



IDENTIFIED GAPS BETWEEN PREPAREDNESS AND RESPONSE AS REVEALED DURING 2015 GORKHA EARTHQUAKE

G. K. Jimée⁽¹⁾, K. Meguro⁽²⁾, A. M. Dixit⁽³⁾

⁽¹⁾ *PhD Candidate, Institute of Industrial Science, the University of Tokyo and Director, National Society for Earthquake Technology-Nepal (NSET), gjimee@nset.org.np*

⁽²⁾ *Professor and Director, International Center for Urban Safety Engineering, Institute of Industrial Science, the University of Tokyo, meguro@iis.u-tokyo.ac.jp*

⁽³⁾ *General Secretary, NSET and Chairperson, Asian Disaster Reduction and Response Network (ADRRN), adixit@nset.org.np*

Abstract

Due to its location in seismically active zone, sitting at the collision boundary of two huge active tectonic plates, earthquakes are repetitive in Nepal. The history of documented big earthquakes in Nepal dates back to the 1223. Since then, the 1255 earthquake, 1934 Bihar-Nepal Earthquake, 1980 Bajhang Earthquake, 1988 Udayapur Earthquake and 2011 Sikkim-Nepal Earthquake brought major devastation to the country with huge loss of lives and property. The 7.8 Mw Gorkha Earthquake occurred on 25th April 2015, which claimed about 9,000 deaths, damaged about 1 million buildings and estimated US\$ 7 billions total loss. In recent decades, there has been significant efforts on Disaster Risk Reduction and Management (DRRM) in terms of policy and guidelines, institutional arrangements and developing the capacity for disaster response. The National Emergency Operation Centre (NEOC) and National Disaster Response Framework (NDRF) were contributory for mobilizing the resources and coordination among the stakeholders in the aftermath of Gorkha Earthquake. About 140,000 national responders led by security forces, more than 4,500 international search and rescuers (SAR) from 34 countries, and a huge number of community responders got involved in SAR operation. This paper is an effort to analyze the gaps between the preparedness initiatives taken before and the emergency response activities performed in the aftermath of 2015 Gorkha Earthquake. The research is based on the review of documents, interactions with survivors and stakeholders at different levels. The identified gaps and challenges and drawn recommendations will definitely help Nepal and other countries with similar context to develop strategic preparedness plans for reducing loss of lives and property from such big unpredictable disasters.

Keywords: Gorkha Earthquake; identified gaps; preparedness; response

1. Introduction

Within a small area, Nepal exposes different physiographic features with distinct topographic, climatic and vegetational characteristics [1]. Such diverse features and altitude variation from 60 meters above the mean sea level to the top of the world within a short distance of about 200 km the country has put as a disaster hotspot [2] and one of the most multi-hazard prone countries in the world [3]. The historical analysis of disaster events for the last 46 years (1971-2016) presents occurrence of 2 events per day causing 3 deaths every day [4]. Further, sitting astride boundary of two huge and active tectonic plates, Nepal is also exposed as one of the highest seismic prone countries in the world. The vulnerable structures, unplanned urbanization and infrastructure development, exposure of people and property, high acceptability to risk due to lack of awareness, preparedness and capacity to cope with disasters, has significantly increased the risk of earthquake in Nepal [3], [4]. Realizing this fact, a report by the Ministry of Home Affairs (MOHA) of Nepal presents that earthquakes are part of natural process, but the weak structures, lack of proper plan and policies with poor implementation in the field are responsible factors for loss of lives and property, which has been reflected in Gorkha Earthquake [5].



Several efforts have been made for Disaster Risk Reduction and Management (DRRM) in Nepal. Till the Gorkha Earthquake, the Natural Calamity Relief Act (NCRA) 1982 was in action, which was more centralized and focused to manage rescue and relief activities after disasters. Recently it has been replaced by Disaster Risk Reduction and Management Act (DRRMA) 2018, with more decentralized and adopting proactive approach. During past couple of decades, several Government and Non-government agencies in Nepal have put significant efforts for preparedness and disaster response, mainly in the field of Search and Rescue (SAR), improving institutional arrangements and policy and plan development.

Beside these efforts, the 2015 Gorkha Earthquake caused significant number of casualties, damaged buildings and infrastructures and loss of property. This study focuses on the response activities conducted in the immediate aftermath of the Gorkha Earthquake such as, coordination among the stakeholders, damage assessment, SAR, medical response, emergency shelter and safety/ security. Due to lack of leadership in the local level, there was problem of coordination between and among the local authorities, District and central Government, which significantly affected in the swift decision making and operation on the ground. A limited number of qualified national SAR and medical teams with limited equipment and lack of management of local resources were the major problems for having an effective SAR and medical response. Lack of understanding of the situation and contextual imagination of potential consequences and required actions among the people was the major problem for post -earthquake safety and further increased risks. Weak mechanism of information collection, analysis and dissemination caused the ineffectiveness and delay in response activities. Maximum number of evacuees tend to use small open spaces nearby their damaged property for shelter due to attachment with the property, society and livelihood, therefore, very few large open spaces pre-identified by the Government were used as IDP camps.

To address the identified gaps, this study has come up with a list of recommendations mainly for developing and improving plans, which further aims in contributing to enhance capacity, improving coordination mechanism, developing/improving information management system and engaging community volunteers for DRRM activities.

2. Methodology

This study is mainly based on the review of documents and interactions with different levels of stakeholders. The situation reports prepared by major actors, after-action reports prepared by emergency responders, and policies, plans and guidelines implemented before Gorkha Earthquake, were reviewed and interactions were conducted through focus group discussions (FGD), interviews with subject matter experts and stakeholders' workshops (Fig. 1).

