University of KwaZulu-Natal

Stakeholder's Perceptions of Using Ecological Infrastructure in Addressing Flood Risks: The case study of the *Emnambithi/*Ladysmith Local Municipality

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A Dissertation Submitted in Partial fulfilment of the Requirements of the Degree for Masters in Town and Regional Planning:
The School of Built Environment and Development Studies

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2016

Declaration

I proclaim that this is my own unaided work and that, where use was made of the work of others, it has been duly acknowledged. This work has not been submitted before for any degree or examination in any other university.

Signature ……... Date ….……

Supervisor ……. Date ……

Abstract

Recent research on integrated flood management decision making has revealed that economic, environmental, and social science aspects need to be holistically considered in flood risk management. For example, Borrows (2006) calls for more inclusion of the elements of cultural, demographic, technological, environmental and institutional changes on flood risk management; as well as the need for these systems to be understood and accommodated. The poor understanding and limited incorporation of the sociological and political aspects of flood risk management is leading to a failure of flood management initiatives by the stakeholders in many places. With the review of the international literature on the sociological and political aspects of flood risk management (see Borrows, 2006., Salvador and Norton, 2011), it is shown that there is a need to understand how sociological and political views have developed, as well as the perceptions people have of flood problems and the solutions. Borrows (2006: 135) argues that "there is little (if any) thought, given to the feelings, behaviour, and thought associated with stakeholders in flooding risk management. This also consider the interests (or needs) that often appear to be in conflict and more adaptable to the uncertainties of natural and man induced changes".

Emerging from the research on integrated flood disaster management, there has been a call for more research to focus on non-structural approaches, such as '*ecological infrastructure* and climate change adaptation measures', which seek to promote cost effective strategies with regards to dealing with flooding and other global disaster problems (see Burt *et al*, 2006; Walters, 2012; Scott *et al*, 2013, and SANBI, 2014 among others). In addition, UNEP (2007) cited in Walters, (2012: 17) states that "An investment in ecosystems and incorporating disaster risk reduction and ecosystem management into development planning, not only offers protection against natural disasters but can also provide a major contribution to achieving sustainable livelihoods for the poor".

This research is based on a case study in the *Emnambithi*/Ladysmith Local Municipality (ELLM), which is a rural South African local municipality in KwaZulu-Natal province. The study explores the potential of using ecological infrastructure (EI) in addressing flood risks in this rural municipality, which has urban and rural sections. The aim of this study is to understand the attitude and behaviour of the selected key stakeholders towards using EI, and subsequently explore the implications of their responses concerning flood risk management and planning. This research considers the indigenous knowledge held by these actors regarding their perceived value of EI in this domain.

The key conceptual, theoretical, and methodological basis of this research was based on (but not limited to the) MEA (2005) and Costanza *et al* (2010) framework of ecosystem's services to obtaining the optimal benefits of the EI. In addition, international precedent cases were examined in order to

explore how the concept of EI has been used in other cities and municipalities to solve flood risks and respond to environmental changes.

This research reviews the range of flood management and environmental policies developed for, and by, the municipality. Their goal was to ensure that both the structural and non-structural solutions are integrated in to trying to strengthen the resilience of Ladysmith to flooding. Secondly, the key informants, including government officials, affected citizens, businesses, politicians, amongst others - were interviewed to determine their perspectives in utilising EI to address flood risk, as well as other co-benefits. The researcher visited two sites where these interventions were taking place. However, in instances where sites could not be visited, desktop research was used to supplement the research process.

The research findings indicate that pollution and illegal dumping plays a critical role in increasing flood risk and undermine the resilience of infrastructure in the urban part of Ladysmith. Hard engineering is the dominant way in which the local government conceptualises and intervenes in flood risk management. Many stakeholders were not aware that hard infrastructure could not withstand the predicted risks of more floods associated with climate change. Due to this lack of awareness, many stakeholders such as officials and Ladysmith citizens do not realise the potential of EI in reducing flood risks as they have limited understandings of how rivers and flooding processes work. In terms of flood risks, the results highlight that there has been a shift in approach from disaster reduction to vulnerability reduction, as poverty seems to be local government's central focus. In contrast to the perceptions of EI for Ladysmith town, the adjacent rural communities have a stronger connection with EI. The analysis of rural community interviews revealed that their use of ecological infrastructure, in relation to flooding, was primarily associated with their spiritual and cultural values of ecosystems services. This strong foundational belief system promotes the regulation, provisioning and support of ecosystem services in the rural context, and is considered to be a more sustainable approach to flooding risk management. Their belief and cosmology is that, when there is any disrespect to sacred sites, which have high cultural and spiritual value, the rural communities become more susceptible to misfortunes such as flooding, droughts, and poverty.

The role of EI in flood risk management in strongly reflected in the belief system and actions of rural communities in Ladysmith. In contrast, the role of EI for flood risk management in urban areas of Ladysmith has had little consideration by local government officials. In order to promote sustainable flood risk management in the context of climate change, the role of EI in flood risk management needs to be increasingly considered in urban areas.

Acknowledgements

I am indebted to the contributions of many participants who have contributed directly and indirectly to this research project. From the municipal manager, *Induna (*headmen), and councillors who have granted permission to work in their areas, and interview people in their areas- I thank you all. I also thank my supervisor Catherine Sutherland for trusting me and providing many opportunities that changed my life. Lastly, to all of my friends, colleagues, relatives, family…, I owe you huge thanks for the support and being with me. *Ngyanithanda nonke- I love you all*

Dedication

- To my parents, my supervisor (Cathy Sutherland), the former principal of Lokothwayo C. School (TJP Nhlabathi), and Almighty for his protection and good guidance**.**

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List of Acronyms

COGTA- Department of Cooperative Governance & Traditional Affairs

DEA- Department of Environmental Affairs

DM- District Municipality

DWAF- Department of Water Affairs & Forestry

DWAS- Department of Water Affairs & Sanitation

EI- Ecological Infrastructure

ELLC- *Emnambithi*/Ladysmith Local Council

ELLM- *Emnambithi*/Ladysmith Local Municipality

ELMOSS- *Emnambithi*/Ladysmith Municipal Open Space System

EMF- Environmental Management Framework

ES- Ecosystems Services

FT- Flooded Town

IDP- Integrated Development Plan

INR- Institute of Natural Resources

LAP- Local Area Plan

LM- Local Municipality

MEA- Millennium Ecosystems Assessment

MTA- *Mthembu* Tribal Authority

NDP- National Development Plan

NEMA- National Environmental Management Act

NG- National Government

PES- Payment for Ecosystem Services

PG- Provincial Government

RC- Rural Community

RSA- Republic of South Africa

SANBI- South African Biodiversity Institute

SDF- Spatial Development Framework

SEMPT- Strategic Environmental Management Planning Tool

SPLUMA- Spatial Planning & Land Use Management Act

SU- Semi- Urban

TEEB - The Economics of Ecosystems and Biodiversity

CHAPTER 1: INTRODUCTION

1.1. Background

As a result of climate change, flooding is increasing, resulting in risk and disaster for rich and poor, the prepared and the unprepared (Ali *et al*, 2013). Floods are a natural phenomenon. However, the disaster component of flooding is exacerbated by human vulnerability, which is caused by poverty and inequality. Given that each flood occurs in a particular physical and socio-economic context, it has not been possible to develop a blue print plan to address the impacts of floods. However, the argument in flood management decision making is that even though flooding may be perceived as a natural phenomenon, flood damage is human made or, at least, exacerbated by human activities (Mwape, 2009). This thesis argues that the problem starts when planning and development decision making allows formal and informal activities, such as the establishment of human settlement, to be located on watercourses and in floodplains, thus impacting on river buffers meant for flood attenuation. Technological interventions and engineering solutions, once seen as the solution to control and manage flooding in these areas are now criticised and have become unpopular in flood decision making, given that many of these solutions have failed. They are expensive and require significant investment in hard infrastructure.

More recently, as a result of a growing understanding of the value of 'soft engineering solutions' to environmental risk, non-structural solutions to flooding, based on flood resilience, are becoming popular solutions (Andjelkovic, 2001., Nisenson, 2007; Sigel *et al*, 2010; Jah 2012; Asjad *et al*, 2013., and Scott *et al*, 2013). This approach calls for more unconventional and innovative methods to manage the scope, complexity and uncertainty of global disasters (i.e. floods) such as emphasizing the importance of taking into account the use of different types and sources of knowledge. Ecological Infrastructure (EI) forms part of the non-structural solutions that complement and support engineering solutions. In South Africa, using EI as a form of climate adaptation is a relatively new approach, with pilot case studies being explored in for example the *uMngeni* Catchment, in KwaZulu-Natal (Pringle *et al*, 2015). Despite its benefits in protecting citizens and business from natural hazards and improving public health, the EI investment also complements policies in urban development, water purification and water treatment, regional development, transport and tourism, to name but the few (TEEB, 2011).

The purpose of this chapter is to highlight the focus of this research project, which covers two broad themes, namely flood risks and EI. It provides the rationale for the study, problem statement, importance of the study, and the location of the case study and why it was chosen. It also outlines the literature or theoretical frames guiding the research. In the last section, the research aims and objectives, subsidiary questions, and the outline of the chapters of this dissertation are presented.

1.2. Research Problem

Previous studies on flooding of Ladysmith town have shown that both hard engineering strategies (i.e. channelization and flood control dams) as well as EI (i.e. rehabilitation of the wetlands and support of environmental solutions) can increase the resilience of Ladysmith to flooding (INR, 1988; DWAF, 1998a; Batuca and Jordaan, 2000; and ELLM, 2015b). However, Ladysmith continues to be impacted upon by flooding (Botes *et al*, 2011; and Koopman, 2011) which is an indication that the solutions to solve flooding are not adequate thus raising questions about Ladysmith town's flood resilience system. This thesis will explore the potential for soft solutions to address this ongoing environmental risk. The importance of studying flood risks in relation to the role and value of EI in addressing these risks forms the focus of this study. Flood risk in this context is defined as the causes of the failure of flood resilience solutions due to human activities and their disharmony with nature (Batuca and Jordaan, 2000.; Mwape, 2009.; Koopman, 2011).

Based on the above mentioned evidence of the continuing flood crises, challenges associated with the rapid growth of towns in the face of human induced climate change, the problem statement was formulated. The problem statement is to examine and understand stakeholder's perceptions (and use) of EI in flood risk management in the selected study areas of the Emnambithi/Ladysmith Local Municipality (ELLM).

1.3. Motivation for the choice of the study area

There are many natural and the human-induced disasters that are known to have happened in Ladysmith. In this dissertation, the main focus will be on flood risks. According to the available literature, the Central Business District (CBD) of Ladysmith (and its adjacent areas) is perceived as vulnerable to flooding and its flooding history is well documented (INR, 1988.; Bell and Mason, 1998.; Alexander, 2000.; Batuca and Jordaan, 2000.; Gobler, 2002.; Thornhil *et al*, 2009.; Botes *et al*., 2011., among others). This town is located within the boundaries of the ELLM and its geographical characteristics are summarised below.

1.3.1. Geography and location of the study area

The jurisdiction in which Ladysmith town falls is the ELLM under the uThukela District. It is situated in the province of KwaZulu-Natal, South Africa at an altitude of approximately **1015m** above sea level (IDP Review 2015/2016 cited on ELLM, 2015a) (See Figure 1.1).

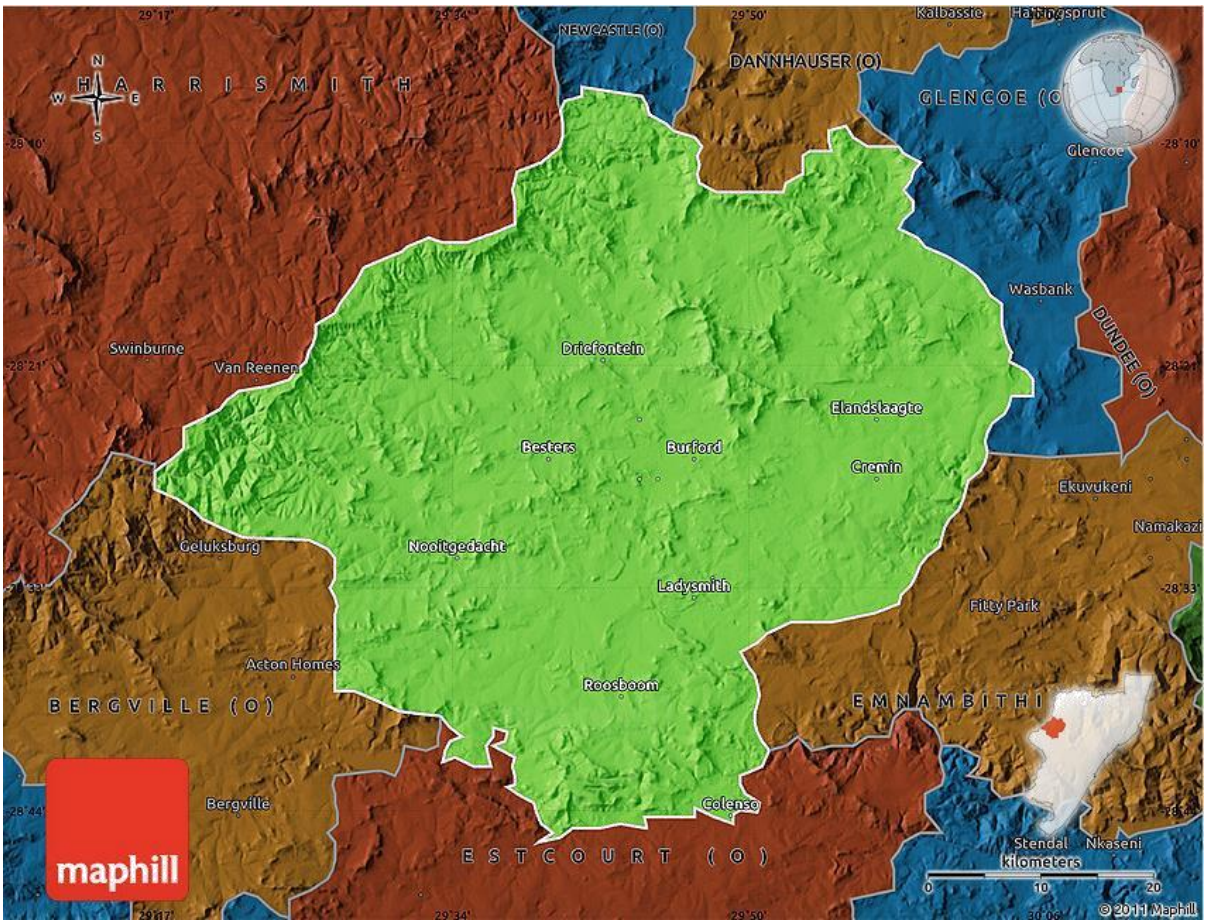

Figure 1.1: ELLM Context Map *(Source: http://www.maphill.com/south-africa/kwazulu-natal/kliprivier-o/3d-maps/political-map/)*

ELLM is bordered by the Free State province (Thabo Mofutsanyane District Municipality) to the west, Dannhauser municipality to the north, Endumeni and Indaka municipalities to the northeast and east, Umtshezi municipality to the southeast, and Okhahlamba local municipality to the southwest. It must be also be noted that recently, the ELLM has merged with the Indaka LM and formed one municipality known as Alfred Duma (See Appendix A2 for the new map of the municipality).

Within the ELLM, Ladysmith town is located 26 km from Van Reenen pass which is on the main transport corridor, the N3, between Durban and Johannesburg. Ladysmith is the primary urban, industrial, economic, and administrative area for both the local municipality and the uThukela district. Ladysmith is located at the geographic coordinates of: $28^{0}33^{'}35^{''}$ S $29^{0}46^{'}51^{''}$ E (See Figure 1.2 and 1.3 below).

