M_W=8.0 Mandi Earthquake Scenario: Multi-State Exercise and Awareness Campaign

Detailed Project Report

Submitted to

National Disaster Management Authority,

Government of India

Ravi Sinha, Alok Goyal, CVR Murty, Chaitanya Krishna,

Mahendra Meena and Rohan Shinde

Indian Institutes of Technology at Bombay & Madras

July 8, 2014

Table of Contents

List of Figures

List of Tables

Acronyms

DC	Deputy Commissioner
DMP	Disaster Management Plan
EOC	Emergency Operation Center
HODs	Head of the Departments
IIT	Indian Institute of Technology
IRS	Incident Response System
IMD	Indian Meteorology Department
MBT	Main Boundary Thrust
MCT	Main Central Thrust
MSK	Medvedev- Sponheuer-Karnik Scale
M_w	Moment Magnitude
NGRI	National Geophysical Research Institute
NDMA	National Disaster Management Authority
SDM	Sub Divisional Magistrate
UT	Union Territory
UC	Unified Command
HP	Himachal Pradesh
CSIR	Council of Scientific and Industrial Research
DDMA	District Disaster Management Authority
SDMA	State Disaster Management Authority

HPSDMA	Himachal Pradesh State Disaster Management Authority
HIPA	Himachal Pradesh Institute of Public Administration
PHED	Public Health Engineering Department
IPH	Irrigation and Public Health

1 Introduction

National Disaster Management Authority (NDMA) initiated a project to develop a multi-state earthquake disaster scenario for a hypothetical earthquake of moment magnitude 8.0 with its epicentre in Himachal Pradesh. The epicentre of the hypothetical earthquake is located in a "seismic gap" in western Himalaya and several scientists expect this region to experience a large earthquake in the future.

The project was undertaken in the states of Punjab, Haryana, Himachal Pradesh and Union Territory of Chandigarh considering the high level of seismic vulnerability (seismic zone III-V) being in Himalayan belt.

The earthquake scenario developed under the project has considered the seismotectonic profile of the region. For the selected moment magnitude and location of the earthquake, the severity of ground shaking has been estimated using appropriate Ground Motions Prediction Equations (GMPE). Information regarding the population, housing types, etc. obtained from census data for the regions under study.

The scenario results are available in multiple forms for various user groups considering the needs of disaster risk management. These results are available in terms of severity of ground shaking or intensity in various parts of the project region, population exposure to different intensity, estimated casualties in different parts of the project region, etc. In addition, the participated states planned to use the shaking intensity information to assess the impact on their most critical lifeline buildings from damage considerations.

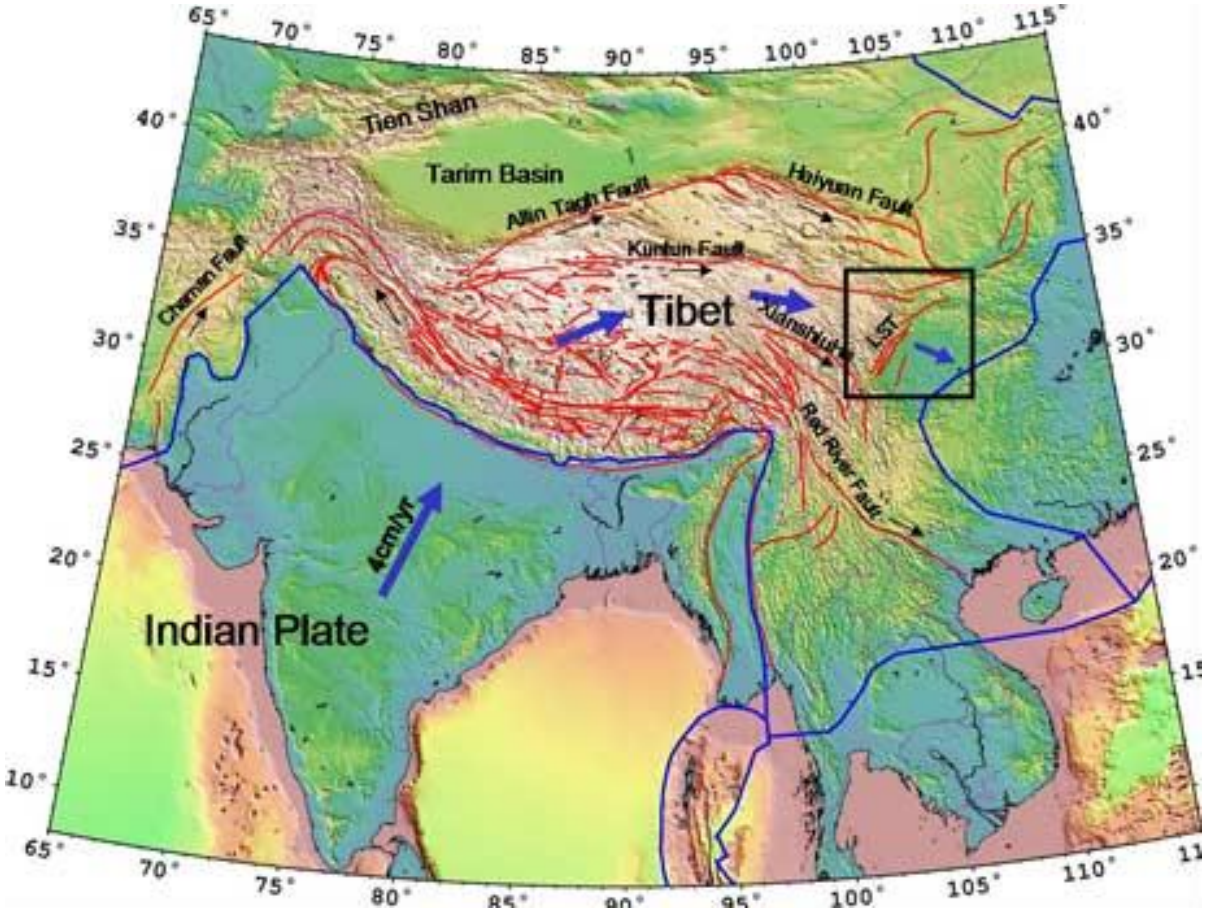
1.1 Objectives of the Project

The following were the objective of this multi-state project:

- To generate awareness amongst the stakeholders of an earthquake of such a high magnitude affecting a large number of states.
- To understand the direct and indirect consequences of the earthquake in the affected area.
- To facilitate preparation of response plans at various levels.
- To facilitate understanding of impact of the earthquake on the functioning and responsibilities of various stakeholders.
- To facilitate inter-departmental and inter-state coordination.
- To provide a template for development of earthquake scenario elsewhere in the country.

1.2 Basic Geography and Tectonic Features of India

India lies at the north-western end of the Indo-Australian Plate, which encompasses India, Australia, a major portion of the Indian Ocean and other smaller countries. This plate is colliding against the huge Eurasian Plate and going under the Eurasian Plate as shown in Figure 1.1; this process of one tectonic plate getting under another is called subduction. A sea, Tethys, separated these plates before they collided. Part of the lithosphere, the Earth's Crust, is covered by oceans and the rest by the continents. The former can undergo subduction at great depths when it converges against another plate, but the latter is buoyant and so tends to remain close to the surface. When continents converge, large amounts of shortening and thickening takes place, like at the Himalayas and the Tibet.



(Source: www.geoportalen.no)

Figure 1.1: Geographical layout and tectonic plate boundaries in India

Three chief tectonic sub-regions of India are the mighty Himalayas along the north, the plains of the Ganges and other rivers, and the peninsula. The Himalayas consist primarily of sediments accumulated over long geological time in the Tethys. The Indo-Gangetic basin with deep alluvium is a great depression caused by the load of the Himalayas on the continent. The peninsular part of the country consists of ancient rocks deformed in the past Himalayan-like collisions. Erosion has exposed the roots of the old mountains and removed

most of the topography. The rocks are very hard, but are softened by weathering near the surface. Before the Himalayan collision, several tens of millions of years ago, lava flowed across the central part of peninsular India leaving layers of basalt rock. Coastal areas like Kachchh show marine deposits testifying to submergence under the sea millions of years ago.

1.2.1 Himalayan Region

The Himalayan mountain belt formed as a result of the collision of India into Eurasia and has accommodated ~2000-3000 km of convergence along the ~2500 km length of plate boundary since the Eocene[1]. The collision has produced three major crustal-scale south verging thrust i.e. Main Central Thrust (MCT), Main Boundary Thrust (MBT) and Himalayan Frontal Thrust (HFT) faults that strike the length of the Himalayan arc which are shown in Figure 1.2.

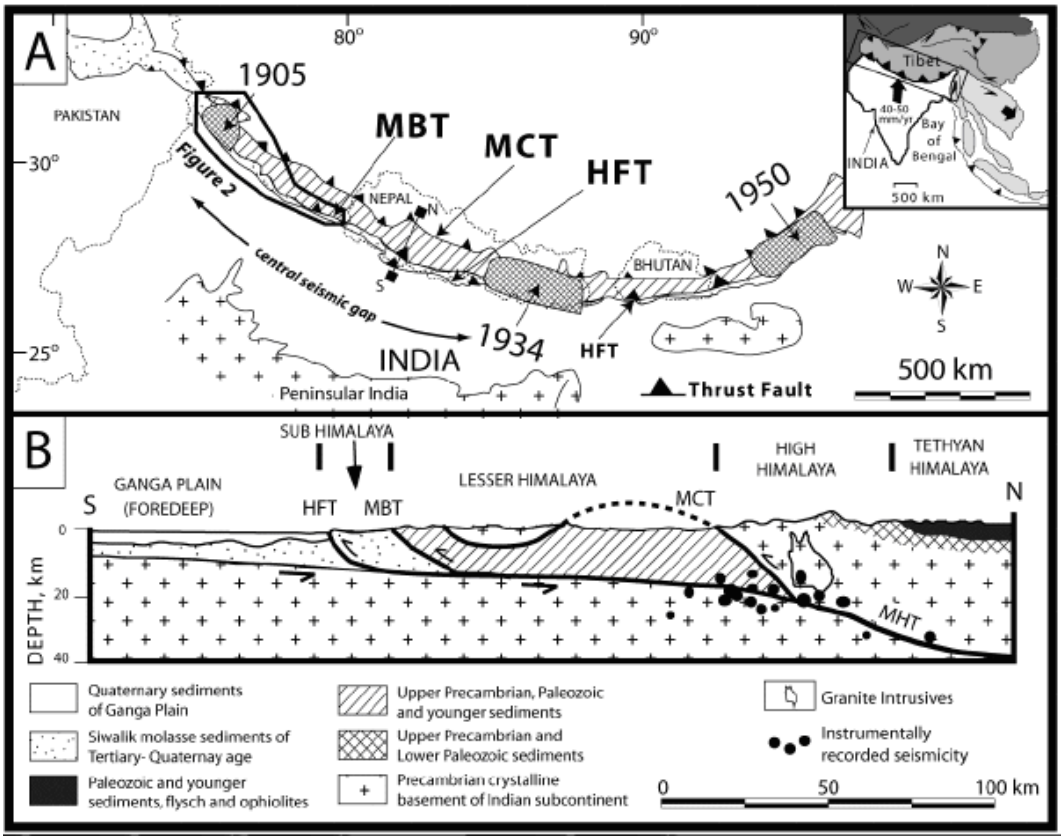


Figure 1.2: MCT, MBT and HFT faults

In detail, the modern active faults are actually a system of faults comprised of a number of individual fault traces – most of them thrust faults. Thus, Northern India is along zones of high seismic activity. Major earthquakes occur frequently along this very active thrust fault system.

[1] Molnar P. and Tapponnier P. (1977). Relation of the tectonics of Eastern China to the India-Eurasia Collision: Application of Slip-line Field Theory to Large Scale Continental Tectonics, *Geology,* 5 PP 212-216.

1.2.2 Seismotectonics of the Region

This region is one of the seismically active regions of the world which has experienced earthquakes since times immemorial. The seismotectonics of the region had been well studied

and the cartographical representation of past earthquakes and seismotectonics of the region is shown in Figure 1.3 (courtesy Wadia Institute of Himalayan Geology).

