Geography 316

Geography of Natural Hazards

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Research Report

The Nepal Earthquake

Word Count: 2485

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1.0 Introduction

One of the worst earthquakes Nepal had ever seen, struck just northwest of the capital Katmandu at 11:56 AM on Saturday, April 25th, 2015. Seismograms recorded an earthquake with a moment magnitude of 7.8 on the Richter scale and IX (Violent) on the Mercalli scale. It affected approximately 8 million people, killing around 8850 people and injuring at least 22,000. The earthquake destroyed homes, historic temples, communication channels, and other crucial infrastructure. The main cause was the subduction of the Indian plate into the Eurasian plate, that led to an excessive strain, and hence the resultant earthquake(s).[1]

Image 1 – The Aftermath of the Nepal Earthquake[2]

Nepal is the eleventh most earthquake-prone country in the world.[3] Being an LEDC (Less Economically Developed Country) meant that neither did it have the infrastructure nor the capacity to cope with such a huge disaster. Moreover, Nepal has been witness to various issues of governance, deforestation, poverty, and urbanization. The complex interaction of several social and physical factors set the conditions for this disaster to strike as fatally and destructively as it

[1] Montgomery, K. (2018, March 15). Quick facts: What you need to know about the Nepal Earthquake.
[2] Nicholas, V. (2015, April 28). [Digital image].
[3] *Nepal Gorkha Earthquake, 25th April 2015* (Rep. No. 336). (n.d.). UK: Curriculum Press.

did. Hence, this paper aims to study this interaction of various factors in order to understand how they work concurrently and increase the vulnerability of populations. It is crucial to study this disaster and scrutinize what went wrong and why in order to understand what aspects of the Nepalese society need to be focused on during rebuilding. The learnings from this case study would also serve as an example for other nations with similar social and physical problems.

With regard to the case study, this paper will address the whole disaster cycle. First the causes and impacts of the Nepal earthquake will be assessed in order to understand how and why the population was made vulnerable. Then, the response to the disaster and its efficiency will be examined to understand how vulnerability was further exacerbated in a time of need. And finally, the measures Nepal has taken to rebuild for the future will be evaluated to understand what problems it still needs to address. Following is a Pressure and Release Model (PAR)[4] for the Nepal earthquake. This model evaluates how Root Causes are translated into Unsafe Conditions with various Dynamic Pressures acting upon them. Hence, it is a very simple yet effective way to understand the vulnerability of a population struck by disaster.

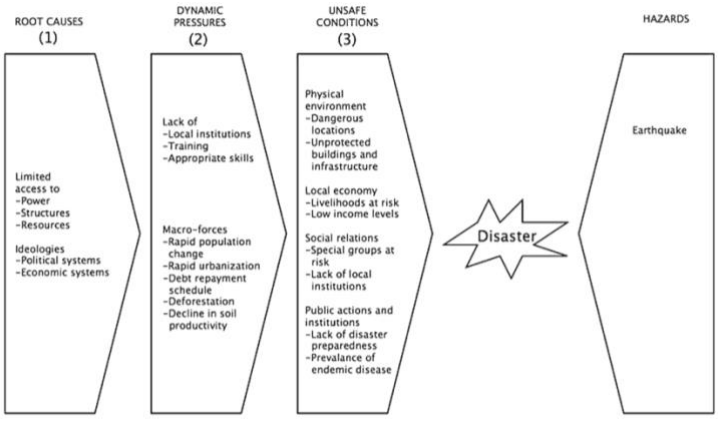

Figure 1 –Nepal's PAR Model[5]

[4] Blair, A. (2018, April 6). *Vulnerability and Resilience*. Lecture presented at GEOG 316 in UBC, Vancouver.

[5] Blair, A. (2018, April 6). *Vulnerability and Resilience*. Lecture presented at GEOG 316 in UBC, Vancouver.