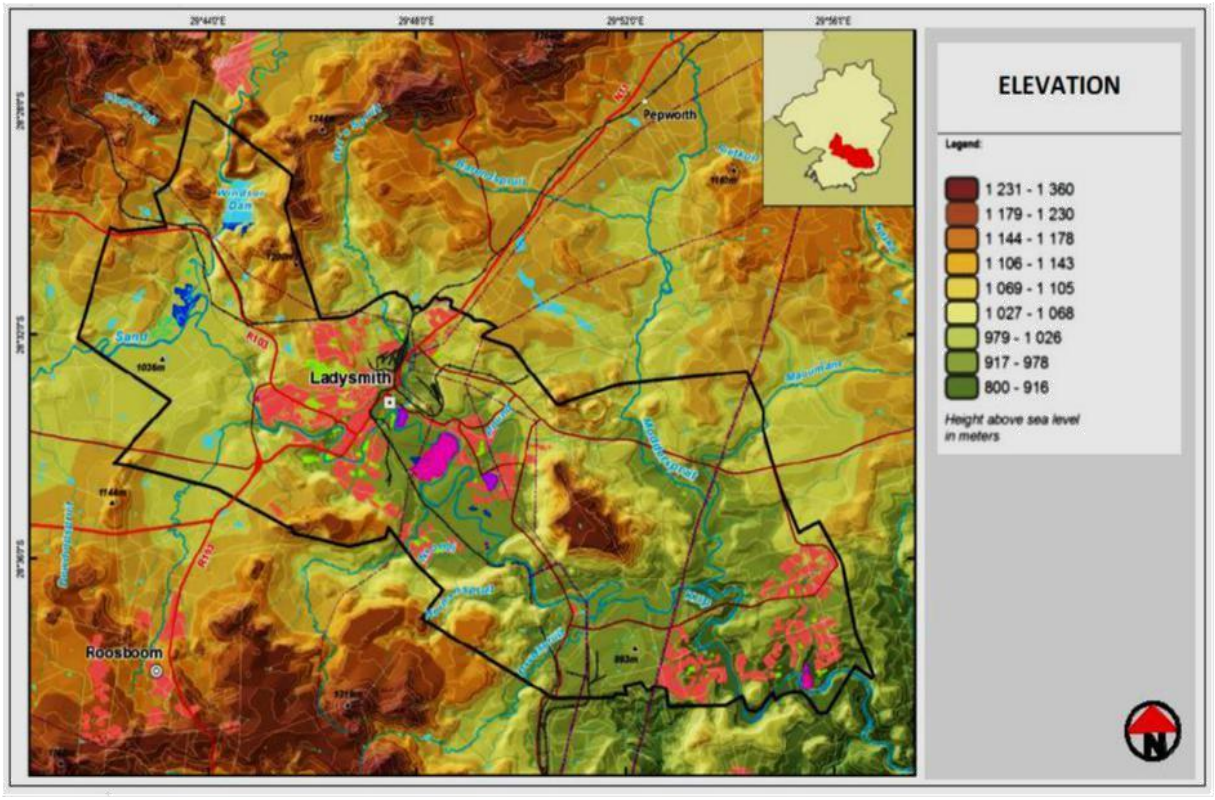

Figure 1.2: Arial map of Ladysmith (*Source: ELLM, 2010b: 44)*

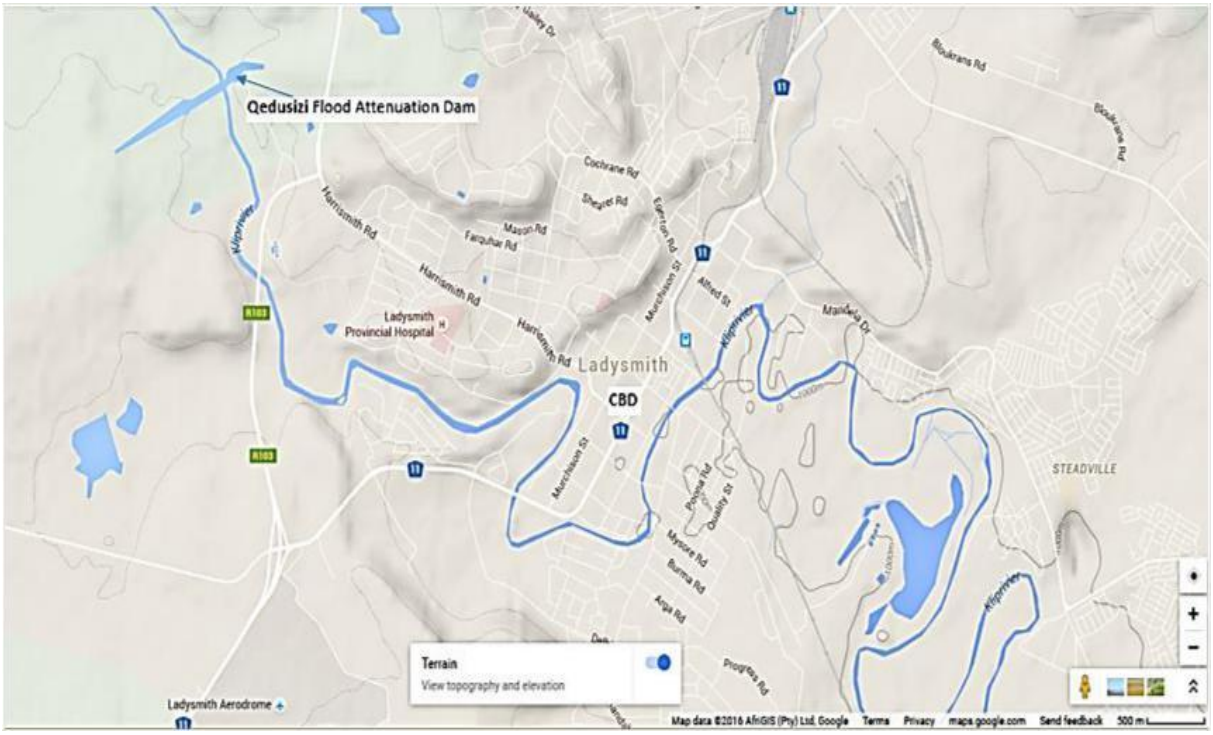

Figure 1.3: Orthophoto map of Ladysmith *(Source: Google Map, © 2016)*

Ladysmith town (Primary node of the ELLM) is strategically located and accessed along the N11 National Route. It is located 370 kilometres from Johannesburg, and 250 kilometres from Durban. Due to its location, it connects with the economic activity associated with the economic and transport corridor between Johannesburg and Durban to a limited extent. Further details of the study area are presented in Chapter 3.

1.3.2. Climate Change predictions for Ladysmith

The climate change predictions show that the high flood risks areas in Ladysmith will increase as those areas currently outside of the recorded disaster area will now face more risk (Thornhil *et al*, 2009). This is supported by the ELLM Spatial Development Framework (SDF) first draft (cited in ELLM, 2012c:58) where it is clearly stated that there will be,

> An increase in the average annual temperature is expected. It is also anticipated that there will be an increase in the severity and frequency of natural events, such as storms and flooding, as the rainfall patterns of the ELM are likely to change. Current research suggests that there may be an increase in summer rain and thunderstorms within the ELM, followed by prolonged periods of drought. The anticipated effect of climate change means that many areas throughout the ELM may become high flood-risk areas as a result of the increase in intensity of storm surges and river flooding. There are numerous instances of inappropriately located development, resulting in exposure to flood risks, as well as instances where the development itself has caused a change in the flood regime, either increasing river velocity or flood levels.

According to the ELLM SDF (2012c) other anticipated effects of climate change include: reduced rainfall resulting in a reduction in water supply; decreased soil moisture resulting from less rain and higher temperatures; temperature impacts on agricultural activities; and health risks relating to a possible increase in the presence of disease vectors (such as malaria) in areas that were previously relatively disease-vector-free (ELLM, 2012c).

As Ladysmith continues to experience flooding, there are a number of issues being raised including the questioning of the location of urban development and settlements within the 1: 100-year flood-line (SDF 1st draft cited in ELLM, 2012c). This is the case as the Ladysmith area has experienced both major and minor flooding events. Studies indicate that the rate of flooding in Ladysmith will continue to increase even without the impact of climate change (Botes *et al*, 2011). Chapter 3 will deal with the more detailed history of Ladysmith flooding and the impact it has.

1.4. Impact of the recent minor floods in Ladysmith

The findings of the Water Wheel, (2011) cited in Botes *et al* (2011: 1) have revealed that, in December and January 2010/2011 there were 33 municipalities that were affected by flooding countrywide. *Emnambithi*/Ladysmith was one of these municipalities. The recent flood events highlighted the impact that relatively minor flooding can have on people and infrastructure. In this instance, the floods did not reach the 1:100 year floodline and yet the damage caused was significant. The floods of January 2011 in Ladysmith have shown that minor floods like this still have an ability to cause damage (See Figure 1.4. below).

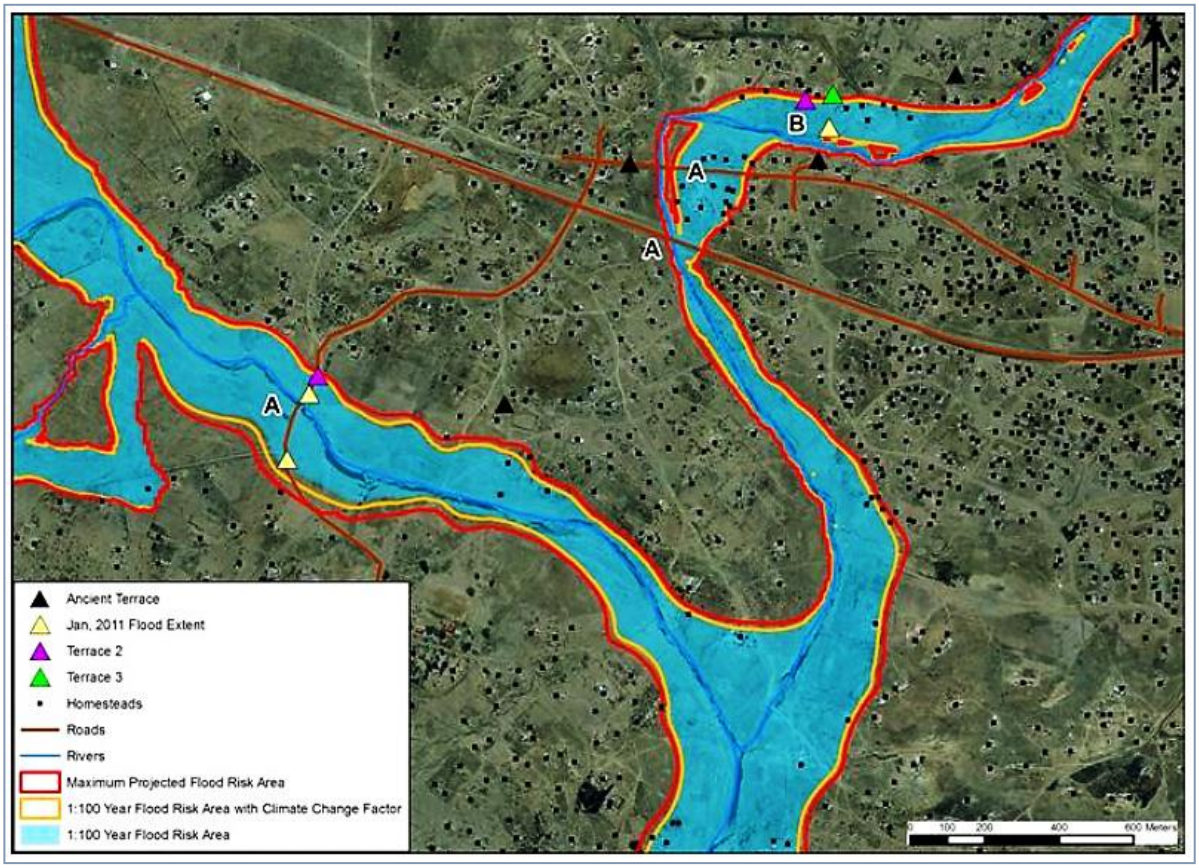

Figure 1.4: Derived Flood Risk Area surfaces: Flood terraces and the recent January 2011 flood extents are shown *(Source: Botes et al, 2011: 13).*

In addition, the study also revealed that the ongoing development of settlement in areas with high flood risk is due to socio-economic factors (Botes *et al*, 2011), which override concerns about environmental risk.

1.5. The Value of the Study

Having discussed Ladysmith's susceptibility to flood risk as a result of climate change and the impact of urbanization, it is argued that the findings of this research can contribute to flood management decision making as the dynamics that are played on the ground will be foreseen (i.e. including the competing interests over land and its optimal use). Therefore, the study will complement the report by the Institute of Natural Resources to Afromaison based on "*Assessment of ecosystem services in the Uthukela District Municipality*" (Quayle and Pringle, 2014) which assisted in the implementation of the Environmental Management Framework and Strategic Environmental Planning tool of the ELLM. In this way, this study will contribute directly to this aforementioned work and also to the plans of the uThukela District Environmental Management Framework (2014) which forms part of advocacy for the use of EI in planning and risks management.

1.6. Research Aim and Objectives

The aim of this research is:

> To examine the knowledge and attitude of government and civil society stakeholders towards using Ecological Infrastructure (EI) for flood risk management and spatial planning in Ladysmith. This includes the role of indigenous knowledge regarding the value of EI by using ecosystem's services.

The objectives of this research are:

1. To understand the role and perceptions of the selected key stakeholders in flood risks
2. To identify the solutions to flood risks management and the extent to which the concept of EI has been integrated
3. To explore the value of EI in addressing flood risks in Ladysmith
4. To determine the implication of using EI for environmental management and spatial planning

Subsidiary Questions:

(i) What is flood risk and ecological infrastructure?

(ii) Whose responsibility is flood risks?

- What is the cause of flood risks?
- Do stakeholders fear the floods?

(iii) What are the strategies and solutions to flood risks in the ELLM?

- Do any of the strategies and solutions include ecological infrastructure?

(iv) What is the role of ecological infrastructure?

(v) What are the implication of using EI for environmental management and planning?

The research aim and objectives provide the framework for the choice of the theoretical framework, and also the methodology employed in this research. These are discussed in the following section, which outlines the structure of the thesis.

1.7. Chapter Outline

Chapter 1 focuses on the purpose of the study. It also delineates the scope of the study upon which the research is based. It covers the motivation for the study, the problem set, research aim, objectives and questions, and then highlights the chapters to be covered, among other things.

Chapter 2 presents the conceptual framework, which is firstly based on the concepts of EI and environmental services. It also explores contemporary debates on different forms of infrastructure planning (both hard and soft engineering strategies). The second part of the chapter focuses on two bodies of knowledge, namely understanding flood risks (i.e. the dominant approaches in flood risks management decision making), and secondly, the role of EI in flood risk reduction. Local or international best practice is used to provide insight in to how EI has been applied in other contexts. It further highlights the role of legislation and policy in supporting the adoption of EI. Secondary data

that shows that the concept of EI is supported in South Africa as a way to address the risks and socio economic factors is reviewed.

Chapter 3 provides the description of the case study and the background of flood history and risks in Ladysmith. It also describes the physical and socio-economic characteristics of the three sites where detailed fieldwork was undertaken as part of this research. Ladysmith town, with its CBD that regularly floods, Emachibini, a peri- urban area under the Ingonyama Trust Board in Ward 7 and 14, and lastly Driefontein, a new investment area with significant wetlands, were selected as case study sites to explore the role and value of EI in addressing flood risk.

Chapter 4 on research methodology focuses on the qualitative methods used to generate the data used in this thesis. This chapter include both primary oral data (key informant interviews) and primary documentary data (analysis of the plans, and Ladysmith Gazzette data archives). It highlights where the data used in the research was sourced from and how it was analysed. It further explains the sampling technique used to gather the data. Participant observation and main informant interviews were conducted and the process of undertaking this type of research is explained in this chapter

Chapter 5 and 6 presents the results of the study with a focus on causes of flood risks, solutions to flood risks, perceptions of the potential of ecological infrastructure to address flood risks, and its implications for planning and environmental management. This data collected through interviews is analysed using a thematic approach. This analysis is supported by evidence gained from personal observations while working in the field and participating in discussions in the selected case study sites.

Chapter 7 presents the conclusion to the study. Recommendations are also made in this concluding chapter. These recommendations are based on the lessons learnt from the planners' professional practices in facilitating the successful flood management projects, which include meaningful stakeholder's participation in the project.

CHAPTER 2: CONCEPTUAL FRAMEWORK AND REVIEW OF LITERATURE

2.1. Introduction

There are two main sections of this chapter that present the conceptual framework and the review of the literature. This chapter focuses on the relevance of the proposed concept of EI in theory and practice. Firstly, the chapter will define the concept of EI based on global and local literature. Secondly, the current paradigm shifts in infrastructure planning and landscape design, which now includes the concept of EI will be discussed. This part deals with the evolution of the concept of EI in planning and other related disciplines. The third part deals with the linkages between EI and ecosystem services. How the concept of EI is used in other successful planning precedents such as China, is also discussed.

2.1.1. Redefining Infrastructure and emerging Infrastructure types

There has been a shift in the manner in which the concept of ecology is defined and it is now closely linked with infrastructure. This raises many questions about how ecology can be interlinked with infrastructure because these are distinct and usually conflicting words. Benedict and McMahon, (2003:6) state that;

> When many people hear the term infrastructure, they think of roads, sewers, utility lines, and other grey infrastructure; or hospitals, schools, prisons, and other social infrastructure. Taken together, these types of facilities are often referred to as built infrastructure.

The abovementioned statement makes it clear that there is still a misconception about our understanding of the concept of infrastructure due to the fact that its scope, and what exactly it incorporates has not yet been clearly defined. The Webster New Dictionary cited in Benedict and McMahon, (2003: 6) defines infrastructure as an "**….** as the substructure or underlying foundation, especially the basic installations and facilities on which the continuance and growth of a community depends"

The limitation associated with this definition is that it is very broad. It does not reflect on whether or not the facilities such as the electricity, bridges, hospitals, dams, roads (under the umbrella of built infrastructure) are the only types of infrastructure. However, there is increasing awareness that there are other forms of infrastructures such as grey, blue, green, social, and EI, to name but a few. Even though built infrastructure is easily distinguished from EI, it is important to note that some of the infrastructure is hard to separate from these main categories of infrastructure types. This is true as the concept of using of blue and green infrastructure are difficult to distinguish from EI. Due to this, they are used interchangeably otherwise when it is specified.

2.1.2. Background of Ecological Infrastructure and its link with planning

According to Yu *et al* (2008), the origin of the EI concept in itself appeared in the 1980s from the discipline of eco-city studies and conservation biology. After this, the MAB (Man and Biosphere) programme of UNESCO (United Nations Educational, Scientific and Cultural Organization) then further developed the EI concept. Despite this, it is acknowledged that the concept of EI is relatively new. However, the ideas behind this concept are not entirely new either in *planning* (discipline of built environment), and *environmental management* (under the discipline of the natural environment). According to Yu *et al* (2008:1), the ideas behind the concept of EI can be traced back in the subject of ecological planning theory, particularly the book by Ian McHarg (1969) entitled "Design with Nature". His work is also well known in the field of ecological planning, landscape architecture, and in the use of Geographic Information Systems (GIS) in disaster risk management. McHarg's work influenced many professionals and practitioners on how to break down a region into appropriate uses and setting aside the environmentally sensitive areas (Augustie and Methew, 2013). McHarg's work is still relevant today.

There are also many ways in which EI can viewed in urban planning to influence living and restore the resilience of urban ecosystems. For example, in China, the manner in which EI (also referred to as negative or non-construction planning) is seen and used in their cities is that it is "an effective tool for smart growth in the context of rapid urbanization because it is planned ahead of time, anticipating the scale, context and configuration of future urban development patterns" (Yu *et al,* 2008: 8). This also means that it is about the protection of the natural, biological, cultural, recreational processes, which secure their natural assets and ecosystems services, essential for sustaining human society (Yu *et al*, 2008:1). The concept of EI has been used widely in Chinese cities such as Beijing, and this is where Yu influenced the design based non-concrete planning which aims to respect the role of EI. This is important as it encourages the use of less land while focusing more on efficiency of preserving ecosystem services as this underpins the socio-economic development of urban and rural communities (Yu *et al*, 2008; and Benedict and McMahon, 2002).

