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Enhancing Community Awareness towards Potential Earthquake of Lembang Fault in comparison to Kathmandu Valley*

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Abstract

Bandung Basin currently is vulnerable to seismic hazards, in particular, Lembang Fault Potential Earthquake. The vulnerability state has risen due to the rapid development and lack of community awareness. Community in Lembang tends to deny the existence of potential disaster that lies in their urban neighborhood. One of the methods used by disaster experts to reduce disaster risk is by comparing with an area of similar characteristics that has been exposed by the same type of disaster. In this book chapter, the same concept will be used to compare Kathmandu Valley with Bandung Basin since both have similar physical characteristics and also prone to seismic hazards.

Keywords:

Bandung; Earthquake; Vulnerability; Fault

1. Introduction

Bandung Basin covers a large metropolitan areas consisting of Bandung City, Lembang City, Cimahi City and some areas of Sumedang District, Bandung District and Bandung Barat District. This valley, of a basin shape, has been a home to 2,058,122 in 1990 and 2,470,802 in 2014 (Center of Statistic Agency, 1991). Bandung is attractive for it's cool climate and it's strategic location that holds collection and distribution. Bandung City, as the capital and biggest city in Jawa Barat has experienced a tremendous development particularly in the last 10 years. The toll road that connects Jakarta and Bandung has caused intensive mobility between these cities and regions. Thus, influx of investments have taken place in Bandung (Tarigan et al., in press).

The topography of Bandung Basin generally goes up from South to the North where geologically there is an active Fault, called Lembang Fault (Meilano et al., 2012). Based on study by Meilano et al (2012), Lembang Fault has shallow creeping rate of 6 mm/year and there are locked region on this fault at 3-15 km. Even though the creeping rate was relatively low and its potential to cause an earthquake is unlikely, Lembang Fault unfortunately also capable to be a creeping media of seismic wave from other epicenter (Yulianto, 2011). From the research by Yulianto (2011) on assessing Lembang Fault activity through sag-pond observation, it was found that 1,000 years ago, Lembang Fault showed its activity and caused an earthquake with high magnitude. Therefore, Bandung is prone to seismic hazards and other cascading disasters, such as landslide and fires.

For years, population of Indonesia has grown significantly from 208.9 million people in 2000 to 249.9 million people in 2013 (World Bank, 2015). Rapid population growth in Indonesia was followed by rapid structural and economical development, fulfilling the community's demands and needs. As one of the tourism region in Indonesia, Lembang and Bandung which also experienced rapid development phenomena. Housing, resort, restaurant, and several tourism attractions were constantly built. Unfortunately, the structural development throughout the years was not followed by an appropriate

*The full work of this chapter is published in the book "Masyarakat Tangguh Bencana, Pendekatan Sosial Ekonomi, Tata Keloladan Tata Ruang." Chapter 3.4, 1st Edition. Editor: Herryal Z. Anwar. LIPI, 2015

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commitment to land use plan, a lot buildings was built on disaster prone area. Those rapid regional developments also have attracted people to migrate to Bandung. Current state of higher building construction and higher population rate in Bandung confronted with potential Lembang Fault earthquake disaster has created a vulnerability condition of Bandung Valley.

Disaster risk reduction commonly has three main actors who closely related to its implementation, they are government, community, and other actors in the main sector of a particular region, which in Lembang case is hospitality business. Every actor holds an important role in the implementation, each with their own needs and interests and ability to exercise influence on policy implementation and its outcomes (Sabatier, 1999). That is why how actors respond to information of potential disaster in their region and how they involve in disaster risk reduction will be the main factor that determines disaster risk reduction implementation success.

Based on the survey and observation conducted on 2013, one of the biggest challenges to implement disaster risk reduction in Bandung Valley area is low community awareness towards potential Lembang Fault earthquake. Community tends to deny the existence of potential disaster that lies in their neighborhood. The last activity of Lembang Fault was occurred 400-600 years ago (Yulianto, 2011). There is no visible evidence about recent earthquake with Lembang Fault as its epicenter. Disasters that once have occurred obviously are government's priority and have been addressed by the government, but what about potential disaster that has not occurred yet? It is not an easy task to change someone's mind set to prioritize something that is not familiar.