2.0 Root Causes and Un-Even Impacts

Apart from the primary hazard - the earthquake itself that led to this disaster, there were various other directly and indirectly induced secondary hazards that further increased the vulnerability of the population. These secondary hazards have been divided into Physical and Social factors. While Physical factors have been analyzed with an aim to understand what physical processes further affected people, the Social factors were examined with an aim to recognize how and why the population was impacted disproportionately

2.1 Physical Factors

2.1.1 Landslides

A mountainous terrain, coupled with intense deforestation, and multiple tremors set the ideal conditions for multiple, region-wide landsides. The landslides proved to be quite fatal with the main shock initiating several mudflows, rock falls, and avalanches. It was estimated that the landslides killed about 2000 people in an instant. While being situated in a valley was not under peoples' control, the wide-spread deforestation was. Nepal has lost over 70% of its forests to timber export.[6] It is known that deforestation directly leads to slope failure through reduced root cohesion and hence reduced shear strength of the slope.[7] Furthermore, the landslides also produced flash floods, as collapsed debris blocked several stream channels. Thousands of people were known to have been evacuated due to this threat. Fortunately, yet ironically, owing to climate change the landslides weren't as deadly as expected. The region's struggle with a prolonged period without rain actually meant that the ground was not very saturated and was hence much more

[6] Nepal Forest Data and Figures. (n.d.).
[7] Blair, A. (2018, April 6). *Mass Movements*. Lecture presented at GEOG 316 in UBC, Vancouver.

stable than it would be during the monsoons. Geological surveys also found that a majority of the rocks were stronger than expected and therefore reduced vulnerability to a great extent.[8]

Image 2 – Resultant Landslide from the Earthquake[9]

2.1.2 Basin Geomorphology

With about half a million buildings destroyed, numerous residential buildings, hospitals, institutions, cultural heritage sites, and crucial infrastructure were lost. Given that the focal regions that were impacted lay within a valley, structural damage evaluators found that, "*the damage was concentrated in a few pockets*"[10]. The geomorphological map of the Kathmandu valley reveals that that these regions are situated directly above river deposits, hence favouring the amplification of seismic waves. Therefore, given that a majority of the population was situated in this 'acceleration-sensitive' region, several buildings collapsed, leading to widespread devastation. Apart from that, the construction of infrastructure along the banks of rivers also made them highly vulnerable to

[8] *Nepal Gorkha Earthquake, 25th April 2015*(Rep. No. 336). (n.d.). UK: Curriculum Press.
[9] AFP. (2015, May 14). [Digital image].
[10] Rai, D. C., Singhal, V., S., B. R., & Sagar, S. L. (2015). Reconnaissance of the effects of the M7.8 Gorkha (Nepal) earthquake of April 25, 2015.

liquefaction, flooding, and slope failure. However, basin amplification of seismic waves is actually a hazard faced by several communities, such as the community residing in the Los Angeles Basin. The distinction lies in the fact that the structures built in such regions have stable foundations and are in sync with the resonant period of the amplified seismic waves. Hence, such advanced practises ensure minimal damage to property, reducing vulnerability. [11]

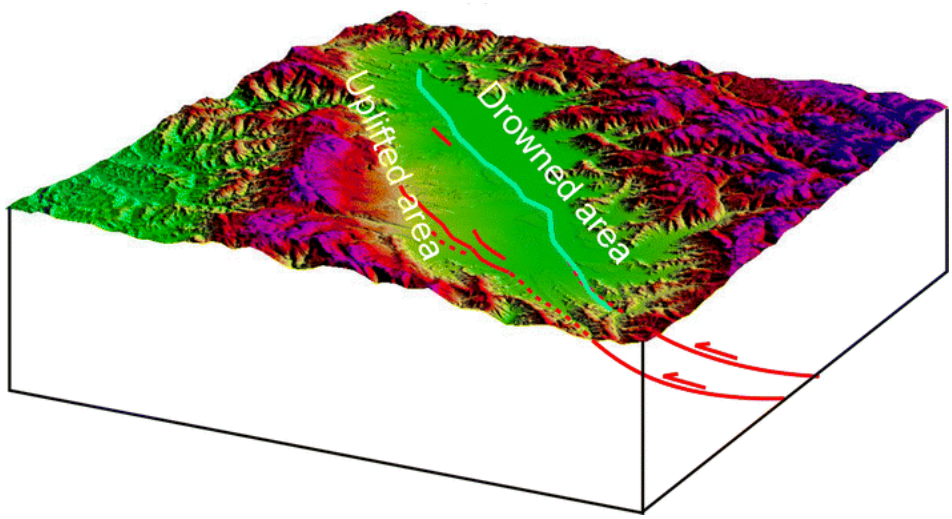

Image 3 – A STRM of the Nepal Valley's Tectonic Geomorphology[12]