2.1.3. Defining ecological infrastructure

Depending on the scale at which it is applied, the scope and understanding of the concept of EI may vary. According to the formal definition of EI derived from the Millennium Ecosystem Assessment Report (MEA, 2005), EI is generally referred to as the functioning elements of nature that produce value, directly and indirectly, for people (Costanza *et al*, 1997; Benedict and McMahon, 2002; MEA, 2005; Yu *et al*, 2008; and Costanza**,** *et al*, 2014). Examples of these primary ecosystems or the systems of nature include forests, wetlands, rivers, land, springs, riparian buffers, minerals and oceans, amongst other; which together form a network of interconnected structural elements in the landscape (Yu *et al*, 2008; De Groot *et al*, 2010).

In addition, the secondary ecosystems (also referred or classed as artificial EIs) can be associated with the soft engineering strategies or engineered environmental designs such as open spaces, gardens, green roofs, parks, cultural heritage corridors, sustainable urban drainage and storm-water management systems, artificial wetlands, and other lower impact infrastructures because they promote the continued functioning of ecosystems services and goods (Benedict and McMahon, 2002, Yu *et al*, 2008; SANBI, 2014; and The Scottish Government, 2011). In accordance with the MEA (2005), policies based on the sustainable use of the world's EI have been developed (Hanson et al, 2008.; TEEB, 2011.; Costanza *et al*., 2014).

The South African Biodiversity Institute (SANBI) has developed the standard South African definition of EI. SANBI is the country's environmental agency for the implementation of EI policies and it reports to the Department of Environmental Affairs. According to SANBI, EI is referred to as the "strategically planned and managed networks of natural lands, working landscapes and other open spaces that conserve ecosystem values and functions and provide associated benefits to society" (Stephens, 2011: 4). From this definition, it is evident that EI exists on a continuum from natural landscapes to transformed landscapes similar to the concept of sustainability[1], which is subdivided into strong and weak forms of sustainability in this context. Even though the preferred EI may mean the natural lands (unmodified), the definition of EI allows for other forms of landscapes or open spaces (including those engineered or constructed by humans) as long as their objective is aiming towards the conservation of the ecosystem values and functions of nature. It must also be noted that some refer to natural capital and green infrastructure as interchangeable with the concept of EI (Benedict and McMahon, 2003; MEA, 2005; The Scottish Government, 2011).

2.1.4. Ecological Infrastructure and the Ecosystem Services links

The concept of EI and ecosystem services are related. They overlap in a sense that it becomes difficult to speak about EI without making reference to the concept of ecosystem services and vice versa. This close relationship between these concepts has caused confusion in the sense that some people use them interchangeably without knowing that they are different. As a result, they are unable to understand the paradigm shift that has taken place. Therefore, it is important to know the difference between these concepts and how they are interlinked.

[1] **Sustainability** is based on the idea that goods and services generated now should be produced in ways do not deplete and degrade the environment as this compromise the needs of the future generations (Davies, 2013). Several approaches are used to ensure that sustainability is realised in a development. Strong sustainability is based on the ideas to protect the value of intact EI (but not everywhere) and it argues that its change should be seriously limited due to the unique elements its provides for human existence and well-being. By contrast, weak sustainability perspective is based on the idea of technological solutions as its assume that the impacts caused by degraded EI due development can be compensated using human capital (ibid).

Costanza *et al*, (1997: 253) summarises the concept of "ecosystem goods (e.g. Food) and services (e.g. waste assimilation) as representing the benefits human populations derive, directly or indirectly, from ecosystem functions for human use". The ecosystems services (and goods) are differentiated from EI in that they are not the elements of nature or ecosystems - such as wetlands, rivers, riparian habitats, etc., but rather the services offered by these elements. Ecosystem services are the dependant variables as they are the services that emerge from the elements of EI (the independent variable).

Due to ongoing research to unravel the complexity of nature and its services, there is yet no single science that has discovered the whole list of services and goods that humans receive from nature for their use and survival in across different spaces over time. Spade (2013:11) explains the uses or functions of soil (the part and parcel of nature) and states that,

> We know that dirt supports the living planet and all of the food that we grow, serves as the *foundation* for our entire built environment, filters and recycles our water**,** dead bodies, and waste, *and* acts as a carbon sink, but we are finding out still more.

From this, one realises that understanding the full complexity of nature's goods and services is an impossible quest and there is a need for a framework to categorise these services so that they can be better understood when we are assessing and trying to incorporate them in decision making.

There is a growing research interest in the subject of EI and ecosystems services (eg. Costanza *et al*, 2014; De Groot *et al*, 2010; Benedict and McMahon, 2002; among others) since MEA- Millennium Ecosystem Assessment (2005). The MEA (2005) marked a major shift in the way in which the concept of ecosystem services is understood. This remarkable shift happened because the MEA (2005) tabled four classification systems that aiming to distinguish between provisioning, regulating, cultural and supporting services. Since then, the efforts to put the concept into practice have increased strongly (e.g. Daily and Matson, 2008; De Groot *et al*, 2010: 261). According to the MEA (2005), these four categories are focusing mainly but not limited to: -

1. **Regulating Services** are those services that create and maintain a healthy environment and they include services such as softening the impact of climate stability, flood and storm protection, regulating water quality, disease control, and erosion control etc.;
2. **Provisioning Services** are the services that produce food, water, fuel for energy use etc.;
3. **Cultural Services** are the services that provide meaningful human interactions with ecosystems include services related to spiritual, recreational and educational value that humans get from EI;
4. **Supporting services** such as soil formation, photosynthesis, and nutrient cycling

There is a growing consensus to use the MEA as a common framework for linking ecosystems to human wellbeing. Thus far, the studies on the role and use of EI argue that an investment in conservation,

restoration and sustainable ecosystem use are increasingly seen as a ''win-win situation'' which generates substantial ecological, social and economic benefits (De Groot *et al*, 2010., TEEB, 2011., CSIR. 2013., Costanza *et al*, 2014). Even though there is a consensus that the value of ecosystems services is incalculable, scholars now debate on how best to define the difference between ecosystem functions and services, and how to categorise the services in order to make them calculable (e.g. Wallace, 2007; Fisher et al., 2009 cited in De Groot *et al*, 2010: 261).

2.1.5. Ecosystem Disservices

While the concept of ecosystems services is important in this research, it has become important to also consider the concept of Ecosystems disservices. Gómez-Baggethun and Barton (2013) have argued that urban ecosystems do not only produce services, but also disservices. This is the case as there are rigorous valuation exercises about the benefits from ecosystem services whereas, there is a paucity of studies to understand the costs deriving from the ecosystem disservices (ibid). Ecosystem disservices have been defined as 'functions of ecosystems that are perceived as negative for human well-being' (Gómez-Baggethun and Barton, 2013: 238).

The main examples of the important disservice from urban biodiversity as stated by Gómez-Baggethun and Barton (2013: 238) include:

> damage to physical infrastructures by e.g. microbial activity decomposing wood constructions, corrosion of stone buildings and statues by bird excrements, breaking up of pavements by root systems, or animals digging nesting holes … Other important disservices from urban ecosystems include fear from dark green areas that are perceived as unsafe in night-time … and blockage of views by trees …. Likewise, just as some plants and animals are perceived by people as services, as discussed above, animals such as rats, wasps and mosquitoes, and plants such as stinging nettles, are perceived by many as disservices.

A summary of ecosystem disservices in urban areas is listed by Gómez-Baggethun and Barton, (2013: 238), revealing the wide range of disservices.

2.2. Understanding flood risk

This section below is subdivided into three main sections namely flood risk management strategies (including the participation and integrated flood risk management decision making), the significance of EI both locally and internationally, and lastly the support for EI in national policy frameworks, legislation and their influence on local decision-making.

2.2.1. The dominant strategies in flood (or disaster) risk management

Worldwide scholars (i.e. Andjelkovic, 2001; Jha *et al*, 2012., Ali *et al*, 2013., and Scott *et al*, 2013) now agree that either using structural and/or non-structural solutions to reduce flooding are in fact misunderstood by the public who believe and expect that these solutions should provide a 'certain' defence against the risk of floods. However, evidence in international and local studies indicate that these solutions are not an absolute protection against floods as it is made very clear that there is no flood control blueprint (Botes *et al*, 2011., Jha *et al*, 2012., Ali *et al*, 2013., and Scott *et al*, 2013). As a result integrated flood management approaches are gaining support as those using both these techniques are becoming more resilient against floods, though addressing and solving floods may differ from one place to another.

It is easy to distinguish between built and EI in flood management. However, it is hard to distinguish other sub-categories of infrastructure that emerge from these two main infrastructure types. For example, most of the literature indicates that the majority of the solutions of the built infrastructure reside under the strategies of hard engineering (also called structural solutions), whereas the solutions of EI reside in soft engineering (also known as non- structural solutions) (Jha *et al*, 2012; Ali *et al*, 2013; and Scott *et al*, 2013). Examples of hard engineering solutions under built Infrastructure may include establishment of stormwater systems in urban development (i.e. pavements, tarmac, concrete, and other impervious built up areas being managed using stormwater systems) in the floodplains, the use of levees, dams, channelization, amongst others (Andjelkovic, 2001.; and Messner *et al*, 2007). The defining characteristics of hard engineering solutions (also known as structural solutions) are that they are:

(a) Expensive options to address flood risks with more success stories in highly developed countries and limited successes in developing countries
(b) Based on controlling and defending the built up areas with hard infrastructure including levees, channelization, and other infrastructure that attempt to 'keep water away'
(c) Resist and do not accept the natural element of flooding
(d) Less environmentally friendly and change the natural flows of the river

Examples of nature's solutions may include the use of wetlands, river systems, riparian habitats, floodplains, passive and active open spaces, parks, springs, healthy mountain catchment areas, and other key ecological areas that provide many other ecosystem goods and services to our communities and to the environment itself (MEA, 2005., Hanson, *et al*., 2008., Yu *et al*, 2008., TEEB 2011., and CSIR, 2013). Furthermore, the concept of EI also relates to soft engineered structures (e. g. water treatment facilities, porous pavements and parks, sustainable urban drainage, green roofs, amongst others) because these aim to bring environmental benefits and also mitigate the negative impact brought *inter alia*, by the degradation of ecological assets (Benedict and McMahon, 2003: 5; The Scottish Government, 2011).

The distinction of soft engineering strategies (also known as non- structural solutions) to its counter-part, hard engineering is that its solution is easily identified due to the following characteristics;

(a) Inexpensive solution to address flood risks (with reported successes in developing countries and developed world)
(b) Accepts flooding phenomena and thus, orient their approaches to flood management and flood resilience approaches 'living with water and adapting in floods' (Scott et al, 2013).

(c) Based on afforestation (naturalization) of rivers and riparian areas
(d) Work with the hard engineering solutions
(e) More environmentally friendly as this promotes more natural flow of the river's channel

2.2.2. Participation and integrated flood risk management decision making

The more recent literature on integrated approaches to flood management decision making has shown that all the economic, environmental, and social science aspects are to be accommodated. This means that there should be more inclusion and more understanding of the elements of cultural, demographic, technological, environmental and institutional changes on flood risk management and the need for these systems to be understood and accommodated (Borrows, 2006).

However, with the review of the international literature on the sociological and political aspects of flood risk management (see Borrows, 2006., and Salvador and Norton, 2011) it is shown that there is a need to also understand how the views have developed and also the perceptions people have of the problem and the solution. Borrows (2006:135) argues that "there is little (if any) thought, given to the feelings, behaviour, and thought associated with stakeholders in flooding risk management. This also consider the interests (or needs) that often appear to be in conflict and more adaptable to the uncertainties of natural and man induced changes".

Factors such as the rise in climate uncertainty, development pressures, and increasing public expectations are also influencing the changing in which flood risk is managed.

2.2.3. The role of Ecological Infrastructure

There are many benefits that EI brings to people to achieve their economic, social, cultural, and other benefits. The sustainable use of ecosystems in cities may involve the high long-term economic savings and positive impacts on social, cultural (including sense of place, identity and community, social cohesion, and local ecological knowledge) and insurance values associated with ecosystem services (Gómez-Baggethun and Barton, 2013).

Most of the literature on the assessment of global EI has shown that EI offers the following benefits (but not only limited to):

(a) Protecting water quality and aquatic habitats;

(b) Providing habitats for terrestrial wildlife, including travel and dispersal corridors (Vermont Agency of Natural Resources, 2005);

(c) Trapping sediment load/transportation from eroding to downstream areas;

(d) Sequesting carbon to reduce the impact of greenhouse gases which cause escalating climate conditions;

(e) Reducing the effects of storm events. However, Vermont Agency of Natural Resources, (2005: 23) explained that, "even a well-buffered low valley river is likely to still be heavily impacted by storm events if the tributaries that feed that river are not buffered with riparian vegetation". Therefore, it is with the design for adequate buffer of vegetation where the storm events can be reduced from impacting negatively on properties.

(f) Recharging underground water and slowly release it to the surface waters during the dry seasons; and this benefits the local people

(g) Supporting significant natural communities and adjacent wetlands; and

(h) Protecting channel-forming processes and channel stability

The following sections further discuss how EI helps in terms of climate change, flood attenuation, isolated wetlands and the impact of obtaining single ecosystems' benefits, reduced erosion and storm events of EI, pollution control of EI, cultural and spiritual benefits, among other benefits leading to more vulnerability to flood risks.

Climate Change

Due to the importance of EI, it is noted that well managed EI can protect human settlements and built infrastructure against extreme events that are likely to happen or increase due to climate change, playing a crucial role as a cost effective strategy in disaster risk reduction (Stephens, 2011; DWAF, 2013).

This is particularly important as the science predictions indicates that in different parts of South Africa, the climatic conditions will either become much wetter or drier, and therefore ecosystems services will be required to help curb excessive loss of water through evaporation and *evapotranspiration* in drier areas (Stephens, 2011). In places where it is expected to become hotter and wetter (i.e. eastern part of the country), EI will be of use as it will slow down flood waters (DWAF, 2013). In both cases (i.e. the case where it will be too warm and too wet), EI can contribute to water security, food security, and other co-benefits through the services provided by intact ecosystems.

However, in order for the services to be maximised during these periods (i.e. floods and droughts), there needs to be intact EI. This means that EI must be buffered, monitored, sustainably used, and well managed. The approaches for ensuring intact EI, particularly in relation to flood management, are discussed further.

Flood attenuation function of EI

During the flooding events in rivers, the riparian areas allow floodwaters to spread out horizontally over the land, thereby reducing the force and velocity with which the floodwaters move down the stream (Kotze, 2000). This reduction in stream power is important for not only the hydrological patterns of the channel/stream flow but also it is useful in the protection of human investments in and around the floodplain (ibid).

Similarly, the same applies to wetlands**.** The wide distribution of the riparian zone in wetlands can absorb floodwaters, thereby reducing the quantity of water coming in to the channel over time, thus reducing flood speeds (Kotze, 2000, Agency of Natural Resources, 2005, and DWAF, 2013). While performing this function, wetlands also support the surrounding communities with food (i.e. fish); provide water, and other economic, cultural and spiritual land use practices, including the sense of place (Agency of Natural Resources, 2005).

Kotze (2000) further remind that, a relatively narrow buffer (the cleared vegetation) may maintain short-term stream bank stability while the practice of maintaining a wider vegetated riparian (or more vegetation) corridor will be more effective in the long-term. They argue that the channel will naturally migrate out of a narrower buffer area. This situation is expected to increase because of climate change that will cause extreme weather events such as floods and droughts.

Evaluating Isolated Wetlands and the impact of obtaining single Ecosystems Services

Although an isolated wetland may perform a significant flood control function, many scholars have argued that an effective control is more often the result of the combined effect of a series of connected wetlands within a particular catchment (Verry and Boelter, 1978 cited Kotze, 2000; and DWAF, 2013). Thus when considered separately, the upstream wetlands may appear as if they have a minor influence on flood attenuation, however, they play a major role in flood attenuation (INR, 1988 and Kotze, 2000). A study by the Institute of Natural Resources (INR, 1988) titled "The role of Wetlands and Land Use in Upper Catchment Areas above Ladysmith" reveals the value of wetlands in managing floods. However, upstream wetlands are often numerous, and when considered collectively (on a catchment scale) their cumulative effect may be substantial (Kotze, 2010: 5). In spite of the focus of the investigation on wetlands, the recent literature (i.e. Kotze, 2000., and Vermont Agency of Natural Resources, 2005) argue that it is important not to evaluate only the potential of one service. For instance, the regulating services (e.g. flood attenuation) brought *inter alia* by the wetlands as this is done at the expense of provisioning, supporting, and cultural functions of ecosystem's services (MEA, 2008). This section argues that the ecosystems functions should not be evaluated in isolation because all the functions work well when they are balanced.

Reduced erosion and storm events function of EI

Vegetated riparian corridors "play a critical role in maintaining channel morphology through bank stabilization, flood attenuation, and providing the space necessary for the expression of meander geometry and the maintenance of channel slope" (Agency of Natural Resources, 2005: 24). Furthermore, these corridors also help to lessen the effects of storm events on river channels, and retain sediment transport (Kotze, 2000; and DWAF, 2013). In order to maximise the functions of riparian vegetation in reducing the impact of storm events, Kotze (2000) stipulates catchment planners and managers must not ignore the tributaries that feed into the main river. He argued that, the tributaries are supposed to be buffered with riparian vegetation. In summary, this means that there should be interconnection in the planning and management of rivers and wetlands because the isolated natural systems work poorly in flood attenuation and storm event regulation.

