Earthquake Hazard and Risk in Nepal

by (Student Name)

Abstract

The continual orogeny processes that created the Himalayan Mountain Range characterize the geological setting of Nepal. As a result, Nepal is subject to reoccurring large-scale earthquakes with an interval of approximately 80 years. Additionally, Nepal's economic status and increased population growth has resulted in poor infrastructure and unreinforced building structures due to high structural demand. Therefore, the combination of the geologic setting and the current population and infrastructure dynamics result in high risk of catastrophic damage with the continually present earthquake hazard.

Introduction

This paper is intended to discuss the hazards and risks prevalent in Nepal. Specifically, this paper will talk about earthquake hazards, historic earthquake events, building code regulations and a brief view of Nepal's earthquake outlook going foreword.

Background

Nepal is located at the convergence of the Indian and Eurasian tectonic plates between India and China and comprises much of the Himalayan mountain range. In fact, 85 percent of the country is considered mountainous (Nepal Disaster Report, 2015). Due to this locale, Nepal frequently experiences earthquakes due to the tectonic setting. The risk of these natural hazards is greatly heightened due to the poor infrastructure of Nepal. The total population of Nepal is estimated to be around 29 million people (Nepal Population, 2017) The largest city, and capital of Nepal is Kathmandu with an estimated 1.5million people in 19 square miles (Nepal Population, 2017). In reference, the size of Davis is 10 square miles with a population of 66,205 people (Census.gov).

With such a large population density, infrastructure failures are drastic. Unfortunately, infrastructure failures are quite common in Nepal as a result of its poor economic status. Due to the regions mountainous nature, only 17% of the land is suitable for agriculture (Nepal Disaster Report, 2015). Therefore, 25% of people live at or below the poverty line as of 2011 (CIA Field Report, 2011). However this number is projected to be higher today due to increased population growth over the last five years. This has resulted in rapid building construction without proper building code adherence to accommodate population growth in the dense urban areas (Joel Achenbach, 2015). In addition, the geologic location of Nepal located in proximity to the Indian and Eurasian plate collision makes it very susceptible to frequent natural hazard recurrences.

The geologic setting of Nepal

The largest influence of earthquake hazards in Nepal is the geologic setting. The reason for the abundance of earthquakes in the region is due to the ongoing orogeny processes creating and shaping the areas mountain range- the Himalayas (USGS, 2015). Roughly 40-50 million years ago these two continental plates of the same density, the Indian plate and the Eurasian plate collided, and the energy was accommodated by the upward movement of the crust, creating the Himalayas (USGS, 2015). Therefore the region is heavily faulted in order to accommodate this movement and is the reason that Nepal experiences many earthquakes.

Furthermore, the movement of the earth as a result of earthquakes is intensified in cities such as Kathmandu due to paleo-geologic settings at one point in time. In fact, Kathmandu resides in the Kathmandu basin (Mughier J.L, 2011). This basin is a relatively unconsolidated sedimentary filled basin, previously a lake. Therefore, any shaking is intensified and is a main factor in building failures and thus casualties (Mughier J.L, 2011).

Earthquakes

Earthquake occurrences in the Himalayan region spark big news headlines – for a good reason. Although earthquakes are not as frequent as the typhoons, considering each year brings a new typhoon season, earthquakes in this region are devastating. Due to Nepal's proximity to the growing mountains of the Himalayas, there have been two earthquakes of note in the last 100 years with catastrophic damages. Theses two earthquakes were an 8.4 moment magnitude in 1934 and a 7.8momemt magnitude in April of 2015 (Access Science, 2015). The time span between these two events is significant. These two dates coincide with the calculated recurrence interval of large earthquakes in the region. In fact, the estimated recurrence interval of an earthquake greater than 8.0 is every 80-100 years. (Kate Ravilious, 2015)