2.1.3 Accessibility

"*Excessive unplanned urban growth leads to many vulnerabilities and impacts on urban environments to varying degrees*".[13] While accessibility was not a secondary hazard, it was a barrier that prevented aid from reaching victims when they needed it most. Therefore, it was a factor that exacerbated vulnerability by inhibiting the timely receipt of crucial assistance for victims in need. It was simply a physical problem of emergency vehicles not having enough space

[11] Rai, D. C., Singhal, V., S., B. R., & Sagar, S. L. (2015). Reconnaissance of the effects of the M7.8 Gorkha (Nepal) earthquake of April 25, 2015.
[12] Shah, A. (2013, February 28). [Digital image].
[13] Bhattarai, K., & Conway, D. (2010). Urban Vulnerabilities in the Kathmandu Valley, Nepal.

to access regions in need due to the narrow and crammed lane system. Moreover, several landslides and rubble from the collapsed buildings only further created blockages on such vital roads. The authors of the paper, Urban Vulnerabilities in Nepal establish that, *"unplanned developments often lead to a variety of urban vulnerabilities, that taken together, make public solutions difficult if not impossible to anticipate, ameliorate or address adequately*." [14] Hence, owing to the uncontrolled growth, a lack of planning, and poor enforcement by the government, these inefficient and unevenly spread spatial arrangements severely hindered accessibility.

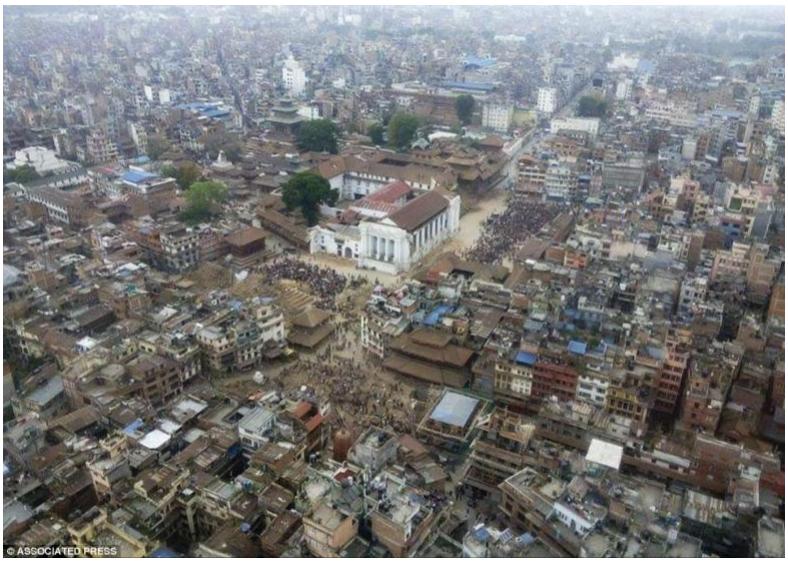

Image 4 – The Urban Housing Cluster in Nepal[15]

2.2 Social Factors

2.2.1 Migration

Rapid and un-controlled urban sprawl in the Kathmandu Valley, ensued as the Maoist insurgency worsened in the rural areas in 1996, threatening these people and forcing them to migrate into the

[14] Bhattarai, K., & Conway, D. (2010). Urban Vulnerabilities in the Kathmandu Valley, Nepal.
[15] Packer, J. (2015, April 27). [Digital image].