Pollution control benefits of EI and consequent implications for river and water reservoir health

With poor management, monitoring of the catchment areas, an excess of nutrients, such as phosphorous and nitrogen, can cause eutrophication in surface waters (i.e. nutrient enrichment that stimulates aquatic plant growth) (Vermont Agency of Natural Resources, 2005). Sources of nutrients include lawn and agricultural fertilizers, and human and animal waste. Riparian areas are very important in keeping pesticide application away from streams, rivers, and lakes, and preventing direct contamination of the water body and reducing the health related danger such as drift (i.e. the movement of the pesticide at time of application away from the application target to the surrounding environment). In this way, the wider riparian vegetation can play a significant role as it can filter and purify water just like the water treatment plants. With the wider riparian setbacks[2], this can increases the retention time for chemicals, allowing more opportunity for contaminants to decompose before reaching the waterbody (Vermont Agency of Natural Resources, 2005). This is important as Asmussen (1977) cited in Vermont Agency of Natural Resources, (2005: 6) discovered that "a 78-foot grassed buffer reduced pesticide levels in surface runoff by about 70%".

This section also shows that the EI can provide economic savings to maintain and treat water rather than investing large sums of money it to engineering water management infrastructure. For example,

[2] **Setback** is defined as the "physical distance separation measured from the edge of developed area to an identifiable natural heritage feature. Examples of natural features include, but are not limited to, wetlands, river, stream, aquifers and ground water recharge areas. The purpose of a setback is to separate two different land uses to minimize the impact of development on natural heritage features and functions, to protect individuals and property from natural hazards, and to control access and encroachment within adjacent natural area"(City of London, 2007:2)

one of the European cities used the EI principle in their strategy to invest in the Green-Blue storm water management (over piped solutions) and thus increased the economic savings (See Box 1 below).

Box 1. Norway Experience on Blue- green storm water option over piped water system

To elaborate how an investment in the value of artificial EI of Hovenbekken river in Oslo (Norway) really works on the ground, the project based on Blue-green storm water management (linked to the opening of the rivers program) was explored during fieldwork undertaken by the researcher in June 2016.

(Photographs by Njabulo Ngcobo, June 2016)

Pictures above show sustainable storm water material used in Hovenbekken River, Oslo. Permeable material discourages runoff and contributes to the reduction of the rate of flooding (OSLOpenNESS, 2015).

The outcome of the economic assessment indicated that the hard engineering solutions investment in a piped solution [Nok 17.4 million-investment cost] over a distance of 6650m of road for runoff, bypassed the cost of investing in a Blue-green storm water strategy (OSLOpenNESS, 2015). In terms of estimated value of a Blue-green storm water management [Nok 14.4 Million investment cost] in Oslo, Norway it is revealed that there was a 3 million Krone (Equivalent to $120,000) investment savings and Nok 600 000 per year in cost savings for insurance claims by using EI (ibid).

Unlike many hard engineering solutions such as piped storm water management, the investment in the Blue-green storm water management indicates how soft engineering can be used in rivers sustain the functions of the natural flows. The Norwegian Blue-green storm water management strategy has also shown that the integration of EI principles (measures that promote permeable materials) in storm water planning can be used to purify the polluted storm water and improve water quality. These soft engineering strategies for low impact storm development in the urban environment will reduce the surface runoff and contribute to more infiltration than surface runoff.

EI impact on aquatic life and the livelihoods of communities

The suspended sediments in close proximity or above the stream can negatively affect the lives of the aquatic biota that breathe with gills (i.e. fish, larval salamanders, and many aquatic insects) (Vermont Agency of Natural Resources, 2005). For example,

> The gills can be coated with sediment or physically eroded by sediment, both resulting in a reduction of oxygen uptake from the water. Gill damage can seriously impair an organism's health, or in severe cases, cause death. Similarly, the turbidity caused by sediment suspended in the water, can also decrease detrital decomposition and algal production …, both important processes that provide food for aquatic invertebrates, to name but a few (Vermont Agency of Natural Resources, 2005: 8).

Therefore, an investment in the maintenance of EI such as river or wetland buffers will improve the health of the river's aquatic life on which the surrounding communities depend. In this way, this improves the socio-economic conditions of the communities depending on the provisioning services (food) of the river.

Spiritual benefits of nature, the role of cosmology, and lessons

Bernard (2003), Nkosi (2011), and Ngobese cited in Henning (2011), focus on the role of African religious practices and how these have led to the environmental conservation of large ecosystems goods and services with their use (and understanding) of spiritual benefits of nature. Bernard (2003) wrote about the impact colonisation and Christianity had on the culture of the Zulu nation (and other Nguni subgroups of Southern Africa). In his study which focused on perceptions, myths, and cosmology of Southern African tribes, Bernard (2003) reported that the rivers and wetlands were seen as the pools in which water spirits reside and they therefore have a sacred status. According to his research, sacred water is critical in the training of healers, as well as being important sites for the performance of family rituals.

Bernard (2003) further stated that the Southern African tribes previously referred to as the 'Bantu people' believe that the water spirits play a significant role in protecting water sources and also in keeping these African tribes alive. The water spirits (not only found in the water, but also in other resources such as forests, soils and mountains) can be chased away by disrespectful behaviour, social disharmony, the killing of sacred animals, or if the over-harvesting of riparian zones take place (Benard, 2003; and Spade, 2013). The study further states that such forces are regarded as the guardians of fertility, morality, and life itself. Any disrespect shown to them may result in drowning, droughts, floods, and tornadoes. This research was done in many countries such as in Zimbabwe and South Africa and it was discovered that such knowledge was uniform and formed the cosmology of these people.

Bernard conducted his study over a very large area (Southern Africa) and did not specifically use Ladysmith as one of the case studies. Thus, it is imperative to verify his findings in the local case study

area. This will be done by furthering his research and then verifying whether this knowledge is true to the Africans (i.e. the Zulus) in Ladysmith. In the face of 'multiculturalism and conflicting rationalities' (see Sandercock in Watson, 2003), it is crucial to broaden the scope of participation and then explore various ways in which people can be included in environmental management which forms part of flood disaster reduction. It is not about whether these beliefs and myths are right or wrong, reliable or not. Rather it is the interest of the researcher to document their perceptions of environmentalism as a way of life and also to record how this has changed. This knowledge is of interest as it relates to the cultural benefits of ecosystems services. Therefore, there is a role that this knowledge can play in decision to manage disasters and environment.

2.2.4. Financial Institutions for managing ecosystem services of EI

There are two different approaches to valuing ecosystem services. This research argues that the conventional market based approach of managing EI is based on the assumption that the supply of EI is infinite. It argues that EI cannot (or should not) be privatized since conventional markets institutional frameworks work poorly, if at all (Costanza *et al*, 2014). This is true as Costanza *et al* (2014: 154) further clarified that "even if fish and other provisioning services enter the market as private goods, the ecosystems that produce them, (i.e. oceans, rivers) are common assets". Scholars (De Groot, 2010; and Costanza *et al*, 2014) further conclude that most ecosystem services are public goods and are the product of common assets (non-rival and non-excludable) or shared pool resources (rival but non-excludable).

In order to measure the value of the ecosystems or EI to humans, the services derived in these natural systems are identified and documented using both qualitative and quantitative measures but some are questioning why there is a monetisation of EI. The notion of putting a value (i.e. the use of monetary units) is actually the estimate of their benefits to society as this is currently perceived as a better tool (or method) to communicate with a broad audience in the monetary or commodity economies. According to Costanza et al (2014:157) "this can help to raise awareness of the importance of EI to society and is serves as a powerful and essential communication tool to inform better, more balanced decisions regarding trade-offs with policies that enhance GDP- Growth Domestic Product but damage ecosystem services".

Having said all of this, one must note that it is then a misconception that the valuation of ecosystem services (in monetary units) is an act of commodification or privatization. Due to the lack of the framework of institutional management of EI, the leading scholars in the subject of EI such as De Groot and Costanza *et al*, (2014; 152) made a call that these services must be valued, and there is also a need to develop a common asset institution to better take these values into account.

According to the global ecosystem report (TEEB, 2011) there are emerging new accounting standards, such as the GASB-34- Governmental Accounting Standards Board of the United States, which exemplify one of the emerging methods to incorporate green infrastructure into a city or state's budget as it highlights the economic trade-offs between built and natural capital. Similarly, the economic savings from the sustainable use of urban ecosystems derive from the lack of the need to restore and maintain public services through built infrastructure investment. Part of piloting the new financial instituting of managing EI in the developing world, the notion of Payment for the Ecosystem Services (PES) has been used in Latin America and in African countries like South Africa (Sherbut, 2012).

Another increasingly popular common financial institution to manage EI benefits is known as the Payment of the Ecosystems Services (PES). It is successful in developing countries such as in Latin America (Sherbut, 2012). According to Blignaut and Mander (2010) cited in Sherbut, (2012: 1), based on their research which considered five watershed restoration and reforestation projects in South Africa, it is estimated that "conservation in these areas has provided a monetary annual return equivalent to R116 to R220 per hectare per year over periods of about 30 years compared to equivalent estimated costs of watershed restoration totalling between R21 to R88 per hectare per year".

The system of PES has been adopted and piloted in South Africa and it is hoped that it will benefit rural communities (especially targeting the former homeland areas) with the incentives of managing ecosystems and also maintaining the good health of the country's ecosystems. It is evident that the South African national government has identified the need to address sustained economic growth while also preserving the natural environment. PES presents an opportunity to achieve these dual goals. The practice is still new and very few studies that explain the methods that worked well and the projects which have been completed. For example, the Palmiet River Rehabilitation Programme in Durban, Okhombe Monitoring Group project in the Ukhahlamba LM (one of municipalities of the Uthukela DM), are emerging as possible case studies (The Water Wheel, 2005). These projects are focusing on catchment management.

Plate 2.1: Land Management Issues in the Okhombe, Mweni Area *(Source: The Water Wheel, 2005: 14)*

The Mweni project by the Okhombe Monitoring Group is not only helping and benefiting the local area, but the benefits of their practice also result in savings in the country's economy. (Please see Plate 2.2 below)

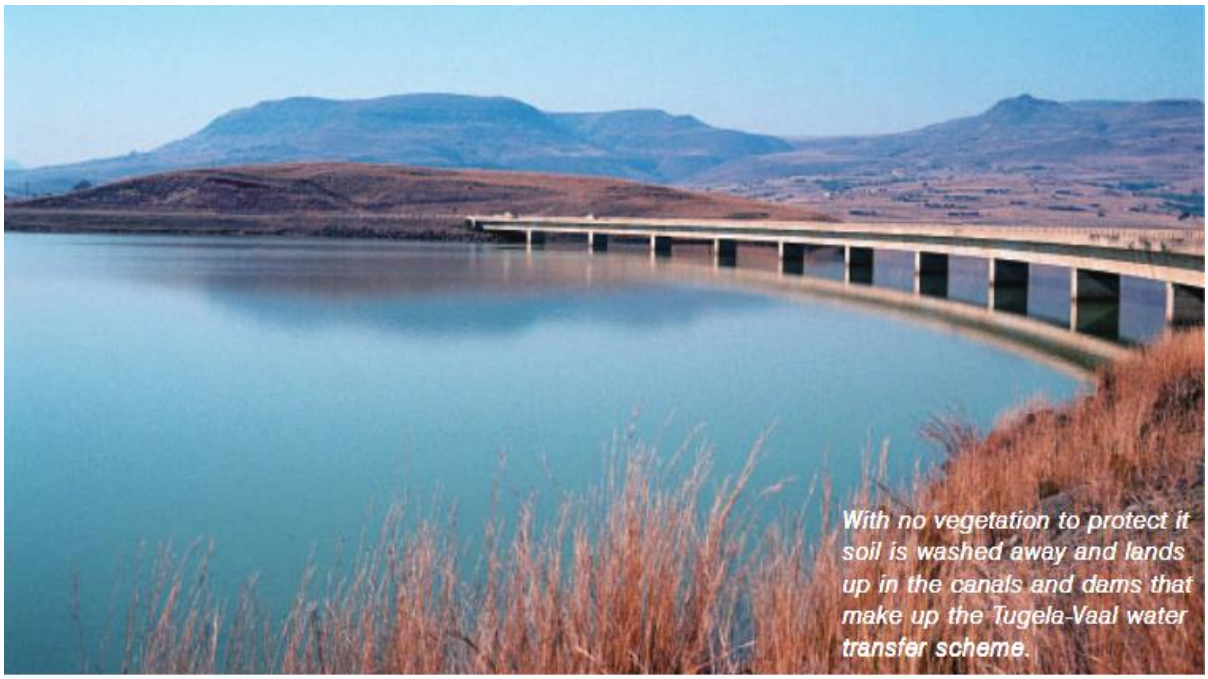

Plate 2.2: Water Regulation Services of the vegetated catchments in the Mweni Area (Source: The Water Wheel, 2005)

The Mweni catchment rehabilitation project shows that the local communities are capacitated with the skills to manage their EIs. With this approach, EI and its various functions are maximised.

2.2.5. International precedents

The section below on international precedents explains the manner in which the principle of EI have been used elsewhere. These cases derived from Nellemann and Corcoran (2010) indicate how the concept of EI can be used differently, and what lessons can be learnt from their programmes. The first case study is a project that was developed in the Philippines over the past two decades after it was hit by a tsunami. After this disaster, an ecological solution was chosen based on re-planting mangroves in the coastal environments.

However, this project did not achieve its goals. According to Nellemann and Corcoran (2010), the cause of the failure in this project was because there was a lack of knowledge and sound science. For example, the unsupervised foreman planted mangroves in the poor soils and other places where the conditions were unfavourable and therefore re-planting of the mangroves aiming to rehabilitate the coastal environment became a failure.

From this international experience, one learns that an investment in the preservation and conservation of EI practices does not simply mean that there will be an automatic transition towards sustainability in terms of environmental, socio-cultural, and other development trade-offs. However, all feasibility studies and reports deriving from the specialists will be required in order to plan adequately and more comprehensively. These studies involve Environmental Impact and Heritage Impact Assessment Studies, to name but a few.

The second case study based in Vietnam was based on the successful practice of an investment in the value of EI (Nellemann and Corcoran, 2010). Just like the case of Philippines, they embarked on the project of mangrove re-planting as a climate change strategy along the coast. From the economic impact study based on this soft engineering approach, they discovered that the cost for mangrove restoration (US$ 1.1 million) was cheaper as compared to expenditure on dyke maintenance which could have resulted in the additional costs of US$ 2.3 million annual expenditure (Ibid). It is also noted that Mangrove re-plantation benefited the local people (estimated 7,500 families) as it improved their livelihoods in terms of planning and protection. According to Nellemann and Corcoran (2010), these projects are not limited in these places but countries like Bangladesh have realised the importance of investing in the value of EI as they apply it in the coastal areas such as planting the forest to form a greenbelt. This was done in order to minimise or regulate the negative impact of cyclones (resulting in floods and storms) (ibid).

Nellemann and Corcoran, (2010) report that today one third of weekday trail users of the American cities (e.g. Washington D.C., and Seattle) are travelling in major urban areas on trail systems. It is important to understand the experience (and their programs) of these cities as the trail system is a good example of how the EI functions are respected and sustainably used (and concept integrated) in transport and land development policy. Municipalities include trails and greenways into city plans not only for recreational purposes, but also to encourage the use of alternative transportation systems that contribute to more respect of the ecological areas. Using passive recreational trails along riparian

areas and natural features allow people to exercise, and renew their spirit, thus contributing to a healthy lifestyle (Steiner and Butler, 2007).

However it is also stated that adhering to a variety of local, national, provincial laws and regulations as well as simple, universal principles of environmental or water stewardship examples, a trail maybe designed to lower the risk of flooding and also serve many other functions (Rail to trails Conservancy, 2016). Good trail design can balance the desire to be near water with environmental protection by incorporating scenic viewpoints, vegetative buffer zones[3], and by minimizing the number of wetland crossings (ibid). Unlike tarmac freeway development, trail development promotes soft engineering development and it also have low environmental impact as it can be allowed within the park or a buffer zone (City of London, 2007; and Steiner and Butler, 2007). In the guideline for good planning and design, the literature also suggests that trail work should be designed in a manner that prevents many potential erosion problems (Bureau of Trails, 2004). For example, this can be done by avoiding the use of heavy equipment whenever possible, thus reducing the amount of disturbances to the natural resources (See Box 2).

Ecological Buffer zone is referred to as a "planned and managed strip of land and vegetation between development sites and identifiable natural heritage features. Buffers are required and designed for the protection of natural heritage features and ecological functions. Key ecological functions may include, but are not limited to, acting as a filter to minimize impacts from adjacent land use, providing linkage as a wildlife corridor around or between habitats, functioning as a windbreak to protect sensitive habitat, and contributing to habitat and species diversity" (City of London, 2007: 2). Zoning, as a management tool for habitat protection, is used to differentiate between areas of development and areas of no development, or open space. In the zoning of land, a buffer is a transition zone between two land uses that separates and protects one from the other. "The width of the buffer zone must be large enough to sustain the two land uses on either side without conflict or impact" (Ibid: 7).

Box 2. Soft engineering trail programs and implication for environmental management and planning

Due to strong activism for trails system, the Seattle Parks and Recreation department has formed a political buy-in to the trails proposed in the city of Seattle. This box discusses these projects.

According to Salisbury (2016) Seattle Parks and Recreation's Trails Program focus mainly on recruiting volunteers and also work with other partners to address the need for trail development standards, construction and maintenance within their natural areas (in more than 4,000 acres). Under the program, they are taking a register of current trails and guiding new trail development. One of the key drivers of the trail development is to avoid environmental impacts. The pictures below show how these impacts are addressed through environmental design solutions in the passive recreational trails.

(*Source: Salisbury, 2016*)

Within the trail programs inside the parks, the Seattle Parks and Recreation has formed a partnership with the organisations such as the Youth Green Corps, among others. Its function is to educate and train young adults through a mix of classroom experiences and outdoor forestry restoration. In an effort to address youth employment and create a pathway into green jobs, Parks teaches site management, restoration skills and management, native plant species, invasive plant identification, and environmental stewardship to the participants in the Youth Green Corps while working in Seattle Parks. In return, the participants aged 18-24 receive the amount of $1,000 per month stipend.