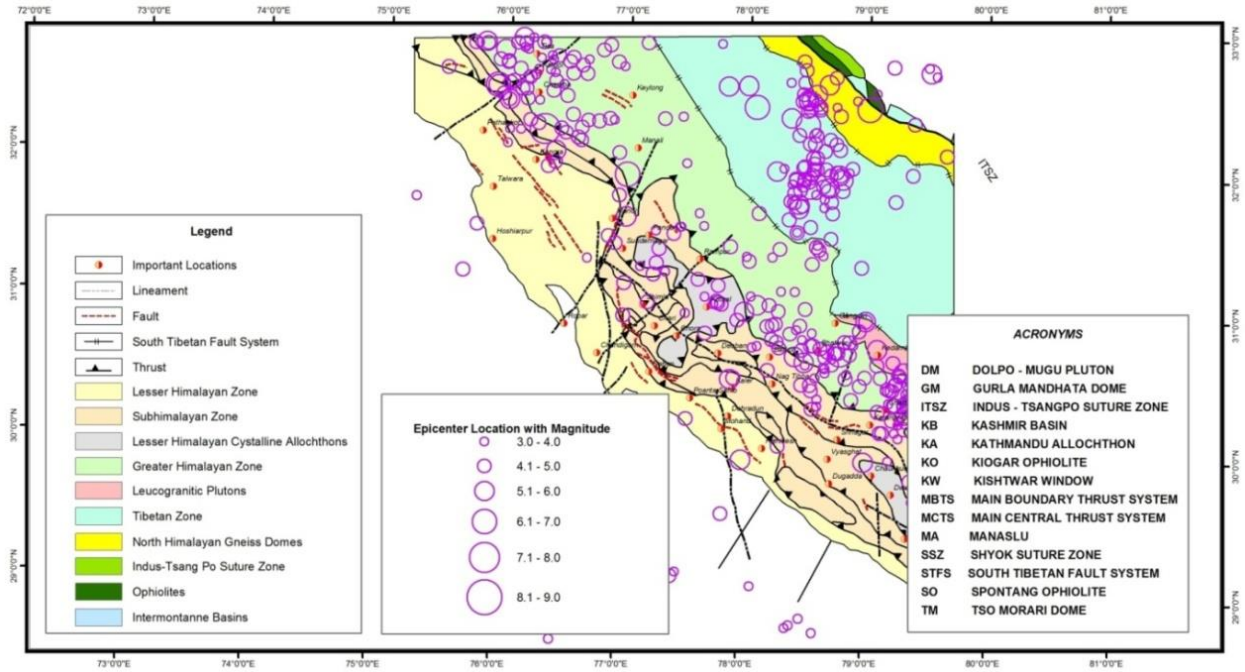


Figure 1.3: Major tectonic features in the Himalaya near the region of interest (GIS data courtesy of Dr. AK Mahajan, Wadia Institute of Himalayan Geology)

The occurrence of earthquakes in the region is attributed mainly to the chief tectonic features in Himalayas such as the Main Boundary Thrust (MBT), the Main Central Thrust (MCT) and Himalayan Frontal Thrust. These are locally termed as the Jwalamukhi Thrust, the Reasi Thrust, the Murree Thrust, the Panjal Thrust, the Zanskar Thrust etc. The other tectonic features of importance in the region are Kallar Kasar thrust, Salt Range thrust, Drang thrust, Ropar Fault and Sunder Nagar Fault. From the available geological and seismological evidence, it is seen that these faults have been active in the past. According to the theory of plate tectonics, the area lies near the boundary of Indian and Eurasian plates along which there is a wide zone of deformation due to cracking and splintering of the lithosphere and is characterized by single dominant direction of under thrusting. Geophysical data in and around Himalayas have shown that the Indian plate is currently moving North-North - Eastwards at a rate of about 5 cm/ per year and colliding with Eurasian plate due to which stresses are accumulating in the region. The accumulated stress is occasionally released in the form of earthquakes along various segments of Himalayan arc.

1.2.3 The Compressional Seismic Belt of Northern India

To understand the occurrence of large earthquakes in this region, the on-going seismotectonic processes must be studied. Earthquakes and active faults in northern India and adjacent regions in Pakistan are the direct result of the Indian subcontinent moving northward as shown in Figure 1.4 at a rate of about 40 mm/yr and colliding with the Eurasian continent.

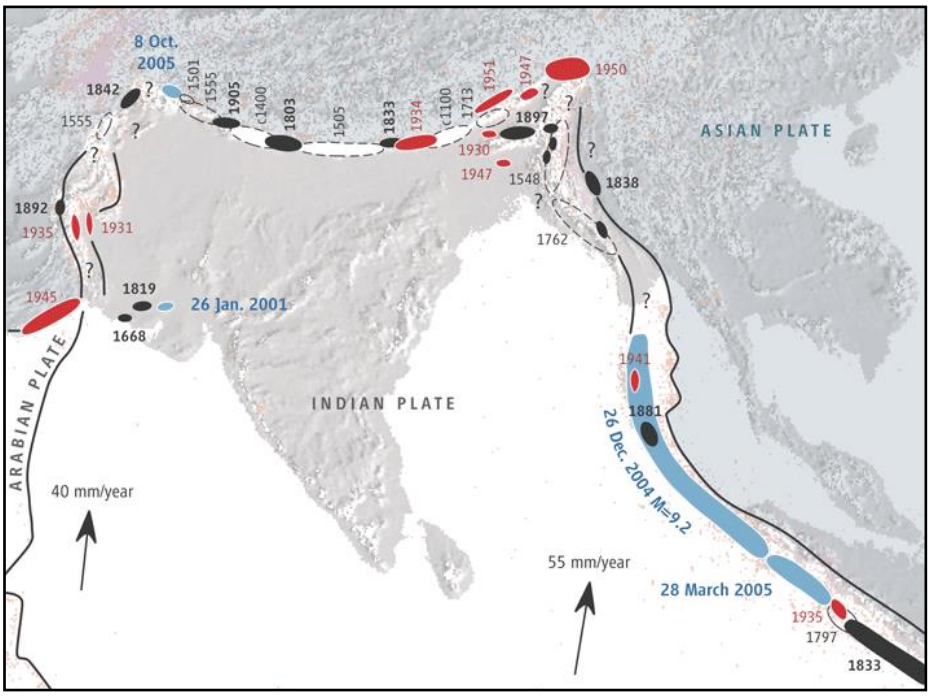


Figure 1.4: The compressional seismic belt of Northern India

1.2.4 Past Earthquakes

Several earthquakes, medium to large have occurred in this region as per data based on instrumental records. A few significant earthquakes that occurred in this region are given in Table 1.1.

Table 1.1: List of significant earthquakes in Northern Himalaya in recent past

Location	Date	Magnitude
Kangra, HP	1905 Apr 04	8.0
Kinnaur, HP	1975 Jan 19	6.2
Uttarkashi, UP Hills	1991 Oct 20	6.6
Chamoli District, UP	1999 Mar 29	6.8
Kashmir	2005 Oct 08	7.6

Source: India Meteorological Department

As explained in previous section, these earthquakes result in the gradual shifting of the India tectonic plate beneath the Tibetan plate, in the geologically young Himalayan mountain range and along the Himalayan arc. Recent earthquakes in the region include the magnitude 6.8

earthquake of 29 March 1999 that struck the Kumaon hills of Uttar Pradesh. Another destructive earthquake of 6.6 magnitude occurred in 1991 near the town of Uttarkashi which killed more than 1,000 people in the same region. In brief, the northern part of India near the Himalayan region is associated with a much higher degree of seismicity than India's peninsular region. Thus, it is very likely to experience large earthquakes.

1.3 Projects Partner Agencies-Description, Roles and Responsibilities

List of project partners and their respective responsibilities shown in following table (Table 1.2):

Table 1.2: List of project partners and their respective roles and responsibilities

S. NO.	PROJECT PARTNER INSTITUTIONS	RESPONSIBILITIES
Government Institutions		
1.	National Disaster Management Authority	Contact Authority Focal Point on Disaster Management in India Project Advisor
2.	GOC-in-Chief, Western Command, Indian Army	Participant to Scenario, Action Plan and other activities of project
3.	Indian Air Force	Participant to Scenario, Action Plan and other activities of project
4.	National Disaster Response Force	Participant to Scenario, Action Plan and other activities of project
5.	Wadia Institute of Himalayan Geology	Earthquake monitoring, hazard assessment, and managing major infrastructure or facilities in the affected region
6.	Seismology Division IMD	Earthquake monitoring, hazard assessment, and managing major infrastructure or facilities in the affected region
7.	Geological Survey of India	Earthquake monitoring, hazard assessment, and managing major infrastructure or facilities in the affected region
8.	Border Roads	Earthquake monitoring, hazard assessment, and managing

S. NO.	PROJECT PARTNER INSTITUTIONS	RESPONSIBILITIES
	Organisation	major infrastructure or facilities in the affected region
9.	Central Water Commission	Earthquake monitoring, hazard assessment, and managing major infrastructure or facilities in the affected region
10.	Bhakra-Beas Management Board	Earthquake monitoring, hazard assessment, and managing major infrastructure or facilities in the affected region
11.	State Disaster Management Authority	Project Advisor
12.	Department of Revenue, Rehabilitation and Disaster Management	Participant to Scenario, Action Plan and other activities of project
13.	Department of Home Affairs and Justice	Participant to Scenario, Action Plan and other activities of project
14.	Department of Water Supply and Sanitation	Participant to Scenario, Action Plan and other activities of project
15.	Department of Local Government	Participant to Scenario, Action Plan and other activities of project
16.	Department of Education	Participant to Scenario, Action Plan and other activities of project
17.	Department of Chief Architect	Participant to Scenario, Action Plan and other activities of project
18.	Department of Census	Participant to Scenario, Action Plan and other activities of project
19.	Department of Housing and Urban Development	Participant to Scenario, Action Plan and other activities of project

S. NO.	PROJECT PARTNER INSTITUTIONS	RESPONSIBILITIES
20.	Department of Health and Family Welfare	Participant to Scenario, Action Plan and other activities of project
21.	Department of Industries and Commerce	Participant to Scenario, Action Plan and other activities of project
22.	Department of PWD (B & R)	Participant to Scenario, Action Plan and other activities of project
23.	Department of Rural Development and Panchayats	Participant to Scenario, Action Plan and other activities of project
24.	Department of Transport	Participant to Scenario, Action Plan and other activities of project
25.	Department of Irrigation	Participant to Scenario, Action Plan and other activities of project
26.	Department of Power	Participant to Scenario, Action Plan and other activities of project
27.	Department of Information and Public Relations	Participant to Scenario, Action Plan and other activities of project
28.	Department of Local Government	Participant to Scenario, Action Plan and other activities of project
29.	Department of Food and Supplies	Participant to Scenario, Action Plan and other activities of project
30.	Mahatma Gandhi State Institute of Public Administration	Participant to Scenario, Action Plan and other activities of project
Autonomous Government Body		

S. NO.	PROJECT PARTNER INSTITUTIONS	RESPONSIBILITIES
31.	IIT Bombay and IIT Madras	Project Advisor Generator/ source of data/ information on geology, seismology
Non-Government		
32.	Geo-Hazards Society	Participant to Scenario, Action Plan, Coordination and other activities of project.

1.4 Process for Launching of the Project

The following steps were taken for launching the project:-

1.4.1 First Initiation

The project was initiated with a meeting at NDMA Bhawan, New Delhi on 12th March, 2012 which was chaired by Hon'ble Vice Chairman NDMA, Shri M. Shashidhar Reddy, accompanied by NDMA members and NDMA Secretary. The meeting was attended by the representatives of participaed states, IIT Bombay, GeoHazards Society and Senior Official from agencies of earthquake engineering such as Wadia Institute of Himalayan Geology, Seismology Division of IMD, Geological Survey of India, CSIR, Bhakra Beas Board etc. The concept and development of earthquake scenario was discussed in the meeting to carry forward the implementation of project at state level.

Figure 1.5: First meeting at New Delhi

1.4.2 Project Conceptualization

The project was conceptualized and developed by NDMA, IIT Bombay & IIT Madras as its technical partners and GeoHazards Society as its implementation partner, in March 2012, at NDMA Bhawan, New Delhi.

