

Assessment of social vulnerability to seismic events: The case of Khuma, North West Province

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Mini-dissertation submitted in partial fulfilment of the requirements for the *Master of Arts in Development and Management* at the North-West University

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Graduation: May 2018

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ACKNOWLEDGEMENTS

Firstly, to God the glory. Jesus, I give you all the praise, for the work on this dissertation was not easy...

This study was fulfilling because of the outstanding people I worked with throughout my studies. Firstly, I would like to thank Professor Dewald van Niekerk for always offering me guidance and encouragement when I felt lost and confused. I would take your constructive criticism hard and thought that you hated me but you were hard on me because you knew I had potential; I had to read and work hard to realise that and therefore I thank you. Thank you for reading my confusing drafts and offering insightful comments, making me feel like I'm a good researcher but at the same time telling me to read more and learn to write objectively. Secondly, I would like to thank the North-West University for the Master's bursary and South African Special Risk Insurance Association (SASRIA) for funding my research project. Special mention must be made of Professor Annette Combrink for being a divine source of strength and a mentor since my coming to the NWU (Potchefstroom Campus). Thank you for the uplifting conversations, support, reading my drafts and offering valuable comments and language editing for my dissertation.

A would also like to thank Gideon Wentink for helping me with my data analysis and to express my gratitude to the African Centre for Disaster Studies team for giving me the opportunity and exposure to become a better researcher and academic. My thanks to Farzanah Loonate for always accepting my assignments and chapters even when I was late; you were so understanding and encouraging when I felt overwhelmed and stressed. Thanks also to Lefa Mothupi from the Matlosana Disaster Risk Management Centre for helping me get to the prominent households and communities for my data collection. A special word of dedication goes to my parents Phumla and Mogkele Letshabo for their loving support.

Thanks to my best friends Kaylin Lovell, Pusetso Sekike and Bianca Schoeman for always being there to support, advice and share knowledge, which encouraged me to do better. Thanks also to the households of Khuma that took part in the study. I would also like to thank the City of Matlosana council employees for letting me do my interviews. I thank everyone who supported me with silent prayers even without me knowing. Thank you all for believing in me and my dreams.

ABSTRACT

Keywords: social vulnerability, disaster risk reduction, Orkney, risk assessments, seismic events

Seismic events are a reality in many vulnerable communities, and significantly affect people's living conditions. As these events cannot be prevented, basic measures should be taken before they occur and expose households to danger. Assessing social vulnerability using risk assessment is the fundamental concern of disaster risk reduction, which among other things looks at population growth and urbanisation. In terms of household awareness and hazard identification of vulnerable people in Khuma, the capacity to relocate people to safer living areas due to the dolomitic environment surrounding the township is important. This case study investigates the poor understanding that exists in terms of the socio-economic vulnerability of communities exposed to seismic events at local government level in South Africa, which in this case is Khuma, located in Klerksdorp, North West Province, South Africa. Studies in recent years have shown that seismic events are among the most devastating natural phenomena, leading to loss of life and damage to property in the affected areas. Social vulnerability is influenced by many aspects, and this case study explores the impact of seismic events on the poor households of Khuma. On 5 August 2014, the mining area in Orkney, a mining town situated in the Klerksdorp District in the North West Province of South Africa, experienced a strong seismic event that was felt all over the country, and even in neighbouring countries. Seismic activity impacts are usually gradual and unnoticeable on the surface; however, immense stresses can build up between tectonic plates and are likely to adversely affect poorly constructed houses. This case study should help provide a better understanding of the social vulnerability faced by households in Khuma. In these unpredictable times, it is necessary to plan and be ready to mitigate the vulnerabilities faced by households due to unexpected hazards. Therefore, the study uses the PAR model as a tool to discuss social vulnerability concepts and the root causes of social vulnerability. The findings strongly suggest that households in Khuma are socially vulnerable. This is due to the fact that the findings of the study support the PAR model in the social vulnerability concepts and the root causes that expose societies to socio-economic vulnerabilities.

OPSOMMING

Sleutelwoorde: sosiale kwesbaarheid, ramprisikovermindering, Orkney, risiko-assesserings, seismiese skokke

Seismiese skokke is 'n realiteit in baie sosiaal-kwesbare gemeenskappe, en het 'n groot impak op mense se lewensomstandighede. Aangesien sulke voorvalle nie voorkom kan word nie, moet basiese stappe geneem word voor die seismiese gebeure plaasvind sodat huishoudings nie aan nog meer gevaar blootgestel word nie. Die assessering van sosiale kwesbaarheid is 'n fundamentele bron van kommer as dit kom by risiko- en rampbestuur. Dit wek kommer in terme van die bevolkings- en verstedelikingsrisiko's wat die inwoners van Khuma in die gesig staar. In terme van huishoudings se bewuswees en die identifisering van kwesbare mense is daar in Khuma 'n gebrek aan kapasiteit om mense te verskuif as gevolg van die dolomietgevaar. Hierdie studie ondersoek die swak begrip wat daar in terme van die sosio-ekonomiese kwesbaarheid van gemeenskappe wat blootgestel is aan seismiese voorvalle op die vlak van plaaslike regering in Suid-Afrika, en hier met spesifieke verwysing na Khuma. Studies in die afgelope paar jaar het aangetoon dat seismiese skokke lei tot groot skade in die areas waar dit plaasvind, dit lei tot lewensverlies in die areas waar dit plaasvind en rig groot skade aan infrastruktuur aan. Dit word gevoel dat 'n beter begrip van die sosio-ekonomiese kwesbaarheid sal lei tot beter ramprisikovermindering, beplanning en ontwikkeling. Op 5 Augustus 2014 is die Orkney-gebied ('n myndorp in Klerksdorp in die Noordwesprovinsie in Suid-Afrika) geskud deur 'n sterk aardbewing wat dwarsoor die land en selfs in aangrensende lande gevoel is. Sosiale kwesbaarheidsaspekte word hierby betrek, en hierdie gevallestudie ondersoek die impak van die seismiese skok op arm huishoudings. Seismiese skokimpakte is gewoonlik stadig en word nie noodwendig op die oppervlak waargeneem nie, maar hewige spannings word opgebou tussen tektoniese plate en dit het normaalweg 'n baie hewiger invloed op swak-geboude huise. Hierdie gevallestudie behoort te help om 'n beter begrip te vorm van die sosiale kwesbaarheid van huishoudings in Khuma, sodat die belanghebbendes en die regering die toepaslike inligting bekom om die impak wat deur hierdie mense in die gesig gestaar word te verminder. Dus ontleed hierdie studie ook die konsepte van kwesbaarheid en die gebruik van die PAR-model as 'n metode om die sosiale kwesbaarheid van huishoudings in Khuma te ondersoek. Die assessering van sosiale kwesbaarheid van huishoudings in Khuma vertoon 'n hoë en vergelykende patroon in huishoudings in terme van die impak van sosiale kwesbaarheid. Die assessering van sosiale kwesbaarheid word na verwys in terme van die biografiese en sosio-

ekonomiese patrone in die betrokke kwesbare gemeenskappe. Veertien sleutelkwesbaarheidskonsepte is geïdentifiseer en ontleed in terme van die literatuur en toe verder gebruik as sosiale kwesbaarheidselemente vir aanbevelings en gevolgtrekkings. Die bevindinge het oortuigend aangetoon dat huishoudings in Khuma inderdaad sosiaal kwesbaar is.

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CHAPTER 1 : ORIENTATION AND PROBLEM STATEMENT

1.1 INTRODUCTION

Earthquakes are among the most devastating and unpredictable occurrences in Mother Nature (Okal et al., 2011:135). They can be massive and destructive and affect people, livelihoods, the economy, the environment, and infrastructure. Earthquakes occur daily all around the world and usually manifest in the form of small tremors (Monaco & Tortorici, 2004:109). Seismic events are a reality in many vulnerable communities, which significantly affect people's living conditions. They cannot be prevented, hence, basic measures should be taken before they occur and expose households to danger.

Assessing social vulnerability using risk assessments is a fundamental concern for risk and Disaster Risk Reduction. The concerns are mainly in terms of population growth and urbanization which households in Khuma are faced with today. Social vulnerability is becoming a big concern for many vulnerable households. In this regard, poverty and unemployment have been the main reasons contributing to household vulnerability. Furthermore, the lack of understanding of hazards faced by vulnerable households has led to them being socially vulnerable without being aware of the fact (Armas, 2008; Basolo et al, 2015). Despite this, households in Khuma are also exposed to seismic events. The vulnerability of these households is partly influenced by social factors and inequalities that shape or influence their exposure to harm and also govern their ability to respond to environmental threats.

The purpose of this study is to investigate the understanding that exists in terms of the socio-economic vulnerability of communities exposed to seismic events at local government level in South Africa using Khuma as a case. The study focused on the socio-economic vulnerability attributes that made the community of Khuma vulnerable to the seismic event that occurred in 2014. This study draws from the work of Martins et al. (2012), that an awareness that disasters and risk are processes structured on spatial-temporal interactions maintained by the social-ecological system between the natural

hazards and the vulnerabilities of socio-economic, political and physical nature is important in the increase of social systems' resilience. It is therefore anticipated that a better understanding of the socio-economic vulnerability to seismic events will lead to better disaster risk reduction planning and development. This chapter is structured as follows: having introduced the main issues necessitating the study, the chapter moves on to demarcate the study problem. The chapter then outlines a number of research questions and study objectives that will help address the study problem. This is followed by a description of the central theoretical statements on which the study is grounded.

The research strategy adopted in this study which entails an analysis of existing literature and the empirical evidence is outlined in section 1.6 of this chapter. Before the conclusions are drawn, the chapter considers the limitations and delimitations of the study and also maps the structure of the thesis to make it easier for the reader to follow the study.

1.1.1 Background in the study area

The township of Khuma was established in 1958 on a farm, Wildebeespan, belonging to the late Mr Motsoenyane. The plot had previously been known as Makweteng. The original name of Khuma was Khumo which meant "riches or wealth" but the name changed to Khuma Location when the township began to develop. Between 1958 and 1969 there were many structures (municipal houses today known as Reconstruction 8 Development Program (RDP) houses, shacks and loan or bank houses) that were built to help the formation of the township.

However, the mine committee (mine, farm and construction workers) were the major contributors to what Khuma is today and it helped build the community structure. With the sinking of Scott Shaft, would-be employees rushed from all over the country to the Khuma Location. Education of the children took place on an informal basis. The first school in Khuma was known as Wildebeespan Bantoeskool (known today as Khuma Primary School). The school was moved to better buildings and was from then on known as Tukisang Primary School (second school in Khuma). The population of the

township grew with new extensions established, such as extensions 6, 7, 8, 9 and 11 around 1995 and 2015 in order to accommodate the growing number of people. This study is concerned with a seismic event that took place in the Dr. Kenneth Kaunda District Municipality in 2014. The seismic event that struck Orkney on 5 August 2014 recorded a 5.5 magnitude on the Richter Scale and resulted in massive structural damage and one death in the Matlosana region, North West Province (Gallo, 2014). This tremor is known as the largest mining-related earthquake in the history of South Africa after the 2005 Hartebeesfontein mine seismic activity led to losses of lives the closure of the mine (Secombe, 2014).

Although four cities and townships were impacted on by the event, Khuma was most affected due to property damage and the disturbance of people's livelihoods (SAPAb, 2014:1). In order to understand the impact of the seismic event, the disaster risk management centers of the City of Matlosana, the Dr. Kenneth Kaunda District Municipality, and other government departments conducted rapid risk assessments (Zeng and McMechan, 2006). The major incident recorded was the massive damage to property, as hundreds of houses collapsed and were then declared unsuitable for a living (SAPA, 2014a). Thousands of people were displaced to community halls around Orkney. Two schools were damaged in Khuma. According to Van Niekerk (cited in Gallo, 2014), the earthquake was an indication that the earth's crust was under stress.

He emphasized this by saying that this could be influenced by what was happening in the Great Rift Valley, in the north-east of Africa, where violent seismic activity was reportedly gradually tearing the continent in two. The following section will be the background of the study. The following section will be an overview of seismic risks

1.2 SEISMIC RISKS: AN OVERVIEW

Seismic events are among the most devastating and unpredictable occurrences known to Mother Nature (Okal et al., 2011:135). They can be massive and destructive as they affect people's livelihoods, the economy, environment, and infrastructure. Despite this, seismic events occur daily all around the world and usually manifest in a form of small

tremors (Bilham, Gaur & Molnar, 2001; Monaco & Tortorici, 2004:109). This may lead to great damage to the areas in which they occur, leading to the loss of lives and damage to property (Shear, 2009:45).

Seismic events are unpredictable as to when they occur (Gallo, 2014). Furthermore, a sudden slip in the earth's crust causes the earth to shake which leads to the huge destruction of society through which people's livelihoods and property are destroyed. Most earthquakes occur at fault zones, where tectonic plates (giant rock slabs that make up the earth's upper layer or crust) collide or slide against each other (Zeng & McMechan, 2006:89; Bischoff et al., 2013). These impacts are usually gradual and unnoticeable on the surface; however, immense stresses can build up between plates (Boshini & Frangopol, 2012). When this stress is released quickly, it sends massive vibrations, called seismic waves, often hundreds of miles through the rock and up to the surface. For an earthquake, the seismic source can be described as a sudden release of energy during movement on a fault (Hudyma, 2007). The energy released during an earthquake is accumulated by the relative movement of the two sides of the fault. The accumulation of the energy continues until the limit of the rock's strength along the fault is reached. A seismic event can therefore be described as a sudden release of energy in the earth's crust, resulting in a series of waves, whereby the first wave is the primary wave known as the compression wave, followed by the secondary wave which is responsible for most structural damage and the surface wave which hits last (Sileny & Mileva, 2006; Sen, 2013).

Although not at high risk of frequent seismic events, South Africa is to some extent prone to earthquakes (Tankard et al., 2009:1389). A number of tremors in South Africa are associated with mining activities (Shane & Booth, 2005:199). The tremor events in South African mines include earthquakes, rock bursts, pillar bursts and tensile cracks, to name a few (Bischoff et al., 2010:68). These tremors have resulted in buildings collapsing thus claiming many human lives. The tremors are also compounded by mudslides, fires, floods or tsunamis (UNISDR, 2013; Hudyma, 2007:56). Smaller tremors that usually occur in the days following a large earthquake can complicate rescue efforts, and cause further death and destruction (Monaco & Tortorici, 2004:117).

Loss of life can be avoided through emergency planning, education, and the construction of earthquake-resistant buildings that sway rather than break under the stress of an earthquake (Basolo et al., 2015). SAPA (2014) suggests that new technologies are being developed all over the world to help reduce the devastating effects of tremors. There is now the development of earthquake warnings (Smith, 2016:1) that provide better protection and give more accurate predictions of seismic disasters. For instance, disaster risk reduction strategies are applied by using base isolation and vibration control technologies in construction (UNISDR, 2013).

However, it is government's legal responsibility to ensure that experienced and qualified contractors are hired for quality and adequate housing (Dow, 2013). Human settlement defines people's environment, these are the places where people learn, work and sustain their livelihoods (Eakin & Bojorquez-Tapia, 2008). Safe housing implies that houses have fewer exposures to risks and can protect people from hazards. Seismic risks have become an increasing concern due to uncontrolled developments, unmonitored mines, and faulty construction practices especially government housing (Lindell, 2000; Smith, 2006; DWA, 2009). The government has attempted to reduce vulnerability by building houses with better building materials and devising housing plans for poor societies. This assisted in disaster risk reduction because altering the natural environment has an impact on reducing casualties, property damage, and socio-economic disruption after a hazard (UNISDR, 2013).

However, there is a challenge to improving seismic safety as households do not have information on how to decrease their vulnerabilities (Vogt et al., 2012; Wisner et al., 2012). This is where governments and stakeholders should get involved in pre-impact adjustments which include hazard mitigation, emergency preparedness and insurance purchase (Gibbons & Ringdal, 2006; Green & Neuberg, 2006:158). Hazard mitigation practices provide an active protection when an unexpected hazard occurs, this approach assists in support and response after impact (Cannon, 2008:348). This is where household insurance purchase becomes significant in terms of a household's financial impact as it may help cover property damage and sustain livelihoods (Ismail, 2014:56). The effects of environmental hazards are a universal danger in many

communities (Boschini & Frangopol, 2013:429; UNISDR, 2013; Wisner et al., 2015). Although hazard risk may occur anywhere, it impacts more strongly in less developed areas, hence urban environments are vulnerable to substantial losses during seismic events (Monaco & Tortici, 2004:112). This indicates that communities should learn how to prepare for hazards even if they are not vulnerable they might be exposed to unexpected risks; The impact of natural disasters on urban residents and their communities can be mitigated through effective local emergency planning and preparedness (Tankard et al., 2009:1380).

Natural disasters occur worldwide, however, their impact is greater in developing countries, where vulnerability to disasters is high (Alcantara-Ayala, 2002:108). It is now widely accepted that disasters are a product of a natural hazard impacting on a vulnerable population (Cannon, 2008: 350). However, the value of the concept of vulnerability is meaningful when coming to hazards because of its complex interactions with political and economic processes that generate vulnerabilities in the first place (Davies, 2014).

In terms of where people live and why they live there, one needs to explore the idea that many people may live “at risk” because they might not be aware of the exposure, stressors, and shocks they are exposed to (Cannon, 2008:351). In some places, there is evidence of a significant degree of choice involved in living in dangerous places (Hyndman & Hyndman, 2009:44). The vulnerability is used analytically to show that people are exposed to risk because of particular personal (household or community) characteristics that make them likely to be affected by natural hazards.

The scientific use of vulnerability has its roots in geography and natural hazards research but this term is now a central concept in a variety of another research context such as public health, poverty, sustainability, climate change impacts and adaptation (Fussel, 2007:155). Social vulnerability in this study was conceptualised as the inability and exposure of societies to withstand adverse impacts from multiple stressors due to lack of coping capacities, poor environmental threats and losses that have an impact on vulnerable households (Bischoff et al., 2013; Wisner et al., 2015:155; Smith, 2016).

Brookes (2005) suggests that one can only talk meaningfully about the vulnerability of a specialized system to specified hazards or range using a conceptual understanding such as the Pressure and Release (PAR) model, and to distinguish between current and future vulnerability. Luera et al. (2003, cited in Fussel, 2007:156) argue that vulnerability assessments should shift away from attempting to qualify the vulnerability of a place and focus instead on assessing the vulnerability of selected variables of concern and to specific sets of stressors.

The problem under investigation is the poor understanding that exists of the socio-economic vulnerability of communities exposed to seismic events at local government level in South Africa, such as the case of Khuma. A better understanding of the socio-economic vulnerability will lead to better disaster risk reduction planning and development. It is essential that regulatory laws be enforced for unexpected hazards that could potentially expose people to seismic hazards. Despite the huge financial promises made by government and stakeholders, there have been poor responses and actions to alleviate the impact of seismic events in South Africa, putting households at risk (Davies 2014). In essence, disasters reflect vulnerabilities and root causes of hazards. People make the best choices from several alternatives and take actions regarding hazards based on their personal perception of risk rather than on some objectively and scientifically derived measure of threat.

Below is a figure of the location of the area of study:

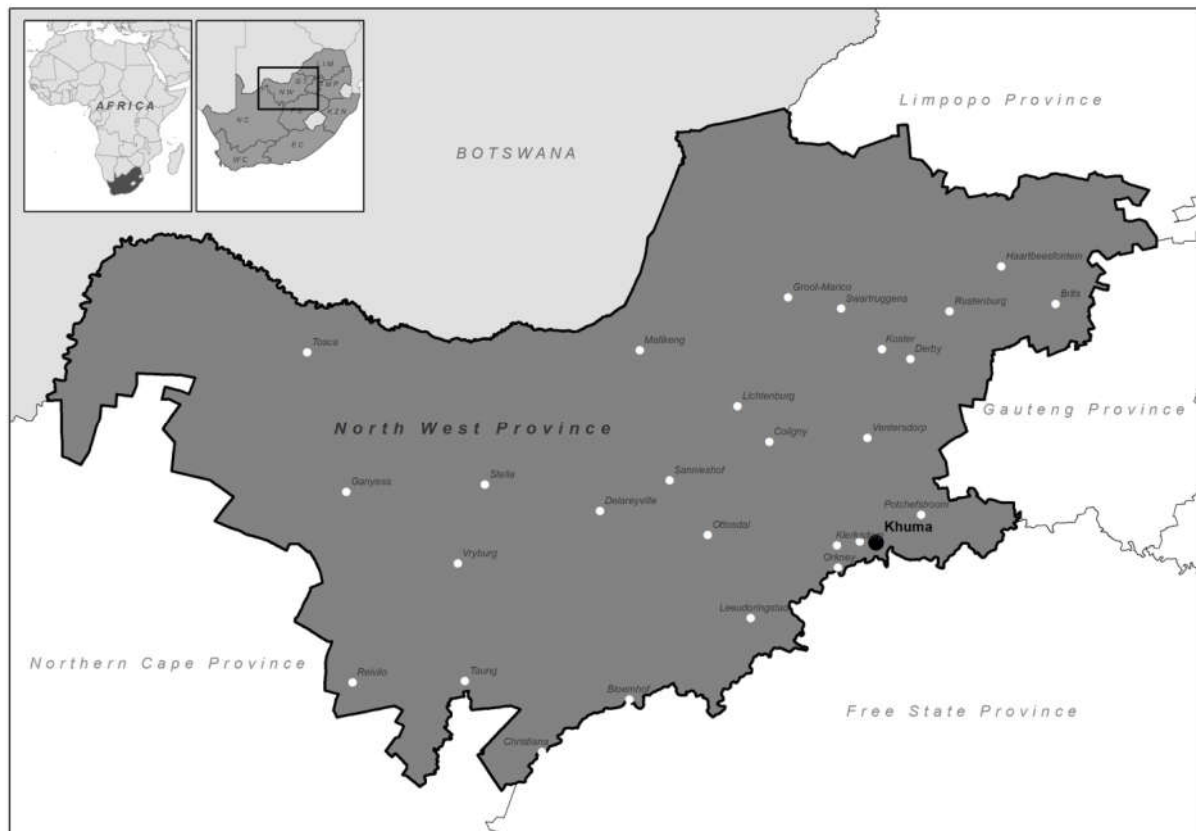


Figure 1.1: Location of Khuma

(Source: Own reproduction)

Khuma is a small township situated in the Dr. Kenneth Kaunda District Municipality of the North West Province of South Africa. It lies between Potchefstroom and Klerksdorp, falling under the Matlosana Local Municipality. Khuma came into being due to mines and agricultural activities in the area including Orkney, the Vaal River and Stilfontein (SAPAb, 2014). Khuma was intended to be a small township and its infrastructure was designed for a correspondingly small population, but the current population is estimated at 67 000 with 11 000 households and it is still growing. The houses in the area are mainly old municipal houses and RDP houses which are households for the small

nuclear family, consisting of two bedrooms. Despite the government assistance with RDP houses post-1994, people still have shacks in their yards due to a serious lack of housing. The first mine in the area was called Margaret Mine, then followed by Tony Shaft and Scott, Hartebeesfontein Goldmine (known as Harties) and then finally Buffelsfontein Mine was established. Tony Shaft was right next to Khuma, due to the economic growth and development, while Margaret Shaft and Scott Shaft had built their own villages, and the mines were later called Stilfontein Goldmine. The significance of the influx of people led to unplanned settlements in these settlements, and houses were badly built.

When the National Party took power in 1948 they introduced laws such as the Group Areas Act which compelled black people to reside in group areas according to their ethnic groups. The township also had its own “group areas” development, hence there is an area called Queenstown, a section for Xhosa-speaking people and the Maseru section for Sesotho and Setswana-speaking people. Most people on the extensions are very versatile linguistically as you find people speaking four to five languages. This led to a mixture of different cultures and beliefs among people. In addition, one can argue that South Africa’s history of social exclusion has led to a strong sense of entitlement to housing post-1994. Because of massive backlogs and housing pressures nationally, most people do not have adequate access to running water and service delivery. Khuma falls within the Matlosana region, Dr. Kenneth Kaunda District Municipality. Khuma has eight public primary schools and four high schools. The infrastructure in Khuma is poor as most extensions have one main road and the other small streets are not paved.

