

# Sikkim Earthquake: Perils of Poor Preparedness

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*An earthquake of the magnitude 6.9 on the Richter scale occurred in Sikkim and the neighbouring states of West Bengal, Assam, and Bihar on September 18, 2011. The tremors were felt in five other Indian states, besides affecting neighbouring Nepal, Bhutan, Bangladesh, and China. Although few lives were lost (111 in all) despite the high magnitude of the quake, primarily because its epicentre was in the remote and thinly-populated area of Mangan, significant lessons were learnt in its aftermath. One important lesson related to the difficulty of accessing the disaster-affected area because of numerous landslides, bad weather. The calamity once again highlighted the crucial role of the armed forces in the post-disaster relief operations. The armed forces located within Sikkim played a significant role in rescue and immediate relief. Although affected themselves, they were the first to respond and provided the succour to the victims within the crucial "golden hours", when no other first responders of the state got activated. The authors, who visited the disaster areas and interacted with the community and the officials, undertook a research study of the earthquake and make several recommendations/suggestions in the article, which are likely to help the state in being better prepared for the management of such disasters in future. Some of the suggestions are targeted at the armed forces as well, as they are equally vulnerable to earthquake disasters in Zone V areas.*

## Introduction

At about 6 pm on September 18, 2011, an earthquake of the magnitude of 6.9 on the Richter Scale, struck the state of Sikkim. The epicentre was 68 km north-west of Gangtok, between Mangan (capital of the North Sikkim district) and Chungthang, a tourist destination popular with foreigners due to its scenic beauty. The earthquake was intraplate<sup>1</sup> and the intense tremors lasted around 40 seconds. The affected area falls within Kanchanjunga Conservation Area, near the border of Sikkim with Nepal. The quake also caused loss of life and damage to infrastructure in other Indian states, including Assam, West Bengal, Meghalaya, Bihar, Tripura, Jharkhand, Uttar Pradesh, Rajasthan, Delhi and Chandigarh. It

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also affected neighbouring countries like Nepal, Bhutan, Bangladesh, and China. All the north-eastern states of India have been experiencing tremors of varying magnitudes and intensities at regular intervals over the past two years. Another earthquake of lesser magnitude (4.2) which shook the northern states of India only a few days earlier, had its epicentre near Sonapat, 40 km from Delhi. Was Sonapat a wake-up call, or is the Sikkim earthquake the precursor of a higher magnitude earthquake, which reputed Indian seismic and disaster experts like A.S. Arya, C.V.K. Murthy, Ravi Sinha and others have been predicting for the Himalayan Ranges. Only time will tell. However, the response to the earthquake in a hilly area with prevailing inclement weather conditions and the management or mis-management of the disaster posed a number of challenges and also showed that a number of lessons still need to be learnt. Thus, there is a need for more research to identify the gaps in the preparedness for and response to disasters of a similar kind.

The National Disaster Management Authority (NDMA) issued guidelines for the management of earthquakes in April 2007(4). These guidelines, however, do not specify any parameters or tools/ mechanisms to assess the performance of states/union territories in a disaster. The guidelines identify six pillars on which earthquake management in India should be based<sup>2</sup>:

1. earthquake resistant construction of new structures;
2. selective seismic strengthening and retrofitting of existing priority structures and life line structures;
3. regulations and enforcement;
4. awareness and preparedness about earthquakes;
5. capacity development to include education, training, research & development, capacity building; and
6. documentation and strengthening emergency response.

This research paper traces the sequence of events in Sikkim, analysing them from the perspective of the six pillars of seismic safety and the specified phases of the disaster management cycle: prevention, preparedness, response, rehabilitation, and reconstruction. It critically analyses the level of preparedness and the response to the Sikkim earthquake and recommends measures to improve the protocols and the systems of disaster management prevailing in the country. It

is hoped that the findings and recommendations below will help practitioners and decision-makers in building a resilient disaster response mechanism for the country. The outcomes can be applied to other similar regions as well, with some modifications to suit local conditions.

