ASSESSMENT OF DISASTER PREPAREDNESS LEVEL OF A COMMUNITY IN ZAMDELA (SASOLBURG) TO CHEMICAL HAZARD

By

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DECLARATION

By submitting my thesis, I confirm that the work submitted for assessment for this work is my own unaided work except where I have explicitly indicated otherwise. I have followed the required convention in referencing the thoughts and ideas of others and I have not previously or in its entirety or in part submitted it for obtaining any qualification.

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XOLA MAVUNDLA DATE

EXECUTIVE SUMMARY

The use of chemicals has increased drastically over the years due to the economic development in various sectors including industry, transport and agriculture. As a result people are exposed to large number of chemicals of natural and manmade origin. They are exposed through the air that they breathe, the food that they eat, the water that they drink and the soil that they touch. Chemicals may have immediate, acute effects as well as chronic affects that often result from long term exposure. In Zamdela residents are situated downwind the chemical industry and mine dumps, which are not rehabilitated and are constantly causing high levels of dust pollution. The challenge here is residents have no clear understanding of chemical hazard and are not aware of the measures that they should take in case a chemical disaster were to occur.

This study found that most of research respondents were not aware of the steps that they can take to prepare for a chemical hazard. Residents also indicated that they have not participated in any training or educational workshops on chemical hazard. Further, majority of residents indicated that they were not at all confident in their knowledge of chemical hazard and that they have never volunteered in a chemical disaster before. The results of this study indicated that there is still a lot that needs to be done in terms of preparing the community of Zamdela for a chemical disaster.

This study concludes with recommendations that may be used by Metsimaholo local municipality to prepare the community of Zamdela for a chemical disaster and on ways that they can educate and train community members on chemical hazard.

DEDICATION

This is dedicated to my mother, Victoria Zanele Mavundla, who has always silently pushed me to be the best that I can be. It is also dedicated to my late father, Ezekiel Mhlopheki Mavundla, and my late brothers, Lumko Mavundla and Sipho Mavundla.

Gone but never forgotten

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TABLE OF CONTENT

HEADINGS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
PROBLEM STATEMENT AND RESEARCH METHODS

1.1 INTRODUCTION

Over the past few years chemical hazards have caused disasters that have left thousands of people either dead or injured, and these hazards have had an adverse effect on the environment. According to the UNISDR (2009 17) a hazard is a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption or environmental damage. The Disaster Management Act 57 of 2002 urges municipalities to have an integrated and coordinated disaster management policy that focuses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post disaster recovery (Republic of South Africa 2002).

The proposed study will seek to examine the level of preparedness of residents in Zamdela residing nearest to Sasol chemical plant.

1.2 BACKGROUND TO THE STUDY

Humans have introduced large amounts of chemical substances into the environment over the past centuries (IFA 2015). These chemical substances can cause server damage and disrupt the lives of people who are exposed to them. The dramatic increase of chemicals was due to rapid economic development in the industrial, agricultural and the transporting sector, resulting in people being exposed to both manmade and natural chemical hazards (Immunize for a Healthy Future 2014). The effects of these chemical pollutants especially industrial chemical substances have caused the soil, air and water to be polluted; it has also contributed greatly to the effects of global warming. Majority of environmental disaster have been cause by industrial mishaps which have not yet been brought under control (Conserve Energy Future 2015). This is due to policies and laws which have not been put in place by pollution control boards because they are usually bypassed by industries due to lack of enforcement.

Outlined below are the effects that chemical hazards have had on the national and international scale:

1.2.1 National Effects of Chemical Industries

The Vaal Triangle is the most polluted area in South Africa, it has numerous industrial plants such as Eskom Lethabo Power Station situated south of Vereeniging, Arcelor Mittal Steel Workers in Vanderbijlpark and Sasol's coal based chemical industries in Sasolburg (Hallowes & Munnik 2006 17). These chemical industries create gas and smoke that carries into the air and dominates the urban skyline. Volatile Organic Compounds (VOCs) are ranges of chemicals that evaporate easily into the air and majority of these chemicals are toxic, Sasol and Mittal have been found to emit significant amounts of VOCs into the air. Majority of residents in the Vaal Triangle complain about itchy eyes, burning mucous membranes and constant headaches, which are the result of the heavy chemicals in the air (Hallowes & Munnik 2006 29).

On the 31st of May and 1st of June 1980 Umkhonto weSizwe logged an attack on Sasol I Natref and Sasol II, there were no deaths only a report of one injured security guard. The attack resulted in eight fuel tanks being destroyed which cost the company about R66 million (South African History Online 2014). In April 2004 Lethabo's sulphur trioxide flue gas conditioning plan sprang a leak. Between May 2005 and May 2006, Omnia reported ten incidents, Natref eighteen incidents, Dow three incidents, Karbochem and Semmin nineteen incidents, totalling up to fifty incidents in one year (Hallowes & Munnik 2006 30). Further in June 2006 there was an explosion at Sasol Company that injured a total of nineteen people (Hallowes & Munnik 2006 30).

The result of the above mentioned lead to the National Department of Environmental Affairs and Tourism (DEAT) to declare the Vaal Triangle an air pollution priority area, making it the first hotspot area to be declared a priority area (Hallowes & Munnik 2006 27).

1.2.2 International Effects of Chemical Industries

In December of 1984 the nation experienced the most server chemical disaster, the Union Carbide plant in Bhopal released deadly methyl isocyanate gas which spread throughout the city of Bhopal (Muller 1984). Over half a million people were affected by the gas (Maruthappa 2009). In June of 1974 the Flixborough Disaster occurred, the Nypro site at Flixborough got damaged by a large vapour cloud explosion, as a result fires burned for

several days on the site. The explosion killed twenty eight workers and injured thirty, and surrounding areas were left damaged (Maruthappa 2009).

1.3 SIGNIFICANCE OF THE STUDY AREA

The Disaster Management Act 57 of 2002 defines preparedness as a community's state of readiness which enables institutions that are part of disaster management plan to be able to mobilise and provide relief in order to deal with or anticipated disasters. There is currently little or no information being given to communities that have large chemical industries operating within their borders going in direct contradiction with the Constitution of the Republic of South Africa (1996) which puts emphasis on promotion of information and transparency. There are no visible awareness programs or preparedness measures being introduced to these communities by municipalities. A municipality's role according to the South African Disaster Management Act 57 of 2002 is to ensure that community members are prepared for a disaster by making sure that they are aware of the disaster hazard and that they know of steps that they need to take encase a disaster where to occur thus reducing deaths and injuries.

The United States Emergency Planning and Community Right to Know Act (EPCRA) of 1986 and the United States Clean Air Act (CAA) of 1990 requires industries to have reports which outline the hazardous chemicals present in the communities they are operating in and these reports should be easily accessible to the public. This effort will enhance a community's emergency response plan thereby protecting it from a chemical disaster. Further, these laws recognise that the public are full stakeholders in the preparation for emergencies and management of chemical risks.

1.4 DESCRIPTION OF THE STUDY AREA

Sasolburg is a town based in the northern part of the Free State, it was established in 1954 as a company town meant to provide housing to white employees of Sasol I and its township Zamdela was established to prove single sex hostels to black employees of Sasol I who migrated from rural areas to seek employment (Malan 8 2015). Sasolburg which falls under Metsimaholo Local Municipality within Fezile Dabi District has since established and now has a blooming population of 149 108 residents (Stats S.A. 2011). Ninety thousand of the population reside in Zamdela which is situated downwind the chemical industry and mine dumps, which are not rehabilitated and are constantly causing high levels of dust pollution (Madubela 2014).

Figure 1: Map of Zamdela Township and Sasol's Plant (Google-Map 2014)

The poverty levels in Sasolburg are extremely high, according to Metsimaholo's IDP (2014 19) 10335 people live with less than R1 – R2 per day and a total of 56670 residents do not have any source of income. This being unexpected for a town that has numerous petrochemical and chemical industries such as Sasol Polymas, Sasol Gas, Natref Refinery, Sasol Chemical Industry (SCI), Dow Chemicals, Karbochem and Sasol Sigma Colliery Supplies. But the reality of the situation is 32% of residents in Sasolburg are unemployed and mostly relay on government grant as their main source of income, this is due to the high levels of illiterate residents that do not know how to write or read and lack basic skills (Metsimaholo Local Municipality IDP 2014 21).

As a result Sasol Company prefers to outsource employees with appropriate skills and qualifications. Majority of the population residing in Sasolburg are employed by Sasol Company as contract workers. High poverty levels especially in Zamdela forced residents to default in paying basic municipal servers such as rent and electricity which in turn hinders on service delivery. Some sections in Zamdela are without electricity, residents are using coal or paraffin stoves as a source of energy for cooking and heating, candles are used as a

source of light. The smoke and chemicals from the paraffin and coal coupled with the chemicals from Sasol Company has had an adverse effect on the health of residents of Zamdela.

1.5 PROBLEM STATEMENT

Chemical industries make certain that the chemical components that they use remain disclosed to the public, claiming that the chemical mixtures are a trade secret (PSR – LA 2013). These chemical components have a negative effect on the health of community members and the environment. Activities that take place within the borders of chemical industries are rarely disclosed, risking the lives of community members living nearest to the chemical plants. It is the duty of government to ensure that there is a disaster management plan is in place that will make certain that a community is able to prepare in case a chemical disaster occurs.

In Zamdela community members are not aware of a disaster preparedness plan that is in place in case a chemical disaster occurs. Meaning that community members especially those living nearest to the chemical plant would not know what to do in a chemical disaster situation thereby exposing them to unsafe conditions. Lemeko (2011 59) states that unsafe conditions are created when people, their livelihood and the environment are exposed to the risk of disastrous conditions.

Residents in Zamdela are facing an uphill battle in restoring the health of their community, over the years the community has started to feel an increase in pollution levels by Sasol Company. The residents of Zamdela maintain a level of mistrust towards Sasol Company, which started in 1987 when Sasol I and Natref fired 865 employees after the Black Union organised a strike because Sasol I and Natref had put measures in place that negatively affected the black work force when the industries were experiencing financial difficulty (Malan 2015 10). During the year 2002 residents of Zamdela monitored their air and they found that the level of benzene in the air was eight times over the United States legal limit (Sasol Facts 2012-13). Long exposure to benzene in the air can cause leukaemia, anaemia, drowsiness, unconsciousness, excessive bleeding, it can also affect a person's immune system and women who breathe benzene for elongated periods end up having irregular periods and a decrease in the size of their ovaries (DES 2013). Residents of Zamdela till this day maintain an attitude of mistrust towards Sasol Company, they strongly believe that the industry does not have their best interests and well being at heart. To add on, the residents in Zamdela feel powerless in the decision making process, a decision can be taken by Sasol Company and the Provincial government without their views being considered. But in the

past years retired members state that the relationship between the community and Sasol I used to be mutually supportive, Sasol I used to communicate its plans with the community of Sasolburg on a regular basis via the church Ministers, moreover, Sasolburg was awarded the prize of most beautiful town in the Free State numerous times in the 1980s (Malan 2015 8). The rising demand in the country's coal industry has forced residents to use low quality coal for energy purposes while the more valuable coal is being converted into liquid gasoline for wealthier buyers.

This study's aim is to assess the level of preparedness of the community members in Zamdela residing nearest to the chemical plant. When a community is better prepared for a hazard they are able to respond and recover quicker when a disaster occurs.

1.6 OBJECTIVES OF THE STUDY

This study's objectives are divided into a primary objective and secondary objectives

1.6.1 Primary Objective

The primary objective of this study will be to assess the level of preparedness of community members in Zamdela Township to chemical hazard, in order to enhance Metsimaholo's local municipality performance to responding and recovering from a chemical disaster.

1.6.2 Secondary Objectives

The following secondary objectives were formulated to address the primary objective of this study:

- To determine the level of vulnerability to chemical hazard for residents in Zamdela.
- To determine the awareness levels of residents in Zamdela to chemical hazard.
- Determining the role that Metsimaholo Local Municipality can play when it comes to risk reduction measures.

1.7 RESEARCH METHODOLOGY

According to Mouton in Skosana, research is a scientific method of enquiry, it is driven by the search for truthful knowledge by seeking to solve new or existing problems, develop new theories or prove new ideas. The purpose of research is to try and arrive as close to the truth as possible, therefore information should be closely assessed by means of reliability and validity.

Alberts (2014 14), defines methodology “as the analysis of the principles of methods, rules, and postulates, employed by a disciple or the development of methods, to be applied within a discipline or a particular procedure or set of procedures.” Research methodology is determined by the researcher trying to explore the perspectives of others with regards to the study or to explore a truth that needs to be discovered (Gray in Skosana 2007 100).

This study will use quantitative approach to assess the level of preparedness of residents in Zamdela to chemical hazard. A quantitative approach will be conducted because of the large sample size of the subjects that will be involved in the study.

For Quantitative approach, questionnaires will be used to collect data. A questionnaire can be defined as a document that has questions designed to obtain information on beliefs, attitudes and perceptions appropriate for analysis (Babbie 2007 246). Questionnaires allow quantitative data to be collected in such a way that is internally consistent and coherent for analysis (Malhotra 2004 176). Open-ended and close-ended questions will be used to administer the questionnaire.

The population sample that will chosen for the study are residents of Zamdela residing nearest to the chemical plant. The understanding behind sampling is to reduce costs and time constraints thereby ensuring that better quality research is conducted.

Crossman (2014) defines sampling as a subset of the population that represents the larger population being studied, it is a method used to gather information about a population without having to measure the entire population. A Population can be referred to as “the totality of all subjects that conform to a set of specifications, comprising the entire group of persons that is of interest to the researcher and to whom the research results can be generalised” (Research Methodology s.a. 39).

The data that will be collected and evaluated together with the literature, books, journals and internet sources acquired. Quantitative methods will be used to process the data, a conclusion will be drawn and recommendations will be made to the necessary stakeholders.

1.8 PRELIMINARY LITERATURE STUDY

According to Lemeko (2011:6) literature review about national, provincial and municipal acts and disaster preparedness framework can assist in identifying the preparedness assessment to test the institutions readiness to chemical disaster. This section seeks to provide a layout of the research and draws attention to the following questions:

- What is disaster?

- What is a disaster risk?
- What is disaster management?
- What is vulnerability?
- What is disaster preparedness?
- What is an emergency management?
- What is mitigation?

- A disaster is declared when there is a serious disruption of the functionality of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources (UNISDR 2009 9).

- Disaster risk assesses the potential losses that could result from the occurrence of a disaster, causing loss of lives, livelihood, assets and services (UNISDR 2009 9)

- Disaster risk management is a process of using organisations, administrative directives and operational skills and capacities systematically, for the implementation of strategies, policies and improved coping capacities in order to lessen the adverse impact of a hazard and the possibility of a disaster (UNISDR 2009 10)

- Vulnerability is the inability of the community to cope and recover from external stresses, shocks and risks. Vulnerability differs from season to season and from person to person within a community owning to their livelihood activities or social standings (Lamichane, 2010).

- According to HEA (2008) disaster preparedness is the capacity and knowledge developed by governments, professional response organisations, affected community and individuals to anticipate, respond to and recover from the impact of likely, imminent or current hazard event or conditions. A disaster preparedness plan must therefore have sound analysis of disaster risk, good linkages with early warning systems and must include activities such as contingency planning, stockpiling of equipment and supplies, evacuation procedures, public information and training (UNISDR 2009 21).

- Emergency management is the management and organisation of resources and responsibilities for addressing all aspects of emergencies, particularly preparedness, response and recovery steps (UNISDR 2009 13).

- To mitigate is to lessen or reduce the scale or severity of the impact that a hazard may have on the community, economy and environment (UNISDR 2009). Mitigation measures that can be taken by Metsimaholo Local Municipality are to ensure that they have engineering techniques, building and environmental policies and public awareness campaigns.

1.9 CHAPTER OUTLINE

This section outlines the structure of the study by summarising each chapter.

- *Chapter 1:* Contains an introduction, background of the study, significance of the study area, disruption of the study area, problem statement, objectives of the study, research methodology and preliminary literature study.
- *Chapter 2:* Contains the Literature review that is relevant to the topic.
- *Chapter 3:* Contains research methodology
- *Chapter 4:* Contains the results, analysis and interpretations of the research findings relating to the levels of preparedness of the community of Zamdela to chemical hazard.
- *Chapter 5:* Presents the summary, conclusion and recommendations that will enhance preparedness of community members in Zamdela to chemical hazards.
- Attachments
- Bibliography

CHAPTER 2
LITERATURE REVIEW

2.1 BACKGROUND

Literature review is an evaluative report of studies found in the literature related to a selected area (Boote & Beile 2005). The review must describe, evaluate, summarise and clarify the literature. It should also assists in revealing sources of data, gives confidence in a topic and in interpreting and making sense of findings (Research Methodology 2007 70). Boote & Beile (2005) state that the review gives a theoretical basis for the research and assists the writer in determining the nature of their research.

2.2 INTRODUCTION

Disasters are as old has human history but in recent years there has been a dramatic increase in disasters and the damaged caused by them, which has made it a cause of national and international concern. The use of chemicals has increased drastically due to the economic development in various sectors including industry, transport and agriculture (WHO 2015). Children are exposed to large number of chemicals of natural and manmade origin, as a result. They are exposed through the air that they breathe, the food that they eat, the water that they drink and the soil that they touch. Chemicals may have immediate, acute effects as well as chronic affects that often result from long term exposure (WHO 2015). The World Health Organisation reported that in 2012 about seven million persons die from chemical exposure, more than twice the death toll of HIV/AIDS, malaria and tuberculosis, and majority of these being children and adolescents (Groundwork 2015). This chapter will analyse the effects that chemical hazards have had on various communities in different countries. The theoretical framework for the study is discussed by showing its relevance to disaster preparedness and the chapter will thus be concluded by summarising the jurisdiction of this study.

According to Kolanchu (2011 20), the threats of chemical hazards are complex, they are not well understood and prepared for, they require specialised protective measures which are often a challenge for communities living closest to the refinery plants. When chemicals leak out of a refinery, one never knows if they are exposed. Many of the chemicals from refineries pose serious health hazards even at very low levels of exposure and some can build up in

the environment contaminating soil, fish and even household dust. Potential hazards which are caused by refineries are thermal radiation, explosion and boiling liquid expanding vapour explosion (Kolanchu 2011 20). Exposure to these hazards can result in breaking windows, first degree burns and skin blisters which could cause death. Zamdela Township and Sasol petrochemical plant are within a walking distance from each other, should a chemical incident occur this may aggravate the impact.