The socio-economic activities in Khuma include small-scale farming, but with high unemployment and crime rates in the area, most people rely on the mines for employment. Communities are diversified, with people from Swaziland, Lesotho, Zimbabwe, Mozambique, Somalia, Iraq, China and Bangladesh. Most of small businesses, apart from taverns and nightclubs, are owned by foreigners who live in Khuma. Due to this, the locals often fight with the foreign and illegal immigrants, as they feel that they are taking their jobs. In terms of the environmental impact, the underlying

dolomite on which Khuma is situated is the main contributor to the physical vulnerability the community faces. Dolomite is prone to the formation of sinkholes due to a fluctuation in water levels, over-exploitation of the water table and the leaching of groundwater that has been polluted, forming a weak carbonic acid that erodes the dolomite. Extracting large amounts of water from the water table raises the chance of dolomite to form in the area in question (Department of Water Affairs, 2009). Earthquakes are an uncommon phenomenon in South Africa; however, the Khuma area experienced earth tremors before in 2005. The event occurred on 9 March 2005 at DRD GOLD'S Hartebeesfontein Mine in Stilfontein. The Council of Geosciences described the 2005 earthquake as having been of a magnitude of 5.3 on the Richter Scale in the same area as Orkney as one of the largest mining-related earthquakes in South Africa (CGS, 2014). The mining regulatory body found that the incident that caused the event had been influenced by mining activities added to seismic events that would recur if mining continued (Cordeur, 2014 and SAPA, 2014a).

The investigation suggested that the mines should be closed and monitored and this was to be implemented with immediate effect. Since then, thousands of people have been left unemployed as mining was the biggest industry in the area (Webb, 2006). The after-shock of the magnitude 5.3 seismic event on 9 March 2005 in the Klerksdorp District of South Africa (Durrheim, 2006) affected the nearby town of Stilfontein, injuring 58 people, and caused serious damage to buildings in the area. In the process of evacuating 3200 mine-workers under difficult circumstances, two miners lost their lives (Lizer et al., 2007:421; Durrheim, 2006). The subsequent seismic activity was the 2014 seismic event which was the largest recorded mining-related earthquake in South Africa. The seismic event was felt throughout the country from the Western Cape, Northern Cape and Mpumalanga (Malehmir *et al.*, 2014:426).

1.3 SEISMIC EVENT OF 5 AUGUST 2014

The 2014 Orkney seismic event took place on 5 August, at 12:22:33 CAT, the event took place in a small gold mining town called Orkney, situated in the Matlosana region (Dr. Kenneth Kaunda District). The Council of Geosciences (CGS) assigned the tremor

a magnitude of 5,5 on the Richter scale - the biggest tremor experienced since 2005 in a small town called Stilfontein in the same area. According to the CGS experts, what made the tremor so dangerous was that it was felt all around the country including neighboring countries and 84 aftershocks were reported up until 31 August. However, it was later confirmed that the seismic event was mine-related and the area is known to be prone to seismic waves. While both natural faults and mining activity might be contributing factors to the seismic event, it was not possible clearly to identify the initial cause of the event as they are comparatively common in mining areas. An examination by the CGS was that the same event might happen again sooner or later. The magnitude of the event damaged thousands of houses in and around Orkney. The damage was made worse by the poor infrastructure of the area, which rendered households vulnerable.

Table 1.1: Seismic event description

Date and time	5 August 2014
Magnitude	5,5 (Local) according to the Richter Scale
Depth	5 km (varying throughout the country)
Region	Orkney (Khuma) - Matlosana, North West
Casualties	1 dead and 34 injured

The problem under investigation is to determine the socio-economic vulnerability attributes of the Khuma community exposed to seismic events, these factors contributed to the household social vulnerability during the 2014 earthquake. It is anticipated that a better understanding of the socio-economic vulnerability will lead to better disaster risk reduction planning and development. The problem under investigation as presented in the following discussion was further explored through addressing several key questions as outlined below.

1.4 RESEARCH QUESTIONS

The key questions the research aims to answer are:

- What is the theoretical grounding of socio-economic vulnerability?
- What is the incidence of seismic events in the Dr Kenneth Kaunda District Municipality?
- What are the socio-economic vulnerabilities of exposed communities to seismic events in Khuma?
- What recommendations can be made for better socio-economic vulnerability reduction in the light of future seismic events in Khuma?

Answers to these questions were provided through both theoretical study of the literature and empirical perspectives of the affected communities and government officials. In line with these research questions, the next section outlines the objectives of the study.

1.5 RESEARCH OBJECTIVES

The objectives of the research are to:

- Research and explain the theoretical grounding of socio-economic vulnerability.
- Describe the incidences of seismic events in the Dr Kenneth Kaunda District Municipality.
- Determine the socio-economic vulnerability of exposed communities to seismic events in Khuma.
- Recommend possible interventions for vulnerability reduction to seismic events in Khuma.

These objectives were achieved within the context of the theoretical statement outlined below.

1.6 CENTRAL THEORETICAL STATEMENT

The case study focused on two central theoretical statements as the basis of the research. The first theory used was the PAR Model. In this case, the research argument maintains that hazard is a natural phenomenon that affects societies differently depending on the way a society is planned. Disasters are an outcome of different indicators (concepts) of social vulnerability which are root cause of social habitats. The second theory is the social vulnerability concept, which indicates that there are certain characteristics which influence the ability of people to withstand the effects of hazards (Mutombwa, 2015:18). These settings are known as social vulnerability concepts. Social vulnerability occurs under many conditions and some of these conditions include the presence of poverty, unemployment, gender, age, urban/rural and education.

However, some of these concepts are interrelated with hazard impact on vulnerable households based on the vulnerability which contributes to exposure of social vulnerability. Seismic events have become an important topic for societies, governments and policy-makers concerned with disasters and disaster risk reduction (Greenhalgh & Manukyan, 2013; Zadehetal, 2014; Gallo, 2014). Although most causes of disaster originate from nature and the economy, these causes lead to vulnerabilities that some people are still unaware of in terms of disasters they are prone to and how to prepare and plan for them to be resilient (Fussel, 2007). Disasters' impact on societies differs depending on what kind of social vulnerability people are exposed to (citation needed). Understanding the PAR Model and social vulnerability concepts in relation to Disaster Risk Reduction will assist governments and societies to include socio-economic impacts in their disaster preparedness plans (Wisner et al, 2012).

In other words, “understanding socio-economic vulnerability leads to better disaster risk reduction” and this includes the need for a strong and consensual framework for vulnerability analysis in a participatory approach from government, stakeholders and community members as they are the driving forces of vulnerability as well as stressors (Canon, 2008:156). Peduzzi et al. (2009) maintain that creating better disaster risk reduction plans and strategies lead to better assessment methods for seismic events

and mitigating vulnerability and this reinforcement fills gaps of knowledge among societies as an intervention to reducing vulnerability. The following section provides the type of research approach used, the methodology employed and indicates how the data was collected.

1.7 METHODOLOGY

The purpose of this section is to present and describe the research methodology to be used in the study. The methodology used in this study comprises a literature study, tools utilised in the study, a discussion of the theoretical paradigms and an empirical investigation. A mixed method was used in allocating quantitative and qualitative data obtained through questionnaires and focus group discussions were the basis of the study. This study applied a mixed method research design underpinned by the use of both qualitative and quantitative data collection and analysis (see Chapter 3 for a detailed research methodology). Data sources including both secondary and primary sources were used.

1.8 LITERATURE REVIEW

A wide range of legislative documents, books, theses, dissertations, newspapers, academic articles, and policies were consulted as a basis for reviewing the literature. The study relied on the reports from municipal and provincial government departments, and assessments conducted by the Provincial Disaster Risk Management Centre. The literature review assists in developing a detailed description of the conditions and events prior to and following the seismic event. The aim of the literature review was to identify theory based on the PAR Model, social vulnerability and the socio-economic impacts the seismic event had on households.

1.9 EMPIRICAL INVESTIGATION

The empirical investigation process involved using research techniques to investigate concepts and observations made (Lunga, 2015). The research utilised experiences and perceptions raised by various government departments and role players. It is through a

case study approach that collection methods and instruments were used to collect data. Using the mixed method, the researcher conducted focus group interviews and questionnaires to document the information, and a case study was used to discuss and analyse the findings. This was done to identify the socio-economic vulnerability drivers faced by households.

1.9.1 Case study investigation

A case study research design aims to test theoretical models by applying them to a real-life situation. It works as a tool which can be used to analyse a specific instance of a study. In this case study, the Pressure and Release Model of Wisner *et al.* (2004) was used to determine the progression of vulnerability prior to and following the seismic event. Using different sources to collect household data, the researcher was able to enhance the relativity of data. The case study aimed to identify the underlying causes, dynamic pressures and unsafe conditions present in exposed households, which contributed to social vulnerability. It was crucial for the researcher to use a mixed methods approach as it enhanced peoples' perspectives and provided a numerical value to support the documented evidence.

1.9.2 Sampling

Sampling implies that there was a procedure for selecting and identifying the right participants for the study. A random sampling approach was used for administering the questionnaires. However, purposive sampling was used to achieve the objective of the study, i.e. affected households and stakeholders that took part in the seismic event (Mason 2002:124). Sixty households were randomly selected from the current list of affected households maintained by the Department of Human Settlements. These households formed part of the qualitative and quantitative survey, and government stakeholders were purposefully selected as they took part in the risk assessment of the event. This means that the case study selected practitioners based on the information required for the aim of the study. The semi-structured questions used to attain information from ten officials offered a great advantage to data saturation.

1.9.3 Data collection

A qualitative and quantitative survey was developed and administered to the 60 randomly selected households. The studies methodological approaches will fully be described in chapter three. Including how the research principles were applied and to ensure consistency all through the collection process. The survey was based on the Pressure and Release Model whose objective is to provide insight into the progression of vulnerability to seismic events in the Khuma area.

1.9.4 Data analysis

Data analysis indicates the way in which data is allocated and managed. Semi-structured interviews were used, following interesting trails and responses that participants give in the conversation in order to obtain more information (Flick, 2014:208). Questionnaires were used to gather rich data from households. It was crucial for the study to involve data analysis after the allocation of data and record significant comments made by the respondents. Semi-structured interviews help the participants express their own views and experiences of the event and its impact whereby the participant's perception is reliable and helps the researcher compare data (Sarantakos, 2013:359). The process was necessary as it was important to note prominent social issues raised by the respondents. Questions were categorized using vulnerability concepts and the PAR Model (progression of vulnerability). In the context of this case study question, themes were derived from the social vulnerability concepts and the theoretical framework of the PAR Model. Occasionally, the methodology was used to cater for the study limitations which follow below. Some participants would not complete the questioners and add some would add information which was good for the study but not beneficial to the studies objective.

1.9.5 Limitations and delimitations

The limitations of the study refer to conditions that limited the study. In this case, there was no room for generalisation as the researcher has to use data collected to analyse the data collected from the questionnaires and semi-structured interviews. This was

because the questions were context specific but had external influences in this case disaster are a natural phenomenon. However, the outcome of the case study was limited to represent a specific area and examined a particular issue. The outcomes of the study and the input provided by participants cannot be generalised to all communities as the only community surveyed in Matlosana was Khuma. The study also focuses on vulnerability assessments undertaken after the seismic event that led to damaged infrastructure. As a result, the scope of the study has been limited to questionnaires and semi-structured interviews. As a consequence, the findings are not necessarily applicable to all affected households, as only government houses (i.e. RDP, old municipal houses and cheap housing) were considered in the study.

1.10 CHAPTER LAYOUT

This dissertation consists of five chapters and the contents of each chapter are explained below.

1.10.1 Chapter 1: Introduction

This chapter is an introductory section that provides an overview of the dissertation and outlines the problem statement. Furthermore, it provides justification of the themes that are introduced for the purpose of this dissertation.

1.10.2 Chapter 2: Literature review

This chapter establishes a relation between two theories: the progression of vulnerability (PAR Model) and social vulnerability concepts. It also explores and evaluates the reviews of household vulnerability and risk assessments using social vulnerability concepts and the dynamic pressures of the PAR Model.

1.10.3 Chapter 3: Research methodology

The author used both quantitative and qualitative research designs. This approach is used to collect information and analyse the data, these two research designs suited the case study investigated. The methodology includes both questionnaires and semi-

structured interviews supported by historical information and literature. The research methodology enabled the author to organise the study and interrelated social vulnerability concepts to the PAR Model.

1.10.4 Chapter 4: Empirical findings

This chapter is embedded in the vulnerability themes identified in the literature and explains the methods followed to conduct the research. It also outlines the empirical outcomes of the analysed data and provides an overview of the findings of the study based on the objective of the research paper based using thematic analysis.

1.10.5 Chapter 5: Conclusion and recommendations

The main findings of this research are drawn from recommendations within the fields of DRR strategies and seismic assessment and can serve as a tool to inform and assist disaster managers to prepare better for vulnerable communities. Conclusions and recommendations relating to the integration of PAR Model and social vulnerability are covered. The main themes used to outline the findings were used as the basis for the formulation of recommendations and future opportunities for disaster risk reduction.

1.11 CONCLUSION

Seismic events affect communities differently, and they also have different influential impacts on people's livelihoods. Although such vulnerabilities usually originate from socio-economic structures (social vulnerabilities) they also have an impact on how households are exposed to vulnerabilities and hazards such as seismic events. In addition, reducing hazard exposure and disaster risks in vulnerable households improves their livelihoods and reduces their impact to seismic events. It is there for significant that disaster practitioners, government and households integrate to ensure that the seismic impact is assessed and prepared for future hazard. There should be a platform for households to know and be made aware of vulnerability factors contributing to disaster risks and seismic events. Disaster risk reduction initiatives should be used to

reduce, identify and prepare for seismic events in future. The following chapter will contain a literature review.

CHAPTER 2 : LITERATURE REVIEW

2.1 INTRODUCTION

Social vulnerability is one aspect that can expose societies to Disaster effects (Mutombwa, 2015). In developing hazard identification plans, it is important to ensure that various aspects are taken into consideration to maximise disaster risk reduction strategies (Rashid & Weeks, 2003; Wisner *et al.*, 2015). There are certain factors that are likely to influence vulnerability in terms of a wide variety of hazards in different geographical and socio-political contexts such as developmental factors that include, among others, poverty, health status, economic inequality and elements of governance (Wisner *et al.*, 2014).

When working with communities that suffer losses from unexpected hazards such as seismic events at a local level, brings about mixed perceptions when coming to risks that are why it is crucial for community members and government officials to participate in social vulnerability assessments after disasters (Lunga, 2015). However, vulnerability concepts affect people in the same society differently depending on where they are located and the kind of infrastructure which supports them (DWA, 2009). Despite the delivery of almost two million houses since 1994, there is still a lack of housing which leads to social vulnerability as people do not have access to adequate and secure housing (Ackerman, 2014:10). The government has attempted to provide mass housing through RDP projects on marginalised land using low-density layout models. This result has led to housing risks, including unsustainable housing environments and poverty entrapment (SAPA, 2014).

Vulnerability has many different connections, depending on the research orientation and perspective (Dow, 1992; Cutter, 1996, 2001). Therefore, two main theories have been proposed in the central theoretical statement of this research to better explain and analyse social vulnerability to seismic events in the Dr. Kenneth Kaunda District Municipality. Disaster risk management experts have argued that enabling communities

to define their own susceptibility to loss and then empowering them to address that susceptibility is critical for disaster reduction (Ellemore, 2005; Wisner, 2004). Although the literature covers a wide variety of vulnerability issues, the main focus of this study is on the impact of social vulnerability on households. This chapter focuses on understanding and determining social vulnerability and also investigates the impact of the socio-economic issues faced by households. The PAR Model and Social Vulnerability theory will be used. It is important to understand the meaning of the key terms used in the questions, as they will be mentioned throughout the study.

2.2 VULNERABILITY AND SOCIAL VULNERABILITY

The United Nations International Strategy for Disaster Risk Reduction (2013:36) describes vulnerability as the characteristics and circumstances of people, societies, systems or assets that influence their capacity to predict, resist, cope with and recover from the adverse effects of destructive events (Rygel *et al.*, 2005 World Bank 2010). Vulnerability can be regarded as a measure of proneness to disaster, along with the ability to withstand or react to adverse consequences of disaster events (Boin & Hart, 2006; McEntire, 2011, cited in Mutombwa, 2015:39). Wisner *et al.* (2004:11) suggest that “vulnerability is characterised by a person or group and situation that influences their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard”.

Vulnerability measures integrate the environmental, social, economic and political exposure to potential harm (Cutter, 2003; Fussel, 2007). In other terms, vulnerability describes how a susceptible a group or society is to adverse events like hazards and disasters (Fekete *et al.*, 2010). Vulnerable groups are usually at high risk of being affected by disasters as they have a hard time in the rehabilitation process due to a lack of resources (Garikipati, 2008). Over the past decades, social vulnerability has had many different connotations and merely labeling a population vulnerable has not been useful (Cutter, 2003:176). For example, marginalisation and disempowerment of some social groups depend on the circumstances of the community, systems, and assets that make it sustainable to the damaging effects of a hazard (Ellemore, 2005:4). For Wisner

et al. (2003), vulnerability means the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard, which can be either an extreme natural event or a process (Anderson, 2000 & Oliver, 2004). The social vulnerability of a household or society has a bearing on their capacity to withstand the adverse effects of hazards and disasters (Hudyma, 2007). To guide understanding, the Pressure and Release (PAR) model is employed to explain how certain social groups find themselves in a vulnerable state and how vulnerability progresses. Vulnerable conditions exist because of pressures on individuals and communities. Social vulnerabilities impact differently on different communities, and the extent of the effects depends on the livelihood cycle of the community in question (Mogotsi *et al.*, 2012:50).

Pressures affecting a community can, therefore, be identified because structures and processes can that create or alleviate vulnerable conditions (Burton & White, 1993; Eakin & Bojorquez-Tapia, 2008). These include organisations such as the private sector, government departments, schools, religious groups, and individuals, among others (Tankard *et al.*, 2009; Vogel *et al.*, 2010:11). The best way to achieve an effective vulnerability assessment when a seismic event occurs is fraught with difficulties, not least because vulnerable groups are instantly and economically invisible and marginalised (Fekete, 2010:728). Despite these, some vulnerability assessments have aimed to be explicitly stakeholder-driven (Garikipati, 2008:2632). According to Burton, Kates, and White (1993), there are three tenets in vulnerability research which need to be identified: vulnerable conditions, people prone to vulnerability, and places that are vulnerable to extreme natural events.

Social vulnerability can be measured in different ways, such as focusing on groups, types of social vulnerability, and the characteristics of social and seismic vulnerabilities that increase exposure to hazards – such as seismic activities in old mining towns (Templeton & Acer, 2005; Garikipati, 2008:2634). Complex interactions of socio-economic and environmental factors operating on different spatial and temporal scales give rise to vulnerability as they affect the ability of individuals and communities to prepare for hazards in order to cope and recover from them (Cutter *et al.*, 2010:1549).

Unplanned urbanisation, population density and growth that have led to inappropriate land use, loss of biodiversity, environmental mismanagement, poverty, social injustice and short-term economic vision, are important determinants of vulnerability (ISDR, 2002; Bohle *et al.*, 1994; Anderson, 2000; Hewitt, 1997). From these statements, it is clear that social vulnerabilities can be understood in different ways, as they are complex but also in many instances, are interrelated. In the past few decades many researchers, governments, non-governmental, global and regional organisations have established strategies to address social vulnerability issues in specific areas (Knutson & Wilhite, 2008:142).

These coping strategies have been created to manage and regulate the social vulnerabilities people and households face. But still, many poor and marginalised people are directly dependent on ecosystem services for their livelihood activities and are therefore particularly vulnerable to changes in environmental conditions and factors that may limit their access to such resources (Tuner *et al.*, 2003; Rygel & Yarnal, 2006:756). In addition, most people vulnerable to natural hazards tend to be socially marginalised groups, including women, the elderly, children, ethnic groupings, single-headed households and religious minorities. Therefore, people engaging in marginal livelihoods tend to be socially excluded groups as they live in illegal settlements and thus have no rights and claims to resources, and are not officially recognised by municipalities and residents in a particular area (Wung, 2008, Peduzzi *et al.*, 2009; Mayer *et al.*, 2005:617-628). Those with inadequate access to economic (credit, welfare, employment) and social capital (networks, information, support) are also most vulnerable (Wisner *et al.*, 2004).

The assumption is that vulnerability is a social condition, or a measure of societal resistance or resilience to hazards (Birkmann, 2006:24). Blaikie *et al.* (1994) and Hewitt (1997) believe that the integration of potential exposure and societal resilience with a specific focus on particular places or regions, fails due to poor governance when reducing risks, because governments usually focus on the aftermath and recovery from hazards rather than reducing hazard risks beforehand. However, socially created vulnerability is also largely ignored by households, stakeholders and governments,

mainly due to the difficulty in quantifying them. This also explains why social losses are normally absent in after-disaster cost or loss estimation reports (Kasperson, Kasperson & Turner, 1995; Cutter, 2003). However, social vulnerability loss is best described using the individual characteristics of people such as race, age, income, health, employment and the dwelling unit such as unsafe dwellings due to urbanisation, economic viability and growth rate that contribute to the social vulnerability to environmental hazards (Gibowics, 2009). Social vulnerability is partly the product of social inequalities such as those social factors that influence or shape the susceptibility of various groups to harm, and that also govern their ability to respond (Oliver, 2004).

Nevertheless, it is also important to place inequalities in perspective. Human vulnerability, history and physical events in terms of community characteristics and their built environments can be prone to high levels of urbanisation, economic vitality and growth rates that contribute to the social vulnerability of places (Cutter *et al.*, 2003:243). The vulnerability of linked human environmental systems is one of the central elements of this dialogue and sustainability research (Burby, 1998; NRC, 1999; Kasperson, 2001). It directs attention to such questions as: Who and what are vulnerable to the multiple environmental and human changes underway, and where? How are these changes and their consequences attenuated or amplified by different human and environmental conditions? What can be done to reduce vulnerability to change? How many more resilient and adaptive communities and societies should be built?

Answers to these and related questions require conceptual frameworks that account for the vulnerability of coupled human environment systems with diverse and complex linkages (Turner *et al.*, 2003:8074). The PAR Model and Social vulnerability theory will be amplified in this chapter. Various expert communities have made considerable progress in pointing the way toward the design of these frameworks (Kasperson & Kasperson, 2001). The first step in reducing vulnerability is to identify and understand the vulnerability models. The following section focuses on the models of vulnerability which are used as key knowledge areas to further analyse social vulnerability to seismic events.

2.3 MODELS OF VULNERABILITY

The term vulnerability is used in a number of traditions and disciplines, from economics and anthropology to psychology and engineering (Adger, 2006). Given the diversity of uses and definitions applied to the concept of vulnerability, it is useful to trace its epistemological origins by discipline (Meijer, 2004). The Pressure and Release Model (PAR) (Wisner *et al.*, 2004) and the social vulnerability concepts are discussed and analysed in the following section as they provide theoretical foundations for the key concepts mentioned above regarding the variables used to identify social vulnerability. Generally speaking, vulnerability to environmental hazards means the potential of loss (Cutter *et al.*, 2003:242). Furthermore, since losses vary geographically, over time, and among different social groups, vulnerability also varies over time.