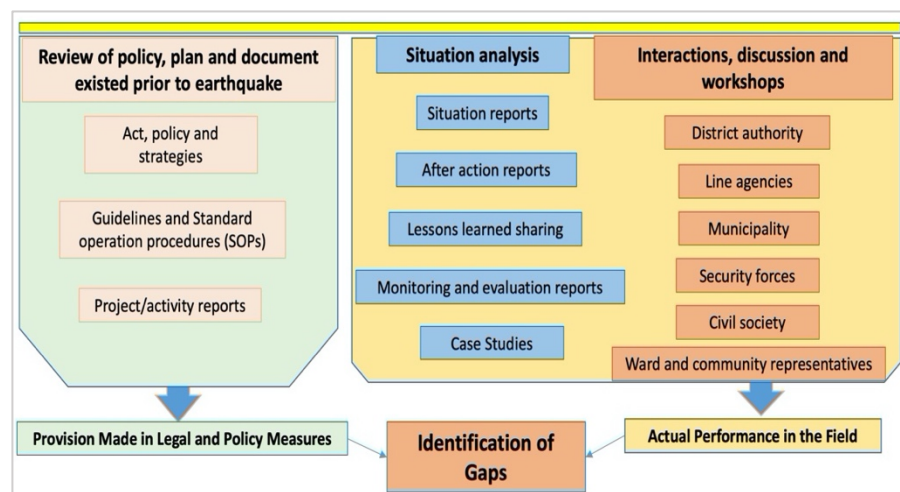


Fig. 1: Methodology adopted for identifying gaps

3. History of earthquakes in Nepal

Though the detail documentation is not available, the historical record of earthquakes in Nepal goes back to 1223 AD [6]. After 1223 earthquake, a destructive earthquake occurred in 1255 killing almost one-third the



population of Kathmandu Valley including the King Abhay Malla [7]. The country, specially, Kathmandu Valley, has been badly affected by earthquakes in every century [8]. The Bihar-Nepal Earthquake is the largest recorded earthquake with detail information, occurred on 15 January 1934 at 2:24 pm NPT, affecting Nepal and India, however caused more than 8,000 deaths and devastated about 90,000 buildings in Nepal, and about 4,300 deaths and more than 70 percent building collapsed in Kathmandu Valley [9]. Since then there have been several destructive earthquakes in Nepal, namely, the 1980 Bajhang Earthquake affected 19 Districts of western Nepal [5], the 1988 Udayapur Earthquake killing 717 people and damaged more than 65,000 buildings in eastern Nepal [10] and 2011 Sikkim-Nepal Earthquake caused 9 deaths and 13,000 buildings damaged [11].

4. Earthquake risk management initiatives prior to Gorkha Earthquake

Several initiatives have been taken for earthquake risk reduction and management by various stakeholders in Nepal, however, it is quite new while comparing with other several countries in terms of systematic and organized initiatives [12]. Besides these efforts, when 7.8 magnitude earthquake hit the country, it suffered with about 9,000 deaths, more than 22,000 injuries, about a million buildings destruction and huge loss of property. The initiatives taken before Gorkha Earthquake are discussed in consecutive sections.

4.1 Policy and institutional arrangements

Having reviewed the past disasters and progression of policies in Nepal, most of the DRRM policies have been triggered by devastating disasters and/or came into action to supplement the main or preceding policies. A review of DRRM policy progression is described in Fig. 2.

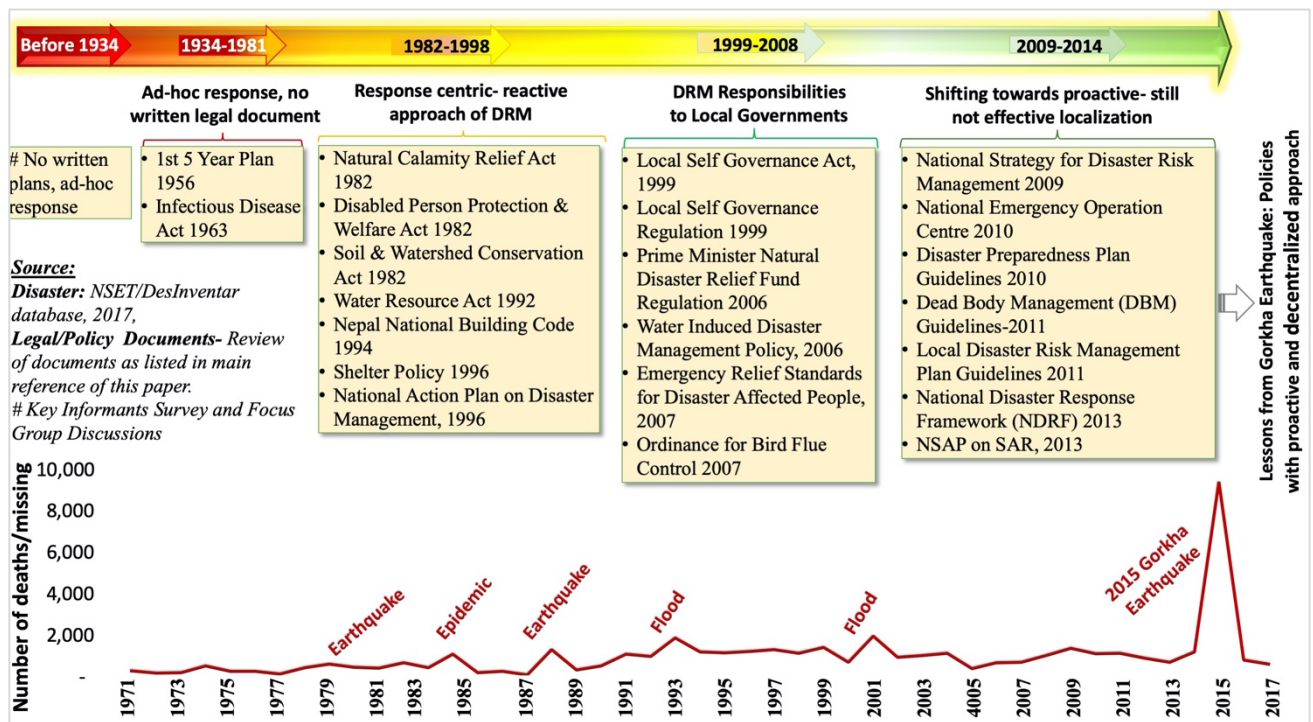


Fig. 2: Progression of DRRM policies in respect to disaster events (before 2015 Gorkha Earthquake)

