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# Impacts of the 2015 Gorkha Earthquake: Lessons Learnt from Nepal

*Shiva Subedi and Meen Bahadur Poudyal Chhetri*

## Abstract

Nepal is highly vulnerable to a number of disasters for example: earthquakes, floods, landslides, fires, epidemics, avalanches, windstorms, hailstorms, lightning, glacier lake outburst floods, droughts and dangerous weather events. Among these disasters—earthquake is the most- scary and damaging. The effects of a disaster, whether natural or human induced, are often long lasting. The Gorkha earthquake of 25 April 2015 enormously affected human, socio-economic and other multiple sectors and left deep scars mainly in the economy, livelihood and infrastructure of the country. Besides the natural factors, the damages from disasters in Nepal are in increasing trend due to the human activities and inadequate proactive legislations. Fundamentally, the weak structures have been found as the major cause of damage in earthquakes. This underlines the need for strict compliance of building codes. Thus, proactive disaster management legislation focusing on disaster preparedness is necessary. This paper analyses and shows the critical gaps and responsible factors that would contribute towards seismic risk reduction to enable various stakeholders to enhance seismic safety in Nepal. Additionally, this chapter aims to pinpoint the deficiencies in disaster management system in Nepal with reference to the devastating Gorkha earthquake and suggest appropriate policy and advanced technical measures for improvement.

**Keywords:** earthquake, proactive, impact, management, legislation

## 1. Introduction

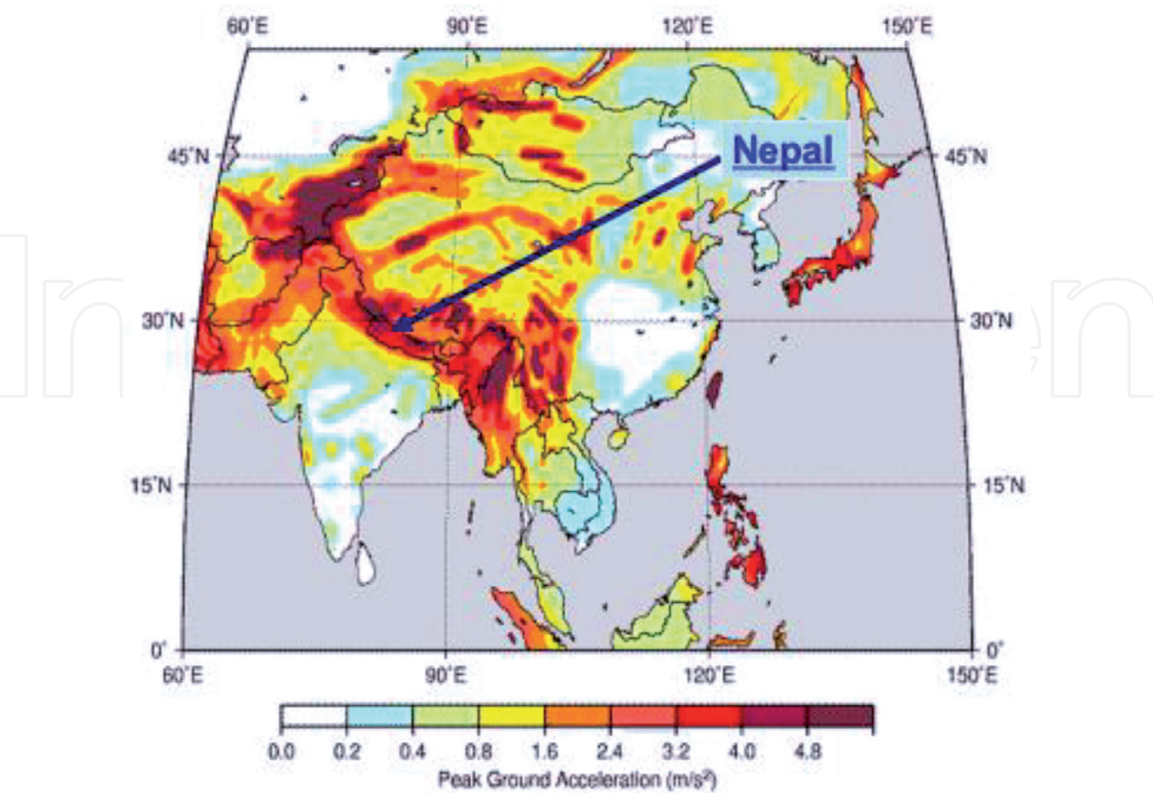
Nepal is facing the fury of natural and human induced disasters with greater frequency and intensity. Disasters are so pervasive in every Nepalese geographic and societal framework that the people are mostly in the verge of known and unknown disasters. The earthquake of 1934, 1980, 1988, 2015 and the flood of July 1993, 2008, 1913, 2014 and 2017 AD are the most destructive disasters which not only caused heavy losses to human lives and physical properties but also adversely affected the development process of the country. The lessons of the earthquakes of 1988 and 2015 and the floods and landslides of 1993, 2008, 2013, 2014 and 2017 have cautioned the concerned authorities and agencies for a coordinated disaster preparedness and response mechanism. Climate change, on the other hand, has become 'extreme.' Nepal is ranked as the fourth most climate vulnerable country in the world in the climate change vulnerability index [1]. Fire is another disaster which occurs on a regular basis and wild fires are damaging to already severely exhausted forests and biodiversity of Nepal which results on economic loss, land degradation and

environmental pollution. The government data show that since the year 2000, annually, an average of 329 people lost their lives due to various disasters and property loss of more than 1 billion rupees. Hence, Nepal is considered as the ‘hot spot’ of disasters.