Valley for safety. As a result, "*the lack of any planning was exaggerated, leading to inappropriate land-use, increased traffic congestion, loss of open space, unmanaged waste disposal, political upheavals, road network over-loads, and institutional grid-lock*".[16] Therefore, with the rapidly increasing demand for housing, limited space, and a lack economic capital, in-numerous 'shanty settlements'[17] were built without any proper urban and infrastructure planning. Eventually, several agricultural lands, river basins, and open spaces were consumed to meet these housing demands, leading to an extremely high concentration of people in a small, "*haphazardly planned urban fabric.*"[18] The impact of this urbanisation is very visible, with increasing air and water pollution, deteriorating ecological sustainability, loss of cultural heritage, and poor infrastructure.[19] Inevitably, this unplanned urbanisation created a very complex organization of multi-dimensional vulnerability, making it nearly impossible to employ mitigation practices as the whole system itself was fundamentally inefficient.

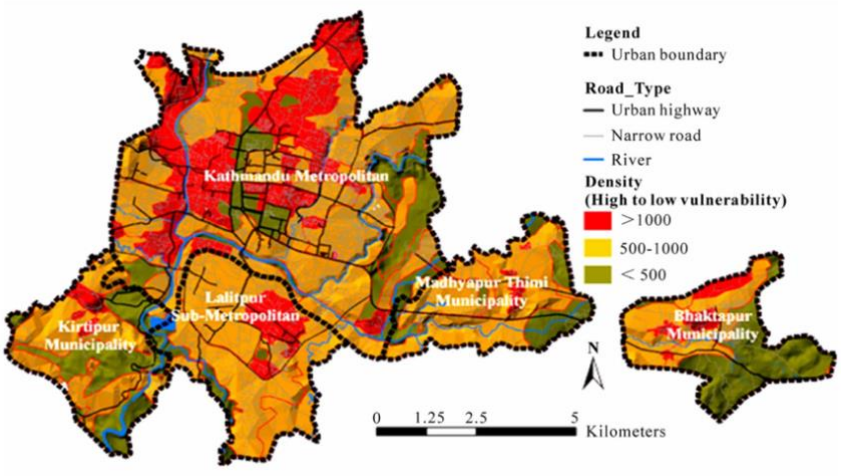

Image 5 – Katmandu's Population Density and Vulnerability[20]

[16] Bhattarai, K., & Conway, D. (2010). Urban Vulnerabilities in the Kathmandu Valley, Nepal.
[17] GCSE Bitesize: Shanty towns. (n.d.).
[18] Jigyasu, R. (2002). *Reducing Disaster Vulnerability through Local Knowledge and Capacity.*
[19] Jigyasu, R. (2002). *Reducing Disaster Vulnerability through Local Knowledge and Capacity.*
[20] Bhattarai, K., & Conway, D. (2010). Urban Vulnerabilities in the Kathmandu Valley, Nepal.

2.2.2 Intersectionality

It is known that vulnerability is highly dependent on the characteristics of a human being i.e. on their race, gender, class, economic capacity, etc.[21] A press release by the World Health Organization revealed that, "*women and babies were more susceptible to injuries and health issues, due to the lack of healthy food and water paired with conditions of poor sanitation*."[22] Moreover, a higher number of women and children were killed just from being inside the house during the earthquake. Spatially, people who lived in poor quality housing in rural areas or in regions situated on lake sediment were severely affected. In terms of economic disparity, subsistence farmers were most affected as all their livestock was lost, and grains destroyed.[23] Another study found that, "*Tibeto-Burman people were hardest hit as they inhabit the higher slopes of mountains as opposed to the central valleys and are less educated and connected*."[24] Hence, as with any disaster, the effects of the Nepal earthquake were also distributed unequally amongst the local population.

Image 6 – A Mother with her Child after the Earthquake[25]

[21] Blair, A. (2018, April 6). *Key Concepts and Approaches to Hazards*. Lecture presented at GEOG 316 in UBC, Vancouver.
[22] WHO. (2015, April 28). Women and children most vulnerable in Nepal earthquake.
[23] *Nepal Gorkha Earthquake, 25th April 2015*(Rep. No. 336). (n.d.). UK: Curriculum Press.
[24] April 2015 Nepal earthquake. (2018, April 06).
[25] DW. (2015, July 22). [Digital image].