2.3 CASE STUDY: ENVIRONMENTAL JUSTICE MOVEMENT

Chemical facilities that store and use hazardous chemicals leave behind toxins which contaminate the environment and endanger the people who live nearby. In 1987 the Toxic Waste and Race in the United States helped catalyse a national movement named the Environmental Justice movement (Orum, Moore, Roberts & Sánchez 2014 6). The movement was brought about by the adverse impacts that chemical facilities had on the environment and health of workers and nearby community members. The movement believes that equal protection and a healthy environment are basic human rights. The section will exam the impact that chemical hazards have had on the environment and communities, and various movements that have formed as a result, in South Africa and the United States.

Sasolburg Air Quality Monitoring Committee was established to monitor the air quality in Zamdela, engagement with both government and industries and raising awareness about the environmental injustices and environmental health concerns due to industrial pollution. Zamdela is an area which is concentrated with high sulphur dioxide emissions and particular matter due to household activities as well as the industrial and power generation sector (Madubela 2014). For the past 50 years community members of Zamdela have been bearing the brunt of pollution, mainly from Sasol chemical industry and other surrounding industries. The community members of Zamdela where made to choose between short term survival in the form of employment by the industries and long term environmental and health damage. Government sees industrial pollution as a necessary evil for the sake of economic development. Sasolburg Air Quality Monitoring Committee with the help of GroundWork made submissions before Parliament during the Air Quality Act hearing, these inputs paid off because the Vaal Triangle was declared a priority area in South Africa, meaning that the air that the people in the Vaal Triangle breathed was not conducive to human health and well being (Madubela 2014).

The South Durban Community Environmental Alliance (SDCEA) was founded in 1995 as a coalition of 16 communities working for environmental justice in south Durban (IDEX 2016).

Community members in South Durban are poor blacks (Africans, Indians and coloured / mixed race communities), they have been exposed to petrochemical industries and air polluting substances from industries, primarily Engen refinery. The level of benzene that was recorded near the Engen refinery was up to 15 times higher than WHO guidelines and the recommended levels in the United States (South Durban: Toxic Hub of South Africa 2016). A study done by the University of Natal medical school found that children in the suburbs south of Durban are likely to suffer from chest complaints than children from other areas of the city, furthermore in November 2000 Settlers Primary School which is located between two colossal refineries Engen and SAPREF, had to call in paramedics to deal with more than 100 children suffering temporary respiratory problems (South Durban: Toxic Hub of South Africa 2016).

Mossville Environmental Action Now (MEAN) movement in Louisianain the US is a grass roots environmental justice group that is demanding that government and the chemical industry causing destruction in the community be held accountable. In December 2013, an explosion occurred at the Axial chemical production facility (Orum *et al.* 2014 18). The explosion resulting in a huge black cloud hovering the local school, the high way was shutdown preventing anxious families from picking up their children from the school. The incident was responsible for more than half a dozen of the population going to hospital. Members of MEAN and residents of Mossville began a residential relocation process with global energy and Sasol in the same year. The relocation processes was caused by the danger of chemical hazards of Sasol operations in Mossville (Orum *et al.* 2014 18). Mossville residents have been living under these conditions for decades where there are massive industrial operations, shelter in place protocol, no alarm systems, undrinkable water, and contaminated farming soil and fish from industrial contaminates. Majority of the residents now consist of the elderly and children who are disproportionately sick and dying.

Los Jardines Institute (The Garden Institute) and residents of the South Valley of Albuquerque (US) have tried for many years to address the issue of the water contamination and toxic smells coming from the Southside Water Reclamation Plant's use of chlorine gas to treat wastewater. The population pin the unidentifiable sicknesses and cancers in the community to the chemicals that they have been exposed to as well as the exposure to chlorine from the wastewater treatment plant. An accident in Albuquerque involving chlorine chemical could potentially impact an area up to 5.40 miles downwind of the plant (Orum *et al.* 2014 20). The wastewater treatment plant was also found to be in violation of the Clean Water Act (1972).

Texas Environmental Justice Advocacy Services (t.e.j.a.s.) movement works with community members of Manchester (US) which is concentrated with chemical industries and lacks zoning laws, to bring issues of pollution, vulnerability, poverty and illness to the attention of various departments as well as local, state and federal agencies. Manchester is a community which has existed for more than 150 years has a large cluster of childhood leukaemia cases and high rates of asthma (Orum *et al.* 2014 22). Residents are seeking redress from damages to their homes, health and for some community members this includes seeking relocation before it is too late. Corpus Christi is the eighth most populated city in Texas; the city has six refinery companies located in the northern part (Earthjustice 2014 5). Three of the six facilities are in violation of the Clean Air Act as a result community members residing nearby the facilities have sued the refineries for personal injuries and toxic trespass.

People Concerned About Chemical Safety (PCACS) movement in West Virginia helps to protect that safety and health of people who work, reside and study in the vicinity of local plants producing highly toxic chemicals. In January 2014, a highly toxic chemical was released into the Elk River from the Freedom Industries facilities in Charleston, West of Virginia (US) (Orum *et al.* 2014 24). The toxic chemical contaminated the public water source that serves 300 000 residents in nine countries, forcing residents to navigate the loss of potable water while bringing these issues forward to the responsible government agencies (Orum *et al.* 2014 24). PCACS worked together with Environmental Justice and Health Alliance (EJHA) to amplify these demands after the Elk River chemical disaster.

Detroit is the largest city in Michigan and the eleventh largest city in the US (Earthjustice 2014 10). Marathon refinery has been in violation of the Clean Air Act in all the last twelve quarters and has been issued with 13 state notices of violation in the past five years. Residents living in the area have reported heart issues affecting family members of all generations.

Philadelphia is the most populated country in Pennsylvania (US). It is host to the largest refinery on the eastern seaboard and the tenth largest in the country (Earthjustice 2014 3). The cancer rate in Philadelphia is significantly higher than in other countries in Pennsylvania. In August 1975, there was a fire at the refinery killing eight fire fighters and sent residents to hospital (Earthjustice 2014 13). The refinery complex has been in violation of the Clean Air Act for all twelve quarters of the last three years and it has also been in noncompliance with the Clean Waters Act for each of the last twelve quarters (Earthjustice 2014 12).

Richmond, California US, is home to a 2900 acre petroleum refinery built in 1902 that is owned and operated by Chevron (Earthjustice 2014 16). A release of flammable vapour led

to a fire on August 6, 2012 at Chevron Refinery (Orum *et al.* 2014 16). The toxic and smoke from the fire caused more than 15000 people to seek treatment for respiratory problems at hospitals in the area (Orum *et al.* 2014 16). Residents insisted that the release of flammable vapour was caused by a wilful negligence that dates back decades, at the expense of low income communities and communities of colour who cannot afford to vacate the area.

Black communities are overburdened by both disparate exposure to industrial pollution and socioeconomic deprivation, they live in extreme poverty and work in hazardous conditions. Additionally, many poor people have weakened immune systems making them more vulnerable to chemical related illnesses; their well being is further compromised by the lack of access to information about the impact of chemicals and their living conditions. There is an urgent need to set up strong protections from toxic and petrochemical industries contamination in our communities.

2.4 LAWS, ACTS & REGULATIONS IN THE REPUBLIC OF SOUTH AFRICA GOVERNING CHEMICAL HAZARDS

2.4.1 The Constitution of the Republic of South Africa (No. 108 of 1996)

The Constitution of the Republic of South Africa guarantees basic human rights and provides guiding principles for society. The rights and obligations that are stated in the Constitution belong to each person and community in South Africa. With that been said, section 24 of the Constitution states that everybody has the right to an environment that is not harmful to human health or well – being (Republic of South Africa 1996)

The term environment includes water, land, places of special importance, the atmosphere, animal and plant life, it can therefore be said that the environment has an influence on human life and the well – being of social communities (The Department of Environmental Affairs 2014 12). When the environment becomes degraded, everyone is affected in the long run, with poorer communities being the first to suffer.

A duty is placed on all spheres of government to take reasonable steps, to make laws, prevent pollution, promote conservation and ensure sustainable development. When social and economic development is concerned, government must ensure that reasonable measures are taken to protect the environment against harmful activities even if such development is needed in the community.

A duty is therefore placed on the district municipality of Zamdela (Fezile Dabi District Municipality) to ensure that there are laws in place that protect the environment and the community of Zamdela from harmful chemicals emission from Sasol refinery.

Section 32 of the Constitution speaks of the right to access to information, which is important for environmental issues (Republic of South Africa 1996). The Constitution guarantees every person the right to access to information held by government or any other person that is required for the protection of any rights. Without access to proper information people will not be able to know the actions being planned or procedures to be followed.

A duty here is placed on Sasol refinery to avail information on the harmful chemical toxins released into the air that may have an adverse impact on the environment and the health of community members of Zamdela.

In 1998 laws that where passed by government are; the National Forest Act, the new National Water Act, the National Environmental Management Act and the Marine Living Resource Act.

2.4.2 The National Environmental Management Act of the Republic of South Africa (No. 107 of 1998)

There are a number of policies and legislation that guide the framework in which the South African department of Environmental Affairs fulfils its mandate. The National Environmental Management Act (NEMA), 1998 (No 107), established the concept of participatory, cooperative and developmental governance in environmental management, including the principles for environmental management and provision for structures to facilitate these (The Department of Environmental Affairs 2014 15). NEMA states the following;

- All important environmental factors must be considered before development decision are taken, promoting the right to sustainable development.
- Government must make rational decisions that address the needs of people ensuring that development is socially, environmentally and economically sustainable.
- People affected by social, economical and environmental impacts of activities must be considered and consulted before decisions are made.
- A worker may not be held liable or be disciplined for refusing to do work that they believe to pose an immediate or serious threat to the environment.
- A person may not be held liable or be disciplined for reporting what they believe to be an environmental risk to a public interest.

- Any person who harms the environment must take reasonable measures to minimise or avoid such harm, even if it is authorised by law.

Other legislations that guide the Department of Environmental Affairs include; National Environmental Management: Protected Areas Act 2003 (No. 57), National Environmental Management: Integrated Coastal Management Act 2008 (No. 24), National Environmental Management: Waste Act 2008 (No. 59) and National Environmental Management Laws Amendment Bill 2013 (No. 14).

In a bid to decrease environmental crimes and bring about law reform, the Department of Environmental Affairs created the Environmental Management Inspectorate (EMI), known as the Green Scorpions. They are tasked with holding individuals, institutions and businesses accountable for pollution, waste and the negative impacts their actions or inactions have on both terrestrial biodiversity and aquatic, amongst other things (The Department of Environmental Affairs 2014 12). Complaints including criminal activities such as air, water and noise pollution, deforestation, mining, illegal dumping, illegal operations and poaching, have been reported.

2.4.3 National Environmental Management: Air Quality Act of the Republic of South Africa (No 39 of 2004)

The Air Quality Act sets out to protect and enhance air quality in South Africa and to secure ecologically sustainable development through reasonable air pollution prevention measures (Republic of South Africa 2004). This can be achieved by involving all spheres of government and the development of air quality management plans.

The main concern when it comes to air pollution is the amount of pollution that reaches the ground level, where it is then inhaled by humans. Majority of residents in Zamdela suffer from irritation of their eyes, noses and throats due to the emission of chemicals.

2.4.4 Legislations, Laws, Acts and Regulations that can be used as a guiding tool for chemical hazard

The Emergency Planning and Community Right to Know Act (EPCRA) was passed in 1986 by the United States Congress in response to concerns regarding environmental and safety hazards posed by the handling and storing of toxic chemicals (Pennsylvania workers and community right to know program 1987). These concerns where trigged by the 1984 chemical disaster in Bhopal, India, causing several deaths and illnesses, raising concerns about lack of planning and preparation for a similar accident in America.

To reduce the likelihood of such a disaster in the United States, the Congress imposed requirements for federal, state and local governments, tribes and industries. These requirements covered emergency planning and Community Right – to – Know reporting on toxic and hazardous chemicals. This helped to increase the public's knowledge and access to information at individual facilities, their uses and releases into the environment. States and communities that are working with the facilities can use the information to improve chemical safety and protect public health and the environment.

Section 301 – 303 of the EPCRA places local government as the responsible body to prepare emergency response plans together with facilities that maintain Extremely Hazardous Substances (EHS) on –site in quantities greater than corresponding threshold planning quantities, the plan must be reviewed annually (EPCRA 1986). Coordinating and overseeing local planning efforts are the responsibility of state government. Section 304 of the EPCRA places responsibility on facilities to report accident release of EHS chemicals and hazardous substances (EPCRA 1986). This information must be available to the public.

REACH, is a regulation which was agreed upon by the European Parliaments Council on 18 December 2006 and entered into force on the 1st of June 2007. The regulation was developed and adopted due to the large number of substances that have been manufactured and placed on the marked in Europe for many years, sometimes in very high quantities with insufficient information on the hazards that they pose to human health and dangers to the environment (REACH Regulation 2006). There was therefore a need to fill these information gaps to ensure that industries are able to assess hazards and risks of the substances and to identify and implement the risk management measures to protect humans and the environment. The REACH regulation is about;

- Improve the protection of human health and the environment through better and early identification of intrinsic properties of chemical substances. This is done by registration, evaluation, authorisation and restriction of chemicals.
- The regulation enhances innovation and competiveness of the EU chemical industry.
- Responsibility is placed on the industry to manage the risks of chemicals and to provide safety information on the substances.
- Manufactures are required to register their information in the central database in the European Chemical Agency (ECA) in Helsinki.
- The regulation calls for the progressive substitution of the most dangerous chemicals referred to as the substances of very high concern, when suitable alternatives have been identified.

The Basic Law for Environmental Pollution Control in 1967 and the Air Pollution Control Law in 1968 where put in place when Japan entered a period of high economic growth around the 1960s (Global Environment Centre Foundation 2016). Heavy chemical industries experienced a period of rapid expansion and at the same time automobiles where beginning to spread. This situation caused severe air pollution resulting in the rapid increase in respiratory diseases such as chronic bronchitis and asthma.

The Chemical Substance Control Law (CSCL) was first enacted in 1973 and has since been amended three times. The purpose of the Act is to evaluate, before manufacturing, whether or not new chemical substances have properties such as persistence and to implement necessary regulations in order to prevent environmental pollution caused by chemical substances that are persistent and pose a risk of impairing human health or interfering with the inhabitation and growth of flora and fauna (CSCL 2010).

The Dangerous Substance and Explosive Atmospheres Regulation (DSEAR) of 2002, puts employers and the self employed to protect people from the risks of fires, explosions and corrosion of metal in the workplace and to members of the community who may be put at risk by work activities (HSE 2016). From June 2015, DSEAR also covered gases under pressure and substances that are corrosive to metals.

2.5 DISASTER MANAGEMENT CYCLE

A disaster by definition is an event that causes serious disruption which can lead to widespread human, material or economic losses beyond the coping capacity of a given society (Mulugeta, Ayonghe, Daby, Dube, Gudyanga, Lucio, Durrheim. 2007 4). The WHO (2015) defines a disaster as the result of a vast ecological breakdown in the relations between man and his environment, a serious and sudden (or slow as drought) disruption on such a scale that the stricken community needs extraordinary efforts to cope with it, often with outside help or international aid . These events exceed the tolerable magnitude within or beyond certain time limits, make adjustment difficult, result in losses of property and income and paralyse life.

At household level a disaster could result in illness or death, economic or social misfortune. At community level a disaster can result in destruction of livelihoods, displacement through conflict or an epidemic. When a disaster occurs at district or provincial level, a large number of people can be affected. Hopkins (2006 26) states that, most disasters result in the inability of those affected to cope without outside assistance. At household level this means having assistance from neighbours, at national level it means seeking assistance from organisations

such as Non Governmental Organisations (NGOs), the International Federation of Red Cross, the United Nations and government agencies.

When it comes to the measurement of the scope of a disaster a common measure is the number of people affected or killed, though it is of importance to note that there is no single measure of a disaster that can capture the full scope of a disaster (Hopkins 2006 26). Individuals can therefore measure the scope of disaster by considering the impact on their families and livelihoods, the disaster manager will assess the speed and success of the disaster response, economists will measure the physical loss to buildings and houses and loss of production, politicians will assess political damages resulting from poor response by government agencies and lastly, health workers will consider the resources required to contain an outbreak (Hopkins 2006 26). When thinking about a disaster there is a need to consider all affected parties and their losses both in the immediate and the long term. Disasters are normally classified in two categories namely; as natural disaster or technological or manmade disasters.

Disasters caused by humans are increasing in importance. They can be classified as complex emergencies, industrial accidents, pollution and displaced populations, they are events which are caused by humans and occur close to human settlements (IFRC 2015). In many years' industrial systems in the former Soviet – bloc countries have left the environment heavily polluted with dangerous substances. Globalisation is now carrying industrial products to previously agrarian societies and as a result potentially hazardous products are now available in communities which do not have adequate regulations governing their use and may not be aware of their presence or health risk (Hopkins 2006 27). Effective disaster mitigation methods to contain these threats are possible and have been used in some countries but other countries see implementing these methods as contrary to short term financial interests.

Chemical disasters pose serious threats to human well being at many levels, they threatens the sustainability of the environment which provides essential goods and services for livelihood, they undermines human health, they threaten physical security and they reduce the ability of a community to care for themselves, especially for children (Manda and Mohammed – Katerere 2004 350). It is important for government to establish and implement a system for sound management of chemicals. Disaster management requires a set of actions and processes that are designed to lessen hazardous events before they become disasters (Mulugeta *et al*. 2007 4).

Disaster management is defined by the UNISDR (2009) as the systematic process of using administrative directives, organizations, and operational skills and capacities to implement

strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disasters. It is the discipline of dealing with and avoiding risks. It involves the preparation for pre disaster activities, disaster response as well as support and post disaster activities. In order to have a basic understanding of disaster management, there is a need to understand three major components namely; hazard, vulnerability and capacity.

Hazards can either be natural or manmade, as discussed earlier. Natural hazards are those which are caused by natural phenomena (geological, meteorological, biological, climatological) and manmade hazards which are solely due to negligence of humans.

Vulnerability can be categories as physical and socio – economic. Physical vulnerability assesses whom and what may be destroyed or damaged by a hazard (Khan 2015 46). It relates to the physical conditions of people and the elements at risk, this includes infrastructure and the proximity, location and nature of the hazard. It looks at the technical capability of buildings and structures to resist the forces acting upon them during a hazard event (Khan 2015 46). Socio – economic vulnerability on the other hand pays attention to the inadequate protection of assets, lack of public education and awareness programs, preparedness measures and limited official recognition of risks (UNISDR 2009).