It is evident that earthquakes do not kill people; rather the weak structures kill the people. Hence, if we stay in a well-constructed earthquake resistant building and the surroundings, we can live safely even in an earthquake prone area. Hence, people living in an earthquake prone country like Nepal must consider of this simple but basic fact. Many countries of the developed world, like Japan, Canada, and USA also have faced several large earthquakes in the past but, when we compare the number of casualties and property losses between the developed and developing countries, the damage is many times higher in the latter. This difference is mainly due to the levels of preparedness between them. In general, disaster preparedness is still not in the priority list of the developing countries like Nepal; as a result, they pay relatively higher price in terms of loss of lives and infrastructures.

## 2. Historical trend of earthquakes in Nepal

Nepal was placed at the eleven-top earthquake vulnerable countries in the world, paralleled as sitting on a time-bomb. Kathmandu, the capital city, is considered as one of the most vulnerable city in the world; and is being put on a red alert. No earthquake had hit the city for over eight decades and was thus considered overdue for an earthquake to occur. Records show that since 1255 AD Nepal experienced 19 earthquakes with significantly large impacts. The last two big earthquakes that hit Nepal were that of 1833 (7.7 Magnitude, killed 414 people) and 1934 (8.3 Magnitude, killed 8519 people). The other earthquakes that occurred



**Figure 1.** Location of Nepal and showing the seismically active zones along the Himalaya and the surrounding region [2]. Source: [https://www.researchgate.net/figure/The-seismic-hazard-map-of-Asia-depicting-peak-ground-acceleration-PGA-given-in-units\\_fig2\\_236145995](https://www.researchgate.net/figure/The-seismic-hazard-map-of-Asia-depicting-peak-ground-acceleration-PGA-given-in-units_fig2_236145995) uploaded by Dina Francesca D’Ayala.

in 1980 in Far Western Nepal (6.5 Magnitude, killed 103 people), and in 1988 in Eastern Nepal (6.5 Magnitude, killed 721 people) were comparatively much smaller in magnitude [2, 3].

The most recent one, we Nepalese people experienced is the 2015 Gorkha-Nepal earthquake which has left a trail of miseries that the affected people will continue to combat for years.

Nepal is a small mountainous country in the South Asia, which lies at the center of the 2500 km long Himalayan range. The entire Himalayan terrain and its surroundings is a highly active seismic zone on earth (**Figure 1**). Nepal's proximity to earthquake hazard is mainly due to her young and fragile geology. Haphazard and unplanned settlements and poor construction practices are the other factors that have made her highly vulnerable to earthquakes. Earthquake is the biggest threat to Nepal as it has encountered 19 major earthquakes since the twelfth century.

### 3. Gorkha earthquake 2015

The devastating Gorkha Earthquake measuring to 7.8 ml having the epicenter occurred near Barpak village of Gorkha district which is 181 km northwest of Kathmandu on 25 April 2015. It was the worst quake to hit the country after the 1934 mega earthquake (8.3 ml). On 12 May 2015, a 6.8 ml strong aftershock caused further damage and sufferings. These earthquakes took the lives of 8970 people where 198 people are missing, and 22,303 people were seriously injured. The earthquakes destroyed 604,930 houses completely and 288,856 houses were partially damaged. It is estimated that the total value of the damages caused by the earthquakes is NPR 706 billion or equivalent to US\$ 7 billion [4]. Around 800,000 people displaced by the earthquake in Nepal were struggled to survive in a context of persistent, a severe lack of safe and adequate housing [5].

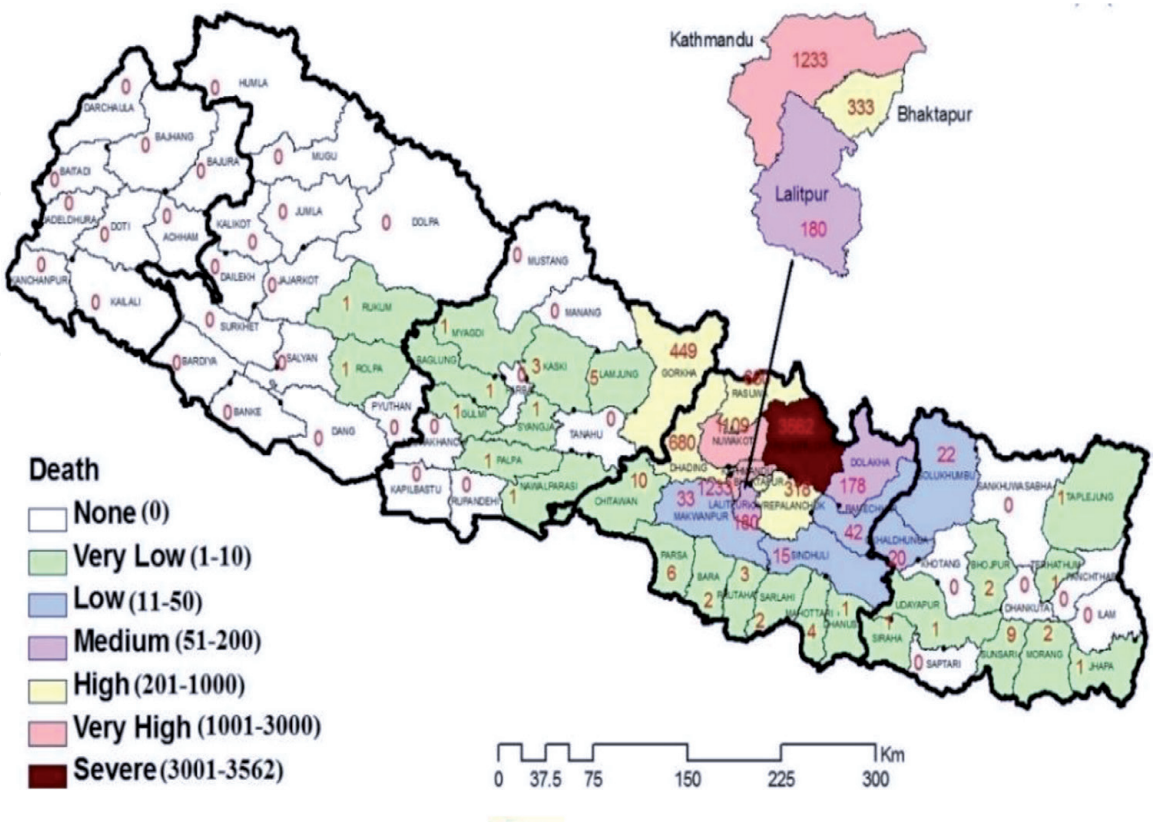


Figure 2.  
Human deaths by Gorkha-Nepal earthquake.