## **Methodology**

The paper is based both on primary and secondary data. The primary data was acquired during a visit to the earthquake-affected areas in Sikkim and through interaction with the community, in both the urban areas of Gangtok and the rural areas in Mangan. First responders, like the police, fire, and emergency services, National Disaster Response Force (NDRF) teams, the army and paramilitary forces located in Sikkim, especially those close to the epicentre were also approached, as were decision-makers such as the officials at the state and district levels along with the migrant population working on numerous hydro projects in the state. Media personnel who covered the incident were also approached. The authors interacted with seismic experts in Delhi and Gangtok. The team spent seven days in the state in the immediate aftermath of the earthquake. The secondary data was gathered from newspapers, electronic media, and the Internet.

The paper gives details about the location, loss of lives and damage to infrastructure and property, as well as the responses at the community and the central government levels as well as that of the first responders and the armed forces. Thereafter, analyses have been carried out covering all phases of the disaster management cycle and other, related cross-cutting issues.

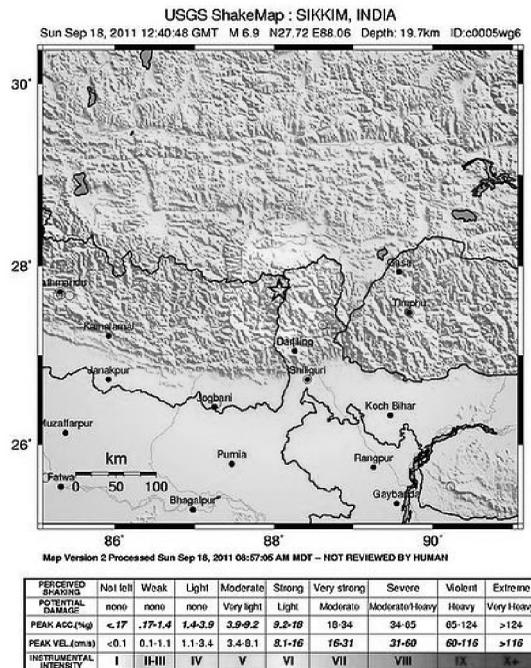
## **Location**

The coordinates of the epicentre of the earthquake were 27.723 degree N and 88.064 degree E, at a depth of 19.7 km. The area is 119 km NNW of Siliguri and 572 km north of Kolkata in West Bengal, and 272 km east of Kathmandu, Nepal. The area is located along a major tectonic boundary: subduction zone purple, ridges red and transform faults green.<sup>3</sup> The maximum intensity was MM VII<sup>3</sup>, with three aftershocks of magnitudes 5.7, 5.1, and 4.6 on the Richter scale, occurring within the first 30 minutes of the main earthquake. In all, there were 20 back-to-back aftershocks on the night of September 18/19. Nepal experienced two immediate after-shocks post the main quake, and experienced a total of 28 tremors of varying magnitude during the night. The continental Indian and Eurasian plates converge beneath the mountainous region of North-east India, near the Nepal border. Although earlier earthquakes in this region were usually interplate in nature, preliminary data indicated that this earthquake was triggered by shallow strike-slip, faulting from an intraplate source within the

over-riding Eurasian plate. Initial analysis also indicated two separate events occurring close together in time at similar focal depths.<sup>4</sup>

Due to its shallow depth, the earthquake caused strong tremors in many areas adjacent to the epicentre (as reported by the community to the team), lasting 40 to 45 seconds. The strongest tremors occurred west of Gangtok and in Siliguri, although similar ground motions registering MM VI on the Mercalli scale occurred in many small towns, such as Mangan, across the elevated region. Light tremors (MM III & IV) were felt as far as Patna and Bihar Sharief. Overall, the earthquake was felt in India, Nepal, Bhutan, Bangladesh and China. Within India, tremors were experienced in Assam, Meghalaya, Tripura, parts of West Bengal, Bihar, Jharkhand, Uttar Pradesh, Rajasthan, Chandigarh and Delhi. In Tibet the earthquake was felt in Shigatse and Lhasa. On September 19, 2011, tremors shook some parts of Maharashtra, mainly Latur, Osmanabad and Sholapur districts at around 0630 hrs (IST). All these districts had also experienced the the 1993 earthquake. The strong tremors near the epicentre and widespread effect were mainly due to the quake's occurring at a shallow depth (See Figure 1) The remoteness of the epicentre coupled with sparse population and infrastructure meant hat fewer lives were lost and damage to infrastructure was minimal.<sup>5</sup>

Figure 1



Source: US Geological Survey.