Prior to 1982 Natural Calamity Relief Act (NCRA), relief and recovery activities were mainly carried out either as the power base or in ad-hoc basis and/or as social and religious work [13]. It was also reflected in 1934 Bihar-Nepal Earthquake, the Government declared many ad-hoc rules and decisions to manage the situation and mobilize the resources for response and relief [9]. Mutual assistance among the people and self-help were spontaneous, and they were the main support mechanisms to overcome the situation. There were no



written, structured and dedicated disaster management policies in Nepal before 1980s [14]. The 1982 NCRA, though it has not been explicitly expressed in written documents, was triggered by the 1980 Bajhang Earthquake [15]. After NCRA, several policies and guidelines came into action, which were mainly pushed by 1988 Udayapur Earthquake and 1993 South-central Nepal Floods [13], for instance, Nepal National Building Code (NBC), shelter policy, National Action Plan for Disaster Management (NAPDM), etc. A huge loss of lives and property due to series of devastating flood and landslides during 1992 and 1993 demanded an effective implementation of existing policies at local levels. In this regard, the Local Self Governance Act (LSGA) 1999 was the major and essential initiative taken during 1990s, which initiated the decentralization of responsibility and authority of DRRM to local Governments. Further, having suffered from several disasters, the Government realized the need to be more proactive and step up efforts on DRRM in Nepal. Thus, Nepal actively engaged in international commitments through participation in several forums, which helped to prepare and improve national policies and provisions. Based on the guidelines of Hyogo Framework for Actions (HFA) 2005-2015, the National Strategy for Disaster Risk Management (NSDRM) 2009 was prepared under the leadership of MOHA involving all Ministries and stakeholders [16]. NSDRM helped strengthening institutional mechanism and developing capacity for resilient communities in Nepal. It emphasised on the collective efforts of all national and local stakeholders for DRR through mitigation and preparedness initiatives integrating DRR in development activities. Thus, it is one of the major steps towards transforming the global practice, shifting from reactive to proactive approach for DRRM.

4.2 Earthquake risk assessment

Kathmandu Valley Earthquake Risk Management Project (KVERMP) 1997-1998, was the beginning for concrete study on earthquake risk management (ERM) in Nepal [12]. It was successful to bring all stakeholders together, including Government authorities, academia, political leaders and communities to work for ERM and establishing community-based approach for understanding and communicating scientific findings in simple way. The School Earthquake Safety Program (SESP), implemented by National Society for Earthquake Technology-Nepal (NSET) under KVERMP, comprehensively contributed for ERM in Nepal through trainings on earthquake resistant construction technology, developing ERM plans, prepositioning emergency supplies, fixing non-structural vulnerabilities and providing general awareness and lifesaving skills through school communities. Japan International Cooperation Agency (JICA) conducted a detail study of Kathmandu Valley in 2002 and came out with detail loss estimation in terms of human casualties and damage in building and infrastructures [17]. NSET in collaboration with WHO and Ministry of Health, carried out structural assessment of major hospitals in Kathmandu Valley and non-structural assessments of Nepal during 2003 and 2004 [18]. The Nepal Earthquake Risk Management (NERMP) was implemented by NSET to enhance the ERM capacity of stakeholders, including Government authorities in two phases during 2005-2015 [11]. The Government identified and assessed 83 open spaces within Kathmandu Valley to be used as evacuation sites for internally displaced people should there be a big earthquake [19]. Several efforts from the Government, academic researchers, civil societies, have been made for ERM in Nepal, however, most of them are based in cities and implemented as short term project or activity.

4.3 Awareness, preparedness and emergency response capacity development initiatives

Awareness is the key for ERM, an aware and informed public is the most important asset for effective preparedness [20] that plays the key role for capacity enhancement. In this context, earthquake awareness, preparedness and capacity development initiatives have been increasingly implemented in Nepal during the last couple of decades. The formal mass awareness activities were initiated since the first Earthquake Safety Day (ESD) approved and observed by the Government in 1999 [21]. Since then every year on 2 Magh (15 or 16 January), Nepal observes ESD nationwide in commemoration of 1934 Bihar-Nepal Earthquake. Several organizations, including Government authorities, I/NGOs, CBOs have put efforts for awareness and preparedness activities, however, there is no systematic record or inventory to access such activities. Hence, this research has considered activities mainly implemented by NSET, one of the organizations working for more than two decades for ERM in Nepal. NSET reports that more than 21,000 families were made aware as



of 2011 and the demand was increasing. The awareness and preparedness programs of NSET generally include the information on earthquake basics, risk reduction measures, ways of being safe during and after earthquake shaking, understanding the environment, pre-positioning emergency supplies, preparing response plans in different context, etc. [22]. However, program activities may vary with the target audience. The capacity building/enhancement activities for earthquake response has been more institutionalized and systematized in recent decade. The emergency response capacity building activities, in a structured way, were initiated through the implementation of Program for Enhancement of Emergency Response (PEER) in 1998 [11]. PEER has been continued by NSET till date for developing instructors and professional responders trained on search and rescue from collapsed structures, pre-hospital treatment, basic lifesaving, water rescue and hospital preparedness. Basically these courses have been provided for the responders from security forces and emergency response organizations [23]. Armed Police Force (APF) had established a separate Disaster Management (DM) section and a dedicated training center for developing emergency responders prior to Gorkha Earthquake. However, after earthquake other two security forces, Nepali Army and Nepal Police have also established Disaster management division/sections. The DM sections of all forces have regular program to produce responders and have deployed in different locations. Similarly, the non-government organizations (NGO) and community-based organizations (CBO), namely, Nepal Red Cross Society (NRCS), NSET and others have put significant efforts for developing emergency response capacity for community responders/volunteers prior to earthquake.