For a community to have capacity it should have a combination of all the strength, attributes and resource available that can be used to achieve agreed goals (UNISDR 2009). Capacity can be classified as physical and socio – economic. Physical capacity includes skills that the community posses that can assist in times of a disaster, physical means and infrastructure that can make it easier for a community to recover from a disaster quicker and societal coping capacities. Therefore, socio – economic capacity involves a community that is well off enough to afford household insurance and ensuring that their houses are built from strong material which will ensure that they are not affected as much by a disaster as would an incapacitated community.

When referring to disaster management, it is important to note that it includes all measures which reduce disaster related losses of life, assets and property by either reducing the hazard or vulnerability of the elements at risk (Khan 2015 46). Figure 2.1 below illustrates steps that disaster managers should take in preparing for and responding to a disaster.

Figure 2: Disaster management cycle (SMCOAD 2015)

The disaster management cycle is known as the life cycle of comprehensive emergency management. Khan (2015 47) states that appropriate action at all phases of the cycle leads to greater preparedness, better warnings, reduced vulnerability and prevention of disasters during the next interaction of the cycle. Therefore, each phase of the cycle has particular needs, strategies, requires distinct tools, resources and faces different challenges. The complete disaster management cycle includes the shaping of public policies and plans that either modify the causes of disasters or mitigate their effects on property, infrastructure and people. The phases shall be discussed in greater detail below.

2.5.1 Disaster

Disaster is not generally considered a phase, but the incident that promotes the actual four phases. When a disaster occurs there is profound damage to the human society. The damage or loss may be that of human life, loss of the environment, loss of property, loss health or anything else. During a disaster people are taken by profound shock.

2.5.2 Response

The response phase normally takes place during or immediately after a disaster and it focuses on immediate or short – term needs of the affected community. The disaster manager in this phase focuses on addressing immediate threats presented by the disaster, this includes saving lives, reducing health impacts, ensuring public safety and meeting the basic subsistence needs of the people affected (UNISRD 2009). It is important for a local municipality to built a strong volunteer group because local communities play the first most important role in responding by rescuing those affected, providing first aid and emergency shelter, long before outside organisations arrive at the scene.

2.5.3 Recovery

When the immediate needs of the population are met and people have settled from the event, they begin to enter into the recovery phase which is the most significant in terms of long term actions (Khan 2015 3). In the recovery phase the main focus is on the restoration of all aspects of the disaster's impact on a community and the return of the local economy to some sense of normality (UNSIDR 2009). In the recovery phase the community has already achieved a degree of physical, economic, environmental and social stability.

2.5.4 Mitigation

The mitigation phase is different from other phases because it focuses on long term measures for reducing or eliminating risk. Mitigation places emphasis on actions which will lessen a disaster's consequences and subsequent hazards (Hopkins 2006 29). Mitigation involves steps to reduce vulnerability to disaster impacts such as loss of life, property and injuries. This may involve changes in local building codes to fortify buildings, revised zoning and land use management, strengthening of public infrastructure and other efforts to make the community more resilient to a catastrophic event. At a time of heightened awareness post a disaster, attention should be focused to other vulnerabilities and mitigation efforts should be directed towards reducing these additional risks (Hopkins 2006 29). Furthermore, disasters expose social vulnerabilities which may predispose populations to other potential disasters. Making affordable and adequate insurance available will help share risks and mitigate the potential effects on the economic devastation that might arise from future disasters.

2.5.4 Preparedness

The main focus of preparedness is for the local municipality to have an understanding of how a disaster might impact the community and how education, training and outreach can build capacity to respond to and recover from a disaster. After every disaster, the involved organisations should examine their actions to see what could be done to improve their effectiveness in responding to future disasters (Hopkins 2006 29). Moreover, the planning process, the mapping of vulnerabilities and the assessing of the shortfalls in existing resources helps communities and organisations to prepare. Common preparedness measures include the (CYEN 2015);

- communication plans with easy to understand terminology and chain of command,
- development and practice of multi – agency coordination and incident command,

- proper training and maintenance of emergency services,
- development and exercise of emergency population warning methods combined with emergency evacuation plans and shelters, and
- stockpiling, inventory and maintenance of equipment and supplies.

When it comes to the stockpiling of emergency supplies, few organisations other then the military can afford to do this on a large scale, given the capital costs and the costs of regular rotation of provisions (Hopkins 2006 30).

A duty is placed on Fezile Dabi District Municipality to ensure that disaster management strategies and policies are implemented that will improve the coping capacity of community members in Zamdela and lessen the adverse impacts of chemical hazards. Strong local volunteer groups are a necessity, this will ensure that after a disaster has occurred community members of Zamdela can fall into the recovery phase much quicker. It is also important for the district municipality to have educational workshops and training on chemical hazards in order to build the response and recovery capacities of Zamdela's community members.

2.6 DISASTER PREPAREDNESS FRAMEWORK

The disaster preparedness framework outlines activities that are essential to the development of a preparedness strategy (Kent 1994 15). It is important to note that activities listed in the framework might not be implemented in the listed sequence, some activities might occur simultaneously or in reverse order. Figure 2.2 outlines preparedness activities which should be included by government when conducting their preparedness planning.

Figure 3: Disaster preparedness framework (Centre for Management of Environment and Disaster 2014).

2.6.1 Vulnerability Assessment

Assessing vulnerability is vital for establishing an essential disaster management plan. Kent (1994 16) when defining vulnerable assessment stresses the inclusion of structured data collection that is geared towards understanding the level of impending threats, needs and immediate available resources. Assessment firstly includes static infrastructure information that determines the extent of development, types of physical advantages and disadvantages faced by a population residing in an area and a map that outlines available structures such as clinics, hospitals and roads ect, that might be useful in times of disasters (Kent 1994 16). Secondly assessment includes dynamic socioeconomic data that indicates causes and levels of vulnerability, demographic shifts and types of economic activities within a community (Kent 1994 16).

Vulnerability assessment is essential when it comes to disaster preparedness for three main reasons (Kent 1994 17);

- Firstly, it informs decision makers about the utility of national and local level approaches to disaster preparedness,
- secondly, there might not be an effective starting point upon which to construct an overall preparedness plan unless disaster threats and levels of preparedness or unpreparedness are fully appreciated and

- lastly, the development of a database through vulnerability assessment should become the basis for maintaining and updating an essential informational tool for development planning purposes.

Vulnerability assessment therefore serves as a starting point for determining the types of plans that should be developed as part of a disaster preparedness strategy.

2.6.2 Planning

Planning is the theme of the entire disaster preparedness process, the objective here is to have agreed upon, implementable plans in place, for which commitment and resources are relatively assured (Kent 1994 18). During an actual disaster, quick and effective action is required, if appropriate action is not taken or if the response is delayed, lives may be lost. Planning for readiness includes working out agreements between people or agencies as to who will provide services in times of disasters to ensure an effective coordinated response (Kent 1994 18). Emergency shelters, public evacuation routes, emergency water sites, chain of command and communication procedures and educating people about what to do in case of a disaster can all be determined in the preliminary plan, even though details might remain uncertain. All of these measures will go a long way in improving the quality, timing and effectiveness of the response plan (Risk doc 2000 11).

Kent (1994 18) identifies four points to be considered in any planning effort;

- Have clear stated set of objectives or an objective.
- Reflect a systematic sequence of activities in a logical and clear manner.
- Assign specific tasks and responsibilities.
- Integrate its activities, tasks and responsibilities to enable the overall objective or set of objectives to be achieved.

Planning must be well coordinated with the inclusion of national and local government, sector department, private sectors, donors, UN agencies and Non - governmental Organisations (NGOs) in order for the plan to be implementable during and after a chemical disaster.

2.6.3 Institutional Structure

It is essential for a disaster preparedness plan to have a coordinated disaster preparedness and response system whereby each design depends on the government structures and traditions of a community under review. However Kent (1994 23) states that a plan will

rapidly deteriorate unless there is horizontal coordination at central government and sub – national level among ministries and specialized agencies and vertical coordination between central and local authorities. It is important to work within the existing structures and systems when it comes to disaster preparedness rather than creating new organisations. The emphasis should be on strengthening existing institutions.

When looking at the delegation of duties, there is no standard method which fits the requirements of all countries, however there are three points that Kent (1994 25) points out that an institution needs to keep in mind;

- Responsibilities should reflect established expertise, a program such as emergency relief should be given to a body that has knowledge about the substance of that particular program.
- Roles and responsibilities should be clearly defined, during a program it is important for one to not be tempted to make compromises about the roles and responsibilities of individuals working on the program. Too many compromises early in the program may make the plan unworkable in the long run.
- Roles and responsibilities have to be appropriate, political and social conditions in a country or regions within that country should be considered when assigning roles and responsibilities.

Botswana's preparedness plan is successful because it uses local tribal leaders to gain information about their needs rather than relying on a central government official who may be less familiar with particular areas and relief requirements.

2.6.4 Information Systems

Early warning systems normally comprise of various elements, like information provided by meteorological offices, by the Department of Health (nutritional surveys) or by the Department of Agriculture (crop forecasts) (Kent 1994 26). An effective preparedness plan therefore needs to establish a committee that will ensure the coordination of all these different inputs. For this type of committee to function there needs to be clear cut guidelines, reporting formats and mechanisms as well as established reporting procedures. The committee needs to be linked to disaster preparedness focal point; this focal point will serve as a chair organisation for the committee.

An added complication involves the combination of this information with grass – roots information, the early warning information that is obtained from those directly threatened , which is often ignored (Kent 1994 26). Ensuring that appropriate information systems are in

readiness including stimulating information exchange systems within each agency in the emergency environment, between organisations and between the organisation and the public (Kent 1994 26).

The disaster preparedness plan must have well assessed and clearly defined means of gathering and disseminating early warning information because it is important that early warning messages are understood by the people who they are issued. Warning systems ensure the functioning of communications systems, such as telephones and telexes and may not be available in times of a major disaster. Consider what type of communications equipment will be needed and be sustainable if power lines and receiving stations are destroyed. Moreover, a preparedness plan should include provisions for access to alternative communication systems among military, police and government networks (Kent 1994 26).

Vulnerability assessment updates and early warning should encompass all the standard features required for any monitoring system (Kent 1994 26). This includes determining changes in patterns of disaster threats, number of vulnerable people and preparations for response. Kent (1994 26) states that monitoring must include a disaster preparedness assessment process in which essential physical aspects of the plan are reviewed system wide, this will ensure that when a disaster does strike all that the plan anticipated is in place. Monitoring must also include an assessment process for post disaster, to make sure that the implementation of the plan is efficient and that appropriate and timely relief is being distributed to targeted beneficiaries.

2.6.5 Resource Base

The types of disasters the plan anticipates will be the guide to the requirements to meet disaster needs. These needs should be explicit and should cover all aspects of disaster relief and recovery implementation. Kent (1994 28) outlines the elements which need to be considered when assessing resources required for a disaster preparedness plan;

- Disaster relief funding

It is essential to establish an emergency contingency fund, especially for items which cannot be easily stockpiled such as medicines, or items which were not anticipated such as alternative fuel. Insurance is also another way to assist with creating reserves against potential disasters.

- Disaster preparedness funding

One should seek funds to pursue activities of the planning process including public awareness and training. Funds should also contribute to develop major inputs for the plan to function effectively.

- Mechanism for aid coordination

A means should be established to ensure coordinated, timely and useful response from the international community when its assistance is required and also assistance from non – governmental organisations (NGOs). All these communities should be brought into the coordinating mechanism.

- Stockpiling

Considerations should be made to the type and amounts of materials needed, where they can be stockpiled and where. For disaster prone poverty stricken regions where stockpiling for a disaster is a luxury, donors are often willing to make contributions to various forms of stockpiling.

2.6.6 Warning Systems

According to the Risk doc (2000 13) the purpose of early warning systems is to detect, forecast, and when necessary, issue alerts related to the impending hazard events. Early warning information should be disseminated in such a way that facilitates decision making and timely action of response organisations and vulnerable groups.

Key messages can be created from the identification of targeted audiences, vulnerable populations and stakeholders (Disaster Awareness and Preparedness Strategy 2012 2). Target audiences include senior citizens centre, neighbourhood groups, community groups, business groups, schools, churches and any individual with special considerations such as disable citizens, those with visual, hearing and cognitive impairments, non English speaking citizens and nursing homes. These messages should be communicated to the targeted audiences in the way that they can understand them and inspire them to take action.

There are a variety of techniques that can be used to deliver messages to the community such as local media (newspapers, radio), speaking engagements (public meetings, school events), special events (local festivals), educational materials (flyers, pamphlets) and online contents (website articles) (Disaster Awareness and Preparedness Strategy 2012 8).

When developing early warning systems the Risk doc (2000 13) stresses the need for planners to account for the public's perception of warning, their experience related to reacting to warning in the past and general public beliefs and attitudes regarding disasters and public early warning. Most importantly when it comes to early warning local indigenous capacities and early warning and alert should be incorporated. If possible the international community should be forewarned about hazards that might lead to appeals for international assistance, the process for this form of warning should also be anticipated in the disaster preparedness plan (Kent 1994 30).

2.6.7 Response Mechanisms

There is a wide number of responses that should be consider, each response depends on the nature of the threat. Listed below will be preparedness mechanisms and strategies that can strengthen and increase the effectiveness of an emergency response (Risk doc 2000 10);

- Evacuation procedures.
- Search and rescue teams.
- Assessment teams.
- Measure to activate special installations such as emergency or mobile hospital facilities.
- Procedures for activating distribution systems.
- Preparing emergency reception centres and shelters.
- Preparations for storing or making arrangements for rapid acquisition of emergency relief supplies and equipment.

When the disaster preparedness plan is in place, these response mechanisms should be familiar to potential beneficiaries or to those with the responsibility of implementing such measures. Alerts must be issued 24 hours before the disaster occurs, advisories must be issued 12 hours in advance and a warning must be issued 60 minutes maximum or anytime before the disaster strikes (Kent 1994 32).

2.6.8 Education and Training

The UNISDR (2009) states that public awareness is the community having common knowledge about disaster risk, the factors that lead to disasters and the actions that can be taken collectively and individually to reduce exposure and vulnerability to hazard. A disaster preparedness plan must be supported by public education campaigns and workshops.

Training workshops should be conducted for community members to give them knowledge and awareness of major hazards including chemical hazards. Community members will be trained on how to interpret alerts, advisories and warnings which will differ based on the time.

Training workshops must be compulsory for every community member and must inform them about the evacuation routes and the manner in which instructions should be followed once disseminated during disasters. Volunteers will assist the elderly, disabled and young children and lead during evacuations to avoid major confusions and frustrations. Community members must be made aware during workshops of communication tools that will be used before, during and after a disaster. Training can never be a once off process, refresher courses are important.

2.6.9 Rehearsals

It is important to rehearse the major elements of a preparedness plan because rehearsals expose gaps that might otherwise be overlooked. Rehearsals are most effective when they are system wide and engage as many disaster response players as possible. System wide simply means all the components which would be involved in a real disaster situation from central to local authorities, should be rehearsed (Kent 1994 35). Rehearsals might simulate search and rescue operations, first aid provision, response or needs assessment, coordination meetings between major organisational players and population leaders, relief transport and logistics and other aspects of an emergency response (Risk doc 2000 15). Rehearsals help with keeping the plan fresh especially during extended periods without disasters.

When it comes to disaster preparedness planning, it is imperative that a community has a map that illustrates places of vulnerability, possible hazards and places of safety in case a disaster where to occur. The district municipality should have reliable stakeholders, who know their responsibilities to make sure that there is coordinated response. Existing institutions within a community should be strengthened by involving community leaders when preparing for a disaster and a budget should be set aside for relief and preparedness programmes.

2.7 EARLY WARNING SYSTEMS

Disasters or hazards impact on a community can be reduced significantly with effective early warning systems. An early warning system that is effective can warn a population in advance

of likely hazards, and enables risks and losses to be mitigated through preparation measures and response action. The technology which is used should be complemented by other essential components in order for it to be effective. Therefore, it is essential that an early warning system be considered as a Complete Early Warning, Preparedness and Response System.

The protection of lives and livelihoods from known hazards while minimising negative impacts on the economy and the environment is the main purpose of having an early warning system. For an early warning system to be effective, it needs to be people centred. An early warning system must empower communities and individuals that are threatened or at risk, to act in sufficient time and in an appropriate manner in order to reduce the likelihood of injury, loss of life and damage of property and livelihood.

The basic concept behind early warning systems is that the earlier and more accurately one is able to predict potential risks associated with natural and human induced hazards, the more likely one is able to manage and mitigate disasters that impact on society, the economy and the environment (Early Warning Systems Framework 2013 5). There are three main reasons why early warning for disaster reduction is a legitimate matter of public policy at the highest national level; those reasons will be listed below.

- Public safety and the protection of human lives

Early warning has proven to save lives and lessen injuries amongst community members.

- Protection of the nations resource base and productive assets

This includes infrastructural and private property or placing an investing to ensure economic growth and long term development, these types of early warning or disaster reduction investments are neither simple nor inexpensive, but the benefits that one reaps are considerable.

- Adaptation of climate change

Accurate, timely and reliable early warning systems enhance climate change adaptation efforts at all levels, especially for people who rely and can only make informed decisions based on climate change information for their livelihood.

2.7.1 Elements of Early Warning Systems

The main objective of people centered early warning systems is to empower communities and individuals who are threatened by hazards to act in an appropriate and timely manner in

order to ensure the reduction of possible personal injury, loss of life and damage to property and the environment (EWC III 2006 2).

A complete and effective early warning system comprises of four inter – related elements spanning knowledge of risks faced through preparedness and capacity to respond (Early Warning Systems Framework 2013 6). The four elements include; risk knowledge, technical monitoring and warning service, dissemination of warnings and communication and community response capability which emphasizes the major components that comprise an effective people – centered early warning system, and why each element is important.