## Losses and Damages

- a) As per official reports of the Government of Sikkim, a total of 87 people were killed in the earthquake with India accounting for 73 (60 in Sikkim, six in West Bengal, and seven in Bihar), seven in China, six in Nepal, and one person in Bhutan. The infrastructure damage in Sikkim (See Figure 2) was as follows: Houses: 100 per cent—4,125; houses requiring major repairs—17,028; and houses needing minor repairs—21,929 with the total being 43,102. It is estimated that approximately 5–7 per cent of the total number of houses in Sikkim were damaged in varying degrees.<sup>6</sup>

**Figure 2: Infrastructure Damage**



*Source:* Associated Press

- b) Out of a total of 779 schools in the state, 682 school buildings were damaged. In Sikkim, all schools whether primary, middle, high or senior secondary, start from class I, unlike in other states. Children fall in vulnerable group and children in primary classes are more vulnerable to disasters. Hence, in the case of Sikkim, since all schools have primary classes, they all become more vulnerable.
- c) Extensive damage was caused to NH 31 (Siliguri to Gangtok) and NH 31A (Gangtok to Chungthang). Whereas NH 31 was opened after the Border Roads Organisation cleared more than 31 landslides on the afternoon of September 19 2011, NH 31A became fully operational after more than a month.
- d) The barracks, depots, and field fortifications of the army units and the Indo Tibetan Border Police (ITBP) battalion deployed in Sikkim were also damaged.<sup>7</sup>

- e) The power supply was disrupted for little more than three days and water supply for about 13 days.
- f) The initial estimate of infrastructural damage in the state was approximately Rs 10,000 crore (\$22.3 billion), The state sought financial assistance to the tune of Rs 7,061 crore from the centre which ultimately sanctioned Rs 1,340 crore.

### **Immediate Response**

During the main tremors, which lasted between 40 and 45 seconds, most people were in their houses as darkness had set in. According to a number of community members, they did not take “curling” or “duck, cover, and hold” positions owing to shock. Once the main tremors were over, they ran outside their homes/dwellings and experienced the aftershocks along with heavy to moderate rain. Most people spent the intervening night of September 18/19 outside their homes. According to the community, there was no government response on that night. When the concerned government officials were asked as to the reasons for this apathy, they pointed out that they did not have the wherewithal (response force and equipment) to come to the rescue of the people.<sup>8</sup>

The army units and the ITBP battalions located in Sikkim who were themselves affected, were the first to respond on their own, for search and rescue, first aid, and for providing immediate relief. By this time the crucial “golden hour” had long elapsed, when precious lives could have been saved, had the Government of Sikkim responded by requesting help from local uniformed forces stationed in the state, immediately after the main tremors.

The NDMA responded by sending 10 National Disaster Response Force (NDRF) self-contained teams (five from Greater Noida and five from Kolkata) by air to Bagdogra in special planes. An NDRF team consists of 45 men, including a doctor and paramedic, a structural engineer, dogs, and four search and rescue teams, with hand-held disaster management equipment for collapsed structure search and rescue (CSSR) and medical first response (MFR). These teams are administratively self-contained, except for vehicles, which have to be provided by the receiving state, when the team fly in. In this case initially, the army provided them with the vehicles from Bagdogra up to Gangtok. Although these teams reached Bagdogra between 0200 hrs and 0330 hrs on September 19, 2011, they could not proceed further as the lone artery (NH 31) from Siliguri to Gangtok was blocked by more than 30 landslides enroute. The teams were put up in Army Transit Camp in Siliguri and they could start only on the afternoon of September 19, when the road was cleared for one way traffic by the Border Roads Organisation (Project

Vartak). The teams reached Gangtok late in the evening, more than 24 hours after the earthquake had struck the state. Sikkim does not have an airfield; but one is expected to come up soon.

The local community consisting of young men and women who formed volunteer teams and helped in search and rescue, guided the first responders from outside the state, and also helped in the cremation of the dead. They also managed the make-shift relief camps for those community members whose houses had either been destroyed, developed cracks, or had been declared unsafe to live in.