5. The 2015 Gorkha Earthquake

The biggest one since 1934 Nepal-Bihar earthquake, the Gorkha Earthquake hit Nepal at 11:56 am local time on 25th April 2015 with 7.8 M_w and the main shaking lasted for 56 seconds [24]. The epicenter was in Barpak of Gorkha District, about 80 km northwest of capital city Kathmandu with focal depth of about 10-15 km [25]. As of March 2016, over 672 aftershocks were recorded including 4 shakings of 6.0 M_w or greater [24]. Out of those, the M_w 7.3 aftershock occurred after 17 days of main shaking, was the biggest shaking. The aftershocks were spread over 120 km east in 40 km width from the epicenter [5].

5.1 Impact of Gorkha Earthquake

The earthquake caused highest impact in 14 Districts of the country and flattened the villages of 30 Districts. Assessments presented that 489,852 private houses were destroyed and 256,697 were partially damaged. Similarly, 2,656 Government buildings were destroyed and 3,622 were partially damaged [26]. The earthquake and aftershocks resulted about 9,000 deaths, more than 22,000 injuries. The shaking time and day both were in favor for taking safety percussions as it was mid-day of Saturday (official holiday in Nepal). The number of casualties could have been much higher, if the shaking had occurred at night and/or during office/school days. Observing the number of school buildings collapsed, specially, the time and day of shaking allowed students to avoid many death and injuries. About 7,000 schools had severe or were significantly damaged [27] with estimated loss of about US\$ 285 millions [28]. Similarly, about 450 public facilities including hospitals, primary health care centers, health posts were completely destroyed [27]. Many historical and cultural heritages have been destroyed, which has direct impact on the tourism industry of the country. The roads and bridges got collapsed disconnecting the villages in the earthquake affected Districts, which affected response and relief activities in immediate aftermath of the earthquake. The post disaster damage and need assessment (PDNA) conducted by the Government estimated the total damage and loss caused by this earthquake was Nepalese Rupees 706 billion (US\$ 7 billion), which was equivalent to one third of the Gross Domestic Product (GDP) in fiscal year 2013-2014 [27]. Besides, the normal life of citizens and ongoing development activities were disturbed for more than 5 months. The infrastructures including roads, electricity and communication network was heavily damaged [22].

The earthquake, in addition to human casualties, caused several secondary hazards such as landslides, fires, avalanches and liquefactions, etc. The landslides mainly in Rashuwa, Dolakha, Sindhupalchok, Nuwakot and Dhading Districts, were devastating causing loss of lives and property and blocked in accessibility [5]. The



avalanche in Langtang was the biggest induced disaster of this earthquake, which claimed 243 lives, including 41 foreign trekkers [29].

5.2 Response to Gorkha Earthquake

The role of the nation is vital in big disasters mainly for coordination, mobilizing resources and dissemination of authentic information for maintaining safety and security in the aftermath. After 2 hours of the earthquake, the Central Natural Disaster Relief Committee (CNDRC) meeting was held at National Emergency Operation Center (NEOC), which directed accelerating SAR and relief operations, free medical treatment, and activation of all DRRM stakeholders. The same day, the cabinet declared state of emergency in the 11 most affected Districts, and later it was extended to 14 Districts; appealed for international humanitarian assistance; mobilized the Prime-Minister Relief Fund and endorsed the decisions of CNDRC [5]. Publishing in national gazette of 27 April, the Chief District Officers (CDOs) were given authority to use the right provided by NCRA 1982 and Basic Goods and Services Control Act, 1960 to manage the situation in the emergency declared Districts. The CNDRC also established a central command post composed of secretaries from 8 different ministries led by Home Secretary. A separate desk was established at the Tribhuvan International Airport (TIA) for facilitating international humanitarian assistance and arrangements were made to facilitate efficient and effective customs' clearance for humanitarian aid especially for SAR and relief items. The international military teams were coordinated through the Multi National Military Coordination Centre (MNMCC) led by Nepali Army and other humanitarian agencies through the Onsite Site Operation Coordination Centre (OSOCC). As per the National Disaster Response Framework (NDRF) developed in 2013, the cluster approach was activated led by the ministries. The cluster lead and co-leads (humanitarian agencies) and other members were activated in different sectors for rapid assessment, response, relief and recovery works. Coordination from central level was done by NEOC. The respective DDRCs were supported for managing the situation and they arranged to deploy the additional human resources in most affected Village Development Committees (VDC), within the Districts for prompt and effective response.

5.2.1 Damage assessment and arrangement of accessibility

Immediately after earthquake the urgent need was to conduct rapid damage and impact assessment. Initially, the organizations and professional individuals started the damage assessment through self-initiation, however, this was formalized, and joint assessment teams were formulated. Thus, safety evaluations of more than 60,000 buildings was conducted [24]. The structures were marked with three colors, i.e. "Green"- inspected/safe, "Yellow"-limited entry/restricted to use and "Red" – unsafe, which helped the general public to decide whether the building can be occupied or not, and to the SAR teams for deciding SAR operations. One of the big challenges was safe demolition of unsafe buildings, since Nepal didn't have prior experience in this field. However, with the involvement of Nepali Army and APF, the more than 11,000 buildings were safely demolished. The debris blocking the accessibility was removed from more than 500 places of different Districts [5].