1.4.3 Project Design

The earthquake scenario development team led by the NDMA, consists of scientific experts in the field of earthquake engineering (from IIT Bombay and IIT Madras). Representatives from Himachal Pradesh, Haryana, Punjab, state governments and Union Territory of Chandigarh were also involved in the project. Inputs were also sought from organizations involved in earthquake monitoring, hazard assessment, and managing major infrastructure or facilities in the affected region such as IMD, Geological Survey of India, Border Roads Organisation, Central Water Commission, Bhakra-Beas Management Board, etc. A part of seismotectonic information for western Himalaya was provided by Wadia Institute of Himalayan Geology. The project team also includes a Coordination Agency (viz. Geo-Hazards Society India) to facilitate the coordination between the various stakeholders, particularly at the state level.

1.4.4 A Training of Engineers on RVS of Buildings, Water Tanks and Pipelines

Training was conducted on 6-7 November 2012 at UT Guest House, Chandigarh for various stakeholders from Punjab Haryana and Chandigarh. In the training programme, Prof. CVR Murty, IIT Madras had taken sessions on Rapid Visual Screening of Water Tanks and Pipelines and Mr. Ashish Sapre and Mr. Chaitanya Krishna from IIT Bombay had taken sessions on Rapid Visual Screening of Buildings.

Similar training programme was arranged in Himachal Pradesh which was conducted in Shimla from 22nd November to 23rd November 2012. Training on Rapid Visual Screening of Water Tanks & Pipelines was conducted by Prof. CVR Murty, IIT Madras for Engineers (IPH Department) at HIPA. Training of Architects and Engineers (PWD Department) on Rapid Visual Screening of Buildings was conducted by Prof. Ravi Sinha, IIT Bombay and was organized by the NDMA and HPSDMA on 22-23 November, 2012 at HIPA.

1.4.5 Capacity Development Programmes on Incident Response System (IRS) and Mock Exercise

In preparation for conduct of Multi-State Exercise on earthquake in the states of Punjab, Haryana, Himachal Pradesh and UT of Chandigarh on 13th February 2013, Capacity Development Programs (CDPs) on IRS and conduct of Table Top & Mock Exercise were planned from October, 2012 to January, 2013.

The capacity development programs (CDPs) was conducted at the Revenue Division level. In addition, due to the large number of districts in certain divisions and where districts are located far apart, additional programs were planned as given in the tentative capacity development programs (CDPs).

Typical CDP for participated states had three days duration which is as follows:

(a) First day – IRS and nomination of Incident Response Team (IRT)

(b) Second day – Table Top Exercise

(c) Third day – Mock Exercise

1.5 Earthquake Scenario

The simulations for the earthquake were carried out using RISK.iitb v3.0, developed at IIT Bombay as a tool for integrated seismic hazard, vulnerability and risk assessment.

The hypothetical scenario is prepared considering the properties shown in Table 1.3.

Table 1.3: Parameters used for earthquake simulation.

Earthquake	Multi-State Earthquake Scenario
Region	Mandi District
M_w	8.0
Depth	15 km
Epicentre	Mandi District, HP

	Latitude	$31^0$33’00” N
	Longitude	$76^0$52’48” E
Parameters		
Fault	Main Boundary Thrust (MBT)	
GMPE	Boore and Atkinson (AB08, NGA)	
Source	Line Source	
Rupture Model	WC84-All	
Rupture Length	200 km	
Maximum MSK Intensity	IX-X	
Grid Size for Analysis	0.5 km × 0.5 km	

1.6 Significance of Scenario Earthquake

The scenario earthquake would help the concerned authorities to check the level of preparedness and address the gaps if there is any. Based upon the history of seismicity and past earthquake of a region a scenario can be developed to estimate the loss in terms of structural, non-structural, social or economic which can help to develop the Disaster Risk Management (DRM) plans.

Table 1.4 shows the frequency of earthquakes. As per the seismicity and history of earthquakes the maximum credible earthquake is considered to develop a scenario.

Table 1.4: Average number of earthquake per year

Description	**Magnitude**	**Annual Nos.**
Great	≥ 8.0	1
Major	7.0 – 7.9	18
Strong	6.0 – 6.9	120

Description	Magnitude	Annual Nos.
Moderate	5.0 – 5.9	800
Light	4.0 – 4.9	6,200

The relationship between earthquake magnitude and energy is given in following Table 1.5.

Table 1.5: Change in energy with magnitude

Magnitude Change	Displacement Change	Energy Change
1.0	10 times	32 times
2.0	100 times	1000 times

M_w 8.0 earthquake represents a great earthquake occurring in the Himalaya. This hypothetical scenario was developed by a NDMA team of earthquake engineering experts from IITs at Bombay and Madras, and in consultation with the Wadia Institute of Himalayan Geology, Seismology Division of IMD and Geological Survey of India. The simulation results, with the epicentre near Sundernagar in Mandi District of Himachal Pradesh, which lies in the seismic zone V, predict strong shaking in the states of Himachal Pradesh, Haryana, Punjab, Uttarakhand and Jammu & Kashmir and the Union Territory of Chandigarh.

The MSK Intensity map using the Boore and Atkinson (2008) GMPE for scenario earthquake is shown in Figure 1.6.

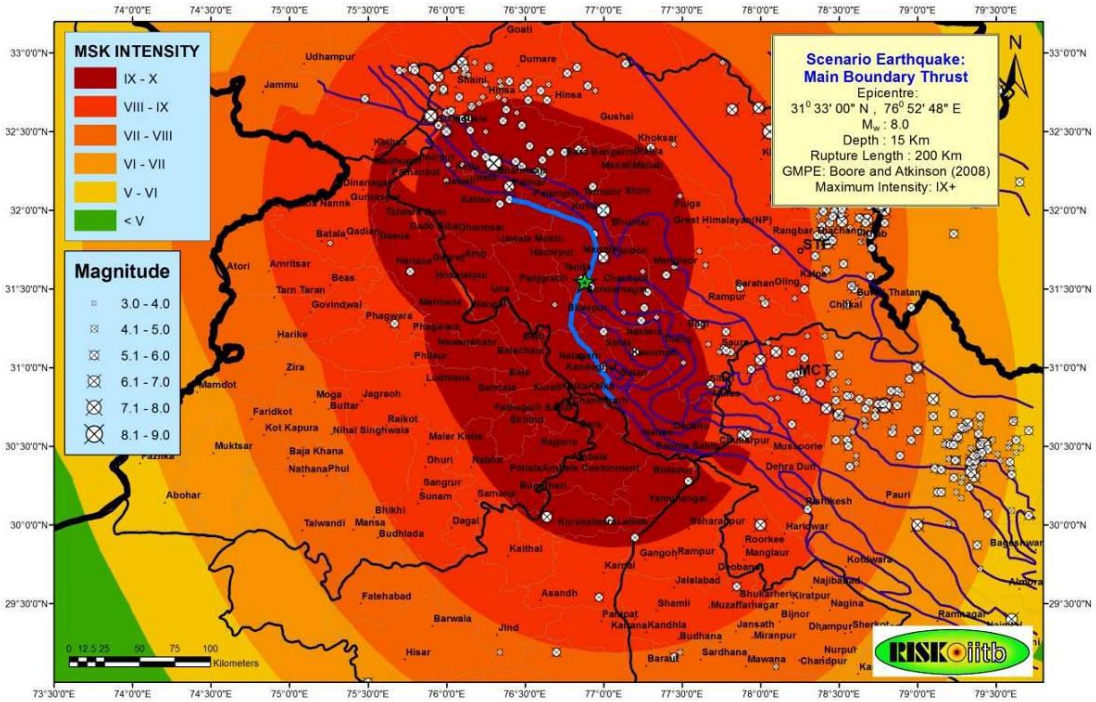


Figure 1.6: MSK damage intensity due to scenario earthquake

It can be seen that the maximum intensity obtained due to this earthquake is IX which is observed at the rupture surface, and the MBT fault is ruptured to a length of approximately 200 km over the districts starting from the middle of Kangra, passing through Mandi, Bilaspur and Solan.

This was the first ever initiative undertaken in the country at the multi-state level. The success of this scenario would depend largely upon the active participation of the SDMAs, DDMAs, various line departments and other stakeholders in coordination with the NDMA and other central ministries/agencies. It is also hoped that the momentum of this initiative will continue to be maintained under the leadership of Hon'ble Chief Ministers of Haryana, Himachal Pradesh and Punjab, and Hon'ble Administrator of UT, Chandigarh duly supported by the state Chief Secretaries and the Advisor, UT of Chandigarh.

The timeline of this project is shown in Table 1.6 and detailed activities which were undertaken by participated states are given in succeeding chapters of this report.

The following table shows the timeline of the various activities undertaken during the project duration:

Table 1.6: Project activity timeline

Sr. No.	Timeline	Participating States			
1.	Project Activities	**UT of Chandigarh**	**Haryana**	**Punjab**	**Himachal Pradesh**
2.	Project Initiation Meeting	13th March 2012			
3.	High Level Project Orientation Meeting	5th June 2012			6th June 2012
4.	Official Project Launch	17th July 2012			21st August 2012
5.	Nomination Of Nodal Officer	Sept- Nov 2012	Aug- Oct 2012	July-Oct 2012	June 2012
6.	Sensitization of Administrative Officer	Nov2012 - Feb 2013		Sep 2012- Feb 2013	16th Nov 2012
6.1	Rapid Visual Screening Training	6th & 7th Nov 2012			21st &22nd Nov 2012
6.2	Capacity Development Programme	7th - 9th Nov 2012	7th Nov - 30th Dec 2012	10-Oct-2012 - 12-Jan-2013	October 2012 - Jan 2013

6.2.1	Training on Incident Response System	7th Nov 2012			October 2012 - Jan 2013
6.2.2	Conduct of Tabletop Exercise	8th Nov 2012			October 2012 - Jan 2013
6.2.3	Mock Drill	9th Nov 2012			October 2012 - Jan 2013
6.2.4	Orientation Workshop for Resident Welfare Association	9th Feb 2012	Nil	Nil	Nil
6.2.5	High Level Meeting with NDMA & State Representatives	9th Jan 2013			
7.	Awareness Generation Campaign	Jan- March 2013	Feb- March 2013	Feb- March 2013	Jan- March 2013
7.1	Media Campaign	Nov2012 - Feb 2013	Feb- March 2013	Dec 2012- Feb 2013	Jan-Feb 2013
7.1.1	Print Media	Jan- Feb 2013	10th - 13th Feb 2013	Jan- Feb 2013	8th -13th Feb 2013
7.1.2	Electronic Media	Jan- Feb 2013	10th - 20th Feb	09- 13 Feb 2013	8th-15th Feb 2013

			2013		
7.1.3	SMS Campaign	Jan- Feb 2013	Nil	13th Feb 2013	8th-13th Feb 2013
7.1.4	Goodwill Ambassador	Cricketer Shri Yuvraj Singh	Nil	Shooter Sh. Abhinav Bindra	Olympian Shri Vijay Kumar
7.1.5	Nukkad Natak	Nov- Feb 2013	10th - 13th Feb 2013	Nil	Nil
7.1.6	Awareness Generation at Cultural events	Nov- Feb 2013		Nil	Feb-13
7.2	Workshop on Earthquake Risk Management	29th Jan 2012	30th Jan 2013		Nil
7.3	Awareness Workshop for Village Sarpanchs	Nil	7th Feb 2013		Nil
7.4	Orientation Workshop for Municipal Counselors/MLAs	12th Feb 2012	Nil		12th Feb 2013
8	Pre Mock Exercise	Nov 2012- Feb 2013	7th -9th Feb 2013	8th - 12th Feb 2013	6th Feb-10th Feb 2013
9	Mega Mock Exercise	13th Feb 2013 at 10.30 am			
9.1	Final Debrief	14th Feb 2013			
10	School Shakeout Preparedness Drill	Nil	March- April 2013	March-April 2013	March-April 2013

10.1	a. Orientation Workshop	Nil	21st -23rd March 2013	3rd April 2013	19 March- 3 April 2013
10.2	b. School Shakeout Drill	Nil	4th April 2013	4th April 2013	4th April 2013

2 Detailed Project Activities of Himachal Pradesh State

State of Himachal is prone to various hazards both natural and manmade. Main hazards consist of earthquakes, landslides, flash floods, snow storms and avalanches, draughts, dam failures, fires – domestic and wild, accidents – road, rail, air, stampedes, boat capsizing, biological, industrial and hazardous chemicals etc. However, the hazard which poses biggest threat to the state is earthquake hazard. The state has been shaken by more than 80 times by earthquakes having a magnitude of 4.0 and above on the Richter scale as per the recorded history of earthquakes. As per the Bureau of Indian Standard (BIS) seismic zoning map five districts of the state, namely Chamba (53.2%) Hamirpur (90.9%), Kangra (98.6%), Kullu (53.1%), Mandi (97.4%) have 53 to 98.6 percent of 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 (25.3%) and Una (37.0%) also have substantial area in MSK IX and rest in MSK VIII. The remaining districts also are liable to intensity VIII.