Local and national NGOs like, Sphere, SEEDs, AIDMI, ADRA India, the Indian Red Cross Society, and international agencies like the International Red Cross and Red Crescent Society also came forward (See Figure 3). They set up an Inter-Agency Group under the Sphere umbrella and in coordination with the East District of Sikkim, distributed relief stores like dry food items, blankets, tents, utensils, and drinking water in the affected villages and towns. They also made a rapid assessment of the funds needed for rehabilitation, for livelihood restoration, and reconstruction.<sup>9</sup>

The state government has been accused of according priority to the evacuation of foreign tourists stranded in the Chungthang, Lachen, and Lachung areas of North Sikkim district and neglecting the poor people living in local villages like Mangan and Bay, and other villages in Jhangu valley of North Sikkim district.

With regard to the short- and medium-term response and recovery, respectively, some issues which are peculiar to Sikkim are highlighted below.

- a) Sikkim receives strong financial support from the central government. In the immediate aftermath of the disaster, the Prime Minister initially announced a relief package of Rs 1,000 crore for the state. A team from the centre visited the state two to three times before making its assessment to the High Level Committee (HLC). The centre finally allocated Rs 1,340 crore, against the demand of Rs 7,061 crore made by the state government.
- b) The Sikkim government had initiated various rural development plans in villages prior to the earthquake. We have to wait and see whether these could withstand the effect of further earthquakes. At present, preliminary reports from a survey being conducted indicate that most of the structures constructed under these projects were able to withstand the tremors, except those that were in the North District, near the epicentre.

- c) The Sikkim government had announced at the beginning of the 2011-12 fiscal that there would be no *kutch* houses in the state by 2012. Plans for each village panchayat had been drawn and construction had started in some locations focusing on the below poverty line (BPL) segment. This means that government funds are available for the construction and renovation of damaged houses. However, more allocations would be required to fulfil the parameters specified by the Building Code for a Seismic Zone V area.
- d) The specific challenge facing Sikkim is that most development funds are designated for “subjects”, i.e., those living in Sikkim before 1972. All others are ‘non subjects’ and do not get housing benefits or pensions even if they have been staying there for some time. The government will have to find a way to also benefit the so called “non subjects” because the earthquake did not distinguish between “subjects” and ‘non subjects,’ when it struck.
- e) Due to the strong visibility created by media, the NGO response has been mostly diverted towards Sikkim, despite the robust government response which has led to oversupply and duplication. This has led to the neglect of some areas, such as Darjeeling, Jalpaiguri, etc., that were equally affected. The media has not given enough coverage to these areas.

### **Analysis of the Disaster: Prevention and Mitigation**

*Parameters, Tools & Mechanisms for Assessing the Performance of the State in a Disaster:* There are no specific parameters, tools or mechanisms for assessing the performance of a state during a disaster. The NDMA must lay down guidelines to assess the response, for improving the capacity of states to face disasters.

*Failure of the State to follow NDMA Guidelines on Management of Earthquakes:* As per Paragraph 7.7.1 (Chapter 7) and Paragraph 8.11.1 (Chapter 8) of the *NDMA Guidelines on Management of Earthquakes*, issued in April 2007, the states were required to take follow-up action on earthquake safety as per time schedule given in Tables 9 & 10 of the *Guidelines*, for strengthening capacity development and response, respectively. The Sikkim government failed to follow the *Guidelines*, leading to poor preparedness and shaky response.

*Indecisiveness:* The Sikkim Government failed to respond quickly with state resources and central resources within the state, because the decision makers could not understand the enormity of the disaster, which led to indecisiveness and delay in the requisitioning of state and central resources in time. The bureaucratic formalities delayed the planning and spending of financial resources sanctioned

by the centre. Nearly five months since the earthquake, the state government has yet to plan and spend the Rs 1,340 crore allocated by the centre.

*Single Artery to State Capital:* There is only one national highway connecting Gangtok to Siliguri, which was blocked at more than 30 places. The responders could not reach the disaster site even by helicopter due to inclement weather conditions. There is a need to have alternate route to link Gangtok with the plains of North Bengal.