Table 2.1: Social vulnerability concepts

Concept	Description
Gender	Women can have a more difficult time during recovery than men, often due to sector-specific employment, lower wages, and family care responsibilities (Blaikie <i>et al.</i> , 1994 & Hewitt, 1997).
Politics and power	Politics and power refer to an authority held by a group within a society that allows for the administration of public resources and implements policies for society. Power may be acquired as a means of governmental direction or in opposition to a government group (Wisner <i>et al.</i> , 2015:154).
Poverty	Poverty is a complex, multidimensional phenomenon. Therefore, the lack of multiple resources leading to physical deprivation can be defined as a condition where people's basic needs such as clothing, food and shelter are not being met. Poverty is increased by the lack of multiple resources leading to physical deprivation due to the lack of what is necessary for material wellbeing, especially food and water, but also housing, land, and other assets (Wisner <i>et al.</i> , 2012).
Age	Age includes everyone involved, especially minorities such as women, the elderly and children. Most women and parents lose time (in prison, teenage pregnancy) and money caring for children and households instead of formally working to get an income for

	their families. Due to the lack of health-care facilities and mobile clinics, mothers or heads of households bear the burden of their families, thus reducing their resistance levels (Christiansen & Subbarao, 2008).
Employment and loss	The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster (Mileti, 1999). This refers to the inability of people, organisations and societies to withstand the adverse impacts of multiple stresses to which they are exposed. Economic fluctuation, lack of skills and deteriorating health make it difficult for people to find employment. Although different groups of a society may share a similar exposure to a natural hazard, the hazard has varying consequences for these societies, since they have differing capacities and abilities to handle the impact of a hazard (Anderson, 2000; Cutter, 2003, Wisner <i>et al.</i>, 2004).
Rural/urban	Rural areas usually consist of a mass of land with small populations where societies are expected to provide their own settlements and are reliant on small-scale farming and livestock. Urban residents may be more vulnerable due to lower incomes, and are dependent on government for housing. Rural communities consist of a mass population with a limited supply of goods (Zhung & Sung, 2003).
Residential Quality	The quality, density and value of residential construction affect its potential losses and recovery. A residence can be defined as a home, house or building used for daily living; it includes an environment, infrastructure and a community (Vincent, 2007). Housing should include better living standards based on social, economic and environmental needs (Siley & Mileva, 2006).
Infrastructure	Loss of water, communication, sewers, and transport infrastructure increase the potential for disaster risks. The loss of infrastructure may place an insurmountable financial burden on smaller communities that lack the resources to rebuild themselves (Mayer <i>et al.</i>, 2005).
Family structure	Families with large numbers of dependants, or single-parent households, often have limited finances to outsource care for dependants, and thus must juggle work and responsibilities and care for family members. This affects their resilience to recover from hazards (Cutter, 2003).
Education	Education is linked to socio-economic status, with higher educational attainment resulting in greater lifetime earnings and

	more resilience. Lack of access to quality education contains people's ability to understand warning information and access to recovery information (Oliver, 2004 & Wisner, 2015).
Population growth	In most cases in Africa, the rate of population growth is higher than the available housing. This makes it hard for poor countries that are experiencing rapid growth and lack of adequate quality housing and social services, as this increases the risks and vulnerabilities of their people (Stephen & Downing, 2001)
Medical services	The lack of adequate health or medical services lengthens immediate relief and long-term recovery from disasters. This means that having health-care services nearby is vital after a disaster in order to provide quick relief to the injured (Vincent, 2007).
Social dependence	Social dependence is increased by economic and social exclusivity or marginalisation of vulnerable people and groups. This therefore makes people reliant on social services for survival (Smit <i>et al.</i> , 2001).
Access	According to Wisner <i>et al.</i> (2012) people earning a living have different access to material, social and political resources. This incorporates hazards into the social system and suggests that unsafe conditions come about as a result of these social, economic and political processes that differently impact on various societies and groups within society (Wisner <i>et al.</i> , 2012:93). This is simply because "access involves the ability of an individual, family, class or community to use resources which are directly required to secure a livelihood while building resilience for pre-disaster times and their ability to adapt to new threatening situations" (Wisner <i>et al.</i> , 2012:94). This means that the access model is mainly focused on social relations and structures of domination, which indicate how social relations influence the flow of goods, money and surpluses between different actors. These structures also include the relationship between government and its citizens. These interactions help form shared and dominant ideologies among dominant structures.

Vulnerability rests largely within the condition and dynamics of the linked human-environmental system that is exposed to hazards, and thus, vulnerability analysis must be comprehensive, treating not only the system in question but also its many and varied linkages (Perrings, 2001; Rose, 2004). Although influenced by nature, seismic events can have a human origin and usually describe a sudden calamitous event that seriously

disrupts the functioning of community and causes loss of property (Kroger, 2008 and Wisner *et al.*, 2012). There are different types of models of vulnerability, as discussed below. A review of the literature and the experience in developing a vulnerability framework (Tuner *et al.*, 2003) suggests that the usefulness of vulnerability analysis increases when it:

- directs attention the vulnerability in the human environment system;
- identifies the complexity of residence and infrastructure;
- looks at the access to emergency facilities and their contribution to assisting people during a disaster;
- draws attention to potential dynamics of vulnerabilities that lead to new hazards and risk; and
- assists in developing models and measures to reduce the exposure to hazards (assuming that the systems and components of vulnerability affect people in the same way).

Having identified these variables, the aim of this literature overview is to identify the variables that could contribute to the social construction of risks faced by households in Khuma. Vulnerability variables are known to be the key indicators to risk hazards. Generally, these variables have a way of letting researchers know about the past, present and future risks that communities are faced with (Burton, 1993 and Chakraborty *et al.*, 2005).

When coming to housing, concrete housing is generally mandatory in countries like China and Japan. The said countries have developed the institutional capacity at municipal levels to deliver adequate housing (Paige, 2009 and Palliyaguru *et al.*, 2014). However, in many countries, the seismic building code is not yet a recommended practice, and the municipalities do not have the comprehensive capacity to implement seismic codes even if it's clear that they are at risk (Wisner *et al.*, 2012; Meijer, 2014). One can argue that often governments choose to neglect the threats until it is too late, for instance, hazards are often not recorded unless someone or something gets destroyed or injured. In recent years, building guidelines and practices have been

drafted by a number of developing countries (Bangladesh, Indonesia and Nepal) (Kroger, 2008; Kelman *et al.*, 2015). However, in many countries, governments do not have contingency plans for seismic events in place, and for this reason they lack resilience due to:

- Infrastructure/residence – the poor construction and design of buildings. Lack of disaster risk plans for seismic events and the absence of lateral seismic design planning.
- Socio-economic – lack of resources and capacity for vulnerable communities. Improper building equipment using transverse reinforcement steel in columns.
- Access – the pummeling effect due to the lack of appropriate space between buildings due to poor quality resources (material) control (Christensen *et al.*, 2005)

Over a decade ago Wisner *et al.* (2004) argued that the systematic comparison of individual and societal response to a disaster in social formations is dominated by different modes of production (e.g., feudal, capitalist, socialist), and constitutes a potentially rich scientific undertaking, but one largely neglected until now. This has become apparent because forests, agricultural areas and oceans are now at risk due to negligence over the past 40 years (Turner *et al.*, 2003:3078). Therefore, it should always be remembered that when dealing with social vulnerability and environmental threats it is best for people to adapt and interact with their physical environment. In the light of this, for a community to be successful, it needs to know the complexities of its immediate environment. This is best done by using the PAR model as it informs the community perception and experiences through the process of identifying hazards in the past and present, and helps prepare for the future. The following section will deal with the PAR model.

2.4 THE PAR MODEL

The Pressure and Release (PAR) model (see Figure 2.1) was introduced by Davies (1978) then developed by Blaikie *et al.* (1994) and modified by Wisner *et al.* (2012) as

cited in Mutombwa, 2015:40). The PAR model indicates that disasters result from an interaction of two opposing forces: hazard and vulnerability (McEntire *et al.*, 2010). There are three dimensions of constraints and pressures illustrated in this model, which lead to the vulnerability of a group or population, namely “unsafe conditions” “dynamic pressures” and “root causes” (Blaikie *et al.*, 1994). A PAR Model is a useful tool for long-term forecasting and generation of synthetic data. The PAR model refers to an action, process or outcome in a system (group, community, household, region, country, sector) in order for the system to better cope with, manage, or adjust to some changing condition, stress, hazard, risk, or opportunity (Smit *et al.*, 2001). Wisner *et al.* (2012) point out that vulnerabilities are reflected or seen under unsafe conditions, but are a result of dynamic pressures which emanate from root causes.

According to Van Niekerk (2005:75), the PAR can be used as an indicator that there are certain underlying causes, dynamic pressures and unsafe conditions which contribute to vulnerability. The conditions of using appropriate methods for modelling a problem depend on many factors, such as required accuracy and the number of series to be modelled; modelling costs; ease of use of the models; and ease of analysis of the results. Based on their timing, adaptations can be proactive or reactive, and depending on their degree of spontaneity, they can be autonomous or planned (Fekete *et al.*, 2010). The PAR model can also be used as a tool to provide an analysis that traces unsafe locations and fragile livelihoods, and helps identify vulnerable locations through dynamic pressures and root causes, to marginalisation, capacities and the recovery, using the PAR model diagram (Wisner *et al.*, 2012:11).

The PAR model can be used to explain how risk can be reduced to promote safe communities. This means that the interaction of risks (e.g. unsafe living conditions and environments caused by, for instance, seismic triggers) together with a hazard, can lead to a disaster if the risks are not reduced. The main purpose of the PAR is to address the risks communities are faced with and assist in identifying and reducing such risks. Figure 2.1 below illustrates the progress of vulnerability.

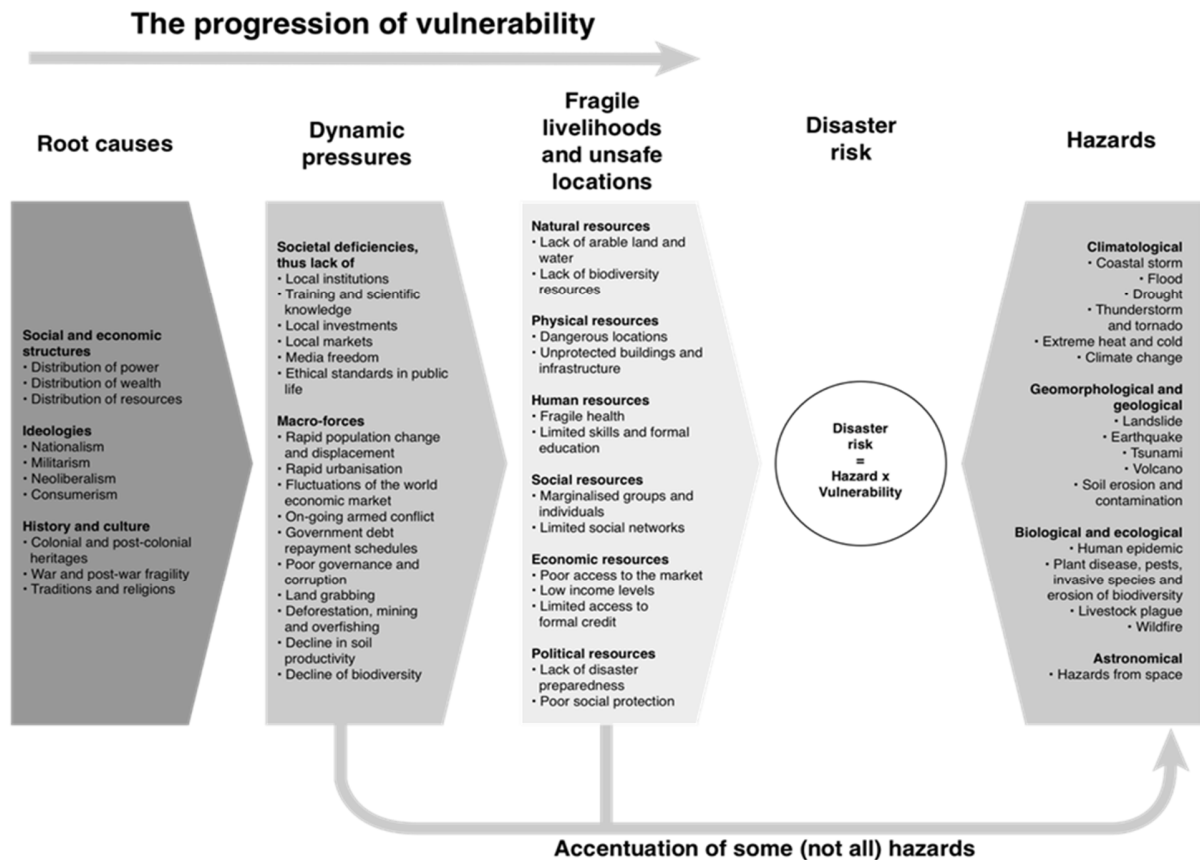


Figure 2.1: The progression of vulnerability (Pressure Model)

(Wisner *et al.*, 2012:12)

The PAR model helps to view environments as social systems that use interactions with a defined geographic space such as a community, or city (Zschocke *et al.*, 2010:62). However, the PAR model recognises that communities have different geographical sub-populations and spaces that may contribute to vulnerability or resilience as a result of recovery and development disparities (Cutter *et al.*, 2008:598). This model is designed to address the root causes of vulnerabilities, reduce risks, achieve disaster risk reduction and reduce hazards by identifying interactions and disparities that make communities susceptible to hazards. Vulnerability has been used to describe the state of exposure, usually associated with a geographical location rather than with individuals or social groups (Adger, 2006:251). An analysis of the progression of vulnerability is illustrated in Figure 2.2.

2.4.1 Root causes

As shown in Figure 2.1, root causes have past origins that explain the ideological and cultural assumptions that give certain structures perceived legitimacy (Wisner, 2004; Wisner *et al.*, 2012; Twigg, 2004, cited in Mutombwa, 2015). Ideologies, socio-economic structures, history and culture create unequal relationships among people of the same society and this unfavourably leads to household vulnerabilities (Smit & Wandel, 2006). Socio-economic conditions such as employment and education greatly influence differential access and ownership of certain resources by women and men of the society (Stephen & Downing, 2001).

In addition, people's employment and education levels influence allocation of resources, power and wealth amongst women, men and households in the same society (Wung, 2008). These conditions create unequal relations in terms of distribution of resources, power and wealth, as shown in Figure 2.1. Zenfpung *et al.* (2006) suggest that these conditions lead to some people and households being more disadvantaged than others, as they have limited access to resources and power, especially decision-making, because of their lack of access to information. History and culture can be described as the root causes. Consequently, certain historical backgrounds and cultures have resulted in people of the same society depending on social measures like gender, age, values and traditions. These different roles have greatly influenced the distribution and access to wealth, resources and power, which may result in increased vulnerability for certain sectors of society (Mayer *et al.*, 2005; Wisner *et al.*, 2015).

Over time, some of the root causes have integrated to cause dynamic pressures which continuously exacerbate differential vulnerability among people of the same society (Mutombwa, 2015).

2.4.2 Dynamic pressures

Dynamic pressures are aspects which show emergence or interaction with root causes, as shown in Figure 2.1. Dynamic pressures tend to be forces that transmit the historic weight of root causes and impact on living conditions (Linzer *et al.*, 2007; Wisner *et al.*, 2012). For instance, dynamic pressures include aspects such as societal deficiencies such as labour migration, lack of local markets and governance, and macro forces such as population growth, urbanisation and housing distribution, which result from rapid urbanisation in response to a root cause.

Urbanisation can be influenced by many vulnerabilities including the lack of housing due to poor governance, unstable economy and rapid population change and displacement (Wisner *et al.*, 2012; Maartens, 2011). Dynamic pressures can bring about development initiatives which can result in negative effects: in this case, in mines. Templeton *et al.* (2005) suggest that development programmes that can increase vulnerability (for example, building cheap housing with no roads), bring us back to dynamic pressure to develop infrastructure, which can lead to unsafe housing conditions (Van Deventer, 2011). Such dynamic pressures tend to expose many households to insecure living conditions and differently affect people living in the same society due to different access to wealth, resources and power.

2.4.3 Unsafe conditions

Unsafe conditions can be observed where the vulnerability of a population is expressed in time and space in combination with a hazard (Alcantara-Ayala, 2002). Unsafe conditions include infrastructure, unprotected buildings and dangerous locations that expose households to vulnerability. However, the unequal distribution of resources, power and wealth may result in a lack of arable land, water and biodiversity resources by other groups in society due to such dynamic pressures as rapid population change and displacement (Mutombwa, 2015:42). Mutombwa (2015) further argues that limited skills and formal education in certain gender groups emanate from a lack of training associated with traditions of a given society in valuing the formal education of one

gender over the other due to different roles and responsibilities assigned to genders. In addition, the progression of vulnerability as shown in Figure 2.1 above, clearly illustrates how root causes are entrenched in social and economic structures. The PAR Model clearly shows the relation between hazard and such social vulnerabilities, and how it affects households differently. In recent years, disaster reduction and prevention have been increasingly highlighted in international societies. This has led to vulnerability themes in disaster research gradually being incorporated into sustainable development strategies. However, after studying the progress of vulnerability, researchers have developed concepts and frameworks that offer a comprehensive approach to the pressure-and-release model.

The PAR model assists in identifying the cause of vulnerability in communities and can provide the operational foundation for insurance and supervisory direction for policy-makers in government. Natural ecosystems and humans are both exposed to hazards, and more and more people are being made aware of its cumulative harm daily. The vulnerability assessment and analysis play a significant role in familiarising and moderating seismic events, being the highlight in the research fields of disasters and hazards in recent years. The vulnerability assessment of seismic events can be carried out in numerous research fields and has seen much progress throughout the years. The PAR model will thus help identify household characteristics, anticipating their capacity and assisting in identifying coping mechanisms to improve people's livelihoods in the event of a hazard.

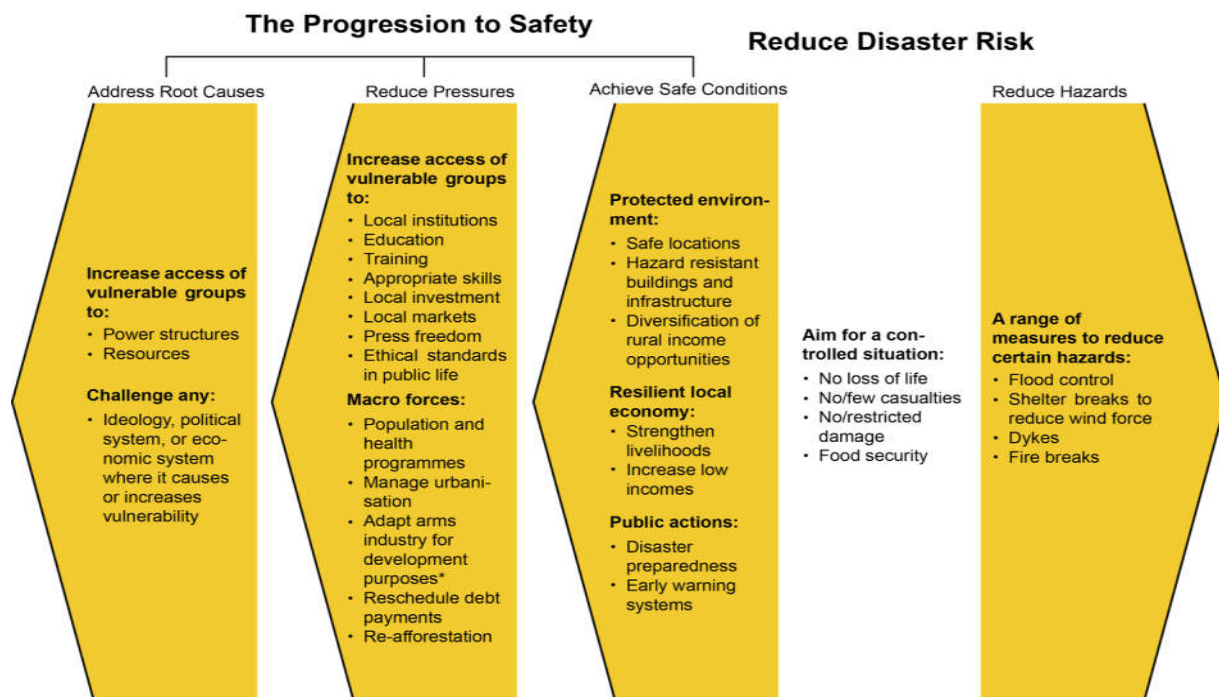


Figure 2.2: The Pressure Release Model

(Source: Wisner *et al.*, 2012)

Van Niekerk (2012:75) contends that the PAR model illustrates important attributes needed to address disaster risk, and by doing so to achieve safer conditions. He further argues that “the disaster pressure release model has become an internationally accepted model for the explanation of the progression to vulnerability and the progression to safety” (risk reduction). Thus, the PAR model is an important reference in this case study, because it seeks to address how risk within communities can be reduced. The following section presents a discussion of the impact of seismic environments on vulnerability of households.

2.5 IMPACT OF SEISMIC ENVIRONMENTS ON VULNERABILITY

Over the past decades, considerable work has been done on seismic vulnerability, and some progress has been made in those studies towards community safety (Wisner *et al.*, 2004). The estimation of damage probability distribution among different damage states of reinforced concrete buildings is a key component of earthquake loss reduction

for the modern city or group of cities (Zenfpung *et al.* 2006:292). With the development of cities and rapid urbanisation, armour-plated concrete buildings became a major component of modern cities. For each building type, a damage probability matrix contains an indication of the probability that a building will experience a certain amount of damage when subjected to a specified seismic intensity (Gibbons *et al.*, 2006 and Zenfpung *et al.*, 2006:292). Attempts have been made to estimate vulnerability of reinforced concrete buildings. Extensive research is at present being performed to develop damage probability matrices (Zung & Sung, 2003; Stephen & Downing, 2001:117). Furthermore, soil plays a very important role in determining the characteristics of damage distribution.

The influence of local soil conditions, location and infrastructure plays a role in damage incidence during an earthquake, and has been recognised for many years (Palliyaguru *et al.*, 2004:69). All the above can be linked to the physical aspects of understanding vulnerability. As can be seen from the above analysis, vulnerability variables range in factors, including the determinants of vulnerability such as:

- population density;
- level and nature of the physical event; and
- economic activities located in earthquake risk zones.

Human action and hazard risks continually interact to alter vulnerability, both at the household and macro-economic levels (Rashidow *et al.*, 2000). Anderson (2000) and Wisner *et al.* (2004) grouped vulnerabilities into three categories:

- Physical/material vulnerability: the inherent weakness of the built environment and lack of access to resources, especially the poor section of the population.
- Social/organisational vulnerability: inherent weaknesses in the coping mechanisms, lack of resilience, lack of commitment.
- Attitudinal/motivational vulnerability: fatalism, ignorance, and low levels of awareness.

The likelihood of a seismic disaster increases when a community's built environment such as lifeline systems, community infrastructure and building is composed of vulnerable elements (Hays *et al.*, 1998). As a result, these magnitudes expose flaws in governance, planning, and the settings of physical structures, their design, construction, and use of the built environment in a country with seismic hazards (Corburn *et al.*, 1992:89). For this reason, the influence of fundamental cultures and livelihoods is at risk. To mitigate seismic impacts, the capacity of a community is significant in the sense that it needs to have the skills and knowledge to prepare for such hazards. Seismic vulnerability is thus a function of the potential losses (from earthquakes) (injury to people and death, damage and other physical structures), and the level of preparedness, and the extent to which a society has been able to translate mitigation measures into practice (Bothara, 2000; Rashidov *et al.*, 2000).