2.1 Results of Scenario Earthquake

Output map of MSK damage intensity, injuries and deaths are shown in Figures 2.1, 2.2 and 2.3 respectively. It can be seen that for the given scenario earthquake major part of the state is going to be in MSK damage intensity VIII or IX.

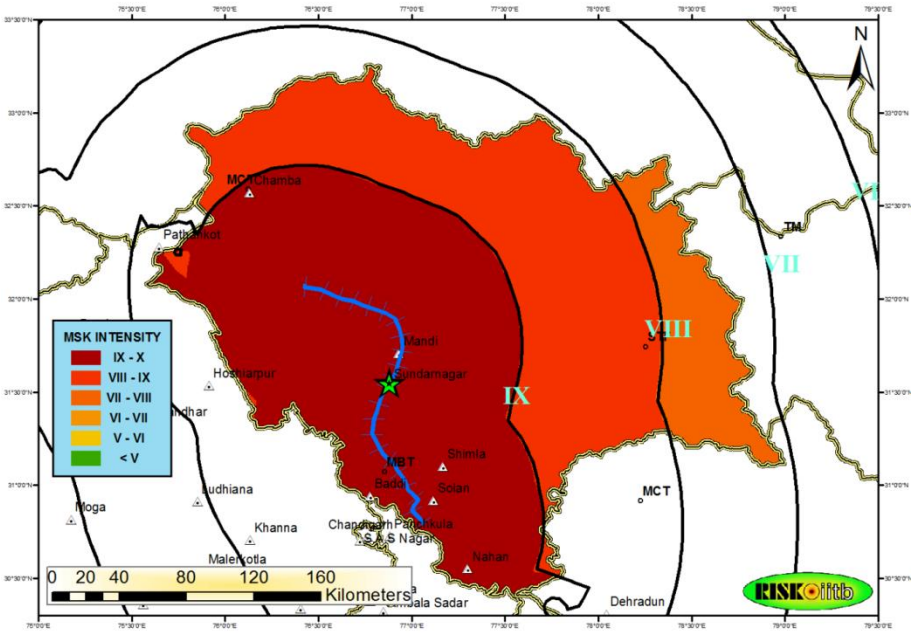


Figure 2.1: Map of MSK damage intensity in Himachal Pradesh due to scenario earthquake

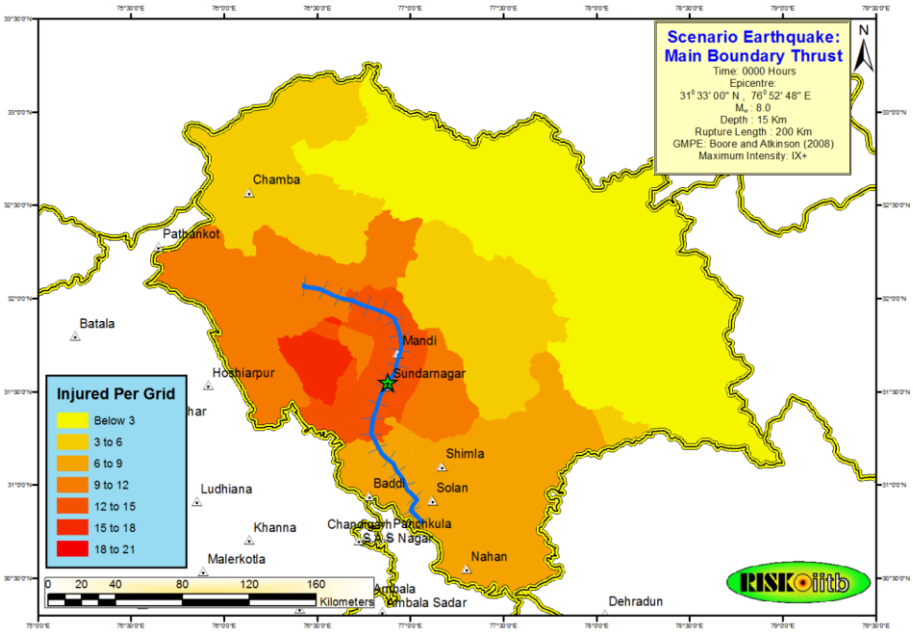


Figure 2.2: Map of likelihood of injuries due to scenario earthquake in Himachal Pradesh

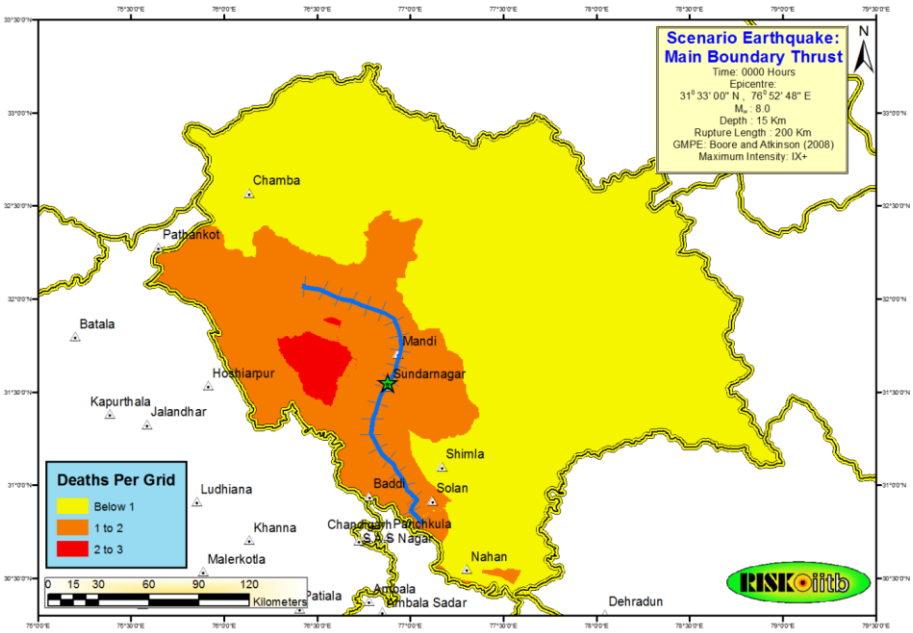


Figure 2.3: Map of likelihood of deaths due to scenario earthquake in Himachal Pradesh

The loss estimation outcomes, based on the census data of Himachal Pradesh state, are projected in terms of deaths and injuries as calculated by researchers of IIT Bombay and are tabulated below:

Table 2.1: Social loss in Himachal Pradesh

Population	Injuries	Deaths
68,56,000	14,90,400	1,88,100

Table 2.2: District-wise social loss in Himachal Pradesh

Sr. No	District	Population	Injuries	Deaths
1	Chamba	5,18,800	1,35,200	14,700
2	Kangra	15,07,200	3,15,000	41,600
3	Lahul&Spiti	31,500	13,800	1,400
4	Kullu	4,37,400	1,11,800	12,700
5	Mandi	9,99,500	2,59,100	29,400

6	Hamirpur	4,54,200	98,600	13,100
7	Una	5,21,057	83,000	13,300
8	Bilaspur	3,82,000	77,000	10,000
9	Solan	5,76,600	83,500	12,600
10	Sirmaur	5,30,100	1,11,600	14,000
11	Shimla	8,13,300	1,86,700	23,300
12	Kinnaur	84,200	14,400	1,600

2.2 Project Activities

A separate report entitled "Annexure to Multi-Stakeholder Scenario Building Manual" has been prepared for all the project activities and how the scenario building manual is implemented in each state. The details of project activities for Himachal Pradesh carried out under this project are furnished in Chapter 1 of the "Annexure to Multi-Stakeholder Scenario Building Manual".

2.3 Mega Mock Exercise

A separate report "Observations from Mega Mock Exercise and Lessons Learnt by Participated States" has been prepared to document all the details and learning from Mega Mock Exercise carried out in each state. The details of Mega Mock Exercise for Himachal Pradesh are furnished in Chapter 1 of "Observations from Mega Mock Exercise and Lessons Learnt by Participated States" report.

2.4 Sound Practices

1. First of its kind of project in Himachal Pradesh, Stakeholders were very keen for new learning and experience.
2. Involvement of educational institution's for awareness generation.
3. Involvement of various Non-government organizations.
4. Preparation/Revision of District Level Disaster Management Response Plan.
5. First time in HP, resources mobilized from various departments.
6. Extensive media campaign.

7. RVS of life line buildings & structures.

2.5 Lesson Learnt

1. Need of modern equipments for disaster management system
2. A fully equipped control room/ Emergency Operation Centre to be set up
3. Set up of an alternate communication system
4. Coordination mechanism between all line departments
5. Regular awareness programmes to educate the public to be held throughout the year
6. Mock drills for earthquakes should be organised frequently
7. Community involvement to be encouraged by including them in awareness activities and also providing them trainings
8. Strengthening of fire services

2.6 Gaps and Recommendations

1. State level mapping of resources should be done beforehand and be a part of the State Disaster Management Plan.
2. Training of stakeholders in various aspects of disaster management is highly needed. The stakeholders must be trained and sensitized enough to understand the niceties of Disaster Management and assist administration getting prepared to face any disaster. Department of Civil Defense & Home Guards, Fire, Health, Police which play an important role in response mechanism must be imparted trainings at regular intervals to keep the response teams in form to respond effectively for any emergency and not just a massive earthquake.
3. State Emergency Operation Centre is not fully equipped, so there is a need of proper functioning of State Emergency Operation Centre for better response in case of real disaster.
4. Rapid Visual Training should be organized for every districts of Himachal Pradesh.
5. Effective Incident Response System not fully institutionalized in state level as well as District level.
6. Resource Mapping and Resource Inventory not fully prepared at state level as well as District level.
7. There is a requirement for alternative communication systems to be in place like Satellite phones since wireless systems get jammed/choked quickly. If possible, there should be an exclusive network of communication during disaster, and all responders should be properly networked/linked with it..
8. Lack of involvement of Community in entire Project.
9. Capacity Development Programs for Govt Officers should organised at district level not Division level, for better preparation and involvement of Government Machinery.
10. Emergency Support functionaries of state level and district level were not well equipped, so there is a need of proper guidelines and mechanism for ESFs.
11. Non government organizations and volunteers should be involved in all aspects like community sensitization and should also be involved in planning for disaster management and trained in rescue and relief.

12. Community sensitization about disaster is crucial. Masses should be educated on awareness on disaster and mitigation and response efforts through inclusion in school curriculum, publicity drives, mass media campaigns, etc. These campaigns should include students, youth, families, elected representatives, etc.
13. Roles of Officers should be clear beforehand and they should be properly trained. Response Teams of officers who give information about damage/losses on reaching a particular spot could also be trained to start rescue and relief operation immediately and not wait for medical teams to arrive. It was also highlighted that when the army is called in to assist the local administration, the chain of command down to the level of the field spot should be clear so that there is no conflict. Further, roles of all officers in the Incident Command should be clear to them and they should be brief beforehand.

3 Detailed Project Activities of Punjab State

Punjab state lies in geosynclines (down warp of the Himalayan foreland, of variable depth, converted into flat plains by long vigorous sedimentation). This has shown considerable amounts of flexure and dislocation at the northern end and is bounded on the north by the Himalayan Frontal Thrust. Much of Punjab lies in the Punjab Shelf, bounded on the east by the Delhi-Haridwar Ridge and on the south by the Delhi-Lahore Ridge. Most earthquakes in this region are shallow though a few earthquake of intermediate depth have been recorded in Punjab.

According to the latest seismic zoning map of India, about 53% of Punjab landmass is vulnerable to severe seismic hazards i.e., prone to shaking of MSK intensity IX and above; 43.4% is vulnerable to moderate seismic hazards i.e., prone to shaking of MSK intensity VIII and 3.7% is vulnerable to low seismic hazard i.e., prone to shaking of MSK intensity VII. In terms of seismic hazard, district Pathankot, Gurdaspur, Amritsar, Tarn Taran, Kapurthala, Jalandhar, Hoshiarpur, Nawanshahr, Ludhiana, Fatehgarh Sahib, Roopnagar, Patiala and S.B.S. Nagar falls in Zone IV while district Ferozepur, Faridkot, Moga, Muktsar, Bathinda, Mansa, Barnala, Sangrur falls in Zone III and Fazilka falls in Zone II of the Seismic Zonation Map of Punjab.