*Provision of Airfield:* Sikkim does not have an airfield. The nearest airport connecting the state by air is at Bagdogra in West Bengal. Although there are plans to construct one in the state, there is a need to expedite the matter. This is significant not only for the management of disasters in the area in future but also to ensure closer connectivity of the state with the rest of the country.

*Disaster Management Plans at State, District, Block, and Village/Mohalla Levels:* Disaster management plans need to be formulated at all the levels of administration, so that all perceived disasters, which Sikkim and the region is vulnerable to, can be mitigated and managed. In fact contingency and disaster management plans should be readied for all inhabited buildings, like offices, cineplexes, malls, residential complexes, shopping areas, etc.

*Community Awareness:* Although the response from the community after the main shocks was quick and positive, which saved many lives, they did not know how to react during the quake. They did not take the standard response steps like “duck, cover, and hold”. There is a need to spread general awareness among the community through information education communication material, village panchayats, through screening short films, dramas, seminars, etc. The community should formulate disaster management plans at the local level and create disaster management teams, which can respond quickly. The local youngsters used modern social networks like Facebook, and Twitter to form the September 18 Group, for seeking donations for relief.

*Structural Audit:* Gangtok, besides being the capital of the State is also its most populated city with maximum infrastructure. Most of the buildings withstood the quake on that fateful night, except the main secretariat, police headquarters, and school buildings. The state government should get an audit of all its buildings carried out to check for structural faults and get them rectified, even if it means reconstructing of some of the buildings. The state should also amend the Building Bye Laws to make all new constructions disaster-resistant.

*School Safety:* Out of the 779 schools in the State, 682 school buildings collapsed/damaged, which means that 80 per cent of the school buildings were affected. All school buildings in the state must be disaster resistant, which has been mandated by the Supreme Court of India in its judgement of April 2009, on a PIL filed after the Kumbkonam School Fire Tragedy of 2004. The NDMA has undertaken a pilot project for school safety, involving two districts in 22 States/UTs, falling in seismic zone IV and V for earthquakes. Each district is to shortlist 200 schools for capacity development on disaster management. Two districts of Sikkim, involving 400 schools have been shortlisted for building the capacity of schools, under the School Safety Programme of the NDMA. This will help in making schools safe.

*Coordination between Non-government Agencies:* A number of NGOs undertook relief, rehabilitation and reconstruction work by forming an Inter Agency Group. Normally, the functioning of NGOs is coordinated at state level to ensure that all the affected areas are adequately covered, which should have been done in Sikkim also for uniform relief. The Inter Agency Group should be chaired by a government functionary of senior rank: at the district level, it could be the DC/ADC and at the state level, a secretary/joint secretary level officer to coordinate the efforts of NGOs and volunteer outfits.

*Response from State:* There was a glaring gap in the state response on the night when the earthquake struck. The state had initiated a move to create a State Disaster Response Force, but the file was kept pending. This earthquake expedited its disposal and it was sanctioned within 15 days of the earthquake striking the state. All states—especially those in the hills or with difficult terrain—must have an adequate local response force and relief material within the state. As happened in Sikkim, a disaster like an earthquake would lead to a blockage of the main arteries (roads), which would prevent or delay the central response teams/material from reaching the disaster site. The weather could also play foul, as happened in this case, preventing the use of helicopters for bringing in the response teams as also relief material and for transporting those with serious injuries.

*Response of NDRF:* Although the state did not ask for the NDRF, the centre, in view of the enormity of the disaster, despatched 10 teams of the NDRF immediately by air and by road. They, however, got stuck at Bagdogra/Siliguri, as NH 31 was closed due to landslides. Inclement weather also inhibited their movement by helicopters, as there were no all-weather helicopters available. The NDMA needs to have dedicated helicopters or the Indian Air Force must ensure availability of all-weather helicopters in times of disasters. The NDRF contingent of 10 teams was commanded by an officer from the battalion in Noida, which had provided some teams. The NDRF battalion commander at Kolkata under whose area of responsibility Sikkim falls, and who sent five teams from his battalion,

was initially left twiddling his thumbs at his battalion headquarters. This was a major tactical blunder by HQ Director General (NDRF), as the commanding officer from the Noida battalion had not operated in the area earlier and was not conversant with the difficulties likely to be encountered by teams. The teams did not have dedicated vehicles and were left at the mercy of the army and the state government, which delayed their arrival in the most affected areas of North Sikkim district. One significant issue that needs to be addressed is that the NDRF teams must have their own dedicated vehicles or provision to hire them locally. Once the NDRF teams reached the earthquake-hit areas in Mangan, they did a commendable job of rescuing people from under the debris and providing first aid to the victims, with the hand-held equipment and tools. Their efforts were appreciated by the locals and the state government alike.