One of the methods that disaster experts commonly use to determine construction vulnerability in an area that has not been exposed by potential disaster is by assessing the damage in other area with similar characteristics that has been exposed by the same type of disaster. Through the comparison, experts are able to estimate the potential damage if the potential disaster occurs and government can initiate a more suitable disaster risk reduction to reduce the estimated damage. In this book chapter, the same concept will be used but with different objective. Rather than to estimate the potential damage, this comparison of two disaster condition aims to provide an image to government and community about potential disaster that might happen in the future.

April 2015 Nepal Earthquake at Kathmandu Valley has some similarities with potential Lembang Fault earthquake and we can learn from it by comparing both vulnerability formation. Through this comparison, we can learn about the similarities and the differences about each of their condition, and use it as an input to improve disaster risk reduction in Bandung Valley as well as oppose the current community's denial and raise community awareness.

2. Earthquake Risk Formation in Bandung Valley and Kathmandu Valley

2.1. Lembang Fault

Lembang Fault is located in northern Bandung City 22 km lengthwise from west to east. Based on empiric data, a fault which reaches more than 20 km long may triggers 6.5-7.0 SR destructive earthquakes (Brahmantyo, 2011).

Despite there has not been any noticeable activity from Lembang Fault for the past years, does not mean that Lembang Fault is free from potential disaster that needs to be considered. It was found that Lembang Fault has shown its activity hundreds years ago, in the Holocene period, and it can be seen through its landscape and form (Natawidjaja, et al. 2004). Moreover, Meteorology, Climatology and Geophysics Agency has stated that in June 2013, there has been a shallow earthquake with Lembang Fault as its epicenter and has 10 km depth, located in Cihideung area. Active fault is a fault that has an evidence of its motion during holocene or less than 10,000 years (Keller and Pinter, 1996). Refering to Keller and Pinters's statement, it can be concluded that Lembang Fault is an active fault. Thus, as a response, there were a revision of disaster map of Indonesia in 2002 and also earthquake-resistant building standard for area near Lembang Fault in 2010 which has been adapted to Peak Ground Acceleration rate at base rock in 2002 and 2010 (WayanSengara, 2013)

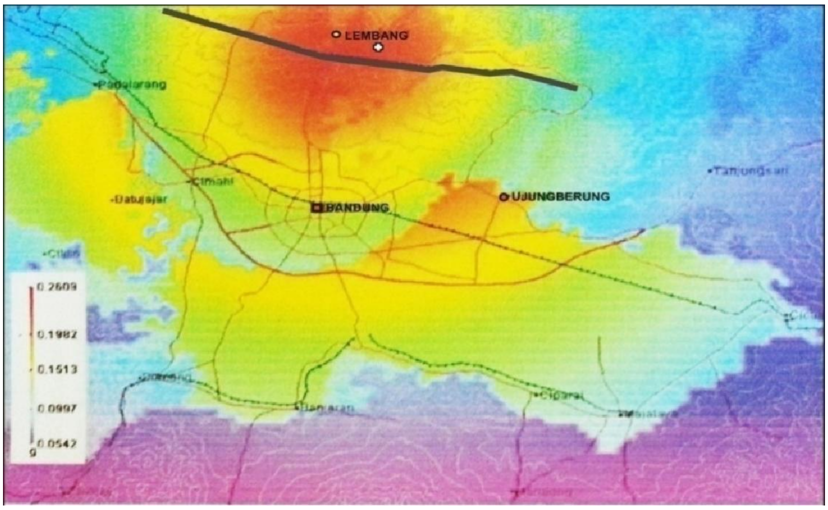

Figure 1Potential Maximum Peak Ground Acceleration by Lembang Fault Earthquake
Source: JurnalSumberDayaGeologi Vol.19 No.5, 2009

Ground motion rate in Bandung and its surrounding is between 0.054-0.2609 g. The higher the number, the higher the rate of ground motion. In the map above, dark blue color represent region with low ground motion rate, meanwhile the red color represent the region with high ground motion rate. Based on the map, there are two area with red color, which are northern and southern area of Bandung. Both of the high ground motion areas were caused by Lembang Fault actvity. In addition to that, particularly in southern part of Bandung, which also the area of Bandung slope, there is alluvial soil from previous TangkubanPerahu Volcano eruption.