Prior to this project, the technical information about the earthquake risk in Punjab state was incomplete and scattered among several governmental agencies. It was not synthesized, was not applied to the infrastructure of modern day Punjab state, and was not presented in a form that the public and government officials could digest.

3.1 Results of Scenario Earthquake

Figure 3.1 shows the predicted shaking intensity (MSK intensity) in Punjab state for the scenario earthquake.

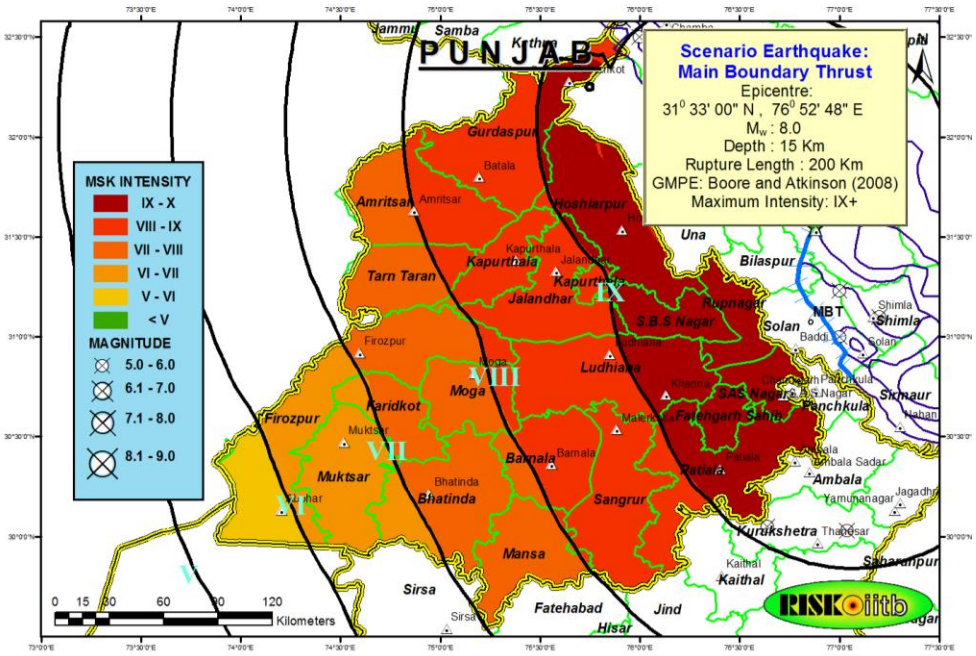


Figure 3.1: Map showing predicted shaking intensity in the Punjab State due to scenario earthquake.

The extent of different damage intensities covered over areas have been represented in Table 3.1 and their corresponding districts are shown in Table 3.2. Similarly Population which is likely to be exposed to different damage intensities is shown in Table 3.3.

Table 3.1: Area under different earthquake intensity

Intensity	Area (km^2)
X to IX	13,992
IX to VIII	20,746
VIII to VII	14,871

Table 3.2: List of districts of Punjab State with different intensities

Intensity	Districts
IX – X	Fatehgarh Sahib, Hoshiarpur, Jalandhar, Ludhiana, Patiala, Rupnagar, Pathankot, S.A.S Nagar, S.B.S Nagar

Intensity	Districts
VIII – IX	Amritsar, Bhatinda, Kapurtala, Tarn Taran Gurdaspur, Barnala, Sangrur
VII – VIII	Muktsar, Ferozepur, Moga, Mansa, Faridkot and Fazilka.

*District having two or more MSK Intensity regions has been listed in the highest intensity group.

Table 3.3: Population exposure under different earthquake intensity

Intensity	Population (in Lakhs)
X to IX	23.85
IX to VIII	70.58
VIII to VII	132.99

The traditional disaster management practice, which is primarily concerned with managing the response following disasters, enumerates disasters in terms of their social (deaths and injuries) or economic losses. There is thus great advantage in developing earthquake scenarios that provide projections of social or economic losses. The injuries and deaths density that has been estimated on RISK.iitb v3.0 are given in Tables 3.4 and 3.5.

Table 3.4: Social loss in Punjab

State	Population (Census, 2011)	Injuries	Deaths
Punjab	2,77,04,236	20,14,700	4,62,500

Table 3.5: District-wise social loss in Punjab

S No	District	Population (Census, 2011)	Injured	% Injured	Deaths	% Deaths
1	Bathinda	13,88,859	72,200	6.4	16,100	1.2

S No	District	Population (Census, 2011)	Injured	% Injured	Deaths	% Deaths
2	Faridkot	6,18,008	31,000	6.1	6,900	1.1
3	Fatehgarh Sahib	5,99,814	60,500	12.5	14,500	2.4
4	Firozpur	20,26,831	94,800	5.6	18,400	0.9
5	Gurudaspur	22,99,026	1,93,400	10.3	44,000	1.9
6	Hoshiarpur	15,82,793	1,46,100	11.4	33,600	2.1
7	Jalandhar	21,81,753	1,75,800	10.0	41,400	1.9
8	Kapurthala	8,17,668	59,100	8.9	13,900	1.7
9	Ludhiana	34,87,882	2,89,900	10.3	68,800	2.0
10	Mansa	7,68,808	43,600	7.0	9,900	1.3
11	Moga	9,92,289	60,000	7.4	13,400	1.4
12	Muktsar	9,02,702	33,400	4.5	6,900	0.8
13	Patiala	18,92,282	1,62,300	10.6	38,300	2.0
14	S. B. S. Nagar	6,14,362	54,800	11.0	12,900	2.1
15	Amritsar	24,90,891	1,60,200	7.9	36,900	1.5
16	Tarn Taran	11,20,070	71,200	7.7	14,900	1.3
17	S. A. S. Nagar	9,86,147	88,600	11.1	21,000	2.1
18	Barnala	5,96,294	40,200	8.3	9,300	1.6
19	Sangrur	16,54,408	1,16,000	8.7	27,200	1.6
20	Rupnagar	6,83,349	61,600	11.1	14,200	2.1

Maps of Likelihood of injuries and deaths in Punjab state for the scenario earthquake are shown in Figures 3.2 and 3.3 respectively.

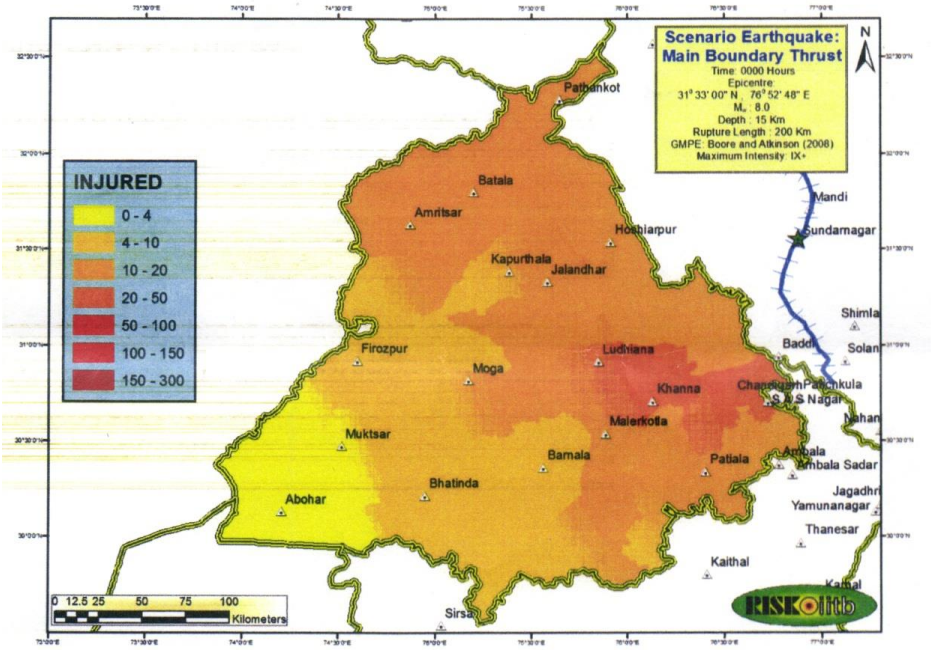


Figure 3.2: Map of likelihood of injuries in Punjab due to scenario earthquake

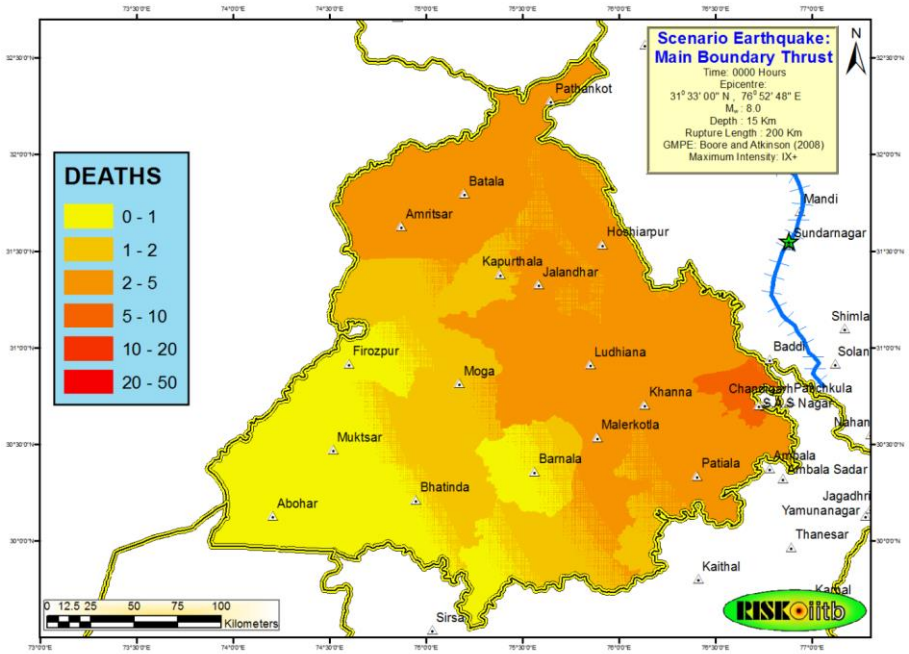


Figure 3.3: Map of likelihood of deaths in Punjab due to scenario earthquake

3.2 Project Activities

A separate report entitled "Annexure to Multi-Stakeholder Scenario Building Manual" has been prepared for all the project activities and how the scenario building manual is implemented in each state. The details of project activities for Punjab carried out under this project are furnished in Chapter 2 of the "Annexure to Multi-Stakeholder Scenario Building Manual".

3.3 Mega Mock Exercise

A separate report entitled "Observations from Mega Mock Exercise and Lessons Learnt by Participated States" has been prepared to document all the details and learning from Mega Mock Exercise carried out in each state. The details of Mega Mock Exercise for Himachal Pradesh are furnished in Chapter 2 of "Observations from Mega Mock Exercise and Lessons Learnt by Participated States" report.

3.4 Sound Practices

1. Vast media campaign
2. Inclusion of schools in spreading awareness
3. Inclusion of awareness generation activities
4. Capacity Development Programmes (CDP)
5. Training for RVS of lifeline buildings & structures
6. Various activities undertaken under Disaster Risk Management Action Plan

3.5 Gap Assessment

- Insufficient training of human resources for rescue and response operations.
- Ineffective inter/intra-coordination in the organisation.
- Insufficient relief resources.
- Unavailability of temporary shelter in case of complete collapse or premises to resume operation of the organisation.
- Unavailability of full fledged Control Room/ Emergency Operation Centre.
- Non-availability of Emergency Communication System.
- Unavailability of back up communication system.
- Temporary care and emergency assistance.
- Resource Mapping and Resource Inventory.
- Lack of logistics support.

- Public health issues.
- Lack of Community Participation.
- Inadequate search and rescue operations.
- Capacity of NGO's needs to be improved.
- Weak relationships with stakeholders.
- Limitations in monitoring to check the performance of stakeholders.
- Inadequate rescue resources like fire-fighting equipment, debris removal vehicles, etc.
- Lack of Fire Services.
- Lack of human resources.
- Lack of equipments.
- Lack of motivation among common public.