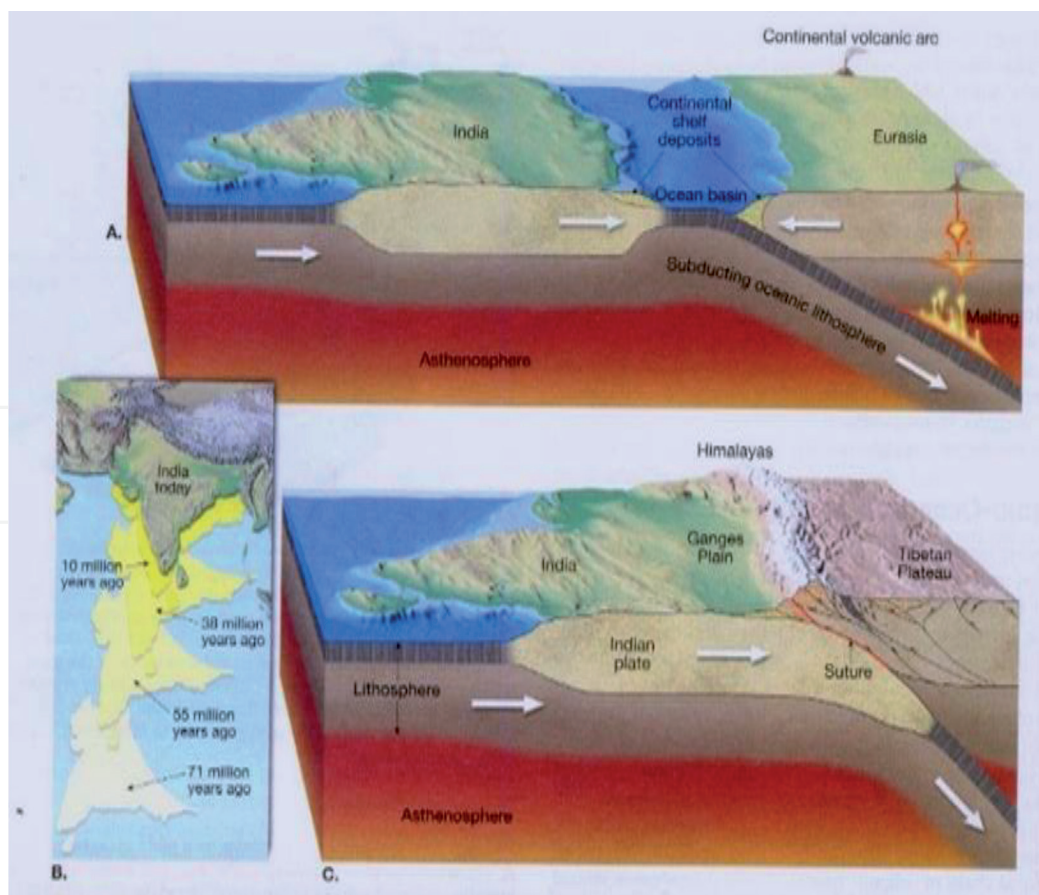
Mostly, old, non-engineered, adobe and masonry buildings collapsed and/or were severely damaged by the earthquake. In addition, some engineered buildings also damaged or collapsed due to poor workmanship and quality of construction materials. The earthquake severely affected 14 districts (Gorkha, Dhading, Rasuwa, Nuwakot, Kathmandu, Lalitpur, Bhaktapur, Kavrepalanchowk, Sindhupalchowk, Dolakha, Sindhuli, Makawanpur, Ramechhap and Okhaldhunga) and another 31 districts affected to varying extents. In this way, this devastating earthquake has affected vast parts of Nepal and left deep scars in the economy and infrastructure of the country.

The 25 April earthquake was followed by a number of aftershocks throughout Nepal, with one shock reaching a magnitude of 6.7 on 26 April at 12:54 am local time. The 25 April earthquake affected the entire Nepal and also affected some parts of India, Bangladesh and the Tibet Autonomous Region of China. Tremors were also felt in Bhutan and Pakistan. All these major earthquakes proved the fact that the casualties were mainly due to the failure of infrastructures.

On 26 April 2015, the Government of Nepal declared the 14 districts as disastrous area and called for international humanitarian assistance (**Figure 2**) [2].

### 3.1 Some scientific facts behind the Himalayan earthquakes

The Himalayan Mountain was formed by the crash between the Indian plate, and the Eurasian plate consisting of nearly the entire continents of Europe and Asia. Once the vast sea-floor of Tethys that lay between the Indian and Asian



**Figure 3.** Collision of Indian plate and Eurasian plate. (a) Before the collision: Subducting Indian plate (left) under Asian plate (right). The gradually closing Tethys sea lies between the two plates. (b) Rise of the Himalaya and Tibet after the collision of the two plates. Indian plate still continues to subduct under Tibet. (c) Progressive northward movement of the Indian plate from near South Pole to the present location [6].

continents, was subducted and consumed underneath Eurasia some 50 million years ago, the northern edge of Indian sub-continent reached the southern shore of Eurasia to collide.