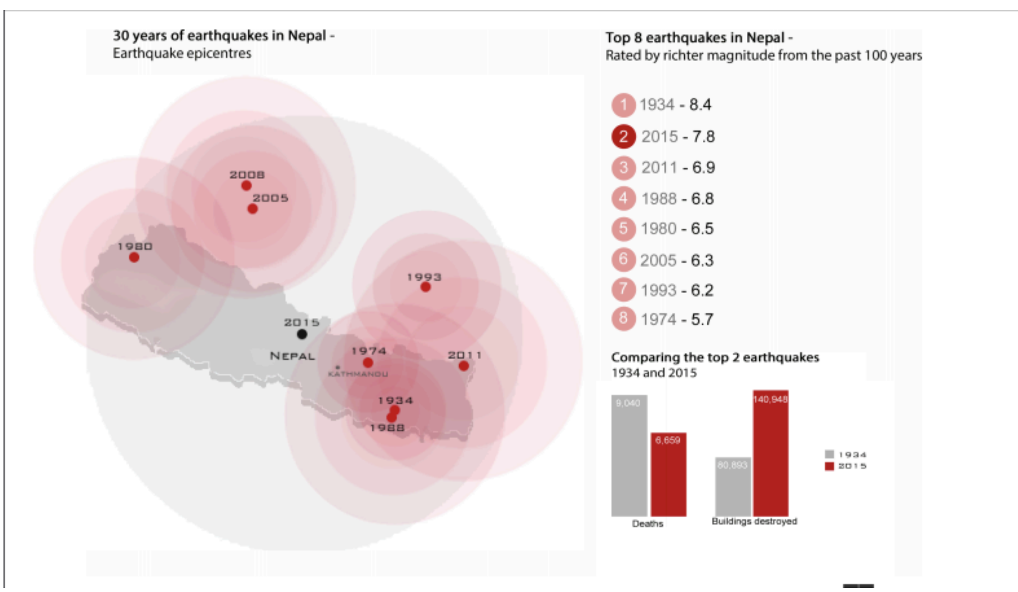
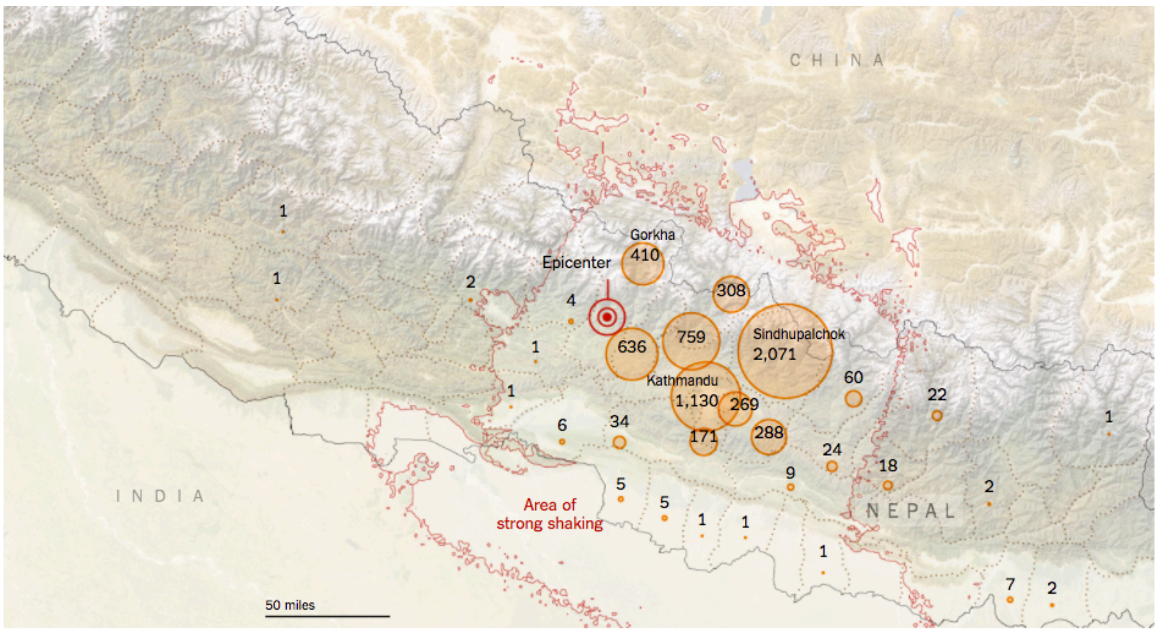


Figure 2: Map showing earthquake epicenters near Nepal in the last 100 years. Source: History of Nepal Earthquakes