2.2 *Formation of Lembang Fault Earthquake Risk*

There are three components of disaster formation, they are capacity, vulnerability, and hazard. All three of the components will affect the formation process in an area. For example, if the capacity is higher than its vulnerability rate, even though there is a hazard, it might not forms a disaster in the future, because the capacity counteracts the vulnerability. But if a region has a low capacity and high vulnerability, also there is a hazard in that area, it is more likely for the region to experience a disaster. Vulnerability is a physical and non-physical factors in a region which will determine the damage cost from disaster exposure. Hazard is a potential that has been in the environment which has an ability to threat a particular region and its community safety. Capacity is a potential owned by a particular region which able to counteract disaster risk or to create a resilience condition after the disaster exposure. Every region or area has different characteristics which will distinguish those three components in each region. Vulnerability in Bandung Valley area can be divided into two, which are structural vulnerability and social vulnerability.

Social Vulnerability: Actors' Perception Towards Potential Lembang Fault Earthquake

Disaster preparedness is an embodiment of actors' perception towards a hazard or potential disaster. More than half of the community know about Lembang Fault but 76% of them were not exactly understand about the risk of Lembang Fault earthquake (Damayanti, 2013). There are three main actors in Bandung Valley area that related to disaster risk reduction, they are business and enterprise actors, local government, and community. Several researches identified that perception of the three actors in Bandung Valley areaare still low towards all types of potential disaster, especially Lembang Fault earthquake. This low awareness towards potential disaster has formed a vulnerable condition.

Individual perception is affected by their culture, communities' view and religion view in the place where they live Garvin (Smith &Petley, 2009), which portrays the condition in Lembang District. From the observation and interview results, culture and community's view, including religious aspect, were affecting actors' perception on disaster risk reduction and their awareness. In substance, cultural

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and religious value can be a positive capacity to support disaster risk reduction, but in this research, cultural and religious value is the one that caused lower awareness towards disaster potential. Their ignorance is the root problem in implementing disaster risk reduction.

Table 1 Actors' Perspective

Actors' Perception		
Community	**Hospitality Bussiness**	**Local Government**
1. Limited knowledge regarding Potential Disaster from Lembang Fault. *Reason: Information were restricted only for local government* 2. Aware of potential disaster in Lembang, except Lembang Fault earthquake. *Reason: They never experience it before* 3. Not very interested in disaster risk reduction. *Reason: they believe that disaster is fate and they can do nothing about it*	1. Limited knowledge regarding Potential Disaster from Lembang Fault. *Reason: Information were restricted only for local government* 2. Aware of potential disaster in Lembang, except Lembang Fault earthquake. *Reason: They never experience it before* 3. Not very interested in disaster risk reduction, but still *Reason: they believe that disaster is fate and they can do nothing about it*	1. Different perception between every level of government about potential disaster *Reason: unequal information dissemination* 2. Aware of potential disaster in Lembang, except Lembang Fault earthquake. *Reason: They never experience it before*

Source :Chairiah, 2013

There is one common perception about potential Lembang Fault earthquake around community, business actors, and local government, which is denial of potential disaster. This was happened because of several reasons such as: (1) Cultural and religious thinking about fate and how human can not to anything to prevent or reduce the risk from potential disaster, and (2) People never experience Lembang Fault earthquake before. It is hard to imagine what might happen.