3.6 Learning & Recommendations

Generally, the stated objectives of the projects have been achieved very successfully, but many lessons, both positive and negative, were learned in the process. These lessons are described below. The experience gained from examining these lessons will benefit all types of mitigation projects in Punjab.

1) **Equipments:** Availability of equipments in the district during the emergency was an issue of concern. Emergency Support functionaries of state level and district level were not well equipped, so there is a need of proper guidelines and mechanism for ESFs. Supply of modern equipments for disaster management system needs a consideration. A certain degree of decentralization in procurement of equipments required in the field level is necessary. It will enable in maintaining a stock of essential equipments thereby making us better prepared.

2) **Full fledged Control Room:** The State Emergency Operation Centre stationed at the Punjab Civil Secretariat building is not in a condition to function as required, both in terms of manpower and location. A fully equipped control room/ Emergency Operation Centre to be set up in a centrally located area where efficient management of crisis with the presence of all government agencies can be undertaken.

3) **Alternative Communication System:** Breakdown in telecommunication system was a major hurdle and made us largely dependency on WT lines under police control. Setting up a communication system in the local community, other than telephonic network e.g. community ham radio, would be very effective in transmitting instant messages in different areas including rural localities. It would serve as an alternative mechanism for communication during emergencies. Since we have a difficult topography where it takes a long period to restore connectivity and communication lines, such radio service will be of great help for transmitting information.

4) Communications barriers, especially the sharing of critical and vital information, must be improved throughout the EOC through further training, practice, and the removal of physical, procedural and technological barriers.

5) Messages often get distorted while being conveyed. Correct information needs to be gathered for proper action.

6) Coordination Mechanism within the department and among all line departments was not efficient enough to respond for an emergency situation.

7) A general lack of coordination between the Nodal Agency and the Support agencies was noticed in the Mega Mock Drill and it was felt by nodal agencies that support agencies were not much aware about their roles and responsibilities.

8) **Regular awareness programmes:** Regular awareness programmes to educate the public to be held throughout the year. There is a need to increase public awareness through mass media campaigns, development of Information, Education and Communication Material, including the subject of Disaster Risk Management in the Syllabi of different courses, sensitization of officers from the Administration, Civil Engineers, Education, Punjab Police, Punjab Fire Service, BSNL and all other parallel agencies, to display Models, Charts and Drawings in Panchayats, BDO's Office etc. showing the earthquake resistant features in typical housing of the district, to hold exhibitions, for creating general awareness, etc., and to transmit media programmes, say once a week, on the hazards in the state, actions for safety, how to achieve safe new construction, need for retrofitting of existing houses, etc.

9) **Drills:** Mock drills for earthquakes should be organised frequently as they give an opportunity to the different emergency support function agencies to come together and to be able to coordinate. In case of a disaster it has been observed that it becomes very difficult to identify who belongs to which agency and how the other agency can be of help. Response drills give a chance to practice things the members of emergency support function agencies are trained to do. Such response drills provide an opportunity for the agencies to test their own potential to combat any adverse situation and also to improvise the existing system. It enables them to gauge their capabilities and develop on them. There is a need for regular mock drills involving Officers, Schools, Hospital Staffs, PRIs etc. Mock Drills must be conducted at least once a year in every residential locality, school, offices and bazaar area. This has been acknowledged at all levels and will be a reality in the days to come.

10) **Incident Response System**: In all the plans, on the immediate event of a disaster, the response activities should follow the Incident Response System (IRS) provided in 'National Disaster Management Guidelines-Incidence Response System'. Where required, revising the previously developed modules of scenario management plans should be carried out to integrate the IRS.

- The chain of command, and the command and control function, must be improved in the EOC operations from Management through the other Section Chiefs, including the regular briefing of the EOC as a whole and preparing EOC Action Plans.

- The Operational Area, including all of its cities and involved special districts, and its Department Operations Centers, must participate completely and more often in large-scale exercises, including field exercises. Initial and refresher training must support

this by preparing anyone who has an assigned role, or potential, to perform in the EOC environment.

11) **Community participation:** Community involvement can be encouraged by including them in awareness activities and also providing them training. Various NGOs and citizen volunteers can be given training in disaster management. This can go a long way in building up community preparedness. NGOS and volunteers from the public should also form part of the disaster management system so that their services can be utilized if need arises. Such programmes involving the local communities, NGOs and members of the public already have the support of the state government.

12) It is important that the members of emergency support function agencies are familiar with the area, various routes etc. In case of any roads being blocked they should know the alternate routes. They should also be able to reach the disaster site in minimum time.

13) The collapse of engineered and non-engineered building during earthquakes is the main contributor to the loss of lives, injuries to the people and economic losses. This is because of the lack of public awareness, lack of institutional mechanism for implementation and insufficient capacity of implementing authorities. Most casualties during earthquakes are caused by the collapse of structures, both engineered and non-engineered, and structural mitigation measures are the key to make a significant impact towards earthquake safety in Punjab. These have to be dovetailed in the planning process at the developmental stage itself. For successful earthquake mitigation, it has to be ensured that all new constructions in the seismic zones are complaint with the BIS codes and for this purpose a techno legal regime has to be put in place. The regulatory agencies (Municipal Bodies, Development Authorities) Work Departments and other agencies and departments have not been able to enforce/ implement these standards/ codes in construction mainly due to lack of capabilities; both in terms of availability of manpower and technical competence. Also, the structural engineers/ architects practicing in the private as well as public sector do not have knowledge of seismic safe designing and construction.

14) Insofar as the existing stock of building is concerned, it will not be possible to retrofit all the buildings. However, it will be necessary to retrofit lifeline buildings and the buildings where people congregate like cinema halls, shopping complexes, multi-storied buildings, etc. The difficulty is that even where state wants to undertake retrofitting of the lifeline buildings, technical support is not available.

15) **Training and Capacity Building**: We have very few experts in disaster mitigation and planning. We must focus our attention to the institutionally and manpower development at all levels. There is a need to train architects, engineers, planners and masons in developing safe housing and infrastructure facilities. Manuals need to be developed outlining methodologies for new constructions and retrofitting of old ones. A strong legal and enforcement framework with appropriate incentives and punitive measures is required together with awareness programmes for general public. All these components must be taken up simultaneously; ignoring one aspect for the other could be counterproductive. Organize training programmes for specialized groups like, disaster management teams in district, sub division and community level, teachers and principals, doctors and engineers, architects and mason and builders & contractors etc.

- There is a need for institutions in the states, which will give technical advice to the urban local bodies in carrying out amendment of the building byelaws. Currently,

civil engineering faculties of most of the engineering colleges do not have this expertise.

- The Municipal Engineers need to be trained in BIS codes so that they are able to enforce these codes after these are included in byelaws. Institutional arrangements need to be made for training of the Municipal Engineers. Training will also be required to be given to engineers of the State Public Works Department (PWD) so that the construction undertaken by the Government agencies is seismically safe.

16) **Strengthening of Fire Services:** Rural areas in the state are quite different because of roads, communication, terrains & distance covered etc. The maximum response time in urban areas is 5 minutes and 20 minutes in rural areas. It is possible in the plans but it is not possible in the narrow lanes & crowded areas. The modern hi tech technology of CAFS has shown extra ordinary results / revaluation to douse the flames.

The Standing Fire Advisory Council has also recommended at least 2 nos. Motor Bike fitted with Water Mist technology equipments for each Fire Station. The Water Mist technology equipped on motor cycle is very useful and it produces extinguishing media equivalent to 1000 ltrs. of water.

The SFAC has also recommended rescue tender for each Fire Stations, in the rescue tender immediate needs for a Fire Station while attending rural fire, inflatable light is important item on the rescue tender because during night hours light is a problem. The inflatable light unit illuminate and area of 55 mtr radius approximately 10,000 sqm area in 3 minutes.

a) Apart from that High population area like (Jalandhar, Amritsar, Patyala, Bhatinda) should be equipped with modernize equipments like Turn Table Ladder, Hydraulic Platform 01 No each.

b) All vehicles should be properly equipped with communication equipments.

c) Each district of state should be equipped with Hazmat Van with all Search, Rescue & Combi Tools as per guideline.

d) Each district, councils & Block administration should equipped with Inflatable emergency lightning system (districts 05 No each, Council 04 No each & Blocks 02 & Panchayat level 01No each).

e) All Firemen should have personal protective equipments, like Helmet, Fire Proximate Suits, Gum Boots etc.

4 Detailed Project Activities in Haryana State

Haryana falls in the seismic zone IV, III, & II and therefore, the region is vulnerable to earthquakes. Although, in recent past, no major earthquakes have occurred in Haryana, yet tremors have been felt whenever there is an earthquake in the Himalayan foot-hills. Therefore, to get prepared at administrative and community level to face any future earthquake, states of Punjab, Haryana, Himachal Pradesh and UT of Chandigarh conducted a Mega Mock Exercise in collaboration with National Disaster Management Authority (NDMA) under a national project 'M_w 8.0 Mandi, Earthquake Scenario: Multi State Exercise and Awareness Campaign'.

The 'M_w 8.0 Mandi, Earthquake Scenario: Multi State Exercise and Awareness Campaign' project, a collaborative initiative of Haryana and NDMA, was launched on 17th July 2012 in Haryana Secretariat Chandigarh, under the Chairmanship of Hon'ble member NDMA Prof. H K Gupta, Hon'ble member NDMA Shri T Nandakumar, Hon'ble Financial Commissioner Revenue & Disaster Management. The meeting was attended by Experts from NDMA, IITB, IITM, GeoHazards Society and Senior Officials of Haryana administration. Hon'ble Financial Commissioner Revenue, Haryana took up the charge as State Nodal Officer for the project. NDMA deputed Ms. Deepshikha Purwar, as State Coordination Officer from GeoHazards Society (associated with NDMA as implementation partner of the project) to coordinate the execution of the project.

The project implementation in Haryana state covered seismic assessment of various life line buildings in selected districts of Haryana. Further Incident Response System (IRS) training was imparted to administrative officers of the selected districts to review and update the Disaster Management Plan (DMP). Awareness campaigns were launched to sensitize public, civic bodies, school and college students in district Panchkula. The concluding event of this one year project was the conduct of Mega Mock Exercise at 15 selected locations of district Panchkula on 13th February 2013.

4.1 Results of Scenario Earthquake

Scenario results are shown in Figures 4.1 to 4.3. As the map (Figure 4.1) clearly depicts that 13 districts of Haryana i.e, Panchkula, Ambala, Bhiwani, Hisar,Jhajjar, Kaithal, Karnal, Kurukshetra, Panipat, Rohtak, Sonipat falls in region with seismic intensity X-VIII. Similarly Figures 4.2 and 4.3 show the likelihood of injuries and deaths respectively in Haryana state.