It reflects the unattended weakness in the built environment of a community and the limitations in the society that affects the ability or inability to absorb losses after a seismic event and to recover from the damage (Bilham *et al.*, 2001). There are large human settlements located in earthquake-prone areas (Corburn *et al.*, 1992). Many of these settlements have a significant proportion of old buildings that are of poor quality, either because of ageing and lack of maintenance or because of deterioration in the material quality (Hay *et al.*, 1998). Unfortunately, most people subjected to such high levels of vulnerability are unaware of the seismic threat they are exposed to (Rashidov *et al.*, 2000). Vulnerability conditions precede seismic events and contribute to their severity, impede emergency response and usually continue long after the earthquake has struck (Hays *et al.*, 1998). Vulnerability assessments should involve multivariate analysis but also demand a consideration of the high degree of uncertainty and surprise in both human and biophysical systems (Cutter, 2003:7).

Vulnerability assessments are elaborated on in the following section. Natural disasters are frequent in some developing countries (Malehmir *et al.*, 2014). One can argue that the poor are usually hardest hit because they only have access to low-cost assets, for instance land or housing, which are more vulnerable to disaster. Reducing vulnerability shock will assist in preparing this sector for their exposure to natural hazards, and could

be rooted in their environmental or socio-economic conditions. Now, vulnerability assessments are shocks as a highly significant component of the 'vulnerability context' (Kelman *et al.*, 2015). However, there is little analysis of how shocks affect households, and there appears to be very little or no attempt to reduce people's vulnerability to hazards and disasters. The following section discusses the assessment of vulnerable households.

2.6 VULNERABILITY ASSESSMENT

According to Cutter (2003:4), livelihood assessment conceptualises household capacities in terms of six categories of assets, or capital: human, social, political, financial, natural and physical (Scoones, 1998 cited in Eakin & Bojorquez, 2008:114). These assets are organised and employed by households to mitigate risk and construct viable subsistence strategies. Eakin and Bojorquez (2008:122) for example, found that having the human capital to engage in non-farming activities as well as having access to land, was of central importance to households and environments prone to hazards caused by seismic events that are influenced by old, unmonitored mine shafts.

While the advantages of different livelihood profiles in terms of risk can be intuitively evaluated, using livelihood analysis to compare households in terms of vulnerability is difficult without having an explicit method for comparatively weighing and aggregating household-level variables (Rashid & Weeks, 2003). While vulnerability and poverty are closely related, vulnerability is defined independently of the person's current poverty or welfare status. Poverty concerns the *ex post facto* realisation of a stochastic focal variable (e.g. well-being) with respect to a socially determined minimum threshold (poverty line), while vulnerability is the *ex-ante* expectation of that focal variable relative to this threshold (Birkmann, 2006:24).

For this reason, Vincent (2007) uses income as a proxy to create household-level indices of adaptive capacity to seismic events by aggregating a set of theoretically determined composite sub-indices of capacity (economic well-being, demographic structure, interconnection, quality of housing and dependence on natural resources).

Vincent (2007) also emphasises the uncertainty involved in theoretical assumptions used in developing such indices, the selection of appropriate indicators, and the directions of the relationship of the indicators to overall capacity, and the dynamic nature of indicators over time, firstly because of uncertainty associated with ranking or assigning of individuals, households or groups into categories of vulnerability, which, because of their multivariate nature, are inherently uncertain categories. For example, the categories “not vulnerable” or “very vulnerable” (and their combined influence on vulnerability) make the evaluation of vulnerability between the two extremes highly uncertain. However, Brooks *et al.* (2005:152) state that the degree to which a system is susceptible to or unable to cope with the adverse effects of vulnerabilities is influenced by the hazard and its capacity.

These may be referred to as genetic determinants of vulnerability as opposed to specific determinants relevant to contexts and hazard types, such as the price of a land (housing) the number of shelters available for the use of vulnerable communities, or the existence of regulations concerning the robustness of buildings. The concept of generic, as opposed to hazard and context-specific determinants of vulnerability, is a useful one if we wish to undertake comparative assessments of vulnerability at the national level. Extremely variable disasters and hazards have a significant influence on the frequency, occurrence, timing and prediction of vulnerabilities caused by at-risk habitats, which are a result of frequent seismic waves. Economic loss occurs when disasters happen without giving early warning, either due to a lack of capacity and preparation, or early warning systems. The following section analyses and evaluates the impact of economic losses and assesses which methods are best used to measure the extent of economic loss while reducing economic vulnerability.

2.7 ECONOMIC VULNERABILITY

While some of the most devastating seismic events (tremors) occur through natural causes, countries can also be struck by “economic shocks that are outside of their control, such as a rapid decline in the price of their major export, changes in interest rates on international capital markets or reduced access to credit” (UNISDR, 2012).

According to Coaffee *et al.* (2009), one way of defining economic vulnerability is the exposure of an economy arising out of economic openness due to globalisation, while economic resilience is defined as the policy-induced ability of an economy to withstand or recover from the effects of such shocks, namely the micro-economy, macro-economic stability, social defence and good governance. The analysis of the economic assessment clarifies how minor economies can accomplish a relatively high level of success just by adapting early warning systems and contingency plans in their disaster policies and guidelines, despite their economic vulnerability. The financial crises of the last two decades provide vivid examples of economic shocks. Economic vulnerability constitutes the difficulty of economic development by magnifying the element of risk in the growth process without necessarily compromising the overall viability (Davies, 2014). The UNISDR (2012, 2013) indicates that increased risk can affect economic growth in a negative manner. The high degree of fluctuation in GDP and low- income earners in small markets is considered as one of the manifestations of exposure to economic shocks.

The fluctuations in household income have a significant influence on the amount, savings and expenditure patterns of a household, which result in frequent recurrent debts and distress (Kappers *et al.*, 2012). The analysis of the economic assessment clarifies how minor economies can accomplish a relatively high level of success just by adapting early warning systems and contingency plans in their disaster policies and guidelines despite of their economic vulnerability (Davies, 2014). However, such weaknesses arise from the fact that large economies are shaped by outside factors (global inflation, oil prices and exports) and a high dependency on imports (Armstrong & Graefe, 2011; Drew *et al.*, 2013). Although economic vulnerability imposes serious constraints on economies, countries must move towards capacity development to build up resilience (Kelman *et al.*, 2015). Thus, it can be argued that economic vulnerability is a precondition of poverty or underdevelopment (Meijer, 2014). However, economic setbacks may be linked with the limited ability to build economic rigidity. The following section further describes urban effects on vulnerability (Smith, 2016).

2.8 URBAN VULNERABILITY

Global disasters over the last decade have shown how vulnerable countries at all levels of development are prone to disasters (Kappers, 2012:577). As large as the economic losses from a disaster have been, the outcomes could have been worse had preparatory steps and early warning systems not been put in place before, during and after seismic events. It is estimated that for most of the cities in developing countries, non-engineered construction accounts for more than half of building collapses, and in some cases, more than 90% (as was the case in Kathmandu in 1988) (Hays *et al.*, 1998; Bilham, 2001). The volume of such non-engineered buildings is, unfortunately, growing, especially on the periphery of developing cities (Bothara *et al.*, 2000 and Malehmir *et al.*, 2014). Urban areas are not hazard prone by nature; rather, the socio-economic structural processes that accelerate rapid population movement, urbanisation and population growth substantially increase hazard vulnerability, mainly of low-income urban households.

Thus, urban vulnerability can be defined as an outcome of physical vulnerability caused by exposure to hazards, human behaviour, population growth, urbanisation, economic vulnerability and a lack of infrastructure, all resulting in potential vulnerability threats. Seismic events affect the full range of social classes from the rich to the poor, the homeless to the royals (Coburn & Spence, 1992). Disasters threaten people in different ways. However, some are more resilient and less exposed than others. Resilience and vulnerability are related and cannot stand in isolation, the reason being that people are affected differently by urban vulnerability. Thus, the inherent effect of an economy affects people's livelihoods in different ways. It is also true that resilience and vulnerability can be inherited, either from a weak economy or an economy that lacks resilience to disaster impacts. Urban vulnerability reflects economic, social and political environments. Usually, societies in seismic-prone countries are subjected to a great number of environmental and natural hazards.

These hazards include factors contributing to poverty, and one needs to be aware that disasters aggravate poverty by destroying the physical environment so that people's

livelihoods are immediately at risk. Natural hazards bring about hardship and distress to poor people and are a persistent contributing factor to poverty. The increase of hazards accelerates the loss of income-generating opportunities and lack of housing due to physical damage, and this results in debt as most people are unable to save (Bischoff *et al.*, 2013)

However, in the absence of mitigation, we have the ability to cushion or reduce loss through resilience, as mentioned above. This refers to the fact that there are inherent and adaptive responses to disaster that enable individuals and communities to avoid some potential losses. These responses can take place at the level of the firm, the household, the market, and the macro-economy (Rose, 2004:309). Correspondingly, Bruneau *et al.* (2003:3) define community earthquake resilience as the ability of social units (community organisations) to mitigate hazards, contain the effects of hazards when they occur, and carry out recovery activities in ways that minimise social disruption and mitigate the effectors of further earthquakes.

However, urban vulnerability is mainly influenced by human behaviour. Due to socio-economic systems, physical assets in urban areas are either susceptible or resilient to the impact of natural hazards. Over the past two decades, vulnerability has come to represent an essential concept in hazard research and in the development of mitigation strategies at the local, national and international levels (Rashed & Weeks, 2003:547). However, many current models of vulnerability are essentially descriptive and too general to help in this regard (Cutter, 2001). Consequently, decision-makers are often obliged to limit analyses of urban areas exposed to natural hazards, rather analysing urban vulnerability in terms of the technically narrow concept of risk that describes how an urban area is exposed to natural hazards (Rashid & Weeks, 2003:550). In this approach, vulnerability depends on the nature of the risks households face, and their exposure to these risks. Their vulnerability can be seen as expected poverty (Chakraborty *et al.*, 2005:523), and is closely linked to their livelihood systems. Therefore, there is a notable difference between for instance urban dwellers, rural subsistence farmers, and pastoralists in terms of their disaster risk profile.

2.9 DISASTER RISK

Disasters destroy livelihoods around the world. However, disaster impacts also set back the economic status of countries by an estimated 1.3 trillion worldwide from 2000-2012 (UNISDR, 2013). Disasters are not natural events (Anderson, 2000). They are dangerous to society and disaster risk arises when hazards interact with the physical, social economic and environmental vulnerabilities and exposure of populations (IFRC, 1999 and UNISDR, 2013). The root of social structures is widely exposed or impacted by social occurs due to hazards which usually lead to social vulnerabilities (Secombe, 2014). However, research indicates that disasters such as droughts, earthquakes, storms and floods are natural hazards, and that their impact is natural. However, damage to infrastructure, loss of lives and livelihoods are considered to result from human acts such as poor infrastructure and lack of mitigation plans (Sileny & Mileva, 2008). Hazards are usually unexpected, sudden events that disrupt people's livelihoods.

The practice of reducing disaster risks occurs through systematic efforts to analyse and administer the contributing factors of disasters which involve the reduction of exposure through mitigating plans, lessened vulnerability through proper development, and enhanced DRR strategies (Okal *et al.*, 2011; Mogotsi *et al.*, 2012; Palliyaguru *et al.*, 2014). Meijer (2014) supports this statement by adding that disaster risk reduction can be defined as the strategies, policies and practices to reduce vulnerabilities and hazard risks by using early warning systems, preparedness plans and mitigation strategies. These methods aim to enhance the resilience of households, minimise risks and losses, and protect socio-economic assets (UNISDR 2013). The argument here is that disasters are manifestations of the social vulnerability of a social system that can be remedied through socio-economic manipulation (Mutombwa, 2015, Basolo *et al.*, 2015 and Rose, 2004). It is crucial to understand that disaster risk reduction describes strategies and comprehensive initiatives which focus on reducing vulnerabilities, risk, and kerbing the occurrence of adverse events which can cause great loss (Cannon, 2008; Mutombwa, 2015). To make this feasible, disaster risk reduction involves disaster preparedness initiatives which enable community participation by everyone in society to take part in vulnerability assessments and resilience-building (Linzer *et al.*, 2007).

A major hazard such as a seismic event exposes people to disaster risk and brings about serious interruptions in a vulnerable society. Disaster risk exposes vulnerable households' health issues, and can cause loss of livelihood and property (UNISDR 2013; Wisner *et al.*, 2012). Disaster risk can be viewed as the possibility of interaction between hazards and vulnerabilities, which may result in great loss of life or property (Mutombwa, 2015:37). There are, however, ways to mitigate hazards such as seismic events. This can be achieved through disaster risk reduction initiatives, such as community housing integration, to reduce the contributing factors to household vulnerabilities. Furthermore, on a global scale, international policies and legislation for DRR aim to help vulnerable people reduce disaster risks through increasing government commitment to implement pro-poor disaster prevention policies and practices (UNISDR, 2013). The legislation for DRR is fundamental to the enhancement of human security (ISDR, 2003), and is the first step in mainstreaming disaster risk reduction into development.

For instance, the Yokohama Strategy and Plan of Action (1994) indicates that risk assessment is a required step in the adoption of adequate and successful policies and measures for disaster reduction (van Niekerk, 2004:559). Risk assessment, therefore, requires the systematic use of information and data to determine the likelihood that a hazard (of a certain magnitude) might exacerbate a vulnerability within a given community (Lindell & Perry, 1993; van Niekerk, 2004:559). It also considers the possible consequences of the hazardous impact. Risk assessment is undertaken by several national, provincial and local government departments as well as some non-governmental organisations (NGOs) (Lunga, 2015). In many parts of the world's developed countries, extreme events occur so frequently that they tend to overwhelm the coping capacity of those affected, and hamper long-term progress, because attention and resources desperately needed for poverty reduction and economic development are diverted to disaster relief and reconstruction.

Even though significant strides have been made to reduce the loss of life resulting from natural hazards, their impact remains considerable (Peduzzi *et al.*, 2009). Disaster risk institutional strategies are there to help address changing expectations associated with

quality from past experiences while using the latest technologies. DRR practitioners are questioning traditional approaches and determining whether they are changing in the light of adopted technological strategies. Although the concept of disaster risk management is traceable to the beginning of the 20th century, it has only gradually become institutionalised (Rose, 2004). This is a product of a social science research perspective that has led to the realisation that the impact of a natural hazard mostly depends on the capacity of the people involved to absorb the impact and quickly recover from loss or damage (Burton *et al.*, 1993 and Winser *et al.*, 2004). For many hazards, there exist considerable knowledge and certainty about the event characteristics (type of hazard, geographical areas at risk, frequency, magnitude, the probability of recurrence), as well as exposure characteristics (geology, elevation, number of people at risk), based on historical experiences. Most impacts of seismic events change, and meanwhile are much more difficult to preserve and to measure, since the changes in average seismic conditions and seismic variability occur over a long period of time it is important for households to be made aware of the risks around them (Sen *et al.*, 2013).

The focus of this study is on seismic events and how social vulnerability can increase the risk of a disaster occurring. The following section alludes to the impact/effects of seismic events in vulnerable conditions.

2.10 THE IMPACT/EFFECTS OF SEISMIC EVENTS

Seismic events are hard to prevent, as human nature cannot stop tectonic plates (Linzer, 2007:422). However, according to Sileny and Milev (2006:1495), seismic records contain information about the effects of the source as well as the effects of the wave propagation through rock mass. Therefore, they argue that the availability of geographical structures after a seismic wave tends to spread to a new area not well known as a simplified model. This means a tremor (seismic event) might be felt differently in the same area due to the region of housing, settlement, exposure to dolomite and environment risks, these aspects are determined by different social vulnerability concepts (see 2.1 table 2.1). This makes the environments susceptible to

seismic events as unrecognisable effects increase and pose a danger to people's livelihoods, meaning that the information detected from the source retrieved by inverting seismograms may include errors due to incomplete knowledge of the rock mass along the propagation path, which in turn causes a distortion in the calculated movement tensor (MT) (Gibowics, 2009:24). Therefore, seismic activity can be defined as the type, frequency and size of earthquakes that can happen over a period in a certain area (Silney & Milev, 2006:1496; Durrheim, 2006:28). However, a seismic event can also be defined as “a sudden movement or release of energy from the earth's crust caused by the accumulated stress and movement along a geologic fault, resulting in the generation of seismic waves which can be destructive” (Eakin & Luers, 2006:371). Therefore, seismic events can be highly dangerous. A tremor usually occurs in areas of seismic activity, which are usually plate borderlines that are found in or near fender bender zones, conservative margins and destructive areas (Paige, 2009:34). However, these factors do not apply to tremors in the Khuma area as they are usually the result of minor rock shifts due to deep gold mining nearby.

Both developing and developed countries can be affected by seismic events, which cause damage to poor structures (Fekete & Birkman, 2010:726). Furthermore, there are precautions that countries and people can take to minimise infrastructural damage before and after seismic events. A good example of this is the location of Kopanang mine (located in the area of this research) that is used to observe records of simulated rock-bursts conducted to measure the distortion of tremors (Silney & Milev, 2006:1499). Information on how to stay safe during a seismic event is necessary to prevent loss of life, property damage and negative impacts on people's livelihoods (Stephen & Downing, 2001:117). More than 90% of the seismic events that take place in South Africa are in mining areas (Goldbach, 2009:36). Researchers have been trying to prove that in the absence of mining activity, it is possible that these events would not occur as frequently as they do (Oliver, 2004:74).

When it comes to building infrastructure, it should be imperative to have a “safety building” so that when seismic events hit, people can be taken to a safe place. This would decrease infrastructural damage and save lives (Oliver, 2004:69). However, less

developed countries suffer most as they do not have disaster risk reduction strategies in place, either due to a lack of resources or limited funding (Mogotsi *et al.*, 2012:48). These factors are made worse by the fact that people cannot afford to house, thus they end up living in poorly built shacks in slums. There are also other factors that affect the impact of a seismic event, as the damage becomes greater if the area is over-populated with poor infrastructure (as in Haiti). The levels of damage can also be increased by the rock type that structures are poorly built. For instance, if a township is built on dolomite rock, nearby mines can make the township susceptible to tremors that might have harmful effects on people (Peduzi *et al.*, 2005:1153). The damage of seismic events can be measured by the magnitude, distance from the epicenter, and the type of plate boundary (Wung *et al.*, 2008:62). Over the years, there have been several tremors and seismic events in the Matlosana region, the worst being in August 2014 that killed one person and damaged and displaced hundreds of houses and destroyed properties, livelihoods, and social amenities such as walls and housing infrastructure (Durrheim, 2006, Gibowics, 2009; Paige, 2009).

However, the focus of this study is on a particular township (Khuma) situated in Matlosana. It looks at an exposed and vulnerable area and the relationship between social vulnerability and the incidence of seismic hazards, with the purpose of identifying the main causes of household vulnerability. It was found that the coping capacities of the exposed population are very low, due to poverty, which is the real vulnerability of this sector to seismic hazard. The following section summarises the chapter.

2.11 CONCLUSION

From the above discussion, social vulnerability models can provide various sources of information regarding social vulnerability, and that use of the PAR model helps to identify the root causes of a hazard. The problem of social vulnerability can be reduced (see section 3), however, it will take time, money and a participatory community approach. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (see sections 2.2.1 and 2.2.2). Nonetheless, there are certain factors that are likely to

influence vulnerability to a wide variety of hazards in different geographical and socio-political contexts. These are developmental factors that include poverty, health status, economic inequality and elements of governance, to name but a few (see section 2.4). Organised community risk assessment would help reduce exposure to hazards and minimise damages experienced after a seismic event. The more people learn of their vulnerabilities, the more resilient they become.

Furthermore, once the variables have been identified, the PAR model can be used to determine and establish how the variables can be used to establish new strategies to reduce the exposure of the community by using people's perspectives, opinions and beliefs to gather information about the environment and to make informed decisions (see section 2.9). Seismic events occur, their impact can be reduced if contingency strategies are put in place and preparation before the event occurs. If these methods are applied before an event takes place, then infrastructural damage can be reduced. Much attention has been given to seismic events in the Matlosana area since 2014, as it is important to develop disaster risk programmes in communities to help make people aware of the threats and vulnerabilities around them. The important aspects in this chapter were looked at from both vulnerability and resilience perspectives.

The relationship between social vulnerability and seismic events is based on how households are affected by such an event. This helps in linking both affected households and vulnerability variables and has allowed the researcher to draw on the analysis and methodology of the research to determine the extent of the damage by using the PAR model principle to determine social vulnerability concepts. The social vulnerability concepts established here include gender, poverty, age, residence, politics and power, infrastructure, family structure, education, medical services, social dependence and access. Chapter three uses the research methodology to discuss the empirical findings of the study and answer the research questions.

CHAPTER 3 : RESEARCH METHODOLOGY

3.1 INTRODUCTION

In Chapter 2, a literature study and empirical analysis are provided to support the focus on socio-economic vulnerability. This chapter uses the identified themes to analyse vulnerability concepts faced by households in Khuma. The chapter focuses on the various aspects of the research approach and methodology used to collect and analyse the data and answer the research questions. The research methods used in the study included an unstructured interview, a questionnaire and semi-structured interviews.

In presenting an overview of the study, Chapter 1 provided a synopsis of the research methodology used in the study. The purpose of this chapter is to describe in detail the methods used to assess the vulnerability to seismic events, as well as the procedure used in designing the research instrument and collecting data, to explain the sample selection, and provide an explanation of the procedures used to analyse the data. The discussion in this chapter revolves around three main elements of the research process: research methodology; literature review and empirical study. The empirical study section includes in-depth discussions of the research approach and design applied in the study including the sample selection, data collection and data analysis.

3.2 RESEARCH METHODOLOGY

The empirical study of this research project consisted of 60 household questionnaires and seven semi-structured interviews. The approach comprised both qualitative and quantitative research methods. These methods were used to find results based on the social vulnerability concepts. Semi-structured interviews with open-ended questions were done, allowing interaction between the interviewer and the respondent (Maartens, 2011:73). The semi-structured interview method is flexible, as it allows the interviewer to deviate or alter the sequence of questions if necessary. Du Plooy (2002:177) justifies this flexibility; depending on the respondent replies, the interviewer is free to deviate

from the predetermined questions to ask follow-up with probing questions. Therefore, the semi-structured interview method can be advantageous, depending on the ability of the respondents to discuss issues beyond the confines of the questions (Struwig & Stead, 2007:98). Mixed-method research involves both challenging and analysing quantitative and qualitative data, meaning a researcher collects both numeric and text information. The research approach will be further discussed in 3.4. This form of research is more than collecting both types of data, it includes the fact that data will be integrated and mixed at some stage of the research process.

However, a qualitative research method was predominantly used in this study, due to the fact that individuals are influenced by the environment within which they function (Smit, 2006), and that the opinion of the participants should not be seen in isolation but within the context of their direct environment. Ultimately, qualitative research involves studying the phenomena in their full complexity, portraying people's multi-faceted forms, and thereafter simplifying what was observed (Leedy & Ormrod, 2001:101). According to Van Niekerk and Roos (2007), the purpose of qualitative design is to:

- Understand the meaning of actions, situations and events;
- Understand the context and the influence of this context on actions;
- Identify unanticipated phenomena and influences;
- Understand the process through which events and actions take place; and
- Develop causal clarifications.

The above factors influence the choice of a case study method, as it “allows the investigation of complex and integrated systems” (Leedy & Ormrod, 2005). The following section covers the research design and describes the objectives of the research.

3.3 RESEARCH OBJECTIVES

The objectives of the empirical research were to:

- Determine the socio-economic vulnerability of exposed communities to seismic events in Khuma.
- Recommend possible interventions for vulnerability reduction to seismic events in Khuma.

In order to achieve the above, a sound research design was necessary. A discussion of the research design follows.

3.4 RESEARCH DESIGN

This research is based on the seismic event that took place in 2014 and the status quo of the affected households. The context of this research called for a quantitative and qualitative research approach (mixed methods research). The use of the mixed method requires the researchers to note the importance of providing significant information and describe how it will be used. The fundamental fact of this method is that it uses a multi-method approach to data collection to avoid errors and bias inherent in any single methodology (Gorrad, 2013). Leddy and Ormaod (2005) stated that some researchers emphasise the combination of techniques or methods of collecting and analysing quantitative and qualitative data which relates more to the practice of triangulation that enriches one particular approach, rather than the consideration of a mixed method approach

A mixed-method research involves both challenging, investigating and analysing quantitative and qualitative data, meaning a researcher collects both numeric and text information. The data may be from a single study or from multiple studies in a programme of inquiry. Therefore, the mixing of the data is a unique element of mixed-methods research. It means that it is not enough to collect and analyse quantitative and qualitative data - they need to be mixed together to form a complete picture of the problem.

