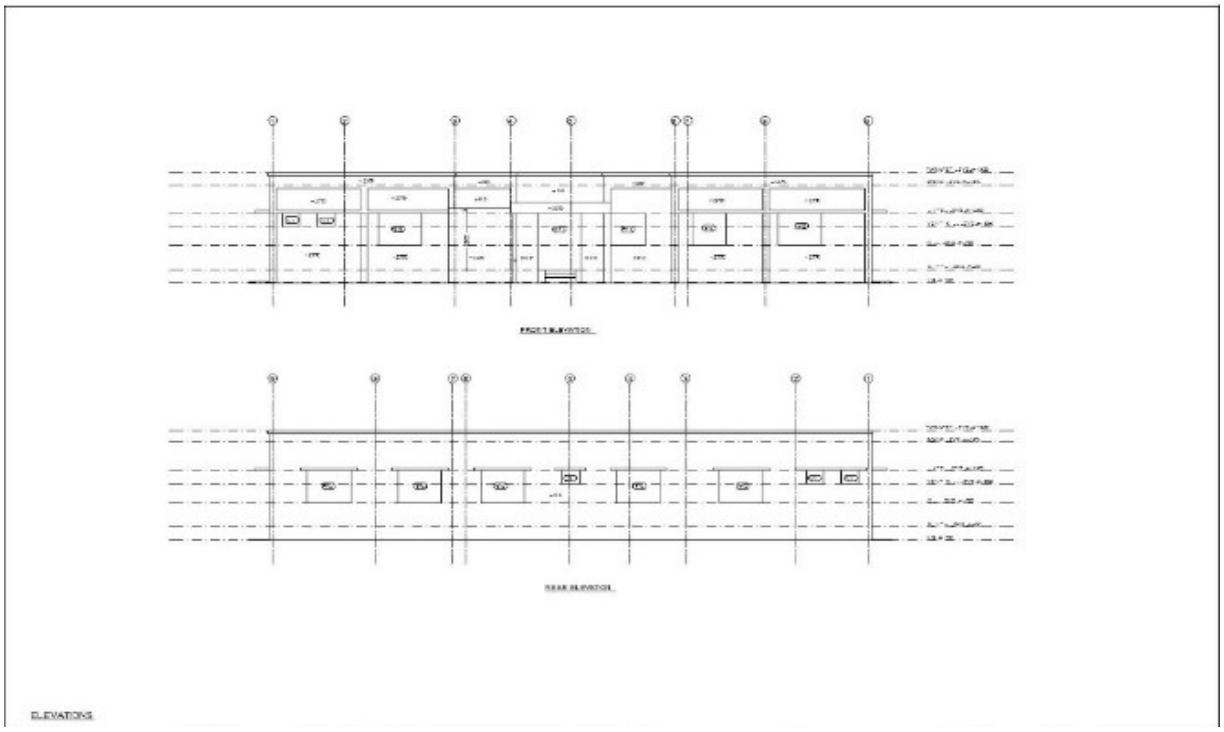


Figure B.16: Typical Elevations

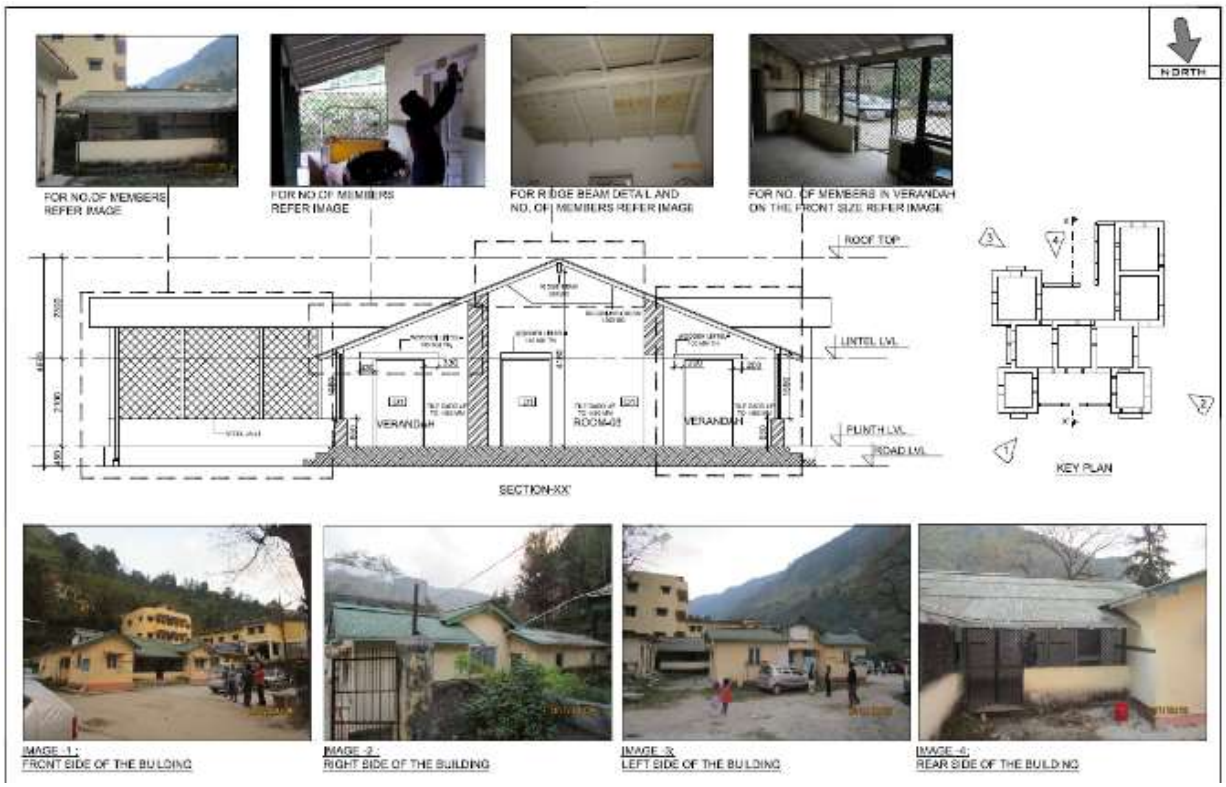


Figure B.17: Typical Section

Apart from the above the material properties data will be synthesised from the data collected and obtained from laboratory results. The procedure for obtaining the Material properties for masonry and RCC are mentioned below.

5b(i): Material Properties using test results for Masonry

(i) Basic compressive stress of masonry is the primary property that is required for analysing the building and it is dependent upon the masonry unit compressive strength and the mix ratio of mortar.
(ii) Using Table 1 of IS 1905:1987, the compressive strength of mortar shall be obtained from the mix ratio results obtained from chemical test conducted in lab.
(iii) Similarly, knowing the compressive strength of masonry unit and mortar grade from (ii) above, Table 8 of IS 1905:1987 will be used to calculate the basic compressive stress of masonry.
(iv) The basic Compressive Stress calculated for masonry in (iii) above shall be further modified by multiplying with three parameters, explained below:
  (a) Stress Reduction Factor (K_s) obtained from Table 9 of IS 1905:1987 which further depends upon two parameters i.e. Eccentricity of loading, which is calculated as per guidelines mentioned in IS 1905:1987 (Table A (Appendix A)) and Slenderness Ratio which is calculated from criteria mentioned under clause 4.7 in IS 1905:1987,
  (b) Area Reduction Factor (K_a) determined as per criteria mentioned under Clause 5.4.1.2 of IS 1905:1987, and
  (c) Shape Modification Factor (K_p) determined as per criteria mentioned under Clause 5.4.1.3 and Table 10 of IS 1905:1987,
(v) Similarly, the permissible flexural / tensile stress based on the grade of mortar is obtained by criteria mentioned under Clause 5.4.2 of IS 1905:1987,
(vi) The permissible shear stress is obtained from the criteria mentioned under Clause 5.4.3 of IS 1905:1987,
(vii) The modulus of Elasticity 'E', another important parameter that is required for analysing the model shall be calculated using the empirical relation given under Clause 7.9.2.1 in IS 1893 (Part 1):2016,
(viii) The material properties thus calculated shall be incorporated in the mathematical model.

5b(ii): Material Properties using test results for concrete

(i) Compressive Strength of Concrete shall be obtained from the Rebound Hammer Test Results and Core Sample Test results.
(ii) Reinforcement details as predicted by rebar locator in a section will be used for checking whether the existing reinforcement percentage is sufficient or not,
(iii) The existing geometric dimensions of all structural members shall be checked with prevalent IS standards such as IS13920:2016 for allowable minimum geometric dimensions. All members found deficient will be identified and listed,
(iv) Similarly, the footing details obtained from the foundation pit during limited geotechnical investigation shall be incorporated in the model.

Step 6: Detailed Vulnerability Assessment (DVA)

(1.) Mathematical model shall be generated using the geometric and material properties on any of the following platform / software such as ETABs, SAP, SAFE, etc.

(2.) Method of analysis finalised in Step 3 of this component shall be used to perform the Detailed Vulnerability Assessment of the building to meet desired performance level as per applicable national & international (if national code is not available) codes and guidelines.
(3.) Demand Capacity Ratios for the various structural members shall be checked for the seismic analysis carried out as per code and vulnerabilities identified.

Pictures showing sample models generated in ETABs is shown under figure B.18 for masonry and figure B.19 for RCC. Figure B.20 shares a flowchart wherein details of all activities that will be performed in this step have been mentioned.

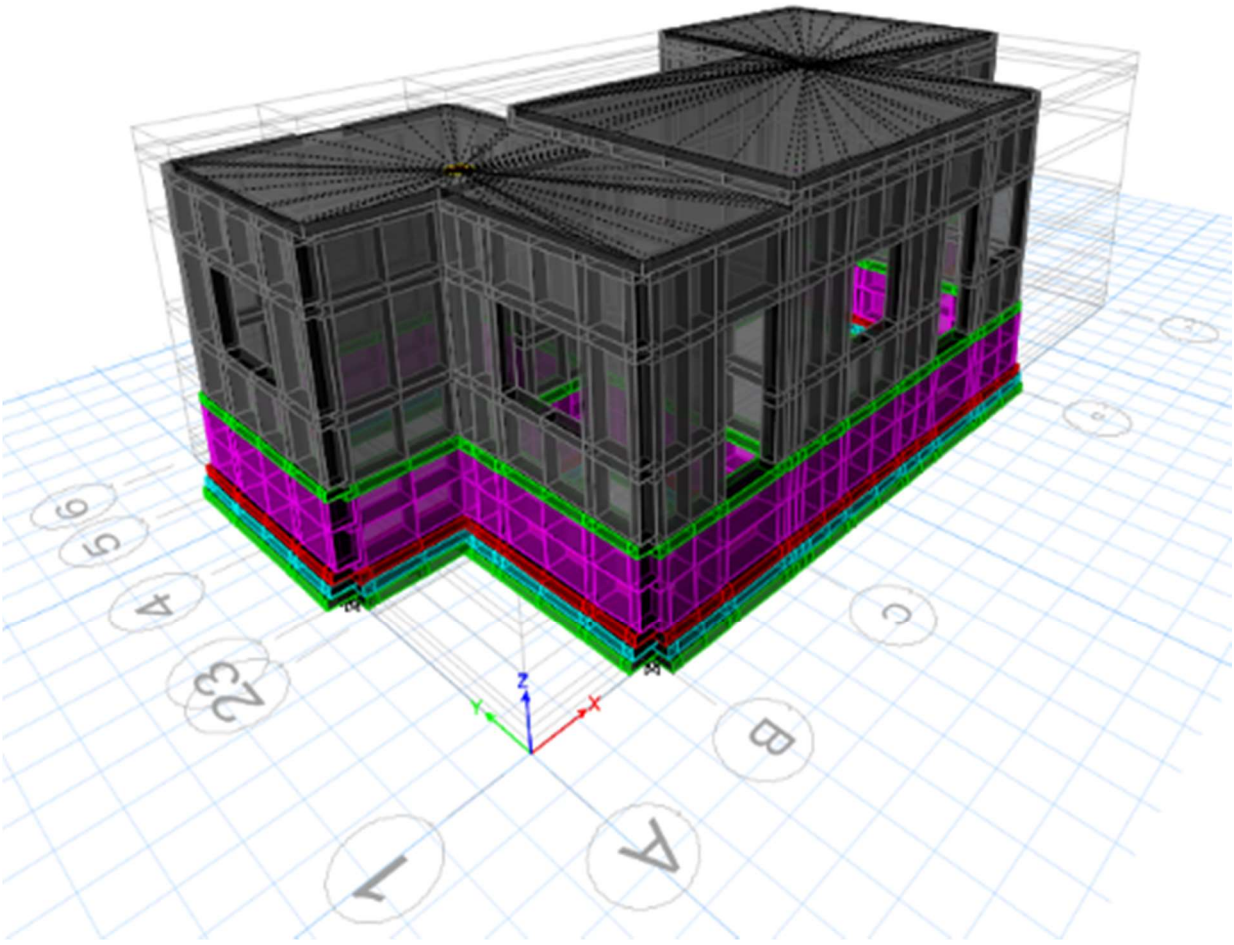


Figure B.18: ETAB Models of Masonry Buildings

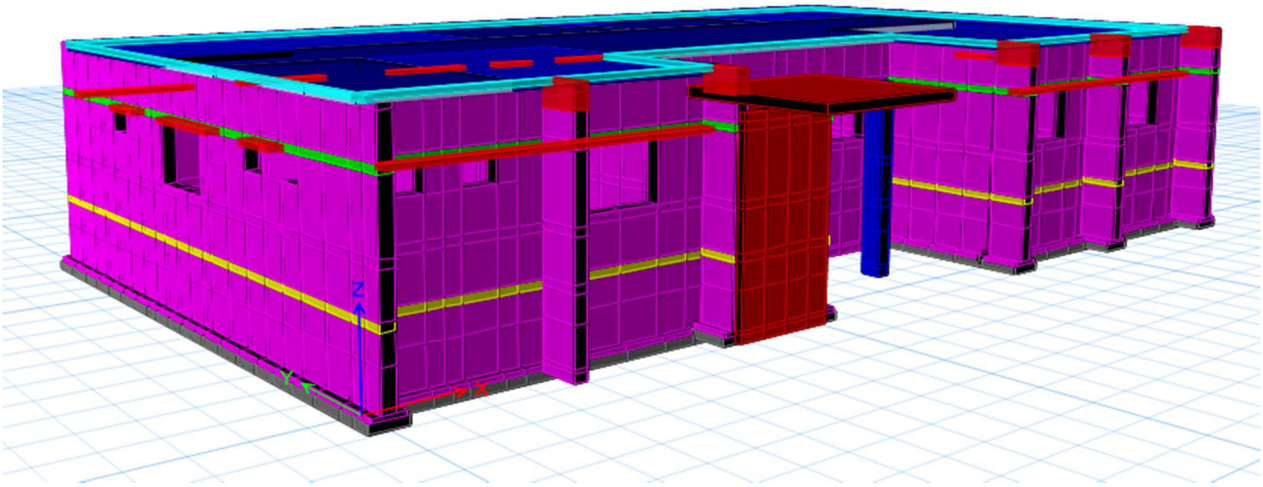


Figure B.19: ETAB Models of RCC Buildings

Detailed Vulnerability Assessment (DVA) of building

Generation of Mathematical model of building:

- Using as-built drawings i.e. geometrical and material properties from NDT, mathematical model of building will be generated.
- Assumptions of parameters that cannot be obtained shall be made on basis of conservative values

Analysis of Mathematical model of building:

- Analysis (as per method of analysis finalized in Step 2) of the building shall be carried out

Output of Analysis:

- Deficient / Failing members and their location i.e. local / global shall be identified.
- Drift parameters shall be checked to be within permissible limits or not
- Performance Level criteria (finalised in step 2) shall be checked to be satisfied or not.

Figure B.20: Detailed Vulnerability Assessment

Step 7: Identification of Suitable Retrofitting Scheme & Analysis of retrofitted Model

(1) Cost effective sustainable retrofitting solution(s) shall be identified for both local and global level for the buildings.
(2) Retrofitting measures shall be incorporated in the model generated above to obtain retrofitted model by altering / incorporating the material properties of material that shall be used in retrofitting and analysis will be carried out.
(3) Desired performance level parameters shall be checked.
(4) If found unsafe, then retrofitting scheme shall be enhanced.
(5) Again analysis of the model shall be carried out and parameters checked for desired performance level.
(6) This iterative process shall be continued until the retrofitted model meets the desired performance level parameters.

Above steps are shown through a flow chart in figure B.21 below.

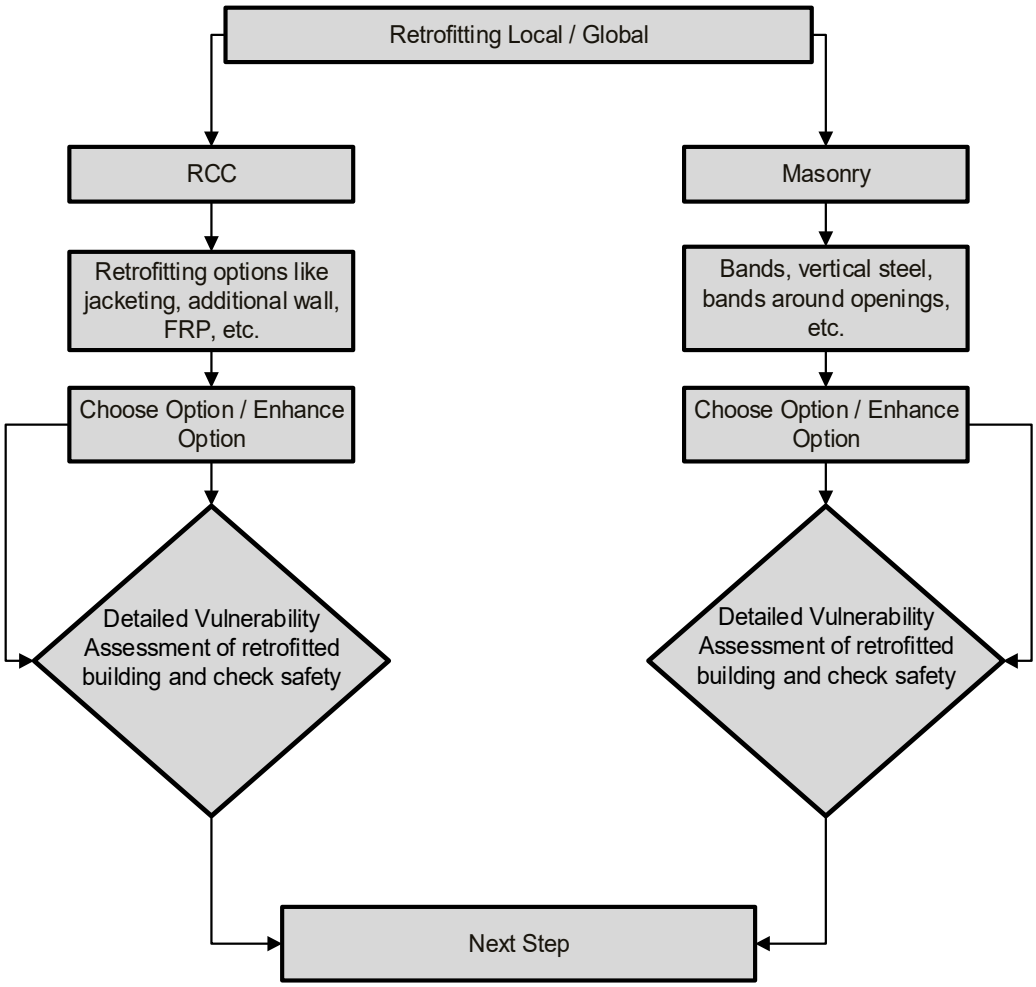


Figure B.21: Procedure of Finalising Retrofitting Scheme

Step 8: Design of Support System for Non-Structural Elements (Appendages) & Equipment

(1) The analysis of appendages and critical equipment in health facilities will be carried out as per applicable national code and guidelines and their vulnerability will also be assessed.
(2) The support system for non-structural elements and equipment found deficient shall be designed as per applicable codes & guidelines.