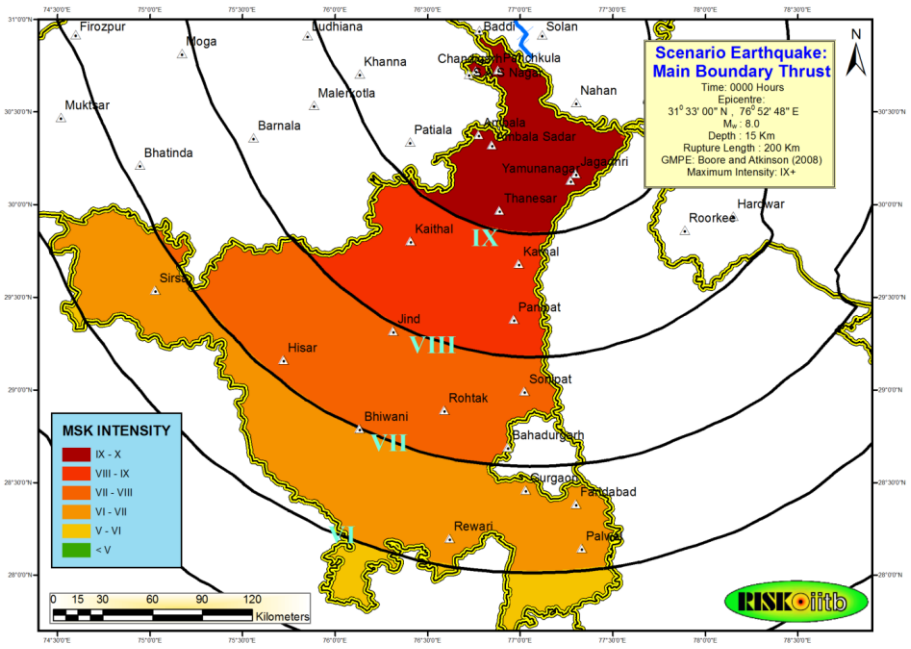


Figure 4.1 : Map of MSK damage intensity in Haryana due to scenario earthquake

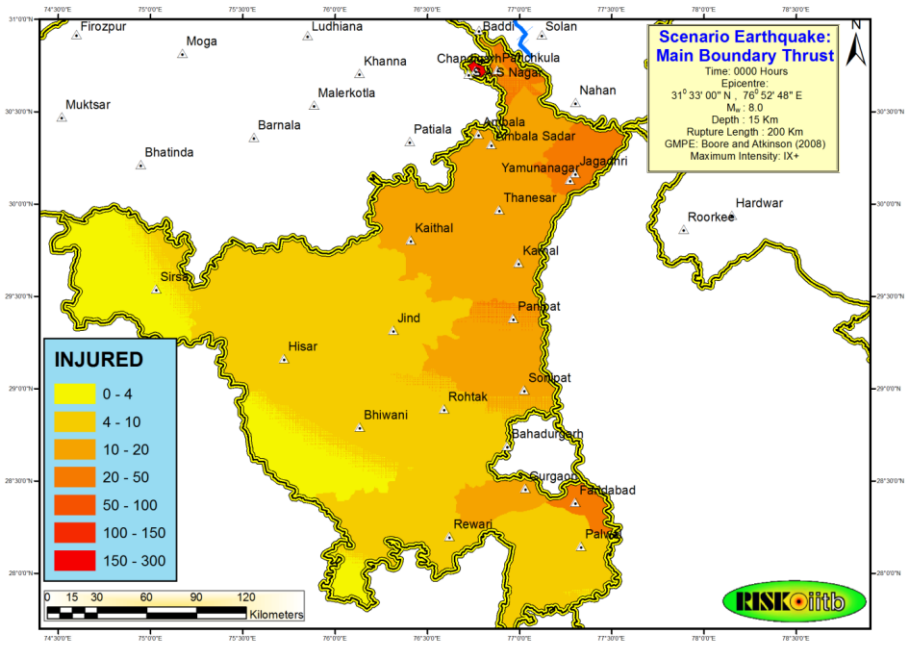


Figure 4.2: Map of likelihood of injuries in Haryana due to scenario earthquake

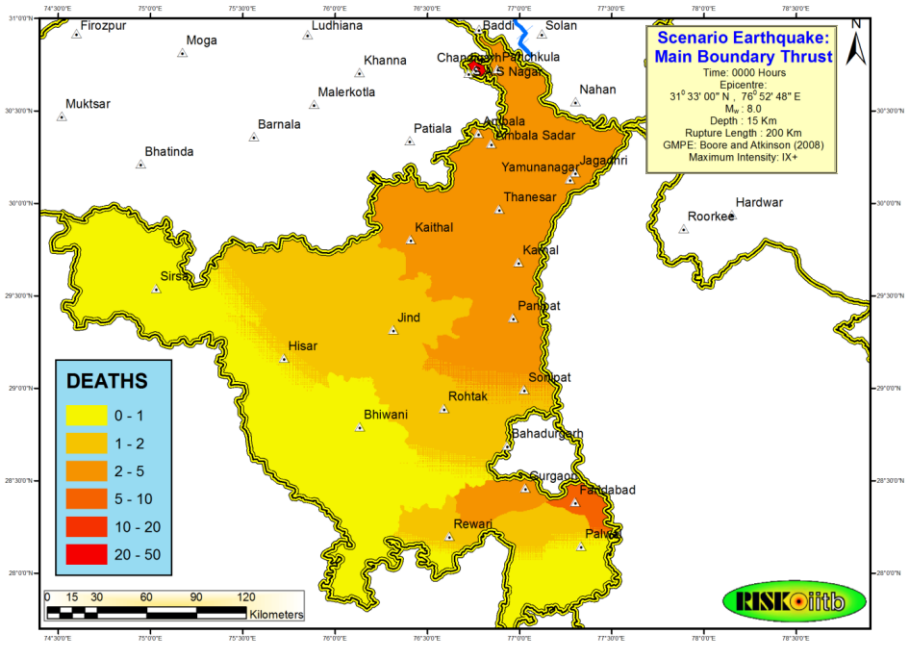


Figure 4.3: Map of likelihood of deaths in Haryana due to scenario earthquake

The loss estimation outcome based on the census data of Haryana state, projected deaths and injuries calculated by researchers of IIT Bombay are tabulated below:

Table 4.1: Loss estimation at state level

State	Population (Census, 2011)	Injuries	Death
Haryana	2,53,53,081	15,04,200	3,23,400

Table 4.2: Loss estimation at district level

Sr. No.	District	Population (Census, 2011)	Injuries	% Injuries	Death	% Death
1	Panchkula	5,58,890	51,900	9.2	11,400	2
2	Ambala	11,36,784	121,700	10.7	26,200	2.3
3	Yamunanagar	12,14,162	114,000	9.3	25,500	2.1
4	Kurukshetra	9,64,231	85,200	8.8	19,500	2

Sr. No.	District	Population (Census, 2011)	Injuries	% Injuries	Death	% Death
5	Kaithal	10,72,861	93,700	8.7	20,400	1.9
6	Karnal	15,06,323	125,700	8.3	28,400	1.8
7	Panipat	12,02,811	85,100	7	19,200	1.5
8	Sonipat	14,80,080	86,700	5.8	19,800	1.3
9	Jind	13,32,042	91,600	6.8	21,200	1.5
10	Hisar	17,42,815	88,500	5	20,100	1.1
11	Bhiwani	16,29,109	71,100	4.3	15,000	0.9
12	Rohtak	10,58,683	55,500	5.2	12,700	1.1
13	Jhajjar	9,56,907	46,200	4.8	9,700	1

4.2 Project Activities

A separate report entitled “Annexure to Multi-Stakeholder Scenario Building Manual” has been prepared for all the project activities and how the scenario building manual is implemented in each state. The details of project activities for Haryana carried out under this project are furnished in Chapter 3 of the “Annexure to Multi-Stakeholder Scenario Building Manual”.

4.3 Mega Mock Exercise

A separate report entitled Observations from “Observations from Mega Mock Exercise and Lessons Learnt by Participated States” has been prepared to document all the details and learning from Mega Mock Exercise carried out in each state. The details of Mega Mock Exercise for Haryana are furnished in Chapter 3 of “Observations from Mega Mock Exercise and Lessons Learnt by Participated States” report.

4.4 Sound Practices

4.4.1 Vast Media Campaign

An extensive media campaign was launched from Jan, 2013 to Feb, 2013 to reach out masses, was successful to spread awareness at a large scale. Posters and Hoardings with messages on Earthquake Preparedness and Mega Mock Exercise, Jingles on FM Radio, Advertisement in Newspapers, etc. were part of the Awareness Generation Campaign.

4.4.2 Inclusion of Schools in Spreading Awareness

Various Awareness Generation activities such as quiz, Poster Making, Slogan writing and Rallies by School students in Panchkula District which not only Generated Awareness among School kids but also among at Community level, as School children played an important role in taking the Safety & Preparedness to their Families.

4.4.3 Pre Mock Exercise

Pre Mock Exercise was conducted twice in Panchkula City at Different Locations made Administration to identify the gaps and overcome those gaps before Mega Mock Exercise.

4.4.4 Hazard and Risk Vulnerability Analysis (HRVA)

District Panchkula has already started the process of HRVA though the process could not be completed before the mock exercise but would surely help in updating the Disaster Management Plan with vulnerable areas in Panchkula

4.4.5 Resource Mapping and Resource Inventory

Under the supervision of Haryana Institute of Public Administration, Haryana state has already completed the task of Resource mapping and Preparation of Resource Inventory which was of great help during the conduct of Mock Exercise.

4.4.6 Standardization of Standard Operating Procedure (SOPs) of Emergency Support Functionaries (ESFs)

Standardization of SOPs of ESFs were already in place for Panchkula Administration which was helpful in assigning the roles and responsibilities of each ESF to function in a coordinated and organized way to achieve efficient response to any emergency.

4.4.7 Preparation of Disaster Management Plans at State/District Level

The preparation updated Disaster Management Plans at State/District Level are underway. The task has already been assigned to Haryana Institute of Public Administration, which has engaged dedicated Officers for each district to prepare the Disaster Management plans. It will be ensured to incorporate the lessons learnt from the Mock Exercise, in these Plans.

4.5 Sound Practices

1. Vast media campaign
2. Inclusion of schools in spreading awareness

3. Pre Mock Exercise
4. Hazard and Risk Vulnerability Analysis (HRVA)
5. Resource Mapping and Resource Inventory
6. Standardization of Standard Operating Procedure (SOPs) of Emergency Support Functionaries (ESFs)
7. Preparation of Disaster Management Plans at State/District Level

4.6 Lessons Learnt

1. Need of compatible communication setup
2. Inter & intra coordination mechanism
3. Establishment of state of the art EOC
4. Training of stakeholders
5. Procurement and maintenance of basic resources
6. Need for large scale public awareness & sensitization

5 Detailed Project Activities of Chandigarh UT

Union Territory of Chandigarh, 'the City Beautiful', located on the foothills of Shivalik range is the first planned Indian city, post-independence. Being located in the Himalayan belt, Chandigarh faces very high vulnerability to massive earthquakes. The Himalayan Frontal Belt is the loci for many earthquakes of magnitude more than 7.5 in the last 200 years[2]. These earthquakes are a result of the ongoing collision of Indian and Eurasian plates.

Recognizing the severity of seismic vulnerability of Chandigarh and level of preparedness, Chandigarh Administration pioneered to participate in the implementation of an earthquake scenario based project, 'Mw=8 Mandi, Earthquake Scenario: Multi State Exercise and Awareness Campaign', supported by National Disaster Management Authority, New Delhi. The project was based on a hypothetical earthquake scenario based on Kangra Earthquake of 1905.

The project implementation at Chandigarh covered seismic assessment of various life line buildings. Further Incident Response System (IRS) training was imparted to administrative officers of the U.T to review and update the Disaster Management Plan (DMP). Awareness campaigns were launched to sensitize public, civic bodies, school and college going children. This one year long project culminated with the successful conduct of Mega Mock Exercise at 15 selected locations of Chandigarh on 13th February, 2013.

According to the latest seismic zoning map of India, Chandigarh falls in seismic zone IV (Zone IV, IS 1893 – 2002) prone to shaking of MSK Scale intensity VII and above. Due to Chandigarh's location, it weathers dozens of mild earthquakes every year[1].

5.1 Results of Scenario Earthquake

Scenario results are shown in Figures 5.1 to 5.3 which represent MSK damage intensity, injuries and deaths respectively. From Figure 5.1, it can be seen that whole UT will experience MSK damage intensity more than IX for given scenario earthquake.

[2] Joshi *et al*. (2009). Paleo-liquefaction Features from the Himalayan Frontal Belt, India and its Implications to the Status of Central Seismic Gap, *Journal of South Asia Disaster*, 2(1), PP 139-154.