5.2.2 Search and Rescue (SAR)

As per the NDRF and the guidance provided by NCRA 1982, the response activities were coordinated by MOHA. A team comprising the senior officers from all security forces led by the Joint Secretary of Secuy and Coordination

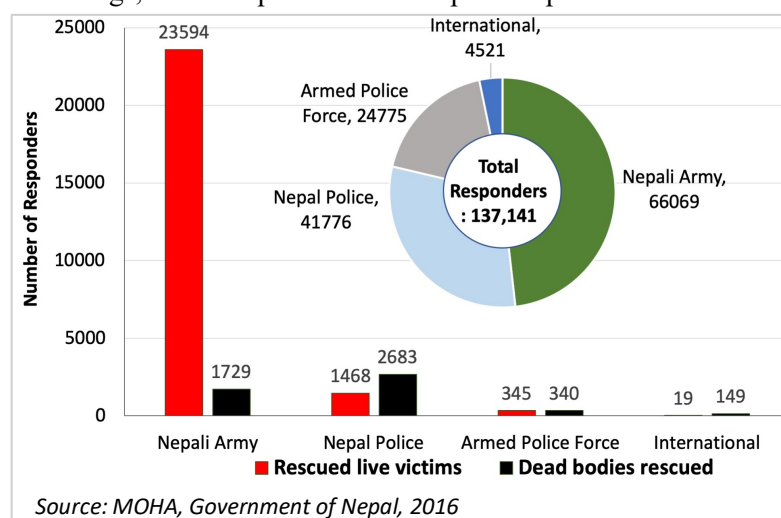


Fig. 3: MOHA, Government of Nepal, 2016



Division, MOHA started the coordination for SAR operations. As presented in Fig. 3, total 137,141 responders were mobilized in Gorkha Earthquake response. Out of these responders, maximum were from Nepali Army i.e. 66,069 followed by Nepal Police and APF from Nepal; and 4,521 international responders from 34 countries [5]. A huge number of community responders/volunteers were mobilized spontaneously in team and/or individuals, developed prior to earthquake by different organizations such as NRCS, NSET and many other organizations in the communities. While observing the operation success, 23,594 victims were rescued by Nepali Army, 1,468 by Nepal Police, and 345 by APF; and 19 by international teams. However, more deadbodies were recovered by Nepal Police followed by Nepali Army, APF and international teams. The international teams were able to rescue only 19 live victims as their arrival was later than the national teams, and were not familiar with the local context. Though it has not been well documented, a huge number of victims who were lightly trapped could come out by themselves and/or supported/rescued by local responders including volunteers from NRCS, who were together and/or could reach first at the scene. Hence, the 'self-help' and 'mutual assistance' among the communities was widely observed as post-disaster support mechanism in this earthquake [30]. A study have shown that more victims were rescued by communities as they were the first responders with better understanding of the local situation [24].

5.2.3 Emergency Medical Response

In the aftermath of earthquake, the Government declared for free treatment in the hospitals and health centers. Several major hospitals in the affected Districts were collapsed. The earthquake caused different level of injuries, i.e. as of July 2015, there were 1,500 injuries requiring long term recovery, 148 spinal injuries and 40 amputations [5]. The field hospitals were established, and several mobile teams or individuals were involved in the field. NGOs and civil societies, including NRCS, mobilized the volunteers for pre-hospital treatment. Health Emergency Operation Center (HEOC) under the Ministry of Health and Population coordinated the national and international medical response support [24]. There were 100 national medical teams mobilized in the field. The security forces, mainly Nepali Army mobilized the well-equipped teams, for medical response in the field. The national SAR teams, especially, who were trained under PEER and/or similar courses, i.e. APF disaster management courses, had built-in medical response skills. The Nepali Army treated with more than 85,000 victims and also assisted the international teams. Besides, onsite treatment by the responders more than 6,000 victims were transported to the hospitals by Nepal Police. APF medical teams were able to treat 551 victims. International medical teams' contribution was significant; 137 international teams from 36 countries worked in the field establishing 20 field hospitals and treated 27,390 victims.

5.2.4 Emergency Shelter

Due to large number of collapsed and heavily damaged structures, and frequent aftershocks, people could not reoccupy their buildings and therefore required emergency shelters [24]. Immediately it was difficult to get shelter tents, therefore many people constructed emergency shelters nearby their damaged buildings for the first couple of days. From the second day of the earthquake, there was distribution of emergency tents and tarpaulins by Government and humanitarian agencies. In 16 open spaces, out of identified 83 in Kathmandu Valley, the Government established IDP camps [31]. However, large number of population preferred to stay nearby their homes, property, livelihood and social ties [32].

6. Identified gaps in Gorkha Earthquake response

The Gorkha Earthquake was long waited, it was the largest in terms of magnitude and impact after 1934, which worked as an opportunity to evaluate the country's capacity to respond to large scale earthquakes. Though there were some ad-hoc adjustments and provisions made, the response mechanism of the Government was broadly guided by 1982 NCRA and National Disaster Response Framework (NDRF) of 2013. As per those two provisions, the Minister of MOHA at the central level and the CDO at the District level led the response activities; the regional mechanism was not active as expected. Based on the review of documents, interactions and FGDs, the following gaps in Gorkha Earthquake response have been identified:



1. Lack of comprehensiveness in existing DRRM Plans. The plans have been developed without conducting proper multi-hazard risk assessment, and still they are more focused on response and relief, instead of covering all phases of DRRM.
2. Lack of understanding of local context in terms of multi-hazard risk and resources, therefore, the available resources (skilled manpower, volunteers, etc.) were not utilized appropriately. This contributed to further risks due to secondary hazards during Gorkha Earthquake.
3. Most of the LGs didn't have DRRM plans prior to earthquake. Very few plans, where they exist, had problem of implementation in real ground [33]. So, in whatever way they responded was in ad-hoc basis with the guidance from respective DDRCs, facing problem in implementation at the ground. Hence, need of elected leaders at LGs, for quick and logical decision making, mobilizing local resources and coordinating with general public, was highly realized.
4. Due to lack of understanding among the key stakeholders of recently implemented policy, plans and SOPs, there was confusions about the procedure, specific roles and responsibilities, which ultimately delayed in decision making and effective emergency response operations.
5. General public awareness for basic safety measures, individuals' responsibilities and plans of respective Municipality or community was lacking. Due to lack of effective awareness, people were not able to imagine the consequences of the earthquake in their context and to be prepared for responding situation, which increased their risk during earthquake.
6. The NEOC, based on the NDRF guidelines, coordinated the response operations through DEOCs. However, while it got down to the local level the coordination was not effective due to the lack of similar mechanism at the local level [33]. And most importantly the horizontal coordination at the local level was missing resulting in difficult mutual assistance among the municipalities.
7. The potentials of national and local NGOs were not properly identified/assessed and integrated, and there was lack of clear policy for mobilization of NGOs in the field for emergency response activities, which created confusions resulting to duplication, overlooking and ineffectiveness in response activities.
8. Due to lack of clear exit strategy with joint plan of actions, regular inter-cluster coordination and progress review meetings with the involvement of all national and international cluster members, the overall emergency response activities were affected.
9. As in other earthquakes, the main source of risk was weak structures, which got collapsed during the shaking and caused huge number of casualties and loss of property. The assessment showed most of them did not meet even the minimum standards of earthquake resistant technology.
10. There was lack of coordination and mobilization plan among the national SAR teams at the central level and in the field, which caused overlapping and/or overlooking SAR operations in the field.
11. Delay in arrival of international SAR teams. Up until Day 9, some international SAR teams were still arriving [24]. There was lack of proper coordination, information verification and deployment plan for international SAR and medical response teams, which led to confusions for prioritizing operation areas and ultimately affected the success of SAR and medical response operation.
12. Insufficient number of national skilled SAR and medical responders and lack of proper materials and TEAs (tool, equipment and accessories) for responders caused delay and ineffective SAR and medical response operations resulting to increased mortalities.
13. Lack of leadership for coordination and mobilization of community volunteers for emergency response activities resulting to ineffective performance. If the community volunteers/resources had been utilized properly, the SAR operation could have been much better.
14. The damaged structures, infrastructures, hazard materials and unstable slopes were the major threats after earthquake. There was lack of expertise for stabilization and/or safe demolition of unsafe structures and infrastructures. It was delayed for removing debris and demolishing the unsafe structures disturbing other emergency response activities.
15. Weak mechanism of information collection, analysis and dissemination created confusion among the general public for further safety measures and individual responsibility, and among the experts and donors for impact analysis for further countermeasures.



16. Large number of internally displaced persons, who could not move to larger IDP camps, had to take shelter in unsafe areas closer to their damaged homes/property putting themselves at risk.
17. Proper care for marginalized and people with disabilities (PWD)s was missing in emergency response activities [33].
18. The security mechanism was not able to control the security issues in the affected communities of remote villages and emergency shelters such as theft, sexual harassments and human trafficking, etc. [34].

7. Recommendations

To address the above-mentioned gaps identified during response to the 2015 Gorkha Earthquake, the following recommendations have been made:

1. The DRRM plan should be based on the multi-hazard risk assessment considering all phases of DRRM i.e. mitigation, preparedness, early warning system, damage assessment, response, recovery and reconstruction/build back better (BBB), and countermeasures should be identified and prioritized for implementation.
2. Conduct multi-hazard risk assessment and maintain/update the inventory of available resources.
3. Comprehensive plans should be developed, led by the mayor of Municipality. The plan should have two committees/team, i.e. 1) Planning committee and 2) working-/implementation team. The plan should have defined tasks/countermeasures for DRRM and clearly defined role and responsibilities of both committee/teams. There should be similar mechanism down to ward level as well.
4. Periodic orientations to the stakeholders and exercises (tabletop and field based) on the plan and SOPs. Periodic exercises shall test the relevance of the plan based on prevailing needs, risks, hazards and vulnerabilities; and shall serve as a platform to review and analyze the current plan for updating or revision, as needed based on the prevailing context.
5. Standard curricula should be developed for earthquake preparedness and risk reduction measures for different levels e.g. community volunteers, students, housewives, civil servants, etc., then implement strategically to reach every individual. Based on the designed standard awareness tools, people at different levels should be made able to have contextual imagination so that they can adopt better and appropriate preparedness measures [35]. Civil societies, volunteers, students and teachers can be used as trainers after providing Training for Instructors (TFI) courses.
6. Establish similar mechanism of coordination at the Federal, Province and Local levels and develop mechanism for vertical and horizontal coordination for mutual assistance and public support.
7. Identifying, assessing, mapping of existing expertise, capacities and scope, the national and local NGOs should be categorized, and policies has to be made for roles and responsibilities ensuring recognition and integration of their contributions in DRRM activities.
8. In the aftermath of earthquake, the inter-cluster coordination meetings should be conducted in regular basis at different levels participating/reporting by all Government and humanitarian cluster members. The Government authorities representing in the cluster should have the major role for the action plan with clear exit strategy based on the situation assessment.
9. Earthquake resistant construction and retrofitting technology, has to be strictly followed in all structures, regardless with the location and occupancy type, through implementation of codes i.e. National Building Code (NBC).
10. Develop and implement the Incident Command System (ICS) in the context of Nepal. Conduct Scenario-based (tabletop and field-based) joint exercises periodically to test individual organizations' SOPs and developing common understanding. In the aftermath of disaster, regular meetings and progress reporting among SAR team will help for developing clear and effective mobilization strategy with appropriate division of responsibility depending on the expertise and capacities.
11. Advocate and approach for standby agreements and cooperation at regional level for emergency response among the neighboring countries. Develop a guideline for proper handling of international