Step 9: Preparation of Documents / Reports under ESMF & DPR

(1) Documents / Reports pertaining to Social and Environmental Assessment under ESMF shall be prepared.
(2) Detailed structural drawings shall be prepared to carry out cost estimation and prepare DPR for submission.

DPR shall be prepared for all activities to make the building safe and habitable. It is pertinent to note here that cost of retrofitting may include following:

(i) Direct Cost – It comprises of the following:
  (a) Cost for Seismic Retrofitting for Structural Members, such as cost for removing of plaster, fixing of bands and other earthquake strengthening measures, etc.,
  (b) Cost for finishing works, such as repair of broken flooring and plastering, painting, replacing and fixing of doors and windows (if any) that will be removed during execution of structural retrofitting works, etc. during carrying out the structural retrofitting works,
  (c) Cost associated with MEP and other Miscellaneous works that will have to be changed or repaired along with structural retrofitting works.

(ii) Cost for Seismic Retrofitting of Non-Structural Appendages & critical Equipment of health facilities,

(iii) Cost for Repair and Restoration – Deterioration of the building due to various problems such as cracking of masonry walls, corrosion of reinforcement in sun-shades, terrace slabs, etc. required to be repaired. Though details of such works are not included under the head of retrofitting, however, they are required to make the building re-habitable. Hence, cost related with this also need to be included in DPR.

(iv) Indirect Cost – Further it is to inform that following indirect costs are associated with retrofitting work and they are beyond the scope of work.
  (a) Indirect Cost associated with Ground Improvement may be required for few sites. This will be ascertained on percentage basis of new construction cost.
  (b) Indirect cost associated with relocation / inconvenience / replacement of services due to disturbance impact during execution of seismic retrofitting works. Hereto this cost is beyond the scope of the contract. However, for arriving at total cost of retrofitting exercise, this cost can be estimated on percentage basis of new building cost, if needed.

Hence, under cost of retrofitting, only cost associated with items (i) and (ii) shall be considered.

This stage will bring out detailed project report as per drawings. For cost estimation Respective State's schedule of rates will be used if available otherwise, Delhi schedule of Rate of CPWD will be used with index factor. Where details are not available in any schedule of rate, rate analysis will be carried out as non-schedule item.

B.2. RETROFITTING AND/OR CONSTRUCTING EVACUATION ROADS, BRIDGES, LANDING STRIPS AND HELIPADS AND MULTI-HAZARD SHELTERS.

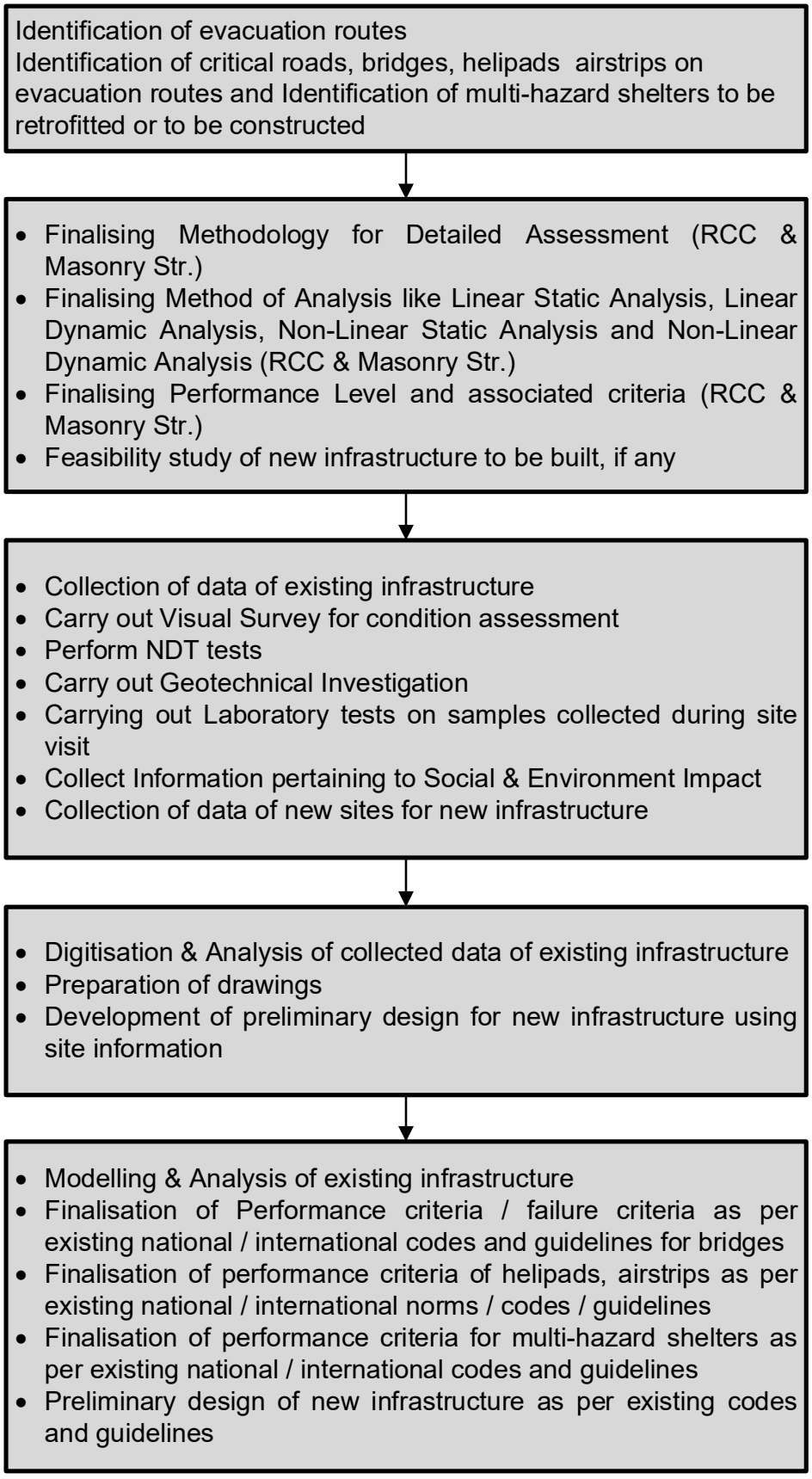
To achieve the above objective, an overall methodology mentioning the activities to be performed, outcome of these activities and deliverables is shown in a tabular format in Table B.2 below:

Table B.2: Bridge Retrofitting Methodology Chart

Step No.	Activity	Outcome	Deliverables
Step 1	• Meeting PMU & respective SPIUs to assess their need • Identification of evacuation routes of State • Identification of critical evacuation routes and associated critical bridges, landing strips, helipads and multi-hazard shelters • Need Assessment of new roads, bridges, landing strips, helipads on evaluation routes and multi-hazard shelters	• Grouping of Infrastructure on the basis of their importance and relevant criteria under different heads such as Critical, Semi Critical and Least Critical to identify infrastructure to be taken up for retrofitting and / or to be taken up for new construction. This may include importance, network redundancy, age, physical condition, etc.	Progress Report
Step 2	• Discussion / project planning meeting with client • Preparation of Methodology for carrying out Detailed Assessment of existing Infrastructure • Finalisation of Performance level and its criteria • Finalisation of Method of Analysis • Feasibility study of new infrastructure to be built, if any	• Plan for detailed visual survey and action plan for existing infrastructure • Final Methodology • Final Analysis method including structural and geotechnical modelling • Final Performance Level and its criteria • Feasibility Report of new projects, if any	Part of Inception Report
Step 3	• Visit sites for Data Collection • Carry out Visual Survey for condition assessment • Perform NDT tests • Carry out Geotechnical Investigation • Carrying out Laboratory tests on samples collected during site visit • Collect Information pertaining to Social & Environment Impact	• Information of identified roads, bridges, landing strips, helipads on evacuation routes and multi-hazard shelters – photographs, – material condition, – material properties, – geometric properties, – existing construction defects – Soil properties such as 'N' value, etc.	Progress Report

Step No.	Activity	Outcome	Deliverables
		– Data on Social & Environmental Impact	
Step 4	• Analysis of collected data • Development of Preliminary Design	• Drawings • Structural systems of corresponding bridges • Material & geometric properties • Identification of structural defects • Proposed Design Options	Progress Report
Step 5	• Finalisation of structural model • Detailed Assessment of infrastructure to be retrofitted • Preliminary Design of new infrastructure if any followed by discussion to finalise the design	• Location of Failing / deficient members • Structural component strength is sufficient or not • Other Safety criteria are satisfied or not • Preliminary project Report	Progress Report
Step 6	• Different retrofitting options to be worked out for bridges showing failure at local and global level	• Retrofitting options at local and global level like restrainers, jacketing of pier, seat width extension, strappers, Increase in bearing, etc.	Progress Report
Step 7	• Detailed vulnerability assessment of retrofitted bridge model • Finalising the design of new infrastructure	• Improved structure is checked to be safe for desired performance level • Final design of new infrastructure	Progress Report
Step 8	• Performing Social & Environmental Impact Assessment and preparation of reports / documents under ESMF • Preparation of detailed project report for approved options of retrofitting	• Reports in compliance to documents under ESMF • DPR (Cost, Specification, BOQ, etc.)	ESMF Documents Reports & DPR

The flowchart depicting the overall methodology for retrofitting of the buildings finalised after due consultation with PMU and respective SPIUs is shown below under figure B.22.


Identification of evacuation routes
Identification of critical roads, bridges, helipads airstrips on evacuation routes and Identification of multi-hazard shelters to be retrofitted or to be constructed
• Finalising Methodology for Detailed Assessment (RCC & Masonry Str.)
• Finalising Method of Analysis like Linear Static Analysis, Linear Dynamic Analysis, Non-Linear Static Analysis and Non-Linear Dynamic Analysis (RCC & Masonry Str.)
• Finalising Performance Level and associated criteria (RCC & Masonry Str.)
• Feasibility study of new infrastructure to be built, if any
• Collection of data of existing infrastructure
• Carry out Visual Survey for condition assessment
• Perform NDT tests
• Carry out Geotechnical Investigation
• Carrying out Laboratory tests on samples collected during site visit
• Collect Information pertaining to Social & Environment Impact
• Collection of data of new sites for new infrastructure
• Digitisation & Analysis of collected data of existing infrastructure
• Preparation of drawings
• Development of preliminary design for new infrastructure using site information
• Modelling & Analysis of existing infrastructure
• Finalisation of Performance criteria / failure criteria as per existing national / international codes and guidelines for bridges
• Finalisation of performance criteria of helipads, airstrips as per existing national / international norms / codes / guidelines
• Finalisation of performance criteria for multi-hazard shelters as per existing national / international codes and guidelines
• Preliminary design of new infrastructure as per existing codes and guidelines

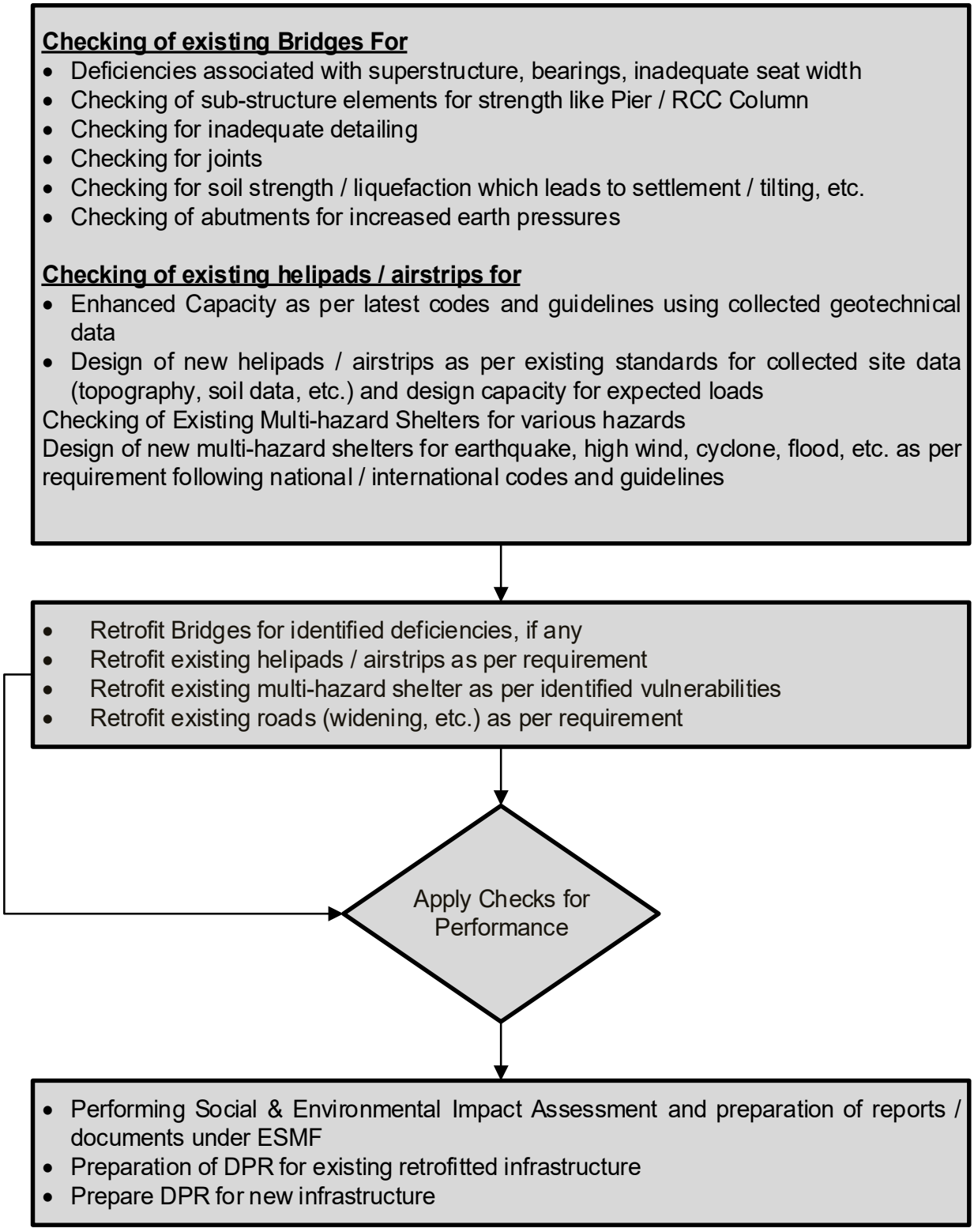


Figure B.22: Flowchart depicting the overall methodology for retrofitting & construction of infrastructure such as bridges / helipads / airstrips and multi-hazard shelters

The broadly specified activities in the flow chart above comprises of number of sub-activities to achieve the task at hand. Accordingly, the detailed methodology showing the different sub-activities under each activity, specific to bridges, is given below:

Step 1: Identification of Critical Bridges

(1) A kick-off meeting with the PMU and respective State Government Officials will be conducted to assess their need for retrofitting and construction of new infrastructure for developing an efficient evacuation system.
(2) The respective State Governments will be asked to share the evacuation routes of roads and bridges and identify list of critical bridges which they want to undertake for retrofitting.
(3) Any previous data that the State Government may have collected / prepared in past of such road / bridge in their list shall be used further for evaluation and shortlisting.
(4) The seismically deficient existing bridges shall be subjected to a quick vulnerability assessment to identify by preliminary screening. The screening procedure is mainly based on
    (a) Seismicity,
    (b) Vulnerability, and
    (c) Importance.
(5) Based on the grouping of existing bridges and other infrastructure on a particular evacuation route, a preliminary cost shall be prepared to obtain a tentative Project Investment Plan – component wise and state wise as per timeline mentioned in TOR.
(6) Simultaneously, need assessment for new roads and bridges for evacuation shall be done.

Step 2: Finalisation of Methodology, Method of Analysis, Performance Level and its criteria

(1) Methodology for carrying out Detailed Assessment of existing Infrastructure shall be prepared and finalised.
(2) Performance level and its criteria shall be finalised.
(3) Method of Analysis of existing infrastructure shall be prepared and finalised.
(4) Feasibility study for new infrastructure to be built, if any shall be done.

Step 3: Data Collection (Sample Form given at end of Annexure B)

(1) Based on list of bridges to be retrofitted obtained from exercise mentioned in Step 1 above, a calendar will be prepared to visit the screened sites.
(2) Permission letters shall be applied to respective state governments for clear passage to conduct the detailed site survey.
(3) Detailed survey wherein geometric and architectural data for preparing drawings, special features, etc. of existing roads and bridges shall be carried out. However preference should be given to bridges where all detailed drawings are available and bridges are not very old.
(4) Simultaneously, the NDT and Geotechnical investigation (including liquefaction potential of soil as per site applicability as per clause 3.12 and 6.3.5.3 following guidelines mentioned in Annex-F of IS 1893 (Part 1): 2016) shall carry out the respective tests and collect samples of material to be tested later in government accredited laboratory to ascertain material properties.
(5) Similarly, based on feasibility study for new construction, respective site visits shall also be conducted to collect data pertaining to topographic conditions and carry out geotechnical investigation, as per requirement.

This step involves data collection which is described in detail in Figure B.23.