Structural Vulnerability

In Bandung Basin case, the most vulnerable aspect is their house constructions. Housing construction can be classified to three types; unreinforced masonry (URM), confined masonry (CM), and non masonry (NM). All of three housing construction types were determined by previous survey on damaged housing construction caused by earth quake in Padang City and Yogyakarta City. Potential disaster level of a region which has never been exposed by any disaster can be predicted through information from other region which has been exposed by disaster with similar hazard characteristics and similar vulnerability. From table below, it can be concluded that unreinforced masonry has the highest damage rate at most of research area.

Table 2 Building Construction Damage Proportion Rate from Previous Earthquake in Indonesia

District/City	**% Damage**		
	CM	**URM**	**NM**
Bandung District (Ibun, Pameungpeuk, Pangalengan)	1%	85%	14%
Ciamis District (Banjarsari, Pamarican, Mangunjaya)	7%	76%	17%
Bantul District (Jetis, Kasihan, Pleret, Pundong)	14%	86%	0%

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District/City	% Damage		
	CM	URM	NM
Klaten District (BayatdanGantiwarno)	13%	77%	10%
Padang City (LubukKilangan, Padang Selatan, Padang Utara)	71%	21%	8%
Padang Pariaman District (Patamuandan V Koto Timur)	43%	39%	18%
Pariaman City (Pariaman Tengah danPariaman Selatan)	18%	79%	3%
Agam District (AmpeknagaridanLubukbasung)	0%	99%	1%

Note: Confined Masonry (CM) : building construction with retrofitting (wood and concrete).
Unreinforced Masonry (URM) : building construction without concrete retrofitting (bricks only).
Non Masonry (NM) : building construction without concrete retrofitting and bricks (boards or woods only)
Source: Earthquake Damage Model for Buildings in Indonesia Research, 2013

Unfortunately, unreinforced masonry and non masonry are the main communities' option to build their houses in villages around Lembang Fault because of its low construction cost. As for other buildings located in urban area of Lembang, 89% of its constructions were made of bricks (Damayanti, 2013). In urban area of Bandung, most of the buildings were made of masonry, although it has a various framing (Surahman,). There were 1.6 % steel buildings, 13.2% wooden or bamboo buildings (non masonry), and 85.2% concrete or masonry buildings (Surahman,). From all of the concrete buildings, 62% were framed (confined masonry), 17.4% were unframed (unreinforced masonry), and 20.6% were unadequately framed (Surahman,). Therefore, if we combine and estimate the amount of vulnerable building through their types in the entire Bandung Basin area, more than half of the buildings will be stated as a vulnerable buildings, because most of the buildings in Bandung Basin are house buildings and commonly were built unadequately.

(1) (2) (3)
(1) Confined Masonry Building, (2) Non-Masonry Building, and (3) Unreinforced Masonry Building

Figure 2 Types of Building Construction in Near Lembang Fault
Source: Observation, 2013

Building construction improvement and retrofitting demand for expensive cost. Thus, building construction improvement can only be carried by community with higher economy level. Restricted budget is the most common problem in adopting earthquake resistant building.

Disaster Preparedness Towards Potential Lembang Fault Earthquake

Until this current time, both community and local government has conducted several disaster risk reduction action, but only limited to mitigation when the disaster occurs. There are three disaster mitigation that have been prepared by local government such as forming a disaster preparedness organization in village level, information dissemination regarding evacuation route, and collaboration with Regional Disaster Management Agency (BPBD). Collaboration with BPBD was carried by practicing evacuation simulation and rebuilding the damaged building construction after the disaster was occurred. All of this effort was mainly concentrated for after disaster exposure.

Although Lembang District already has three types of disaster mitigation, all of those efforts were

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mainly concentrated for after disaster exposure. Moreover, the entire scheme of disaster risk reduction were centered on the government and there was no independent action from the community to reduce their potential risk. In terms of structural mitigation, more than 50% of the communities did not consider the potential earthquake hazard when they decided Lembang as their neighborhood and when they were building their house (Damayanti, 2013). In addition to that, 98% of the community also did not provide any insurance for their house (Damayanti, 2013).