Nowadays, the Indian crust has reached far to the north beneath Eurasia that caused the uplift of the region, and ultimately created the Himalaya (i.e., “For example, see “in **Figure 3**” the north beneath Eurasia (Tibet)”). Gradually, the powerful push of the Indian continental crust forced itself to break into slices at a depth and created a lower and upper-blocks. The breaking plane separating these two blocks of the Indian crust is called the Main Himalayan Thrust (MHT). This gently northward sloping fault in the Indian crust reaches beneath the Tibetan Plateau which is shown in **Figure 4**.

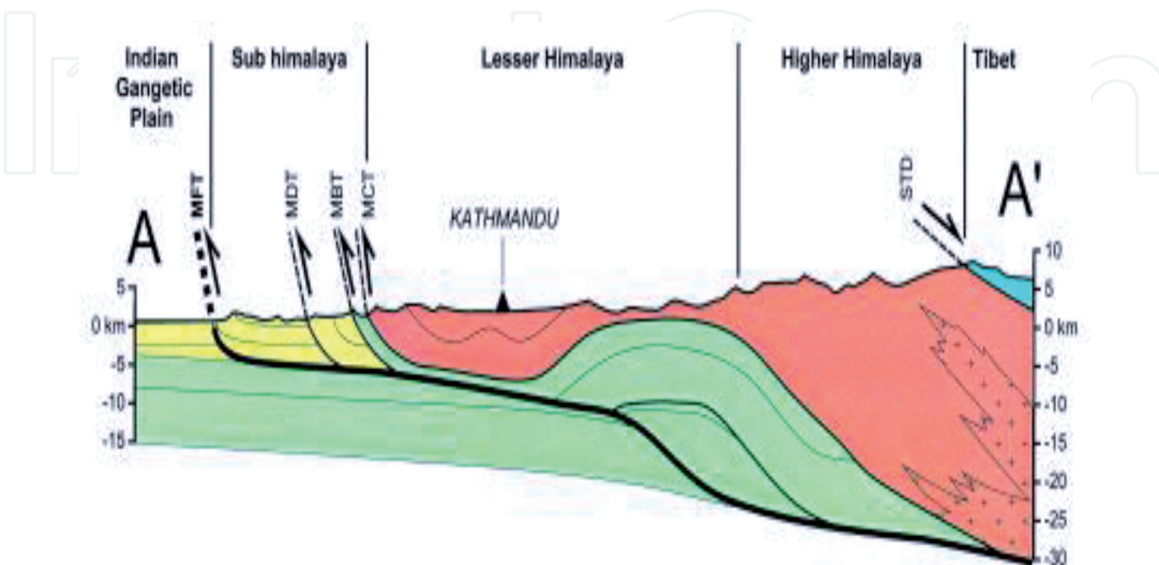
Now, India continues to move towards north at a speed of about 5 cm/year, and this movement constantly creates a stress build up within the Himalayan region. As a result, it causes to store enormous amount of energy within it. “For example-the breaking of the Indian crust into the lower and the upper blocks along the Main Himalayan Thrust (MHT). During an earthquake the block below the MHT will slip to the north beneath Tibet and the upper block moves to the south. The MHT emerges at the Main Frontal Thrust (MFT) [3].”

**Figures 3 and 4** and the text related thereof have been extracted from the article of Professor Dr. Bishal Nath Upreti which has been cited below in Ref. [3].

On 12 May 2015 at 12:50 local time another strong aftershock measuring 7.3 Magnitudes struck with the epicenter in Sunkhani of Dolkha district. The epicenter was just 76 km northeast from the Kathmandu. This area was already affected by the jolt of 25 April’s earthquake. The initial quake was followed by several aftershocks. This quake toppled already weakened buildings, triggered a series of landslides, which further hindered relief efforts. This quake alone killed more than 100 people [2].

The movement of tectonic plates that triggered massive earthquake in the country on 25 April caused the altitude of Kathmandu Valley to increase by 80 cm. In total 438 numbers of aftershocks with local magnitude  $\geq 4$  have been recorded till 6 March 2016 [7].

As shown in **Table 1**, it is estimated that the total loss by the Gorkha earthquake is NPR 706 billion (US\$ 7 billion) [2, 4].



**Figure 4.**  
The breaking of the Indian crust into the lower and the upper blocks along the Main Himalayan Thrust (MHT). During an earthquake the block below the MHT will slip to the north beneath Tibet and the upper block moves to the south. The MHT emerges at the Main Frontal Thrust (MFT) [8].

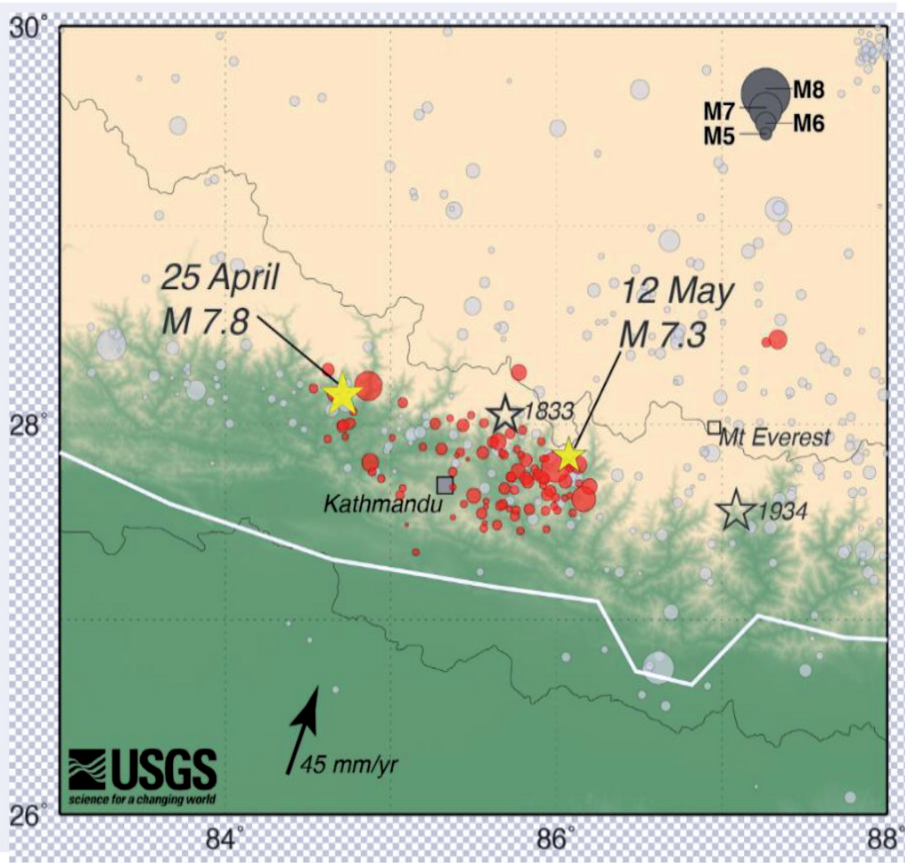
Particulars	Number/amount
Persons dead	8970
Missing	198
Injured	22,302
Affected families	8,86,456
Displaced families	6,49,815
Houses damaged (fully)	6,04,930
Houses damaged (partially)	2,88,856
Total material loss (in US \$)	7 billion