2.2.3 Governance

The frail and yet high-priced housing has made it unaffordable for most Nepalese people and hence forced them to squat on open lands, "*constructed along the ecologically sensitive and marginal areas, such as riverbeds and lowlands, waste dumps, and along dangerous or untenable flooding areas without proper access to clean water, making them extremely vulnerable to life-threatening events and conditions*".[26] Most of these spontaneous houses built with local materials in the Kathmandu Valley have been built with little regard for building regulations, seismic codes, and regulations. Moreover, the existing legislature itself is insufficient and ineffectual in controlling such practices. Apart from governance, it is also simply the fact that infrastructure has not been designed in a smart manner. For example, "*drinking water pipes often follow the narrow winding streets and run parallel to sewage pipes making service maintenance difficult*" [27], and also greatly increasing the potential of freshwater contamination during a disaster. Hence, improper and inefficient governance greatly increased the vulnerability of the Nepalese people.

Image 7 – Shanty Settlements alongside a River in Nepal[28]

[26] Bhattarai, K., & Conway, D. (2010). Urban Vulnerabilities in the Kathmandu Valley, Nepal.
[27] Rai, D. C., Singhal, V., S., B. R., & Sagar, S. L. (2015). Reconnaissance of the effects of the M7.8 Gorkha (Nepal) earthquake of April 25, 2015.
[28] Dreamstime. (2007, April 5). [Digital image].

3.0 Preparation and Response

"*Our government is not strong enough to handle this, we must take care of it ourselves*", said Kshitiz Nyaupane, a local from Kathmandu.[29] Nepal was under no circumstances prepared to deal with an earthquake of such magnitude. The nation has been resource-trapped with an inefficient government that is still recovering from issues of the past. Nepal's political system has been distressed by historic tendencies of tension, inefficiency and, instability. "*A decade-long civil war sparked off by a Maoist rebellion ended in 2006, and the monarchy that had ruled Nepal since the 1700s was abolished in favor of parliamentary democracy. The competing and highly divisive factions of Nepali politics have been unable to come to an agreement on a constitution since then, and issues like disaster preparedness have taken a backseat amid an impasse that has lasted nearly a decade."*[30]

Right after the earthquake, Nepal declared a state of emergency and made an appeal for international aid. The international community of countries and organizations promptly started working towards raising money, delivering aid and relief, sending rescue teams, and other post-disaster essentials. However, Nepal's complex geology and geography of urbanization made it rather difficult to access several regions in need. "*The airport was closed, roads and bridges damaged, tonnes of rubble blocking the streets and alleys of Kathmandu. Water supply pipes, electricity infrastructure was all rendered unusable while food, water, fuel, and medical supplies were all still stuck in the trucks*".[31] Hence, while Nepal itself was not prepared, its rampant growth only made response trickier, wasting crucial time and further increasing vulnerability.

[29] Iyengar, R. (2015, April 28). Nepal Earthquake: Thousands Died Due to Poverty, Political Turmoil.
[30] Iyengar, R. (2015, April 28). Nepal Earthquake: Thousands Died Due to Poverty, Political Turmoil.
[31] Chughtai, S. (2015, April 26). Nepal was made vulnerable by more than its violent geology.

4.0 Rebuilding for the Future

'Two years and $4.1 Billion' after the disaster, in 2017, Al Jazeera examined Nepal's rebuilding efforts in order to evaluate what was accomplished with respect to assisting the locals get back to leading a normal life. Sadly, they came to the realize that, *"Nepal was falling short of that goal because of poor coordination between government and donors, a lack of understanding of local concerns, and a dearth of civic engagement."*[32] While the government failed to coordinate with various ministries for the rebuilding process, several donors had not yet met their promised aid targets either.

It was established that the rebuilding process lacked transparency, and that nobody in the public spectrum was aware of how it was going to span out. "*The process, however, is onerous. Only 12 percent of the money has been distributed. Only 544,996 families have received their first payment, which is only 17 percent of the total government grants for house building. Just 20,889 homes had been rebuilt as of April 6, according to the National Reconstruction Authority*."[33]

Apart from the process rehabilitation, it is also imperative for the government to evaluate what made their population so vulnerable and address those aspects of society - in order to reduce losses when the next disaster strikes. Most of these vulnerabilities could have been mitigated with the employment of various simple and obvious strategies. There was scope for mitigation in every aspect, be it physical, social, or political.