Another example of collaboration between government and civil society organisations was between the department of Seattle Parks and Recreation and Seattle Trails Alliance (STA). STA is made up of a coalition of walkers, hikers, commuters, foresters, pedestrians, runners, and neighbours who are coming together to democratize public space.

Volunteers to improve the experience of getting outdoors in Seattle have built the **Seattle Trails App** as a free collaborative project. It is a teamwork between Seattle Parks & Recreation Department, Seattle Trails Alliance and volunteer software developers. Its function is not only to show you where all the official trails in Seattle are, but its features enable the users to also document and officially report issues that are found while walking on trails to help the city improve its park.

Due to the trail programme, there is reduction of the need for construction of more roads and investment in other luxurious transportation infrastructure systems and thus contributing to the protection of the EIs especially those that are responsible for flood attenuation. This practice indicates how the design of the place can influence the living and consumption patterns of the people. This is also relevant in terms of the ELLM Disaster Management Plan Review 2015/2016 as it is states that, the development policy with their sustainable development policies can contribute in disaster management as it form part of the non-structural strategies. In this way, the experience and programs of these cities are important in this research because they clearly show how the municipal officials and other parties in protecting the key multifunctional EIs such as riparian zones used the development policies in their planning.

From reviewing the precedent studies contained in the literature on EI, the lesson learnt is that without careful planning and sound science in investing in disaster mitigation, the application of EI can also be a waste and a disaster rather than a solution to environment and to development itself as evidenced in the case of Philippines (Nellemann and Corcoran, 2010). However, the notion of EI seems to be a success in many precedent cases where they relied on sound science. Examples of these successes have been highlighted in Vietnam, Bangladesh, and Seattle among other places (Nellemann and Corcoran, 2010; Salisbury, 2016). KwaZulu-Natal also offered an interesting case as it is clearly shown how the community led project that has been used by the Okhombe Community Monitoring Group in the Drakensberg were able to drive the initiative to rehabilitate the catchment in order to avoid the siltation of the Tugela-Vaal transfer scheme (The Water Wheel, 2005). This section has shown that it is impossible to restrict the access to the natural features because communities have links to nature. However, there are ways to regulate human action in relation to nature and many examples have shown how the water and environmental stewardship can achieve better compliance and harmony between people and EI.

From a planning perspective, zoning by-laws are the most effective and versatile regulatory tool that are used to implement the policies of the official plan (City of London, 2007: 2). However, the real implementation of these policies on the ground depends on the buy-in by the users of the space, and whether the processes of participation represented the users' opinion. The review of the precedent cases about the causes of the failed projects underlies the fact that, governments undermine the local control and have poor understanding of the existing structures that shape the community's understanding of natural features. There are many ways to do this such as promoting locally controlled environmental rehabilitation programs.

2.1.1. Adopting of Millennium Ecosystem Assessment policies in South Africa

Not only have the MEA criteria been accepted in academia and environmental agencies and movements but governments (such national, provincial, district, and local municipalities) have translated the principles and its ideas into practice. The role of national governments in using the MEA framework is in terms of developing new regulations and markets to protect ecosystem services and functioning (TEEB, 2011). South Africa is part of this quest to minimise the violation of natural assets as the country's authorities realise the role of EI in climate change adaptation and the service it gives to saving the costs for their communities.

For example, SANBI aligns with the MEA policies as it has already established a framework for implementing the concept of EI. This is in accordance with the requirements of the Department of Environmental Affairs (a custodian of the environment in the country of South Africa), Section 24 of the Constitution, and in terms of the requirements of National Environmental Management Act of 1998, amongst others. Furthermore, the concept of EI is supported in terms of South Africa's National Development Plan 2030 vision. This is the case in the MTSP- *Medium Term Strategic Planning 2014-2019, in terms of the outcome number 10* which indicates that the government is supporting the "protection and the enhancement of the environmental assets and natural resources" (Phillips, 2014: 28).

This is not just in theory but there are various pilot projects in the country aligned with the government (Department of Environmental Affairs). These projects included 'Working for: Water, Wetlands, Ecosystems, Land, and Fire, among others". Other than government, the non-exhaustive list of other stakeholders in the environmental agency in South Africa and KwaZulu-Natal applying EI thinking are SANParks (South African National Parks), CSIR (Council for Scientific and Industrial Research), WESSA (the Wildlife and Environment Society of South Africa), WWF (World Wide Fund South Africa), DWAS (Department of Water Affairs and Sanitation), and KwaZulu-Natal eZemvelo Wildlife.

2.1.2. Supporting legal frameworks, policy, and legislation

In January 1999 the Department of Provincial Affairs and Constitutional Development (now the Department of Provincial and Local Government) published the White Paper on Disaster Management. The principal focus of the policy was on preparedness, prevention and mitigation of the disasters. This meant that reducing the potential for loss of life and injury, and the economic and environmental costs that result from disasters is prioritised through appropriate steps aimed at:

(a) Increasing preparedness for disasters and improving response capacity among all sectors of society by,
(b) Disseminating relevant information and undertaking programmes of awareness creation, education and training;
(c) Reducing the probability of disasters occurring and reducing the severity of the consequences when they do occur; and
(d) Reducing the vulnerability of communities, especially the poor and disadvantaged, to the hazards and threats posed by disasters (Department of Provincial and Local Government, 1999).

To achieve these objectives, the policy proposed that the risk reduction strategies should be incorporated in all development planning and actions undertaken in the public and private sectors. It further stated that the development plans of the local municipalities should be prepared within the framework of coherent and integrated disaster management frameworks deriving from the national, provincial, and the district municipality. Due to the limited scope of this research that focuses on the role of local government, it is impossible to discuss the details of other spheres of governments in disaster management. However, the ELLM disaster management unit must align with the guidelines from the provincial department of Cooperative Governance (COGTA) responsible for the establishment and update of the disaster management frameworks in the KwaZulu- Natal. COGTA specializes in issues concerning disasters and disaster management in this province. In order to implement provincial and national legislation and policy in local municipalities, a district office has been established in Ladysmith and its function is to further assist Uthukela DM and hence the ELLM. The National Disaster Management Framework and the Disaster Management Act, 2002 (Act No. 57 of 2002) further prescribes the structures and procedures that are required to be implemented at the municipal level of governance.

This section has explained the main national policy and legal framework for the disasters in South Africa as required in terms of DMA. It also has set out what the responsibilities of the spheres of government in the implementation of the important requirements set out in the DMA are. Most importantly, this section indicates the relationship between the planning and disaster management and policy that will be further discussed in the following section.

2.1.3. Legislation and Policy Framework for the Integration of the Disaster Management Plans into the Development Plans

There are positive trends in the South African literature, policy frameworks and legislation on disaster management, particularly around the issues of climate change, flooding, development, and environmental issues. For example, the key policy proposals set out in the White Paper, (South Africa, 1999:13) are focused on the incorporation of the risk reduction procedure into developmental programmes in South Africa (Reid, 2005). According to *ibid*, the primary aim of the policy proposals is to build a resilient South Africa by reducing vulnerability in households, communities and areas that are at risk. The assurance of making the role of the local municipalities in disaster management possible has been through implementing legislation that guides the development plans.

Municipal Systems Act No 32 of 2000 (MSA)

In terms of section *26(g)* of the Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000) it is stated that there should be an inclusion of Disaster Management Plan as an essential part of the municipal Integrated Development Plans (IDP) and therefore, it is required that, the ELLM complies with this.

NDP and MTSF 2014- 2019

A main focus in addressing natural resource degradation and depletion of EI is to implement the Environmental Management Framework as this ensures that policies and programmes address the long-term needs, and that unavoidable environmental losses are offset by investments in related areas (Phillips, 2014). The protection and sustainable use of natural capital or resources in South Africa is guided by the National Environmental Management Act of 1998. The Environmental Management Framework is also an attempt to ensure that the appropriately targeted land, estuaries, coastal areas and oceans are protected (Phillips, 2014). In fulfilling their commitment to the international community to addressing climate change through implementing NEMA and respecting the Constitution of the country, legislation to address air pollution has been passed, and measures to ensure water security and healthy catchments, rivers and wetlands will be reinforced. Due to this, there are as many reasons as to why investment in EI make sense in variety of scales including, the role of South Africa in the world.

This is the case because South Africa is not just the contributor to greenhouse gas emissions (and thus causing climate change) but it is also vulnerable to the impacts of climate change as this is affecting their economy, water, food security, health, and natural resources (Phillips, 2014: 28).

2.1.4. Other guiding legislation and its relevance

National Environmental Management Act, 1997 (Act No. 107 of 1997)

The legislation requires an Environmental Impact Assessment for any greenfield development to ensure that appropriate measures are taken into account for any development that will affect the natural systems protected in terms of this legislation. The concept of sustainability is applied as one of the measures to minimise the environmental impact of the development and its impact on the public and the future generations. Furthermore, NEMA also assigns the duty to all the organs of the state to play a role in taking care of the environmental issues more seriously. As for the District municipality and the Local Municipality, they are required to establish an Environmental Management Framework and also a Strategic Environmental Plan. This ensures that environmental matters are taken into account in development or strategic plans of the Local Municipality.

National Water Act, 1998 (Act No. 36 of 1998)

National Water Act (NWA) states that any developer establishing a township is required to provide 1 in 100 flood line data to avoid encroachment into these inundating areas causing harm to the lives, investments, and properties of humans. The importance of zoning of these lands for water's right of way (conservation) has proven to be very important as those that continue to stay in these areas comesat a high price, as many of the costs cannot be recovered (Mandela cited on Ladysmith Gazette, 1994, Jah et al, 2012, and Ali *et al*, 2013).

According to the NWA, the wetlands and associated riparian habitats, are protected and should be zoned as the no-go areas in terms of development on site. However, an exception is made when there is high demand (eg. public good associated with the development) such as in the case when the development would impact positively on the environment. In this particular case, the rezoning of the wetland and its riparian area can happen but must take into account the guidelines for the effective management of wetlands or at least comply with the low impact development guidelines. The following should be taken into account:

(a) The wetlands should be retained for the ecosystem goods and services they supply, and only the rehabilitation and conservation activities may be proposed within this zone.

(b) In cases where wetland impacts cannot altogether be avoided or acceptably mitigated on-site, consideration must be given to establishing off-site (e.g. the wetland offsets) that would result in a positive impacts for wetland management in the region.

(c) A 32m confidence buffer will be established around each wetland as an on-site delineation of wetlands.

In the case of Ladysmith, South Africa there is no total restriction of the wetland development proposal as long as the proposed development resides harmoniously with nature or at least has a minimal impact (i.e. the reviewed risk management plans for mitigating the negative environmental impacts).

Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)

In terms of Conservation of Agricultural Resources Act, it is stated that there should be a 10m buffer as the objective of protecting stream banks from erosion and head cuts and general overgrazing of immediate riparian zone. This is an important guideline for the farming and grazing practices done in the inundation areas. This was important because it guided the researcher when he was doing a participant observation and taking notes about the land uses that caused the flood risks. There is also an ongoing battle between the proposed "Preservation and Development of Agricultural Land Framework Bill: Draft" currently in attempt of repealing the Agricultural Land Act, 1970 (Act No. 70 of 1970) but due to limited scope of the study, this legislation will not be discussed.

KZN Ingonyama Trust Amendment Act, 1997 (Act No. 15 of 1997)

KZN Ingonyama Trust Amendment Act is important in this research because one of the case studies (the Emachibini, ward 7 and 14) is administered by the Ingonyama Trust namely, the Abathembu Tribal Authority. This area is enlisted in the Ingonyama Trust Land Act of 1994. In terms of gate keeping in areas outside of the scheme, the Induna was identified as a custodian or key stakeholder to be consulted first before entering and doing research in the rural village of Emachibini because the land is under control of the traditional authority. Due to its governance under both the Ingonyama Trust Board and the municipality, the development regulation is that developers must apply to the Ingonyama Trust Board to lease these lands as no one is permitted to own the property. After obtaining the authorisation to use the land, the developer is expected to fulfil the requirements of the local authority in the municipality in terms of meeting the requirements of the traditional Land Use Management System expected when using the land outside of the scheme.

Spatial Planning and Land Use Management Act, 2013 (Act No. 16 of 2013)

This is the current planning legislation guiding all the municipalities (and the role of other organs of the state) and it follows the *Development Facilitation Act* No. 67 of 1995 (*DFA)* which is deemed to be unconstitutional. In terms of the *Spatial Planning and Land Use Management Act* (SPLUMA), more

planning control is given to local municipalities. Most of the decisions relating to land development in the municipality fall under the mandate of the municipality who is expected to create by-Laws of SPLUMA. Currently, the municipalities are in the process of creating the categories of land development application and the by-Laws relating to SPLUMA. These have already taken effect since July 2015, but there are many challenges faced by the municipalities in the implementation of this national spatial planning legislation.

Among other development principles, SPLUMA in Chapter 2, section 7 (d) speaks about the principle of spatial resilience which is relevant in the subject of flooding. This development principle found in SPLUMA states that there must be flexibility in spatial plans in terms of policies and land use management systems as they must be accommodated to ensure sustainable livelihoods in communities most likely to suffer the impacts of economic and environmental shocks.

With this in place, the planners at the local level will be in a better position to influence decision making in the sense that they can understand with the knowledge of various stakeholders and thus advise the developers, mayors, councillors, and the community, among others about the spatial use of land for optimal benefit. This will help integrate the work of the spatial planners with those of environmentalists and other professionals to take into consideration the issues of sustainability and climate change affecting their places.

KZN Heritage Act, 1997 (Act No.10 of 1997)

While the South African Heritage Resources Agency prevails over the administration of heritage resources in all the provinces in accordance with the National Heritage Resources, 1999 (Act No. 25 of 1999), the principal legislation guiding cultural heritage sites in KwaZulu–Natal is the KwaZulu-Natal Heritage Act, 1996 (Act No. 10 of 1997). This information is important as any initiative concerning heritage resources in the province, as defined or protected in the Act, must be approved by Amafa aKwaZulu-Natali. In terms of the Act, the proposed development in the ELLM (and KZN) must prevent the violation of the historical, palaeontological, and archaeological sites aligning with the report or specialist studies such as those of the Heritage Impact Assessment.

2.2. Conclusion

As part of the conceptual and theoretical background, the first section of this chapter discussed what EI is and how is it interlinked with the work of past ecological planners who emphasised the importance of environmental aspects in design. As part of discussing the impact of EI, the researcher also reviewed and discussed the relationship between ecosystems services and disservices as argued by different scholars in the field of EI. Recent debates were discussed and international and local EI programmes were examined in order to explore how EI has been used elsewhere. Section 2.2 of this chapter has discussed the literature that dominate a recent understanding of flood risk decision making. The review of the literature on integrated flood risks decision making has shown that there is a need to incorporate the sociological and political aspects in flood risk management literature, as the technicians usually ignore this. Lastly, this chapter has considered how (and which) South African legislation and policy framework the local municipalities can refer to and apply for the integration of EI principles and disasters issues in the development plans and programmes.

CHAPTER 3: CONTEXT AND THE BACKGROUND TO THE CASE STUDY

3.1. Introduction

This chapter on the background of the case study presents the history, socio-economic and physical characteristics, and the strategic positioning of Ladysmith. It describes the environmental characteristics of the municipality based on climate, the relationship between topography and hydrology, and the geology and soil conditions that contribute to its susceptibility to flooding. The last section deals with the motivation of the case studies sampled in order to collect primary data.

3.2. The socio-economic analysis of the municipality

Currently, the ELLM consists of 27 wards representing a range of settlement patterns including urban to municipal service centres, agricultural landscapes, industrial, and semi-rural residential settlements (ELLM, 2012a). Within the jurisdiction of this municipality, these wards are represented by 50 councillors. Approximately 30% of the municipality is urban whilst 70% is rural. The municipal area covers approximately 3020 km² in extent and has a population of about 240 000 people (ELLM, 2015a) (*Please see Table 3.1*).

Table 3.1: *Emnambithi*/Ladysmith Local Municipality Population Distribution and Services (Source: ELLM, 2015a)

Population and Household size (2010)	**Stats**
Total Population	242 707
Population Growth	0.52%
Number of Agricultural Households	19,004
Household total	58,058
Population density (People per Square Kilometre)	80
Household Density (Households per Square Kilometre)	17
Flush toilets connected to sewer	56.1%
Weekly refuse collection	58.1%
Electricity for lighting	82.1%

ELLM comprises a dual governance system of managing land by both the municipality, which follows the formal administration system, and the Traditional Authority such as *Abantungwa*/Kholwa in Driefontein, Nkosi, and Ebathenjini, among others. According to the IDP review 2015/2016, it is stated that this situation will change because in the 2016, there an expected amalgamation of the Emnambithi/Ladysmith and the Indaka municipalities both lying in the uThukela District (ELLM, 2015a). This merger is supported by the Department of Rural Development as it forms part and parcel of Spatial Land Use Management Act, 2013 (Act No. 16 of 2013). Due to this amalgamation process and the impact this will have, the case study of the Emachibini (under the Mthembu Tribe) residing in Ward 7 and 14 of the current boundary of the ELLM was selected. This rural village, which is referred to as *Isigodi* extends its borders to the Indaba LM (ward 8) and will be explained in the following sections.

3.3. Attractions or tourism areas in close proximity

The natural attractions in close proximity to the ELLM include the Drakensberg Mountain, archaeological sites, nature reserves (game viewing and bird watching), uThukela Biosphere Reserve, Tugela Catchments and Tugela River, Natural Bush, and Forests. Beside its rich war history and the cultural attractions such as the Battlefields and Memorials, Museums, Monuments, the area also possesses a rich history of Rock Art, Crafts, Recreation (Horse Riding) and tourism routes among other things. According to the IDP 2012/2017 (ELLM, 2012a), the ELLM is also well located in relation to at least two of the major tourism destinations in the KwaZulu-Natal. In fact, it serves as a base for the exploration of the Battlefields to the north and Ukhahlamba-Drakensburg Park to the south.