- SAR and medical response teams. The international SAR teams should be guided by concerned national authorities based on the local context.
12. Develop/revise the strategic action plan for national SAR capacity development. Options can be: a) develop dedicated SAR teams with professional skills at Federal, Province and Municipal (local) levels to be associated with security forces at respective levels; OR b) create a separate dedicated National Disaster Response Force (NDRF) merging existing SAR responders from different organizations and deploy at different levels as recommended in option 'a'; OR c) Convert one of the existing security forces, for example, APF as National Disaster Response Force (NDRF), and deploy at different levels as recommended in options 'a' and 'b'. Considering the investment made so far, existing capacity and responsibility, option 'c' can be appropriate for Nepal. Regardless of the options, the capacity development and provision of pre-positioning equipment in respective location is prerequisite. Based on the international practices, diverse physiography, scattered settlements and the sociocultural setting of the country, at least 20 professional responders for 50,000 population are required [23], hence for estimated 30 million population in 2020, more than 12,000 professional responders are required in Nepal with about 500 sets of equipment.
 13. The studies have reported more than 80 percent of the victims were rescued by community volunteers or themselves [24]. The self-help and mutual assistance was observed everywhere in the aftermath of earthquake. The support from community volunteers in local context was very helpful for national and international SAR teams. Thus, the community volunteers are valuable assets for disaster response. Ideally every individual should have basic lifesaving skills. However, considering the local context of the country, at least 1 volunteer, who can support others with basic life-saving skills [e.g. Basic Emergency Medical Response (BEMR), Community Search and Rescue (CSAR), fire response and Basic Water Rescue Skills (BWRS)], should be developed and eventually forming of 1 squad of 6 trained responders for every 2,000 population in Nepal. Thus, at least 90,000 volunteers should be developed in the country with 3,750 sets of equipment. Every Municipality should be capable to respond certain level of disaster in terms of SAR and medical response. For this, LGs should allocate certain budget annually for DRRM.
 14. Mainstreaming DRRM in development is always the must. Guidelines with defined responsibility for rapid damage assessment for safe evacuation and scene size up has to be developed. The capacity building for assessment of secondary hazards and safe demolition of unsafe structures is required.
 15. Develop/review the national disaster information/database (spatiotemporal) management system for collection, verification and analysis, and develop a dissemination guideline. The information should be disseminated through designated authority/person promptly and accurately.
 16. Open spaces need to be identified at different levels, i.e. neighborhood, in Ward/community and in the city level, so that those can be used as per the types and scale of disasters. Utilize the open spaces identified by Kathmandu Valley Town Development Authority (KVDA) [36] for planning evacuation sites in the community and neighborhood.
 17. National database of PWDs and people who require special care, should be prepared through national census and in coordination with respective group/association ensuring priority services during disasters.
 18. Develop a nation-wide volunteers' network engaging community people, school/colleges students, political groups, retired security forces and professionals from related fields, for mobilizing in social causes, including disaster response activities. Provide trainings on safety/security measures, basic life-saving skills and maintain roster with recognition.

8. Summary

The efforts made by different stakeholders in Nepal during last couple of decades helped a lot to reduce the risk and manage the post-disaster situation of 2015 Gorkha Earthquake. Comparing with the magnitude of earthquake, the loss of lives and property was significantly high. Further, it has been said the loss of lives could have been much higher, if the shaking had happened at night or on office/school day. However, provided with



the limited resources, progressing policies and improving institutional arrangements, the post-earthquake response activities performed in average level. The ‘self-help’ and ‘mutual assistance’ among the community, motivation in national stakeholders and responders and international support played important role. Summing up the long list of gaps mentioned above, this has come out with four major gaps i.e. lack of clarity in responsibility for DRRM tasks and weak coordination among the stakeholders; lack of comprehensive DRRM plan at LGs and no clear understanding of existing plans; lack of public awareness and preparedness about the earthquake risk reduction measures; and lack of emergency response capacity at national and community levels. Hence to overcome with these gaps, a comprehensive DRRM plan based on local context has been recommended in municipalities considering all phases of DRRM with prioritized countermeasures and defined roles and responsibilities. Effective awareness required among different actors so that they can imagine the consequences and required actions during disasters. Strategy for SAR capacity enhancement at national and local level has to be developed with more emphasis in community volunteers’ network.

