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Earthquake resilience capacity of the Kathmandu Valley, Nepal: a case study of Gairi Gaun

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ABSTRACT

Experts argue that soft fluvial, alluvial and lacustrine sediments of the basin, shallow groundwater table, unplanned urbanization and rapidly increasing population have made the Kathmandu Valley more vulnerable to seismic hazard. However, there is a lack of empirical studies, which helps to rational opinion building in this topic. This paper evaluates the strategic measures, policy options and the analytical tools available in the context of seismic risk management of the valley taking Gairi Gaun of Ichangu-Narayan Village Development Committee (VDC) as a case. This study assessed the knowledge of community people regarding seismic hazard by conducting questionnaire survey and key informants' interview. Field survey was also conducted to identify safe places and nearby health centers and evacuation routes within the study area.

Results indicate that the awareness level of the community people regarding seismic hazard is generic. Knowledge on the activities to be carried out before, during and after the earthquake, was found to be very limited. Only few people heard about GO BAG, an emergency kit, but had no idea about its content. Majority of the people in the community were aware of earthquake resistant technology but only one of them reported of having used it during the construction of his residence. Moreover, people were unable to imagine the post-shock scenario. Most of them were unaware of the escape routes from their houses or evacuation routes to nearby health centers in case of injury, should an earthquake occur.

Although knowledge of seismic hazard was found transferred through relatives, friends and other means of communication, the people hardly shared the knowledge within their family members. Since safe places in the community are reducing day by day, an urgent need has been felt to safeguard such locations for conducting rescue operations in post-shock scenario.

Keywords: Seismic hazard, fluvio-lacustrine deposits, earthquake preparedness, Kathmandu Valley

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INTRODUCTION

Kathmandu Valley, with an area of 667 km^2, is located in the central part of the country and also contains the capital city on it. The valley floor, having average elevation of 1340 m above mean sea level, is made up of soft lacustrine sediments. Mountains encircling the valley and rising up to 2800 m from mean sea level are mainly made up of rocks (slate, quartzite, limestone, marble, slate etc.). Kathmandu Valley comprises five municipalities namely Kathmandu, Lalitpur, Bhaktapur, Kirtipur and Madhyapur Thimi. It is assumed that the valley has total population of 3.4 million (Panta 2010). Due to the rapid flow of migrants from the other parts of the country into the valley, this figure may be quite high.

The continual subduction and collision of Indian Plate beneath the Tibetan Plate has made Nepal a seismic prone country. The first recorded earthquake in the history of Nepal was that 1255 AD. Other major earthquakes reported in Nepal are earthquakes of 1408, 1681, 1810, 1833, and 1866 (Chitrakar and Pandey 1986). Although these earthquakes were reported, none of them were considered remarkable damaging as the 13th century event (Bilham 1995). In terms of relative vulnerability to earthquakes, Nepal was ranked at the eleventh most risk country in the world (UNDP/BCPR 2004). In general, the effect of devastating earthquake is underestimated because it does not occur frequently and the young generation slowly forgets of its devastating effects as the suffered population passed away.

During the occurrence of an earthquake, due to soft fluvio-lacustrine sediments, the valley floor will be shaken badly in comparison to the encircling rocky-mountains. The shallow groundwater table and the presence of fine sand layers in subsurface may lead to liquefaction in many parts of the cities especially those which are near to rivers and its tributaries. Other factors that make the Kathmandu Valley more hazardous are uncontrolled and poor construction practice of buildings (mainly because of not including seismic forces in design and construction), haphazard networks of roads and rapidly increasing population. All these factors make the Kathmandu Valley more prone to seismic hazard than other parts of the country. Shaking intensities in the Kathmandu Valley were similar for 1833 and 1934 earthquakes (Bilham 1995). During the 1934 event, the Kathmandu Valley

Fig. 1: Location map of the study area

experienced earthquakes with intensities VII, IX and X in Modified Mercali Scale (NSET and GHI 1998).

Therefore, it is necessary to raise awareness in the community people regarding seismic hazard and make the communities earthquake resilient in the valley. In this context, this study has been initiated taking Gairi Gaun as a case. Gairi Gaun is located about 1.5 km from Swayambhu (Fig. 1). The study area is predominated by *Nagarkoti,* an ethnic caste of the valley.