Earthquake happens very fast and there will not be much time for people to evacuate them self. Disaster risk reduction that focuses on raising communities' resilience and awareness is urgently needed in Lembang District. One of the most important problems that need to be addressed is how to change community's perspective on Lembang Fault Potential Earthquake by educating them through other similar earthquake that has occurred.

2.3 Lesson Learned from Kathmandu Valley

Kathmandu Valley is located in Nepal. It has three districts, Kathmandu, Lalitpur, and Bhaktapur. The overall area of Kathmandu Valley is amounted of 665 square kilometres and has a bowl shaped or basin, surrounded by Mahabharat mountain range in every sides (ICIMOD, 2007). Kathmandu Valley is covered by thick lacutrine and fluvial deposits, which were formed from lake sediment and rivers deposits. Sedimentation soil has a low soil density and can be easily influenced by the earthquake motion (LIPI, 2008). Thus it will be more vulnerable for the buildings above the sedimentation soil, which was experienced by Kathmandu Valley. Moreover, KathmanduValley has a long history of destructive earthquake because of its location in seismic zone (ICIMOD, 2007).

Vulnerable condition in Kathmandu Valley

Earthquake that occurred on April 2011 was not the first massive earthquake that struck Nepal. The first massive earthquake that has been successfully documented by several scientist and engineer was on 1934. Learning from the previous earthquake in 1934, government of Nepal with helps from related organization begin to assess the vulnerability condition in Kathmandu Valley in particular and estimate the damage from the potential earthquake if it happens in the future, which now we found out that the potential earthquake that similar to 1934 earthquake was really happened in 2011. To simplify the description of vulnerability condition in Kathmandu Valley, it will be divided by three aspects, social, they are structural, and government characteristics.

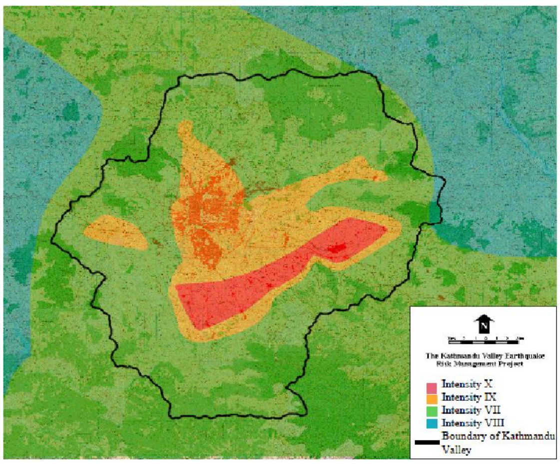

Figure 3 Modified Mercalli Intensity distribution from 1934 Earthquake in Kathmandu Valley
Source: NSET & GHI, 1998

The highlight of social vulnerability was in lack of community awareness towards the potential disaster. The previous disaster was happened in 1934, it was way too old for the current community to experience or know about that event. Since they do not experience it and no one can convey their

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experience, it is harder for the community to aware of the former earthquake event. Poverty and lack of education also took a role in contributing to lack of community awareness (ICIMOD, 2007).

There are two main points of structural vulnerability condition in Kathmandu Valley. The first is inadequate buildings' standard. Every year, there are more than 4,000 buildings constructed by the owner without any engineering knowledge. Inadequate building standard meets sedimentation soil has formed a highly vulnerable condition in Kathmandu Valley. This case mainly happened to old housing buildings owned by community with lower economic level. The distribution of the poor community has increased to 118% in Kathmandu Valley (CBS, 2005). The second one is rapid yet uncontrolled structural development. The root problem of the second case is urbanization, because the development was centralized in Kathmandu Valley. From 1991 to 2001, percentage of total population in Kathmandu Valley has grown from 5.98% to 7.10 of Nepal's population (CBS, 2003). Both of the main points are linked to each other, urbanization caused poor population grows higher in Kathmandu Valleyas well as their housing buildings over the years, and has increased the vulnerability level of Kathmandu Valley.