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References

- [1] B. N. Upreti, “The Physiography and Geology of Nepal and their Bearing on the Landslide Problem,” in *Landslide Hazard Mitigation in the Hindu Kush-Himalayas, 2001*, 2001st ed., B. N. Tianchi, Li; Chalise, S. R.; Upreti, Ed. Kathmandu, Nepal: ICIMOD, 2001, pp. 31–50.
- [2] G. Tuladhar, R. Yatabe, R. K. Dahal, and N. P. Bhandary, “Knowledge of disaster risk reduction among school students in Nepal,” *Geomatics, Nat. Hazards Risk*, vol. 5, no. 3, pp. 190–207, 2014.
- [3] MOHA, “Disaster Risk Reduction and Management in Nepal, National Position Paper for Asian Ministerial Conference on Disaster Risk Reduction (AMCDRR), 3-6 July 2018,” 2018.
- [4] G. K. Jimée, K. Meguro, and A. M. Dixit, “Nepal , a multi-hazard risk country : Spatio-temporal analysis,” *J. Nepal Geol. Soc.*, vol. 58, pp. 145–152, 2019.
- [5] MOHA, “Gorkha Earthquake 2015: Experiences and Lessons Learned,” Kathmandu, Nepal, 2016.
- [6] M. R. Panta, “A Step towards a Historical Seismicity of Nepal.,” *Adarsha, a Suppl. to Purnima, J. Samsodhana Mandala*, vol. 2, pp. 29–60, 2002.
- [7] NPC, “Post Disaster Needs Assessment, Vol. B: Sector Report,” Kathmandu, Nepal, 2015.
- [8] A. M. Dixit, R. Guragain, and S. N. Shrestha, “TWO DECADES OF EARTHQUAKE RISK MANAGEMENT ACTIONS JUDGED AGAINST GORKHA EARTHQUAKE OF NEPAL APRIL 2015,” no. April, pp. 1–10, 2015.
- [9] B. Rana, *The great earthquake of Nepal 1934 (Nepalko Mahavukampa BS 1990)*, Third Edit. Kathmandu, Nepal: Bookhill Publication, Anamnagar, 1935.
- [10] G. K. Bhattarai, D. Chamlagain, and S. Rajaure, “Seismic hazard assessment for eastern Nepal using 1934 and 1988 earthquakes,” *J. Nepal Geol. Soc.*, vol. 42, no. January 2015, pp. 85–93, 2011.
- [11] NSET, “Safer Society, NSET Report 2013,” Kathmandu, Nepal, 2013.
- [12] J. Bothara, J. Ingham, and D. Dizhur, *Earthquake risk reduction efforts in Nepal*, no. October. 2018.
- [13] MOHA, “Nepal Disaster Report: Policies, Practices and Lessons,” Kathmandu, Nepal, 2011.
- [14] G. K. Jimée, K. Meguro, and A. M. Dixit, “Learning from Japan for Possible Improvement in Existing



- Disaster Risk Management System of Nepal,” *Open J. Earthq. Res.*, vol. 08, no. 02, pp. 85–100, 2019.
- [15] T. R. Vaidya, “Personal Communication.” Kathmandu, Nepal, 2019.
- [16] MOHA, “National Strategy for Disaster Risk Management,” Kathmandu, Nepal, 2009.
- [17] JICA, “The Study on Earthquake Disaster Mitigation in the Kathmandu Valley, Kingdom of Nepal Final Report,” 2002.
- [18] R. Guragain and A. M. Dixit, “Seismic Vulnerability Assessment of Hospitals in Nepal,” in *13th World Conference on Earthquake Engineering*, 2004, p. 9.
- [19] MOHA, “Kathmandu Valley Open Spaces,” Kathmandu, Nepal, 2013.
- [20] W. N. Carter, *Disaster Management: A Disaster Manager’s Handbook*. Manila: ADB, 1991.
- [21] MOHA, “Earthquake Safety Day Guidelines.” Ministry of Home Affairs, Government of Nepal, Kathmandu, Nepal, p. 40, 2014.
- [22] G. K. Jimée, B. Upadhyay, and S. N. Shrestha, “Earthquake Awareness Programs as a Key for Earthquake Preparedness and Risk Reduction: Lessons from Nepal,” *15th World Conf. Earthq. Eng.*, p. 10, 2012.
- [23] G. K. Jimée, A. M. Dixit, M. Tandingan, and S. Sharma, “Strategy for Developing Professional Emergency Responders in Nepal,” *14th Int. Symp. Urban Saf. Mega Cities Asia*, p. 12, 2015.
- [24] B. Lizundia *et al.*, “M7.8 Gorkha, Nepal earthquake on April 25, 2015 and its Aftershocks,” EERI, Oakland, 2016.
- [25] G. B. Motra, “Performance of Buildings during Gorkha Earthquake 2015 and Recent Trends of Repair/Rehabilitation Works,” *IOE Grad. Conf.*, p. 5, 2015.
- [26] A. M. Dixit *et al.*, “What WORKS is Earthquake Preparedness and Risk Reduction and NOT Earthquake Prediction: Lessons Learned from Nepal’s Gorkha Earthquake of 2015,” p. 26, 2017.
- [27] NPC, “Nepal Earthquake 2015: Post Disaster Needs Assessment, Vol. A: Key Findings,” Kathmandu, Nepal, 2015.
- [28] C. C. Neupane, “Performance of School Buildings in Gorkha Earthquake 2015,” no. November, 2018.
- [29] M. Horrel, “The fate of Langtang village two years after the Nepal earthquake,” 2017. .
- [30] NSET and UTokyo, “National Workshop on Disaster Preparedness and Response Planning at Municipality Level in Nepal,” in *National Workshop on DPRP*, 2019, p. 53.
- [31] MOHA, *Gorkha Earthquake 2015: SAR and Relief Initial Report for 1 Month*. Kathmandu, Nepal: Ministry of Home Affairs, Government of Nepal, 2015.
- [32] B. Khazai *et al.*, “Emergent Issues and Vulnerability Factors in Temporary and Intermediate Shelters Following the 2015 Nepal Earthquake,” Heidelberg, 2015.
- [33] G. K. Jimée, “Focus Group Discussion (FGD) with DRM Stakeholders in Nepal, 17 August 2019.” Kathmandu, Nepal, p. 14, 2019.
- [34] R. Bhattarai, “Bipad Byabasthapan ra Bhukampale Sikaeka Path haru (Disaster Management and Lessons Learned from Earthquake),” *J. Self-Governance Rural Dev.*, vol. 42, no. 20, pp. 60–65, 2016.
- [35] K. Meguro, “Strategy For Taking Full Advantage Of Earthquake Early Warning System For Earthquake Disaster Reduction,” *14th World Conf. Earthq. Eng.*, 2008.
- [36] KVDA, *Atlas of Open Spaces in Kathmandu Valley*, 1st ed. Kathmandu, Nepal: Kathmandu Valley Town Development Authority, 2014.