KNOWLEDGE OF SEISMIC HAZARD

From the household (HH) questionnaire survey, knowledge of community people on the causes of seismic hazard was evaluated. Although, almost all the respondents (97%) experienced the shocks of earthquake in the past, 70% of them did not know about the causes of earthquake. 11% of the respondents believed in theological myths, only 8% were aware of the scientific reasons and the remaining had superstitious beliefs about earthquakes. Some of them said that earthquake occurred due to increased population; others supposed that it was due to tall buildings. Some also assumed that it was due to the unequal load on earth surface or pumping of groundwater or due to the action of wind.

In order to assess their preparedness level during seismic hazard, three conditions were assumed: if they were inside buildings, if they were driving/riding vehicles and if they were in open space. In case of respondents residing in their buildings, most of them (88%) would escape through the main gate of the building, some (7%) would stay inside quietly and a few (5%) would go beneath rigid structures like table, bed etc. For the second condition (driving/riding vehicle), 51% of the respondents would stay inside by stopping the vehicle, 23% would move a little farther and stop the vehicle in open space. Similarly, 26% respondents said they would not be able to feel the shock while they were driving/riding a vehicle. In case third situation (residing in an open space), most of them (89%) would stay where they were and some of them (11%) would try to move to a safer places (those places, not having tall buildings, trees, electric poles, etc.).

PREPAREDNESS LEVEL

Preparedness level of the community people regarding seismic hazard was very low. Most of them (91%) had never heard about the GO BAG, an emergency kit. A few people, who had heard about it, had no proper idea regarding its contents. Although majority of the people (52%) were aware of earthquake resistant buildings, surprisingly, only a single person reported to have used the technology. Others reported of not using the technology because of high cost and ignorance while constructing their houses.

Although the community people were little aware about earthquake hazard via relatives, friends and other means of mass communication such as radio, television and newspapers, they hardly shared the knowledge within their family members.

POST-SHOCK SCENARIO

If the 1934 earthquake were to reoccur, 23% of buildings of the Kathmandu Valley would be heavily damaged and 1.4% population would be killed (JICA/MoHA 2002). If there were an earthquake of 8.3 magnitude centered on the Kathmandu Valley, 95% of water pipes and 50% of pumping stations and treatment plants would be seriously affected and that would disrupt the water supply of valley for several months. Moreover, 60% of telephone lines and 40% of electricity lines along with all the sub stations would be non-functional for a month. Also, 50% of bridges and many narrow roads would be unusable because of damage and debris. Hardly few hospitals would be functional and the only international airport of Nepal would be isolated from the cities as most of the access roads and bridges and its runway would be partially or totally unusable (NRCS 2008).

In such a condition, the knowledge of community people seemed to be limited in order to manage their activity during the post-shock scenario. More than three quartile population (84%) in the community were planning to leave their houses immediately after the shock. Moreover, they were unable to prioritize their activity after the shock. Most of the respondents (72%) would inform the occurrence of earthquake to their family members instead of applying safety measures for their lives.

After an earthquake, people were planning to go to nearby health center in case of minor injuries and to hospitals in case of major injuries but they were unable to estimate the safe route to reach the health centers. They would follow the short-cut route or the route they are following during the normal life forgetting an important fact that the buildings or other structures would be collapsed. There are no hospitals in the locality. A sub-health post, having ANM and a helper will not able to manage the casualties in the post-shock scenario.

A STEP FOR DEVELOPING COMMUNITY RESILIENCE

Achieving all, or even some, of the following ten essentials, a city will become more resilient (http://www.unisdr.org).

- Put in place organization and coordination to understand and reduce disaster risk, based on participation of citizen groups and civil society. Build local alliances. Ensure that all departments understand their role in disaster risk reduction and preparedness.

- Assign a budget for disaster risk reduction and provide incentives for homeowners, low-income families, communities, businesses and the public sector to invest in reducing the risks they face.

- Maintain up-to-date data on hazards and vulnerabilities, prepare risk assessments and use these as the basis for urban development plans and decisions. Ensure that this information and the plans for your city's resilience are readily available to the public and fully discussed with them.

- Invest in and maintain critical infrastructures that reduces risk, such as flood drainage, adjusted where needed to cope with climate change.

- Assess the safety of all schools and health facilities and upgrade them as necessary.