As for government vulnerability, the challenge is in their coordination and political instability (ICIMOD, 2007). After the earthquake in 1934, there was still no central department of disaster management in Nepal, although there are many organizations working in disaster management (ICIMOD, 2007). Disaster risk reduction demands for multisectoral collaboration. To achieve that, Nepal needs a central department of disaster management that can lead the coordination between related organizations.

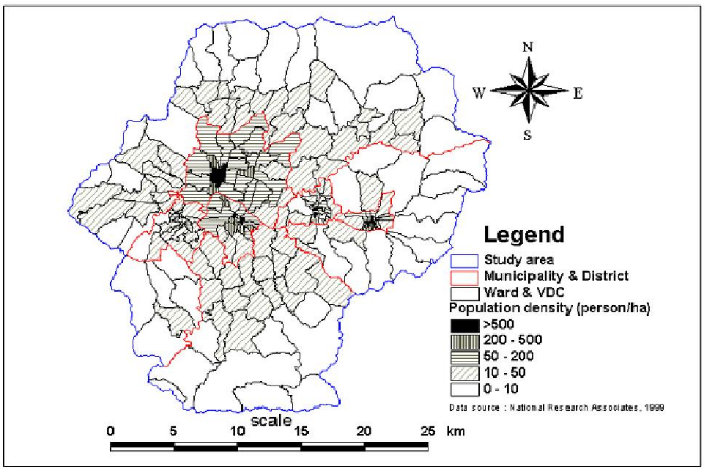

Figure 4 Administrative Boundary and Locality Classification in Kathmandu Valley
Source: Earthquake and Megacities Initiative, 2010

Disaster Risk Reduction in Kathmandu Valley

In 1998, with consideration of potential major earthquake in the future, similar to earthquake in 1934, The Kathmandu Valley Earthquake Management Action Plan was formed. This plan was a part of Kathmandu Valley Earthquake Risk Management Project (KVERMP), conducted by many organization and municipal government in Kathmandu Valley (NSET & GHI, 1998). NSET and GHI were the ones who responsible for the plan implementation. To enhance the implementation success of this plan, NSET and GHI has conducted several activities, such as estimates the damage from future earthquake in Kathmandu Valley through examining the loss if the same earthquake magnitude in 1934 occurs in the future. Besides that, NSET also came up with other safety and risk related programs, such as School Earthquake Safety Program, Nepal Earthquake Risk Management Program, Community-Based Disaster Risk Management in Nepal, Municipal Earthquake Risk-Management Projects, Municipal Disaster Risk Reduction Programs in Nepal, Kathmandu Valley Earthquake Preparedness Initiative, and Kathmandu Valley Earthquake Risk Management Project.

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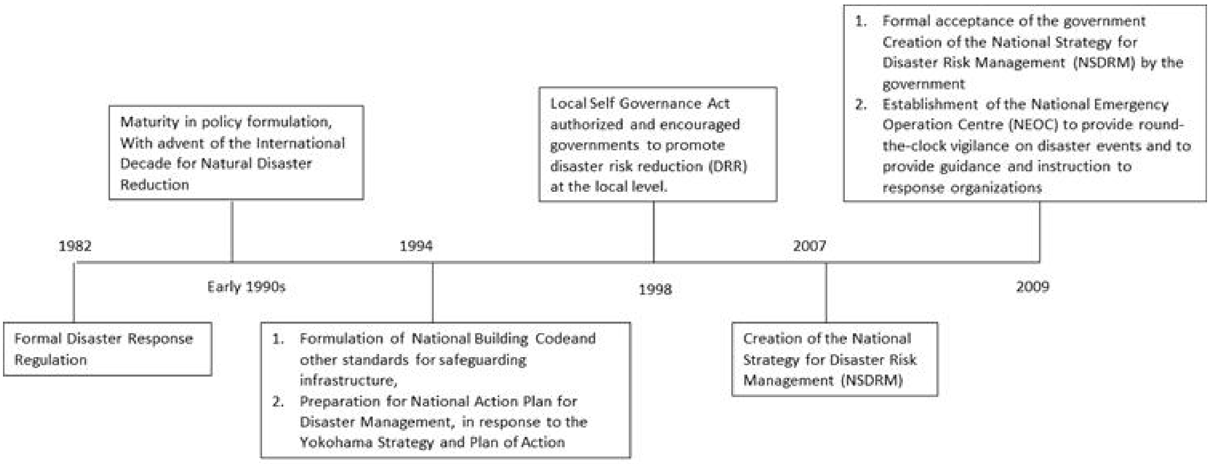