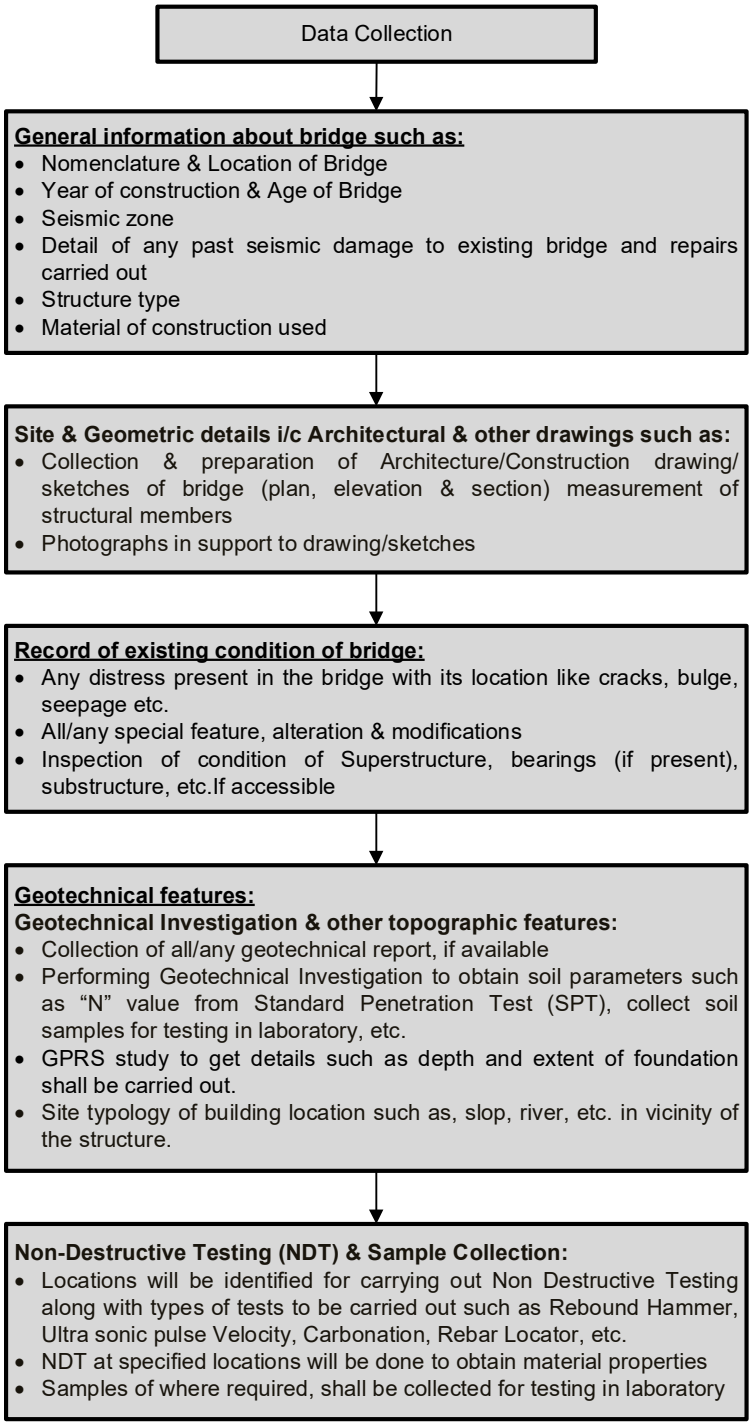


Figure B.23: Details of Data Collection

Step 4: Compilation of Data

This involves analysis of collected data and convert the data into desired format to use it in mathematical modelling and analysis of bridge. Details of this step are given in Figure B.26.

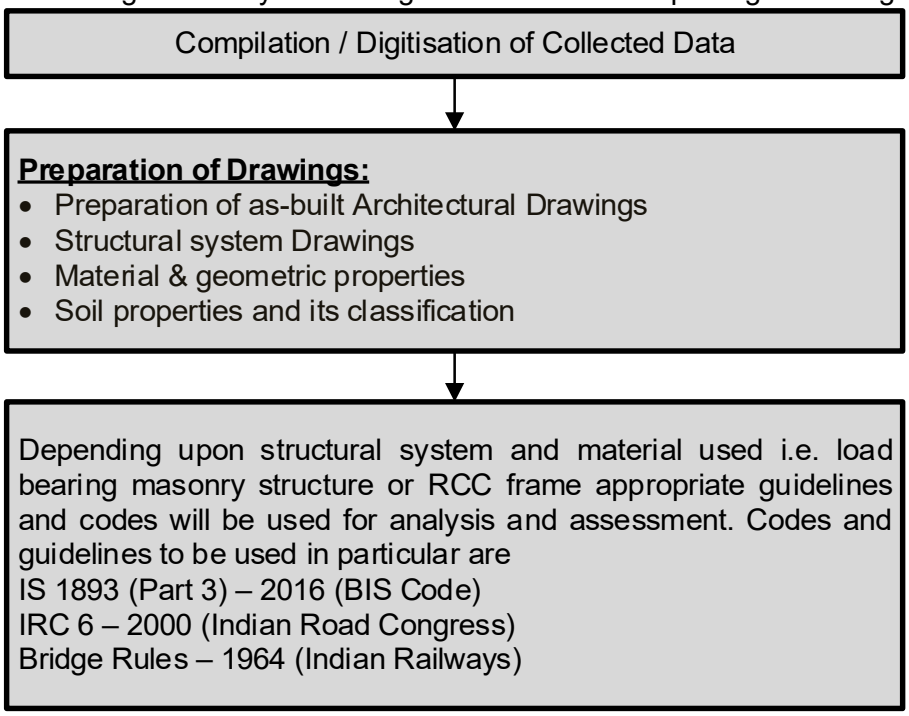


Figure B.24: Compilation of Collected Data

Step 5: Detailed Assessment

(1) Design Philosophy: The design philosophy for retrofitting should normally conform to that for new bridge design. This is the minimum design performance expected from a retrofitted structure. The design philosophy for new structures is as follows:
   (a) The structure is designed to resist Design Basis Earthquake (DBE) with only minor damage, which should be repairable.
   (b) The structure is designed to resist Maximum Considered Earthquake (MCE) with some structural damage but controlled so as to prevent collapse.

(2) Mathematical model shall be generated using the geometric and material properties obtained from data collection above. Soil properties will be modelled along with substructure modelling.

(3) Detailed Seismic Assessment of expected performance of existing bridge will be carried out to determine seismic capacity, weaker sections and mode of failure.

(4) The strength evaluation can also be made according to codes following dynamic methods of analysis.

(5) Performance Level criteria finalized in Step 2 shall be checked.

(6) On the basis of detailed seismic assessment, it shall be determined whether individual component level retrofit such as extending seating width, providing restrainer or a global retrofit of complete bridge is to be undertaken.

This deals with the detailed seismic assessment of the bridge depending on material used, structural system (Super and Sub structures excluding foundation). Step is described in Figure B.25.

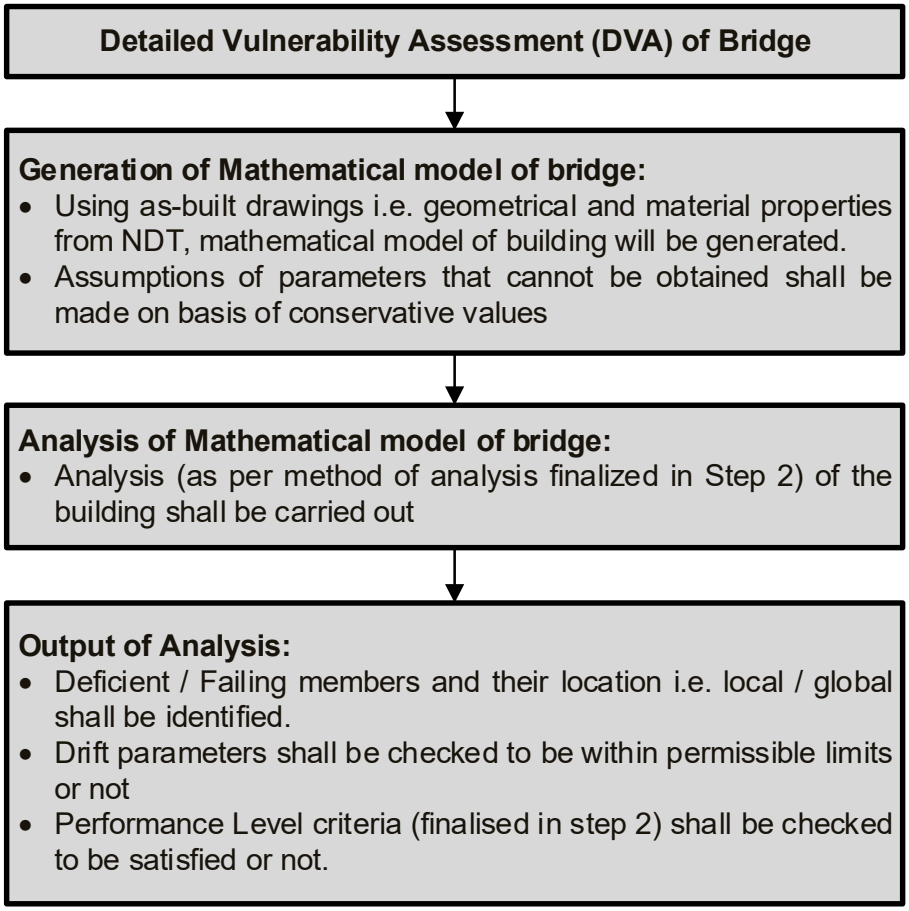


Figure B.25: Detailed Assessment of Bridge

Step 6: Identification of Suitable Retrofitting Scheme & Analysis of retrofitted Model

(1.) Depending on the type of failure estimated in previous step bridge has to be rectified by retrofitting the bridge as per need.
(2.) Cost effective sustainable retrofitting solutions shall be identified for both local and global level for the bridges.
(3.) Retrofitting measures shall be incorporated in the model generated above.
(4.) The retrofitted structure should be analyzed using finalized method of analysis.
(5.) Check of the criteria to meet the desired performance level shall be made.
(6.) If it is not satisfied, alternate retrofitting option has to be incorporated in model and checked again after re-analysis.
(7.) Step 6 shall be continued until the bridge meets the performance criteria.

The step is described below in Figure B.26 below.

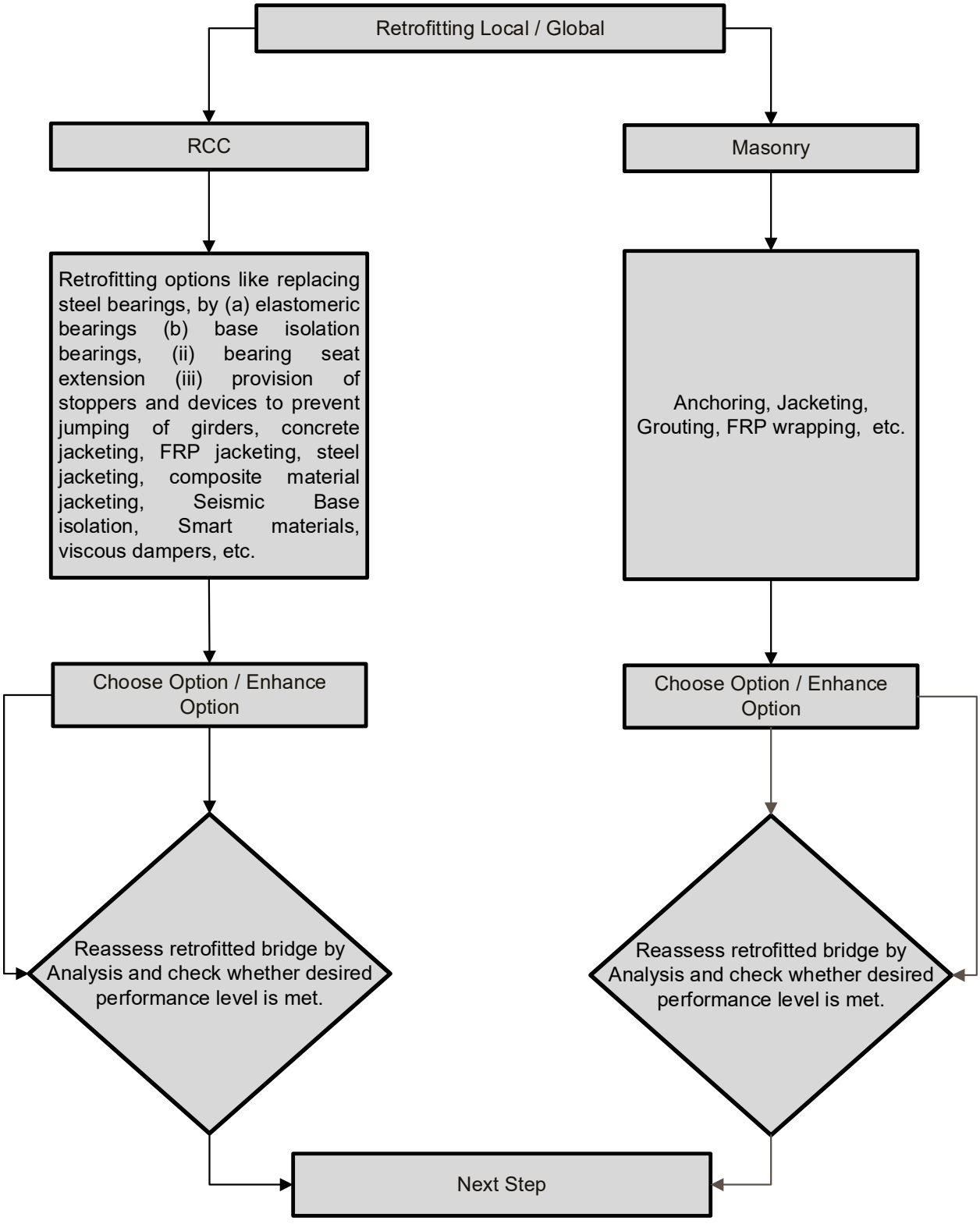


Figure B.26 Steps to Choose Suitable Retrofitting Scheme

Step 7: Preparation of DPR

(1.) Documents / Reports pertaining to Social and Environmental Assessment under ESMF shall be prepared.
(2.) Detailed structural drawings shall be prepared to carry out cost estimation and prepare DPR for submission.

This stage will bring out detailed project report as per drawings. For cost estimation Respective State's schedule of rates will be used if available otherwise, Delhi schedule of Rate of CPWD will be used with index factor. Where details are not available in any schedule of rate, rate analysis will be carried out as non-schedule item.

For retrofitting of existing multi-hazard shelters, the sub-activities mentioned above for retrofitting of existing buildings can be followed. However, care needs to be taken that the multi-hazard shelter shall be analysed as per the specific multi-hazard relevant codes and guidelines such as for seismicity, seismic code will be referred, whereas for buildings prone to cyclone, relevant code governing analysis and design of building in cyclone affected areas shall be used. Similarly for other hazards, the respective hazard code shall govern the analysis.

B.3 CONSTRUCTING SMALL TECHNOLOGY DEMONSTRATION UNITS OF CRITICAL INFRASTRUCTURE SUCH AS SCHOOLS, HOSPITALS, ETC.

The following methodology shall be used to achieve the above target.

(1.) A kick-off meeting with the Centre followed by respective State Government Officials will be conducted to know their respective requirements and also discuss possible numbers and respective locations of such demonstration units.
(2.) Based on input from respective state Governments, a calendar will be prepared to visit all sites within stipulated time as per TOR to carry out Geotechnical Investigation for obtaining soil properties of the proposed site.
(3.) Architectural team will be put in action to design few options based on input received.
(4.) The architectural plans and drawings will be submitted to the State Government for approval.
(5.) Thereafter, the structural design and calculations to prepare the structural drawings will be carried out.
(6.) Finally, the DPR will be prepared on the basis of the structural drawings to prepare and submit the estimate for construction of such demonstration unit.

Flowchart of activities is given in Figure B.27 below.

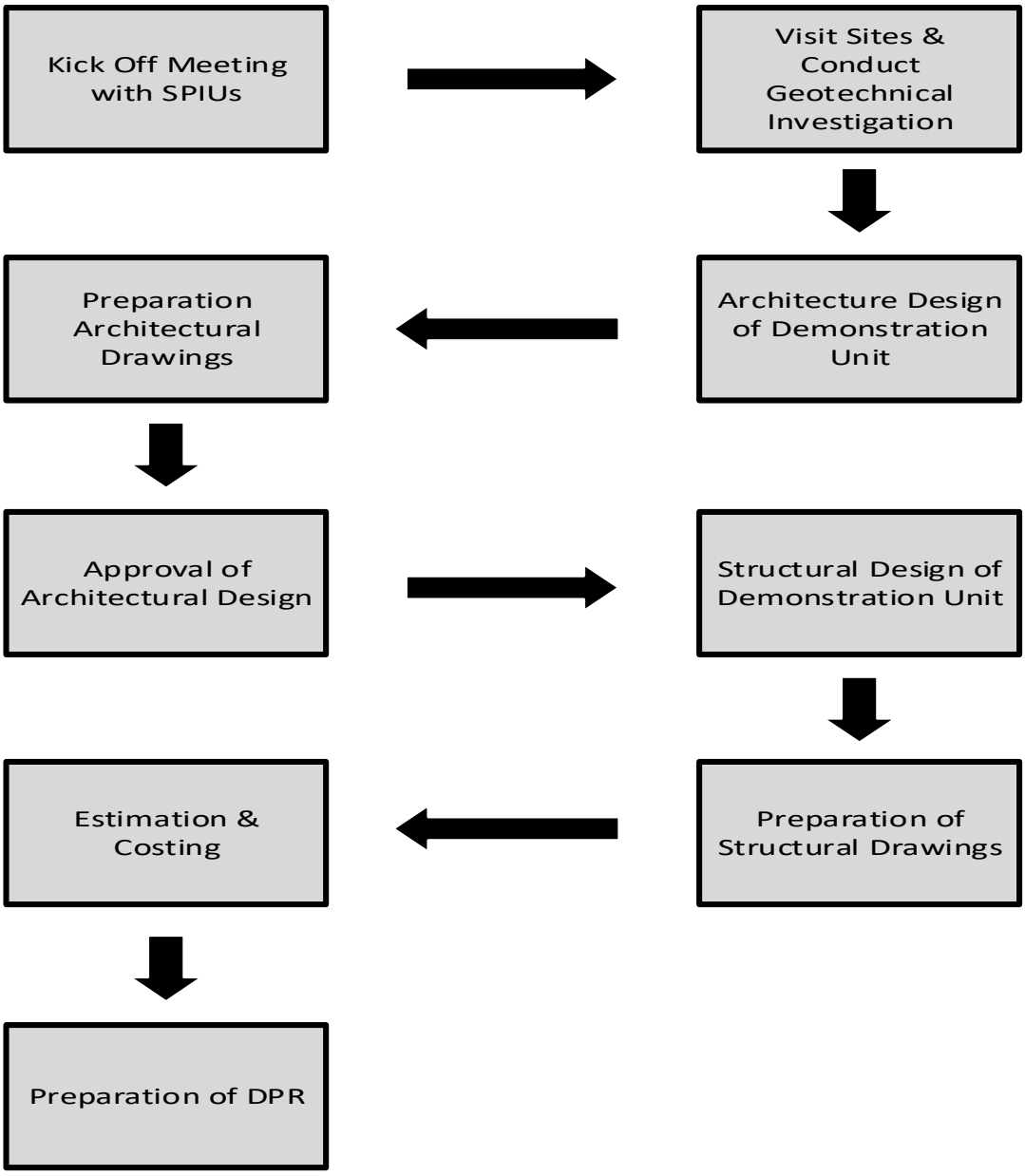


Figure B.27: Flowchart Depicting Methodology for Constructing Small Technology Demonstration Units of Critical Infrastructure.