- Apply and enforce realistic, risk-compliant building regulations and land-use planning principles. Identify safe land for low-income citizens and develop upgrading of informal settlements, wherever feasible.

- Ensure that education programmes and training on disaster risk reduction are in place in schools and local communities.

- Protect ecosystems and natural buffers to mitigate floods, storm surges and other hazards to which your city may be vulnerable. Adapt to climate change by building on good risk reduction practices.

- Install early warning systems and emergency management capacities in your city and hold regular public preparedness drills.

- After any disaster, ensure that the needs of the survivors are placed at the centre of reconstruction with support for them and their community organizations to design and help implement responses, including rebuilding homes and livelihoods.

The study was able to address first, third and seventh of aforementioned points to some extent. From the field visit, it was revealed that there were some private lands not occupied with buildings as on July 2010 (Fig. 2). These open spaces can be used as evacuation and rehabilitation shelters during the post earthquake scenario.

In order to make the community people aware, a leaflet was prepared containing information on what should be done before, during and after the earthquake. The leaflet was distributed along with above map locating their house and informing probable route to reach to the safe place. Besides, a presentation session was conducted in order to raise the awareness level of the people about the causes of earthquake, its possible damage, and the activities that can be done to reduce the seismic hazard. Moreover, enlarged copies of the map were prepared and erected as hoarding boards in two public places.

DISCUSSIONS AND RECOMMENDATIONS

The entire community within the study area was vulnerable to seismic hazard due to the low quality existing infrastructures. About 45% of the houses were non-concrete houses, most of them being made up of unbaked brick. Haphazard network of electric wire and tilted electric poles