Figure 6 Nepal's Disaster Risk Reduction Timeline

Source:American Society of Nepalese Engineers (ASNEngr), America Nepal Medical Foundation (ANMF), & Computer Association of Nepal–U.S.A. (CAN-USA), 2015

As for programs that focus on enhancing public awareness, there are Earthquake Safety Day, Radio & Television Programs, Shake Table Demonstrations, Orientation Lectures, Consultations for Homeowners, Mobile Earthquake Clinics, Earthquake Vulnerability Tours, and Community-Based Disaster Risk Management Programs.Several disaster risk reduction activities has been organized in Nepal since year of 1982. Here is the timeline of disaster risk reduction activities in Nepal.

3. Discussion

3.1 Kathmandu and Bandung Valleys' Vulnerable Condition Towards Fault Earthquake

This comparison aims to give an image of what community needs to anticipate through learning from other region that has similarities and has exposed by the fault earthquake. Areas around Kathmandu Valley and Bandung Valley have several similarities, which contribute to the process of vulnerable condition formation in each area. Vulnerable condition in Kathmandu Valley was originally formed by the geological condition of Kathmandu Valley and high rate of urbanization, thus high rate of urbanization is the root problem in Kathmandu Valley. High rate of urbanization has triggered the increasing of poverty number in Kathmandu Valley, as well as rapid structural development. Moreover, most of the buildings were an inadequate structural building, that highly prone to earthquake motion.