B.3.1 FORMS/ QUESTIONNAIRE RELATED TO COMPONENT B

The following forms will be used for collecting the data for Component B

Form B1**:** List of Critical Infrastructure
Form B1A: Data Collection Forms Checklist
Form B1B General Building Data

Form B1C: Architectural Data
Form B1D: Structural Data
Form B1E: Non-Structural Appendages & Equipment
Form B1F: Non-Destructive Test Results
Form B1G: Geotechnical Investigation Results
Form B2: List of Evacuation Plan & Routes
Form B3: Construction of Small Technology Demonstration Units

Form B1: List of Critical Infrastructure and buildings											
State											
Name of Surveyor											
Name of Respondent											
Designation of Respondent											
Contact of Respondent											
Date											
S.No.	**Infrastructure**	**Infrastructure Address**	**Seismic Zone**	**Usage**	**Occupancy (Inhabitants)**	**Year Construction**	**Built Up Area of the Infrastructure**	**Height of the Infrastructure**	**Footfall (Serving Population)**	**Drawings of Plans of the Infrastructure**	**Remarks**

Form B1A: Data Collection Checklist

Location	
Date	
Contact Details of Respondent	
(Email, Mobile No. & Address)	
Name of Surveyor	

S.No	Data Required	Remarks
1	Architectural Drawings with all openings position and thickness of wall (Architectural Questionnaire)	
2	Floor wise plan (including the specification of expansion joints (whether the gap is clean or filled with debris), cut outs and specification of material) (Structural Questionnaire)	
3	Elevation Drawings (including truss if present) (Architectural Questionnaire)	
4	Structural System and Connection Details (Structural Questionnaire)	
5	Beam and column arrangement for every floor along with their dimensions including slab dimensions and reinforcement (Architectural Questionnaire)	
6	Details (size and reinforcement) of concrete bands if present (NDT Questionnaire)	
7	Material Property (Structural Questionnaire)	
12	Type of foundation and its dimension (Geotech Questionnaire)	
13	Tie Beam and Plinth Beam detail (size and reinforcement)(Structural Questionnaire)	
14	Roof top tanks (type and capacity) and support system (Structural Questionnaire)	
15	Parapet/ railing detail (thickness, height , length) (Structural Questionnaire)	
16	Location of heavy machinery (Structural Questionnaire)	
17	Details of Decorative elements, cantilever and cladding (Non-Structural Elements Questionnaire)	
18	Staircase Detail/ Waist slab condition (Architectural Questionnaire)	
19	Boundary Wall and Gate detail (Architectural Questionnaire)	
20	Information of any existing damage along with the information of location (Floor and room) (Cracks, seepage, corrosion, settlement etc.) (General Questionnaire)	
22	Non-Structural Appendages (Non-Structural Elements)	

Note: Provide list/ Data as separable Attachments.

Seal and Signature of the Responding Officer on behalf of the State

Form B1B: General Building Data

State				
Block				
District				
Pin Code				
Area type	Rural		Urban	
Name of investigator				
Date				

Building Functionality

Residential		Flat		Hotel		Anganwadi	
Educational		School		College		Hospital	
Community		Hall		Old Age Home		Orphanages	
Assembly		Town Hall		Banquet hall		Community Hall	
Court Complex		Marriage Hall		Org. Building		Old Age Home	
DC Office		DC Resident		Fire Station		Tourism Office	
PWD Office		SEB Office		IPH Office		Post Office	
Police Station		Electric Sub Station		Water Pump Station		Commercial Building	
Telecom		Govt. Bank		Market		Others	

Occupants

No. of Occupants	
No. of Storey	

Shape of the Building

Rectangular		Circular		L-Shaped		T-Shaped	
U-Shaped		H-Shaped		Plus Shape		None Drawing shape	

Dimension of Building

Length		Width		Height		Diameter	

Primary Building Material

Brick Masonry		R.C.C. Frame		Composite		Steel	
Stone & Blocks		If Yes					
Stone & Blocks		Random Rubble Masonry		Dry Rubble Masonry		Coursed Rubble Masonry	
Other		Refer Drawing Sheet					

Site Topography

Flat		Crest		Downward Slope		Trough	

Building Characteristics

Age of the Building				
Basement	Yes		No	
No. of Floors in Basement				
Predominant Material in Basement				

Roof Type	Flat		Open Gable		Shed Roof		Hip Roof	
Material Used in Mortar	Mud		Cement		Lime		Sand	
Property of Mixture								

Staircase	Separated		Connected		Enclosed					
No. of Staircases (refer drawing sheet)										
Material Used in Stairs	Brick		Stone		Wood		Concrete		Steel	

	Refer Drawing Sheet				
Lift	If Yes,				
No. of Lifts					
	Refer Drawing Sheet				
Fire Access	Yes		No		
	If Yes,		Refer Drawing sheet		

Apparent Quality of Construction	Poor		Moderate		Good		
Quality of Concreting	Poor		Moderate		Good		
Maintenance Undertaken	Yes		No				
Visible Corrosion	Yes		No				
	If Yes,	Minor		Acute			
	Drawing Sheet No.						
Retrofitting History	Yes		No				
	Refer Drawing Sheet						
Water Seepage	Yes		No				
	If Yes,		Minor		Acute		
Diaphragm Action	Presence of Diaphragm Opening				Yes		No
	If Yes,	Drawing Sheet No.					
	Location of Opening		Corner		Centre		Random
	Percentage of Opening			<50%		>50%	
	Drawing Sheet No.						
Waterlog	Building Above G.L (Prevent Waterlogging)				Yes		No
	If Yes,	Drawing Sheet No.					
Flood	Past Flood Record			Year of Event		Duration	
Landslide	Landslide History			Yes		No	
	If Yes,	Drawing Sheet No.					
Fire	Is Kitchen a Separate Unit				Yes		No
	Any Event of Fire in the Past				Yes		No
	if Yes,	Cause of Fire					
		Damages Reported		Sheet No.			

Form B1C: Architectural Data		**Remarks**
Block		
District		
State		
Pincode		
Area type		
Name of investigator		
Date		
Building Name		
Building Owner/Incharge		

Building Plan & Information of Immediate Vicinity	Refer Drawing Sheet #					
	Refer Drawing Sheet #					
Building Plan with Description of all Openings	Refer Drawing Sheet #					
	Refer Drawing Sheet #					
Elevations	Refer Drawing Sheet #					
Sections	Refer Drawing Sheet #					
All Opening Sizes & their Location	Refer Drawing Sheet #					
	Refer Drawing Sheet #					
Sizes of Structural Members						
	Column	Sheet No.				
	Beam	Sheet No.				
	Slab Type	Sheet No.				
Cantilever Balcony	Refer Drawing Sheet #					
Truss Details	Refer Drawing Sheet #					
Lintel Details	Refer Drawing Sheet #					
Waist Slab Thickness	Refer Drawing Sheet #					
Storey height Variation	If Any,	Yes	No			
	Refer Drawing Sheet #					
Clear internal Storey height of Each Floor	Refer Drawing Sheet #					
Height of Gable End/Wall	Refer Drawing Sheet #					
Floor/ Roof Covering	Refer Drawing Sheet #					
Distance from Adjacent Building height of the adjacent building						
Columns on Hill Slopes						
Earthquake Bands	Yes		No			
	Plinth		Gable			
	Roof		Lintel			
	Window Cell Level		Corner			
Vertical Steel	Present	Yes		No		
	Corner					
	Junction					
	Jambs of Openings					

Form B1D: Structural Data		
Block		**REMARK**
District		
State		
Pincode		
Area type		
Name of investigator		

Date													
Building Name													
Building Owner/In-charge													
Present Condition of Building	Any Structural Crack Present in the Building				Yes		No						
	if Yes,												
	Crack Element	Horizontal			Vertical				Diagonal				
		Minor		Major	Minor		Major		Minor		Major		
	Beam												
	Column												
	Wall												
Building Distress	Corner Crack in the Wall		Yes										
	If Yes,	Drawing Sheet No.											
	Settlement Crack		Yes		No								
	If Yes,	Drawing Sheet No.											
	Bulging		Yes		No								
	If Yes,	Drawing Sheet No.											
	Wall Overturning		Yes		No								
	If Yes,	Drawing Sheet No.											
	Partial Wall Collapse		Yes		No								
	If Yes,	Drawing Sheet No.											
	Vertical Crack in the Wall		Yes		No								
	If Yes,	Drawing Sheet No.											
	Wythe Separation		Yes		No								
	If Yes,	Drawing Sheet No.											
	Diagonal Cracks near Openings		Yes		No								
	If Yes,	Drawing Sheet No.											
Roof	Roof Sag		Yes		No								
	If Yes,	Drawing Sheet No.											
	Roof Collapse		Yes		No								
	If Yes,	Drawing Sheet No.											
Column	Shear Cracks in Column		Yes		No								
	If Yes,	Drawing Sheet No.											
	Vertical Cracks in Column		Yes		No								
	If Yes,	Drawing Sheet No.											
	Column Sway		Yes		No								
	If Yes,	Drawing Sheet No.											
Beam	Shear Cracks in Beams		Yes		No								
	If Yes,	Drawing Sheet No.											
	Horizontal Cracks in beams		Yes		No								

	If Yes,	Drawing Sheet No.								
	Tensile Cracks in Beams		Yes		No					
	If Yes,	Drawing Sheet No.								
Horizontal Band	Horizontal Band at Plinth Level			Yes		No				
	If Yes,	Drawing Sheet No.								
(Masonry Construction)	Horizontal Band at Lintel Level			Yes		No				
	If Yes,	Drawing Sheet No.								
	Horizontal Band at Sill Level			Yes		No				
	If Yes,	Drawing Sheet No.								
	Horizontal Band at Roof Level			Yes		No				
	If Yes,	Drawing Sheet No.								
Pounding	Building Susceptibility of Pounding			Yes		No				
	If Yes,	Drawing Sheet No.								
Expansion Joint	Present	Yes		No						
	If Yes,	Drawing Sheet No.								
Irregularities	Presence of Different Storey Height			Yes		No				
	If Yes,	Drawing Sheet No.								
	Presence of Short Column			Yes		No				
	If Yes,	Drawing Sheet No.								
	Presence of Re-entrant			Yes		No				
	If Yes,	Drawing Sheet No.								
	Presence of Soft Storey			Yes		No				
	If Yes,	Drawing Sheet No.								

Form B1E: Non-Structural Appendages & Equipment					
Block					
District					
State					
Pin code					
Area type					
Name of investigator					
Date					
Building Name					
Building Owner/ In charge					
S.No.	**Potential Hazard**	**Present (Y/N)**	**Size & Approx. Weight**	**To Be Moved/Anchored**	**Total Items**
Architectural/Outside:					

1	Wall Cladding				
2	Facade				
3	Sun Shade				
Equipment in health facilities:					
7	Filing Cabinets				
12	Fire extinguishers				
	Ceiling and Overhead:				
21	Water Tank (Plastic)				
23	Wall mounted Items:				
24	Shelves				
26	Wall-Mounted Gadgets				
28	Air Conditioners				
29	Water/Air Purifiers Mounted				
	Others:				
30	Aquariums				
Non-Structural Appendages					
31	Chajjas				
32	Parapet				
33	Water Tank (Masonry)				
34	Canopy				
	Others:				
	Connection Details	Refer Sheet No.			

Form B1F: Non-Destructive Test Results			
Block			
District			
State			
Pin code			
Area type			
Name of investigator			
Date			
Building Name			
Building Owner/ In charge			
NDT			
	Location of the Test Performed	**Refer Sheet No.**	
S.No	**Parameter**		**Results (Unit)**
1.	Masonry Unit		
2.	Dimensions (mm) BRICK-A		
3.	Dimensions (mm) BRICK-B		
4.	Water absorption (%) BRICK-A		
5.	Water absorption (%) BRICK-B		
6.	Compressive strength (N/mm²) BRICK-A		

7.	Compressive strength (N/mm²) BRICK-B												
8.	Mortar Composition (Based on chemical analysis)												
Rebound Hammer													
	Nomenclature	Readings						Inclination angle	Avg. of 7 readings	Compressive Strength (N/mm^2)			
	Readings	1	2	3	4	5	6	7					
Ultrasonic Pulse Velocity													
	Nomenclature	Readings					Trans. Method	Avg. of 5 Readings	Pulse Velocity	Avg. velocity	Quality of Concrete		
	Readings	1	2	3	4	5							
Core Test													
	Nomenclature	Dimensions								Compressive Strength			
Rebar Locator Results													
	Nomenclature	Drawing Sheet No.								Remarks			

Note: Provide list/ Data as separable Attachments.

Seal and Signature of the Responding Officer on behalf of the State

State:

FORM B1G : Geo-Technical Test Results				
Block				
District				
State				
Pin code				
Area type				
Name of investigator				
Date				
Building Name				
Building Owner/Incharge				
Soil Investigation				
S.No.	**Parameter**		**Result value (Unit)**	
A	**Foundation**			
1	Allowable Bearing capacity			
2	Depth of foundation (As Built)			
3	Width of Foundation (As Built)			
4	Coefficient of Subgrade Reaction			
B	**Soil Characteristics**			
5	N' value from SPT			
6	Sub Soil Strata			
7	Natural Moisture Content			
8	Density			
9	C			
10	Φ			
11	Liquid Limit			
12	Plastic Limit			
C	**Ground Water table**		**Remarks**	
D	**Soil & Foundation Type**			
	Hard	Medium	Soft	Can't Say
	Sandy soil	Yes	No	
F	**Foundation**			
	Isolated	Combined	Raft	Pile
	Refer Sheet No.			

Note: Provide list/ Data as separable Attachments.

Seal and Signature of the Responding Officer on behalf of the State

State:

Form B2: List of Evacuation Plan & Routes

State	
Name of Surveyor	
Name of Respondent	
Designation Of Respondent	
Contact of Respondent	
Address of Respondent	
Date	

S.No.	Infrastructure Name Evacuation Plan Belongs to	Infrastructure Address	(Latitude, Altitude and Longitude) (in Degree)	Seismic Zone	Usage	Capacity for Inhabitants to Evacuate	Year of Construction (DD/MM/YYYY)	Area covered for Evacuation (Sq.m)	Details of Evacuation Plan (Attach Plan)	Drawings of Evacuation Plans	Remarks

Note: Provide list/ Data as separable Attachments.

Seal and Signature of the Responding Officer on behalf of the State

State:

Form B3: Construction of Small Technology Demonstration Units

State					
Name of Surveyor					
Name of Respondent					
Position Of Respondent					
Signature of Respondent					
Date					
Small Technology Demonstration Units Already Existing			Yes		No
If yes,	List them		Address		
Installation of Small Technology Demonstration Units (Yes/No)					
How many Small Technology Demonstration Units are required					
List the Places where you want to have the Demonstration Units					
Name of the Building where STDU are to be	Area Allocated for Demonstration Units	Address			

Note: Provide list/ Data as separable Attachments.

Seal and Signature of the Responding Officer on behalf of the State
State:

ANNEXURE C

C. COMPONENT C

C.1 GENERAL APPROACH

Technical Assistance to improve the Disaster Risk Reduction or Management proposes for four prong approach as below:
A. Training and Capacity Building process
B. Awareness Programmes and Documentation
C. Institutionalize Seismic risk reduction in professional institutions mandate
D. Research & Development (R&D)

C.2 TRAINING AND CAPACITY BUILDING PROCESS IN GENERAL

The proposed methodology envisions the holistic approach to build the capacity of various stakeholders' viz., engineering institutions, physical and social development departments, schools, colleges and professional institutions. The approach further proposes three prong approach which includes

1) Institutionalization,
2) Education, awareness and sensitization and
3) continued operational research and documentation.

The methodology proposes systematic training design development which first analyses the training and non-training needs. This is to analyse the causative factors which transform the social dimensions and attitude towards disaster safety and resilience.

The following are the key assumptions considered for our training methodology development.

1. The education, capacity and awareness are continuous process and are directly dependent on individual's social, political and economic factors.
2. The process demands minimal but continued project resources to maintain the momentum, assess the tangible benefits and outcomes towards safety and resilience
3. The tangible impact of intervention may or may not be realized during the project management cycle and may require continuous additional resources
4. The training will be more effective if training (Technical skills and knowledge) and non-training needs (Policy, legislation, laws etc.) are being addressed with equal priority.
5. Since the resources are always in scare, it is imperative to mainstream education, awareness and skills in ongoing development projects and programmes to sustain the momentum.

The Training methodology is shows in the Figure C.1 which explains the proposed steps. The brief narratives are stated below complementing the flow chart.

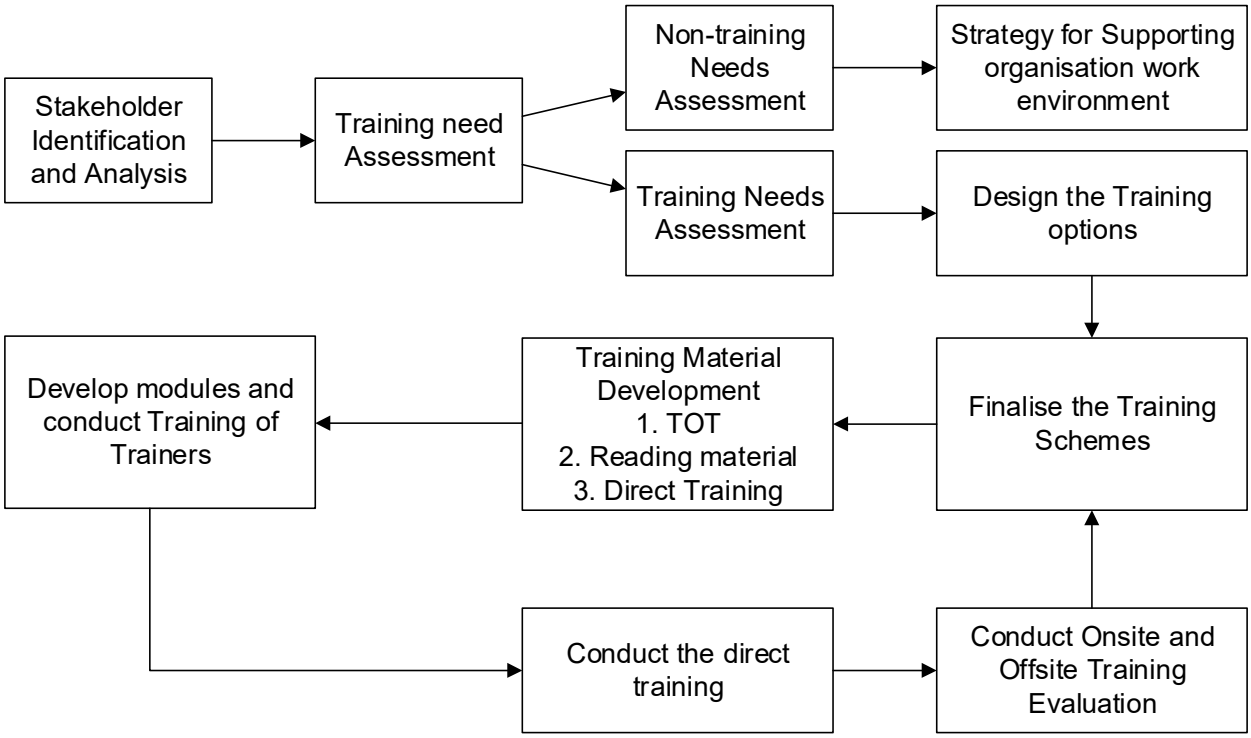


Figure C.1: Flowchart Showing the Process Proposed for Training for the Capacity Building

Step -1: Stakeholder analysis and selection

The stakeholder analysis is essential due to their roles, responsibility and stake to make society safe and resilient. The stakeholders, work and responsibility vary as per the states socio-economic and geopolitical conditions. A broader stakeholder are tabulated in the matrix given below for ready reference in Table C.1.