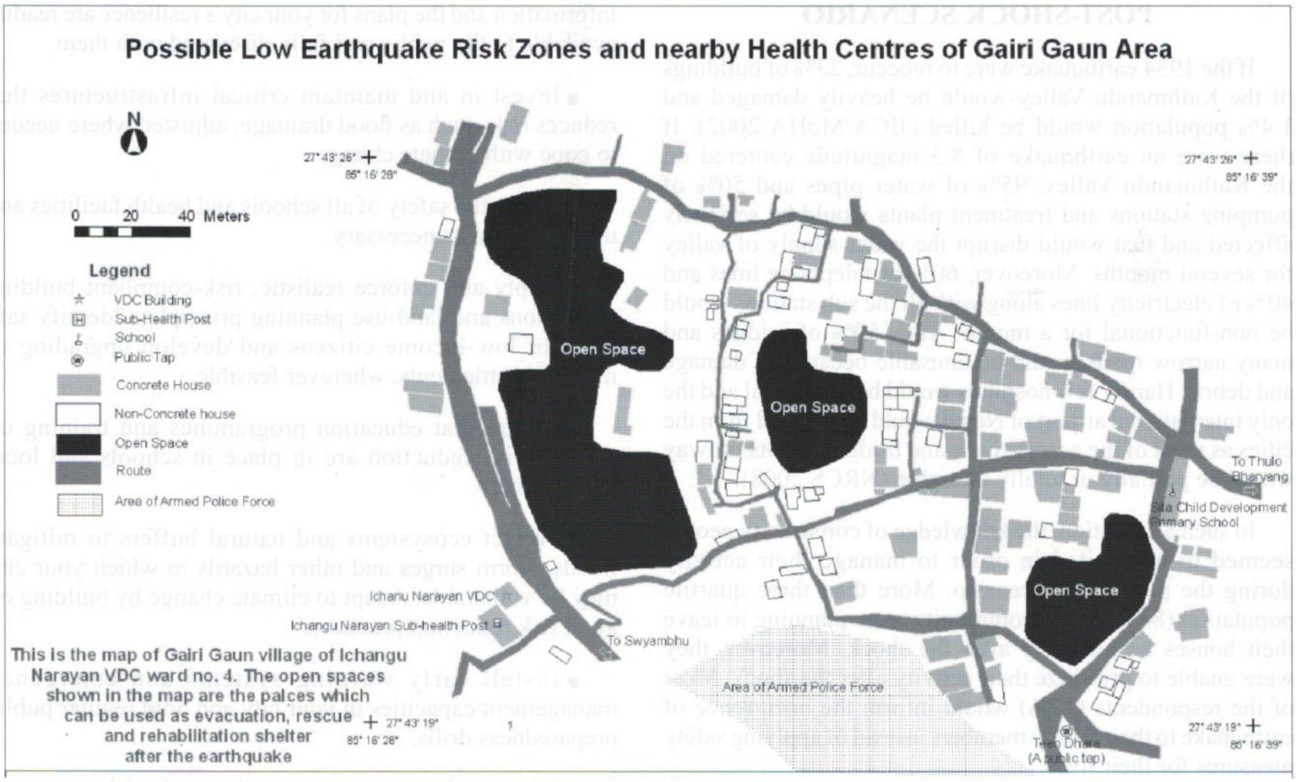

Fig. 2. Map of Gairi Gaun showing open spaces and nearby health centers

could add the problem in post shock-scenario. Public places such as schools, health centers, and VDC building were not earthquake resistant. To address these circumstances, building of earthquake resistant structures could be a mandatory measure. Although the government has implemented the "National Building Code (NBC)" since 2003, due to lack of the proper monitoring, inhabitants were constructing buildings violating the codes. Similarly, the structures built before implementing NBC will create problems during and after the earthquake. So, proper implementation of NBC for future construction work is needed and this could be done with the help of local authorities, Community Based Organizations (CBOs) and media. Local authorities can play a major role in monitoring and the CBOs and media in awareness raising activities. In case of already built buildings, retrofitting could be one of the feasible measures to make them earthquake-resistant to some extent. However, some extremely old houses or those constructed with minimum consideration to earthquakes should be demolished as they possess a direct threat to the entire community. Moreover, an extensive study on the assessment of engineering design for the houses will definitely reveal possible solution measures to minimize the effects of earthquakes on them.

The open spaces and public land in the Kathmandu Valley is reducing day by day. Due to high commercial value, private open spaces are now transforming into high rise buildings. Additionally, the public open spaces are encroached by community people and in some places by local CBOs (such as local clubs, mother groups) and build commercial buildings to generate income. Although a similar trend can be observed in the study area, fortunately, there is still some open space remaining at Gairi Gaun. Since open spaces shown in the map (Fig. 2) are private properties, there are high chances of buildings being constructed on them at any time. The government should take initiatives to preserve such sites to be used during disasters in the future, those plots of land can be used in order to evacuate people and conduct rescue and rehabilitation activities.

There is no doubt that the Kathmandu Valley will face many problems after a major earthquake; one alarming situation will be seen in the health sector. Hardly few hospitals in the valley will be functional after the shock. Only four hospitals in the valley have disaster management plan. In such a context, even those people who have reached the hospital may not get proper treatment. Therefore, an urgency to develop and implement disaster management plan in the hospitals, at least in case of government hospitals has been felt.

The scenario of Kathmandu Valley after a devastating earthquake is alarming. To cope with such a situation, it is necessary to build disaster resistant structures and disaster resilient communities in the valley. For this purpose, seismic hazard analysis of the valley, considering specially the area with fault zones, soft sediments and shallow groundwater table should be carried out and the result could be used in designing new earthquake-resistant structures and strengthening existing structures. Since open spaces in the community are reducing, the local authority should take some initiative to preserve those spaces for conducting rescue operations in post-shock scenario.

CONCLUSIONS

Because of soft fluvial, alluvial and lacustrine sediments of the basin, shallow groundwater table, unplanned urbanization with rapidly increasing population, and buildings being constructed not following building code properly the valley of Kathmandu is considered as one of the most vulnerable places in Nepal in terms of seismic hazard. A questionnaire survey and key informant's interview were conducted at Gairigaun of Ichangu-Narayan Village Development Committee (VDC) to understand the level of knowledge and state of preparedness in relation to seismic hazard. Results revealed that the awareness level of the community people regarding seismic hazard is generic as majorities of them do not know the scientific causes of an earthquake. Knowledge on the activities to be carried out before, during and after the earthquake, was also found to be very limited. Majority of the people in the community were aware of earthquake resistant technology but only a few of them reported of having used it during the construction of their residential buildings. Most of the community people are unaware of the escape routes from their houses or evacuation routes to nearby health centres in case of injury during an earthquake event. These results clearly demand for a coordinated, people-centred awareness campaigning in community level. Similarly, since open spaces in the community are reducing day by day, an urgent need has been felt to safeguard such open locations for conducting rescue operations in case of post-shock scenario and other public welfare activities.

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