**Table 1.**  
*Losses due to the Gorkha-Nepal earthquake [2].*

3.2 Causes and consequences of Gorkha earthquake

The 2015 Gorkha Nepal earthquake took place in between the boundary of Indian tectonic plate and the Eurasian plate. The two plates stuck together by friction building up energy that only a major earthquake could release. Increasing population, unplanned settlements, poor construction practices, untrained human resource, lack of search and rescue equipment and medical services are the other major reasons of the devastating earthquakes.

Some scientists believe that the Gorkha earthquake did not release all the stress that had built up underground and some of this stress has shifted west to an area stretching



**Figure 5.**  
*Map depicting more than 100 aftershocks that have occurred since the magnitude 7.8 earthquake in Nepal on April 25, 2015. To date, the largest aftershock is a magnitude 7.3 on May 12. The 1833 and 1934 stars represent the most recent large historical earthquakes on this portion of the plate boundary. Source: <https://www.usgs.gov/news/magnitude-78-earthquake-nepal-aftershocks>.*



from the west of Pokhara in Nepal to the north of Delhi in India. The research is published in the journals Nature Geoscience and Science. Its authors say more monitoring is now needed in this area. Therefore, there is already long overdue of a major earthquake. The last mega earthquake happened in 1505 which is estimated to have exceeded M8.5. The scholars say the new stress that has moved as there could already be accumulating to the tension that has been building up over five centuries [7, 9].

**Figure 5** reflected above clearly indicates the scale of the 25 April 2015 Gorkha-Nepal Earthquake and the major aftershocks of 12 May 2015. Tremors which scattered in various area (has been highlighted in red color) what felt or noticed by many people inside and outside the buildings. These effects corresponded to an intensity with a high magnitude.

#### **4. Problems related to the Gorkha-Nepal earthquake**

Although the Nepalese security forces, volunteers and others worked hard- days and nights, the response work was as not well organized and prompt. A key criticism was of a slow and inadequate relief effort, which failed to reach in due time to many of the affected people of remote, rural and hilly areas. It was basically because of the lack of road network, transport resources, and adverse weather condition. Major delays were also caused by bureaucratic procedures and even bitter mutual accusations - both in public and private—over who was to blame and who should be in control of funds and resources. Thousands of people in the affected districts were lacking basic needs. Rainy season and cold-winter and morbidity caused the earthquake victims daily life much more difficult.

On the other hand, the earthquake victims repeatedly complained that the rice distributed in some districts by the food distributing organizations (World Food Program (WFP) through Nepal Red Cross Society (NRCS) was “substandard and inedible” as highlighted by the media from time to time, which also caused in deteriorating health status of the earthquake victims in the vulnerable settlements and; led to increase more morbidity [2]. There were high number of injured people or caseload recorded during the first day, so the orthopedic service and treatment was the most urgent for majority of patients after earthquake. However, the proportion of reported death at hospitals was relatively low [10].

In addition, there was a painful moment of family isolation, and collective cremation as most of the family members could not follow the ritual practice in that emergency which is so vital in human life from cultural and religious point of view.

##### **4.1 International cooperation and disputes**

For any government, it would be difficult to cope alone with such a huge disaster. In such a situation, international assistance is important for response and recovery works. So, on 26 April 2015, the Government of Nepal declared an emergency in the worst affected districts and called for international humanitarian assistance. However, it is more difficult in Nepal due to some of its inaccessible landscape and difficult terrain. Unfortunately, it risks adding a human induced calamity to a devastating natural disaster. During the mission of search and rescue efforts, an American helicopter crashed near the Nepal-China border resulting in the sad demise of five American soldiers, two Nepali soldiers and five disaster victims.

In course of the response phase, the relationship between Nepal government and the international community was not encouraging. There was the problem of mutual trust and allegation between the two sides. The international communities



did not fully trust the government; questioning its ability to deliver services while the government wasn't happy because the donor communities wanted to distribute relief assistance through their agents whereas Nepalese government sought any assistance to be collected into the Prime Minister Relief Aid Fund and then distribute to the affected areas. Actually, the government wanted to adopt one door policy. However, the relationship between the Nepal Government and International Community did improve as time elapsed.

#### **4.2 Foreign aid commitments**

There was a donor community meeting on 25 June 2015 in Kathmandu, Nepal. The highest-profile international donor conference ever held in the country amassed more than 300 delegates from 56 nations, development partners and the donor community. In a major boost to Nepal's reconstruction and recovery efforts, development partners and the donor community have pledged \$4.4 billion in aid during the International Conference. This has come as a huge relief to the reconstruction and recovery bid and brought cheers to the government. However, till now, except a small portion, the committed amount has not been provided by the international community to the Government of Nepal [2].