In terms of Physical aspects, landslides in such a geographic setting were imminent. Had the government recognized this, they could have installed various mechanisms to prevent debris falls,

[32] Adhikari, N. (2017, April 25). Nepal's earthquake disaster: Two years and $4.1bn later.
[33] Adhikari, N. (2017, April 25). Nepal's earthquake disaster: Two years and $4.1bn later.

reinforced weak and important buildings, strictly regulated deforestation, educated and trained people, or even just installed an early warning system built along with earthquake-proof bunkers to protect the locals. Moreover, in the long-run what really needs to be paid attention to is the uncontrolled urbanization, because if anything, it was this that made people most vulnerable before, during, and even after the disaster.

In terms of Human aspects, Nepal needs to ensure that no group is affected disproportionately. "*A deeply rooted caste system meant that the Dalits (lowest caste) are at risk of not receiving appropriate aid."*[34] Such ideologies that divide society need to be countered by education, reasoning, and protective laws. Furthermore, the resilience of individual communities can be increased by educating them about a disaster and its prevention and promoting practices of social cohesion at all community levels. Social cohesion through community networks has proved to reduce vulnerability of people in a community, irrespective of their characteristics.[35] Because if the government is unable to help everyone, at least the communities can help themselves.

In terms of Political aspects, the Nepalese government needs immediate restructuring to curb corruption and the inefficient bureaucracy. The government has the greatest role in protecting the lives of its people. In the coming years, it is imperative that they revise their legal and institutional procedures, strictly enforce laws to protect its fragile environment and people, and improve disaster preparedness.

[34] *Nepal Gorkha Earthquake, 25th April 2015*(Rep. No. 336). (n.d.). UK: Curriculum Press.
[35] Blair, A. (2018, April 6). *Key Concepts and Approaches to Hazards*. Lecture presented at GEOG 316 in UBC, Vancouver.

5.0 Conclusion

"*A core belief in Hinduism is that nature cannot be destroyed without humanity destroying itself."*[36] Urbanization, deforestation, and inefficient governance are issues that have persistently troubled Nepal. To build its resilience, Nepal needs to start working promptly and address issues faced by its people and environment through effective and faithful governance. Without addressing such fundamental matters, Nepal will be vulnerable to such a catastrophe again as, "*certain decisions taken as part of rehabilitation not only reinforce pre-disaster vulnerabilities but also create new ones."*[37]

The purpose of this paper was to understand the interactions of physical and social factors in creating multidimensional vulnerability. The inferences drawn from this case study can help understand problems in other, "*rapidly urbanizing cities of the Third World, which share similar socioeconomic conditions and environmental contexts*".[38] Hence, further studies must aim to study and understand the complex interactions of these factors in greater depth, in order to devise mitigation strategies that cater to the needs of such fragile systems.

[36] Nepal Earthquake Case Studies. (2015).
[37] Bhattarai, K., & Conway, D. (2010). Urban Vulnerabilities in the Kathmandu Valley, Nepal.
[38] Bhattarai, K., & Conway, D. (2010). Urban Vulnerabilities in the Kathmandu Valley, Nepal.

6.0 Sources

6.1 Annotated Bibliography

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The authors of this peer reviewed journal article examine the physical factors that lead to the made Nepalese vulnerable and eventually led to disaster. The findings are presented in high detail and are based on field surveys and observations by the authors. This source is important as it examines the root causes of the disaster with respect to basin geomorphology and the lack of building regulation and structural weaknesses. The source seems very reliable and hence it will help support theories about the physical processes that led to the natural disaster and also devise future mitigation practices.

Jigyasu, R. (2002). *Reducing Disaster Vulnerability through Local Knowledge and Capacity. The Cace of Earthquake Prone Rural Communities in India and Nepal*(Unpublished master's thesis). Norwegian University of Science and Technology. Retrieved April 6, 2018, from https://brage.bibsys.no/xmlui/handle/11250/230996

This source is a thesis published by Norwegian University of Science and Technology. It examines the, “past and present status of local knowledge, skills and capacity of rural communities in India and Nepal for reducing their vulnerability to earthquakes”. The thesis has a heavy focus on urban sprawl and how it made the Nepalese highly vulnerable. There is also an emphasis on sustainable practises of rural communities that should be embedded into society as a part of the rebuilding

process. The source covers the topic in high detail and will help focus on what community systems failed and how they could be improved.