*Response of the Armed Forces:* The army and ITBP troops are located in the area which was affected by the earthquake and so were themselves affected; however, despite this and facing inclement weather conditions, they were quick to respond. They saved many lives and provided food and temporary shelters to the victims. Army doctors helped in first aid and provided emergency medicines. The Indian Air Force, made available the much needed helicopters, which brought in the first responders and relief, and evacuated the injured for treatment at military and civil hospitals. The major lesson learnt by the uniformed forces operating in Zone V vulnerable areas from this experience is to ensure that the all infrastructure in the area, be it the field fortifications/living barracks/ammunition/supply/ordnance depots or field ambulances/hospitals or bridges, etc., must be earthquake resistant. Existing structures must be evaluated by the structural engineers, and the buildings/structures found weak must be retrofitted. The army formations/units earmarked for disaster management and for aiding civil authorities should first of all make disaster management plans in conjunction with the state and concerned districts. They should also be authorised hand held equipment, like rotary saws, inflatable lighting towers, rubberised jacks, cutters, expanders and drillers, as are available with the NDRF teams. This will help them to respond in a professional manner.

*Fatalities:* Most of the deaths occurred among people from outside the state, mainly the supervisory staff and labour force working on the numerous hydel projects in the state. People working in states in sensitive seismic zones must be given basic training for what to do in times of disasters, for example, earthquakes, on their arrival. They must be made aware of the dos and don'ts necessary before, during, and after an earthquake. Temporary dwellings must be constructed at safe and comparatively open spaces. That few lives that were lost in Sikkim in spite of the magnitude of the earthquake, can be attributed more to luck and sparse population, rather than sound preparedness on the part of community and the first responders.

## **Analysis of the Disaster: Rehabilitation and Reconstruction**

The rescue and immediate relief phases are already long over and the rehabilitation and reconstruction phases which should have started simultaneously have already been unacceptably delayed and even temporary shelters have not been built up. It is the local community's in-built social bonding that has enabled the victims to stay with the lucky survivors whose houses did not crumble which has prevented a crisis at the state level. The state government must take an immediate call for approving the designs of school buildings and dwellings, in keeping with the parameters necessary for Zone V. As almost 15 per cent of the schools and dwellings require 100 per cent rebuilding while most other structures would require minor to major repairs, for which trained masons would be necessary. If trained masons are not available, special training for master trainers must be organised, in Sikkim itself. These master trainers would then train the local masons and grade them as per their capability. The rehabilitation of affected people should be entrusted to NGOs and reconstruction and repair work could be worked out on a public private partnership model. The aim should be take the Sikkim earthquake disaster as an opportunity to rebuild better.

## **Analysis of the Disaster: Cross-cutting Issues**

*Role of Media:* It was amply clear that the media projected Sikkim as the sole area devastated by the earthquake. The centre and the NGOs similarly gave priority to Sikkim, although certain areas in the adjoining Siliguri district of West Bengal were equally badly affected. Hardly any NGO was seen operating in that district. The media must play its role without any prejudice and cover all the affected areas in a neutral and constructive manner. Media is presently also not highlighting the general awareness and mitigation programmes, initiated by the government and NGOs. These have rarely been highlighted by the media. The role of media in preparedness and mitigation is as important as the response.

*Business Continuity in Industrial Sector:* As Sikkim falls in seismic Zone V for earthquakes, it should be mandatory for industries in the state, to have "on-site" and "off-site" disaster management plans for not only most accident hazard industries but even for the medium and small scale industries for business continuity. (The most accident hazard industries are those industries which are producing or handling more than 10 million tonnes of hazardous materials. The Ministry of Environment and Forests has laid down certain rules for these industries, which are mandatory and must be followed for safety.)