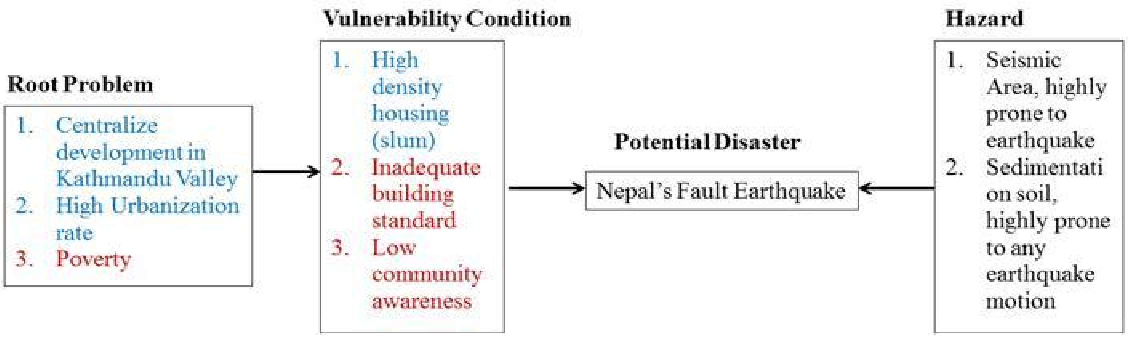

Figure 7 Formation of Disaster Risk in Kathmandu Valley

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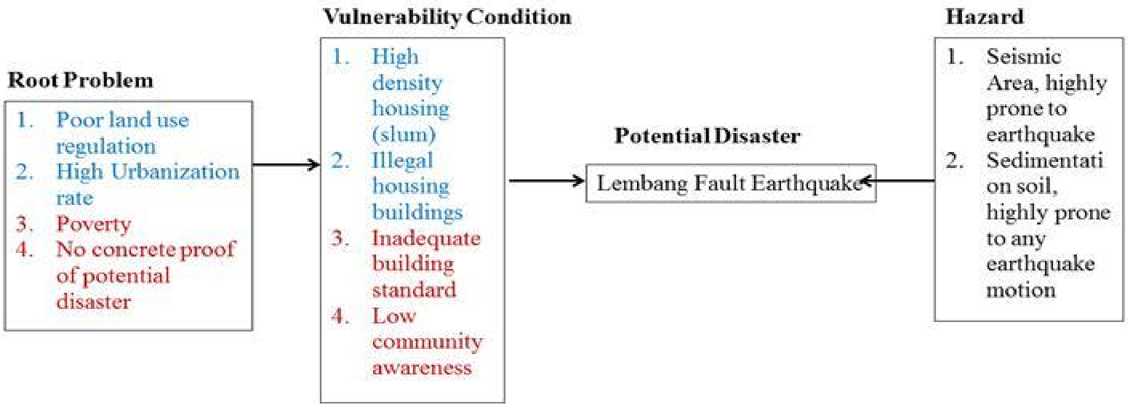

Figure 8 Formation of Disaster Risk in Bandung Valley

Vulnerable state in Bandung Valley area was formed by rapid development in Bandung and Lembang area. Rapid development happened because Bandung and Lembang is one of the main tourism attraction in Indonesia, thus it attracts people to practice their business interest. Most of the constructions in Bandung and Lembang were house buildings, restaurants or cafes, and hotels. There are two main area that will experience the most severe damage from potential Lembang Fault earthquake, they are area in surroundings Lembang Fault and area in Southern Bandung (Bale Endah). Unfortunately, both of the areas were dominated by middle to low income community, a lot of their house buildings are inadequate to earthquake resistant building standards. The main challenge in Bandung Valley that enhances their vulnerability state is the community awareness. Lack of community awareness happened because the actual earthquake has never happened or there is no one that has experienced the earthquake before.

Table 3 Comparison of Disaster Risk Reduction in Kathmandu Valley and Bandung Valley

Region	Vulnerable Condition	Disaster Risk Reduction	Challenges
Kathmandu Valley	High density housing (slum), inadequate building standard	Formulation of National Building Code and other standards for safeguarding infrastructure	• Financing problem to rebuild old buildings and retrofitting. • Update standard for new and modern type of building.
	Low community awareness	Earthquake Safety Day, Radio & Television Programs, Shake Table Demonstrations, Orientation Lectures, Consultations for Homeowners, Earthquake Vulnerability Tours, and Community-Based Disaster Risk Management Programs.	Community with low education level were still facing problem in understanding the disaster risk reduction.
Bandung Valley	High density housing (slum), Illegal housing buildings, inadequate building standard	Revision for disaster map of Indonesia in 2002 and also earthquake-resistant building standard for area near Lembang Fault	• Financing problem to rebuild old buildings and retrofitting. • Violation of land use and disaster map regulation • Update standard for new and modern type of building.

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Region	Vulnerable Condition	Disaster Risk Reduction	Challenges
	Low community awareness	Information dissemination regarding disaster mitigation	• Information was limited to evacuation practice, disaster risk reduction was not included • Communities deny the existence of potential Lembang Fault Earthquake

Nepal and Lembang are not exactly the same, but they have numbers of similarities whether it is in the terms of their potential disaster condition, structural condition, and social condition. What has happened in Nepal could be also happened in Lembang.

4. Conclusion

Bandung Valley has some similarities with Kathmandu Valley in terms of their land use and structural condition (both experienced rapid development with a lot of inadequate housing buildings), and social condition (both were dominated with middle to low income communities). There are several findings in this study about disaster risk reduction in Kathmandu Valley and Bandung Valley, as follows.

1. Both Kathmandu and Bandung were facing the same problem in retrofitting or rebuilding old building construction, because it requires higher cost and most of the old buildings were owned by community with low economic level. To address this challenge, both Kathmandu and Bandung need to create an appropriate financial scheme, such as incentive, particularly for the poor.

2. Spreading the knowledge about the fault earthquake in Kathmandu Valley to community in Bandung might help the community to stop denying and finally understand their

3. Indonesia can imitate what Government of Kathmandu has done to enhance their community awareness and not only limited to evacuation knowledge.

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