The most recent large scale earthquake was a 7.8 magnitude earthquake occurring April 25th 2015 at 11:56am Nepal Standard Time (USGS Earthquakes Hazards Program, 2015). The epicenter was 174km northwest of Kathmandu in the village of Barpak (Arwa Damon, 2015). The focus was at a depth of 8.2km (USGS Earthquake Hazards Program, 2015) and produced relatively low frequency ground motion (Parajuli, Rishi 2015)

Figure 2 contains a graphical representation of the number of casualties and buildings destroyed in the April 2016 earthquake as well as the 1934 earthquake. The number of casualties is estimated to be between 6,000-9,000 (Nepal Earthquake, 2015). It is important to note the timing of this earthquake. The earthquake occurred in the afternoon, during a time when many Nepalese were working and away from structures, reducing the number of deaths. It is suggested that if the earthquake occurred at night that the casualties would have been considerably higher. The estimated number of building destroyed is 510,762 (Nepal Earthquake, 2015). Of the buildings destroyed, some were invaluable World Heritage sites (Nepal Earthquake, 2015)



By The New York Times | Sources: United Nations, U.S.G.S.

Figure 3: Map representing Casualties from the April 2015 earthquake.

In contrast to the 1934 earthquake, the number of casualties was significant less, however the number of buildings destroyed was greater. This can be attributed to an increase in buildings to account for increased population growth. However building codes have not been explicitly enforced resulting in greater structural failures (Joel Achenbach, 2015). Additionally, it is feared that due to the timing of the April 2016 earthquake, the number of casualties is not representative to the potential risks associated with large- scale earthquakes in the region (Parajuli, Rishi 2015).

The April 2016 earthquake also triggered a large avalanche at Everest base camp, killing 21 climbers (Buckley, Thomas 2015). This resulted in an early end to the climbing season and resulted in many Sherpa without income from the climbing industry. In addition, a large-scale avalanche was triggered in the Langtang Valley. 329 people were reported missing after the avalanche (Shrestha, Sahina 2015)

Aftershocks were frequent following the April earthquake. The largest was on May 12th and was a moment magnitude 7.3 (USGS) killing an additional 128 people and destroying buildings that had withstood the April 2015 quake (Manesh Shrestha 2015). It is important to note that the earthquake one-month prior displaced many people – causing people to be in the open air and away from structures (Manesh Shrestha 2015). This resulted in few casualties due to building collapse. Although the May 2015 earthquake was some time after the April earthquake, the slip occurred along the same fault and as such, is considered an aftershock (USGS).

Figure 4: Location of the May 12th 2015 aftershock.

In all, the April and May 12 earthquake equated to $10 billion in damage – roughly 50% of Nepal's nominal GDP (Unni Krishnan, 2015).

Earthquake occurrence in the Nepal region that resulted in a high amount of casualties raises the question regarding building codes. After the 1994 earthquake with a moment magnitude of 6.8, the Nepalese government drafted a Nepal National Building Code (NBC) (Nepal Earthquake Clearinghouse, 2015). Although there is a drafted building code for construction, the implementation of the code is not explicitly enforced (Jason Gale, 2015). Municipalities of Nepal are responsible for enforcing building codes, but only a fraction of the municipalities in Nepal incorporate the building codes into the permit process (Jason Gale, 2015). In addition, villages and urban slums are not required to adhere to the building codes drafted, which require reinforced structural walls. Therefore, when earthquakes do occur, the poorer economic areas are more susceptible to a higher number of casualties and building failures (Jason Gale, 2015).

Conclusion

Ultimately the poor economy of Nepal and the continued lack of enforcement of building codes in more urban, densely populated areas make the risk of large scale eruptions in Nepal catastrophic. With a reoccurrence interval of roughly 80 years, continued population growth could result in even higher casualties. It is unclear whether or not the Nepalese government will begin to enforce more strictly the NBC established or continue to allow for code violations due to such few resources in the developing country. For the time being, the resource demand to adhere to the building codes is unable to satisfy the population growth Nepal is experiencing. Therefore, the risk of earthquakes is greatly heightened due to the lack of building code enforcement and continued population growth with earthquake hazards a guaranteed reoccurring event.

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