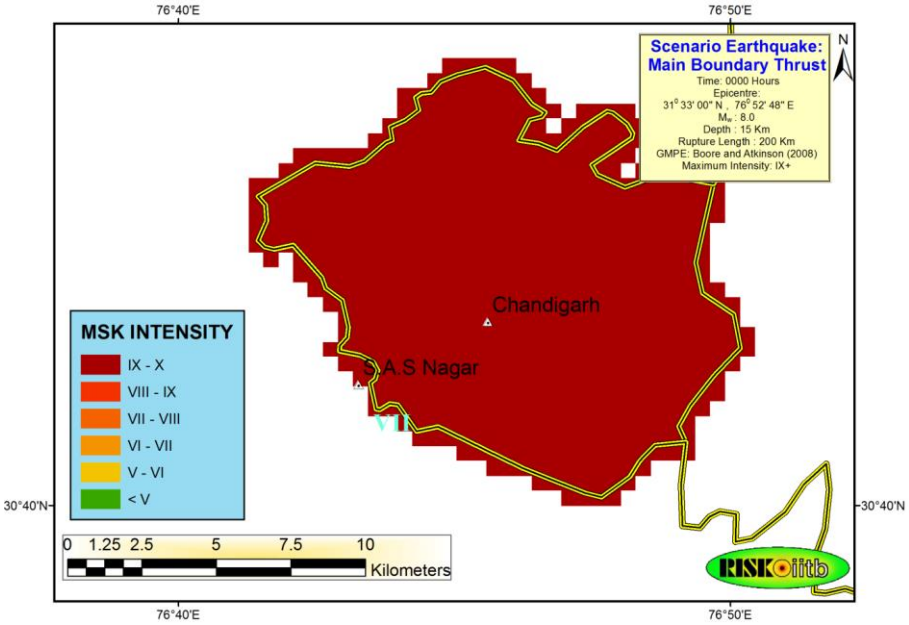


Figure 5.1 : Map of MSK damage intensity in Chandigarh due to scenario earthquake

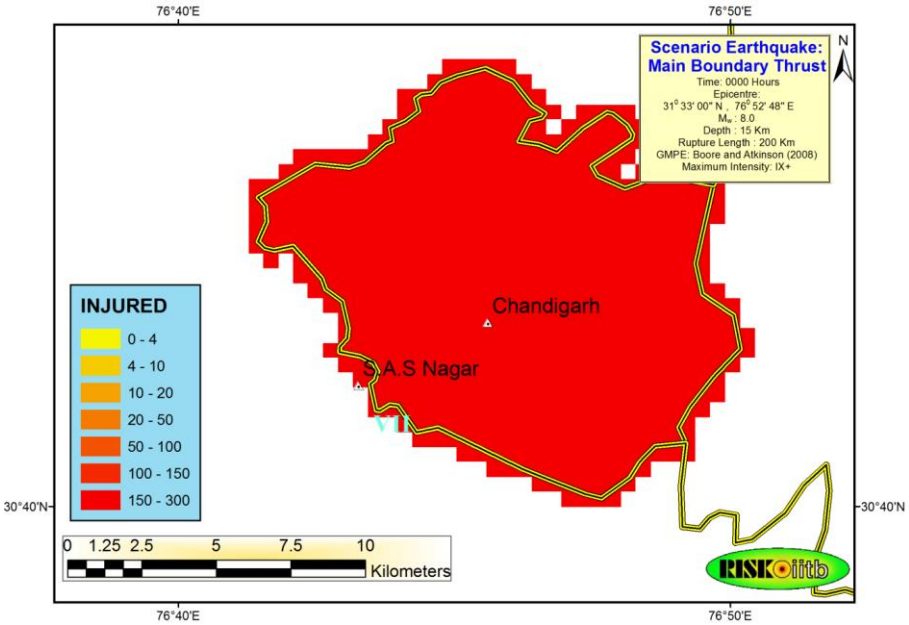


Figure 5.2: Map of likelihood of injuries in Chandigarh due to scenario earthquake

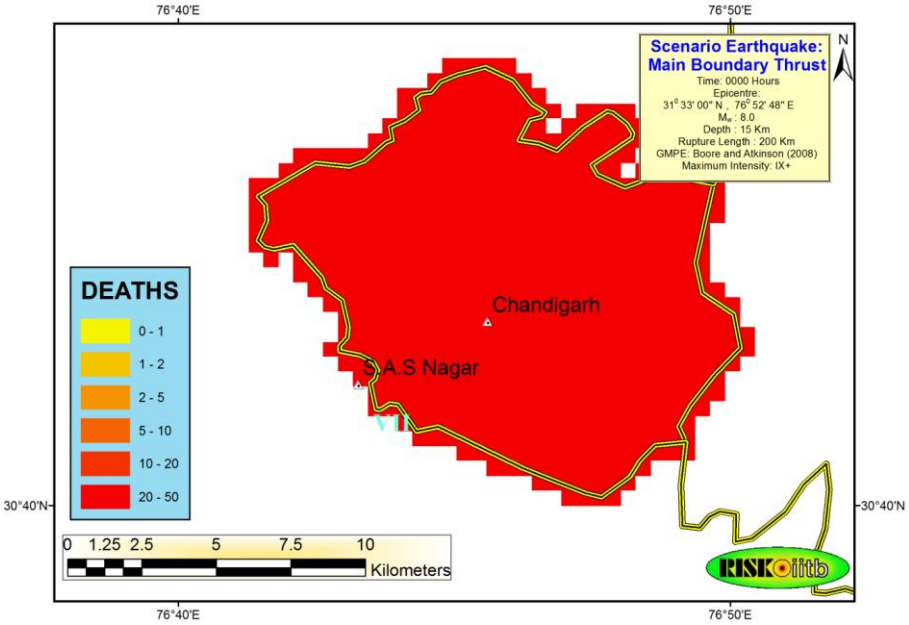


Figure 5.3: Map of likelihood of deaths in Chandigarh due to scenario earthquake

The loss estimation outcome[3] based on the census data of Chandigarh, projected deaths and injuries as below:

Table 5.1: Loss estimation for Chandigarh

District	Population (Census, 2011)	Number of Injured	% Injured	Deaths	% deaths
Chandigarh	10,54,686	1,02,400	12.0	24,200	2.3

5.2 Project Activities

A separate report entitled "Annexure to Multi-Stakeholder Scenario Building Manual" has been prepared for all the project activities and how the scenario building manual is implemented in each state. The details of project activities for Chandigarh UT carried out under this project are furnished in Chapter 4 of the "Annexure to Multi-Stakeholder Scenario Building Manual".

[3] Loss Estimation Report by IIT Bombay.

5.3 Mega Mock Exercise

A separate report entitled "Observations from Mega Mock Exercise and Lessons Learnt by Participated States" has been prepared to document all the details and learning from Mega Mock Exercise carried out in each state. The details of Mega Mock Exercise for Chandigarh UT are furnished in Chapter 4 of "Observations from Mega Mock Exercise and Lessons Learnt by Participated States" report.

5.4 Sound Practices

5.4.1 Vast Media Campaign

An extensive media campaign was launched from Nov. 2012 to Feb. 2013 to reach out to the masses which was successful in spreading awareness at a large scale. Posters and Hoardings with messages on earthquake preparedness in relation to Mega Mock Exercise, jingles on FM Radio, advertisement in newspapers, etc. were part of the awareness generation Campaign. Shri Yuvraj Singh was the Goodwill Ambassador for this campaign to capture the minds of the citizens of Chandigarh.

5.4.2 Inclusion of Schools in Spreading Awareness

Various awareness generation activities such as quiz, poster making, slogan writing and rallies by school students from about 150 Schools of Chandigarh not only generated awareness among school kids but also at the Community level, as School children played an important role in taking the safety & preparedness messages to their families.

5.4.3 Inclusion of Awareness Generation Activities in Cultural Fests and Events of Chandigarh

Various activities such as screening of animated movie on earthquake preparedness and public lectures in Chandigarh carnival were crucial in conveying the message on earthquake safety and Mega Mock Exercise.

5.4.4 Response of Civil Defense

Department of Civil Defense and Home Guard was one of the most prepared emergency support functionaries & was very much clear about its roles and responsibilities. Team of trained Civil Defense and Home guards played an important role in search and rescue of trapped victims.

5.4.5 Pre-Mock Exercise

Pre-Mock Exercise conducted in Chandigarh at different locations was helpful in identifying the gaps and overcome the same before the Mega Mock Exercise.

5.5 Lessons Learnt

5.5.1 Compatible Communication Setup

Establishment of a compatible communication setup is one of the major lessons learnt after this exercise. Though devices and wireless communication channels were available but a compatible connectivity with Unified Command, EOC and three incident command posts could not be established because of heavy rush on the channels. Administrative Officers faced difficulties in sending and receiving messages from the Mock Exercise Locations because they were not trained enough to handle the communication set up with an entirely different set of language to be used. Hence, Administrative Officers too need training to make efficient use of the wireless Communication setup.

5.5.2 Coordination Mechanism

Coordination Mechanism within the department and among all line departments was not efficient enough to respond for an emergency situation. The flaws were evident during the conduct of mock exercise at 15 locations. There were issues of inadequate ambulances, absence of medical Staff, rescue team not having the rescue tool kit, inadequate relief aid etc at some or the other locations. These issues can be sorted out with more of sensitization activities with Emergency support functionaries to provide efficient response.

5.5.3 State of the art EOC

Establishment of a 24*7 functional and fully equipped Emergency Operation Centre is required in Chandigarh with basic vital equipment required for any type of emergency and just not for a massive disaster.

5.5.4 Hazard and Risk Vulnerability Analysis (HRVA) of Chandigarh City

Though the purpose of selection of Mock Exercise location was to identify the most vulnerable areas of Chandigarh which might face maximum damage due to a massive earthquake, but still there are many areas in the city which are highly vulnerable hazard and need to be identified using HRVA in order to take necessary actions to reduce the vulnerabilities and hence the risk of severe damage. Rapid Visual Screening of Critical Infrastructure would be helpful in identifying critical infrastructure.

5.5.5 Standardization of Standard Operating Procedure (SOPs) of Emergency Support Functionaries (ESFs)

Standardization of SOPs of ESFs needs immediate attention to assign the roles and responsibilities of each ESF to function in a coordinated and organized way to achieve efficient response to any emergency.

5.5.6 Resource Mapping and Resource Inventory

Resource mapping and Resource inventory is essential for effective emergency response. As even the same is being incorporated in the Chandigarh Disaster Management Plan.

5.5.7 Training of Stakeholders

Training on specialized fields of disaster management is required to sensitize the stakeholders to help them understand the risks of a hazard and make better decision during an emergency.

5.5.8 Awareness Generation and Sensitization of Media and Community on Disaster Management with a Multi Hazard Approach

Sensitization of media on disaster management with a multi hazard approach in-order to provide media coverage without creating chaos and panic in the society. Also, a large scale awareness generation at community level is required to lessen the impact of any future disaster.

5.5.9 Disaster management plan

Chandigarh disaster management plan is reviewed and updated every year, and plans to incorporate lessons learnt from the Mega Mock Exercise and detailed standard operating procedures of emergency support functionaries, to respond efficiently during an emergency.

5.6 Future Road Map

5.6.1 Disaster Management Plan

Post-Mega Mock Exercise, review of disaster management plan of Chandigarh is under process to incorporate the gaps identified. Incorporation of Standard Operating Procedures (SOPs) and updated resource inventory is underway. The final document of DM Plan of Chandigarh would be a comprehensive document to guide various departments and agencies of Chandigarh at the time of an emergency by clearly speaking out their roles & responsibilities.

5.6.2 Capacity Building

Capacity building and training of stakeholders (Departments and Agencies) would be more focused on all phases of disasters i.e Mitigation, Preparedness, Response and Recovery to lessen the impact of disasters. Mass awareness generation would cover various levels such as Administration, schools, colleges, community, hospitals and individual level.

6 Recommendations

A project was initiated by the National Disaster Management Authority (NDMA) in partnership with Indian Institute of Technology Bombay and Indian Institute of Technology Madras to develop a multi-state earthquake disaster scenario for a hypothetical earthquake of moment magnitude 8.0 with its epicentre in Himachal Pradesh. The project was undertaken in the states of Punjab, Haryana, Himachal Pradesh and Union Territory of Chandigarh.

The project was the first-ever national initiative to develop an earthquake disaster scenario covering a large area (multi-state, in this case). The project was carried out with cooperation of the participated state governments, several central government agencies and scientific organisations. The execution of the project has brought out several future opportunities for similar projects in the country. The most important recommendations for future scope are given below.

1. A realistic understanding of the earthquake risk and possible consequences of an earthquake in the future was extremely important to secure sustained interest of the various stakeholders. It is therefore felt that, to the extent possible, mock exercises should be based on scientifically developed scenarios of future earthquakes.
2. Earthquake risk scenarios require several important data from central government agencies, state governments and others with assets in the affected region. This information is not readily available with most agencies, and is often of poor quality. Considering the importance of accurate scenarios for credible scenarios, efforts should be made to compile and maintain this information by nodal government agencies as a matter of routine. Most of the information are also useful for other important purposes such as development of growth plans, and will be found beneficial by various agencies.
3. Scenario development and mock exercises are important programs for improving awareness about earthquake disaster risk in a region. However, the state governments also need to undertake long-term risk mitigation programs in order to reduce the likely consequences of an earthquake disaster. States may not have the technical capability or resources to develop risk mitigation plans, and should collaborate with scientific and technical organisations for these programs. The NDMA may also consider providing long-term technical support to the state governments to undertake these programs.