## **Conclusion**

The Sikkim earthquake has highlighted a number of inadequacies. Sikkim has many times been cut-off due to the Darjeeling agitation, and the Supreme Court has had to intervene to direct the governments of West Bengal and Sikkim to keep the lone highway clear at all times. During the earthquake, the community responded well but were not trained in dealing with the situation. The response of the state government initially was one of helplessness and indecision due to non-availability of trained response force and equipment. The army and paramilitary force which were in situ helped in rescue and immediate relief. They have to now look inward to see if they are well-equipped to manage disasters, and if their infrastructure is safe enough to sustain the seismic shocks in Zone IV and V areas. The NDRF response in Sikkim was quick but it was delayed due to landslides and bad weather. They have to ensure that appropriate transport is available to enable them to reach the disaster site(s) at the earliest. In Sikkim, the response of the central government was quick and overwhelming: 10 NDRF teams reaching within six hours of the quake, and the armed forces and paramilitary forces responded within three to four hours. (All these forces being central forces would amount to overwhelming response.) The response of the state government was slow and the poor preparedness was evident.

The state now faces the challenging task of not only rehabilitating the affected people and providing shelters, but to make this an opportunity to build better infrastructure and make Sikkim disaster resilient. This can be done by taking appropriate measures to ensure prevention, mitigation, and preparedness. All others, be it the central government, the NGOs, and other organisations should give the required support to make it possible. It is hoped that this paper will aid in the process of training and capacity development in both the state and in the country.



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### Notes:

1. About 95 per cent of all earthquakes in the world occur along the boundaries of the tectonic plates and are called "interplate earthquakes". An example of such a quake is the 1897 Assam earthquake. The remaining quakes occur within the plate itself, away from the plate boundaries, and are called intraplate earthquakes. The 2011 Sikkim earthquake and the 1993 Latur earthquake fall within this category.
2. National Disaster Management Authority, "Guidelines on Management of Earthquakes", Government of India, New Delhi, April 2007.
3. MM denotes the Modified Mercalli Scale, which is used to measure the "effects" of an earthquake. The Richter Scale is a measurement of the "intensity" of an earthquake. MM VII denotes, "Damage like fine cracks in buildings of good design and reinforced concrete constructions; moderate damage in well built ordinary structures; considerable in poorly built or badly designed structures, some chimneys broken; also noticed by persons driving motor cars."

In stray cases, landslips of roadways on steep slopes; cracks on roads and seams of pipelines." See Brig. (Dr.) B.K. Khanna and Nina Khanna, *Disasters: Strengthening Community Mitigation & Preparedness*, New India Publishing Agency, New Delhi, 2010, p. 63.

4. Magnitude 6.9 Sikkim Earthquake, India: Tectonic Summary, US Geological Survey, September 18, 2011. See also Preliminary Earthquake Report, 6.9 Indo-Nepal Region Earthquake, National Earthquake Information Center, World Data Center for Seismology, Denver, September 18, 2011.
5. Prakash Adhikaar, "Quake Hits Vast Himalaya Region Killing 63", September 19, 2011, *Agency France Presse*. See also "Eight killed, 100 Injured as Strong Quake Jolts Sikkim–Nepal Border Region", *Economic Times*, September 18, 2011.
6. See [www.sikkim.gov.in/asp/Misc/Sikkim\\_govtgazettes/GAZ/GAZ2010/659%20-20700.pdf](http://www.sikkim.gov.in/asp/Misc/Sikkim_govtgazettes/GAZ/GAZ2010/659%20-20700.pdf).
7. "Sikkim Quake: ITBP Building Collapse, Pegog Area Badly Hit", *Economic Times*, September 18, 2011.
8. Most inputs from primary sources were procured during visit of team to Gangtok and Mangan, in Sikkim after the earthquake and interaction with state government officials, community, and NGOs engaged in recovery work in Sikkim.
9. See "Corporate Disaster Resource Network Sphere India", September 22, 2011. See also [Cdrn.org.in/,,,/Himalayan-Sikkim-Earthquake- Situation Report](http://Cdrn.org.in/,,,/Himalayan-Sikkim-Earthquake- Situation Report).