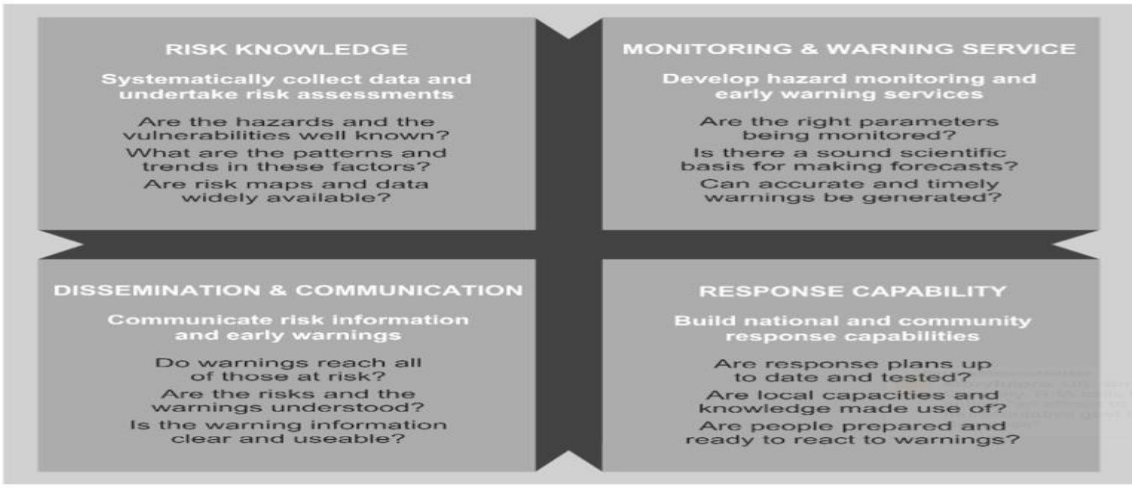

Figure 4: Elements of early warning systems (EWC 2006)

2.7.1.1 Risk Knowledge

Risks arise from the combination of hazards and vulnerabilities at a particular location. Risk assessment requires the systematic collection and analysis of data and should be considerate to the dynamic nature of hazards and vulnerabilities that arise from environmental degradation, rural land – use change, urbanization and climate change (EWC III 2006 2). Risk assessment and maps help to motivate a community, prioritise early warning system needs and guide preparedness for disaster prevention and responses.

2.7.1.2 Monitoring and Warning Service

Warning services are the core of the system. The Early Warning Systems Framework (2013 7) stresses that there should be a sound scientific basis for predicting and forecasting hazards and a reliable forecasting and warning system that operates 24 hours a day. In order to generate accurate warnings in a timely manner, there has to be continuous monitoring of hazard parameters and precursors. Warning services for different hazards

should be coordinated where possible in order to gain the benefit of shared institutional procedural and communication networks (EWC III 2006 2).

2.7.1.3 Dissemination and Communication

Early warnings must be sent to people or the community that is most at risk. Early warning messages must be clear and contain simple useful information in order to enable proper responses that will help safeguard lives and livelihoods. Regional, national and community level communication systems must be pre – identified and appropriate authoritative voices established (EWC III 2006 2). The use of multiple communication channels is necessary to ensure as many people as possible are warned, to avoid failure of any one channel and reinforce the warning message.

2.7.1.4 Response Capability

It is important that communities understand their risks, respect the warning service and know how to react. Education and preparedness programmes play a major role. It is also important that disaster management plans are in place, well practiced and tested. Communities should be well informed on options for safe behaviour, available escape routes and how to avoid damage and loss to property (EWC III 2006 2).

It can therefore be said that it is generally recognised that it is important to establish effective early warning systems to identify the risk and occurrence of hazards and to better monitor the level of vulnerability of a population. This will help to guarantee consistency of warning messages and mitigation approaches, improving coordination at a multi – level and multi – sector scale.

2.7.2 Basic Principles of Early Warning Systems

The following are the basic principles of an effective early warning system according to Early Warning Systems Framework (2013 10 – 13).

- Political recognition of the benefits of early warning systems with effective planning, legislation and budgeting and that effective early warning system is built upon four components:
    I. Hazard detection, monitoring and forecasting.
    II. Analysis of risks and incorporation of risk information in emergency planning and warnings.

III. Disseminating timely and authoritative warnings with clarity on the responsibilities and authority for issuance of warning.

IV. Community emergency planning and preparedness and the ability to activate emergency plans to prepare and respond.

- Risk assessment at different levels is carried out by using hazard, exposure and vulnerability information.
- At national and local levels of public administration and authority there is a need for a coherent set of linked operational responsibilities established for early warning practices. To be affective, these early warning systems should themselves be components of a broader program of national hazard mitigation and vulnerability reduction.
- Government has the sole responsibility to designate an agency or agencies for the issuance of early warnings for natural and man induced disasters.
- Decision makers should be identified and must have locally recognised political responsibility for their decisions. Actions resulting from warnings are normally based on previously established disaster management procedures of organisations at national and local level.
- There needs to be consistency regarding timely, redundant and sustainable warning dissemination mechanisms.
- At national and local level, early warning systems must be based upon risk analysis which includes the assessment of hazard. Warnings information must be communicated to the vulnerable population so that they may take appropriate actions to mitigate loss and damage.
- Locally predominant hazard types and patterns, including small – scale or localised hydro meteorological hazards related to patterns of human economic or environmental exploitation, must be incorporated if early warning is to be relevant to risk reduction practices.
- At local level, there is a need to constantly monitor changes in vulnerability patterns, such as the sudden increase in vulnerability resulting from social developments. This may include rapid urbanisation, economic changes, abrupt mitigation, nearby conflict or similar elements which alter the social, economic or environmental conditions of an area.
- Local warning systems must provide for a range of communication methods and must provoke multiple strategies for protection and risk reduction.
- To be sustainable, all aspects of the design and implementation of early warning systems require the involvement of stakeholders at local and national levels. This

includes the production and verification of information about perceived risks, agreement on the decision making processes involved and standard operational protocols. Equally important is the selection of appropriate communication media and dissemination strategies, which can assure an effective level of participation in acting upon receipt of warning information.

2.7.3 Key Actors in Early Warning Systems

Developing and implementing an effective early warning system requires the contribution and coordination of a diverse range of individuals and groups (EWC III 2006 4). Listed below is a brief explanation of the types of organisations and groups that should be involved in early warning systems and their functions and responsibilities.

Communities**,** especially those that are most vulnerable, are fundamental to people – centered early warning systems. They should be involved in all the aspects of the establishment and operation of early warning systems , be aware of the hazards and potential impacts that they are exposed to and be able to take action to mitigate the threat of loss and damage (EWC III 2006 4).

Local governments are at the centre of effective early warning systems. They should be empowered by national governments, have considerable knowledge on the hazards that their communities are exposed to and be involved in the design and maintenance of early warning systems. They must understand advisory information received and be able to advise, instruct and engage the local population in a manner that increases public safety and reduces the possible loss of resources on which the community depends (EWC III 2006 4).

National governments hold the responsibility for high – level policies and frameworks that facilitate early warning and for the technical systems that predict and issue national hazard warnings (EWC III 2006 4). National governments should interact with regional and international governments and agencies to strengthen early warning capacities and ensure that warnings and related responses are directed towards the most vulnerable communities.

Regional institutions and organisations provide specialised knowledge and advice, which supports national efforts to develop and sustain early warning capabilities in countries that share a common geographical environment (EWC III 2006 4). They also encourage linkages with international organisations and facilitate effective early warning practices among adjacent countries.

International bodies can provide international coordination, standardisation and support for national early warning activities and foster the exchange of data and knowledge between individual countries and regions (EWC III 2006 4). Support may include the provision of advisory information, technical assistance and policy and organisational support necessary to aid the development and operational capabilities of national authorities or agencies.

Non – governmental organisations play a role in raising awareness among communities, individuals and organisations involved in early warning, at community level. They can also assist in implementing early warning systems and in disaster preparedness. They can also play a role to help ensure that early warning stays on the agenda of government policy makers (EWC III 2006 4).

The private sector has a diverse role to play in early warning including the development of early warning capabilities in their own organisations. The media plays a vital role in improving the disaster consciousness of the general population and disseminating early warnings (EWC III 2006 4). The private sector can also help by providing skilled services in form of technical manpower, know – how or donations (in-kind and cash) of goods or services.

The science and academic community has the role of providing specialised scientific and technical input to assist governments and communities in developing early warning systems. Their expertise is central to analysing hazard risks facing communities, supporting the design of scientific and systematic monitoring and warning services, supporting data exchange, translating scientific or technical information into comprehensible messages and to the dissemination of understandable warnings to those at risk (EWC III 2006 4).

The media in all its forms is important and instrumental in advancing early warning. The many forms of social media should be assessed for use in early warning and employed to use at its highest potential (Early Warning Systems Framework 2013 17).

2.8 CONCLUSION

In conclusion vulnerable community members of Zamdela need effective disaster risk reduction planning to deal with chemical hazard. The focus must be on preparing and preventing chemical disaster within the area, to reduce the impact that the disaster might have on the community. Livelihoods that provide the population with little more than basic needs are unlikely to enable the provision of self protection.

It is important that attention be paid to the local population and engage in public awareness such as education campaigns, public consultation through relevant structures such as civil organisations, and through local media covering topics that are related to hazards affecting the entire community. Public awareness is also necessary to ensure that the community is aware of disaster preparedness planning.

The municipality should develop and implement policies that will promote transparency regarding activities of chemical emission in Sasol refinery – in an attempt to reduce the risk of chemical disasters.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the research design, the research methodology, face-to-face interviews and the design and construction of the questionnaire. It also addresses the reliability and validity of the research instruments, the population under study and the sampling procedure. Ethical considerations pertaining to the research are also discussed.

3.2 RESEARCH DESIGN

Thomas (2010 308) writes that research design can be thought of as the master plan or logic of a research that shows light on how the study should be conducted. It shows how the major parts of the research study (the samples, measures, programs etc.); work together in an attempt to address the research questions. Research design aims to plan, structure and execute the research to maximise the validity of the findings. A research design can thus be seen as an action plan from getting from “here to there”, where ‘here’ may be defined as the initial set of questions to be answered and ‘there’ is some set of conclusions or answers (Thomas, 2010 308).

3.3 RESEARCH METHODOLOGY

The choice of research methodology to be used by a researcher is made by establishing what kind of data is to be gathered to assess the level of preparedness by community members of Zamdela to chemical hazard. Data can therefore be either qualitative or quantitative.

Qualitative research attempts to study the everyday life of different groups of communities and people in their natural setting, it attempts to make sense of phenomena in terms of the meaning people bring to them (Thomas 2010 302). It represents data as a descriptive narration with words and is normally used in social sciences to enable researchers to study social and cultural phenomena. Quantitative research on the other hand makes use of questionnaires, experiments and surveys to gather data. The data is revised and tabulated in numbers, which allows the data to be characterised by the use of statistical analysis

(Thomas 2010 303). Both quantitative and qualitative research is important in their respective fields. However, quantitative research is more objective, statistical and numerical and qualitative is more about social and psychological research. For that reason this study will use quantitative research.

3.3.1 The quantitative research used in this study

According to Sukamolson (2016) quantitative research is essentially about the collection of numerical data in order to explain a particular phenomenon. MacDonald and Headlam (2011 8) state that quantitative research looks to quantify data and generalise results from a sample of the population of interest. Data collection through quantitative research are believed to yield more accurate and objective information because they were collected using standardised methods, can be replicated and can be analysed using sophisticated statistical techniques, unlike qualitative data. Decision makers at national level in most cases tend to favour quantitative information because they are accustomed to basing funding decisions on numbers and statistical indicators.

Quantitative researchers prefer to remain detached from the study and from the sample. The researcher tries to not influence the study with their own personal values, feelings and experiences. This being a different case when involving qualitative research, the researcher whilst not wanting to bias the research maintains that they cannot approach a study without considering their own perceptions, values, feelings and experiences. Quantitative research is basically about asking people for their opinions in a structured way so that the researcher can produce hard facts and statistics to guide them. In order for the research to get reliable statistical results it is important that people are surveyed in fairly large numbers and to ensure that they are a representative sample of the researchers target market. Quantitative research normally comes later in the research study or once the scope of the study is understood.

Quantitative methods emphasise objective measurements and the statistical, mathematical or numerical analysis of data collected through polls, surveys and questionnaires or by manipulating pre – existing statistical data using computational techniques. Quantitative research designs are either descriptive (subjects usually measured once) or experimental (subjects measure before and after a treatment). Quantitative data collection methods are much more structured compared to qualitative data collection methods.

There are a wide range of techniques available to analyse quantitative data such as graphs to show data through tests of correlations between two or more data sets, cluster analysis

used for identifying relationships between groups and subjects where there is no obvious hypothesis to identify whether there are genuine differences between the groups.

Face – to – face interviews will be conducted as a secondary method and a questionnaire will be used as a primary method in this study. These two methods of data collection have been chosen because they are effective methods of gathering primary data and also gathering a lot of information in a short space of time. The questionnaire is designed and planned in such a way that it easy to understand, complete and administer.

3.4 FACE-TO-FACE INTERVIEWS

According to Wyse (2014) face-to-face interviews remain a popular data collection method; this is especially important in South Africa, a country with low levels of literacy. Rather than having the respondents read and answer questionnaires, the researcher can ask the respondents to answer the questions orally and record the answers. For this to be a success it is important that the researcher be able to speak the home language of the respondents. Using an interviewer or assistant from the area can be helpful, but the interviewer or assistant should be trained on how to conduct an interview and the dos and don'ts of face-to-face interviews or else it will jeopardise the entire exercise.

3.5 QUESTIONNAIRES

A questionnaire is a tool for collecting and recording information about a particular issue of interest (Kirklees Council 2016 1). It is usually made out of closed-ended and open-ended questions. A questionnaire should always have a defined purpose that is relevant to the objectives of the research and it needs to be clear from the beginning how those findings will be used. Moreover, a questionnaire should be designed to include elements which make it pertinent and relevant to the population to be sampled, thereby maximising response rates and minimising error or bias (Survey questionnaire design 2012 4).

It is important to consider the order in which questions are presented in a questionnaire; sensitive questions should be placed at the end thereby allowing the researcher to establish trust before asking questions that might be embarrassing to the respondent. Tabled below are the advantages and disadvantages of using a questionnaire.

Table 1: Advantages and disadvantages of a questionnaire (Milne 2016)

Advantages	**Disadvantages**
They are objective because responses are gathered in a standardised way.	Respondents may answer questions superficially especially if the questionnaire takes a long time to complete.
It is quicker to collect information using questionnaires.	Badly designed questionnaires can be misleading.
Can contact a large number of people at a relatively low cost.	Questionnaires normally occur after the event, so participants may forget important issues.
Can be analysed more scientifically and objectively than other forms of research.	Questionnaires are sometimes argued to be inadequate to understand some forms of information such as change of emotions, feels, behaviour etc.
When data has been quantified, it can be used to compare and contrast other research and may be used to measure change.	There is a level of research imposition – meaning that when a researcher develops the questionnaire the researcher is making their own assumptions about what is and is not important.

Based on the advantages tabled above regarding a questionnaire, it is clear that a questionnaire is a suitable method to use for testing the preparedness levels of residents in Zamdela on chemical hazard. Care will be taken in this research to combat the above mentioned disadvantages of a questionnaire.

3.6 THE DESIGN OF THE QUESTIONNAIRE FOR THIS RESEARCH

According to Kirklees Council (2016 1) a questionnaire should be designed in such as way that;

- it can collect factual information in order to classify people and their circumstances,
- it gathers straightforward information relating to people's behaviour,
- it looks at the basic attitudes or opinions of a group of people relating to a particular issue and
- it collects baseline information which can then be tracked over time to examine changes.

If a questionnaire is badly designed it will fail to gather the necessary information resulting in it being a waste of time for both the researcher and respondents. The researcher should ensure that their questionnaire is spread out and uncluttered. Three type of questionnaires can be found, self-administered, psychological tests and investigator-administered. For the purpose of this study a self-administered as well as investigator-administered questionnaire will be used.

3.6.1 Self-administrated questionnaires

A self-administered questionnaire is handed to respondents to complete at their own time but the researcher is available in case problems are experienced (de Vos, Strydom, Fouché & Delport 2012 188). The researcher limits their own contribution to the completion of the questionnaire to the minimum. A self-administered questionnaire was chosen for this study. Tabled below are the advantages and disadvantages of a self-administered questionnaire;

Table 2: Advantages and disadvantages of a self – administered questionnaire (NEDARC 2006)

Advantages	**Disadvantages**
Costs They are less expensive than interviews because they do not involve the cost of having to hire, train and employ skilled interviewers.	**Bias** There is a possibility that responses to questionnaires are given by people who feel strongly about the topic.
Efficiency They can be distributed in large numbers at once and they involve less administrative time.	**Respondent error** Respondents may answer questions that they do not understand and the researcher may never know.
Anonymity The respondent is assured anonymity and privacy and the respondent can therefore feel freer to provide honest responses.	**Incomplete surveys** There is a high chance that questions may be skipped resulting in incomplete questionnaires.

3.6.2 Investigator-administrator Questionnaires

The researcher here presents and administers the questionnaires and immediately collects the completed questionnaires afterwards (Mitchell & Jolley 2009). The advantage of this type of questionnaire is that it has a higher response rate because researcher can clarify questions for responders. The disadvantage here is that the researcher's presence may hurt sense of anonymity and thus decrease honesty of responses. The investigator-administered questionnaire was used for this study.

3.7 CLOSED-ENDED QUESTIONS

Closed-ended questions should be used when all the possible theoretically relevant responses to a question can be determined in advance and the number of possible responses is limited (de Vos *et al.* 2012 198).

The advantages of closed-ended questions (Horst and Martens 2015) are as follows:

- Time efficient, it is easy and quick for responders to answer and responses are easy to interpret and code.
- Answers from different respondents are easy to compare.
- Responders are more likely to answer about sensitive topics.
- There are fewer irrelevant or confusing answers to questions.

The disadvantages of closed-ended questions (Salloway 2016) are as follows:

- Suggestive, close-ended questions do not give an opportunity for a person to think of their own response, they simply put forward responses from which to choose (most often a yes or a no). If the answer that the respondent wishes to use is not an option it can lead to frustration and poor inaccurate results.
- Respondents with no previous knowledge on the subject are able to respond to closed-ended questions, this can lead to false information and the entire questionnaire may be ruined.
- Close-ended questions leave room for misinterpretation because respondents must either mark a yes or no; this leaves too much possibility for getting the answer completely wrong.

3.8 OPEN-ENDED QUESTIONS

Open-ended questions can be used if a researcher wants to learn how the respondents think, to discover what is important to them or to get an answer to a question with many possible answers (de Vos *et al.* 2012 196).

The advantages of open – ended questions (Andrew 2011) are as follows:

- Not limiting in nature, open ended questions allows the responder to answer with their own words which in turn draws out the respondents' attitude and intension giving the respondent an opportunity to reflect on their own feelings.
- Extra information, respondents answers provide extra information that can be used in a later stage by researchers who may need to use contextual information about the questionnaire target for secondary analysis.
- Cutting down error, from the respondents as they are not likely to forget their answers as opposed to filling up a questionnaire with a yes or a no answer, this allows the respondent to think before answering a question thereby sharpening their verbal and communication skills.