#### **4.3 Formation of reconstruction authority**

A high-level National Reconstruction Authority (NRA) has been formed under the chairmanship of Prime Minister (PM), including four ministers picked by PM, a chief executive officer, Vice-chairperson of the National Planning Commission, Chief Secretary and three experts having 15 years of experience in related field. The roles and responsibilities of the NRA are to find out the total loss from the Gorkha earthquake; acquire necessary land following legal procedures; order concerned authority to remove physical structures after providing compensation to the owners; coordinate with different bodies for effective implementation of reconstruction work; order owners to remove their damaged structures or to remove them at their own cost; and direct the concerned agencies to accomplish necessary work of recovery providing them with necessary budget.

### **5. In post-earthquake recovery and reconstruction progress**

Within exactly 2 hours, the Central Natural Disaster Relief (CNDRC) Committee headed by the Acting Prime Minister met and declared a state of emergency and commenced the Search and Rescue (SAR) and relief operations. During a disaster, obviously, the priority was to save lives and providing medical support to the injured. In this respect, the government of Nepal did well. However, when it came to the relief works, it was caught in a midst of heavy criticism; and which was not without reason. Lack of proper management of relief goods, weak distribution mechanism, alleged corruption in procurement of tarpaulin sheets, tents for shelter and food etc. added up to the chaos in relief work. Even the capital city where the Command and Control Centre was functioning, and all relief supplies landed at the nearby airport, people did suffer due to inadequate management of relief work. The performance outside the capital was even poorer [3]. The chaos continued for weeks and months. Even 3 months after the earthquake when rainy season had already begun, majority of the people lacked shelter. It is also important to note that the following five phases were adopted right after the Gorkha earthquake:

- I. Search and rescue (as mentioned in above paragraph).
- II. Humanitarian relief work (immediate treatment, water, sanitation, shelter, food and protection).
- III. Early recovery part (rehabilitation of schools, regaining access to health service, restarting and restarting business as usual).
- IV. Recovery and reconstruction (restructuring homes, buildings, infrastructure development etc.).
- V. Long-term socio-economic development process (restoring income, improving livelihood and so on).

The recovery efforts are still underway in post-disaster setting. All identified recovery and reconstruction activities were expected to be completed on time, but it is being slow. The livelihood recovery strategy is being followed as a two-pronged approach—a livelihood restoration package and employment creation. Similarly, owner driven reconstruction, integrated habitat approach, relocation of village, urban reconstruction to improve cultural settlement, cash transfer, community outreach, social inclusion and capacity build-up are main aspects. The NRA coordinating for interacting with the NGOs and civil society organizations and implement specific measures in partnership with these agencies were important policy approaches adopted during the rehabilitation and recovery phase [11]. Despite the claimed of lots of tasks achieved, many studies pointed out that satisfactory results have not been achieved as expected with NRA and much remain to be done.

In a big disaster, when the initial phase of SAR and immediate relief operations are over, rehabilitation and reconstruction phase begins seriously. For a successful implementation of this phase, a national government must show a firm commitment, careful planning and adequate resource mobilization. Rehabilitation and reconstruction is a long-term process, require a huge investment and it may last for years to complete. A low-income country like Nepal also needs to ensure financial resources not only from its internal resource but also through grants from international bi-lateral and multilateral agencies.

### **5.1 Recovery from 2015 Gorkha earthquake: still long way to go**

Several efforts have heightened in post-earthquake scenario since 2015, by the government with support from international and national partners. Three years after the catastrophic earthquake left a pain for the society, and an equal number of injured, this traumatized nation appears to be in a bit recovery mode now; a 45% of the quake-damaged houses have been rebuilt, and another 32% of houses are under construction [11] as of December 2018. The NRA has signed the government's private housing grant agreement with 742,135 beneficiaries, out of which 337,319 have completed rebuilding their houses while 233,343 houses are currently under construction. Seventy seven percent of the earthquake-damaged houses are already rebuilt or being rebuilt, and people have taken ownership of this reconstruction campaign. 4172 out of the 7553 earthquake-damaged schools have been rebuilt, and another 2498 schools are under construction.

The post-earthquake reconstruction could not gain momentum immediately due to institutional constraints and the lack of adequate resources. At the beginning, the absence of elected representatives of people at local levels and the lack of clear policies and procedures also slackened the speed of reconstruction.

Many people were exposed to risks due to poor shelter, poor hygiene, and trauma. Moreover, people did not receive recovery support immediately, and had to spend monsoon season without a house. Since political commitment has always been weak in Nepal, leaders often focused on party politics and direct their effort to change the government [12]. Consequently, weak government and leadership have direct effect in the reconstruction and recovery efforts.

As Nepal was moving towards a new administrative set up and election process at that time, leaders could not give enough attention to reconstruction and recovery efforts. Some weaknesses found in planning, coordination and management which need to be improved in the future [13]. The process of reconstruction of health facilities became a bit slow than expectation.

The slow progress of post-earthquake reconstruction is in part the outcomes of resonant socio-political scuffles in the Nepali society identified mainly by following reasons. Firstly, political dysfunction has worsened in the post-earthquake time, and secondly, the lack of trust between the State and NGOs has led to many possible reconstruction projects being turned down.

In the international context of emergency and system resilience, Professor Deborah MC Farland from Emory University, said, “the trust is one of the most important prerequisites for resilient health/system in any emergency or disaster. In her presentation, she evidently linked this example with Ebola outbreak of 2015. A community where engagement and ownership are the keys to building the resilient system which is important to strengthen at the time of system breakdown” [14]. Congruently, we observed some gaps on mutual trust among government, community and stakeholders in terms of system recovery process herein Nepal during the phases of post-earthquake.

In other words, post-disaster governance has played a crucial role in the reconstruction performance [15]. However, the slow reconstruction pace has been met with substantial criticism both inside and outside Nepal, and many organizations, including donors, have urged the Nepali government to accelerate the reconstruction and the delivery of grants.