Table C.1: Stakeholder classification, their work domain and responsibility

Stakeholders V	Principle Area of Work	Responsibility
Physical Development Government Departments	•Infrastructure development •Construction and Management •Environmental and ecological management •Natural resource management	Design and enforcement in Safer and resilient physical Infrastructure development
Social Development Government Departments	•Social and welfare management •Vulnerable society care •Poverty and health improvement	Enforcement and support in safer and resilient community development

Stakeholders V	Principle Area of Work	Responsibility
	•Sustainable Development goals	
Administration and Finance Government Departments	•Law, rules and regulations formation	Resource allocation and their enforcement
Development NGOs	•Supporting development programmes and projects	Project implementation for safer societal development
Community and Households	•Safer and resilient society and infrastructure	Direct beneficiaries
Professional Institutions and Bodies	•Skill development •Certification of quality of professionals •Policy development and enforcement support	Well qualified professionals available to meet the goals
Educational Institutions	Skill development Curriculum/development/enforcement/ research	Providing adequate skills to meet the safety goals
Government Controlling Bodies	Law enforcement and monitoring	Ensuring better enforcement towards effective outcomes

Step-2: Training Need Assessment

Referring to the list of stakeholders identified, their key work domain and responsibility, the need assessment will be carried out. The assessment process includes interviews, on-site and off-site assessment, questionnaire, situation analysis and other management games. This will provide spectrum of needs, which will be further segregated into training needs (viz., skills, knowledge, expertize, aptitude etc.) and Non-Training Needs (Laws, Organizational Support, policies and norms). This will help to understand the improvement needs. The training needs will be considered for developing appropriate training design for various stakeholders. The non-training needs will be shared with the respective key department/ stakeholders for further workplace improvement. The mitigation measures will be provided with the department. In close coordination, the team will help the department to improve the working condition.

Step-3: Training Design

Based on the specific needs by each identified stakeholders, the training design schema will be developed with various options. In close coordination with the stakeholders, the design schema will be finalized for further content development. As per the TOR, following activities are identified for capacity building in the proposal, however, based on discussion with the state authorities, the specific stakeholders will be finalized.

- Training and Capacity building of Emergency and first responders.
- Curriculum revision for introduction of Earthquake Engineering topics in Engineering, and Architecture education.
- Training & Capacity Building for Engineers, Architects and Masons; and Municipal and State bodies
- Development of IEC material for sensitization programmes for communities
- Training of State officials and PMU officials related with implementation, management and monitoring of this project.

Based on the nature of job and skill requirements, the training modules will be developed. The design will focus on adult learning principles considering aspects- self learning, problem oriented, experience, ready to learn and internal motivation. The content will be delivered through case study, lectures, games, audio-video systems and presentations. The content will be subjected to the various stakeholder needs. The content will be delivered in two phases if desired 1) Training of Trainers & or 2) Direct training.

Step-4: Training of Trainers (TOT) modules

The TOT is proposed to ensure that the skills development activities are continued by the trained professional beyond the project management cycle. The process will develop the TOT modules which will enable the potential master trainers to continue with the planned capacity building activities. The TOT modules will provide instructions, how to address each training modules, their evaluation criteria and training delivery skills. The TOT for each training series will be conducted for the potential trainers and further certified. This will be link to the direct training modules.

Step-5: Direct Training

The trained master trainers will be engaged to conduct the direct training on specific training series. Four Phase training are proposed with varying engagement of instructors and trained master trainers. In first phase, there will higher engagement of instructor and gradually more engagement will planned for master trainers. In the last phase, Instructors will be engaged in only monitoring and evaluation of training, leading to the exit of the instructors (Figure C.2).

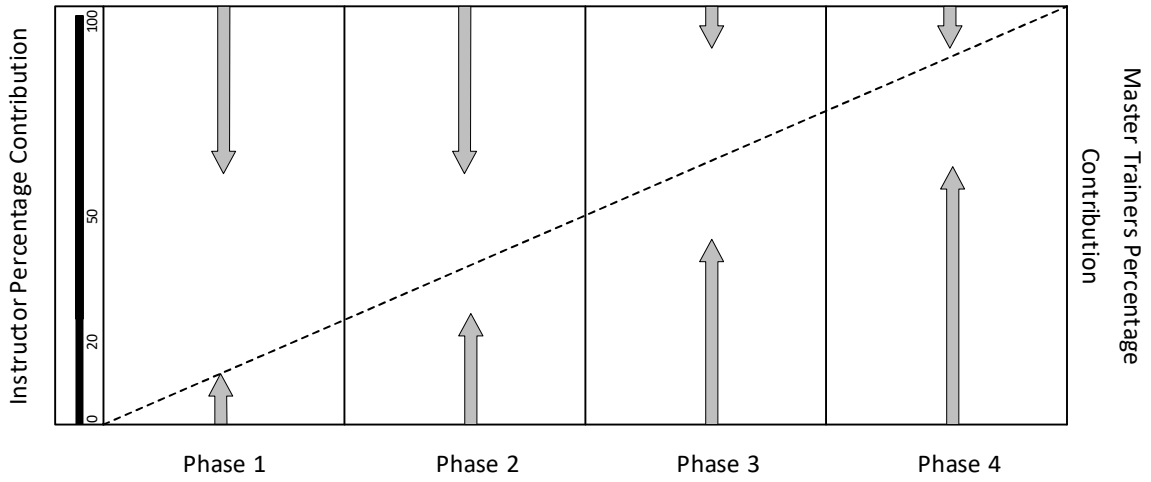


Figure C.2: Training Contribution by Instructors and Potential Master Trainers

Step-6: Evaluation of Capacity Building

The evaluation of capacity building is essential component, which will be planned from the on-site training to the post training attitudinal changes and behavioral transformation. The provision will be proposed to ensure monitoring and evaluation of the planned activities beyond project management cycle. The strategy will ensure monitoring and evaluation of the developed modules and their future revision

Awareness Programmes and Documentation

The proposed approach understands the key role of awareness and sensitization, which are the basis for attitude and behavior transformation for the safer and resilient society development. Need assessment conducted during the training design, will be the basis for the understanding the current gaps and required capacity and sensitization.

A thorough assessment will be carried out to understand social –cultural aspects and various available awareness and sensitization tools. The process will optimize the resources and identify effective sensitization and awareness tool. The thrust will be given to develop innovative, value adding, optimal resource demanding tools, which is socially acceptable and feasible ones. This will include posters, inclusion in cultural activities, radio and TV shows, Jingles, seminars and conference etc.

The approach will develop various guidelines for community, house owners, urban bodies, municipalities and village panchayats for safer and resilient physical development. A set of guidelines will be developed to support these stated activities.

Large scale information, education and communication (IEC) through audio-visual and print materials will be developed to support above stated activities.

C.3 INSTITUTIONALIZE SEISMIC RISK REDUCTION IN PROFESSIONAL INSTITUTIONS MANDATE

The methodology further scopes strengthening of the professional bodies in seismic risk reduction. This may include State Training Institutions for Public works, Administration, Heath Services, Administration Services through state designated Administrative Training Institution(ATI) in the identified states. These states have fully functional ATIs and having department for disaster management. The project will further strengthen these institutions and build the capacity for training of the respective departments. Further professional state chapters of engineering, health and architecture & planning will be coordinated and identify policy intervention gaps. In close collaboration and coordination with these authorities, the guidelines or laws or legislation will be drafted. A thorough review process will be conducted and finalized. The strategy will be provided to these authorities to enforce the developed laws and review of the progress in defined timeline. The other activities include preparation of a model bill for National Council of Professional Engineers (NCPE) and formulation and implementation of Techno-legal Regime for structural design reviews, implementation monitoring and licensing of professionals.

C.4 RESEARCH & DEVELOPMENT (R&D)

The proposal underscores the importance to continuous and sustained research and development in the area of hazard assessment, structural retrofitting and other social dimensions of disaster management. Following steps are proposed to ensure strengthening/Establishing seismic research and development program including setting up a center of excellence.

- Identify the existing R&D institutions and their mandate
- Review their services with respect to set mandate and requirements
- Establish the agreement with parent organization to enhance the institution capacity

- Develop the strategy and estimate the resource requirements for Centre of Excellence
- Submit to the project management unit for appraisal and further approval

C.5 SPECIFIC ACTIONS FOR COMPONENT C UNDER NSRMP

(i) Critical review of existing material/draft bill for National council of Professional Engineers (NCPE) from the perspective of present day seismic risk mitigation/disaster risk reduction and suggest improvements in structure of bill as well as content of the bill.

(ii) Status of seismic research development programmes will be studied in detail to identify gaps, challenges, role of key institutions. Document will be prepared in form of an action plan to strengthen seismic research programmes and suggestions will be made for setting up a center of excellence. For this, TOR will be prepared for consultancy services to develop proper action plan along with procurement documents and work plan.

(iii) Existing curriculum of Engineering and Architecture will be reviewed critically and gaps will be identified. Document will be prepared identifying the key institution, entry point for implementation at National and State level. TOR for consultancy services will be prepared for this component to include Earthquake Engineering as implicit component in various courses.

(iv) Existing Techno-legal regime at National and State level will be reviewed and document will be prepared on how it has to be designed and implemented in structural design reviews, monitoring and licensing of professionals. For carrying out this work relevant TOR will be prepared for consultancy services.

(v) In past traditional earthquake resistant construction performed very well in the event of an earthquake. To encourage & document such type of construction an action plan along with TOR for consultancy services will be prepared.

(vi) Standardized IEC materials will be prepared on the basis of existing material or new IEC material will be prepared on the basis of need assessment of capacity building of various identified stake holders.

(vii) TORs will be prepared for consultancy services for designing training modules after assessing existing modules along with Action Plan to implement the same for Engineers, Architects, Masons, State & Municipal bodies.

For carrying out these specific tasks and to review present status of these tasks data will be collected at National/State levels for which a form has been developed. National/State authorities will be required to provide relevant data.

C.6 FORMS FOR COLLECTING DATA PERTAINING TO COMPONENT C

The following forms will be used for collecting the data for Component C.

Location:

Date:

Name of Respondent:

Position of Respondent:

	Existing building bylaws with provision of Earthquake Engg.	Yes	No
	Details of the provision in brief:		

	Practice of Traditional Earthquake Resistant Construction	Yes	No
	Details of the Construction Technique		
	Training and Capacity building of State and Municipal bodies	Yes	No
	Frequency of Training:		
	Training and Capacity building of Eng., Architects:	Yes	No
	Frequency of Training:		
	Training and Capacity building of Masons:	Yes	No
	Frequency of Training		
	Information, Education and Communication	Yes	No
	Audio used	Yes	No
	Audio-Visuals used	Yes	No
	Print Media used	Yes	No
	Sensitization programme for communities	Yes	No
	Training conducted for communities:	Yes	No
	Frequency of Training		
	Attachment of sample manuals required		
	Institutes doing research for Disaster Management:	Yes	No
	Number of Institutes:		
	Centre of Excellence for studies on Disaster Management:	Yes	No
	Number of Centre of Excellence:		
	Any Specialized Courses on Disaster Management:	Yes	No
	Details of Courses:		
	Does current curriculum covers Disaster Mitigation study in B.Tech and B.Arch	Yes	No
	Any topic regarding Earthquake Engineering in B.Tech and B.Arch?	Yes	No
	Are the courses sufficient for equipping the students with proper knowledge?	Yes	No
	Any revision to the course structure necessary:	Yes	No
	Proposed topics to the incorporated:		

ANNEXURE D

D. COMPONENT D

D.1. BACKGROUND

NDMA data suggests that About 58.6% of the country is prone to earthquakes (Zone III, IV and V). Due to the unpredictable nature of the earthquake hazard, along with poor infrastructure facilities and lack of preparedness results in increased loss and damage during such a disaster. Thus under NSRMP the main objective of the NDMA is to reduce vulnerability of communities and their assets to natural disaster by taking appropriate mitigating measures. key objectives of the programme are:

- Reduction in vulnerability of eight states through creation of appropriate infrastructure which can help mitigate the adverse impacts of earthquakes, while preserving the ecological balance of a mountainous region.

Mitigation measures as part of NSRMP may require construction, retrofitting, repair and modification work to be undertaken at multiple project locations. It is possible that such work would involve environmental and social assessment, land acquisition and involuntary resettlement. As per the World Bank and NDMA mandates It will be essential for every mitigation project proposed under this programme to conduct an Environment and Social Assessment to assess the possible environmental and social impact and also minimize or mitigate any adverse negative impact resulting from the implementation of the programme.

Sendai Framework quotes vulnerability as “the conditions determined by physical, social, economic, and environmental factors or processes which increase the susceptibility of a community to the impact of hazards”, associating the vulnerability with both the physical environment and the human dimension of disaster. While Vulnerability is defined through four different factors, hazard is characterized by probability and severity. In contrast, while exposure is determined using structures, population and economy factors, capacity and measures is closely addressed the resilience concept.

There are different ways to classifying vulnerability types with reference to a specific settlements or geographical sites. The key categories or types of vulnerability are Physical, Economical, Environmental, and Social.

The NSRMP the project implementation would require construction, regeneration, repair and modification work to be undertaken at multiple locations. It is possible that such work would involve environmental and social assessment, land acquisition and involuntary resettlement. This document describes the principles, objectives and approach to be followed while developing the ESMF, which will further helps in developing the Environmental and Social Commitment Plans, preparing communication and information dissemination strategy, and to minimize or mitigate the adverse environmental and social impacts resulting from the implementation of the NSRMP.

D.2 AIMS AND OBJECTIVES OF ENVIRONMENT AND SOCIAL ASSESSMENT FRAMEWORK (ESAF)

The Environment and Social Assessment provides the framework (guidelines, and procedures) for the management of environmental and social issues which are likely to arise due to the implementation of project activities in the following mountainous states of Assam, Bihar, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Tripura and Uttarakhand.

The same assessment framework may be implemented in the other states/UT based on the specific need of the project. The Environmental and Social assessment has to be integrated during the implementation phase of the project.

D.2.1 OBJECTIVE OF ESAF

The broad objective of the ESAF is to ensure ecologically balanced and sustainable development during various phases of implementation (planning, construction and post construction phases) of the all project activities. The key objectives of the ESAF are:

- Provide a framework for the integration of social and environmental aspects, at all stages of planning, design, execution, and operation of various projects.
- Avoid or minimize adverse negative Environmental impacts of the proposed projects
- Enhance positive environmental and social outcomes from the implementation of the programme.
- Support compliance with applicable laws, regulations, and policies.

D.2.2 KEY CONTENTS OF THE ESAF

The framework details out the various policies, guidelines and procedures that need to be integrated during the planning, design and implementation cycle of the World Bank-funded project. The framework describes the principles, objectives and approach to be followed for selecting, avoiding, minimizing and/or mitigating the adverse environmental and social impacts that are likely to arise due to the project. It also outlines the indicative management measures required to effectively address or deal with the key issues that have been identified. The required institutional arrangements for effective environment management have also been outlined as a part of this framework.

Specifically, the Environmental Management Framework includes the following:

- Information on GoI's environmental legislations, standards and policies and World Bank safeguard policies that are relevant in the over-all project context.
- Process to be followed for environmental and social screening to guide decision-making about proposed sub-projects.
- Steps and process to be followed for conducting environmental and social impact assessment and preparation of Environmental Management Plans/Resettlement Action Plans (as required) for selected sub-projects.
- Preliminary assessment of anticipated environmental and social impacts in the context of broad/known project interventions.
- Generic environment management plans measure to avoid, minimize and mitigate anticipated impacts.

- Entitlement matrix to guide the preparation of Resettlement Action Plans, as and when needed.
- Institutional arrangements for environment and social management, including monitoring and reporting.

D.2.3 KEY LAWS, REGULATIONS AND POLICIES APPLICABLE FOR ESMF

For the implementation of any project as part of the mitigation measures proposed under the NSRMP, the project must be compliant with all applicable laws, regulations, and notifications. The following section lists out some of the Nation and relevant World Bank Policies applicable for the projects

D.2.4 NATIONAL LAWS RULES AND REGULATIONS

(i) Environment (Protection) Act, 1986 & EIA Notification S.O. 1533 dated 14th September 2006
(ii) Forest (Conservation) Act, 1980
(iii) Water and Air (Prevention & Control of Pollution) Acts
(iv) The Land Acquisition Act (LA) of 1894 amended in 1985
(v) Ancient Monuments and Archaeological Sites and Remains Rule 1959
(vi) National Rehabilitation and Resettlement Policy, 2007
(vii) The Ramsar Convention on Wetlands of International Importance 1971

D.2.5 WORLD BANK ENVIRONMENTAL AND SOCIAL POLICIES AND STANDARDS

The World Bank's environmental and social safeguard policies (ten of them) are a cornerstone of its support to sustainable poverty reduction. The objective of these policies is to prevent and mitigate undue harm to people and their environment in the development process. These policies provide guidelines for bank and borrower staffs in the identification, preparation, and implementation of programs and projects. The following ten are relevant for considerations under this ESMF.

1. Assessment and Management of Environmental and Social Risks and Impacts;
2. Labor and Working Conditions
3. Resource Efficiency and Pollution Prevention and Management
4. Community Health and Safety
5. Land Acquisition, Restrictions on Land Use and Involuntary Resettlement
6. Biodiversity Conservation and Sustainable Management of Living Natural Resources
7. Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities
8. Cultural Heritage
9. Financial Intermediaries, and
10. Stakeholder Engagement and Information Disclosure

In line with the requirements of the World Bank, the Bank’s environmental and social safeguards policies shall be applied to all the major sub-project activities. The ESMF identifies the potential impacts of various sub-project activities and outlines the indicative management measures required to effectively address the same. Appropriate institutional arrangements towards implementing the indicative measures have been detailed in the framework.

D.2.6 THE KEY COMPONENTS FOR CONDUCTING AN ASSESSMENT (ENVIRONMENTAL AND SOCIAL)

D.2.6.1 SOCIAL AND ENVIRONMENTAL SEISMIC RISK ASSESSMENT PROCESS

Social and environmental risk assessment and risk mapping contribute to ensure that policy decisions are prioritized in ways to address the most severe risks with the most appropriate prevention and preparedness measures. The overall process of risk assessment into risk management process by following:

a. Identification of the risk by hazard and exposure recognition,
b. Risk analysis as potential consequences composed by the assessment of the hazard impact level in quantitative terms, and
c. Risk evaluation, which allows the classification of risk according to criteria.

In other words, the risk management is based on scientifically supported risk assessment, which leads to the needs identification for the risk treatment with measures in both the pre- and during-disaster phase.

D.2.6.2 RISK IDENTIFICATION:

The first step of the risk assessment process is the recognition of the risk. This includes the identification of the potential hazard, the definition of the extent of the area that will be studied, the establishment of the exposure model and the risk metric per type of impact. Risk assessment is mainly conceptualized in four steps;

a. Hazard identification and vulnerability analysis
b. Risk Estimation
c. Risk Evaluation
d. Feedback or Post Audit Analysis

This framework considers seismic risk as product of hazard, vulnerability, exposure and capacity measures as shown in following Figure.