The disadvantages of open – ended questions (Tucker 2016) are:

- Time consuming, open ended questions take longer to answer than those with defined parameters.
- Tough to analyse, responses are difficult to code and interpret.
- Vague answers, open ended questions allow respondents to answer with vague details and limited information if they do not want to provide complete answers.

For the purpose of this study both open-ended and closed-ended questions will be used. According to White (2003 93) both open and closed questions should be used in a questionnaire but closed questions should dominate. The questionnaire should consist of a section of closed-ended questions suitable for statistical processing by computer and a section with open-ended questions that will be processed manually.

3.9 VALIDITY OF THE DATA COLLECTION INSTRUMENTS

Validity according to de Vos *et al.* (2012 172) "refers to truthfulness, accuracy, authenticity, genuineness and soundness as synonyms for validity, and stresses the fact that these terms describe what validity is about: that the test or instrument you are using actually measures what you need to have measured." In simple terms validity is concerned about whether the

research is believable and true and whether it is evaluating that which it is supposed to evaluate. Listed below are procedures that can be used to validate the instruments and the data for this research.

3.9.1 Content Validity

This is the type of validity in which different skills, behaviours and elements are adequately and effectively measured (Zohrabi 2013 258). The research instruments and the data is reviewed by the research expert in the field, unclear and obscure questions can be revised and complex items reworded. Further, questions which are ineffective and non-functioning can be discarded. In addition, the questions could be face validated by these persons.

3.9.2 Internal Validity

Internal validity is concerned with the degree to which the researcher observes and measures what is supposed to be measured (Zohrabi 2013 258). In order to boost the internal validity of the research instruments and the data, the researcher according to Merriam (1998) in Zohrabi (2013 258) may apply six methods; triangulation, members checks, long-term observation at research site, peer examination, participatory or collaborative modes of researcher's bias.

Triangulation will be discussed in detail as it was chosen as the best method to boost the internal validity of the research instruments and the data. In order to strengthen the validity of evaluation data and findings, for this study the researcher collected data through several sources, questionnaires and interviews. When a researcher gathers data through one technique it can be seen as a weak, bias or questionable study, unlike when a researcher collects information from a variety of sources and with a variety of techniques can confirm findings (Zohrabi 2013 258).

3.9.3 External Validity

External validity is concerned with the applicability of the finding of the research in other settings or with other subjects (Zohrabi 2013 258). In simpler terms it is the degree to which the conclusion of the study holds for other persons in other places and at other times.

3.10 RELIABILITY OF THE DATA COLLECTION INSTRUMENTS

Reliability according to de Vos *et al.* (2012 177) occurs when an instrument measures the same thing more than once and the outcome is always the same. Something which is

reliable will perform in future as it did in the past. Listed below are procedures to increase the reliability of measures (de Vos *et al.* 2012 177);

- Use two or more indicators for example using two or more questions in a questionnaire to measure each aspect of a variable.
- Eliminate items which are unclear because unclear items are unreliable and people may respond to those items differently at different times.
- Increase the level of measurement because indicators at higher or more precise levels of measurement are more likely to be reliable than less precise measures.
- Standardise the conditions under which the test is taken.
- Moderate the degree of difficulty of the instrument because any test that is too difficult or too easy does not reflect an accurate picture of one's performance.
- Use pre-tests, pilot studies and replications.

The more reliable a researchers instruments and observations, the more consistent and dependable the researchers results will be. The relationship between reliability and validity is thus straightforward, an instrument can be reliable but not valid, but an instrument cannot be valid without first being reliable.

3.11 POPULATION

A population is the totality of persons, events, organisation units, case records or other sampling units with which the research problem is concerned (de Vos *et al.* 2012 223). Hassan (2016) defines a research population as a well defined collection of individuals of objects known to have similar characteristics or traits. In this study the population is residents of Zamdela residing nearest to the chemical industry Sasol of all races, gender, educational status and socio – economic status.

3.11.1 The eligibility criteria

Eligibility criteria are characteristics that must be shared by all participants of a particular study (Roswell Park 2016). The eligibility criteria in this study were that the participants had to be residents of Zamdela residing nearest to the Sasol chemical industry and must be of the age of 18 and above.

3.12 THE SAMPLING PROCEDURE

De Vos *et al.* (2012 224) defines a sample as a small portion of the total set of objects, events or population from which a representative selection is made. Sampling is studied in an effort to understand the population from which it was drawn. A number of people residing nearest to the chemical plant of Sasol took part in the study to assess the level of preparedness to chemical hazard by residents of Zamdela. Time and money was saved by selecting a sample to be studied rather than attempting to study the entire population of Zamdela in respect to their level of preparedness to chemical hazard. Obtaining data from the entire population of Zamdela as well as analysing and interpreting vast amounts of data would have been impossible to accomplish within the time constraints and with the limited financial resources which were available for conducting this research.

3.12.1 Non-probability sampling

The odds of selecting a particular individual in a non-probability are not known because the researcher does not know the population size or the members of the population (de Vos *et al.* 2012 231). Each unit in a sampling frame does not have an equal chance of being selected for a particular study.

3.12.2 Convenience (Accidental) sample

De Vos *et al.* (2012 232) states that in a convenience sample the residents are usually those who are nearest and most easily available. Any case which happens to cross the researchers path and meets the criteria set for the study, gets included in a convenience sample. The risk of bias is greater in a convenience sample than in a random sample because each member of the population does not have an equal chance of being included in the sample.

3.12.3 The size of a sample

The general rule when it comes to sample is to always use the largest sample possible. A larger sample enables researchers to draw more representative and accurate conclusions and to make more accurate predictions than in a smaller sample (de Vos *et al.* 2012 224). In the study a convenient sample of 50 respondents has been obtained from residents of Zamdela who are residing nearest to the Sasol chemical plant. People who were available and willing, and met the criteria of the study, completed the questionnaire at the time when the researcher was conducting the research, where included in the sample.

3.13 DATA ANALYSIS

Although data analysis in quantitative study is a diverse and complex process, it has become relatively easy with clear instructions and the aid of computerised data analysis software. Quantitative data analysis by definition is the technique by which researchers convert data to a numerical form and subject it to statistical analysis (de Vos 2012 249). Data analysis is conducted to ensure that data is reduced to an intelligible and interpretable form so that the research problems can be studied and tested, and conclusions drawn. It is important to note that data analysis does not in itself provide the answers to research questions; answers can be found by interpretation of data and the results. Data can thus be analysed manually or by computer.

Analysis of data included gender, level of education, length of stay in Zamdela and the population's level of disaster awareness and preparedness to chemical hazard.

3.14 PILOT STUDY

De Vos *et al.* (2012 237) defines pilot study as small study conducted prior to a larger piece of research to determine whether the methodology, sampling, instruments and analysis are adequate and appropriate. The pilot study should check respondents understanding and ability to answer the questions highlight areas of confusion and errors, as well as providing an estimated average time for the completion of the questionnaire (Kirklees Council 2016 5). It is important that the investigation be executed in the same manner as is planned for the main investigation, if this is not done the pilot study will not be of much value (de Vos *et al.* 2012 241).

It is for this reason that the questionnaire used for this study was piloted. A sample of 30 employees who work at Metsimaholo Local Municipality (Sasolburg, Free State Province) were selected. After the questionnaires where completed without assistance, the employees where asked give their opinion with regards to the questionnaire. Attention was paid to the critique and suggestions given by the respondents; this enabled the researcher to design a better questionnaire.

3.15 ETHICAL CONSIDERATION

"Ethics is a set of moral principles which is suggested by an individual or group, is subsequently widely accepted and which offers rules and behavioural expectations about the most correct conduct towards experimental subjects and respondents, employers, sponsors,

other researchers, assistants and students" (de Vos 2012 114). Ethical principals should therefore be internalised in the personality of the researcher in such a way that it becomes part of their total lifestyle.

Ethical issues in the conducting of the research have been addressed in the following manner:

3.15.1 Voluntary participation

It was made clear to the respondents that the research was for academic purposes only and the respondents' participation in the study was absolutely voluntary, nobody was forced to participate.

3.15.2 Informed consent

The researcher informed the willing participants of the purpose, nature, data collection methods and extent of the research prior to commencement.

3.15.3 Deception of subjects and/or respondents

Adhering strictly to all the ethical guidelines serves as standards about honesty and trustworthiness of the data collection and the accompanying data analysis.

2.15.4 Violation of privacy/anonymity/confidentiality

The researcher ensured that total anonymity and confidentiality of the respondents will be maintained. The researcher made sure that names of respondents will not be used for any purpose nor will the information be shared that would reveal their identities in any way.

3.16 CONCLUSION

The focus of this chapter was on the procedures that the researcher followed in conducting this study. The chapter dealt with research design, addressing the population, sampling procedures, instruments for data collection and data collection procedures. In order to enhance the validity and reliability of researcher results, there where measures that where adhered to. Lastly, ethical concerns which could have hindered on the survey were attended to.

CHAPTER 4
DATA ANALYSIS AND INTERPRETATION OF RESULTS

4.1 INTRODUCTION

In this chapter the responses that were given by the respondents to the questions listed in the questionnaire will be presented, collated, analysed and interpreted. A total number of 58 questionnaires were received back out of the 70 that were distributed to residents in Zamdela living nearest to Sasol chemical plant, giving a total response rate of 83%. The questionnaire that was used in this study is grouped in two parts, Part A deals with the personal profile and educational background of the respondents and Part B deals with disaster preparedness and awareness levels of the respondents to chemical hazard in Zamdela. The data which was collected was entered as frequencies and converted to percentages to make the responses easy to compare and convenient to display as tables and figures.

4.2 PART A: PERSONAL PROFILES

The demographic profile of the respondents relates to information of the respondents in terms of gender, age, education and nature of residence. This information was used to determine whether the results were influenced by respondents' biographic information. Data is displayed in the graphs and tables below.

4.2.1 Gender

In question one of the questionnaire the respondents had to indicate their gender. According to Figure 4.1 below there are more female respondents (58.62%) than male respondents (41.38%) of residents who completed the questionnaires. According to the UNDP (2003), "gender determines what is expected, allowed and valued in a woman or a man in given context." Gender determines opportunities, responsibilities and resources as well as powers associated with being male or female. The combined effect of these differences means that men and boys and women and girls face different types and levels of exposure and vulnerability to hazard risks and disaster impacts and their ability to recover from it.

Women and girls tend to be the main victims of natural and manmade disasters especially during the day time, because women tend to spend more time indoors and near the house than their male relations, as men usual go to work during this time. In Bangladesh, amongst other countries, radios and televisions are not found in the homes of some families, therefore women and girls who are confined to the house have no access through radio or television to warning information (UNDP 2003).

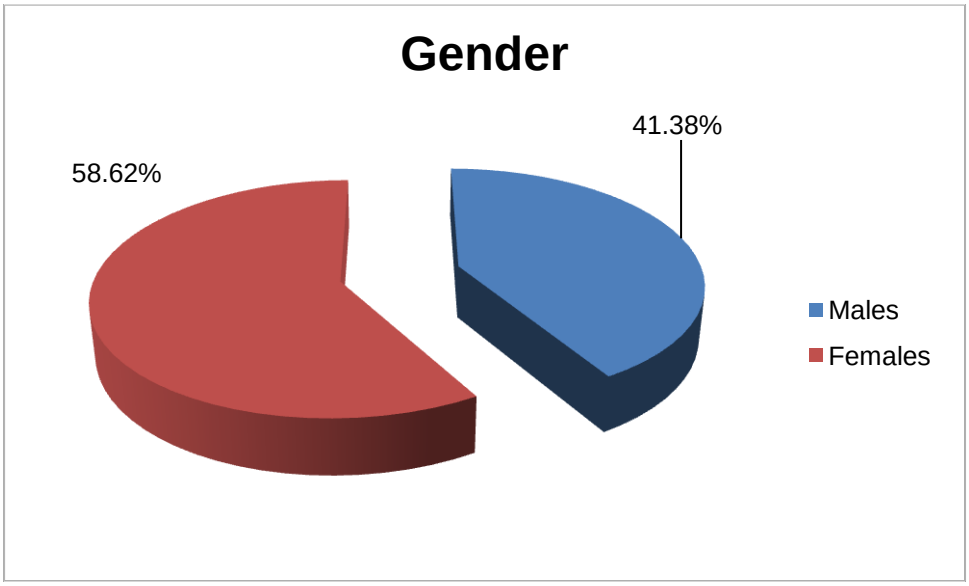

Figure 5: Gender of the participants in the study

4.2.2 Age Group

The respondents were requested to indicate their age group. A breakdown of the respondents' age is represented in Table 4.1 below. The results indicated that the majority (43.10%) of respondents who reside near Sasol chemical plant within this study are between 25-34 years old and the minority (6.90%) indicated that they are between 45-54 years old.

The children and the elderly are the most vulnerable groups in disaster events. Children in the youngest age groups do not have the ability to protect themselves during a disaster because they lack the necessary resources, knowledge or life experiences to effectively cope with the situation. The elderly living alone and people of any age having physical, sensory or cognitive challenges are also likely to be more vulnerable to disasters. These people have special needs that require the assistance of others, they might have great difficulty in receiving and interpreting warning information and taking protective actions.

Table 3: Age Group

Age	Frequency	Percentage (%)
18-24	12	20.69%
25-34	25	43.10%
35-44	12	20.69%
45-54	4	6.90%
55 & above	5	8.62%
Total	**58**	**100.00%**

4.2.3 Highest level of education

Respondents were asked to indicate their highest level of education and information, the results are reflected in Table 4.2 below. It is evident that 21 respondents have Grade 12 qualification (36.21%), followed by 19 respondents who have a tertiary qualification (32.76%). Only 1 respondent (1.72%) has a primary school qualification.

The relationship between education and vulnerability to disaster is not well understood, although education is associated with both income and poverty. People with higher levels of education are likelier to have access to and act upon varied hazard information from preparation to recovery (Flanagan, Gregory, Hallisey, Heitgerd and Lewis 2011). Muttarak & Pothisiri (2013 4) emphasis that education is a key tool to promote disaster preparedness because highly educated individuals are most likely to have better economic resources to undertake preparedness actions, and also education may influence cognitive elements and shape how individuals perceive and assess risk and how they process risk minimising information. Moreover, educated individuals are most likely to have more awareness of risks because they might have greater access to information sources and be better able to evaluate risk information.

Table 4: Highest level of education

Level of education	Frequency	Percentage (%)
Primary school	1	1.72%
Secondary school (excluding Grade 12)	17	29.31%
Grade 12	21	36.21%
A tertiary qualification	19	32.76%
Total	**58**	**100.00%**

4.2.4 Period residing in Zamdela

Respondents were asked to indicate how long they have been living in Zamdela. According to Figure 4.2 below, majority of respondents have been living in Zamdela for a period of 21 years and above (69.23%), followed by 18.46% who have been living in Zamdela for 11-20 years and the minority of respondents have been living in Zamdela for a maximum of 10 years and below (12.31%).

The majority of the respondents (69.23%) who took part in this study have been residing in Zamdela for 21 years and longer, meaning that the respondents might have indigenous knowledge which can be pasted down from generations in ways to deal with hazards. This sort of knowledge could contribute significantly to disaster risk reduction. The South African government in January 2003, promoted the Disaster Management Act 57 of 2002 (South Africa 2002). The Act recognised the critical role that traditional councils can play; one of the functions of traditional council is to promote indigenous knowledge systems for sustainable development and disaster management.

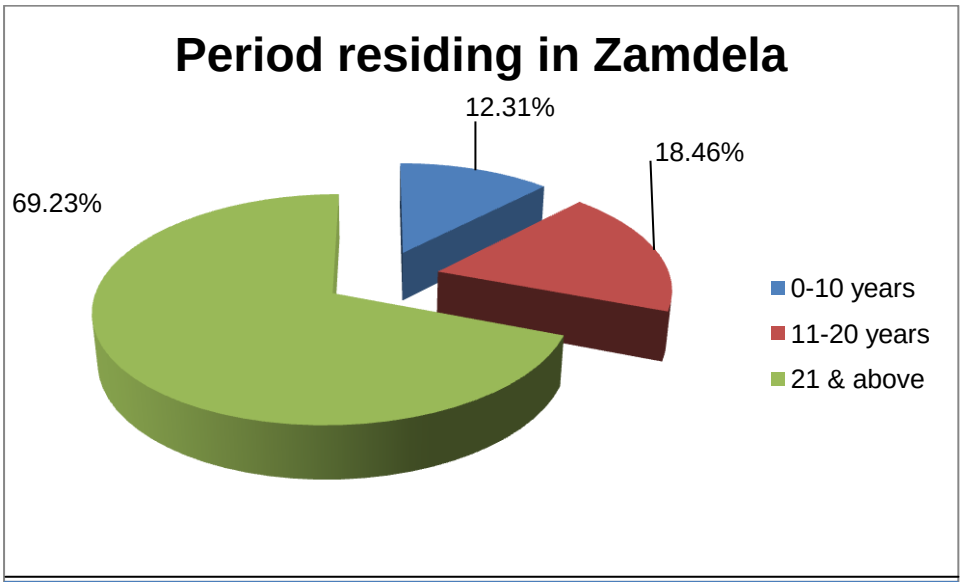

Figure 6: Period residing in Zamdela

4.2.5 The head of the household

Further, respondents were asked to indicate the head of their households. Table 4.3 indicate that majority of respondents households are headed by single fathers (37.93%), followed by 36.21% of household headed by single mothers and the minority of respondents households

are child headed households (1.72%). Single-parent households are vulnerable in a disaster because all the daily caretaker responsibility falls on one parent.

Table 5: The head of the household

Head of Household	Frequency	Percentage (%)
Child (including orphan's)	1	1.72%
Older person (above 55)	7	12.07%
Single mother	21	36.21%
Single father	22	37.93%
Both parents/partners	7	12.07%
Total	**58**	**100.00%**

4.3 PART B: DISASTER PREPAREDNESS AND AWARENESS

Communities can be affected by disasters at any time without warning. It is important that a community has a disaster preparedness plan which can respond to all the areas needs within the community during an emergency. Official help will not always be available immediately after a disaster and therefore it is imperative that a community is readily prepared.