It thus seems that a mixed-method approach is best used to investigate and integrate quantitative and qualitative data collection and analysis into a single study or a programme inquiry. This form of research is more than collecting both types of data, it includes the fact that data will be integrated and mixed at some stage of the research process. Whereas mixed methods design is adopted in this study, a qualitative research method was predominantly used in this study with the quantitative methods used to quantify the responses. The research target audience consisted of the directly affected households of the 2014 seismic event in Khuma, North West Province, and government officials. Furthermore, the research included disaster management practitioners and town planners as respondents.

3.4.1 Summary of research design

Table 3.1 provides a summary of the research design for this study. It details how the study took place, what tools were used, how the data was composed, the instruments that were used, the proposed issues, and the methods used to collect data (Lunga, 2015 and Fourier, 2012). This table helps to provide insight into the general strategy used to integrate and choose the different mechanisms for the study, in a logical and coherent manner. It also highlights the important fact that the research design was used to clearly define what type of design should be used for the research problem.

Table 3.1: Research elements

Research paradigm	Constructivism
Research design	Qualitative and quantitative methods
Data collection	Questionnaires and key informant interviews
Data interpretation	Thematic analysis
Validity	From research instruments and triangulation with existing data and literature review.
Ethical issues	I. Informed consent. II. Ethics clearance from North-West University.

	III. Permission from participants.
Total population of the affected households	Approx. 1400 households
N count (questionnaires)	60
N count (key informant interviews)	7

3.5 INSTRUMENTATION

The researcher chose household questionnaires, semi-structured interviews (key informant interviews) because it is a personal method of interaction with the respondents - the questions are still predetermined but allow room for individual contribution and explanation (Mason, 2002 and Maartens, 2011:73). When coming to the sampling procedure participants were selected, because they provide substantial contributions to filling out the structure and character of the experience under investigation – with the unit of analysis being the experience and not individuals or groups or cases. Although it was a valid methodology to make appropriate and meaningful comparisons between sub-groups in the population, it reflected the characteristics, perceptions and behaviours of the population as a whole.

The questionnaires were used to address two main purposes. Firstly, the purpose was to examine the perceptions of the randomly damaged households that were assessed by government officials regarding the extent of the damages and affected households. In this study, a purposeful sampling technique was used to select households that were affected by the 2014 seismic event and government officials to participate in the study. The participants in the study were selected based on their shared geographical setting of either residing or working in Khuma Township. Sixty affected households participated in the questionnaires and ten government officials participated in the study through one focus group discussion. Factors assessed and used as a measurement of these perceptions by the researcher included gender, age, residence (time), infrastructure,

social dependence, poverty, family structure, population growth, access to medical services, access (general), politics, and power (see section 2.2.2). To determine the validity and reliability of the questionnaire the researcher had to choose the appropriate questions and methods of delivery to be used. The validity is inherently more difficult to establish within a single static measure. If the questionnaire is perfectly valid then it must measure in such a way that inferences can be drawn from the questionnaire and methodology. Like most research studies there were limitations (see section 3.4 below). The relevant information contained in this research study could only be gathered from households living in Khuma.

The people who took part in the semi-structured interviews were residents, community leaders and field practitioners working in the area. This helped provide insight on how the government had been planning to assist households. The researcher often asked questions and was present to provide information in case there was any uncertainty raised by participants (Maartens, 2011:79). The researcher was accompanied by a research assistant and a volunteer from the disaster risk management centre of the district (Dr Kenneth Kaunda District Municipality). The researcher ensured that people understood the questions by translating them into Setswana, Sesotho, English and isiXhosa. After every questionnaire, the researcher made notes and discussed issues with the participants which they might have misunderstood during the completion of the questionnaire. This helped with ensuring completeness of data, and that participants did not give less or more than what was asked or expected of them. All field notes were transcribed following the interviews. The following section describes the capturing of the data used in this study.

3.6 DATA CAPTURING

The researcher used multiple primary data sources. Previously conducted studies, journal articles, book publications, policy documents and reports were used to collect secondary data (McLafferty, 2004). Field work was the main activity used in the study to collect the primary data (Lunga, 2015:120). After the data had been collected, the records were examined and transcribed.

The data were analysed according to eight steps of Tesch (1990:142-145) and they included:

- Reading and making notes of all transcribed material.
- Considering the substance of interviews conducted looking for the underlying meaning.
- Compiling a list of all topics that came to the fore in the research.
- Clustering the topics
- Using a cluster list, once again considering the data, coding the topics and correlating coding with data.
- Elaborating the topics with the aim to turn into categories and determining the interrelationships.
- Making a final decision on the coding of the categories and alphabetising the list
- If necessary, recoding existing data.

The household questionnaires were captured and analysed using Survey Analytics (see www.surveyanalytics.com). The key informant interviews were transcribed and interpreted. As an argument of final divergence, the transcribed data were then developed into themes, preferences and perceptions according to the information gathered from the respondents that took part in the study. The researcher and assistants also took notes throughout the semi-structured interviews and questionnaires and then compared the contributions. This helped to ensure that a balanced contribution was considered to reflect both sides of the story so that the researcher also remained objective when analysing the data discussed with respondents.

Visual diagrams were used to summarise the data collected through the various discussions. This process assisted the researcher in categorising the patterns, data and trends formulated from collected data and made it easier to recognise information. The information collected from all responded was then used to formulate themes in order to answer the research questions.

3.6.1 Reliability and validity of research methodology

Reliability and validity are two concepts that should not be underestimated by the researcher as it could lead to results of the research study being insignificant and incorrect (Sarantakas, 2013). The researchers' credibility lies in the essence of their methodology through testing questionnaires, reports and interviews as indicated in the previous sections. The questionnaires filled in by households were kept confidential by the researcher. The key informant interviews were also unstructured and the researcher used recording, observations and notes as triangulation. The following will be the ethical considerations of the study.

3.7 ETHICAL CONSIDERATIONS AND LIMITATIONS

Interviews were conducted in person and it was ensured that participants' privacy was respected. The respondents were advised to answer questions from the point of view of their own insights and experience. The researcher clearly explained the purpose and objective of the research to the respondents, and ensured that the participants were fully aware that they were not forced to participate in the research. They were given the opportunity to ask for explanations of the questions where they were unclear. This prevented the participants from feeling threatened by the researcher. Some households feared that their opinions of councillors and construction companies (those busy with the infrastructure and housing repairs) would be used against them instead of helping them. However, such fears were allayed. The researcher could empathise with the respondents because the researcher is part of the community under investigation and has a relationship with the respondents. Being close to the respondents, and living in the same environment made it challenging at times to facilitate the semi-structured interviews. However, the researcher had assistants present to help with the objectivity and focus of the study. The fact that the researcher has prior knowledge of the community added significant value in understanding the nuances and underlying meaning of responses.

3.8 CONCLUSION

The purpose of this chapter was to outline issues pertaining to the research methodology of the study. This chapter indicated the approach used by showing how data were collected and used to analyse to research objectives. A mixed-methods approach was used to collect the data, a qualitative method was used to discover the perceptions and integration of household's vulnerability to seismic events. This process helped identify details of people's housing conditions, perceptions, gender roles, socio-economic issues and norms. The qualitative method was specifically designed to investigate the inadequate living or housing conditions that contribute to households being exposed to seismic events. Using the qualitative design for this case study research allowed the researcher to observe and reflect the context specific to the research objectives.

A quantitative design was used to highlight objective measurements and the statistical, or numerical analysis of data collected through the case study, computational techniques were to analyse questionnaires using a quantitative research assisted to bring logic to the figures collected. The quantitative approach focused on numeric and unchanging data. The research questionnaires ensured convergent reasoning rather than divergent reasoning. To ensure the validity and reliability of the research semi-structured interviews and focus groups were utilized ethically to collect the data. The use of the mixed method helped to explore and maximise the findings. Using a mixed method as a tool enhanced the quality of the case study research because both research designs complemented each other in ensuring that the research findings were cross-checked. The researcher ensured that ethical research practices were maintained always to avoid privacy invasion and being unintentionally hard for the households. This enabled the research to be optimal and transparent.

CHAPTER 4 : EMPIRICAL FINDINGS

4.1 INTRODUCTION

The purpose of this study was to investigate the socio-economic vulnerability attributes of communities exposed to seismic events at local government level in South Africa using Khuma as a case-study. The study was necessitated after the Khuma community was seriously affected by the 2014 earthquake that occurred in Orkney (see section 2.1 for the full details of the earthquake). To achieve this goal, a mixed method research approach was applied. Chapter 3 of this study provided a comprehensive discussion of the research methodology applied to the study. This chapter addresses the second and third objectives of the study respectively, i.e. to describe the incidences of seismic events in the Dr Kenneth Kaunda District Municipality and to determine the socio-economic vulnerability of exposed communities to seismic events in Khuma.

The empirical stage of the study also aimed to establish socio-economic attributes that contributed to the high impact of the 2014 earthquake in the Khuma area. Disaster risk management experts have argued that enabling communities to define their own susceptibility to loss and then empowering them to address that susceptibility is critical for disaster reduction (Wisner et al., 2004). Therefore, this chapter presents the empirical findings and the analysis of the findings of the study. The chapter starts by providing a discussion of the research context in which the research project was conducted. This section is followed by a discussion of the research participants and is succeeded by a presentation and discussion of the findings from the focus group interviews and questionnaire. The conclusion is provided at the end of the chapter.

The social vulnerability concepts and the PAR model form the basis of the empirical findings of the chapter. The relevance of the PAR model in this study is that it considers all the factors that influence social vulnerability including lack of access to resources (including information, knowledge, and technology); limited access to political power

and representation; social capital, including social networks and connections; beliefs and customs; building stock and age; frail and physically limited individuals; and type and density of infrastructure and lifelines (Cutter et al., 2003). Therefore, empirical findings were created from data themes allied to the social vulnerability concepts which explain the exposure of households to seismic events. The above sections in Chapter 3 provided the background and thematic coding used to describe the different themes used to analyse the data. The empirical findings are analysed below using graphs and tables using a qualitative and quantitative approach. The following section is a discussion of the biographical information of the participants that took part in the study.

4.2 BIOGRAPHICAL INFORMATION

This section presents the findings from data collected through focus group discussion and questionnaires administered to the community and government officials. All interview responses were transcribed verbatim and initially checked and categorised manually to identify core “presenting” themes and patterns, informed by the PAR model. Themes that emerged from the data were pieced together to provide a comprehensive picture of the views and experiences of the respondents. Therefore, the findings are presented according to the identified themes. The findings of this study strike a chord with the literature as there is convergence between the views of the participants and the scholarly literature and other research consulted.

The socio-economic vulnerability in the study area was assessed using a number of factors including demographic characteristics, governance implications of vulnerability, access to resources, exposure to seismic risk and access to hazard risk and information. Whereas the factors assessed in this study are not all inclusive, they capture the essence of what happened during the 2014 earthquake that hit the Khuma community. It is imperative to identify and assess a complex network factors which shape the vulnerability of a community as social and economic trends reinforce, transform or weaken existing patterns of risk. The household information provided in this section contains a gender breakdown, the living conditions, heads of households,

how long people have been living in Khuma, why they settled there, and their access to adequate housing.

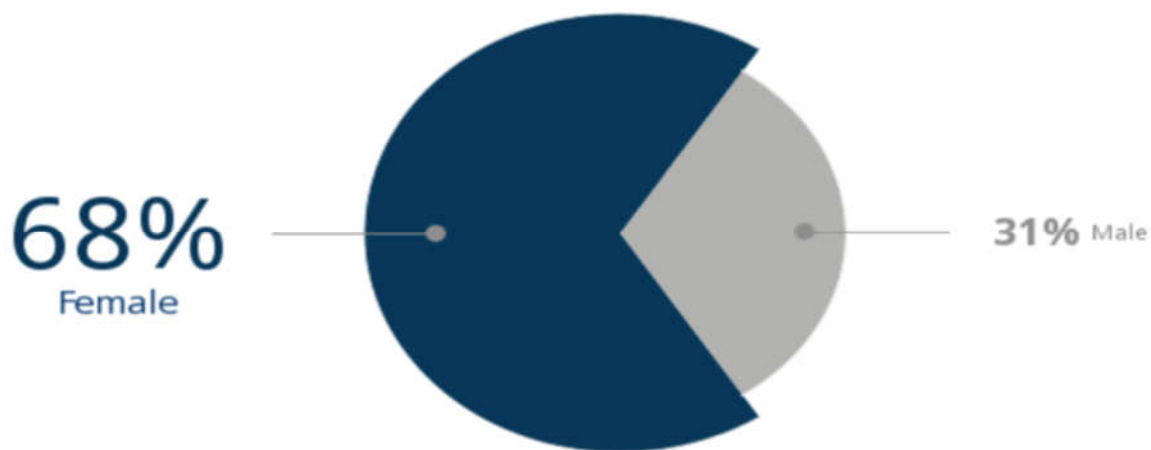


Figure 4.1: Gender distribution of respondents

From the above Figure 4.1, it can be seen that 19 (31%) of the respondents were male and 41 (68%) were female. Most of the respondents indicated that the hazard had a negative impact on their lives and that they felt this could have been prevented if the disaster practitioners had warned them that in future, events of this magnitude might take place, because most of the respondents were female and unemployed or elderly. The abovementioned respondents could play a great role in reducing disaster risk if only government could strategize better in terms of the rehabilitation process. The literature shows (see section 2.2.3) mostly women were affected because of the gender distribution in the affected areas (hazards). The result of this is that women are more prone to being victims of disaster than men.

Most of the respondents had been residing in Khuma for many years, as can be seen by Figure 4.2 below.

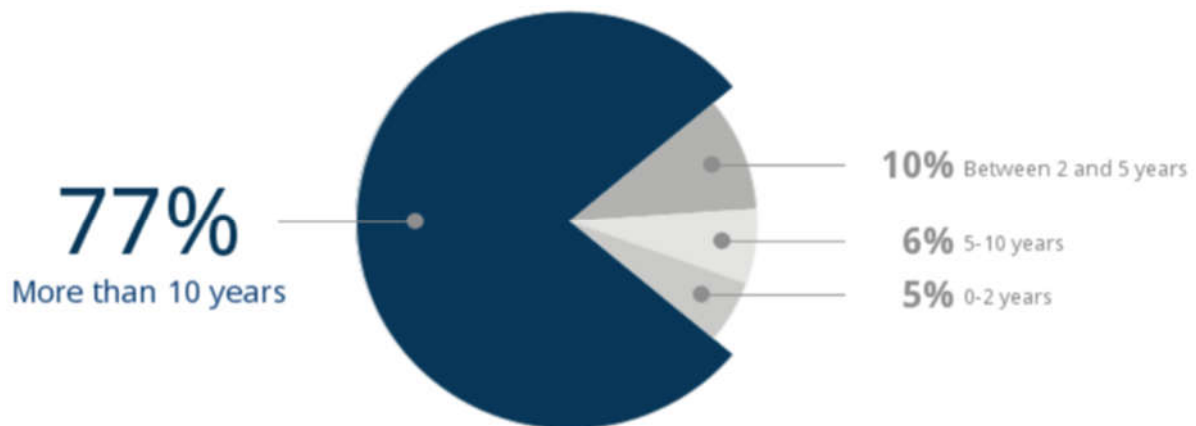


Figure 4.2: Years of residency in Khuma

As is evident in the chart above, most respondents (77%) had been resident in the area for five to ten years, four (11%) households had been living there for two to five years, and two (10%) households for less than two years. Thus, forty-six households know the area better as they have been residing in Khuma for more than ten years. Furthermore, the figure above illustrates that it is fair to argue that many of the participants know the history of hazards in the area. Most of the participants who had been living in their homes for decades were either born, raised or found the houses due to work.

The respondents moved to Khuma for varied reasons relating to the mining industry. Some people have been living longer in their households because their parents were working in the mines or they moved there after their parent lost employment at the mines. In addition, respondents either had children or spouses who took part in building the newer RDP houses (in the post-1994 period). Moreover, 70% (40) of the households that took part in the study occupied old municipal houses which were built before the 1970s. Their bricks were made of clay and the roofing of asbestos. Furthermore, most of the houses were built in unsafe physical environments, particularly in dolomitic areas. From the government respondents, it became clear that the municipal council had run out of safe land on which to build houses. This means they cannot afford to relocate people to safer areas in the township. Moreover, because the majority of the households have lived in the area for more than 10 years, most experienced both seismic events (2005 and 2014). Some of the respondents were

quoted as saying that the 2014 seismic event was worse than the 2005 event. Figure 4.3 deals with home ownership in the area, and the following section further analyses the home ownership challenges faced by households living in Khuma.

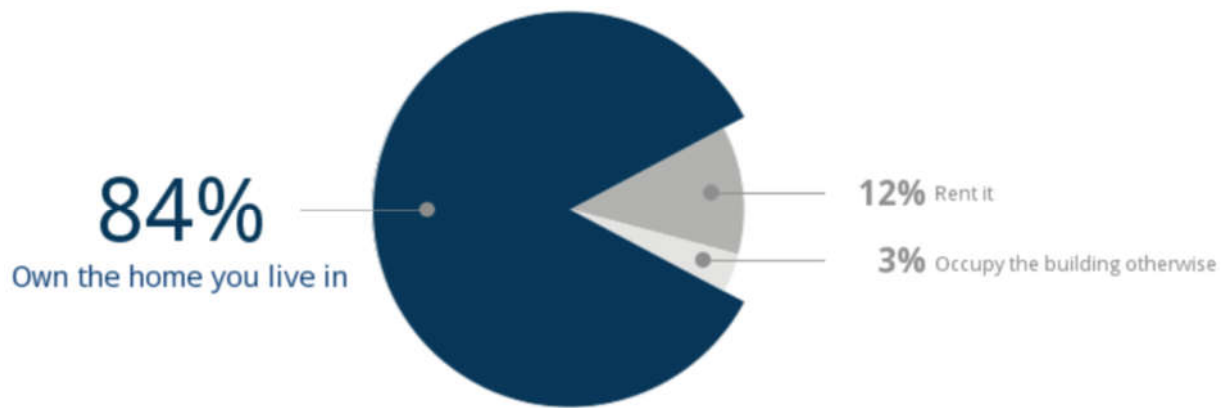


Figure 4.3: Home ownership

The figure above indicates that 49 of the houses (84%) are owned by the residents, seven houses (12%) are rented, and 3% (two people) are occupying “otherwise”. “Otherwise” can be defined as people living in houses illegally to avoid paying rent, or occupying houses for safety and security purposes on behalf of the owner. Home ownership is a root cause under the PAR model, and as many people don’t own the houses they live in, it is difficult to access and own RDP houses, which are given free to some groups of people but not to all. Although 84% of respondents indicated that they owned the home in which they lived, this did not mean that the household they live or occupy legally their property.

People were given free RDP houses to live in by the government, because they couldn’t afford adequate housing. When interviewed on the matter, the respondents indicated that it takes a long time to change title deeds. At times one needs to obtain the services of a lawyer to change title deeds, which the community can’t afford. Due to this obstacle, some people have lost their homes in the past due to not having their houses registered in their names. This makes communities more vulnerable because people

are forced to live in houses given to them by the government, their parents, or their spouses who have passed on, without legally owning the home themselves. From the above pie chart, one can argue that living in a shack is safer than living in a poorly built RDP house (the researcher's observation). From the research, a significant portion of the 84% of respondents made up this poor, vulnerable group. Of the total respondents, 77% live in these RDP houses (see Figure 4.4 below).

One of the respondents indicated that: *The ANC doesn't want to give us service delivery for our housing, no shacks, free electricity and jobs.* One could argue that the government would be creating a problem of dependence by doing so. When standards are improved by giving people houses, expectations are created in others who can afford houses but who then want free housing. Nevertheless, one could also argue that if government does not take care of the people, households could become more vulnerable. Respondents identified the problem that people who can afford housing for themselves live in RDP houses, and nothing is done to stop or monitor who receives RDP houses. There are many young and middle-class people living in RDP houses that should be occupied by poor people. Some of the respondents felt that in the "olden" days (pre-1994), in order to have an "old municipal house" there had to be a breadwinner, and it was required that the person working had to pay rent and utilities monthly, otherwise they would be removed from the house. This meant that the people who could get housing had to ensure that they could consistently pay monthly rent as that was a basic requirement for housing.

However, today anyone can obtain a government house. As one respondent indicated: *As a person, you must to know the right people.* This makes it hard for people living in poverty because of the delay by government in giving them access to housing. Poor people rely on government to subsidise their housing, rent and utilities. Most of the people living in Khuma haven't paid rent in years, and as a result, the municipality owes Eskom and Midvaal Water (electricity and utilities companies) millions of Rand for electricity and water. The municipality is not in a position to buy and install water and electricity metres because people do not pay rent in the township. Most people end up renting shacks, occupying unfinished houses, or living in unsafe houses just to find

security and shelter. Shack dwellers further face an additional risk relating to shack fires. As one respondent indicated: *[they] were renting shacks in their yard and one of their renters burned down one shack, but the fire burned all the shacks around the yard.* In these circumstances the municipality could not assist anyone because they were renting the shacks and were not home owners of RDP houses. It is therefore critical to also understand the type of structure a household occupies, which is shown in Figure 4.4 below.

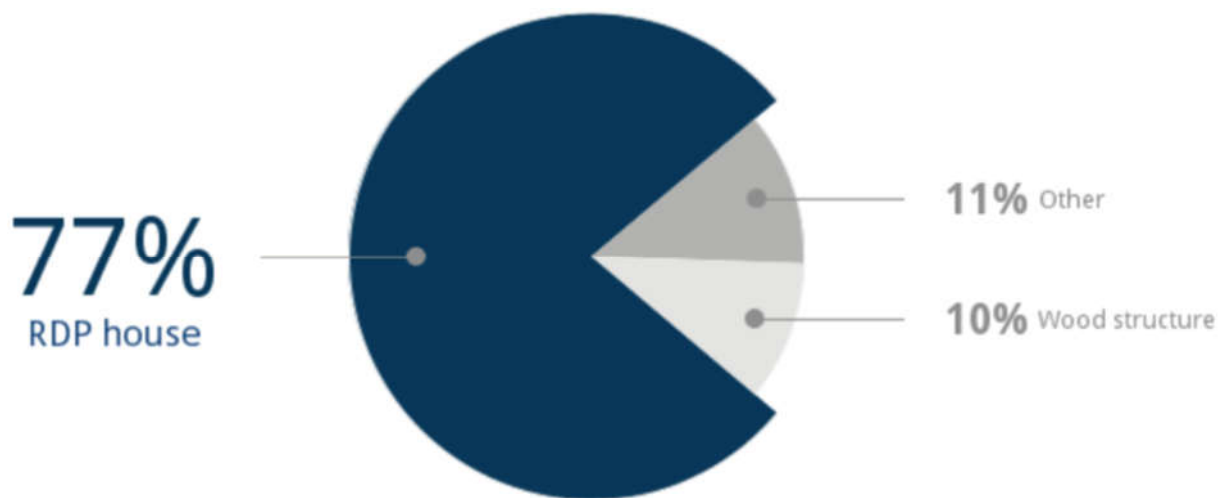


Figure 4.4: Housing structure

Households that took part in the study had one thing in common; they were all vulnerable households and had been affected by the 2014 seismic event. Figure 4.4 indicates that most of the households that took part in the study lived in old municipal houses or new RDP houses. Seven (11%) people lived in “other” forms of housing, which included extended RDP houses, two-room RDPs, own houses next to RDP houses, and self-built houses. 10% of houses were built of wood, or had used wood as the main source of construction. The kind of structure people live in tells a lot about the socio-economic conditions of these households.