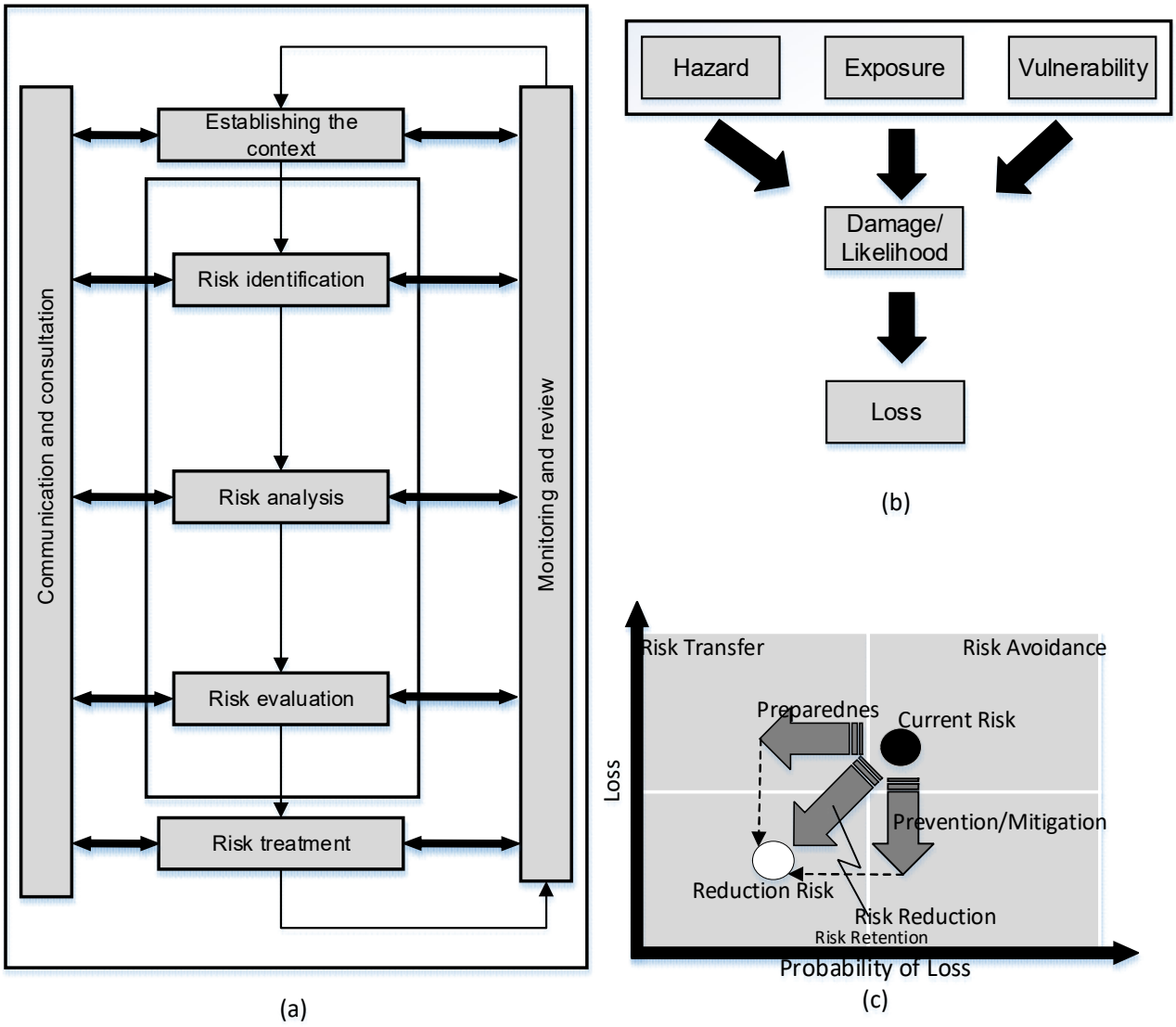


Figure D.1: (a) Risk Management Process, (b) Risk analysis input and output, (c) concept of disaster risk treatment

An effective environmental and social risk assessment, to begin the risk scenarios that will be studied will be listed, according to the available hazard and exposure data, delineating the basic layer of the preparedness map in the region.

Mountainous regions are different in their geography, weather patterns and lifestyle. People in the mountains are used to regular changes such are facing regular landslides, earthquakes, avalanches etc. Over the year's locals have also developed adaptation techniques to such extremes. Various data and assessment methods are available understand these local conditions and the risks in this region.

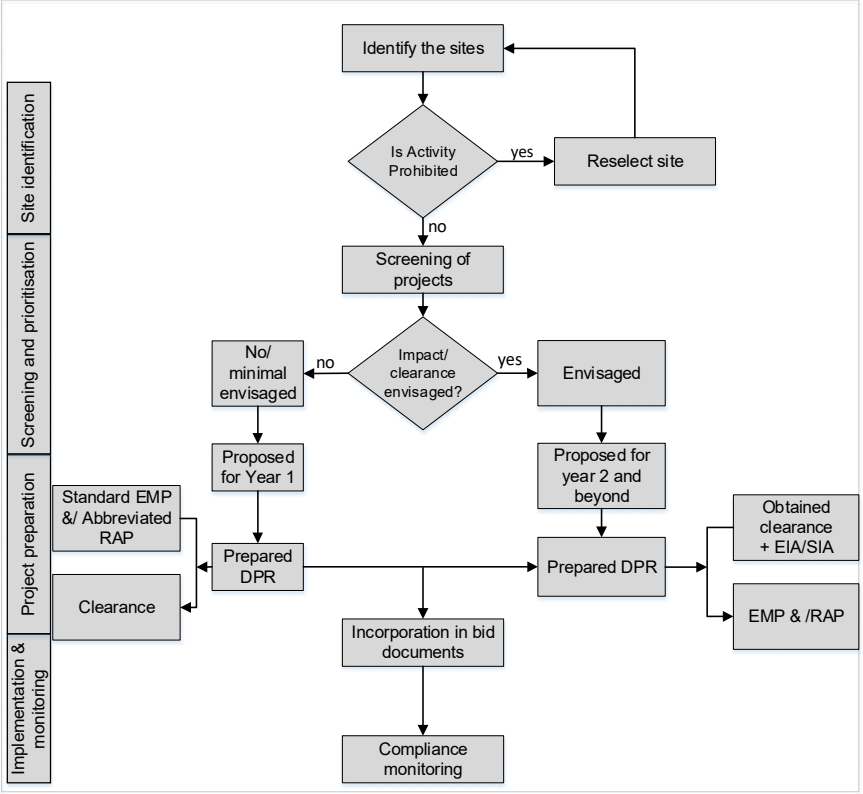
D.2.7 Application of the ESMF and Our Approach

The Environment and Social Assessment Framework has been carefully designed in line with the requirements of the World Bank's environmental and social framework along with compliances and mandates for seismic regions set by NDMA. The Approach of the framework will be in compliance to codes / standards, guidelines issued by Bureau of Indian Standards for Earthquake resistant structures. Other National and International norms of practices will also be referred as per needs. The work will also refer the local rules and regulations, guidelines, buildings bye-laws applicable where the building is located. In addition, relevant nationally defined Guidelines will also be followed.

Site identification, screening and review, implementation, and monitoring are the essential elements of a subproject. The ESMF should be integrated into all these phases of a sub-project. The key process steps would be:

- Site screening for potential environmental and social impacts
- Further assessment, as required, of significant environmental and social impacts and the development of environmental and social management plans with appropriate mitigation measures
- Integration of the management plans with contract documents so that the mitigation measures will be put into practice during the implementation phase
- Facilitation in carrying out periodic monitoring through the proposed online monitoring tool.

The overall applicability and process of the ESMF has been depicted in the flow chart below.



Source: Environmental and Social Framework, NCRMP, 2009

Figure D.2: Process of ESMF

D.2.8 METHODOLOGY ADOPTED FOR THE ESMF

In line with the overall methodology of the NSRMP project we have defined ESMF methodology through various steps as indicated in the Table below:

D.2.8.1 METHODOLOGY OUTLINE

Step No.	Activity	Outcome	Deliverables
Step 1	Preparatory Phase - Introductory Meetings	• Identification of Stakeholders and Introductory meeting at project States level (8) • Stakeholders understanding about the work to be done Stakeholders: • NDMA, • SDMA, and or State Representatives	Understanding of the objectives, finalisation on methodologies, work plans,
Step 2	Identifying the Project Site	• Planning for detailed survey and verification for project location including the project components i.e. A and B and C. • Geographic details , seismic zone of project location.	Baseline Profile
Step 3	Site screening for potential environmental and social impacts prohibited activities.	• Identifying environmental sensitivities in and around the site location (forest reserves, water bodies , wetlands, protected areas, etc.)	Environmental Screening Assessment Form
Step 4	Identifying the Potential Environmental impacts	• Assess any kind of environmental impact due to the proposed mitigation measure. • Impact on ecosystem, local biodiversity. (flora and fauna) • Impact on local environment (air, water, soil, temperature, noise etc) • Any potential adverse impacts (landslides, floods etc)	
Step 5	Vulnerability Assessment and Structural safety of Mitigation measure	• Building will survive or fail • Structural component strength is sufficient or not • Safety compliance check	Assessment Report
Step 6	Detailed vulnerability assessment of retrofitted building	• Retrofitting options compliance and safety check	Assessment Report
Step 7	Preparation of preliminary Environment Action / Management Plan	• Environment Management actions outlined in the Plan	Project Report

Step 8	Preparation of detailed project report for approved Mitigation Measures	• Detailed Project Report	Final integrated Project report.

D.2.8.2 ESMF DETAILED METHODOLOGY

PREPERATION PHASE:
Meeting with NDMA, State Authorities, visit to all the project states and understanding of the objectives, finalisation on methodologies, work plans, studies of national social and environment policies, States specific policies and rules, DM Act and Regulations followed by respective states

Introductory Meetings
- Identification of Stakeholders and Introductory meeting at project States level (8).
- Stakeholders understanding about the work to be done.

Stakeholders: NDMA, SDMA, and or State Representatives

Deliverable 1:
Reconnaissance visits to the States
- This will include the Stakeholders meetings at State level;
- Detailing of ESA work as per the project component A, B, C, and D;
- Identifying the needs of orientations and capacity building;
- Designing the ESA for project site identified under multi hazard mitigation infrastructure i.e. ESA for identified building or identified critical infrastructure for retrofitting and repairs;

Deliverable 2:
Identifying the Project Site
- This will include the Stakeholders meetings at State level;
- Detailing of ESA work as per the project component A, B, C, and D;
- Identifying the needs of orientations and capacity building;
- Designing the ESA for project site identified under multi hazard mitigation infrastructure i.e. ESA for identified building or identified critical infrastructure for retrofitting and repairs;

Deliverable 3:
Screening of site location (as per the following steps in flow chart)

Developing criteria for evaluating the results of screening

Deliverable 4:
Developing draft ESMF
- ESA reports for detail project report and Investment Proposal
- Preparation of an Environmental and Social Commitment Plan

Deliverable 5:
Complete Environmental and Social and Impact Assessment of identified 50% of risk mitigation sites

Deliverable 6: Draft ESCP document
Environment and Social Commitment Plans for at least 50% of the DPRs; Indicative EMP for Critical Infrastructures like Roads, Bridges, public buildings, etc; Finalization of all Environment and Social management instruments/documents

Deliverable 7:
Integration of ESMF and ESA reports with Web MIS, Project Management and M&E

The details of various steps are explained as follows:

- **Step – 1: Preparatory Phase - Introductory Meetings**

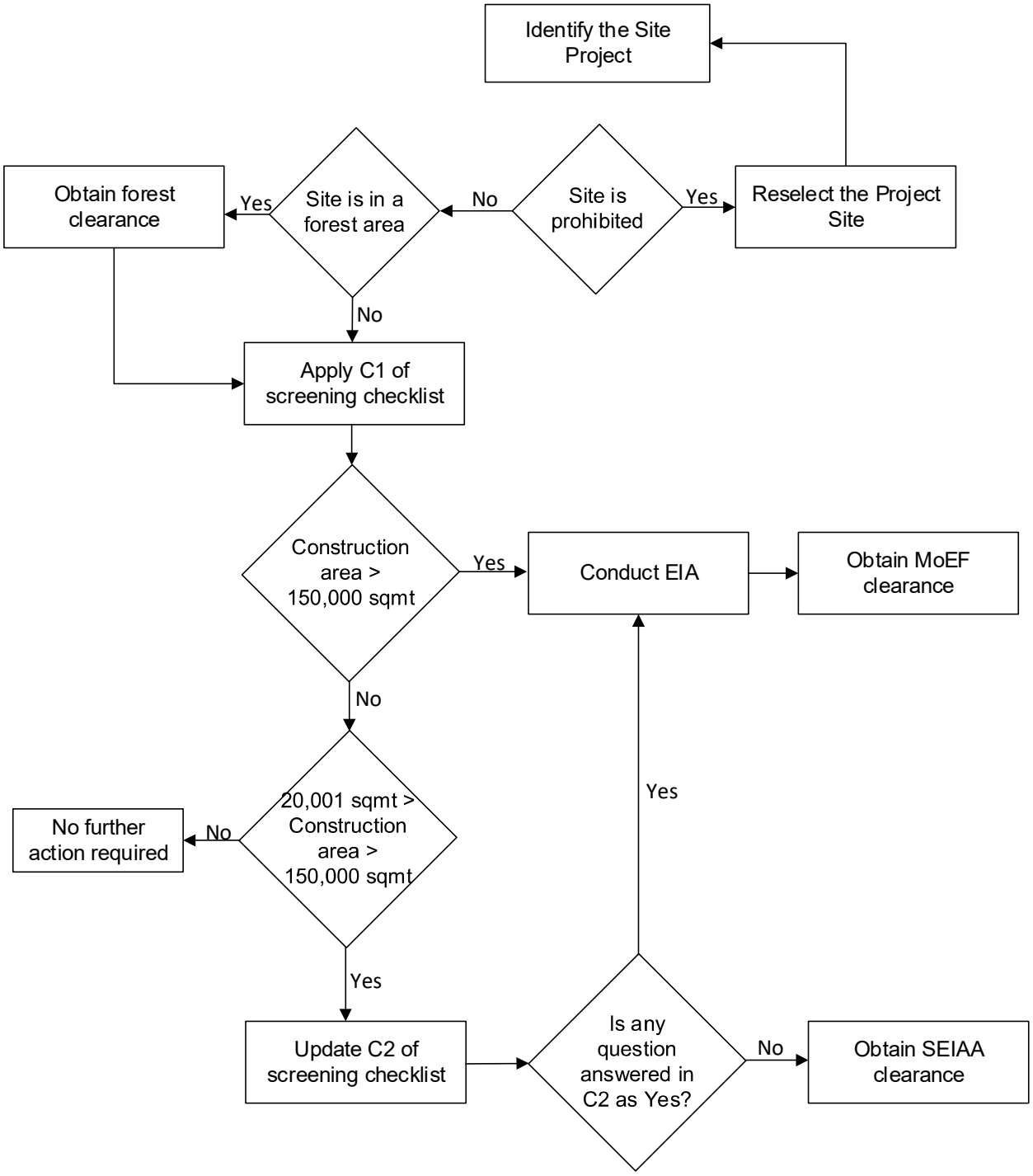
  (i) Identification of Stakeholders and Introductory meeting at project States level (8)
  (ii) Stakeholders understanding about the work to be done
  (iii) Stakeholders:
    - NDMA,
    - SDMA, and or State Representatives

- **Step – 2: Identifying site location**

  (i) Teams will visit the states to identify probable project locations.
  (ii) All the reports of initial visual assessment carried out will collected and reviewed in brief along with data available from various government sources, photographs etc.
  (iii) A thorough Location Profile based on geography and demographic details will be documented.

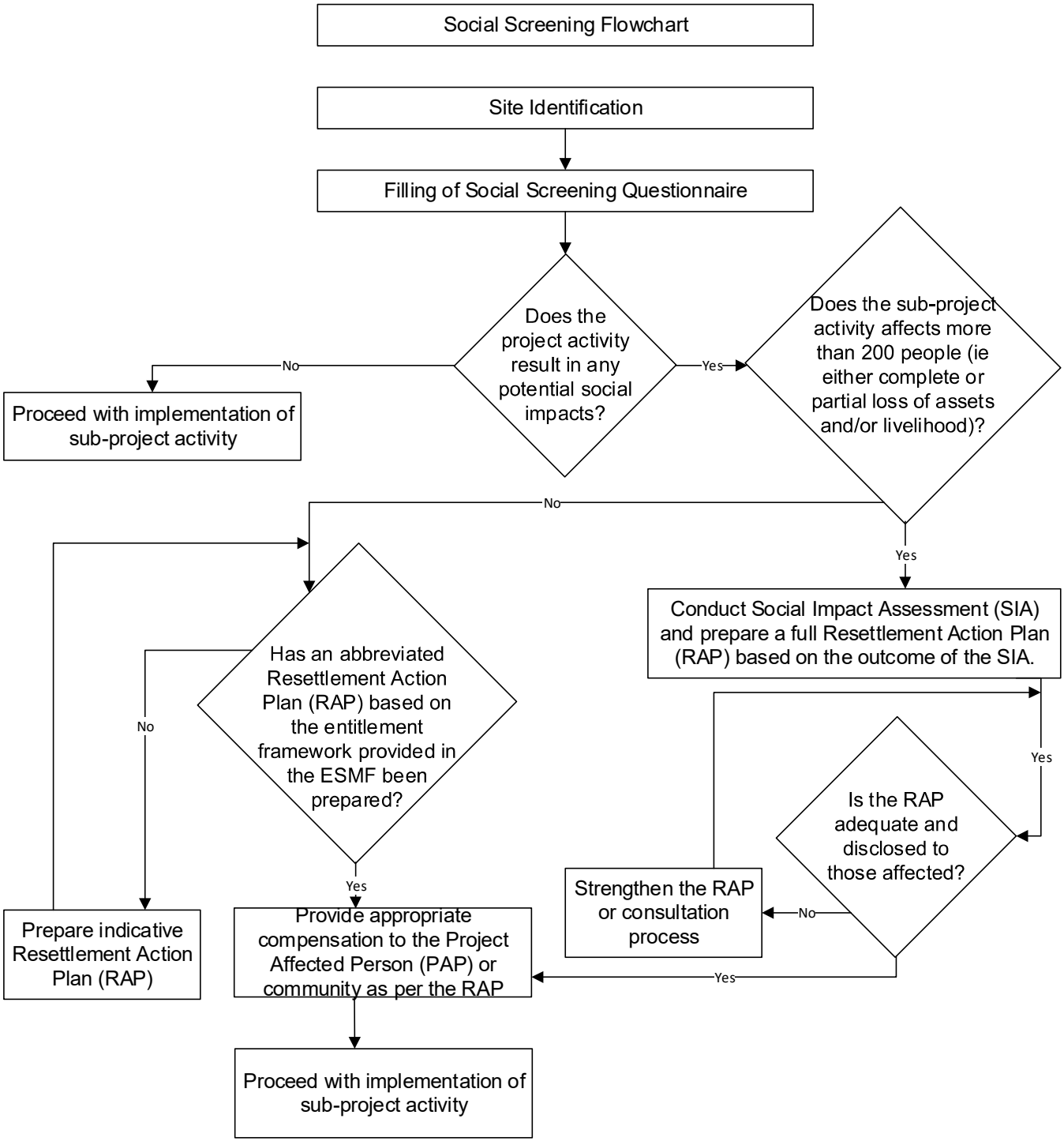
- **Step – 3: Screening of site location:**

  The objective of the screening process is to identify those sub-projects that have minimal or no environmental or social impacts. This step involves data collection and critical review of visual assessment carried out earlier to identify Project locations. During the screening process, it is also confirmed that none of the projects is prohibited as per the existing government notifications. The Environmental screening form as per requirements of NCRMP is attached as Annexure 1. On similar line the Environmental and social screening forms will be developed for National Seismic Risk Mitigation Project.