3.4. Environmental factors

There are environmental factors contributing to the continued (and discontinued) flooding of Ladysmith town. These natural factors include geological and soil conditions, and the topography and hydrology of the ELLM.

Geological and Soil Conditions of the ELLM

Because of the dolerite sill, the gradient is gentle and broad floodplains have thus been created downstream of the town. Due to this, flooding occurs during heavy rains (Botha and Singh, 2012). Some areas with the rocky environment of the municipality are difficult to dig out (Ibid: 28). This may also lead to greater runoff as the geological structure and soil condition leads to less absorption, as it is impervious.

Topography and Hydrology

A study conducted by the INR (1988) revealed that there is a relationship between topography and rainfall which makes Ladysmith susceptable to floods. The study also revealed that "the highest rainfall is falling on the steepest slopes of Klip River and where the river develops and in areas where the soils are shallowest and runoff levels are greatest and therefore, the town of Ladysmith is susceptible to flooding as it is located in the flood plain" (ibid: 24).

Within the ELLM area of jurisdiction, there are two major rivers traversing the municipality and this includes the Klip River and Sunday's River (and their tributaries). Both the aforementioned watercourses drain into the Tugela River (*please see Table 3.2 below* for the categories of rivers of the Department of Water Affairs).

Table 3.2: ELLM major rivers in the Drainage Areas and the Uthukela Water Management Area (ELLM, 2010a:21-22)

WMA	Quaternary Catchment	Major Rivers
uThukela Water Management Area,	V12A	Klip River (and Braamshoekspruit)
	V12G	Klip- River (and tributaries Modderspruit)
	V12F (partial)	Klip River (and tributary Sand River)
	V12E (partial)	Sand River
	V12B	Ngogo River (and Tributaries Tatana and Mhlwane)

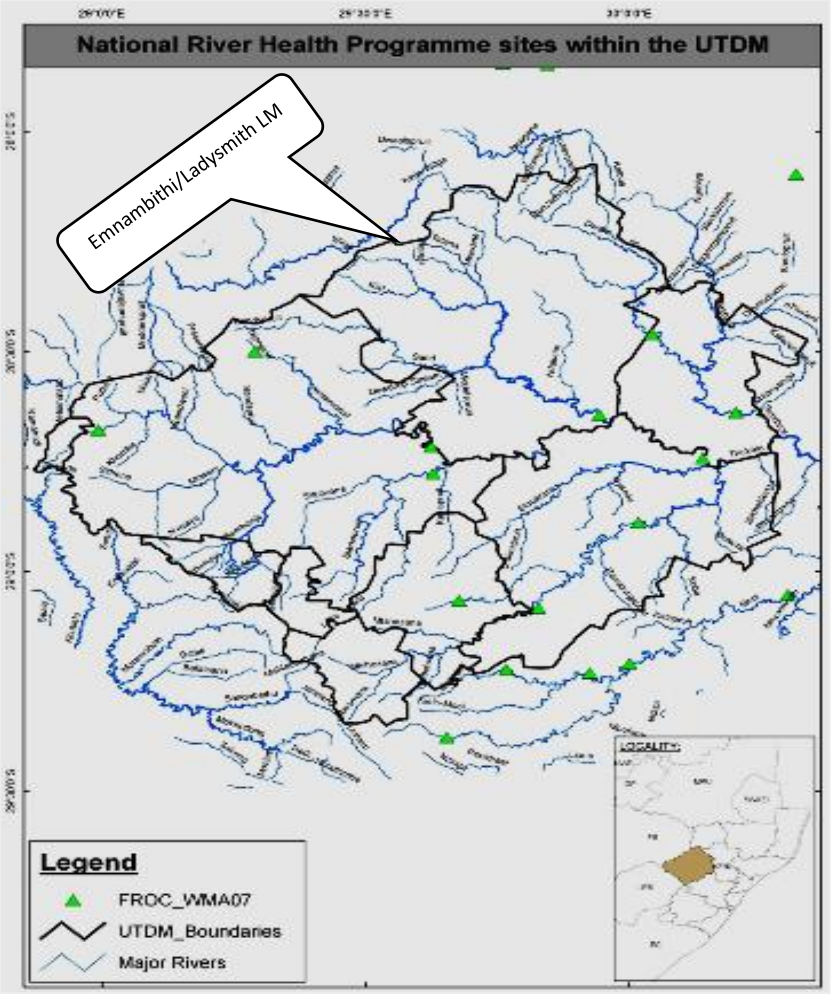

Figure 3.1: River's Map: District Context *(Source: Henning et al, 2012:6)*

The administration entity in which all these water features fall is the uThukela Water Management Area No. 7 (WMA No. 7) or in Drainage Region V. Further characteristics of the Klip River as a major stream leading to the flooding of Ladysmith town are highlighted in Table 3.3. below.

Table 3.3: *Klip River Catchment Characteristics within the ELLM* (Source: DWAF, 1998b; and ELLM, 2010a)

Klip River Area	1585 km^2
Plant growth	2% plantation
	35% thin bush
	63% grassveld
Catchment slope	**Y**= 11%
Mean annual rainfall	950mm
Extreme rainfall region	35% region 2
	65% region 3
Mean annual runoff	227 x $10^6 m^3$

3.5. The Locational problem of Ladysmith CBD and its adjacent areas

Unfortunately, Ladysmith CBD and surrounding suburbs have been laid out within the incised meanders of the Klip River, which rises in the Drakensberg foothills near De Beers Pass to the northeast and is joined by the Sand Spruit upstream of the town (Botes *et al*, 2012). Due to its location in the floodplain of the Klip River, it has experienced repeated flooding throughout its history. Since its formal establishment in 1850s, Ladysmith has experienced more than 29 major floods while the minor floods occur almost every year (Grobler, 2002, Botes *et al*, 2012, and the IDP 2012/2017 cited in ELLM, 2012a) (Please see the flood-line map in Appendix F1**:** and the estimated flood costs in table 3.1).

After the construction of the Qedusizi flood attenuation dam, Ladysmith does not experience the major floods that it did before, but minor floods happen almost every year. However, this dam may face certain risks as did the Windsor Dam silted up in just 38 years after its establishment in 1950s (Batuca and Jordaan, 2000). This dam failure was because of the silt which reduced its efficiency including poor planning or design (ELLM, 2012c). This suggests that hard engineering does not provide all the solutions to flooding.

3.5.1. The history of significant flood damage in Ladysmith

Flooding has always taken place in Ladysmith since its establishment in the 1850s. Before the recent big flooding events recorded in 1994 and 1996 (Alexander, 2000; Batuca and Masson, 2000; ELLM, 2012b), the previous records of flooding have been documented in the study conducted by the Institute of Natural Resources (INR, 1988) as shown in Table 3.4 below.

Table 3.4: The number of recorded flooding events in Ladysmith since the 18th century to the end of 1980s *(Source: INR, 1988:26)*

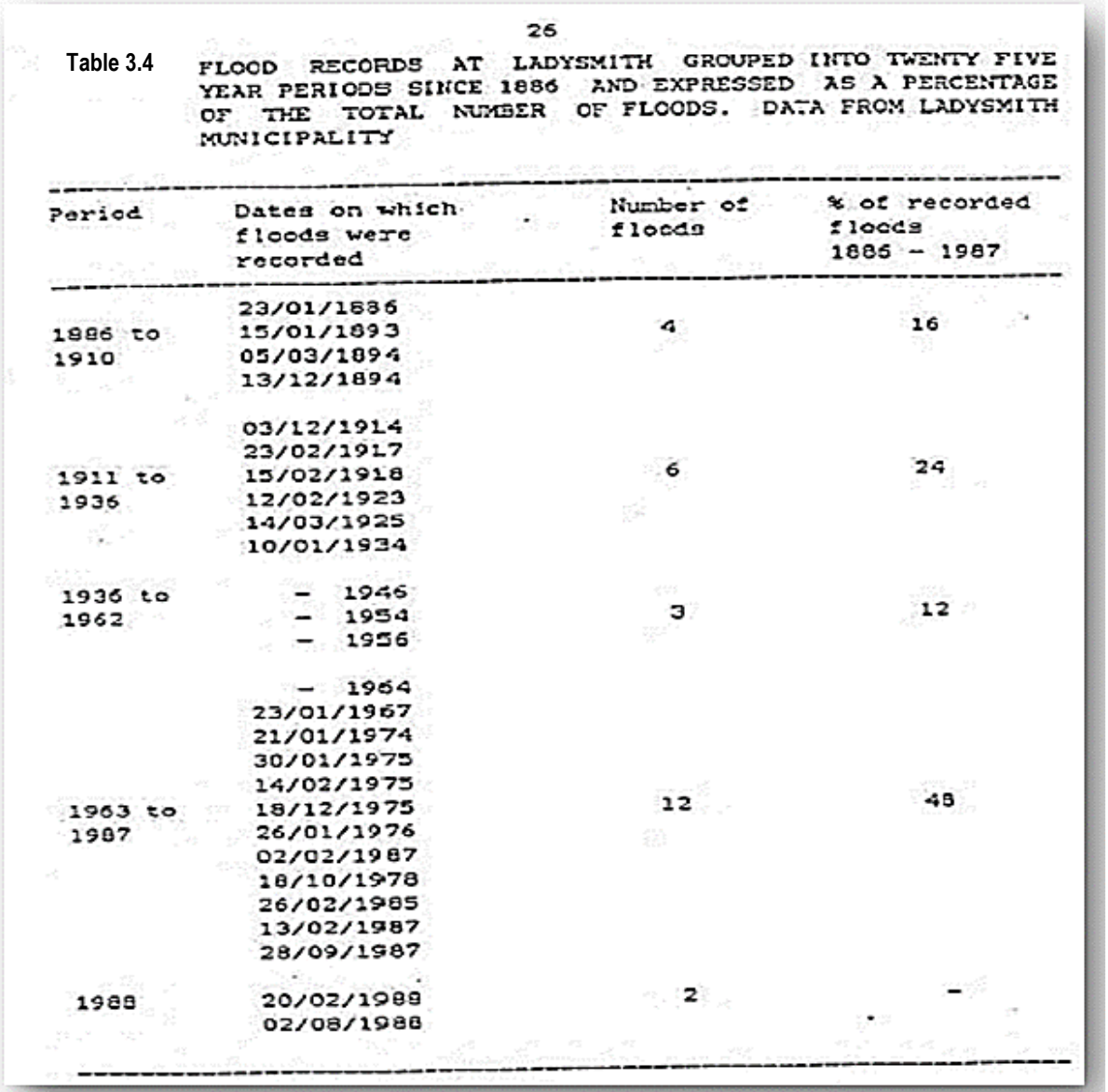

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Table 3.4 FLOOD RECORDS AT LADYSMITH GROUPED INTO TWENTY FIVE YEAR PERIODS SINCE 1886 AND EXPRESSED AS A PERCENTAGE OF THE TOTAL NUMBER OF FLOODS. DATA FROM LADYSMITH MUNICIPALITY

Period	Dates on which floods were recorded	Number of floods	% of recorded floods 1886 – 1987
1886 to 1910	23/01/1886 15/01/1893 05/03/1894 13/12/1894	4	16
1911 to 1936	03/12/1914 23/02/1917 15/02/1918 12/02/1923 14/03/1925 10/01/1934	6	24
1936 to 1962	– 1946 – 1954 – 1956	3	12
1963 to 1987	– 1964 23/01/1967 21/01/1974 30/01/1975 14/02/1975 18/12/1975 26/01/1976 02/02/1987 18/10/1978 26/02/1985 13/02/1987 28/09/1987	12	48
1988	20/02/1988 02/08/1988	2	–

Table 3.4 above clearly shows that, flooding in Ladysmith has been documented since the 1800s and making it a disaster problem.

The literature also documents the history of the estimated flood damages using monitory terms. The Green Paper on Disaster Management in South Africa (1998) reflected on the estimated costs of flood damage which happened in Ladysmith and other places in the country (See Table 3.1 below).

Table 3.5: The costs of flooding in South Africa. Ladysmith is highlighted in yellow *(Source: Disaster Management Task Team, 1998: 12)*.

Counting the costs of some recent disasters

Quantifying exact damages is difficult - some disasters impact far beyond the occurrence and restoration phase. However, the estimates below show some of the results of recent disasters:

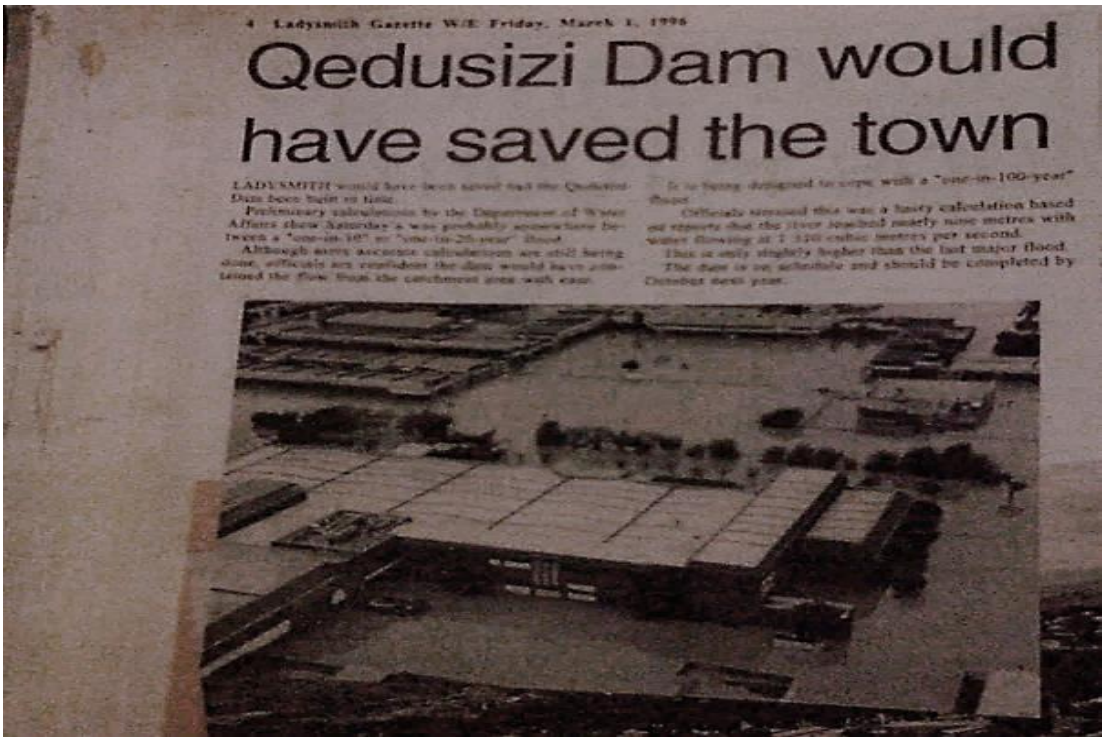
PLACE		DISASTER	COST
LADYSMITH;	Floods: 1994	400 families evacuated;	R50 million damages
LADYSMITH	Floods: 1996	Damages to infrastructure	R25 million
MERRIESPRUIT	Slimesdam: 1994	17 lives lost	R45 million damages
PIETERMARITZBURG	Floods: 1995	173 lives lost	Emergency shelter needed for 5 500
SOUTH AFRICA	Drought: 1991-92	49 000 agricultural jobs lost 20 000 non-agricultural jobs lost Negative effect on the current account of the balance of payments (Estimated at R1,2 billion - *Reserve Bank figure*)	
NORTHERN PROVINCE	Floods: 1996	R105 million damages	
MPUMALANGA	Floods: 1996	R500 million damages	

Figure 3.5 above further acknowledges that there is a difficulty in quantifying the damages. Even though these costs are treated as relative to what was lost in Ladysmith due to the floods they are in no way a full representation of the reality and the costs which were incurred on the ground. In his message to Ladysmith, the former president of South Africa Mr Mandela said “the impact of flooding in Ladysmith is incalculable” (The Ladysmith Gazette, 1994).

This meant that the notion of monetising the costs of flood losses are not sufficient in indicating the reality of what has been lost socially, psychologically, environmentally, and economically. In this way, the presentation of Ladysmith flood losses and impacts shows that there is uncertainty in pricing the flood losses in Ladysmith town. Instead, the literature on Ladysmith flooding suggests that an economic analysis can attempt to measure the flood losses but it is impossible to measure the human suffering. Despite this, the economic analysis presented in various literature also relies on estimates (which may differ from one person to another).

There is also a paucity of hydrological studies to determine if the historical Klip River flooding (29 serious floods) was above 1: 100 year flood line. This reveals that the dangerous floods that used to happen in Ladysmith would have been caused by minor or bigger flooding events. This is the case as there are people who argued that ‘*Qedusizi* dam would have saved the town’ of Ladysmith in 1996

(Ladysmith Gazette, 1996: 4) (See Figure 3.2 below).



4 Ladysmith Gazette W/E Friday, March 1, 1996

Qedusizi Dam would have saved the town

LADYSMITH would have been saved had the Qedusizi Dam been built in time.

Preliminary calculations by the Department of Water Affairs show Saturday's was probably somewhere between a "one-in-10" or "one-in-20-year" flood.

Although more accurate calculations are still being done, officials are confident the dam would have controlled the flow from the catchment area with ease.

It is being designed to cope with a "one-in-100-year" flood.

Officials stressed this was a hasty calculation based on reports that the river reached nearly nine metres with water flowing at [illegible] cubic metres per second.

This is only slightly higher than the last major flood.

The dam is on schedule and should be completed by October next year.

Figure 3.2: The perceptions about the severity of Klip-River flooding, 1996 in Ladysmith *(Source: Ladysmith Gazette, 1996:4).*

This view (See Figure 3.2 above) support that, the flooding events that happened in 1996 were below 1: 100 flood line because Qedusizi cannot deal with the flooding events this engineering design capacity This shows that, the subject of flooding in Ladysmith is a complex and a contested subject as there are different perceptions about its impact and severity.