Bhattarai, K., & Conway, D. (2010). Urban Vulnerabilities in the Kathmandu Valley, Nepal: Visualizations of Human/Hazard Interactions. *Journal of Geographic Information System,02*(02), 63-84. doi:10.4236/jgis.2010.22012

The authors of the peer reviewed Journal article study the historic context of the Valley's uncontrolled urbanization and examine, "the geographical features of the resultant urbanized Valley landscape". The article will help understand about how urban sprawl and its resultant issues was one of the biggest factors that made people vulnerable. Hence, it will also help understand what issues to address during rebuilding. The source seems quite reliable and has a great amount of contextual details.

Nepal Gorkha Earthquake, 25th April 2015(Rep. No. 336). (n.d.). UK: Curriculum Press. Retrieved April 6, 2018, from https://www.queenelizabeths.derbyshire.sch.uk/PDF/sixthform/work-2017/Geography - Nepal Gorkha earthquake.pdf.

This piece of literature is a summation of every aspect of the disaster in Nepal. It was prepared by a British Curriculum support material company and hence seems reliable. The strength of the document lies in the fact that it delineates summarizes everything about the earthquake, from causes to impacts with a good focus on both physical and social factors. Hence, it is crucial as it

will help guide this research paper and ensure that the analysis of the issues is the right direction. However, it is not very academic and hence reliable only to a certain extent.

WHO. (2015, April 28). Women and children most vulnerable in Nepal earthquake. Retrieved April 06, 2018, from http://www.who.int/life-course/news/nepal-earthquake/en/

This source is a press release by the World Health Organization (WHO) and is hence highly reliable. It examines in detail the social factors that led to women and children being selectively affected and hence assesses what made them so vulnerable. It will be useful for the research paper as its investigation of social factors will help better understand differential vulnerability to the disaster. Hence, with respect to rebuilding practises the source gives a concrete aspect of society to work on in order to reduce vulnerability.

Nepal Earthquake Case Studies. (2015). Retrieved April 06, 2018, from http://journeys.dartmouth.edu/NepalQuake-CaseStudies/environment-and-climate-change/

This source is a website of a collective project by Dartmouth University that, "explores the human impacts of these (Nepalese) disasters by asking students to engage in collective research and writing of case studies focused on specific areas of inquiry related to the earthquake." The source is hence highly reliable. It will help gain an insider perspective in order understand vulnerability better from the perspective of the locals and assess what aspects of Nepalese society and governance needs to be focused on during rebuilding.

Montgomery, K. (2018, March 15). Quick facts: What you need to know about the Nepal Earthquake. Retrieved April 06, 2018, from https://www.mercycorps.org/articles/nepal/quick-facts-what-you-need-know-about-nepal-earthquake

This source is a simple factsheet that summarizes the natural disaster with statistics. The source seems to reliable as it was prepared by Mercy Corps, a reputable non-government organization. The source has a lot of useful statistics that cover quite a few aspects of the Nepal earthquake. Apart from that, the source has a great set of photographs of the damage, recovery efforts, etc. which would be quite useful if included in this research paper.

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AFP. (2015, May 14). [Digital image]. Retrieved April 6, 2018, from http://www.presstv.com/Detail/2015/06/11/415336/Nepal-landslide-Taplejung-Surendra-Bhattarai-earthquake

April 2015 Nepal earthquake. (2018, April 06). Retrieved April 06, 2018, from https://en.wikipedia.org/wiki/April_2015_Nepal_earthquake

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DW. (2015, July 22). [Digital image]. Retrieved April 6, 2018, from http://www.dw.com/en/nepals-quake-survivors-face-increased-risk-of-trafficking/a-18599390

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Jigyasu, R. (2002). *Reducing Disaster Vulnerability through Local Knowledge and Capacity. The Cace of Earthquake Prone Rural Communities in India and Nepal*(Unpublished master's thesis). Norwegian University of Science and Technology. Retrieved April 6, 2018, from https://brage.bibsys.no/xmlui/handle/11250/230996

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