A community taking time to develop a disaster preparedness plan can assist in quickly getting the community on the track to recovery following a disaster. For a community's preparedness plan to be successful, the entire community needs to be educated, informed and organised. Community members should not be ignored based on their literacy levels or their age. Part B of the questionnaire below, will look at assessing the level of the respondent's preparedness and awareness to chemical hazard in Zamdela.

4.3.1 Disaster preparedness meetings/trainings attended in the past twelve months

Respondents were asked to indicate meetings or training programmes that they have attended in the past 12 months to better prepare for a chemical disaster. Table 4.4 indicated that 50 out of 58 respondents have never attended any training or meeting for disaster preparedness in the past 12 months, a total sample size of 86.21% A meeting on how to better prepare for a chemical disaster was attended by 2 respondents (3.45%). First aid training was also attended by 2 respondents (3.45%). Further, training as part of a Community Emergency Response Team was attended by 1 respondent (1.72%).

It is imperative for a community to have disaster preparedness meetings and training so that a community's preparedness plan of action can be created. The community's preparedness plan of action can assist community members with the following:

- Establishment of local warning systems so that in the event of a disaster local radio stations can provide information on evacuation routes, temporary shelters and other emergency procedures.
- A neighbourhood directory can be created with contact details of community members including important numbers such as the local police department, local fire department and ambulance services.
- Community members with special needs can also be identified, these members can include the elderly, individuals whose hearing or mobility is impaired and children who are home alone most of the time.
- Community members with special skills or equipment can be identified, who might be able to assist during an emergency.

Table 6: Disaster preparedness meetings/trainings attended in the past twelve months

Disaster preparedness meetings/trainings	Frequency	Percentage (%)
Attended a meeting on how to be better prepared for a chemical disaster	2	3.45%
Attended first aid training	2	3.45%
Attended training as part of a Community Emergency Response Team (CERT)	1	1.72%
Two of the above	2	3.45%
Three of the above	1	1.72%
None of the above	50	86.21%
Total	**58**	**100.00%**

4.3.2 Institutions responsible for conducting disaster preparedness meetings/trainings

Respondents were asked to state which institutions where responsible for conducting the above mentioned trainings or meetings. Table 4.5 indicated that the above mentioned trainings or meetings were conducted by Red Cross Society (1.72%), 2 respondents mentioned that Sasol Mining was responsible for conducting their training or meetings (3.44%) and 3 respondents stated that their training or meetings were conducted by Sasol Company (5.17%). Only 1 respondent stated that their training or meetings were conducted by Kentucky Fried Chicken (1.72%).

Table 7: Institutions responsible for conducting disaster preparedness meetings/trainings

Institution	Frequency	Percentage (%)
Kentucky Fried Chicken	1	1.72%
None	51	87.95%
Red Cross Society	1	1.72%
Sasol Company	3	5.17%
Sasol Mining	2	3.44%
Total	**58**	**100.00%**

4.3.3 Preparedness levels for chemical disaster

Respondents were asked how being better prepared for a disaster will assist them in time of a chemical disaster. Table 4.6 below indicated that 12.07% respondents said that being prepared for a chemical disaster would assist in helping them identify places of safety. There were 51 respondents (87.93%) who did not respond to this question when they were completing the questionnaire. The lack of response from respondents may have been brought by the fact that respondents did not understand the question or those who understood the question might have felt that answering the question would have been too much of an effort.

Table 8: Preparedness levels for chemical disaster

Preparedness for chemical disaster	Frequency	Percentage (%)
Help identify places of safety	7	12.07%
None	51	87.93%
Total	**58**	**100.00%**

4.4.4 Confidence in knowledge of chemical hazard

Respondents were asked to measure their level of confidents in knowledge of hazard by using frequency "*Very Confident*" (1), "*Partially Confident*" (2) or "*Not at all Confident*" (3). Figure 4.3 below indicates that majority (82.69%) of respondents were not at all confident in their knowledge of chemical hazard. Only 15.38% were partially confident in their knowledge of chemical hazard and the minority (1.92%) were confident in their knowledge of chemical hazard. Respondents lack confidence in knowledge of chemical hazard, they are not aware of its intensity, frequency or probability.

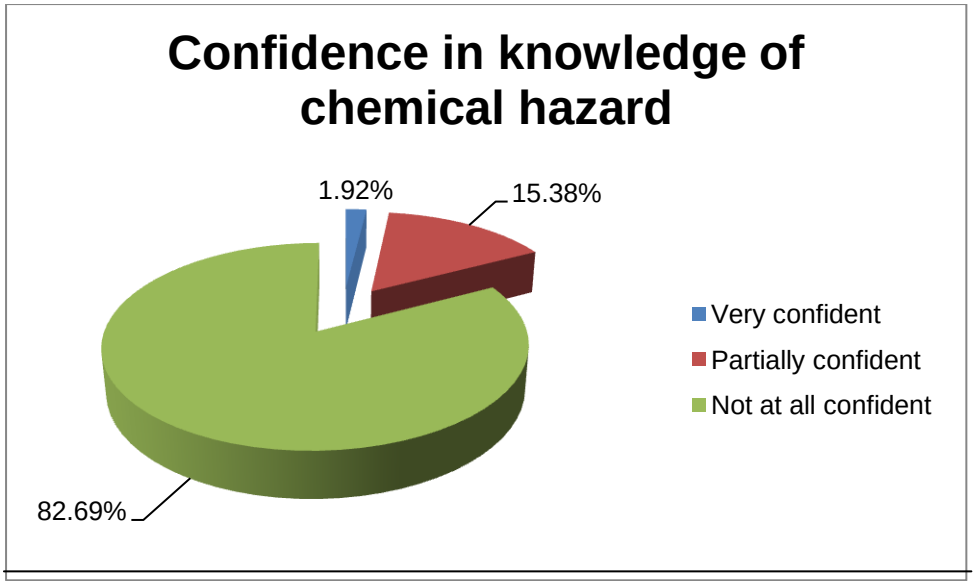

Figure 7: Confidence in knowledge of chemical hazard

4.3.5 Confidence in sources of disaster information

Respondents were asked to measure their level of confidents in sources of disaster information by using frequency "*Very Confident*" (1), "*Partially Confident*" (2) or "*Not at all Confident*" (3). The benchmark in terms of responses for every statement is marked (filled in green) in Table 4.7 below. In this section the response benchmark for majority of the statements is three (3) *"Not at all Confident"*.

Respondents indicated that they were partially confident in disaster information that they received from local media (43.10%), this includes disaster news from the local newspaper and local radio station. Respondents had no confidence at all in sources of disaster information from local government officials (60.34%) these being the municipal employees of the local municipality, the respondents were also not at all confident in the local government website (58.62%) being the local municipality's website and local health care providers (48.27%) such as the local nurses and doctors. Furthermore, respondents also had little to no confidence in neighbourhood associations (60.34%) and religious organisations (41.38) comprising of local churches. Furthermore respondents were partially confident in receiving information relating to disaster from friends and family members (39.66).

One can therefore come to the conclusion that based on table 4.7 below, the majority of respondents had no confidence in the listed institutions relaying disaster related information to them. However local media was listed as the few institutions which the respondents had

partial confidence in relaying disaster related information. Kakonge (2012) states that in Africa, the media plays a vital role in educating and informing the public about issues and events particularly in times of disasters, both by reporting the event itself and acting as a catalyst for evoking responses.

Table 9: Confidence in sources of disaster information

Local Media	Frequency	Percentage (%)	Local Government Officials	Frequency	Percentage (%)
Very confident	15	25.86%	Very confident	12	20.69%
Partially confident	25	43.10%	Partially confident	11	18.97%
Not at all confident	18	31.04%	Not at all confident	35	60.34%
Total	**58**	**100.00%**	**Total**	**58**	**100.00%**
Local Government Website	**Frequency**	**Percentage (%)**	**Local health care providers**	**Frequency**	**Percentage (%)**
Very confident	7	12.07%	Very confident	19	32.76%
Partially confident	17	29.31%	Partially confident	11	18.97%
Not at all confident	34	58.62%	Not at all confident	28	48.27%
Total	**58**	**100.00%**	**Total**	**58**	**100.00%**
Neighbourhood Associations	**Frequency**	**Percentage (%)**	**Religious Organisations**	**Frequency**	**Percentage (%)**
Very confident	14	24.14%	Very confident	19	32.76%
Partially confident	9	15.52%	Partially confident	15	25.86%
Not at all confident	35	60.34%	Not at all confident	24	41.38%
Total	**58**	**100.00%**	**Total**	**58**	**100.00%**
Friends or Family Members	**Frequency**	**Percentage (%)**			
Very confident	18	31.03%			
Partially confident	23	39.66%			
Not at all confident	17	29.31%			
Total	**58**	**100.00%**			

4.4.6 Sources that have given information about chemical disaster in the past twelve months

Respondents were asked to indicate which sources have given information about chemical disaster in the past twelve months. Table 4.8 below shows that majority (82.75%) of respondents indicated that none of the mentioned source have given information about chemical disaster in the past twelve months.

It is important that sources of disaster information form part of the disaster preparedness team prior to a disaster event, this will ensure that these sources are brought into disaster planning and that their coverage is informed and accurate. The main role of sources of disaster information is to ensure that there is a pathway of information dissemination. These sources provide an important disaster management public service, especially is broadcasting alerts, warnings and advisories.

Table 10: Sources that have given information about chemical disaster in the past twelve months

Sources	Frequency	Percentage (%)
Local Media	3	5.17%
Local Government Website	2	3.45%
Local Health Care Provider	1	1.72%
Neighbourhood Association	1	1.72%
Friends or Family Members	3	5.17%
None	48	82.75%
Total	**58**	**100.00%**

4.4.7 Volunteering in chemical disaster

Respondents were asked to indicate whether they have ever volunteered in a chemical disaster before. Figure 4.4 below indicated that none of the respondents have ever volunteered in a chemical disaster before (100.00%). Volunteering is the principal of committing time and energy for the benefit of society and the community, the environment or people outside one's immediate family, without expectation or concern for financial gain (The Free Dictionary 2016).

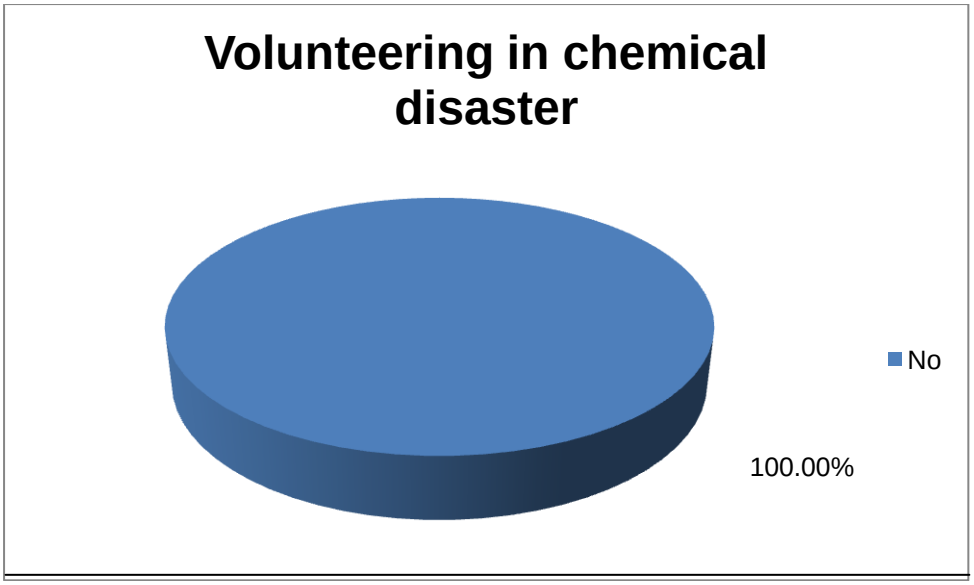

Figure 8: Volunteering in chemical disaster

4.4.8 Best alarm method in case of a chemical disaster

Respondents were asked to indicate the best method to be used as notification in time of a chemical disaster. Table 4.9 below indicates that majority (32.76%) of respondents preferred to be notified by the local radio in time of chemical disaster, followed by 29.31% whom would like to be notified by a siren. The minority indicated that they would like to be notified of chemical disaster by telephone (3.45%). Early warning is a major element of disaster risk reduction, early warning alarm methods can often prevent a hazard turning into a human disaster by preventing loss of life and reducing the economic and material impacts.

Table 11: Best alarm method in case of a chemical disaster

Best chemical disaster alarm method	Frequency	Percentage (%)
Local Radio	19	32.76%
Telephone	2	3.45%
Siren	17	29.31%
Door to Door	5	8.62%
Social Media	9	15.52%
Local Police and Fire	6	10.34%
Total	**58**	**100.00%**

4.4.9 Best disaster preparedness education aid

Respondents were asked to indicate the best way they would prefer to be taught about disaster preparedness. Table 4.10 below indicates majority (79.31%) of respondents prefer to be taught by means of workshops, followed by videos (12.07%) and the minority (8.62%) prefer to be taught by means of flyers.

The preference for workshops might stem from the fact that workshops are more interactive, community members will be able to ask questions were they lack understanding, residents that are not able to read or write will be accommodate for and different languages can also be catered for. Disaster education interventions can be influential in raising awareness and knowledge of disaster, which assists in enhancing disaster preparedness (Muttarak & Pothisiri 2013 4). Finding the best teaching method for disaster preparedness can provide lifesaving and life sustaining information and skills that can protect a community.

Table 12: Best disaster preparedness education aid

Best teaching method	Frequency	Percentage (%)
Flyers	5	8.62%
Workshops	46	79.31%
Videos	7	12.07%
Total	**58**	**100.00%**

4.4.10 Best place to receive disaster preparedness information

Respondents were asked to indicate the best place to receive information about disaster preparedness. Figure 4.5 below indicates that majority (33.33%) of respondents prefer to receive information at the town hall followed by respondents indicating that they would prefer to receive information about disaster preparedness in their neighbourhood (27.78%) and church (12.35%).

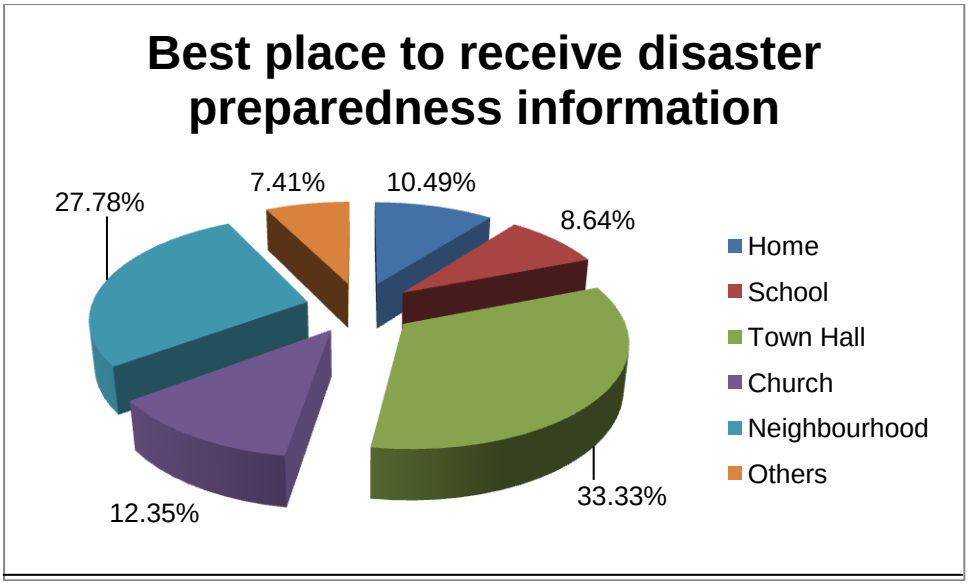

Figure 9: Best place to receive disaster preparedness information

4.5 Conclusion

Listed below is each topic outcome from the questionnaires that were distributed to residents residing nearest to Sasol chemical plant:

- There is a need for preparedness and awareness programmes to accommodate the differences between women and girls and men and boys, if women and girls are left out of planning for disaster than their needs are unlikely to be met.
- A disaster preparedness plan should be designed in a way that children and the elderly are incorporated into disaster scenario exercises.
- Respondents in Zamdela whom have obtained a tertiary qualification may have the cognitive ability to be trained to assist when it comes to educating community members on chemical hazard and the importance of developing a community based disaster preparedness plan. Furthermore, traditional authorities and communities have a critical role to play in terms of disaster risk reduction.
- With the appropriate political support and disaster preparedness education, single-parent headed households have the potential to have a huge influence in community decision making, especially when coming to disaster related issues.
- For the safety and well being of community members residing nearest to the Sasol plant, Sasol together with the local municipality can have an awareness campaign to educate the community about a preparedness plan of action.
- Sasol Company and the local municipality can form part of a stakeholder's database for training community members in Zamdela on disaster related issues as well as

evacuation measures, first aid and Cardiopulmonary Resuscitation (CPR) training. This kind of initiate will improve the capacity and resilience of the community members of Zamdela to chemical hazard.

- It is imperative that education and training on disaster preparedness be given to community members in Zamdela. This will assist in saving lives in time of disaster, meeting humanitarian needs (such as food, shelter, clothing, public health and safety), assessing damage and distribution of resources.
- Awareness in Zamdela should focus on educating the community on what chemical hazard is, the impact thereof and ways in which residents can be prepared in case a chemical disaster occurs.
- The local media in Zamdela can be a vital actor for issuing warnings of chemical disaster to government officials, relief organisations and the public as well as for gathering and transmitting information about affected areas and for facilitating community based discussions about disaster preparedness and response.
- Sources of disaster information can assist by supplying needed information to decision makers and the effected public as well as disseminating information on preparedness measures for chemical disaster, stimulate volunteerism and donations and the disclosure of the need for improvement in government response.
- Community members are usually the first on the scene in an emergency or disaster and remain long after official services have left, community members in Zamdela can play a vital role in helping those affected to respond and recover and can provide invaluable assistance to official agencies.
- For effective and sustainable early warning systems, communities at risk need to be actively involved to ensure that there is no limitation in early warning systems when coming to saving lives. Therefore, community members of Zamdela together with Sasol and the municipality need to ensure that early warning systems are understandable, trusted and relevant to the at risk community, for them to be effective.
- Furthermore, with the right educational aid the community will have an increase in their general knowledge that could in turn influence values and capacity to plan for the future and improve allocation of resources.
- Sasol Company together with the local municipality and sourced stakeholders could train community members on disaster preparedness at their nearest town hall as well as distribute flyers to the resident’s homes.