Source: Environmental and Social Framework, NCRMP, 2009

Figure D.3: Diagrammatic Representation of steps for Environmental Screening



Source: Environmental and Social Framework, NCRMP, 2009

Figure D.4: Diagrammatic representation of steps in social screening

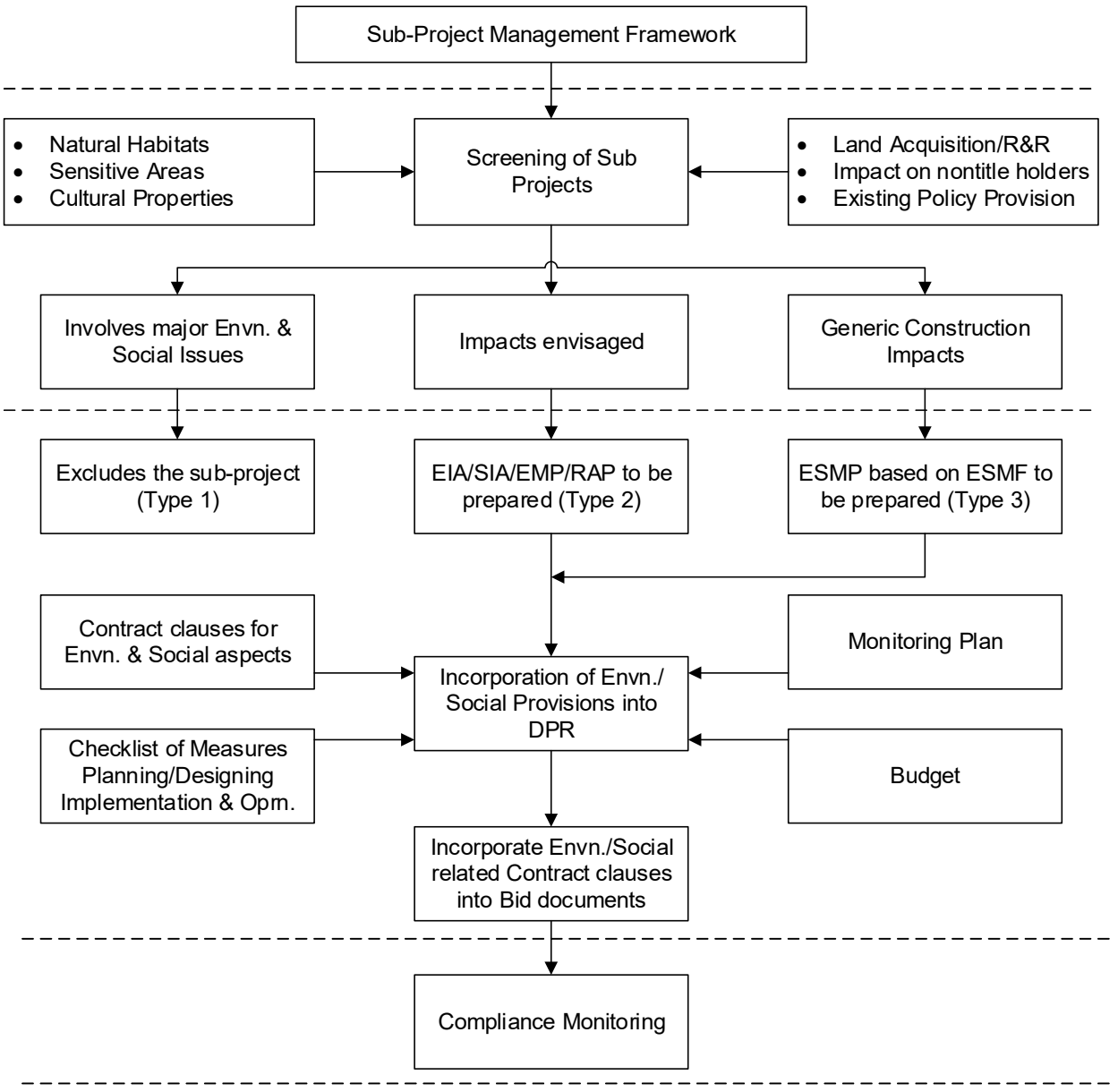
D.2.9 SUB PROJECT MANAGEMENT FRAMEWORK:

This ESMF will further lays down the principles and guidelines for addressable of environment and social safeguard impacts due to the implementation of the NSRMP in the selected states/cities, which has to be taken up as part of the Component 2 of the project. The key objectives of the ESMF are to:

- Provide a framework for the integration of social and environmental aspects at all stages of the project planning, design, execution and operation of various sub-components
- Ensuring positive social and environmental impacts of sub-projects and avoid / minimize and manage any potential adverse impacts.

In line with the requirements of the World Bank, the Bank's environmental and social safeguards policies shall be applied to all projects to be taken up under NSRMP. The framework identifies based on the project screening carried out as per the previous section, the type of projects that are required to undergo rigorous EA / SA and the projects that could have environmental and social impacts that could be addressed through an ESMP prepared based on the ESMF. The ESMF identifies the potential impacts in the project cities due to the planning, design, implementation and operation of the projects and outlines the management measures required for an effective addressable of the same. The adoption of this framework shall ensure that the projects meet the national and state level environmental and social requirements and are also consistent with the applicable safeguards policies and provisions of the World Bank.

The ESMF is to be applied at all stages of project as indicated in the following flow chart, as in identification of subprojects, screening and up to implementation and operation stage. The framework encourages participatory approach to preparation of sub-projects in respective cities/sites.



Screening provides an overview of sub-projects that are likely to involve impacts and those that have no / minimal impacts, thus providing inputs to consider further requirement of environment and social assessments followed by preparation of ESMP. Screening shall also determine the category of the sub-project and the manner of application of the ESMP.

- **Type 1 –** The sub-projects that would involve land acquisition and/or significant social impacts. These sub-projects would need to be excluded from further consideration in the project.
- **Type 2 –** The sub-projects that require a full review and are likely to involve environmental impacts and impacts on non-titleholders that would require an EIA / SIA and project specific EMP / RAP.
- **Type 3 –** The sub-projects that would require limited review involving generic environmental and social impacts that could be addressed through a generic ESMP.

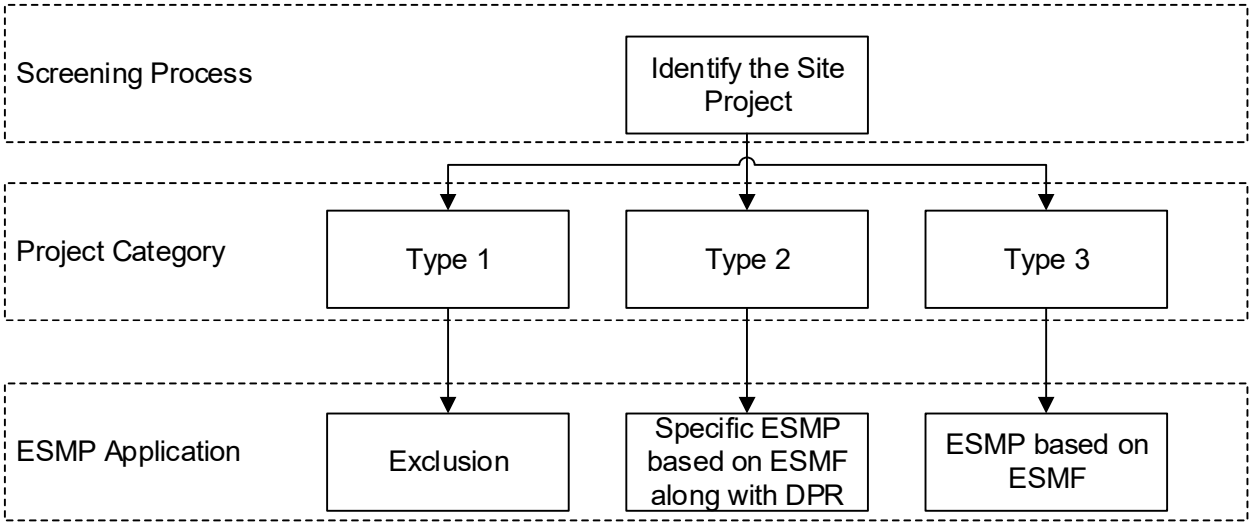


Figure D.5: Project Categorization

- **Step – 4: Identifying of Potential Environmental Impacts:** Potential environmental impacts of the project are assessed during this stage. Environmental impacts may can be classified into two categories:

  - General Environmental Impacts: tree felling, degradation of water quality, Air pollution, noise pollution, etc.
  - Adverse Environmental Impacts: Landslides, flooding, glacial lake outburst flood etc.

The management plans for the environmental impact vary depending on the adversity of the impact. In case of General environmental impacts adaptation and mitigation measures to compensate of the impacts are outlined in the Environment management plan. However, when the mitigation measure poses adverse impacts on the environment, a detailed EIA of the project is required based on which the environment management plan is created.

- **Step – 5: Vulnerability Assessment and Structural safety of Mitigation measure:** In the case of any existing or proposed building for the new project it will be essential to check the compliance to Seismic norms. This step will deal with the finalisation of safety levels to be used for analysis of building depending on its use (critical or other).

- **Step – 6: Detailed vulnerability assessment of retrofitted building:** In case of any retrofitted buildings in the area, structural safety of these buildings is also assessed as per the Indian building standard norms.

- **Step – 7: Environment Management Plan:** This involves preparation of a contingency/ management plan, to safeguard the environmental and social impacts. Other structural mitigation options to safe guard the built environment will also be listed in the project report.

- **Step – 8: Integration of the Environment Management and Commitment Plans with detailed project procedures:** This stage will bring out detailed project report. Integrating the environment and social management plan across all stages of construction.

D.2.10 MONITORING AND REPORTING SYSTEM

PIUs will be responsible for compliance monitoring and reporting to the PMU at the centre. An environment and social specialists will ensure compliance of the project activities with the NDMA and World Bank safeguards as well as oversee implementation of environment and social provisions as per the ESMF, EMP and RAP where applicable.

The objectives of Monitoring and Evaluation include:

- Project management and timely completion;
- Successful completion of Environmental management, R&R activities identified in the EMP and R&R plan as per the implementation schedule;
- Compliance with the Environmental policy, R&R policy and entitlement framework.

The environment and social specialist shall play a key role in reporting the progress of implementation as well as compliance to the PIU, PMU at NDMA.

ANNEXURE 1: PROCEDURE FOR CONDUCTING PROJECT SPECIFIC EIA

The following process is to be followed for sub-project activities, wherein the requirement for further assessment has been determined.

Step 1: Scoping
Scoping is a process of detailing the terms of reference of EIA. The results of the screening checklist may also be utilized for drawing up the terms of reference. Quantifiable impacts are to be assessed on the basis of magnitude, prevalence, frequency and duration. Non-quantifiable impacts (such as aesthetic or recreational value) are commonly determined through the socio-economic criteria.

Step 2: Baseline Data Collection
After identification of the areas, where the sub-project activity could have significant impacts, the baseline status of these areas needs to be monitored. The likely changes on account of both the construction and operation of the proposed sub-project should be predicted. The base line data would provide a description of the existing environmental status of the identified study area. The site-specific primary data should be collected for the identified parameters and supplemented by secondary data if available.

Step 3: Impact Assessment and Assessment of Alternatives
Impact prediction is a way of mapping the environmental consequences of the significant aspects of the subproject and its alternatives. For every sub-project, possible alternatives should be identified and their environmental attributes compared. Alternatives may be covered with respect to siting of the sub-project as well as technologies. These alternatives can then be ranked for identification of the options that aid in minimizing the adverse environmental impacts of the sub-project. After the identification of the alternatives, a mitigation plan should be drawn up for the selected option and should be supplemented with an Environmental Management Plan (EMP). The EMP guides the proponent towards environmental improvements and acts as a crucial input in monitoring the environmental clearance conditions. Hence it is essential that the details of monitoring should be included in the EMP.

Step 4: Preparation of the Draft EIA Report
An EIA report should provide clear information about the different environmental scenarios without the subproject, with the sub-project and with sub-project alternatives. The proponent should prepare the Detailed Project Report and provide the information in a logical and transparent manner.

Step 5: Public Consultation
Public consultation can ideally occur at various stages of the EIA. However, it is essential that the public consultation is done after the preparation of the draft EIA Report. All Project Affected People (PAPs) are entitled to have access to the summary of the impact assessment statement. The affected persons may include bonafide local residents, local associations, environmental groups active in the area, and any other person located at the sub-project site / sites of displacement. All PAPs should be given an opportunity to make oral/written suggestions and comments on the impact assessment report.

Step 6: Decision Making
Decision making process involves consultation between the project proponent (assisted by a consultant) and the impact assessment authority (assisted by an expert group if necessary). The decision on environmental clearance is arrived at through a number of steps including the evaluation of EIA and EMP.

Step 7: Monitoring
Monitoring has to be done during both construction and operation phases of a sub-project. It is done to ensure that the commitments made are compiled and also to observe whether the predictions made in the EIA reports are correct or not. It may be noted that the predictions made may differ from the actual outcomes as a result of the adoption of mitigation measures. If the impacts, however, exceed the predicted levels, corrective action should be taken.

ANNEXURE 2: NATIONAL CYCLONE RISK MITIGATION PROJECT ENVIRONMENT SCREENING FORM

This screening form is in 3 parts – Part A provides general information about the site. Part B helps assess whether the site selected for the project is prohibited or not. Part C provides details on environment and social screening respectively.

PART A: GENERAL INFORMATION ABOUT THE SUB-PROJECT

Sub Project ID:

1. Name of the State	
Type of proposed sub-project activity (tick the applicable option)	
2. Cyclone Shelter	
3. Cyclone Shelter with Access Road/Culverts	
4. Plantation of Mangroves	
5. Roads/Bridges/Culverts	
6. Shelter Belt Plantation	
7. Saline Embankment	
8. Coastal canal	
9. Communication Tower	
10. Any Other (Please Specify)	

Location of the sub project activity:	
1. Village	
2. Taluka	
3. District, State	
4. Size of the sub-project:	
Land requirement for the sub project (in Ha or m^2)	
1. Total Requirement	
a. Private Land	
b. Govt. Land	
c. Forest Land	
Note: If any forest land has been proposed for the sub-project activity, then relevant clearances must be obtained from the Forest department.	
Implementing Agency Details (sub-project level)	
1. Name of the Department/Agency	
2. Name of the designated contact person	
3. Designation	
4. Contact Number	
5. E-mail Id	
Details about the Screening Exercise	
1. Date	
2. Name of the Person	
3. Name of the Agency/Department	
4. Contact Number	
5. E-mail Id	

PART B: ASCERTAINING WHETHER THE SITE IS A PROHIBITED SITE

Objective	On updating this section, the user would be able to ascertain if the activity is permissible at the selected site

PART B1: List of sites where sub-projects are prohibited

List of prohibited areas:	**Yes**	**No**	**Provide details**
1. Is the construction being proposed in whole or in part within a biosphere reserve, national park wildlife/bird sanctuary, game reserve, tiger reserve/elephant reserve, wetland, important bird areas, coastal area with corals, mangrove area, estuary with mangroves, turtle nesting grounds, swamps/mudflats, notified sensitive eco zones.			If yes, mention area
2. Is the sub-project located in whole or in part between the HTL and the LTL?			
3. Is the sub-project located in whole or in part 200 meters from an estuary boundary?			If yes, mention name & distance.

4. Is the sub-project located in whole or in part 500 meters from flood plain or modified flood plain or by flood control systems of a riverine system?			If yes, mention name & distance.
5. Is the sub-project located in whole or in part 500 meters from railway line?			If yes, mention details
6. Is the sub-project located in whole or in part within 100 meters from the protected limits of notified archaeological sites or monuments?			

PART C: ENVIRONMENTAL SCREENING FORM

Objective	On updating this section, the user would be able to ascertain the nature of clearances required for the site

PART C1: Proximity to environmentally sensitive areas:

Applicability of this section			
Is the sub-project located in whole or part within a radius of 10 km from any of the following?	**Yes**	**No**	**Provide details**
1. Biosphere Reserve			If yes, mention name & distance.
2. National Park			If yes, mention name & distance.
3. Wildlife/Bird Sanctuary			If yes, mention name & distance.
4. Game Reserve			If yes, mention name & distance.
5. Tiger Reserve/Elephant Reserve			If yes, mention name & distance.
6. Endangered species habitat			If yes, mention name & distance.
7. Wetlands			If yes, mention name & distance.
8. Important Bird Areas (IBAs)			If yes, mention name & distance.
9. Coastal area with corals			If yes, mention name & distance.
10. Mangrove area			If yes, mention name & distance.
11. Estuary with mangroves			If yes, mention name & distance.
12. Natural Lakes			If yes, mention name & distance.
13. Swamps/mudflats			If yes, mention name & distance.
14. Interstate boundaries			If yes, mention name & distance.