3.6. Motivation of case study selection

This section below is about the motivation of other two case studies in relation to Klip River and Ladysmith town which is the subject site. These are Driefontein (in the north of the upper catchment areas of Klip River, north of Ladysmith) and Emachibini (in the South East of the town and near the confluence of Klip River). Appendix A1 and A2 shows the location of these case studies in relation to the town centre and Klip River.

Driefontein case study

Secondary sources of data (Environmental Management Framework by ELLM (2010a), Henning *et al* (2012), and SANBI, (2014), among others) indicate that Driefontein is a strategic location for the wealth of EI. In particular wetlands and soil with agricultural potential are prevalent. Driefontein is also one of the main catchment areas of the Klip River which joins other rivers such as Ngula and Mhlwane River (ELLM, 2011a).The ecological areas such as wetlands located in this area are of national importance but they are not always intact due to degradation and the influence of human activities (ELLM, 2010a).

Due to its large population, the Driefontein area has been identified as a priority for investment, as it is more vulnerable to environmental change. This means that there will be growth in the economy of this area encouraging more people to settle in this region. Due to poor planning and urban sprawl, the expected development can encroach on the rich EI reducing its ability to regulate the functions of the water disasters. It is expected that there will be an increase in the migration of rural people near to the approved social facilities and other establishments that will attract people for employment. Therefore when the expected growth happens as planned, Driefontein will become an urban area and even more people will live in these areas.

The Sundays River and its adjacent areas are excluded from the case study because the river and its catchment contain relatively healthy EI such as rivers and wetlands (Henning *et al*, 2012). (Please see the map in Figure 3.3 below)

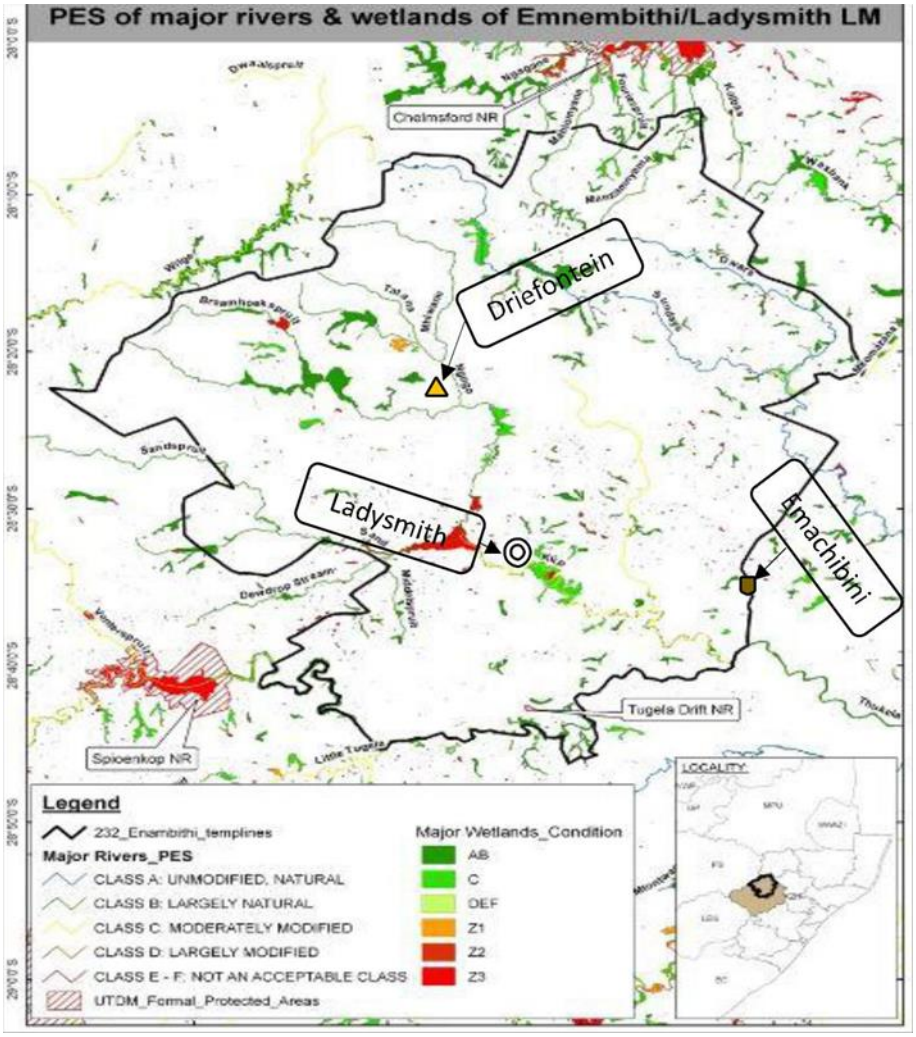


Figure 3.3: State of present Ecosystems in the ELLM *(Source: Henning et al, 2012: 9)*

The map indicates that the Sundays River is located in a relatively unmodified catchment and the condition of the wetlands in these areas is not of concern in comparison as those in Driefontein. The researcher used secondary sources of data to discuss the other catchments.

Emachibini Case Study

Unlike Driefontein and Ladysmith, Emachibini (with *Egolokodo*) is not situated along the Klip River. In terms of locality, the Emachibini which is highlighted in green is located in the north of the confluence between Tugela and Klip River (See figure 3.3 and Appendix A1).

The reason for the selection of Emachibini is that this area falls under the shared jurisdiction between the Ingonyama Trust Board (Abathembu Tribal Authority) and the municipality. There has also been no previous studies done in this area. It is also poorly incorporated into the development or strategic plans of both the ELLM and the Indaka LM. The portion under the ELLM is Ward 7 and Ward 14

whereas the rest of the remaining farms falls under the Indaka LM (former Ward 8). Both these local municipalities are located in the Uthukela DM. Despite its transboundary issues, the area is still rural with some households that are located on large plots of land (eg. 1 to 2 household per hectare). The majority of the households in Emachibini rely on agricultural activities (EMF cited on ELLM, 2010a).

According to the maps (SDF and the Environmental Management Framework cited in ELLM, 2010a & Henning *et al*, 2012), this village has moderate agricultural land, steep areas, and some areas have poor soils with high erosive potential. Due to its rural character this village provides a greater possibility where traditional practices will have been preserved. The researcher was interested in understanding local environmental and risk management narratives in relation to extreme weather events and the people's cosmology in relation to flooding and climate change. Their cosmology has a possibility of creating lessons about how these events were dealt with in the past and what they mean now.

Bernard (2003) emphasised that the rich indigenous knowledge of the Zulu (and other groups in Southern Africa) is diminishing as they were severely affected by colonisation, apartheid, and later neglected by the post- apartheid government (i.e. alienation of the people's uses of waterways and the spiritual water sites through the privatisation of sacred water sites and the damming of rivers). With the choice of this case study, the researcher tries to fill some of the gaps left by Bernard (2003) as she was not able to conduct a study in Ladysmith and the Emachibini (*Isigodi*[3] level). This was important as the researcher expected that he might get the same or the different results to Bernard (2003), thus adding to knowledge of cosmology and the use of EI in the face of climate change.

CHAPTER 4: RESEARCH METHODOLOGY

4.1. Introduction

The research aim and objectives, which focus on understanding the perceptions of stakeholders towards EI in flood risk management, support the use of a qualitative empirical approach. This chapter discusses the main research instruments and techniques used to collect primary oral and documentary data. The primary oral data collection included stakeholder interviews, participant observation and focus groups whereas the primary documentary data was derived from the analysis or review of development strategies and policy frameworks and plans for the municipality. This was analysed with reference to provincial and national obligation of the list of legislations in section 4.7.1. Ethics was addressed at the outset of the study so as to obtain the university's approval of the research process. This chapter also discuss the ethical issues that were taken in to account including obtaining permission from respondents to undertake interviews. The sampling method is presented, including a discussion on snowballing and judgemental sampling techniques, which were used to identify the main stakeholders in the study. The last section presents the limitations of the study and how the data collected was analysed (i.e. thematic analysis).

4.2. Ethical Issues

In order to ensure that the interviewees were informed and hence voluntarily participated in the research, a gatekeeper's letter and authorisation was obtained from the authorities in the study areas. Representatives of the communities, including the Induna Mr FS. Madonsela of the Emachibini, MTA, the ELLM Municipal Manager Mr. Madoda Khathide, and selected ward councillors of the upper catchment areas above Ladysmith were approached at the outset of the study. After the purpose of the study was explained to these key informants, their permission was requested to conduct interviews with the municipal officials and rural residents living in the area under their watch (See Appendix B3 and B4 for permission). The names of the participants were coded (See Table 4.1) and they were referred to as the respondents, thereby ensuring their anonymity in case some are not happy with their names appearing in the document.

4.3. Stakeholders or main informant interviews

Main informant interviews were done with a focus on the questions of flood risks and EI. Stakeholders were identified using the snowballing[4] and purposive sampling techniques[5]. From this, many interviewees were derived from the local government and other government representatives' e.g. Planning officials, disaster managers, environmentalist, Flood Liaison Committee Members, and ward councillors (please see Table 4.1 and the list of respondents below the references). Other stakeholders interviewed included business leaders, church leaders and NGO representatives, teachers, workers and the flood and climate affected citizens. These stakeholders were chosen because they are both experts in the field of flood risks and environmental management while others are the victims of and are susceptible to flood risks. Interviewees who are located close to EI were also selected to assess their perceptions of the value of these environmental services.

In terms of the type of questions asked, the researcher used open and close ended questions. The interview schedule was long and each respondent was therefore only asked the questions and sections that they were familiar with. For example, the rural and town communities who had been impacted by floods were asked more of the open-ended questions based on their knowledge about the areas such as flood risks, the solutions to flooding, and also the use or understanding of EI. On the other hand, the government actors were asked similar questions that were both open ended and close ended. However, they were also asked to respond to the *questions that were most relevant to their job specification. They were asked to comment on issues* related to responsibilities of other departments, it they were knowledgeable about these matters. (See Appendix C1 and C2 for the interview schedules used for the stakeholders and focus group meetings held with the respondents).

4.4. Sampling

In order to determine the main actors to be interviewed, the researcher first used the snowballing technique. This technique was useful as it was possible to map out or select the main informants to be interviewed in relation to the themes of this research. This means that this sampling technique was used successfully. Even though the researcher needs to control the subjectivity or bias created

[4] **Snowballing** is referred to as a type of non- probability sampling technique used to locate the information rich participants or key informants in the area being studied. It helps the researcher identify other participants using the recommendations given by other participants (ACAPS, 2011).

[5] **Purposive sampling** is a form of non- probability sampling technique also known as judgemental sampling. It is called this way because it use the subjective knowledge of the researcher to judge the most authoritative participants whom he thought represented the actual population (ACAPS, 2011). In this case, the theme of ecological infrastructure and flood risk.

by the selection of respondents by key informants, who can act as gatekeepers, this method does enable the researcher to identify the main actors related to a particular issue, in this case flooding.
by the selection of respondents by key informants, who can act as gatekeepers, this method does enable the researcher to identify the main actors related to a particular issue, in this case flooding.
This is important to note as some scholars in social science and planning state that even though key actors are identified as being knowledgeable or an expert in a field of work, they will be influenced by their own ideology and framing of the world and hence may not provide truly objective information (Lubke, 2004., and Yu 2014). For example, Yu (2014) further argued that planning proposals are not objective because after all their intensive work that determines good professional practice, planners still use their training, knowledge, own discretion, gut feeling to decide on what is right. In this process, there are winners and losers showing that there is a need to understand the politics and power dynamics involved. With this, it is clear that planning proposals are not value neutral.

Because the authorities such as the municipal manager, ward councillors, and *Izinduna*[6] were identified, they then helped in the identification of other informants that could offer the relevant information in the subject being researched. After many respondents were identified and recommended by others, the researcher ensured using purposive and judgemental sampling that there were a diverse set of participants that contributed to the research questions being asked. The purpose of this was to find more knowledgeable actors who could represent the voice of diferent communities and other stakeholders. The subjective knowledge of the researcher was required to judge the most authoritative person whom he thought represented the actual population for the users at risk of environmental change and flooding. Since EI is regarded as an adaptation tool for flood risks and climate change, the focus was also oriented towards identifying actors who were located close to main EI as this help the researcher to understand their attitude and use of this infrastructure.

4.4. Research participants

The researcher traced the diversity of actor groups such as the stewardship groups, famers and farmers' association's representatives (i.e. commercial farmers, communal and subsistence farmers), old residents, teachers, NGOs, church leaders or members, and many others. In terms of coding, the researcher grouped these stakeholders in order to ensure that their identity is hidden and

[6] ***Izinduna*** is a plural Zulu word for Induna which means the headman (under the Zulu King) and responsible for mediating between the king and the respective tribal clan

confidentiality is ensured to those who shared their knowledge with the researcher (See Table 4.0. and Figure 4.1 below)

Table 4.1: List of respondents, their affiliation, location in proximity to Klip River, and the date of interviews

Broad Category of Stakeholders	Affiliation	Location	Date of Interview
National Government	Environmental Affairs	Ladysmith town (floodplain) and eZakheni	24/02/2015
Provincial Government	Amafa AkwaZulu- Natal Official	Pietermaritzburg	27/02/2015
Local Government	Town Planning Unit	Ladysmith Town (floodplain)	24/02/2015
	Environmental Hygiene	Ladysmith Town (floodplain)	06/05/2015
	Disaster Management	Ladysmith Town (floodplain)	06/05/2015
	Flood Liaison Committee Member	Ladysmith Town (floodplain)	06/05/2015
	Parks & Gardens Section	Ladysmith Town (floodplain)	06/05/2015
	Parks & Gardens Municipal official	Ladysmith Town (floodplain)	06/05/2015
	Engineering Municipal Official	Ladysmith Town (floodplain)	13/05/2015
Flooded Town Community	Elder	Ladysmith Town (floodplain)	11/05/2015
Flooded Town Business	Store Manager	Ladysmith Town (floodplain)	10/05/2015
	Photographer	Ladysmith & Acaciaville	10/05/2015
Farming Representative	Farmer	Ladysmith Town (floodplain)	17/05/2015
Semi- Urban	Politicians	Driefontein, Upper Klip River Catchment	15/05/2015
	Anonymous NG official	Driefontein, Upper Klip River Catchment	24/02/2015
	Anonymous NG official	Driefontein, Upper Klip River Catchment	24/02/2015
	University student	Driefontein, Upper Klip River Catchment	03/06/2015
Rural Community	Elder	Emachibini, MTA(confluence)	04/05/2015
	Elder	Emachibini, MTA (confluence)	06/05/2015
	Focus Group- Youth girls	Emachibini, MTA (confluence)	05/05/2015
	Focus Group- Elders	Emachibini, MTA (confluence)	06/05/2015

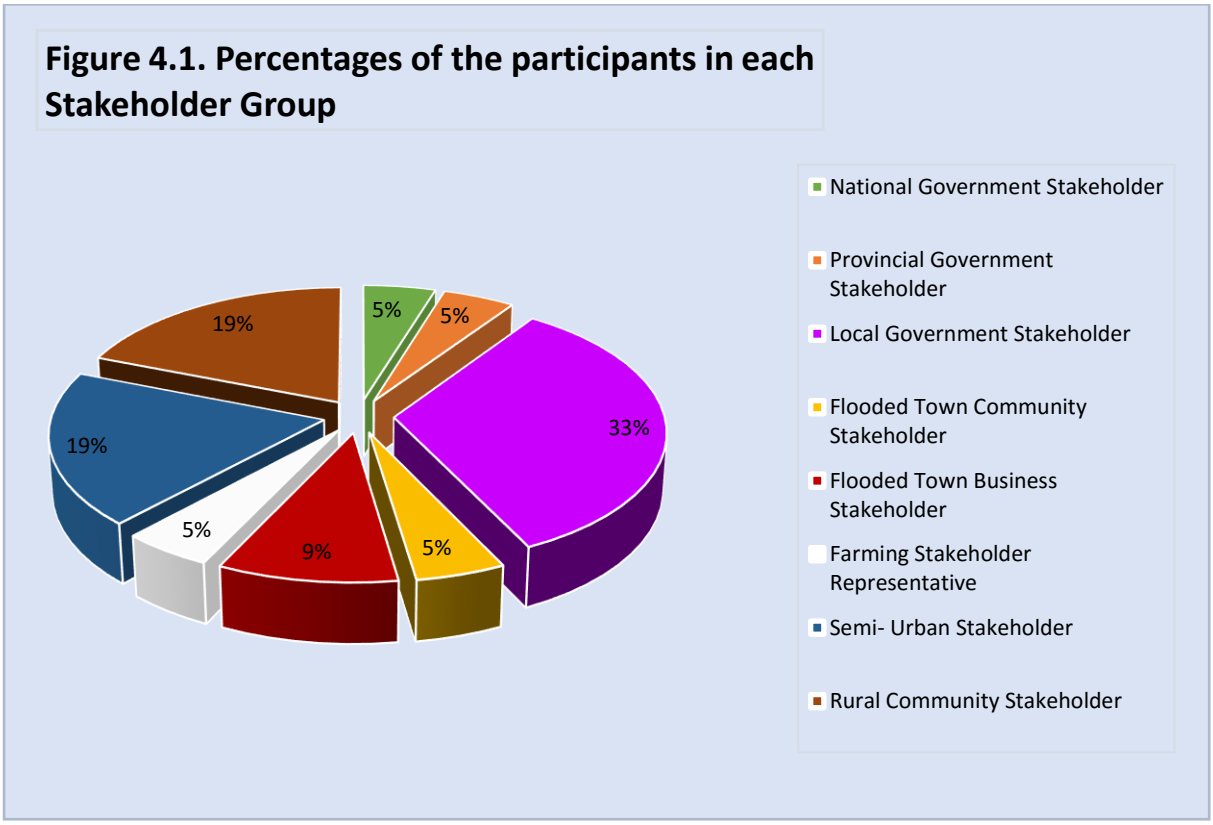


Figure 4.1: Percentages of the participants in each Stakeholder Group

There were twenty-nine total interviews done with the respondents in three case studies within the ELLM. Table 4.1 and Figure 4.1 above; indicate that there were many participants from the Local Government Stakeholder group contributing 33% of the population interviewed. As table 4.0 shows many of these participants are the municipal officials representing various departments such as Disaster Management, Environmental Hygiene, Parks and Gardens, Spatial Planning, and Engineering Services. The second most dominant participants in the interviews were from the Rural (19%) and Semi-Urban (19%) stakeholder group and they reside in the upper and lower catchment of the Klip River. Other participants were drawn from the business sector, flood affected community residents/elder, National and provincial government.