The dearth of progress strongly contrasts with the promises what made at the time of donors’ conference held in June 2015, in Kathmandu. During this conclave, donor countries pledged nearly about 4.1 billion USD for the long-term recovery of Nepal after having made serious discussion on cross-sectoral part, a level of commitment that surprised many, and covers just under half of the 9.18 billion USD the Nepali government now expects will be required to rebuild the country. In return, the Nepali government promised to establish a national reconstruction authority that centrally governs all the reconstruction efforts; and to safeguard all the activities they carry out expeditiously and impartially. Certainly, the government was able to quickly map the needs and damage immediately aftermath of the earthquake and communicate those needs to intercontinental contributors mainly for fund, which was promising. This makes it even more unsatisfactory that the rebuilding progress has been slow, despite the availability of wide resources [16].

As a matter of fact, there are several factors responsible for the slow recovery such as—the dominance of government control, weak governance, lengthy bureaucratic process, lack of long-term commitment among NGOs and wait-and-see attitudes of the affected people—all these things weaken the community’s capacity and ability to rebound. In a resource-poor community, public involvement from inhabitants, NGOs and private sectors are crucial for post-disaster recovery cycle. An encouraging framework to govern NGOs that should have developed by the Nepal government so that they could have mobilized others to help the residents to rebuild their communities. Poor coordination among major reconstruction actors also influenced the promptness of work in terms of recovery work.



In such a way, the slow pace of progress has been blamed on a number of factors from the political willingness, to the lack of legal or administrative, resource and technical stuffs. Likewise, structural problems remain the same and we are too late in accomplishing the task in due time.

## **6. Strengths, gaps and challenges**

There were psychosocial consequences of that devastating earthquake disaster. The nightmare and traumatic situation caused by the disaster upon many people particularly among the children and adolescents are still going on and may remain further. The below mentioned gaps and challenges were identified after the earthquake:

- Nepalese people showed resilient capacity and self-recovery from the earthquake.
- Search and Rescue (SAR) works carried out by the security personnel of Nepal and others was commendable although it was slow and inadequate while they failed to reach in due time in the remote, rural and hilly areas. It was also compounded by the lack of equipment, road network, transport, and well-trained human resources.
- Damage and need assessment was delayed.
- Gap between the need of the affected people and delivery of services was predominant all the time.
- Open spaces for temporary settlement of the displaced population were also lacking.
- Although there were 4521 foreign team members from 34 countries, they were able to save only 16 lives. So the performance of the international SAR team is not encouraging.
- Emergency warehouses, prepositioning of relief materials with proper inventory were also lacking.
- Debris management was found as one of the big problem basically because of the lack of debris management equipment, tools and techniques.
- Accurate and proper communication between District Emergency Center (DEOC) and Central Emergency Operation Centre (CEOC) was not effective.
- A weak database and an absence of modern technology were other bottlenecks for effective response during Gorkha earthquake.
- Cumbersome administrative process between the government, donor agencies, contract agencies and beneficiaries were one of the problems to set-up the pre-fab buildings which delayed in restoring the schools and health facilities.
- Lack of local technical persons/technicians for fixing up pre-fabricated building/s.

## **7. Lessons learnt from the Gorkha earthquake**

- Lack of awareness, preparedness as well as coordination among disaster management stakeholders was evident.
- Weak law enforcement and monitoring of building codes and town planning and lack of training for professionals in earthquake resistant construction practices have been found as the major factors of infrastructure damage; lack of adequate preparedness and response capacity among various stakeholders.
- The biggest lesson is that to be safe from earthquake is to build earthquake resistant infrastructures. There should be no COMPROMISE in building compliance.
- Arrangement of appropriate and essential equipment/s based on the nature of disaster can assist for the quick search and rescue works.
- Modern technology and strategic communication/risk mapping/satellite mapping/earth observation are also important tools and techniques in reducing the disaster risks; and in life-saving.

All most all casualties were due to the collapsed infrastructures. This emphasizes the need for strict compliance of town planning bye-laws and building codes in Nepal.

## **8. The takeaway message**

Nepal should adopt long-term and sustainable efforts to mitigate the hazards occurring following the major disasters, for instance, the devastating Gorkha earthquake. Even though disaster management and risk reduction may be considered expensive in view of the competing demands for resources in a developing country like Nepal, this is high time for the government to invest into preparing for and responding to expected and unexpected disasters before the human and economic consequences of inaction are extensive, and unmanageable. This book chapter suggests some basic principles and guidelines to reduce the impact of the potential future earthquake disaster not only in Nepal but also for other earthquake prone countries as well. Following are the basic and fundamentals for earthquake management in Nepal and beyond:

- Construction of earthquake resistant infrastructures.
- Licensing system for engineers and masons.
- Selective seismic strengthening and retrofitting of existing structures and life-line structures – a priority list for structural safety audit, seismic strengthening and retrofitting is required.
- Effective implementation of Building Code and other legislations.
- Mass awareness and preparedness.

- Capacity development through education, training, research & development (R&D).
- Data collection, documentation and information sharing.
- Effective and efficient response during and after emergency.
- Build Back Better (BBB).
- Strengthening a society with social, capital and community resilience would be the safe and sustainable approach against disasters.
- Effective disaster governance is highly necessary not only during response phase but also important to capacitate the institutional efficiency in all phases (preparedness, response recovery and reconstruction) through technical and institutional strength.
- Public and private partnership for DRR ensures the risk management and developmental activities in the affected communities via small-micro-entrepreneurship (i.e., trained local people can support to other community's reconstruction process).
- To provide psycho-social support for the traumatized persons, disabled, and body part amputated people is very important. As it is long term and directly associated with the family, and his or her individual livelihood, it is needed to pre-plan from the respective government in post-disaster context from the humanitarian point of view.