Some participants mentioned that they had to pay (bribes) for free houses. This indicates the corruption in government and puts people’s livelihoods at risk. Such a

situation falls under the root cause of the PAR model because having a house in one's name is an asset and allows one to let it (resources). The majority of respondents complained that most people who occupy RDP houses lease them from people who received the house free, or they are living there because the person who owns the house lives elsewhere. These home-owners are thus further exploiting the marginalised because they are renting free government houses (not meant for them in the first place) to people who can barely afford them. Many householders, therefore, did not obtain their houses from the government, but from family members through a form of "inheritance". The occurrence of the 2014 seismic event in this area highlighted the risk of inadequate housing, the need for quality housing, and led to householders needing to find alternative accommodation because their houses would not withstand another earthquake.

As most of the households surveyed occupied RDP houses, the researcher aimed to understand the nature of these RDP houses and thus delved deeper to determine whether there was any correlation between the type of RDP house and the problems experienced by the respondents. Figure 4.5 below shows the different types of RDP and other houses.

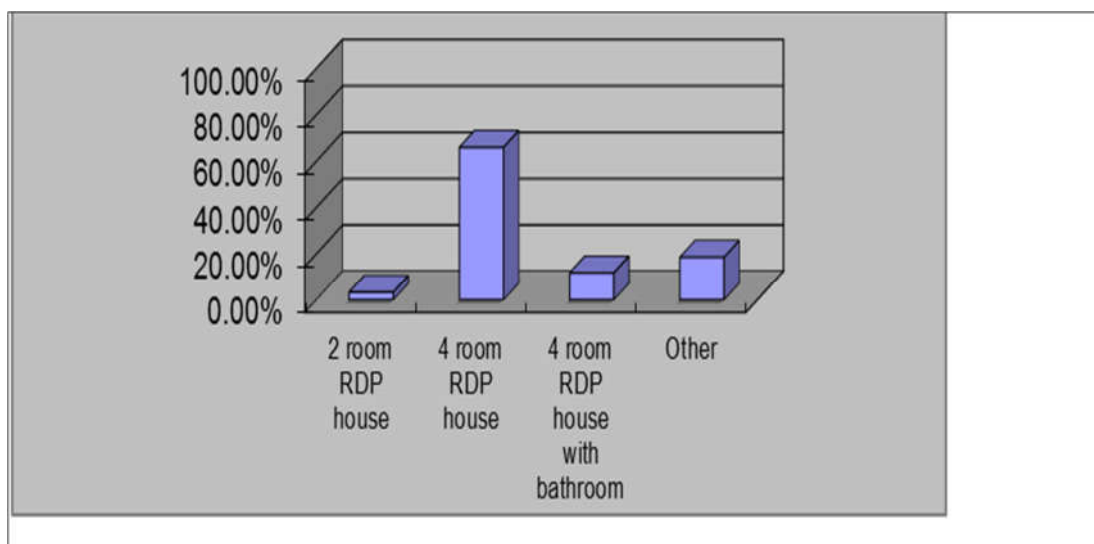


Figure 4.5: Types of houses

The households that took part in the study indicated that their RDP houses were:

- Four-room RDP houses;
- Four-room RDP with a bathroom;
- Two-room RDP houses; or
- Other houses included (self-built houses and extended RDP houses).

These housing types are similar because they were built by the government in the pre- and post-1994 era. However, the houses were affected in different ways. Most of the four-room houses had damaged walls, cracks on the floors and damaged roofing (pre-1994) (previously known as old municipal houses). This section falls under dynamic pressures category under the pressure resale model (PAR model) as houses pre-1994 are more durable than those post-1994. Both types are poorly built but one is better than the other. Houses pre-1994 paid for monthly utilities and those post-1994 are not, as people complained that they are poor and cannot pay for utilities. The old municipal houses and new RDPs were affected differently because some were old, and secondly, poor building materials were used to build the new houses.

Most houses (both pre- and post-1994) shifted on their foundations when the event took place. Some householders noticed cracks both inside and outside, where some householders noticed that damage started appearing only after a week or two following the event. One respondent came home only to realise that their whole house had collapsed following the damage assessment (see section 3.8 below). This is an indicator that houses are poorly built and that makes them more vulnerable and exposed to seismic events. Besides the physical structure of the houses, to understand the socio-economic vulnerability in the Khuma community, the social construction of households was investigated (as per the PAR model in chapter 2). Figure 4.6 below illustrates the different heads of households.

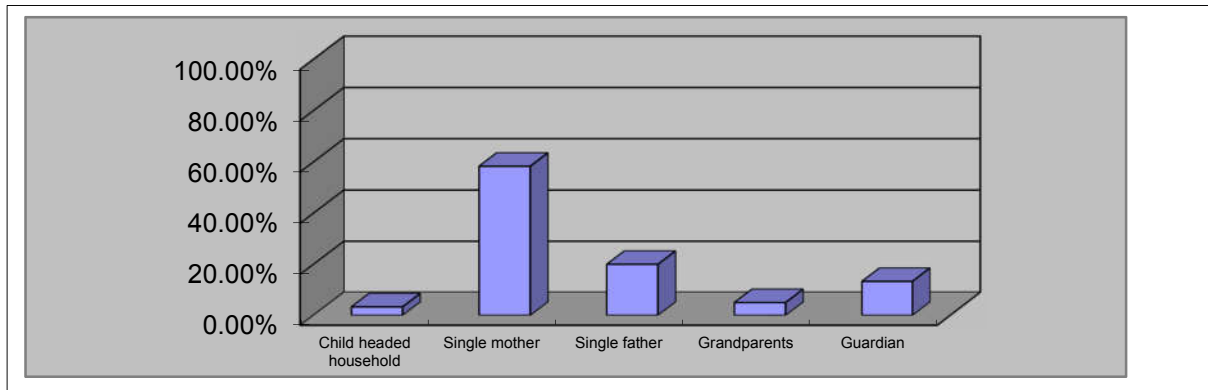


Figure 4.6: Heads of households

Regarding gender, most of the respondents were female and heads of their households. Involved in the study were thirty-five (58%) female respondents, twelve (20%) male respondents, eight guardians (13%) and two (5%) grandparents as heads of households. To better understand the research question, Figure 4.1 looks at the gender affected most during the seismic event, and Figure 4.6 looks at the specific gender of the household head. The larger number of female-headed households in this sample indicated that one could expect to find most households in Khuma to be headed by females. Women and men play different roles when it comes to households and taking care of their families, however, women carry the brunt in times of peril (see Figure 2.1 above). Research has shown that women and mothers are more likely to spend their income on food, children and their needs, before spending money on themselves (Greef, 2007).

This section falls under the fragile conditions of the PAR, indicating that mostly women, the disabled and elderly are usually affected by disaster. The gender representation among all four types of heads of households made it possible for all parents and guardians to be represented in the study. However, most of the heads of households were female, for varying reasons. Some women stated that: *Most men ran away from their families after the mines closed, and after retrenchment [in the mines], most “us” women are left single and some single fathers are alone because they lost their*

spouses. The mothers because of extreme poverty and suffering...the father is back to [his first] wife [and left] me alone with [the] children... It was thus stated that guardians and grandparents were left to look after the children. Figure 4.6 above can be described as an indicator that most households therefore also rely on a single breadwinner (see section 2.2.3 and 2.4). However, due to family responsibilities, loans, school fees, food, electricity and other household essentials, many households struggle to make ends meet. And here again, the issue of finding employment was that although some respondents had skills and qualifications, there was no market for jobs in the area (eligible unemployment).

To further illustrate the marginalisation that occurs, being a single-parent household and an older person, added another layer of complexity to the recovery from the seismic event. For example, the oldest respondent in the study was taking care of seven great-grandchildren. The house was so badly damaged that the children had to be taken to other family members for shelter. The whole family had to relocate, as there was no roof and the walls were falling in. Furthermore, the walls and roofing were falling apart because the old municipal house had not been renovated in over 40 years. When government officials came to do damage assessment after the seismic event, that house had been overlooked. This error reduced the elderly respondent's chance of getting quick assistance as she was unable to fill in the damage form which was sent out by volunteers. She later sent her children to claim damages and report that her house was in a dangerous state, but still no progress was made. The following section is an analysis of the variables of a seismic event on households.

4.3 SEISMIC EVENT

Exposure to seismic risk is one of the contributing factors in increasing the vulnerability of communities. In this study, most respondents alluded to the fact that poor building structures, old houses and environmental risk (dolomite) were contributing factors to the damage and effects on the households during the 2014 earthquake. To illustrate the heightened risk in which households found themselves, questions were asked about

where and how the respondents acted or responded during and after the seismic event. Figure 4.7 shows where the respondents were located during the seismic event.

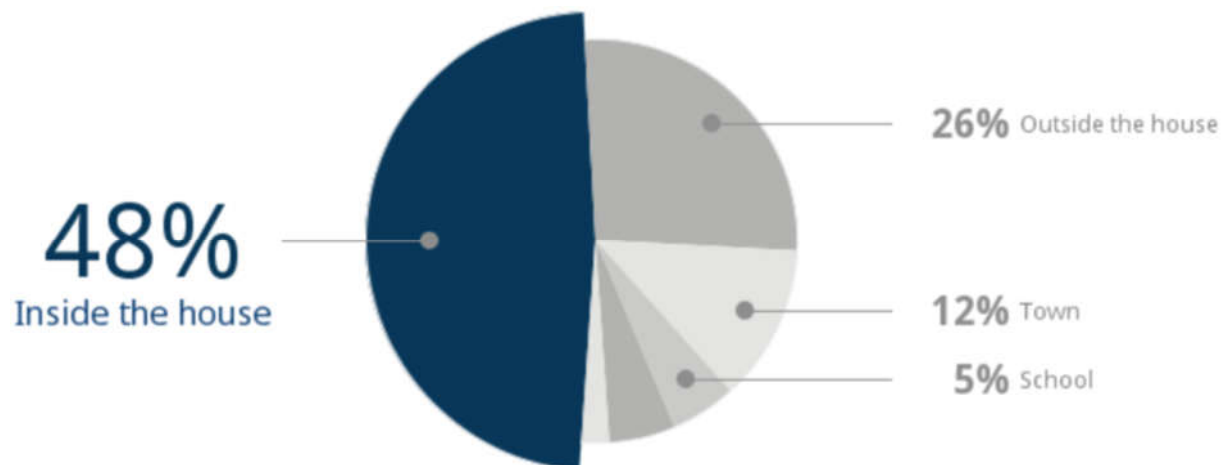


Figure 4.7: Location of respondents during seismic event

Twenty-seven (48%) households stated that they were inside their homes when the event took place, fifteen were outside the house (26%), seven (12%) were in town and three were at school (5%). This means that most householders are likely to be inside their homes when another seismic event occurs. This section falls under the root causes and fragile conditions of the PAR model, as the reason why most people were in their homes during the seismic event was due to their unemployment and thus they spent most of their time in their houses. The findings revealed that most of the households' resilience depends on health available in Facility structures and they have free access to clinics, doctors and mobile clinics, those affected by the seismic event were immediately sent to the health facilities and were either assisted or sent to hospitals for further medical assessments.

The elderly who were outside their houses and the children at school were more susceptible and at risk because the elderly could not run to escape and the children didn't know whether to run or stay in their classrooms. These minority groups were at

risk of getting injured during the seismic event. One of the respondents indicated that some people could not run out of their homes because they were trapped due to broken and locked doors. He said: *my mother ran out of the house naked when she heard the ground move [because] she was bathing*. Another respondent indicated that: *Under these circumstances some people were trapped in their houses and could not escape*.

While conducting the research, it was observed that most people could be found at home during the day as a result of unemployment or having small home industry businesses nearby. This indicated that they spend most of their time inside the house, or that they get back home before noon. It was found that during the day people are usually at home relaxing and watching television, playing cards or listening to the radio. With such poorly-built houses, this increases their chance of getting injured during a seismic event. Figure 4.8 shows the extent of damage assessment undertaken by government, and the following section describes the process used to assess the damage of the affected households.

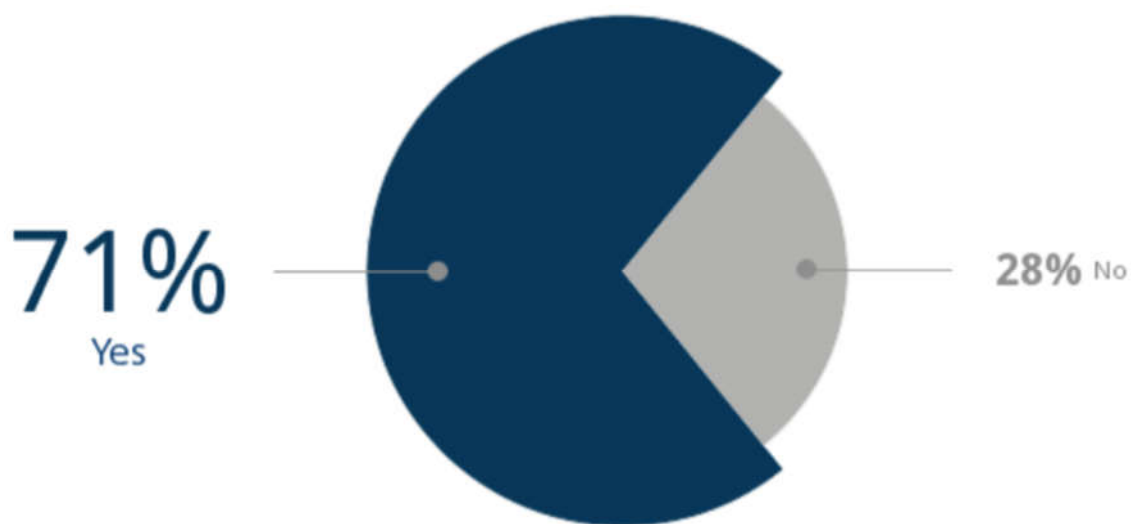


Figure 4.8: Damage assessment undertaken by government

Seventy-one per cent (71%) of the affected households indicated that a government official or volunteer came to assess (“look”) at their houses. However, most households were unable to access claim forms to register their houses to be fixed or rebuilt. Some respondents alleged that they had to buy the forms for the damage assessment from volunteers (assessors), or that they were unaware of the need to formally register their claims/losses. This section can be referred to as dynamic pressures of the PAR model, as there was a lack of pre-planning by the disaster practitioners regarding the seismic hazard. From the respondents, it became apparent that political interference also occurred in this process. Politicians used this event as an opportunity to exert their power and authority by assuring people that their houses would be fixed, while understanding there was no budget to help people affected by the event (see 2.2.3 and 2.7).

However, after two weeks of meetings and assessments after the event took place, it was declared a provincial state of disaster (Smit, 2001). This declaration meant the mobilisation of additional funds and resources. Some of the respondents were quoted as saying: “we go complain to the ward councillors about the houses but nothing is done to help us...they tell us to wait” One of the respondents told the researcher that not being part of the ruling ANC party made it hard for people to get assistance because they did not share the same views as the councillors. One respondent indicated that some leaders and officials misused their powers by assisting people whose houses were not affected by the event. Over the almost past two years since the event, only approximately 40 houses had been fixed, and there are still thousands of householders waiting for their houses to be repaired. Communication has been problematic, and respondents complained that the councillors needed to convey accurate, clear and complete information to his/her constituency about the municipality’s programmes, policies and services, especially in the event of a hazard or disaster. The respondents felt that in a disaster situation, it is government’s responsibility to take care of its people, especially the poor and vulnerable.

Furthermore, and due to frustration, some people took matters into their own hands when they realised that people whose houses had not been damaged due to the event

were being fixed. In retaliation, they demolished their own houses to get attention from government. From the research, it became apparent that the respondents perceived the reconstruction and rehabilitation undertaken by government-appointed contractors as problematic. Three different contracting companies were used to repair the identified damaged houses. Most people were pleased with the services of contractor “A”, however, most people complained about contractors “B” and “C” who fixed houses but after two weeks the respondents would again experience problems with cracked walls. When they complained to their ward councillors, their councillors referred them back to the contractors knowing well that the contractors would do nothing to fix the problem. This added a layer of frustration and fuelled additional conflicts with the disaster management practitioners and ward councillors. Those affected also ended up not attending the necessary meetings because they felt that they were going to be lied to, or given empty promises. Due to this perception of poor political leadership, respondents took matters into their own hands by remaining in unsafe houses.

Furthermore, some respondents indicated that they took loans and pension funds to fix their houses, because they could no longer wait for the government (thus further adding to their economic vulnerability). Besides the underlying political and administrative issues relating to the actual reconstruction following the seismic event, it is important to understand the socio-economic conditions which render the Khuma community increasingly vulnerable to the impact of hazards of all kinds.

4.4 SOCIO-ECONOMIC VARIABLES

Income remains one of the best indicators of socio-economic vulnerability. When presented with the question pertaining to source of income, 30% of respondents said that they relied on a pension grant, 22% relied on social grants, and 21% generated income from casual employment, while 10% represented the “other” category. To receive a pension from the South African government, the recipient must be at least 60 years of age, which automatically identifies them (the elderly) as a more vulnerable group. It is deduced that the 30% of respondents who are relying on a pension for

income are either at least 60 years old, or the respondents are dependent on a pensioner to provide this income.

Based on previously cited statistics, 68% of the respondents were female and 58% of the households headed by a single mother. This has great socio-economic implications as females are more vulnerable due to sector-specific employment demands, lower income, and family care responsibilities. In addition, single-parent households often have limited income available to outsource the care of dependents, thus increasing the need to manage both work and family responsibilities. Therefore, gender, economic status, and age greatly influence the community's vulnerability during and after seismic events. Most people in the study were above 50 years of age, female, and relied on pensions and grants as their only sources of income. Thus, most people in the study who received grants and pensions were women from poor households.



Figure 4.9: Source of income

During the study, the researcher concluded that most households felt empowered by the grants they received, as they believed the government cared for them by giving them monthly grants. However, this can hold certain social problems. One case that emanated from the research is a good example: When a child receives a grant, that

child is seen as the breadwinner. In one household, the family relied on a child disability grant. The disabled child is called “the man of the house” (i.e. head of household) because of the disability grant, however, the child does not attend school, because the money is used for household utilities and to assist the other “normal” children of the household. Although a disability grant is provided, the disabled child remains marginalised. Similarly, older persons are left as guardians of their grandchildren which means their meagre state pension needs to be used for raising the children. Most youth in Khuma lack skills, so they are reduced to doing casual work (manual labour), which is not very popular with the younger generation. Youth become despondent with their situation which in turn leads to other social ills such as crime and drug abuse. Furthermore, there are a few hindering factors in the Khuma which exclude those able and willing to work from receiving an income.

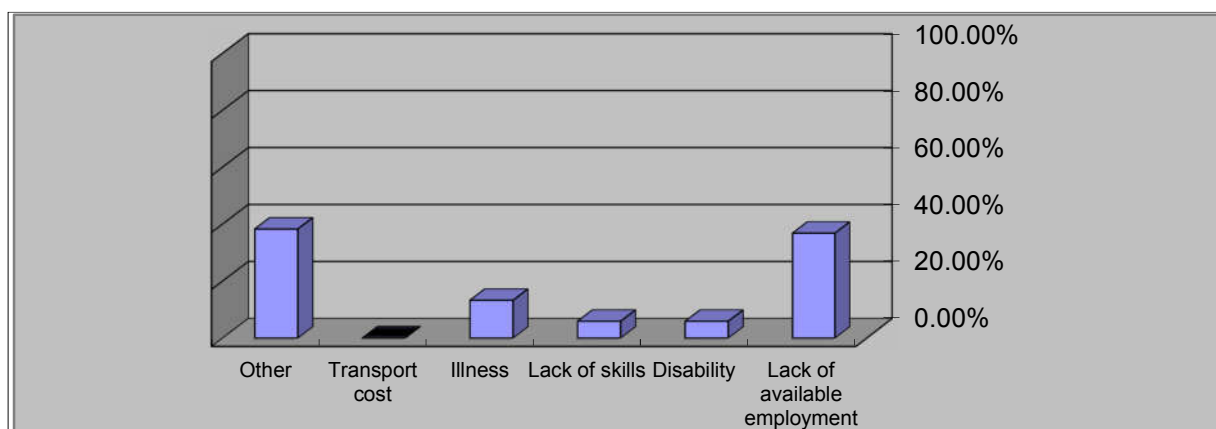


Figure 4.10: Hindering factors to employment

Thirty-six per cent (36%) of the respondents were of the opinion that the lack of available employment is an impediment to their safety. Thirteen respondents (5%) indicated that illness or disability was a hindering factor to their employment potential. The last category of possible reasons for employment hindrance was allocated to “other” by 38% of the respondents. Although some people survive on grants and pensions as a source of income, 93% of people said that they spent their money on

food, housing and health treatment. This means that only 19% could save money occasionally and 80% said that they were unable to save money, as they used it for monthly household essentials (see Figure 4.11). Employment-hindering factors are considered dynamic pressures in the PAR model as they indicate and give reasons for why people can't get access to employment. From the questions and comments of the respondents, the researcher observed that the respondents had a strong sense of entitlement. They were very vocal about their discontent with the lack of job opportunities and the poverty they are faced with. Figure 4.11 below analyses their household expenditure.

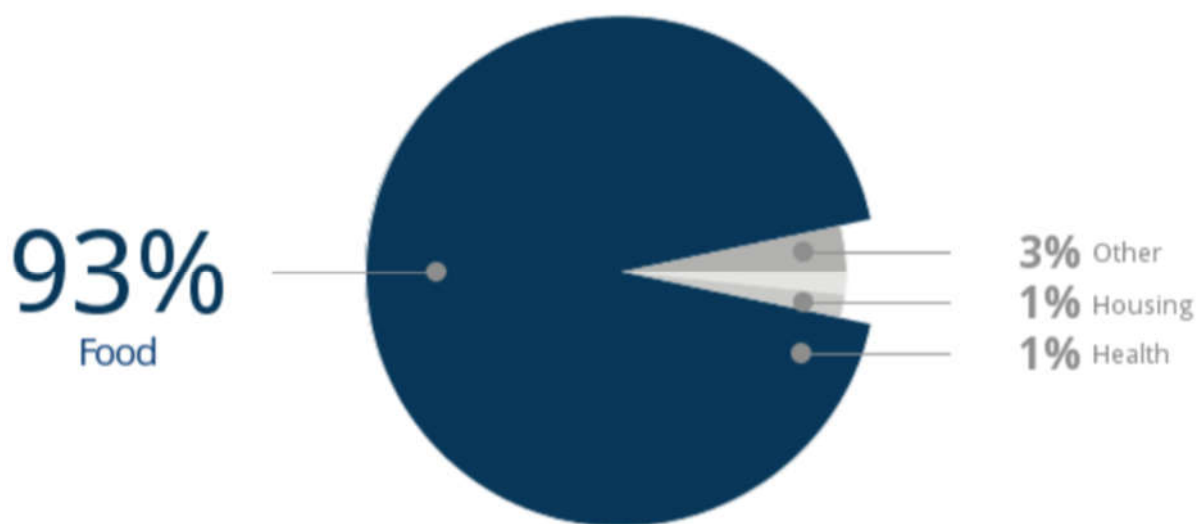


Figure 4.11: Monthly expenses

Based on Maslow's Hierarchy of Needs (1943), food, water and shelter are the basic physiological needs that must be met in order to survive. When considering the low-income status of some of the respondents, it is not surprising that many of them (93%) indicated that most of their income goes towards food and household expenses. When asked about their highest expenditure, only 1% of the respondents specified housing, with another 1% mentioning health expenses. The "other" expenditure category was chosen by 3% of the respondents. The high level of financial resources allocated to household expenditures makes the respondents more vulnerable when faced with a

seismic event. Other needs, like safety and security, are placed on the back burner because the basic need for nutrition must first be met before a focus can be on other needs.