To conclude community members in Zamdela lack the capacity to deal with chemical hazard. There is a need for public awareness campaigns that will focus on educational

campaigns, public consultation through relevant structures and through media coverage. It is important to note that in order for a disaster preparedness plan to work proper community based planning needs to occur, coupled with a well established resource base, warning and response systems as well as public education and training of community members.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter will attempt to revisit the purpose of the study in order to ascertain whether it has been achieved or not. Problem statements were posed in the first chapter of this study, these problem statements needed to be answered as the study unfolded. This chapter will therefore discuss whether the literature review and the questionnaires that were administrated in this study contributed in answering the problem statements on which this study was based.

This chapter will provide information regarding the following:

- An overview of the study
- Findings from the literature review
- Findings from the empirical research
- Findings in relation to the objectives of the study
- Conclusion
- Recommendations

5.2 AN OVERVIEW OF THE STUDY

This section will provide an overview of the preceding chapters of this study. The purpose here is to focus the reader's mind on the important aspects of each chapter thereby ensuring that the findings and the recommendations that following make a meaningful link.

5.2.1 Chapter One

The problem statement, which is that chemical industries make certain that the chemical components that they use remain, disclosed to the public, these chemical components have a negative effect on the health of community members and the environment. Activities that take place within the borders of chemical industries are rarely disclosed, risking the lives of community members living nearest to the chemical plants. It is the duty of government to ensure that there is a disaster management plan in place that will make certain that a community is able to prepare in case a chemical disaster occurs. The lack of communication

by Sasol Company and Metsimaholo local municipality regarding the activities at the plant has left community members in Zamdela exposed, resulting in residents not being aware of the necessary steps that they need to take in case a chemical disaster were to occur.

The primary objective of this study is to assess the level of preparedness of community members in Zamdela to chemical hazard, in order to enhance Metsimaholo's local municipality performance to responding and recovering from a chemical disaster.

The secondary objectives of the study are to determine the level of vulnerability to chemical hazard for residents in Zamdela, to determine the awareness level of residents in Zamdela to chemical hazard as well as to determining the role that Metsimaholo local municipality can play when coming to risk reduction measures.

In order to assess preparedness of community members in Zamdela residing nearest to the chemical plant, questionnaires were distributed personally, with the help of two assistants, among the respondents and the completed questionnaires were collected after completion.

5.2.2 Chapter Two

Chapter two outlines the literature review, literature such as articles, acts, policies, textbooks etc. were used. Kolanchu (2011 20) states that, the threats of chemical hazards are complex, they are not well understood and prepared for, they require specialised protective measures which are often a challenge for communities living closest to the refinery plants. When chemicals leak out of a refinery, one never knows if they are exposed. Many of the chemicals from refineries pose serious health hazards even at very low levels of exposure and some can build up in the environment contaminating soil, fish and even household dust.

Section 24 of the Constitution of the Republic of South Africa states that everybody has the right to an environment that is not harmful to human health or well – being (Republic of South Africa 1996). Further, Section 32 of the Constitution speaks of the right to access to information, which is important for environmental issues. The Constitution guarantees every person the right to access to information held by government or any other person that is required for the protection of any rights. A duty is therefore placed on all spheres of government to take reasonable steps, to make laws, prevent pollution, promote conservation and ensure sustainable development.

The Air Quality Act sets out to protect and enhance air quality in South Africa and to secure ecologically sustainable development through reasonable air pollution prevention measures (Republic of South Africa 2004). This can be achieved by involving all spheres of

government and the development of air quality management plans. The main concern when it comes to air pollution is the amount of pollution that reaches the ground level, where it is then inhaled by humans. Majority of residents in Zamdela suffer from irritation of the eyes, noses and throats due to the emission of chemicals.

In order for proper disaster preparedness, better warning and reduced vulnerability to occur in a community, appropriate action needs to be taken at all phases of the disaster management cycle. Each phase of the cycle has particular needs, strategies, requires distinct tools, resources and faces different challenges. The complete disaster management cycle includes the shaping of public policies and plans that either modify the causes of disasters or mitigate their effects on property, infrastructure and people.

The disaster preparedness framework outlines activities that are essential to the development of a preparedness strategy (Kent 1994 15). It is important to note that activities listed in the framework might not be implemented in the listed sequence, some activities might occur simultaneously or in reverse order. It is imperative that a community has a map that illustrates places of vulnerability, possible hazards and places of safety in case a disaster where to occur. The local municipality should have reliable stakeholders, who know their responsibilities to make sure that there is coordinated response. Existing institutions within a community should be strengthened by involving community leaders when preparing for a disaster and a budget should be set aside for relief and preparedness programmes.

A community should have an effective early warning system that can warn a population in advance of likely hazards, and enables risks and losses to be mitigated through preparation measures and response action. It is essential that an early warning system be considered as a Complete Early Warning, Preparedness and Response System. The protection of lives and livelihoods from known hazards while minimising negative impacts on the economy and the environment is the main purpose of having an early warning system. For an early warning system to be effective, it needs to be people centred. An early warning system must empower communities and individuals that are threatened or at risk, to act in sufficient time and in an appropriate manner in order to reduce the likelihood of injury, loss of life and damage of property and livelihood.

5.2.3 Chapter Three

Chapter three looks into the empirical research design that was used in this study to investigate the research problem. There was a detailed discussion of the choice of research design and the data collection instrument and the motivation of the implementation of

quantitative survey research by means of questionnaires. A quantitative approach was chosen for the purpose of this study as it was the researcher's intent to establish and confirm a given situation in Zamdela through the opinions of the residents regarding their level of preparedness to chemical hazard.

5.2.4 Chapter Four

In this chapter the data collected from the questionnaires were analysed and interpreted. The findings show that people in Zamdela residing nearest to the chemical plant lack preparedness when it comes to chemical hazard.

5.3 FINDINGS FROM THE EMPIRICAL RESEARCH

It was found that more than 60% of the respondents in this study (86.21%) indicated that they have never attended a meeting or had training for chemical disaster preparedness. It was further found that only 8.62% of respondents attended chemical disaster preparedness training, first aid training and training to form part of a Community Emergency Response Team (refer to table 6).

Respondents in this study indicated with a high percentage, more than 60% that they have little to no knowledge of the importance of being prepared for a chemical disaster. Less than 20% of respondents said that being prepared for a disaster would assist them in identifying places of safety (refer to table 8).

It was also found that more than 80% of respondents indicated that they were not at all confident in their knowledge of chemical disaster and less than 2% of respondents were very confident in their knowledge of chemical disaster (refer to figure 7).

Majority of respondents in this study (more than 40%) indicated that they are not at all confident in the following sources of disaster information: local government officials, local government website, local health care providers, neighbourhood associations and religious organisations (refer to table 9). Further, more than 40% of respondents indicated (43.10%) that they were partially confident in local media as a source of disaster information.

A large number of respondents in this study (more than 80%) indicated that there were no sources that gave out information about chemical disaster in the past twelve months (refer to table 10). Further, all the respondents in this study (100%) indicated that they have never volunteered in a chemical disaster before (refer to figure 8).

Over 20% of respondents indicated that they would prefer to be warned about a chemical disaster through the local radio or by siren. Minority of respondents in this study (less than 10%) indicated that they would prefer to be warned by use of telephone or the response team warning people door-to-door (refer to table 11).

Respondents in this study (79.31%) indicated that the best way that they can be taught about chemical disaster is through the use of workshops (refer to table 12). Further, majority of respondents (33.33%) indicated that they would prefer to receive disaster related information at their town hall.

5.4 FINDINGS IN RELATION TO THE OBJECTIVES OF THE STUDY

5.4.1 The primary objective of this study was to assess the level of preparedness of community members in Zamdela Township to chemical hazard, in order to enhance Metsimaholo's local municipality performance to responding and recovering from a chemical disaster.

This was attained through the responses by the participants in this study to the questionnaire. It was found that a large number of respondents indicated that they have not attended a disaster preparedness meeting or training in the past twelve months (see tables 6).

A large number of participants further indicated that there has not been any source that has given information on preparing for a disaster in the past twelve months (see table 10). A large number also indicated that they lack confidence in sources of disaster information (see table 9).

5.4.2 The following were the secondary objectives of the study

- to determine the level of vulnerability to chemical hazard for residents in Zamdela.
This secondary objective was attained through the literature that was used for this study. The importance of assessing vulnerability within a community before compiling a disaster management plan was discusses (chapter 2, 2.6.1). Assessing vulnerability will assist in informing decision makers about the utility of local level approaches to disaster preparedness and the development of a database through vulnerability assessment.

- to determine the awareness level of residents in Zamdela to chemical hazard. This secondary objective was also attained through the literature that was used for this study. The importance of early warning systems was discusses as well as the four inter-related

elements, the basic principles of early warning systems and the key actors in early warning systems (see chapter 2, 2.7. 2.7.1-2.7.3)

- determining the role that Metsimaholo Local Municipality can play when it comes to risk reduction measures. This secondary objective was also attained through the literature review that was used for this study. The municipality needs to develop a disaster management plan that will assist the municipality as well as residents in Zamdela in preparing for a chemical disaster. The plan must have set objectives, assign specific tasks and responsibilities and integrate its activities, tasks and responsibilities to enable the overall objective or set of objectives to be achieved (see chapter 2, 2.6.2).

5.5 CONCLUSION

The problem statement depicted the lack of preparedness of community members in Zamdela to chemical hazard. There is a need for clear communication channels between the community, the municipality and Sasol Company regarding chemical hazard.

Reliable and accurate knowledge of chemical impact is imperative because decision makers allocate scarce resources to chemical hazard events on the basis of their interpretation of trends in and causes of the impacts and their expectations for the future.

The wrongs of the past need to be corrected, after the Sasolburg Air Quality Monitoring Committee with the help of GroundWork monitored the air quality in Zamdela and put its findings forward to the Parliament during the Air Quality Act hearing, it was found that the air that residents in Zamdela were breathing was not conducive to human health and wellbeing (refer to chapter 2, 2.3). There is a need for a transparent system where the needs of community members are put before those of business persons. The Disaster Management Act (Republic of South Africa 2002) states that preparedness enables organs of state and other institutions involved in disaster risk management, the private sector, communities and individuals to mobilise, organise and provide relief measures to deal with impending or occurring disaster or the effects of a disaster.

Local municipality is the sphere of government that is the closest to the people, making it somewhat the most important sphere of government because it provides for basic services that determine the quality of South Africans everyday lives. This should therefore make it easier for local community members to work hand-in-hand with the local municipality to solve local problems.

5.6 RECOMMENDATIONS

To assist residents in Zamdela to better prepare for a chemical disaster, the researcher recommends the following:

5.6.1 Disaster Preparedness Planning

Disaster preparedness can be viewed as measures that is taken to prepare for and reduce the effects of a disaster thereby predicting and where possible preventing disasters as well as mitigating their impact on the vulnerable population and respond to and effectively cope with their consequences allowing the affected community to get back to normalcy within a short time period (IFRC 2016). Disaster preparedness serves as a temporal connector between the pre-impact phases (hazard vulnerability analysis and mitigation) and post-impact phases (response and recovery). Further, preparedness planning ensures that the resources necessary for responding effectively in the event of a disaster are in place and those who have to respond know how to best use those resources (Sutton and Tierney 2006 3).

Metsimaholo local municipality, Sasol Company together with community members of Zamdela should ensure that they develop a disaster preparedness plan. The plan should include:

- The purpose of the emergency plan
- The formation of an emergency team and its chain of command
- The formation of emergency shelter and public evacuation routes
- Instructions, activities and immediate resources for the emergency team
- Inventories of assets, expected actions and controls
- Inventories of resources

This will ensure that in time of a chemical disaster community members will know what needs to be done, how, when and by whom before and after a chemical disaster.

Essential resources such as disaster relief and preparedness funding should be planned for as well as resources such as food, water, medication, blankets etc should be stockpiled to ensure that they are readily available in time of a disaster. The emergency response team should be trained on how to adequately use the resources.

5.6.2 People Centred Early Warning System

People centred early warning systems will empower communities and individuals who are threatened by hazards to act in an appropriate and timely manner in order to ensure the reduction of possible personal injury, loss of life and damage to property and the environment (EWC III 2006 2). Early warning messages must be clear and contain simple useful information in order to enable proper responses that will help safeguard lives and livelihoods. It is important that communities understand their risks, respect the warning service and know how to react.

Listed below are the elements that should be included in the early warning system for community members in Zamdela to warn them of possible chemical disaster:

- Hazard mapping, Sasol Company's underground grass pipes can be shown on the map, these maps can therefore be distributed to residence making them aware of hazardous parameters and available escape routes. The hazardous parameters should be continuously monitored.
- Local, provincial and national community level communication systems should be identified and voices of authority established, this will allow for clear communication at all spheres of government in time of disaster.
- Multi-channel communication should be established, such as the use of the local newspapers in Sasolburg, local radio station (Karabo FM), local municipality's website, Councillors public meetings and flyers. The multi-channel communication can be used to educate community members of safe behaviour, available escape routes and how to avoid damage or loss of property when a chemical disaster occurs.

Identified below are key role players that can ensure an effective early warning system:

- Community members in Zamdela residing near the chemical plant should be involved in all the aspects of the establishment and operation of early warning systems as well as be aware of the potential hazard impacts that they are exposed to so that they will be able to take action to mitigate the threat of loss and damage.
- Metsimaholo local municipality should be at the centre of effective early warning systems. They should be empowered by the provincial government and have considerable knowledge of chemical hazards and be involved in the design and maintenance of early warning systems. The municipality must understand advisory information received and be able to advise, instruct and engage the community

members in Zamdela in a manner that increases public safety and reduces the possible loss of resources on which the community depends.

- Non – governmental organisations in Zamdela should be identified because they play a role in raising awareness among communities, individuals and organisations involved in early warning, at community level. They can also assist in implementing early warning systems and in disaster preparedness. They can also play a role to help ensure that early warning stays on the agenda of government policy makers.
- Private sector such as local business owners can help by providing skilled services in form of technical manpower, know – how or donations (in-kind and cash) of goods or services.

5.6.3 Public Awareness Campaign

Public awareness is the extent of common knowledge about disaster risks, the factors that lead to disasters and the actions that can be taken, individually and collectively, to reduce exposure and vulnerability to hazards (IFRC 2011 5). Public awareness and education campaign can be started modestly and tailored to meet the needs of the population and its risks. They can build on and support existing volunteer mobilization and peer-to-peer communications. To support this, there will be a need for strong and unified disaster risk reduction messages and clear and targeted information, education and communication materials.

Campaigns are hosted to provide uniform, large scale impact with standard messages (IFRC 2011 23). Metsimaholo local municipality together with Sasol Company can hold public awareness campaigns which may include the following activities:

- Publicize means in which community members can prepare for chemical hazard by using the following - posters, local newspapers, information cards, flyers.
- Oral presentations on disaster preparedness can be hosted in the local halls in Zamdela, Ward Councillors can be included to lobby community members attendance.
- Zamdela’s Arts and Culture centre can assist by hosting a performance and cultural arts show were local community members can perform plays that can educate community members of chemical hazard and the preparation thereof. Local arts and crafts can be sold during the shows to raise funds for disaster preparedness.
- Competitions for community members can be held, where they get quizzed on their knowledge of chemical hazard, prizes can be given. This will entice community members thereby increasing their need to learn about chemical hazard.

- A local website can be created by Sasol Company informing community members about their chemicals and various preparedness measures that they can take as well as have a complaints section including a question and answer section for community members who might need clarity on certain issues.

In order for public awareness campaign to be successful they need sustained messages repeated over a long period of time through activities in the public, education and private sector.

5.6.4 Involvement of Community members

Involvement of community members in disaster management increase their capacities for producing things that they need and for managing their political and social lives as they desire and at the same time reduce their immediate and long-term vulnerabilities to events that threaten their economic and socio-political existence (Ahmed 2015).

Community members in Zamdela are the main actors and propellers, they share in the benefits of disaster risk reduction and development. Community members can take part in and implement pre-, during and post-disaster measures thereby increasing people's capacities and options. Residence are therefore better able to control resources, take part in decision making which affects their lives, have more control over the natural and physical environment and ultimately have the confidence to participate in disaster mitigation and risk reduction.

5.6.5 Training of volunteers

The Disaster Management Act 57 (Republic of South Africa 2002), clearly states that the local municipality needs to establish a unit of volunteers who will participate in disaster management in the local municipality during a disaster. It is the duty of the local municipality to identify needs and organise the hands-on training to volunteers.

Currently Metsimaholo local municipality does not have volunteers to assist in case a chemical disaster occurs. It is imperative that the municipality have its own volunteers who will be registered and trained so that it is ease to work and avoid havoc during a chemical disaster.

BIBLIOGRAPHY

Ahmed, Z. 2015. Why is it important to have a community-based disaster management? [Online]. University of Dhaka. Retrieved from: http://www.quora.com (19 January 2017).

Alberts, G. 2014. A Managerial Model for Mergers in Local Government in the Free State Province. North West University (Thesis PhD).

Andrew, C. 2011. The benefits of open-ended questions [Online]. Retrieved from: https://en.over-blog.com/The_benefits_of_openended_questions-1228321782-art342678.html (29 July 2016).

Babbie, E. 2007. The Basics of Social Research. New York, NY: Wadsworth/Thomson Learning.

Basic Law for Environmental Pollution Control. 1967. Japan.

Boote, D.N. & Beile, P. 2005. Purpose of Literature Review [Online]. Retrieved from: http://library.queensu.ca/webedu/grad/Purpose_of_the_Literature_Review.pdf (25 May 2016).

Caribbean Youth Environment Network. 2015. CYEN [Online]. Retrieved from: http://www.cyen.org/innovaeditor/assets/Disaster_Management_Notes_and_Questions.pdf. (4 July 2015).

Causes and Effects of Industrial Pollution – Conserve Energy Future. 2015. Industrial Pollution. [Online]. Retrieved from: http://www.conserve-energy-future.com/causes-effects-of-industrial-pollution.php (18 March 2015).

Chemical Substances Control Law (CSCL). 2011. Japan.

Crossman, A. Types of Sample Designs [Online]. Retrieved from: http://www.sociology.about.com/od/Research/a/sampling-design.htm (22 April 2014).

De Vos, A.S. Strydom, H. Fouché, C.B. & Delport, C.S.L. 2011. Research at Grass Roots: For the Social Sciences and Human Service Professions. 4th ed. Pretoria.

Developing Early Warning Systems: A Checklist. 2006. EWC III Third International Conference on Early Warning: From concept to action. Bonn, Germany.

DFID: Department for International Development. 1999. Sustainable Livelihoods Guidance Sheet.