The above basics are necessary to reduce the impact of earthquakes in the short-term, medium-term and long-term. They recognize the enormous challenge in improving seismic safety because of the inadequate numbers of trained and qualified civil engineers, structural engineers, architects and masons proficient in earthquake-resistant design and construction of structures [2].

Despite some efforts made from Government, local people, INGOs, NGO in reducing risk reduction, disaster specific needs, priorities and plans have not been well addressed from disaster management perspective.

## 9. Conclusions

The Nepalese and their neighbors and friends all over the globe, have to reconcile themselves to the fact that tens of kilometers beneath where they live, the Indian and Eurasian plates will continue to tussle. Hence, they must build on the fundamental strengths they possess—social capital and community resilience. In mega disasters, a nation can be socially and economically affected not just for days or months, but for years. Effective implementation of Building Codes to make earthquake resistant buildings and other infrastructures is highly desirable. Educating the people to Build Back Better (BBB) must be the motto of the government. Henceforth, the government should call on experts inside and outside the country to engage in interdisciplinary collaboration for BBB. Non-governmental organizations, the private sector, experts, intellectuals, media and international community can contribute in the rebuilding and disaster-preparation efforts by working together.



## **Conflict of interest**

The authors declare that they have no competing interests.

## **Limitation**

This chapter may not cover earthquake impact associated all the cross-cutting sectors what readers can expect.

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## References

- [1] Government of Nepal, Ministry of Home Affairs. Presented: National position paper on disaster risk reduction and management Nepal. (018). 03-06 July 2018. Ulaanbaatar, Mongolia; 2018. p. 1
- [2] Chhetri Meen BP. Socio-economic impacts and lessons learned from the Gorkha, Nepal Earthquake 2015. Nepal Centre for Disaster Management. Presented Paper at the IDMC 22-24 October. Gumushane, Turkey; 2018
- [3] Upreti BN. Causes, Consequences and Future Earthquake Disaster in Nepal-insights from the 2015 Gorkha Earthquake. Zambia: Department of Geology; School of Mines, University of Zambia; 2015
- [4] Government of Nepal, National Planning Commission (NPC). Nepal Earthquake 2015-Post Disaster Needs Assessment; key findings. Kathmandu. p. 98. Vol. A. Available from: <https://www.nepalhousingreconstruction.org/sites/nuh/files/2017-03/PDNA%20Volume%20A%20Final.pdf>
- [5] Amnesty International Nepal. Earthquake Recovery Must Safeguard Human Rights. London; 2015. pp. 1-21. Available from: [https://www.amnestyusa.org/wp-content/uploads/2017/04/p4583\\_report\\_-\\_nepal\\_report\\_on\\_earthquake\\_web.pdf\\_-\\_adobe\\_acrobat\\_pro.pdf](https://www.amnestyusa.org/wp-content/uploads/2017/04/p4583_report_-_nepal_report_on_earthquake_web.pdf_-_adobe_acrobat_pro.pdf)
- [6] Tarbuck EJ, Lutgens FK, Tasa DG. Earth: An Introduction to Physical Geology. 12th ed. Pearson; 2016. p. 816
- [7] Government of Nepal, Ministry of Home Affairs; and DPNET-Nepal; Nepal disaster report 2015, DPNET-Nepal, Kalimati, Kathmandu. 2015. Available from: <http://www.drrportal.gov.np/uploads/document/329.pdf>
- [8] Pandey MR, Tandukar RP, Avouac JP, Vergne J, Heritier Th. Journal of Asian Earth Sciences. 1999;17:703-712
- [9] Government of Nepal—Affairs Ministry of Home (MoHA) and Disaster Preparedness Network-Nepal (DPNet Nepal) – Nepal Disaster Report 2015. Nepal disaster risk reduction portal [Internet]. Available from: <http://drrportal.gov.np/risk-profile-of-Nepal>
- [10] Samita G, Risnes K, Rogne T, Shrestha SK, Nygaard OP, Koju R, et al. Impact of 2015 earthquakes on a local hospital in Nepal: A prospective hospital-based study. PLoS One. 2018;13:e0192076. DOI: 10.1371/journal.pone.0192076
- [11] Government of Nepal. National Reconstruction Authority. Singha Durbar, Kathmandu: Newsletter; 2019. Available from: <http://nra.gov.np/en/>
- [12] Bhujel R, Efforts made by government in post-earthquake reconstruction and recovery 2015. Research Gate. Lalitpur; 2017. DOI: 10.13140/RG.2.2.25158.27204. Available from: <https://www.researchgate.net/publication/317716970>
- [13] Subedi S, Sharma GN, Dahal S, Banjara MR, Pandey BD. The Health Sector Response to the 2015 Earthquake in Nepal. Report from the Field, Disaster Medicine and Public Health Preparedness. Vol. 12. Iss. 4. One Liberty Plaza, New York, USA: Cambridge University Press; 2018. Available from: <https://www.cambridge.org/core/journals/disaster-medicine-and-public-health-preparedness/article/health-sector-response-to-the-2015-earthquake-in-nepal/F0421ED348BDC571AD67721AFAFB158B>
- [14] Mc Farland Deborah A. Ebola Virus Disease an Evolving Epidemic.

Building Resilient Health System.  
Emory University, Atlanta, USA. Video  
Available from: <https://www.coursera.org/lecture/ebola-virus/building-resilient-health-systems-rQ5kx>

[15] Lam ML, Khananna V, Kuipers R.  
Disaster governance and challenges  
in a rural Nepali community: notes  
from future village NGO. Himalaya the  
Journal of Association for Nepal and  
Himalayan Studies. 2017;**37**(2):11

[16] Kumar N. Why Nepal is Still in  
Rubble a Year After a Devastating  
Quake. Time. 2016. Available from:  
<http://time.com/4305225/nepal-earthquake-anniversary-disaster/>  
[Accessed: 9 August 2016]