Households barely have enough money to put food on the table. To augment their income, they take out loans and thus get into debt to survive. However, to obtain a full picture of income and expenditure in households one needs to look at the life choices households face daily, access to the job market, and the challenges they are faced with in the immediate surroundings. The availability of employment and access to economic activities remains a massive hindrance. This, however, was not always the case.

Back in the 1980s and 1990s Khuma was a wealthy township (refer to the meaning of Khuma in Section 3.3) as it was surrounded by mines and farms. After the 2005 seismic event, all socio-economic activities changed drastically as all mines in the Stilfontein area were closed and thousands of people were left unemployed (Smith, 2016). This led to extreme poverty in many ways. The money people received was not enough to reduce or stop the vulnerabilities people faced in the years to come. The opening and closing of mines had a huge impact on the households and people living in Khuma. The low income and high expenses of households therefore have a direct bearing on the ability of households to save money, which offsets economical vulnerability in the long term.

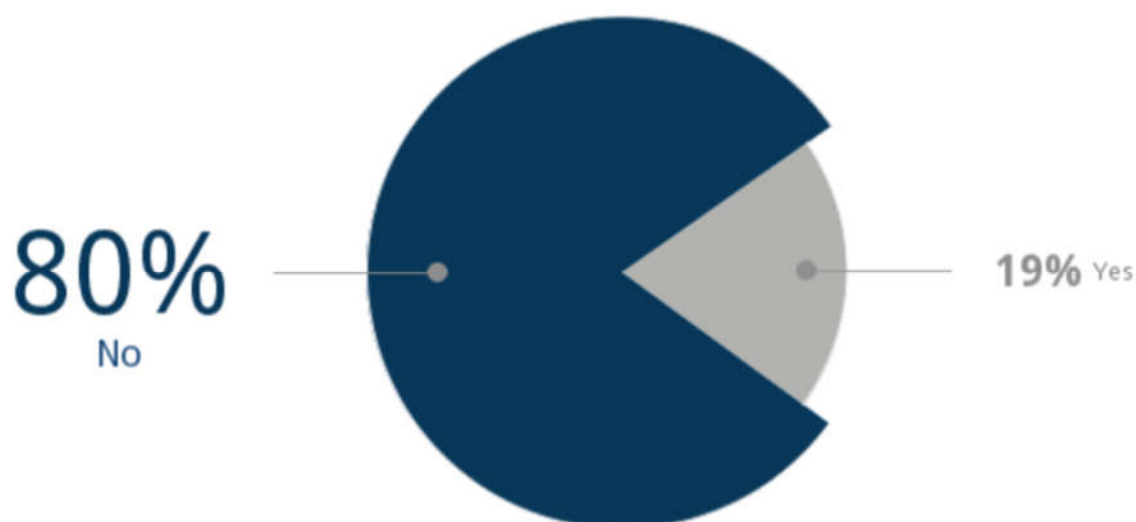


Figure 4.12: Household's ability to save

Eighty per cent (80%) of the respondents indicated that they were unable to save at all and approximately 19% said that they saved only occasionally. Due to this, some children know from an early age that they might never get a tertiary education. However, this is not only due to poor households getting a low income, it is also about the high cost of living and increases in living costs that make it difficult for people to save money. The overall problem is that people are spending more than they earn.

The researcher noted that most households did not see savings as a priority as they are used to living in debt. Their reasons were that whether they like it or not, they cannot afford to save money as they have to spend all their income monthly. However, it was clear that they were not aware that the lack of savings has its consequences. For instance, most households have no retirement funds in place and they are just waiting to get old (or sick) in order to qualify for the old age and disability grants. People were also unaware that the higher the interest rate the more you have to pay on your loan each month. The research thus clearly shows the vulnerability of households living in debt and who find themselves locked into a vicious cycle which they are unable to break free from.

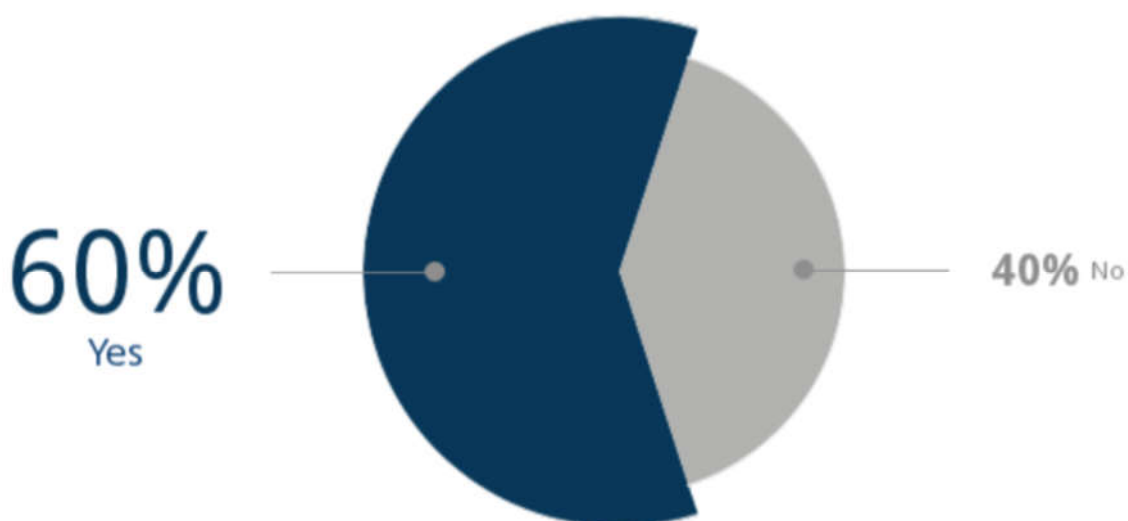


Figure 4.13: Dependence on social support for livelihoods

As indicated above, 60% of the households agreed that they depended on social support for their livelihoods. Social support played a big role in helping people with food, money and other necessities. The literature suggests (see Chapter 2) that people rely heavily on social support structures in times of need. As a result, the social reliance of households falls under the fragile conditions of the PAR model. In order to establish the level of social support in the study area, respondents were asked whether they had any form of social support such as a church group, volunteer group, friends and family. 77% of the respondents indicated that they did not have any form of social support, and only 22% indicated that they did have social support in the form of a church group, NGO, volunteer groups, friends or family.

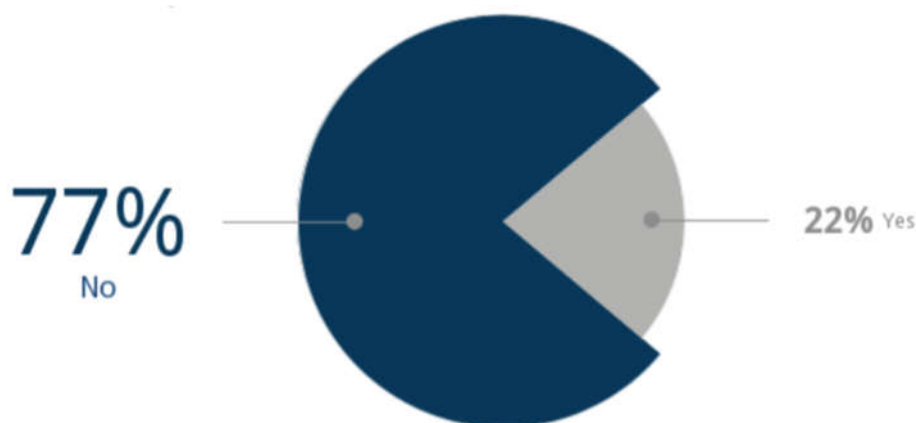


Figure 4.14: Access to social support networks

Most respondents complained that their councillors did not consider their needs and there was a barrier when it came to information between the people and the government. Certain people received information and others did not. For this reason, people do not trust their ward councillors. The households feel council misused their power and authority because they did not fulfil their promises. The residents in Khuma have been waiting for almost two years for the government to repair their homes. From the research, politics and power are still prevailing elements which contribute to social

vulnerability. Vulnerable people and places are often excluded from decision-making and from access to power and resources (Adger, 2006). Hence policy interventions to reduce vulnerability need to be able to identify vulnerabilities within social-ecological systems, to recognize the mechanisms which cause vulnerability in the first place, and to redress marginalization as a cause of social vulnerability (Adger, 2006).

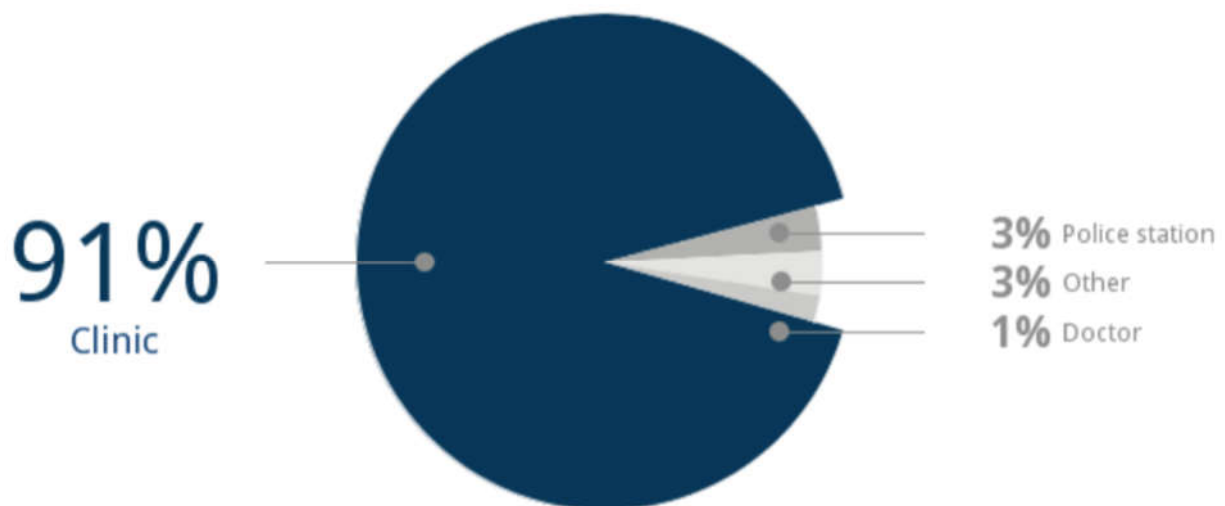


Figure 4.15: Availability of community services

In the event of a hazard, the interaction of disaster and vulnerability arises due to the fact that people's lives are lost and some experience serious injuries. Respondents are therefore relying on structures within their area for their livelihood which 77% of them do not have. This will have serious implications for the economic situation of the residents as well as the social vulnerability of the people in the study area. In the Pressure Model (Wisner et al., 2012:31; see Chapter 2), the progression of vulnerability is expressed as different elements including root causes, dynamic pressures and unsafe conditions - all contributing to and creating vulnerability.

The lack of local institutions is firstly described as creating a dynamic pressure and furthermore the lack of local institutions (see section below) also contributes to a vulnerable society and in effect unsafe conditions are created. It is clear therefore that

not having access to social support structures contributes to a community's vulnerability. Beside the assets (or lack thereof) of households which render them vulnerable, one also needs to consider the availability of community resources to obtain an accurate view of the level of vulnerability in a community.

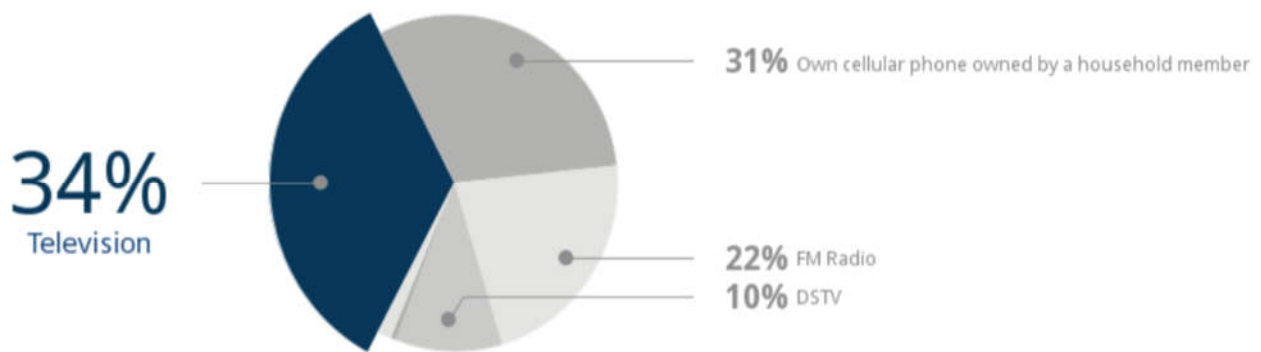


Figure 4.16: Access to communication

The figure above indicates that 34% of the households had access to television, 31% to cellular phones, 22% had access to radio and 10% to satellite TV such as DSTV. This shows that every household had one or two forms of communication, meaning they had access to information if an early warning was to be issued. Access to communication plays a major role, as communication barriers can expose a household to danger. Communication is crucial during a disaster or hazard. However, even though people had access to communication this was never effectively used by government or other stakeholders. Respondents on numerous occasions during the research complained about the poor communication received from their ward councillors and government officials. Below are a few responses from the respondents regarding access to communication by households:

- **Respondent 1:** *Ke ya go mmona gapetse fela o dule ale busy! O na gana ke mang re mo voutetse...ke senyegetswe.* [You go see him (councillor) time and time again his busy all the time! Who does he think he is? We vote for him that one...my things are damaged.]

- **Respondent 2:** My child I live here many years since I was born but I never see such unless government...in apartheid we had jobs and house and now fokol, *puse yarona ya tena! Batho ba naganela distala le losika la bonna, sies ga ke nna le tv le dikop...i!* [People (government and councillors) think about their friends and family not the people, distrusting! I now don't have a tv and cups...]
- **Respondent 3:** *Mokoncsilara waits eke le EFF ga nkitla a nthusa kasepe, waitse difestere disenyagile le menyako!* [The councillor knows that I am from EFF, help or talk to me, he knows my windows and door broke but he won't assist me.]

The respondents highlighted that after the seismic event government's means of communication was coming to observe the household damages, however, they didn't give people access to communication (the people had no one to listen to their complaints). Councillors were too busy to give them time and to listen to their complaints. As a result, the complaint forms were given to people they knew (friends and family) and not to those who needed urgent assistance for their damaged houses. Respondents even complained that there was a time where the complaint forms were sold by volunteers; they were not freely given to households and some had to beg volunteers for complaint forms. The communication between the community and government was poor, thus, hundreds of houses are still not fixed. This means that the rehabilitation process was taking longer than it should. Having communication tools such as TVs, radio and cell phones helped households get more information on how to complain and get assistance. It is unfortunate that people lost a lot during the seismic event, some people lost communication tools such as their TVs and radios during the tremor (seismic event), and they cannot be replaced. The following section is a summarised deduction of the data analysis.

4.4 CONCLUSION

The data collected indicated that there were barriers between the government officials and the affected people. This gave the researcher a better understanding of the relationships between the households and other stakeholders. In general, mistrust exists between most of the community members in Khuma and government officials and

politicians. Poor communication can be blamed for the occurrence of most of the misunderstandings. The rehabilitation and reconstruction of the damaged houses was not accomplished according to the needs and wants of those affected and in general, the affected households felt betrayed by the government. Most households are headed by single mothers and most rely on government grants. Most people living in Khuma are not originally from Khuma so after the mines closed, most men went back to their original families and left their Khuma families destitute. In conclusion, the objective of this chapter was to determine what makes households socially vulnerable to the impact of seismic events. In order to achieve this, the theoretical grounding given in Chapter 2 was used to construct the research intervention. This chapter aimed to explain the socio-economic vulnerabilities faced by households in Khuma. Using data analysis, the variables that make households socially and economically vulnerable could be identified. The data was collected using questionnaires and unstructured interviews. The data was analysed by comparing the questionnaires and the unstructured interviews. This assisted in balancing people's views through "rich data" and determining social vulnerabilities. The triangulation of the data assisted in the validity and reliability of the data collected. In the following chapter, the recommendations and conclusion of the study will be presented.

The following section provides recommendations emanating from the study. As indicated in Chapter 2, using the social vulnerability variable and the PAR model for communities to achieve resilience, there has to be an integration between the governments, the people and resources. This would then lead to better outcomes in the community. Hence, reducing vulnerabilities can help reduce the risks that people face every day.

CHAPTER 5 : CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

The literature indicates that a framework for addressing seismic risk must consider the seismic hazard present in an area, the exposure of communities, the vulnerabilities of such communities, infrastructure and assets. However, it is beyond the scope of this study to explore these three elements (seismic hazard, exposure and vulnerability) all at once and so the study focuses on the vulnerability component of the equation. The study also indicated the social vulnerability concepts used to measure vulnerability, is an important key step towards effective risk reduction and the promotion of a disaster-resilient culture.

As such, this research study aimed to contribute to seismic research by investigating the level of awareness and understanding that exists in terms of the socio-economic vulnerability of communities exposed to seismic events at local government level in South Africa, using the Khuma community in the Matlosana Local Municipality, North West Province as a case-study. As stated in Section 1.1, an awareness and knowledge of the vulnerabilities of communities residing in areas with seismic activity will enhance households' ability to protect themselves against events such as earthquakes by reducing livelihood vulnerability to minimise the losses. The purpose of this chapter was to provide the conclusion and recommendations of the study. In this chapter, a summary of each chapter in the study was presented, reflecting on how each research objective highlighted in Chapter 1 was achieved. The chapter further presents the recommendations, based on the findings from the study that can be utilised to improve the awareness and understanding of socio economic vulnerability attributes that make communities vulnerable to seismic events.

5.2 SUMMARY OF THE STUDY

The chapters in this study are chronologically and contextually arranged to show a linkage between the chapters in addressing the full ambit of the study. In Chapter 1, an overview of the entire study is provided. Chapter 1 further conceptualises the problem under investigation, that is, the poor or lack thereof of awareness and understanding of socio- economic vulnerabilities for addressing seismic risk. Therefore, in the chapter, there is a recognition and justification of the importance of a knowledge of communities' vulnerabilities in order to effectively address the impacts of seismic events. The study is categorised into four study objectives drawn from four research questions to address this problem, and achieve the overall goal of the study. In addition, in Chapter 1 the central theoretical statements on which the study is grounded are provided. A synopsis of the research methodology used to address each research objective is also provided in Chapter 1 and is further presented in detail in Chapter 4. Chapter one is concluded with a layout of the chapters of the study.

To fully understand the concept of vulnerability, it was necessary to provide the theoretical explanations underpinning this concept with specific reference to disasters. This is important since the concept is used in in a variety of disciplines and thus in different contexts. Chapter two focuses on the origin and definitions of the term, as well as the different frameworks for measuring vulnerability. Attention was paid to the social vulnerability concepts and types of vulnerability and the PAR model. This is so because the study focused on socio-economic vulnerability and the PAR model was later used in Chapter four in the analysis of the empirical findings.

In Chapter 3, a detailed research methodology applied to the study was provided. This was made necessary because only a synopsis of the methodology was presented in Chapter 1. The chapter is divided into three sections namely: the research methodology, the literature review, and the empirical study, and these sections are discussed in detail. The chapter included the empirical study section which provides an in-depth discussion of the research approach and design that was applied to the research study. The research study was based on a mixed method approach and the

motivation for using this research approach was provided in Chapter 3. In addition, an in-depth discussion on the data collection methods used in the research study is included in the chapter. The data collection tools that were applied in the research study are also discussed. Furthermore, the chapter presented a discussion of the method of data analysis applied to the study and concludes with a discussion of the issues relating to validity and reliability of the research results. In Chapter 4, the empirical findings of the case study were presented and discussed. The chapter firstly included a discussion of the research context in which the research study was conducted. This discussion was followed by a discussion of the research participants and is succeeded by the presentation and discussion of the findings from the interviews. The presentation and analysis of the findings was followed by the summative discussion of findings of the study and the reconfiguration of the PAR model using the vulnerability attributes emanating from the findings. By considering the empirical findings in Chapter 4 and the theoretical groundings of vulnerability outlined in Chapter 2, the conclusions and recommendations made in the study are provided in Chapter 5. The chapter demonstrates how each of the objectives of the study were achieved

5.3 A REVISED PAR MODEL

The revised PAR Model in figure 4.17 below gives an illustration of the social vulnerability concepts discussed in Chapter 2, the highlighted models used in Chapter 3, and the summary of the data analyses in Chapter 4. As a result, the revised PAR Model was created from the original PAR model discussed in Chapter 2 which will help to explain the analysis done in Chapter 4. Elements of the study are described below.

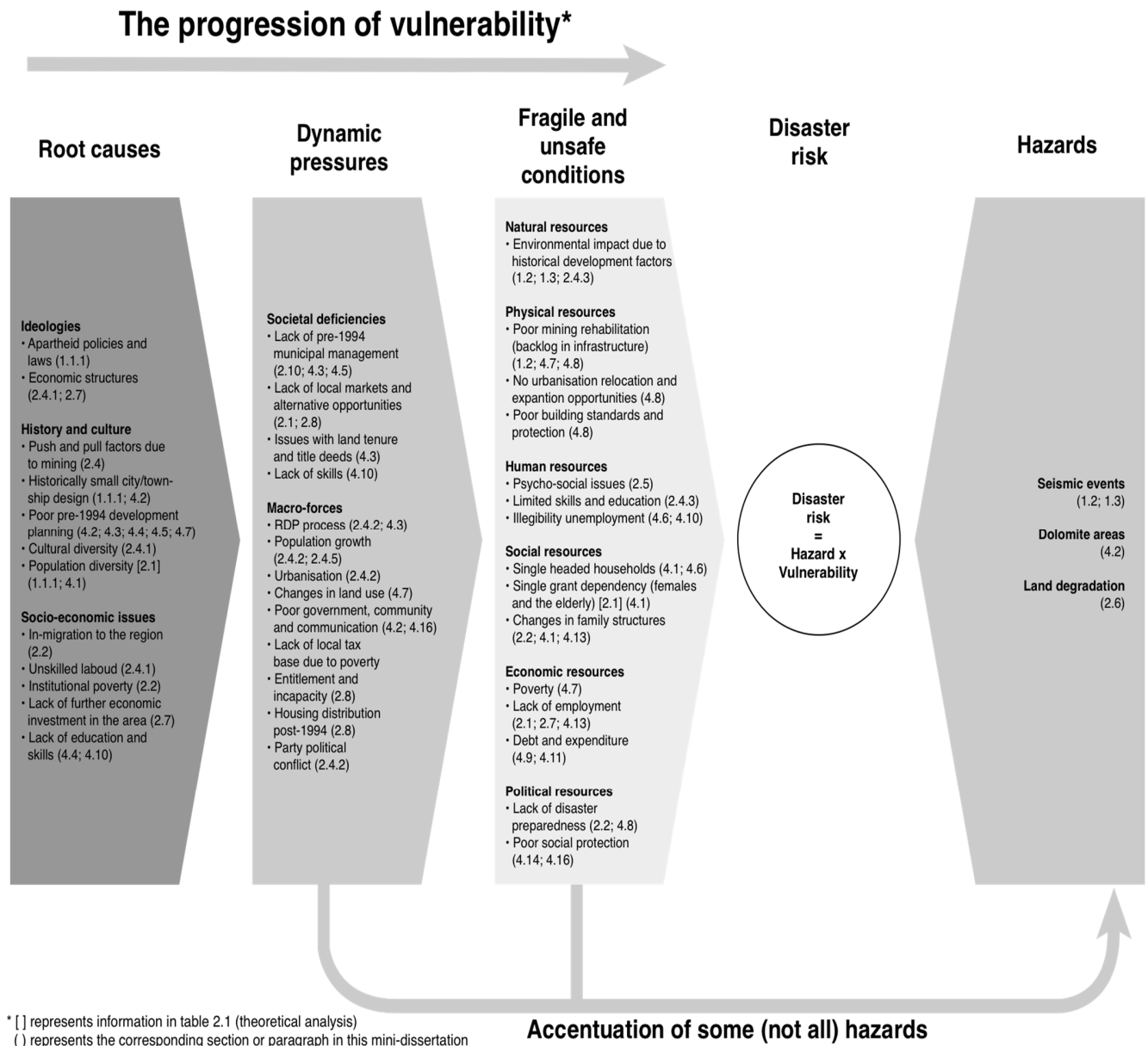


Figure 5.1: The Progression of Vulnerability: The case of Khuma – revised model

As indicated in Chapter 2 using the social vulnerability variable and the PAR model in order for communities to be resilient there has to be an integration between the governments, the people and resources. This would then lead to better outcomes in the community. Hence, reducing vulnerabilities can help reduce the everyday risks people are faced with.