Disaster Awareness and Preparedness Strategy. 2012. Banks County LEOP [Online]. Retrieved from: www.co.banks.ga.us/dept-ema3_4_4294208927.pdf (4 July 2015).

Disaster Management Cycle. 2015. Community Organisations Active in Disaster (SMCOAD) [Online]. Retrieved from: http://www.southernmainecoad.org/disaster-management.html (4 July 2015).

Disaster Management Framework. 2014. Centre for Management of Environmental and Disaster [Online]. Retrieved from: http://www.slideshare.net/sachinsinghshekhawat/disaster-management-an-overview (4 July 2015).

Disaster Preparedness for Effective Response (HEA). 2008. Guidance and Indicator Package for Implementing Priority Five of the Hyogo Framework.

Disaster Preparedness Framework. 2014. Centre for Management of Environment and Disasters [Online]. Retrieved from: http://www.slideshare.net/nandeesh1/disaster-overview (25 May 2016).

Early Warning Systems Framework. 2013. United Nations Development Programme (UNDP). Guyana.

Earthjustice. 2014. Community Impact Report: The Toll of Refineries on Fenceline Communities.

Environmental Health Fact Sheet. 2013. Department of Environmental Services (DES) [Online]. Retrieved from: www.des.gov (22 April 2014).

Flanagan, B.E. Gregory, E.W. Hallisey, E.J. Heitgerd, J.L. and Lewis, B. 2011. Journal of homeland security and emergency management. A social vulnerability index for disaster management [Online]. Vol. 8 Art. 3. Berkeley Electronic Press. Retrieved from: http://gis.cdc.gov/grasp/svi/A%20Social%20Vulnerability%20Index%20for%20Disaster%20Management.pdf (24 October 2016).

Google Map, 2014. Map of Zamdela Township and Sasol's Oil Refinery [Online]. Retrieved from: www.googlemap.com (1 December 2014).

Groundwork. 2015. Environmental Justice Action. Centre for Environmental Rights [Online]. Retrieved from: http://www.groundwork.org.za (29 July 2016).

Hallowes, D. & Munnik, V. 2006. Poisoned Spaces: Manufacturing wealth, producing poverty. The Groundwork Report.

Hassan, M.A. 2016. Research Population [Online]. Retrieved from: http://www.academia.edu/5563491/Research_Population (29 July 2016).

Hopkins, J. 2006. Disaster definitions: Public health guide for emergencies. International Federation of Red Cross and Red Crescent Societies.

Horst, H. Martens, R. 2015. Close-Ended Questions. University of Twente [Online]. Retrieved from: https://www.utwente.nl/ces/toetsing/Docenten/testing-grading/job-aid/closed-ended-questions/ (29 July 2016).

Immunize for a Healthy Future: Children's Environmental Health 2014.[Online]. Retrieved from: http://www.who.int/ceh/risks/cehchemicals/en/ (22 April 2014).

Information For Action (IFA). 2015. Harmful Chemicals in our Environment. Plant Agenda. [Online]. Retrieved from: http://www.planetagenda.com/chemicals.htm (18 March 2015).

International Development Exchange (IDEX). 2016. South Durban Community Environmental Alliance (SDCEA) [Online]. Retrieved from: http://www.idex.org/partners/south-africa/sdcea/ (25 May 2016).

Introduction to Disaster Preparedness. 2000. Disaster Preparedness Training Programme: Risk Reduction. International Federation of Red Cross and Red Crescent Societies [Online]. Retrieved from: https://www.ifrc.org/Global/Publications/disasters/all.pdf (4 July 2015).

Kakonge, J.O. 2012. Improving the Role of the Media in Disaster Management for Africa [Online]. Retrieved from: http://www.globalpolicyjournal.com/blog/21/06/2012/improving-role-media-disaster-management-africa (24 October 2016).

Kent, R. 1994. Disaster Preparedness: Disaster Management Training Programme 2nd ed. University of Wisconsin Disaster Management Centre.

Khan, A. 2015. Disaster Management Cycle – A Theoretical Approach. University of Science and Technology , Bannu, Pakistan.

Kirklees Council. Research & Consultation Guidelines. Corporate Research & Consultation Team [Online]. Retrieved from: http://www.kirklees.gov.uk/community/yoursay/questionnaires.pdf (29 July 2016).

Kolanchu, P. S. 2011. An Analysis of Community Awareness to Chemical Hazards in Zamdela Township – Sasolburg [Unpublished Master's Thesis]. University of the Free State.

Lamichane. K. 2010. Sustainable Livelihood Approach in Sssessment if Vulnerability to the Impacts of Climate Change: A study of Chekampar VDC. Gorkha District of Nepal. National College – Baluwater.

Lemeko, M. 2011. Assessment of Disaster Preparedness of Ngwathe Local Municipality Regarding Floods. University of the Free State (Thesis Masters).

MacDonald, S. Headlam, N. 2011. Research Methods Handbook: Introductory guide to research methods for social research. Centre for local Economic Strategies [Online]. Retrieved from: http://www.cles.org.uk/wp-content/uploads/2011/01/Research-Methods-Handbook.pdf (29 July 2016).

Madubela, T. 2014. Vaal Environmental Community News. Stopping Polluters from Complying – Submission presented to the Portfolio Committee on Water and Environmental Affairs [Online]. Retrieved from: http://vaalenvironmentalnews.blogspot.co.za (25 May 2016).

Makhalemele, L.M. 2008. Towards a Human Resource Provisioning Policy for Municipalities in the Northern Free State. Vanderbijlpark: North-West University. (Thesis - PhD).

Malan, L. Sasol One Natural Gas Project EIA: Social Impact Assessment. Calmare Social Impact Assessment Consultant. University of Cape Town (Thesis PhD).

Manda, N. Mohamed – Katerere, J. 2004. Chemicals: Chapter 11. Africa Environment Outlook – Our environment, Our Wealth.

Maruthappa, S. 2009. Case Study on Major Chemical Disasters. Safety Engineers Association.

Metsimaholo Local Municipality. 2014-2015. Metsimaholo IDP. Sasolburg. Metsimaholo Local Municipality.

Minter, E.D. 2003. Pros & Cons of Interviewing. University of Wisconsin.

Mitchell, M. & Jolley, J. 2009. Research Design Explained 6th ed.

Muller, R. 1984. A Significant Toxic Event: The Union Carbide Pesticide Plant Disaster in Bhopal India [Online]. Retrieved from: http://www.tropmed.org/rreh/vol1_10.htm (4 March 2014).

Mulugeta, G. Ayonghe, S. Daby, D. Dube, O.P. Gudyanga, F. Lucio, F. Durrheim, R. 2007. Natural and Human – induced Hazards and Disasters in sub – Saharan Africa. International Council for Science. ICSU Regional Office for Africa Science Plan.

Muttarak, R. & Pothisiri, W. 2013. The role of disaster preparedness. Case study of 2012 Indian Ocean Earthquake on Thailand's Andaman Coast [Online]. Art. 51. Vol.18. Retrieved from: http://www.ecologyandsociety.org/vol18/iss4/art51/ (24 October 2016).

National Environmental Management: Air Quality Act of the Republic of South Africa (No 39). 2004. RSA.

Orum, P. Moore, R. Roberts, M. Sánchez, J. 2014. Who's in danger? Race, Poverty, and Chemical Disasters. A demographic analysis of chemical disaster vulnerability zones. US.

Oxford Dictionary. 2006.

Pennsylvania Workers and Community – Right – to – Know Program: Request for information / complaint form [Online]. Retrieved from: https://www.cdc.gov/niosh/docket/archive/pdfs/NIOSH-071/0071-020193-Tinney-Attach5.pdf (May 31 2016).

Physicians for Social Responsibility – Los Angeles (PSR-LA). 2013. Health Effects of Chemicals Used in Fracking. [Online]. Retrieved from: http://www.psr-la.org/health-effects-of-chemicals-used-in-fracking/ (18 March 2015).

Preparing for disasters. 2015. International Federation of Red Cross and Red Crescent Societies (IFRC) [Online]. Retrieved from: https://www.ifrc.org/en/what-we-do/disaster-management/preparing-for-disaster/ (4 July 2015).

Public awareness and public education for disaster risk reduction. 2011. A guide: International Federation of Red Cross and Red Crescent Societies [Online]. Retrieved from: www.ifrc.org (19 January 2017).

Questionnaires: Some Advantages and Disadvantages. Aberdeen University [Online]. Retrieved from: http://www.icbl.hw.ac.uk/ltdi/cookbook/info_questionnaires/ (29 July 2016).

Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation. 1907/2006. European Union.

Republic of South Africa. 1996. Constitution of the Republic of South Africa. Act 108 of 1996, Chapter 11. Pretoria: Government Printers. RSA

Republic of South Africa. 2002. National Disaster Management Act No 57 of 2002: Government Gazette No. 27534. Pretoria: Government printers. RSA

Republic of South Africa . 1998. National Environmental Management Act No 107 of 1998. Pretoria. Government Printers. RSA

Republic of South Africa. 1980. National Key Point Act 1998. RSA

Republic of South Africa. 1993. Occupational Health and Safety Act No 85 of 1993. Pretoria. Government Printers. RSA

Republic of South Africa. 1998. The National Environmental Management Act of the Republic of South Africa (No. 107). 1998. RSA.

Salloway, L. 2016. The Disadvantages of Closed-Ended Questions [Online]. Retrieved from: http://www.ehow.com/info_7737070_types-questions-quantitative-research.html (29 July 2016).

Sasol Facts [Online], 2012 – 13 [Online]. Retrieved from: www.sasolfacts.co.za (22 April 2014).

Skosana, V.R.P. 2007. A critical Evolution of the Link Between Integrated Development Planning and the Budget at Emfuleni Local Municipality. Vanderbijlpark: North-West University. (Dissertation – Master of Arts).

South African History Online: Towards a People's History [Online]. Retrieved from: http://www.sanistory.org.za (22 April 2014).

South Durban: Toxic Hub of South Africa. 2016. South African Environmental Justice struggle against "toxic" petrochemical industry in South Durban: The Engen Refinery Case [Online]. Retrieved from: http://umich.edu/~snre492/brain.html (25 May 2016).

Statistics South Africa. 2011. [Online]. Retrieved from: http://beta2.statssa.gov.za/?page_id=993&id=metsimaholo-municipality (18 March 2015).

Sukamolson, S. Fundamentals of quantitative research. Chulalongkorn University [Online]. Retrieved from: http://www.culi.chula.ac.th/Research/e-Journal/bod/Suphat%20Sukamolson.pdf (29 July 2016).

Survey Methods, Pros & Cons. 2006. NEDARC [Online]. Retrieved from: http://www.nedarc.org/media/pdf/surveymethods_2006.pdf (29 July 2016).

Survey Questionnaire Design. 2012. Fairfax Country Department of Neighbourhood and Community Services [Online]. Retrieved from: http://www.fairfaxcounty.gov/demogrph/pdf/questionnairedesign.pdf (29 July 2016).

Sutton, J and Tierney, K. 2006. Disaster preparedness: Concepts, guidance and research [Online]. University of Colorado. Retrieved from: http://www.colorado.edu/hazards (19 January 2017).

The Dangerous Substances and Explosive Atmospheres Regulations. 2002. No. 2776. United Kingdom.

The Free Dictionary. 2016. Definition of volunteerism [Online]. Retrieved from: http://www.thefreedictionary.com/volunteerism (9 December 2016).

Thomas, P.Y. 2010. Chapter 4: Research Methodology and Design [Online]. Retrieved from: http://uir.unisa.ac.za/bitstream/handle/10500/4245/05Chap%204_Research%20methodology%20and%20design.pdf (29 July 2016).

Tucker, K. 2016. The Disadvantages of open-ended questions [Online]. Retrieved from: http://www.ocms.be/info_8713738_disadvantages-open-ended-questions.html (29 July 2016).

UNISDR. 2009. Terminology. [Online]. Retrieved From: http://www.unisdr.co.uk (1 December 2014).

United Nations Development Programme. 2010. Bureau for Crisis Prevention and Recovery: Gender and Disaster. New York [Online]. Retrieved from: http://www.undp.org/content/dam/undp/library/crisis%20prevention/disaster/7Disaster%20Risk%20Reduction%20-%20Gender.pdf (24 October 2016).

United State. 1970. Clean Air Act (CAA) 1970. US.

United States. 1986. The Emergency Planning and Community Right –to-Know Act 1986. US.

What are eligibility criteria, and why are they important. Roswell Park Cancer Institute [Online]. Retrieved from: https://www.roswellpark.org/clinical-trials/eligibility-criteria (29 July 2016).

White, C.J. 2003. Research: An Introduction for Educators. Pretoria.

Whittaker, J. McLennan, B & Handmer, J. 2015. International Journal of Disaster Risk Reduction. A review of informal volunteerism in emergencies and disaster: Definition, opportunities and challenges [Online]. Vol. 13 (358-368). Retrieved from: http://www.sciencedirect.com/science/article/pii/S2212420915300388 (24 October 2016).

World Health Organisation (WHO). 2015. Children's environmental health: Chemical hazards [Online]. Retrieved from: http://www.who.int/ceh/risks/cehchemicals/en/ (16 June 2015).

Zohrabi, M. 2013. Mixed Methods Research: Instruments, Validity, Reliability and Reporting Findings. Iran.

ANNEXURE 1: Research Questionnaire

RESEARCH QUESTIONNAIRE

University of the Free State
PO Box 339
Bloemfontein
9300

To whom it may concern

RE: MINI DISSERTATION - MASTERS IN DISASTER MANAGEMENT

I, Xola Mavundla, am currently registered as a Masters Degree student in disaster management with the University of the Free State in Bloemfontein (student number 2010002638). As part of the process of completing my mini dissertation I am required to research a topic and produce a mini dissertation. The topic that I have chosen is **ASSESSMENT OF DISASTER PREPAREDNESS LEVEL OF A COMMUNITY IN ZAMDELA TO CHEMICAL HAZARD.**

I would appreciate it if you would be so kind as to complete the attached questionnaire which will approximately take 20 minutes of your time. The information provided will be treated with the utmost confidence and individual names will not be identified. Equally, a copy of summary report will be available to your institution if so required.

Thank you for your cooperation

_____

Xola Mavundla

QUESTIONNAIRE

PART A: PERSONAL PROFILE

Indicate your choice by marking the appropriate block with an "X".

1. Gender

1.	Male	
2.	Female	

2. Age

1.	18 – 24	
2.	25 – 34	
3.	35 – 44	
4.	45 – 54	
5.	55 above	

3. What is your highest level of education?

1.	None	
2.	Primary School	
3.	Secondary School (excluding Grade 12)	
4.	Grade 12	
5.	A tertiary qualification	

4. How long have you been living in Zamdela?

1.	0 – 10 years	
2.	11 – 20 years	
3.	21 and above	

5. **The head of this household is a....**

1.	Child (including orphans)	
2.	Older person (above 55)	
3.	Single mother	
4.	Single father	
5.	Both parents / partners	
6.	Persons with disability/ chronic illness	

PART B: Disaster Preparedness[1] and Awareness[2]

6. **In the past 12 months, I have....**

☐ **1.** Attended a meeting on how to be better prepared for a chemical disaster[3]
☐ **2.** Attended first aid skills training
☐ **3.** Attended training as part of a Community Emergency Response Team (CERT)
☐ **4.** None of the above

7. **Which institution was responsible for conducting the training sessions?**

_____
_____

8. **How will being better prepared for a chemical hazard personally assist you in time of a disaster?**

_____
_____
_____

9. **How confident are you in your knowledge of preparation for a chemical disaster?**

Indicate your choice by marking the appropriate block with an "X".

☐ **1. Very Confident** ☐ **2.Partially Confident** ☐ **3.Not at all Confident**

10. **How confident are you in the following sources of disaster information?**

Indicate your choice by marking the appropriate block with an "X".

10.1.Local Media ☐ **1.Very Confident** ☐ **2.Partially Confident** ☐ **3.Not at all Confident**

10.2.Local Government Officials ☐ **1.Very Confident** ☐ **2.Partially Confident** ☐ **3.Not at all Confident**

10.3.Local Government Website ☐ **1.Very Confident** ☐ **2.Partially Confident** ☐ **3.Not at all Confident**

[1] Preparedness is the knowledge and capacities developed by government, professional response and recovery organisations, communities and individuals to effectively anticipate, respond to, and recover from, the impact of likely, imminent or current hazards events or conditions (UNISDR 2009).
[2] Disaster awareness is when the local population has knowledge about how to prepare for impending disasters and emergencies in their area thereby reducing their vulnerability to hazards (Inccdp.doc 2000 5).
[3] A chemical disaster incident or accident involves a chemical substance that can cause large scale damage to the environment and injuries or deaths to humans, animals or plans (Business Dictionary 2015).

10.4.Local Health Care Providers ☐1.Very Confident ☐ 2.Partially Confident ☐ 3.Not at all Confident

10.5.Neighbourhood Association ☐ 1.Very Confident ☐ 2.Partially Confident ☐ 3.Not at all Confident

10.6.Faith Based Organisations ☐ 1.Very Confident ☐ 2.Partially Confident ☐ 3.Not at all Confident

10.7.Friends or Family Members ☐ 1.Very Confident ☐ 2.Partially Confident ☐ 3.Not at all Confident

11. From which of the following sources have you received information about chemical disaster in the past 12 months? *(Check all that apply)*

☐ 1. Local Media

☐ 2. Local Government Officials

☐ 3. Local Government Website

☐ 4. Local Health Care Providers

☐ 5. Neighbourhood Association

☐ 6. Faith Based Organisations

☐ 7. Friends or Family Members

12. Have you ever volunteered to help out in a chemical disaster?

_____

13. Which of the following is the best method to notify you and your family members of a chemical disaster situation in your area? *(Check two that apply)*

☐ 1.Radio ☐ 4.Door to Door

☐ 2.Telephone ☐ 5.Social Media

☐ 3.Siren ☐ 6.Local Police and Fire

☐ 7.Other

8.List others: _____

_____

14. How would you like to learn about disaster preparedness?

Indicate your choice by marking the appropriate block with an "X".

☐ **1.Flyers**
☐ **2.Workshops**
☐ **3.Videos**
☐ **4.Others**
5. List

others_____

_____

15. Where would you like to receive this information?

Indicate your choice by marking the appropriate block with an "X".

☐ **1.Home** ☐ **4.Church**
☐ **2.School** ☐ **5.Neighbourhood**
☐ **3.Town Hall** ☐ **6.Others**

7.List others: _____

_____