PART C2: Environmental screening – results and outcome

Purpose this section	• Based on the answers provided in Section above, this section would help the user ascertain the nature of clearances required • All questions provided in the appended list need to be updated

Screening results Yes

a. Is the sub-project/any part thereof in forest land?
b. Forest clearance is required

c. Is the area of the sub-project construction activity >150,000 square meters? EC is required from the MoEF
d. 150,000 is applicable (i.e. The area of the sub-project construction activity s >20,000 square meters but < square meters)
   At least one of the questions in PART C2 is answered 'Yes'
   EC is required from the MoEF
e. 150,000 PART C 2 is applicable (i.e. the area of the sub-project construction activity is >20,000 square meters but < square meters)
   None of the questions in this is answered 'Yes'
   AND EC is required from the SEIAA

D.3 PROJECT MANAGEMENT INFORMATION SYSTEM FOR DESIGN WORK

The proposal envisions comprehensive project management Information system, which follows the systematic project management cycle steps. The conceptual framework of the system is shows in the figure D.6

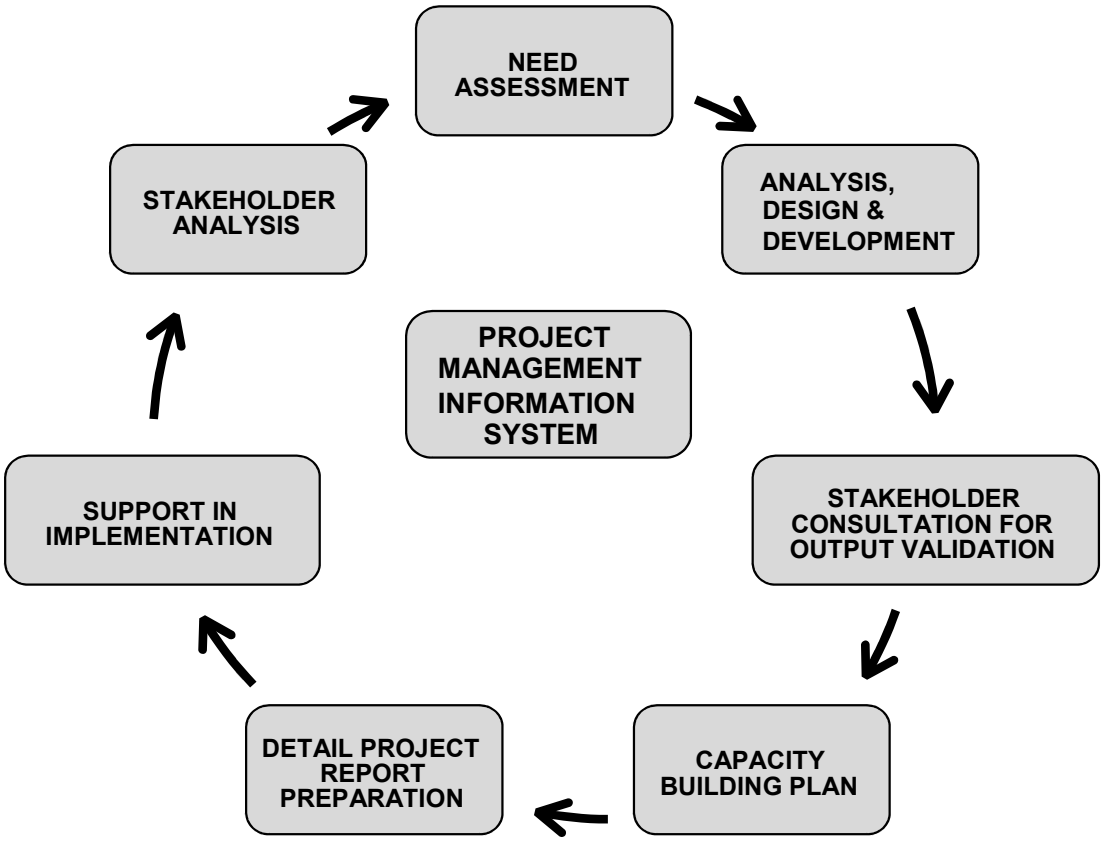


Figure D.6: Conceptual Framework

Description of Conceptual Framework is given below:

1. Step 1 - Stakeholder Analysis

The system recognizes the role of various stakeholders, those directly or indirectly influence the sustained continuation and implementation of the project post DPR finalization. In this phase, various stakeholders including government, non-government and community will be involved at state, districts and pilot study areas defined by NDMA. State of Art communication and management tools will be employed to understand their stake and roles and responsibilities in the project planning and implementation.

2. Step 2 - Needs Assessment

It is understood that the need assessment plays pivotal role in project analysis and development. The methodology will follow State of Art tools and techniques to assess the needs of government, non-government and community management, financial, operational, functional and technical needs.

3. Step 3 – Analysis, Design and Development of MIS

Based on stakeholder analysis and needs assessment, the component activities will be analysed following the NDMA terms of reference (TOR). The detailed methodologies for Component A, Component B & Component C have already been discussed in detail in compliance to the TOR. Based on the needs, the MIS specs will be developed. Online web based application will be developed applying best available tools and technologies for the required outcomes.

4. Step 4 - Stakeholder Consultation for Output validation

The Components' design document and software will be finalized by the key project teams in a given timeline with desired expectation. The project team will facilitate NDMA to operate and validate the outcome in close consultation with relevant stakeholders. To support the speedy evaluation process short workshops will carried out at various levels for effective understanding. The feedback will be incorporated and documents will be finalized.

5. Step 5 - Capacity Building Plan

Various components require adequate capacity building and skills of various stakeholders for project implementation. Following standard training methodologies, the training modules will be designed and training contents will be developed for direct trainings and master trainings. Other elements of capacity building and skills Information, Education and Communication (IEC) material will be also developed following standard practices.

6. Step 6 - Finalize Detailed Project Report

Based on all above stated steps, the detailed project reports will be prepared aligned to the committed timeline. The team will ensure that all developed reports are legible and following the national / international standards.

D.4 PROJECT MANAGEMENT ARRANGEMENT FOR IMPLEMENTATION

NSRMP requires a proper project Information Management arrangement involving National and state level stakeholders. These stakeholders will be identified and a system will be developed for implementing the DPRs prepared under present project. The system will have defined roles and list of correspondence agencies (New/Existing) for monitoring, reviewing, auditing, providing guidance, changing norms even financial under special conditions. The system will advocate mainstreaming of all these mitigation actions in existing programs and policies.

Some approval system will be developed for scrutinizing and approving the proposals at the time of implementation. In brief a system will be design to incorporate activities like project planning, project implementation and financial management.

Figure D.7 Shows needed Project Management arrangement, which will be designed keeping the basics of project management and other rules regulations in view.

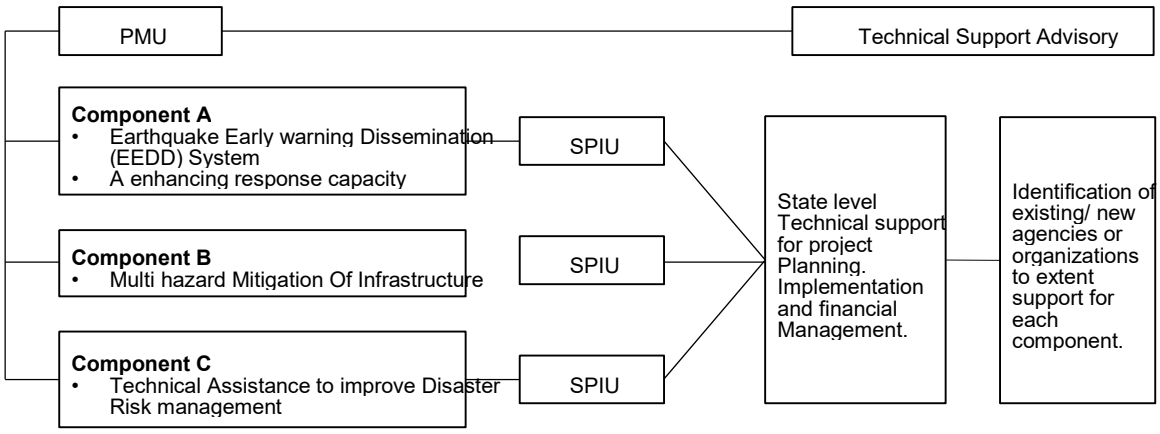


Figure D.7: Project Management Arrangement

D.5 FINANCIAL MANAGEMENT SYSTEM

Designed financial management system will ensure a system will ensure a system of release of funds to various states on the basis of approved budgets, timely progress, expenditure reports in compliance to existing applicable guidelines. Similarly technical supporting system will be designed for States and roles and responsibilities of technical support agencies will be developed

System will ensure following:-

- Funds available on time at identified stages of work.
- Transparent operations
- Financial reporting
- Monitoring and Audit arrangements
- Time frame

D.6 TECHNICAL APPROACH & METHODOLOGY FOR MANAGEMENT INFORMATION SYSTEM (MIS)

Approach and Methodologies

Management Information System (MIS) is an integrated user-machine system for providing information to support operations, management and decision making functions in an organization. The system utilizes computerized and manual procedures; models for analysis, planning, control and decision making; and a database. (Davis, G.B. 1985. MIS: Conceptual Foundations. Structure and Development. 2nd ed. New York, NY: McGraw-Hill.)

MIS facilitates managerial functioning. Management information is an important input at every level in the organization for decision making, planning, organizing, implementing, and monitoring and controlling. MIS is valuable because of its content, form and timing of presentation. In the context of different levels of decision making, information can be described as source, data, inferences and predictions drawn from data, value and choices (evaluation of inferences with regard to the objectives and then choosing a course of action), and action which involves course of action.

Background of the Project area

The Himalayan belt is seismically one of the most active intra-continental region anywhere in the world. Between 1897 and 1952 there was a phase of very high seismic activity when 14 major earthquakes (M≥7.5) including 5 great earthquakes of M≥8 occurred. Thus, the first phase of the programme looks at the high risk mountainous states. The following 8 states have been considered in the current phase of the programme:

i. Assam
ii. Bihar
iii. Himachal Pradesh
iv. Jammu & Kashmir
v. Manipur
vi. Meghalaya
vii. Tripura
viii. Uttarakhand

The key objective of developing MIS for NSRMP is to establish and operationalize the web based MIS and ensure its regular updating from the implementing agencies in coordination with the Project Management Unit.

MIS and IT specialist shall be responsible for generating the necessary progress and information tracking reports, as may be required. S/he will also coordinate with the line departments for timely input of data into the MIS system.

Approach
The MIS would be a web enabled fully integrated system that provides (24 X 7) real time access to the authenticated, reliable and accurate information with clearly mapped roles and rights of responsible agencies.

NSRMP MIS will be designed considering business goal and objective. Detailed need analysis will be conduct to understand nature of the data and workflow. In the analysis phase data flow diagrams, logic model and data model technic will use and based on that, appropriate system and software will design and develop. For example, ArcGIS and other geospatial platform are more appropriate to collect locational information while web-based platform is more appropriate to collect attribute data. Mobile App will be use in such case where data collection is involved directly from the filed or instant data processing and analysis is needed. i.e. survey. The web-based platform will be developed using combination of several programing languages i.e. C#, python, JavaScript, etc. However, all the data collected from different tools and software will store in centralized object-relational database management system.

The information and analysis will be available for user from web-based online platform based on given access rights. For that, the data security framework will design to define and implement access control. Certain spatial data services will be created and published to make available publicly. The services will be consumable to user in their software and system.

Two servers will be used to store and manage the data collecting from different tool and platform i.e. state and county level server. Mainly, raw and unprocessed data will store in the state level server while final data and analysis will store at national level server. Disaster recovery plan will take into account in which database mirroring, replication and offside backup strategy will be implemented. These servers will also use to host website and published certain data services.

Relevant stakeholder will be trained on use of the system. User manual will be developed for each tools and software.

MIS will help in streamlining and standardizing key processes associated with various functional aspects of the project. The tool shall cover the following activities:

- Track programme and financial progress of the project
- Track physical progress against targets
- Identify and report on key deviations and exceptions to the project. Report on constraints or bottlenecks being faced in the execution of the project & suitable action for the same
- Provide status of compliance with environmental and social management framework
- Provide real time status of the projects from Line Department level to Program Level
- Facilitate procurement activities including preparing the procurement plan
- Monitor assets / equipment and site inventories

Process of MIS

The MIS implementation process involves following sequential steps:

- Step 1: First establish management information needs and formulate broad systems objectives so as to delineate important decision areas (e.g., general management, financial management or human resources management). This will then lead to ask what information units will be needed to monitor the identified factors of concern.
- Step 2: Develop a general description of a possible MIS as a coarse design. This design will have to be further refined by more precise specifications. For efficient management of information processing, the MIS will be based on a few databases related to different sub-systems of the organization.
- Step 3: Once the information units needed have been determined and a systems design developed, decide how information will be collected.
- Step 3: Develop a network showing information flows.
- Step 4: Test the system until it meets the operational requirements, considering the specifications stipulated for performance and the specified organizational constraints.
- Step 5: Re-check that all the critical data pertaining to various sub-systems and for the organization as a whole are fully captured. Ensure that information is generated in a timely manner.
- Step 6: Monitor actual implementation of the MIS and its functioning from time to time.

This MIS tool should provide broad range of capabilities to support all critical back office functions with features or modules for procurement management, financial management, project management, etc. The expectations from the tool have been summarized under the following heads:

- Accounting and financial management
- Procurement and inventory
- Project management
- Compliances
- MIS reports and Documentation

MIS Web based and Mobile Application - Project Description

Objective

The Objective of this requirement is to create web based and mobile application which will facilitate us to create and manage various projects. The system should able to create the project with track able records, the application will use the data entry forms and mobile/tab device to capture the progress from the site or from project office.

The collected information will be updated to the central server where data will secured for further processing. The data will be updated as and when it’s required based on the project progress.

Management Information System (MIS) is an integrated user-machine system for providing information to support operations, management and decision making functions in an organization. The system utilizes computerized and manual procedures; models for analysis, planning, control and decision making; and a database.

MIS facilitates managerial functioning. Management information is an important input at every level in the organization for decision making, planning, organizing, implementing, and monitoring and controlling. MIS is valuable because of its content, form and timing of presentation. In the context of different levels of decision making, information can be described as source, data,

inferences and predictions drawn from data, value and choices (evaluation of inferences with regard to the objectives and then choosing a course of action), and action which involves course of action.

Project Scope

Functional Requirements

1. **Application Framework**
    a. Web Application / Mobile
    b. Multiple Department / Users
    c. User & Role Management
    (Mobile User/Data Entry/Approver/Mangers/Management)

2. **Master Management**
    a. HSN Master for GST (for Purchase)
    b. Item/Work master
    c. Item UOM Master
    d. Item/Work/Service category & Sub category
    e. Item/Work/Service Master with HSN Code Mapping
    f. Supplier / Contractor Master
    g. Department, User Management
    h. Warehouse with Bin location master

3. **Purchase Management**
    a. Indent Creation
    b. Indent Approval
    c. Quote Submission
    d. Quote Comparison and Approval
    e. Purchase Order Creation
    f. Purchase Order Approval
    g. PO Cancel
    h. PO Cancel Approval
    i. PO Amendments
    j. PO Amendment Approval

4. **Material Inward Management**
    a. Goods Receipt Note (GRN)
    b. GRN Entry
    c. GRN Approval
    d. Stock account on GRN Approval
    e. GRN Location update (Bin Location)
    f. Bin Change
    g. Stock Reports (Purchased Material)

5. **Inventory Management**
    a. Issue Request from Site
    b. Issue against the request.
    c. Issue Return Management (From Project site)
    d. Stock Disposal entry
    e. Issue transaction reports (Stock Ledger / Stock Movement)
    f. Inter unit stock transfer

g. Preparing Delivery Challan for Dispatch of Items/Machine/Tools
h. DC Approval

6. Project Management

a. Create New Project
b. Create the Annexure of the Work Details
c. Project Estimation
d. Project Estimation Approval
e. Create the Budget and Allocation
f. Budget Approval
g. Budget Revision and Approval (Both Increase and Decrease)
h. Setting up Payment Release Schedule
i. Contractor Nomination
j. Project Amendments
k. Amendment Approvals
l. Project Cancellation
m. Cancellation Approval
n. Tender Creation
o. Tender Approval
p. Request for Quote Submission
q. Quote Comparison and Approval
r. Project Conformation with Contractor

7. Work Order/ Service Order Management

a. WO/SO Order Creation for Project
b. WO/SO Approval
c. WO/SO Cancel
d. WO/SO Cancel Approval
e. WO/SO Amendments
f. WO/SO Amendment Approval

8. Work in Progress (WIP) – Update by Department

a. Data entry against each project
b. Provision to update the progress against each work item list in the Project
c. Provision to enter the Payment Release against each Work Item (WO/SO)
d. Provision to enter the data from Mobile App
e. Maintain completion status of each work items
f. Approval by Site Engineers
g. Approval by Project Officers/Managers
h. Escalation entry for Project delays.
i. Delay Notification to Project Stack holders
j. Provision to capture actual cost
k. Budget Revision Request

9. Report

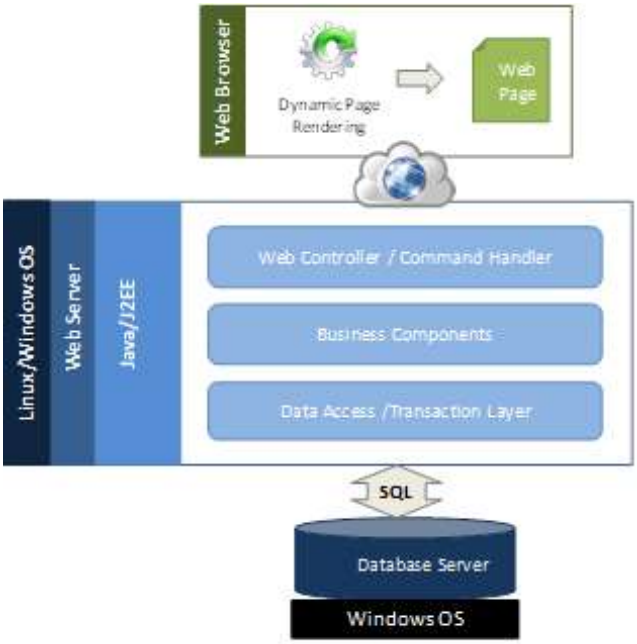
a. Project Status Report
b. Project Dashboard State/Contractor Wise
c. Individual Project/State/Contractor Wise
d. Project Payment Status
e. Project Completion Delays
f. Pending Project based on Completion Date

g. Finical Budget Report
h. Budget Allocation Reports
i. Project Wise Budget Report
j. Overall Status Dashboard
k. Report to Various Ministries
l. Auto email Generation of Projects

10. Accounts & Finance

a. Bill Passing Against Purchase Orders
b. Bill Passing Against Service Orders
c. Bill Passing Against Work Orders
d. Bill Approvals
e. General Payments
f. Payment Authorization
g. Project Expenditure Report
h. Balance Sheet
i. Fund Flow Statement
j. Cash Flow Statement
k. Budgeted and actual profit report
l. General Ledger

Technical Architecture



Front End	HTML5, JSP, J Query
Business Layer	Spring 5.0, Hibernate 5.4
Data Base	Oracle 11g/MS SQL Server 2016
Web Server	Tomcat 8
Server	Windows/Linux/Ubuntu

The product is developed using Web based Java Technologies with responsive UI. It's developed using service oriented architecture to provide maintainability and extensibility for functional enhancements.

Formats will be designed for each of the above modules. These formats can also be used for monitoring and reporting of project activities, and form a part of the project tracking framework.

Critical Actions:

The following are the two critical actions will be undertaken while performing the assignment;

- Establishing the MIS System and its regular improvement
- Ensuring appropriate dissemination of information on a regular basis

DDF Consultants Pvt. Ltd. *was founded in 1997 as a partnership firm, by the name of Design and Development Forum. DDF provides specialized consultancy in the areas which have a bearing on the built environment. These include, among others, design and development of human settlements, Regional and Urban Planning, Environmental Planning, Engineering and Architectural Design, keeping disaster resilience as an integral component of the process.*

In addition the firm has experience in Disaster Risk Reduction which reflects in number of projects related with vulnerability assessment, condition assessment, retrofitting, up-gradation of various types of educational and health buildings in India and abroad. The firm has developed the tools and guidelines for Disaster Risk Reduction planning. Beside this the firm has vide experience in developing Master Plans, Zonal Plans, and Development Plans etc. in which disaster management planning and guidance for implementing various bye laws, rules, acts, regulations, Indian standards etc. are made integral part. Sensitization and public awareness programs, public participation meetings have been organized several times in number of Planning Projects including Smart city Planning.

The Aga Khan Agency for Habitat *addresses the increasing threat posed by natural disasters and climate change, and it works to ensure that poor people live in physical settings that are as safe as possible from the effects of natural disasters; that residents who do live in high-risk areas are able to cope with disasters in terms of preparedness and response; and that these settings provide access to social and financial services that lead to greater opportunity and a better quality of life.*