The empirical findings have shown that the impact of the 2014 seismic event in Khuma was exacerbated by social vulnerability attributes such as gender, access, poverty, infrastructure and urbanisation as discussed in Chapter 2. However, the poor infrastructure and lack of maintenance led to injuries and infrastructural damage of houses. Thus, the lack of knowledge and resources made it difficult for people to deal with risks in the area. The occurrence of tremors seems to be a norm in Khuma, but seismic events of the nature described in this dissertation are occasional. The seismic event damaged thousands of houses and affected peoples' livelihoods and the environment.

Race, poverty, age, gender, urbanisation, politics, infrastructure and access are major socio-economic issues because it is the source of social vulnerability. For instance, in their study, Cutter et al. (2003) found that race contributes to social vulnerability through the lack of access to resources, cultural differences, and the social, economic, and political marginalisation that is often associated with racial disparities. This study revealed that most households that took part in the study live in dire poverty. Most families are headed by single female parents which puts them at risk of being marginalised. The study also underlined that households of low socio-economic status are less likely to access good quality health-care. For instance, because residents have emergency services nearby they are likely to recover quickly after a hazard because health care is nearby. However, they are prone to other risks such as fires due to the unavailability of fire and rescue services. Due to the seismic event, people live in anxiety and constant fear of getting hurt during a subsequent event, since people did not receive proper medical help after the original event.

Education has a cause and effect on the socio-economic status of an environment. The study revealed that one of the main reasons hindering people from obtaining employment is that most households had low levels of education. This made it hard for them to obtain employment. In terms of residency, people faced a serious problem because RDP houses are often occupied by people who can otherwise afford adequate housing, yet nothing is done to obviate this problem. The type of households that these respondents live in clearly demonstrates their economic status. Khuma was established

due to mines and farming. When the mines closed in 2006, poverty and unemployment increased and social vulnerability became more pronounced in this area. The seismic hazard caused people to evacuate their homes. Economic issues arose as government had no budget in place for such an event. Delays in rebuilding and repairing the affected households led to more infrastructural damage. Furthermore, due to the low-quality work by contractors, households are still at risk because their homes were not properly repaired. This led to households living in consistent risk and fear of their homes collapsing.

According to Cutter et al. (2003), the quality and ownership of housing is an important component of vulnerability. The nature of the housing stock (mobile homes) and the nature of ownership (renters) and the location (urban) combine to produce social vulnerability (Cutter et al., 2003). This study revealed that most home-owners do not own their homes legally as it is a long process to change the title deeds of houses, which does not add to their economic capital, and neither does it motivate dwellers to take remedial action or transfer risk (for instance taking out insurance on their homes). Therefore, people “own” houses they live in but occupy them full-time without changing title deeds. This puts them at risk of losing their homes because they do not own the homes legally. Therefore, this raises a question as to whether government is aware that people have a challenge when it comes to changing title deeds.

Following the seismic event, local councillors remained active in the community by keeping some people informed. After the provincial declaration of a state of disaster, the provincial government allocated a budget of almost R38 million for the homes to be repaired. However, this was the second event of its kind since 2005, and the district and municipality did not have an adequate contingency plan in place. This was challenging because Khuma is a dolomitic town, meaning that people constantly live at risk and this threatens people’s livelihoods. Thus, the district and municipality need to have a plan in place to reduce and manage risks people face daily.

The lack of institutional support from government affected the rehabilitation process, as those severely affected are still living in damaged houses. As a result of these

underlying issues, it is evident that there is still a problem with the allocation and rehabilitation process of repairing houses. Managing the rehabilitation process of houses could help reduce the inadequate work that contractors were doing. The people should be trained on how to react to seismic events and government should have risk and disaster risk management plans in place for such events. It would be best for councillors to have better relationships with community members. In that way, people would attend meetings and there could be two-way communication between government officials and the people. In order to reduce social vulnerabilities, households need to learn more about the risks they are susceptible to. If they become aware of these risks, then households will become more resilient. The following section provides elements of social vulnerability to seismic event.

5.4 ELEMENTS OF SOCIAL VULNERABILITY TO SEISMIC EVENT

The objectives of the study were to consider the socio-economic vulnerability of communities exposed to seismic events. This section alludes to how the objectives of the research were reached.

5.4.1 Gender

In terms of gender, the study revealed that during and after the seismic event mostly women were affected. However, this was because most of the respondents were women and they were either unemployed, self-employed or relied on grants for a monthly income. The vast majority of the female respondents were people who were poor (vulnerable) and tended to have a more difficult time during recovery than men, often due to sector-specific employment, lower wages, and family care responsibilities.

5.4.2 Politics and power

Most respondents complained that their councillors did not consider their needs and there was a barrier when it came to information between the people and the government. Certain people received information and others did not. For this reason, people do not trust their ward councillors. The households feel council misused their

power and authority because they did not fulfil their promises. The residents in Khuma have been waiting for almost two years for the government to repair their homes. From the research politics and power are still prevailing elements which contribute to social vulnerability.

5.4.3 Poverty

At a household level, poverty is the single most important factor determining vulnerability to natural hazards including seismic events. The poor are exposed and vulnerability reflects their location where houses are being built (on marginal and poor land). This makes it difficult for young people to go elsewhere besides their immediate surroundings to find employment, and what makes it more problematic is that the youth lack education and skills needed for the job market. Most of the respondents who took part in the study were unemployed. This was influenced by many factors. Some people could not find work because of age, other illness, lack of skills and disabilities. Most households relied on social support such as grants, pensions and NGOs to assist them. However, the other challenge was that people spent over 80% of their monthly income on food due to the high prices of food. People consistently have to borrow money to survive. Due to the lack of employment and a solid income, people live in debt. This makes it challenging for households to even rent decent housing. Poverty and unemployment may lead to physical deprivation due to the lack of necessities for material wellbeing, especially food, but also housing, land, and other assets as in the case of households in Khuma.

5.4.4 Age

The respondents who took part in the study were all adults, the oldest being over a hundred years of age. As indicated above, most of the heads of the household were single female parents. Human developments have a great impact on their surroundings such as urbanisation and population growth, which influences on the environment have underpinning effects that can lead to social vulnerability. However, ongoing changes in gender, age and population growth are widely understood as indicators of social

vulnerability. The unique characteristics of the respondents' ages had an influence on the way people reacted to the seismic event. Therefore, a wide range of people's ages suggests that people acted according to their experiences, behaviours and history of the communities they live in. The way a person acts during a hazard can be influenced by age. The study revealed that older people ran out of their houses, others were trapped in their houses and most households were in their homes during the seismic event. All the above reactions were influenced by people's perspectives, age and experience of hazards in the communities. However, the unique characteristics of social vulnerability were the individual, social and household's capacity to withstand the diverse effects the seismic event had on their households. The findings also revealed that during the seismic event the demographic of the households was a major influence especially in the response and recovery process of the seismic event. However, people's social vulnerabilities could be associated with their risk perception - the findings of another social vulnerability which is unemployment. This will be discussed in the following section.

5.4.5 Employment

Due to the closure of mines since 2006, thousands of people have lost their jobs. This resulted in many socio-economic losses in the community. The area is surrounded by mines and therefore most people rely on mining for employment. The employment opportunities in Khuma are rooted in specific and interlinked deprivations, in this case mining, domestic work and manual labour. The study was purposeful in manner in that it focused on households that were affected by the seismic event. However, the study identified households' social vulnerability by what the households didn't have in their houses, rather than what they do not have, focusing on their employment. In the case of Khuma land was used for farming and mining but mainly mining and then came the closure of mines. This study revealed that most people don't have jobs and are unemployed, this was mainly influenced by factors hindering people from working which were disability, illness, lack of skills and old age.

Most respondents who took part in the study were unemployed when the seismic event occurred and they are still unemployed, and this makes them more socially vulnerable as they do not contribute anything to the economy but rely on government and social support. Therefore, underprivileged households that were exposed to poor housing are now more vulnerable because of the damage that occurred during the event. Employment plays a big role in the resilience and vulnerability of households; for instance, some of the respondents who were employed reported that they had to take out loans to fix their houses. Those who cannot afford loans are in a waiting process for government to repair their homes and more than two years later people are still waiting, because they cannot afford to repair and rebuild their homes. This suggests that if households are employed or have cheap housing insurance they might become more resilient.

5.4.6 Rural/urban linkages

This study of seismic events in Khuma revealed that households are socially vulnerable. However, there is a linkage between rural and urban challenges that expose them to social vulnerability. In addition, when comparing the two areas, both combinations can vary greatly when considering vulnerability. The social vulnerability of households to seismic events is understood as an outcome of their exposure to over-population and unemployment resulting from urbanisation and the closure of mines. The study found that most vulnerable households currently have no adaptive capacity to reduce their social vulnerability.

Furthermore, other factors related to the social vulnerability of households include for instance, location, property authorisation, access and unemployment. The difference between rural areas and urban centres is mainly characterised by the over population in urban eras, informal settlements, improved infrastructure in cities and the proximity of emergency services. The main reason why people moved to Khuma was because of the mines and the work opportunities available at the time. This led to over-population in the township as it was designed to accommodate mine workers and people who were relocated out of nearby farms then began to settle in Khuma This forced households in

Khuma to change their livelihoods, as most people in nearby rural farmers were self-reliant and used small-scale farming to make their own food rather than buying and selling food in urban areas. Here the linkage between rural and urban areas is that Khuma's population grew due to the mining sector and people moved in due to employment opportunities. This urbanisation process made it difficult for people to get access to basic services such as water, housing and infrastructure.

Nevertheless, people moved to the township and adapted to the livelihood and became dependent on income and resources generated in the urban centres. People moved to Khuma because of work opportunities in the mines and other people were relocated from nearby farms to settle in Khuma such as the Motswenyane family who established Khuma. When the mines closed and people lost their jobs, it had a dual impact on the rural areas as well, since some people flocked there for casual employment and free primary education. The land surrounding Khuma was used for mining, which needed human capital for labour and job opportunities. Access to land for housing became difficult; land and housing became expensive due to over population. This had a negative effect and the governance in the township was deteriorating. Access to services and infrastructure is limited in the township mainly because of high population density, limited capacity and a lack of housing access. Additionally, access to services and infrastructure becomes difficult for low-income households due to unemployment, social vulnerability and illegal occupation. The whole issue of houses is discussed in the following section

5.4.7 Residence

The study reveals that all households have a history and issue with regards to their title deeds to the properties they were residing in and this is influenced by the fact that it's a long process to change RDP houses. The reasons for people to live where they are currently residing differed from household to household. Respondents replied that they settled because their parents died, they are sitting in for someone or occupied a house because it had no title deed and the house was empty. This influenced people's social vulnerability because of them being unable to change title deeds and this has made

people live in houses for years with a deceased person as the title owner. This also means that households cannot apply for household insurance because the house is not in their name. The lack of property capital (title deeds) contributing to some people not taking good care of their houses because they fear to fix the homes because the home owner might decide to move back after they repaired the house. As a result, households would rather reside in a house that is unsafe for they perceive as safety and security purposes of the houses they live or stay in.

Some people settle in to look after households for someone they know or are related to, mainly because the person owning the property can afford housing elsewhere and they need someone to rent or live in the house just for safety and residential purposes. This is not fair because they are people who need RDP houses and other people who can afford housing are renting RDPs to the poor. Whether houses were habitable or uninhabitable after the seismic event played a role in whether the RDP household remained intact or damaged played a major role in terms of people's social vulnerability. The following section deals with the household family structure.

5.4.8 Family structure

Most households that took part in the study were single female, single male, grandparents, guardians, and child-headed households. This indicated problems in the family dynamics because over 60% were households headed by single parents who had many dependents. The household perspective on social vulnerability to hazards has an individual perspective in terms of how they perceived the seismic event. Heads of households, for instance, are usually identified as vulnerable demographic groups during evacuation, as some are ill, old or disabled and cannot evacuate in the required time period during a hazard.

The ill, disabled and elderly become socially vulnerable during an evacuation and recovery process as their needs are misunderstood and not addressed during a hazard. This makes it difficult for single mothers as they have to shoulder the work and family responsibilities alone, ensuring that the children are taken care of, and the households

looked after. Most families in this study ranged from three to seven members. Households in which adults and children were living with their parents were unlikely to be found during the study, but single parent's especially female-headed households were common with over 60% being prevalent in Khuma. Guardians and grandparents head up around 30% of the household adults, compared with less than 10% headed by children in the community. The following section is a summary of the effects of social vulnerability on education.

5.4.10 Education

Regarding education, most respondents did not have any tertiary education or skills required for the job market and they relied on manual labour and casual employment. Even though all primary schools and some secondary schools in Khuma are free, pupils still drop out. The lack of education makes it hard for people to understand information and interpret the information they are given. Educating socially vulnerable households about the risk and hazards they are exposed to, makes people aware of their immediate surroundings, which, in the long run may help empower people to become self-reliant concerning disaster risk reduction strategies. The following is a summary of the population growth.

5.4.11 Population growth

In most cases, urbanisation is characterised by over-population which leads to housing problems. Social vulnerability can be determined by a few factors such as age, gender, population, employment and other processes or factors which increase the exposure of a community to the impact of hazards. Khuma was designed to accommodate a certain portion of miners and farmers working in the mining industry as mines gave people from all over the country, employment opportunities. The township was thus negatively influenced by overpopulation, informal settlements and increased unemployment after the mines closed.

Thus, new extensions were established to accommodate people who did not have housing. The government also subsidised people who were not paying basic utilities,

which, at the time seemed like a great opportunity to assist households, but later this had a negative impact socially and economically because more people still did not pay rent. This therefore exposed households to social vulnerability because more people were unemployed and the government was not able to provide free basic services for every individual. In the process of producing many more houses, contractors started to build poor quality structures which exposed people to unsafe housing. Most of the respondents complained that they had experienced housing problems since the time they moved in. The biggest challenge seems to be that government cannot assist every vulnerable person. Increasingly, more people are unemployed and this is an indicator that these people are going to have to wait for government to provide housing for them. Urban and rural human settlements face specific ecological and social challenges in relation to social vulnerability. South Africa is experiencing a long-term urbanisation trend which places infrastructural pressures on urban properties and results in diminishing the critical potential of rural areas due to the migration of unemployed young adults to the cities. The following is a summary of the medical services in Khuma.

5.4.12 Medical services

Having access to emergency services and health service was a major advantage for many households as they got a quick response from nearby clinics and general practitioners for assistance. The findings revealed that over 90% of the household's resilience depends on baseline health being available in the township. The elderly and children were more susceptible to social vulnerability because they were likely to have a lack of food, blankets, safe housing and have sustained injuries during the seismic event. These minority groups were at risk because the elderly could not run to escape, the children were in schools, and heads of female households were in their homes during the seismic event.

Regarding emergency services, the health service was a major advantage for many households as they got a quick response from nearby clinics and general practitioners for assistance. Apart from the need to deliver proper medical assistance to the thousands of people in rural and urban areas who currently lack it, vulnerable

communities face challenges of rapidly deteriorating hospitals, lack of equipped mobile clinics and for those who already have clinics, improved medication. Changing social vulnerability conditions will increase the demand for and use of health services especially during a hazard. Thus, improving health and medical services consistently will increase people's resilience and help those people cope and recover quickly from hazards they are exposed to. The following section gives a brief discussion of the social dependence of households.

5.4.13 Social dependence

Most respondents agreed that social support was significant especially after a disaster, but they do not necessarily rely on social support for the improvement of their livelihoods. Social dependence is increased by economic and social exclusivity or marginalisation of vulnerable people and groups. Social relations strengthen community involvement and participation, and a lack of social relations or disintegration of social relations makes households, and social organisation more vulnerable. Such networks of interdependence rooted in traditional values of Ubuntu ("I am because of others") are lost during economic advancement and urbanisation. Seismic events bring about major social issues. When they occur, they have a major impact on society. This means that communities should take a collective approach to dealing with natural hazards. This therefore makes people reliant on social services for survival.

5.4.14 Access

Lack of institutional capacity, resources and budget made it difficult for government to assist people in a timely manner. In this case study, the term 'access' refers to socio-economic and political processes that have an impact on various societies and groups within society. This is simply because access involves the ability of an individual, family, class or community to use resources which are directly required to secure a livelihood while building resilience for pre-disaster times and their ability to adapt to new threatening situations (Wisner et al, 2015). Houses that are poorly constructed, risk located, or lack resilience protection, should not be considered formal housing

especially amongst poor people as they are dependent on housing issues and particularly vulnerable to the poor building construction of RDP houses. If people only have access to poor conditions they should also have access to improved housing, since better quality housing is more durable and offers a longer-term property investment.

5.5 ACHIEVEMENT OF INDIVIDUAL OBJECTIVES OF THE STUDY

This section outlines how each of the individual objectives set in Chapter 1 were achieved to achieve the overall objective of the study as reflected in the discussion above. The achievement of each objective is summarised below:

5.5.1 Objective 1: To research and explain the theoretical grounding of socio-economic vulnerability.

The first objective of the research study was addressed in Chapter 2. As the purpose of the study was to investigate the socio-economic vulnerabilities of the Khuma community to seismic events, it was necessary to provide a theoretical understanding of the concept of vulnerability in general at first and then demarcate the concept in disaster studies, specifically seismology.

5.5.2 Objective 2: To describe the incidences of seismic events in the Dr Kenneth Kaunda District Municipality.

The second objective of the study was addressed through the empirical findings in Chapter 4. The presentation and analysis of findings were based on the elements of the PAR model.

5.5.3 Objective 3: To determine the socio-economic vulnerability of exposed communities to seismic events in Khuma.

Together with the second objective of the study, the third objective of the study was addressed through the empirical findings in Chapter 4. The main elements of social

vulnerability were highlighted in Chapter 4 and this assisted in redrawing the PAR model.

5.5.4 Objective 4: To recommend possible interventions for vulnerability reduction to seismic events in Khuma.

Objective 4 was addressed in Chapter 5 of the study. The aim of Chapter 5 was to present the conclusions and recommendations made from the research study based on the findings in Chapter 4 of the study. In Chapter 5, a summary of the chapters of the study is outlined. The chapter further provides an outline of the overall objective of the study as well as the achievement of each of the individual objectives of the study and discusses how each objective was addressed with the aim of achieving the overall goal of the study. Chapter 5 further presented the recommendations based on the findings from the study.

5.6 RECOMMENDATIONS

It has been argued throughout the study that there is a need for communities to be aware of, and to understand their vulnerabilities to reduce the impact of disasters. Particularly, the understanding of social vulnerability is important if impacts of seismic events are to be minimised. This section suggests some recommendations in line with the findings of the empirical study and the literature, which would help to better understand the socio-economic vulnerability of households in Khuma.

Recommendation 1: Disaster risk awareness campaigns

It is recommended that the communities of Khuma be educated in the seismic risks which they face.

Recommendation 2: Disaster risk assessment

It is recommended that the government and the disaster management department have a specific team of practitioners and volunteers who will be responsible for risk assessment. Emphasis should be placed on physical vulnerability assessments to

assess the vulnerability of assets such as buildings, and infrastructure; social vulnerability assessments of highly vulnerable groups and their coping capacity; and economic vulnerability assessments of economic assets and processes such as business interruptions. This is important because nothing much can be done about the seismic hazard itself.

Recommendation 3: Infrastructure development and maintenance

It is recommended that the City of Motlasana take a closer look at the development of Khuma because at this point it is advisable to stop all infrastructural development and rather put attention on fixing the current infrastructural problems, such as repairing the damaged houses that people are living in.

Recommendation 4: Municipal service delivery

It is recommended that the municipality needs to find an improved method on how people can easily change their title deeds as most households reside in houses that they do not legally own. It is further recommended that the municipality should monitor and investigate the ownership of RDP houses. It is also advised that councillors take their roles seriously by serving their community.

Recommendation 5: Development and implementation of contingency and mitigation plans

It also recommended before any practical changes can take place, that stakeholders such as the Disaster department, Social development, Education and economic development department should come up with contingency and mitigating plans on how to reduce the social vulnerability issues facing Khuma households.

Recommendation 6: Involvement of the mines in the development of Khuma

The Khuma Township was established as a result of the mining activity in the area and therefore it is recommended that the mining companies become involved in the welfare

of the community through, for example, providing adequate housing and working with the municipality to improve service delivery.

Recommendation 7: Improved spatial planning by the municipality

It is recommended that as the Khuma Township is continually growing, the municipality must improve the spatial planning to reduce the congestion of households. This will help reduce the negative impacts of natural hazards. Considering the above, it can also be argued that the use of community participation and disaster risk awareness can lead to job opportunities and improve people livelihoods.

5.6 RECOMMENDATIONS FOR FUTURE RESEARCH

The recommendations for future research are as follows:

- The use of GIS to develop an early warning system for seismic events for the greater Orkney area including Khuma.
- Development of multi criteria for social vulnerability assessments in Khuma.
- Seismic risk mapping for the greater Orkney area including Khuma.
- Investigate the contribution of social vulnerability to expected losses from seismic events in order to improve spatial planning in Khuma and the surrounding areas.

5.7 CONCLUSION

The objective of the study was to investigate to what extent poor or limited awareness and knowledge of vulnerabilities by communities in Khuma contributed to the high impact of the 2014 earthquake in the area. The empirical findings revealed that the development of seismic events in Khuma was as due to mining activities around the township. However, poor building construction as well houses being built in dolomitic areas led to serious effects after the seismic event in 2014. This was exacerbated because people were not aware of where and how to report the damage. Furthermore, the risk of seismic activity might occur in the near future and the effect might be even more devastating. The development of seismic events is because of past mining

activities and while most mines in the area have closed, this has nevertheless placed people at increased risk because these mines are not maintained.

This study sought to unravel the socio-economic vulnerabilities of the Khuma community to seismic events like earthquakes. This study was made necessary after an earthquake hit Khuma in 2014, leading to loss of life and negatively affecting many people. The achievement of this goal was based on realising the objectives as outlined in Chapter 1, that is, to research and explain the theoretical grounding of socio-economic vulnerability (Chapter 2); describe the incidences of seismic events in the Dr Kenneth Kaunda District Municipality and to determine the socio-economic vulnerability of exposed communities to seismic events in Khuma (Chapter 4); and to recommend possible interventions for vulnerability reduction to seismic events in Khuma (Chapter 5). Moreover, the achievement of the overall objective was made possible through the review of literature in Chapter 2, the employment of a suitable methodology to collect data in Chapter 3, the presentation of empirical findings in Chapter 4 and providing the recommendations in Chapter 5. The section below outlines how each objective was addressed in order to achieve the overall goal of the study.

Urbanisation and overpopulation are important factors since households with insecure ownership of houses such as RDP houses are less likely or able to invest in housing. Social vulnerability and socio-economic vulnerability are factors that affect the resilience and exposure of communities. The elimination or minimisation of further hazard problems in the area can be affected by reducing the exposure people are faced with. This case study has shown that in disaster (hazard) events, the socially vulnerable are more likely to be unfavourably affected. By addressing social vulnerability effectively, it will be possible to decrease economic loss, damage to infrastructure and human suffering.

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