Some of the participants were specialists in their field whereas others (more experienced) were familiar with many issues outside their current occupations. Due to the aforementioned blurring of the boundaries, the researcher noted that there are some instances where some of the participants would talk on behalf of other departments. For example, some of the participants such as the community members in Ladysmith town were linked to knowledge and activities that broadened their experience such as being a retired geographer, teacher, old resident, and a representative of the Church and NGO member.

4.5. Participant Observation

Another technique used to collect primary data to complement and balance the findings of the interviews was participant observation. The purpose of using this technique in the collection of the data is because informants' responses do not always capture the reality and everyday lived worlds of the ordinary people that they represent. It is also a useful way of groundtruthing data collected from interviews. In this way, the "data obtained through participant observation assist in terms of checking against the participants' subjective reporting of what they believe and do" (Mack *et al*, 2005:14). He further argues that in order to balance and see what is really happening on the ground, one must learn how to be like an insider while remaining an outsider (Ibid).

The outcome of this exercise was useful as it helped the researcher to witness activities such as the actions and interaction of people with their lived space at different periods of time. For example, the activities communities perform when obtaining their livelihoods both in summer and in winter, and on week days and weekends were observed to reveal the interaction people have with the environment.

The specific case studies in the ELLM were selected for participant observation. This was done informally while the researcher was busy visiting the key informants or gatekeepers to request their consent for the interviews. In this process, notes were taken, and the GPS coordinates of the main ecological sites thought to be important were taken. After the ethical clearance was received in February 2015, the researcher went to the field again (period from 24th of February to the17th of May 2015) to interview the key informants in their offices and homes. In the process of walking around, the researcher was able to observe and record more land use activities over a period of two weeks. The third phase in which participant observation was performed during the follow up of the interviews with main actors who had not been interviewed in phase 1 and phase 2. These interviews took place in the winter months of May and June, 2015. The information collected through participant observation provided insights which deepened the discussion and the synthesis of the research findings.

Because the Researcher was born and raised in the ELLM (and so he is insider), there was a good understanding of the culture and the dress code of the different places was understood. The researcher was able to 'fit in' to the different areas (Ladysmith town, Driefontein, and eMachibini). This community understanding enabled a rapport and trust between the researcher and the respondents because the researcher is a Zulu and language was not a barrier to Zulu speaking people.

The areas were observed on a number of occasions for example, in summer and winter (period from December 2014 during vacation to June 2015), working days and the weekends and this allowed the researcher to see the change in land uses and the pressure on these places at different times in the year. On the final site visit, the researcher spent two weeks (01st of May to 17th of May 2015) in the area as he wanted to finalise the observations and record the use of the EI, amongst other things.

4.6. The Focus Groups

There were two focus group interviews undertaken (05 May to 06 May 2015) with the key informants representing the Rural Community (RC) Stakeholders and the case study used in the Emachibini, MTA. In terms of the types of questions asked, the researcher used open-ended questions as this allowed the respondents to be open and to respond and discuss the input from the other participants. The participants were chosen based on their knowledge of uNomkhubulwana7. The participants consisted of different age groups and genders. Each focus group consisted of five people and they were asked questions about the cultural use of important EI, in particular community water or the rain related tradition known as the uNomkhubulwana[7]. As this dissertation also supports the work of the scholars such as Bernard (2003), Nkosi (2011), and Dr. Ngobese cited in Henning (2011); the researcher was interested in harnessing indigenous knowledge, heritage, oral history, and the community's cosmology on how they manage (or managed) disasters related to floods and other water related activities. This is relevant to this study in terms of the spiritual or cultural benefits of ecosystems (MEA, 2005) which is the second theme of the dissertation.

The first focus group interview conducted in the Emachibini community consisted of the people who are practising the traditional practice of uNomkhubulwana (at least those who know and keep some of the parts of the practice). The purpose was to understand the shifts that had happened and if they understood the importance of the practice now. Five young girls from a variety of age groups (+ 15 to 33 years old) were selected because of their current and previous knowledge of the involvement with the uNomkhubulwana. This relates to the cultural benefits of ecosystems services and the researcher was interested in knowing where the main sacred sites that connect the community with nature are.

[7] ***UNomkhubulwana :*** also known as *uNomhhoyi* is referred to as the *Inkosazane yezulu*- an angel of the rain or the female Goddess of rain found in the scared water sites (Bernard, 2003, Ngobese cited on Henning, 2011., and Nkosi, 2011., and Respondent 3: RC Stakeholder- Elder, 2015). As a well-known woman figure, *uNomkhubulwana* is referred to a powerful ancestor who is responsible for the rain, fortunes of good harvest in their agricultural fields, and also helps the Zulu agriculturalist tribes or communities when they face droughts (Respondent 3: RC Stakeholder- Elder, 2015., Nkosi,. 2011., and Ngobese cited on Henning, 2011). This has become a common belief or cosmology shared by many traditional Zulus.

The narratives helped in the mapping of the benefits of ecological sites and what cultural services they offer.

The second focus group interview was undertaken with the people of the *Emachibini, MTA*. The group consisted of participants from mixed genders. The rationale for the choice of these people was because they were recommended by some community members as they say that they are those who possess rich knowledge about the tradition of *uNomkhubulwana* and hence their knowledge is important to the study. The gendered role of performing the practice of *uNomkhubulwana* was explored in the focus groups. The focus group questions included topics such as their understanding of climate change, flooding, and droughts and how this is linked with the knowledge they have. The principal person that was targeted was Mrs. Mthembu, an elder carrying knowledge about sacred EI and indigenous knowledge. She provided further evidence when she decided to call others who have an interest in the topic and who possess rich information about the practices of the Emachibini. There was great excitement in the exchange of ideas which was evident in the chanting of songs or poems and the length of the focus group interviews (lasted about an hour). This symbolised their joy and willingness to participate and give out information by sharing their experiences and culture. There were five participants (two males and three adult females) who contributed directly in the information of the focus group, which was recorded.

4.7. Analysis of the primary documentary data

Many sources of primary documentary data were reviewed in order to understand the flood risks of Ladysmith and the use and understanding of EI in the municipality. One of the important internal document that was reviewed in the municipality was the Flood Control Scheme Manual because it speaks directly to flood management. This document was created by the Department of Water Affairs for the ELLM as a means to control and manage flooding in Ladysmith Town. There is also a wide range of literature about Ladysmith Flooding and EI solutions such as the INR (1988), Bell and Mason (1998), Quayle and Pringle (2014), Batuca and Jordaan (2000), Thornhill *et al* (2009) reports and papers, amongst others.

Another source of primary documentary data that the researcher used to address the objectives of the research was the review of the strategic or development plans of the municipality. The purpose of this was to check the extent to which these strategies and policy frameworks are incorporating the concept and the value of EI. The local plans of the ELLM were reviewed in order to determine whether they have complied with its Environmental Management Framework and the Strategic Environmental

Planning Tool (acting as a master plan for the natural environment) and its spatial development framework (acting as a master plan for the Built Environment). The review of this material enabled an assessment of the extent to which planning tools and instruments include EI in their discourses and construction.

The Ladysmith Gazette (data archives on Ladysmith flood history from 1994 onwards) which is available in the Gazette's office in Ladysmith and articles found online were used to understand the flooding of Ladysmith and the solutions to flooding.

4.7.1. Policy and guiding legislation

In the South African context, there is relevant legislation guiding the implementation of flood risk management and environmental projects in municipalities. While reviewing the Emnambithi/Ladysmith strategic plans and comparing them with what is happening on the ground, the list of the following legislation and policies were used, and they included:

- Constitution of the Republic of South Africa Act, 1996 (Act No. 108 of 1996), Section 24
- National Development Plan 2030
- Medium Term Strategic Plan 2014/2019
- Disaster Management Act, 2002 (Act No. 57 of 2002)
- National Environmental Management Act, 1998 (Act No. 107 of 1998)
- National Water Act, 1998 (Act No. 36 of 1998)
- KZN Heritage Act, 2008 (Act No. 4 of 2008)
- Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000)
- Green Paper on Disaster Management, 1998
- White Paper on Disaster Management, 1999
- National Disaster Risk Management Framework, 2005
- A Framework for Investing in the Ecological Infrastructure in South Africa, 2014
- Spatial Planning and Land Use Management Act, 2013 (Act No. 16 of 2013)
- Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983
- KZN-Ingonyama Trust Act, 1994 (Act No. 3 of 1994) and,
- KZN Ingonyama Trust Amendment Act, 1997 (Act No. 9 of 1997)
- Traditional Leadership and Governance Amendment Act, 2003 (Act No. 41 of 2003)
- Local Government: Municipal Finance Management Act, 2003 (Act No. 56 of 2003)

Another purpose of reviewing these legislations and policy frameworks was to identify the relevant stakeholders and their responsibilities in the case study area in relation to flood risk. The analysis of data and discussion of results was influenced by the legislation that applies in the case study and to the topic being studied.

4.7.2. List of major plans analysed in the study

The Environmental Management Framework, Disaster Management Plan, Policy on the ELMOSS, and the inclusion of these in the development plans such as the SDF, IDP, & LAPs were reviewed as part of the empirical research for this thesis. Further plans were reviewed such as the Municipal Audit Report, Agriculture Development plan, Rural Development Strategy, Ladysmith CBD regeneration strategy, CBD design guideline, in order to see whether or not they are aligned with the environmental and disaster related information incorporated in their strategic plans. Most importantly, these sub-plans were evaluated to check whether or not the issue of EI investment and disaster risk management are prioritised. This is important as they are part of climate change adaptations and sustainability. The available feasibility studies and other secondary data showing the alignment with the legislation and local plans was reviewed (i.e. environmental impact and heritage impact assessment, which were available online, amongst others).

4.8. Thematic analysis of data

During the stages of data processing, there was an analysis of the primary oral and documentary data by arranging the relevant responses in themes based on the following categories:

a) **Theme 1:** Reflections on the causes and understanding of flood risks
b) **Theme 2**: Perceptions on the measures taken into account in addressing flood risks
c) **Theme 3**: Perception (and understanding) of the value of EI
d) **Theme 4**: Planning and environmental management implications

This idea of arranging the qualitative data into themes is used in social sciences and it helps in understanding the main responses by interviewees so that responses can be compared and synthesised in a logical and rigorous manner (See Figure 4.2 below)

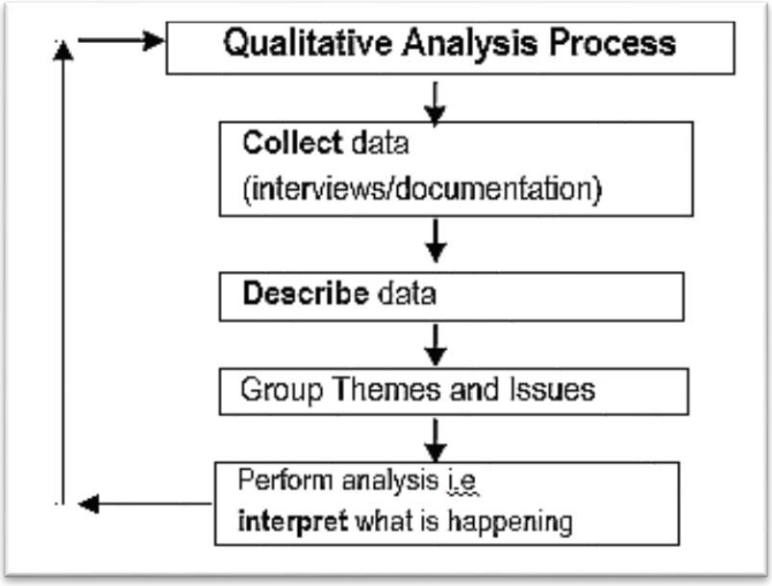


Figure 4.2: The interpretation of qualitative data *(Source:Biggan, 2008: 118)*

In addition, the transcription of the tape recording of the interviews and focus groups was undertaken in order to improve the quality of the notes recorded during the interviews or focus groups. After transcribing the data obtained from the interviews, the responses were grouped according to themes.

4.9. Challenges of the research during the site visits

There were areas that were visited which were unsafe due to poor surveillance. This included Matthews Farm in Ladysmith town, and *Egolokodo*, Emachibini (out skirts of the town and the municipality). Poor accessibility was also found to be a problem in visiting some of the rural areas where roads are non-existent. The sacred site of *Unomjikilili* (See Figure 6.18) and the unidentified palaeontological site called *Onyaweni*[8] are examples of such places, which are accessible only by footpaths. Although it was slightly cheaper to conduct research in Emachibini (i.e. more walking required than paying for transport) these factors contributed to the large amount of time being spent travelling and thus increasing the time required to finish the research. Unfortunately, not all of the data gathered was used due to the scope of the study, difficulty in analysing some data, and time constraints.

[8] ***Onyaweni*** *is a Zulu word* meaning on-the-foot because there is a historical human footprint on the rock along the river. Due to this mythical human toot print, the area has become well known to the residents and elders of Emachibini agrarian community and some claim that this is a foot of *Kubheka* who occupied the land long time ago in history. Due to the lack of documented history about this place, it remains unknown whose foot it was.

The interaction with the key informants prior to travelling to the places was useful as it provided warnings about the context of the research sites and thus the researcher was prepared and even arranged transport where walking was unsafe. In spite of this level of danger while walking in some of the sites, visiting these areas provided rich information which proved that the method chosen worked well.

Another challenge associated with data analysis was that the process of transcribing data and translating the recording from Zulu into English was time consuming. In addition, the translation of the environmental concepts into Zulu required significant effort and more research before going to the field as many concepts do not translate directly between the two languages. For example, the concept of 'ecological infrastructure' should be understood clearly and not inappropriately applied into the non- expert respondents or otherwise there can be a lack participation on the subject. Also the organisation of the data collected into themes and trying to bring these together was challenging.

4.10. Limitations

Due to time constraints, problems with obtaining consent for the research, and the limited budget, among other reasons no site visit was undertaken in order to verify the information on the maps of EMF, Driefontein LAP in the Upper Catchment areas of the Klip River above Ladysmith. Therefore, the data on this case study was based on desktop research only and subjective analysis. Due to this, the researcher acknowledges that he would have obtained even richer information if he had personally mapped the area with the GPS and the knowledge obtained from the local people while on site. The site visit would have also included pictures of the current land uses.

4.11. Conclusion

This chapter has explained the methodology used to collect the data required to address the aims and objectives of this research. As the research falls under qualitative methods, the researcher explained in this chapter how he used various techniques such as stakeholder interviews, focus groups, participant observation and review of primary documentory data to collect data on flood risks and the value of EI. The purpose of using these techniques aimed at ensuring that the reporting of the perceptions of stakeholders through the key informant interviews and focus groups were balanced with evidence observed and heard while interacting with the people who were not formally interviewed.

CHAPTER 5: STAKEHOLDER'S PERCEPTIONS OF USING ECOLOGICAL INFRASTRUCTURE TO ADDRESSING FLOOD RISK

5.1. Introduction

This chapter presents stakeholders' perceptions of flood risks and the value of EI in the case study of the ELLM. Respondents represent the following actor groups in the ELLM in relation to flooding: Rural Community (RC), Semi-Urban (SU), Farming Stakeholder Representative, Flooded Town (FT) Business, FT Community, Local Government (LG), Provincial Government (PG), and the National Government (NG). The analysis and discussion does not only consider the similarities and differences of the stakeholder's perceptions but it further compares these findings with the baseline information produced by (and done for) the municipality. The respondent's reflections as well as the baseline information, which represents strategic planning in the municipality will be discussed and brought together, using the major themes. These themes focus on the causes of flood risks, and understanding of flood risk. The analysis and discussion commences with the general reflection on the causes of flood vulnerability while the last section deals with the perceptions to flood risks.

5.2. General reflection on the causes of flood vulnerability

This section presents and examine the views of the stakeholder's on what they say is the cause of flood vulnerability. It reveals what their thoughts are about the fear of floods now as compared to the past, the failure of stormwater, poor location of Ladysmith, lack of law enforcement and environmental awareness, Zulu cosmologies of floods, and indirect drivers of flood vulnerability, among other things.

5.2.1. Stakeholders' perceptions and the severity of floods in relation to the *Qedusizi* dam

The outcome of the interviews about flooding in Ladysmith has shown that those who have witnessed earlier severe river floods (namely old respondents who witnessed the Klip River flooding) stated that this flooding happened before the construction of *Qedusizi*[9] flood attenuation dam. They stated that the *Qedusizi* dam flood control scheme has reduced the risk of flooding significantly (Respondent 2: RC Stakeholder-Elder, 2015; Respondent 5: LG Stakeholder-Disaster Section, 2015; Respondent 12: LG Stakeholder-Flood Liaison Committee Member, 2015; Respondent 10: Farming Stakeholder

[9] ***Qed'Usizi*** *is a Zulu word, which means an end to suffering.*

Representative, 2015; Respondent 11: FT Community Stakeholder-Elder, 2015). These respondents have less fear and trauma of the frequently appearing current floods of Ladysmith in comparison to those who arrived later on to live and work in the municipality, as they have witnessed the severe floods prior to the construction of the dam (Respondent 4: LG Stakeholder-Town Planning Unit, 2015; Respondent 7: NG Stakeholder-Environmental Affairs, 2015; Respondent 8: Flooded Business Stakeholder-Store Deputy Manager, 2015; Respondent 13: LG Stakeholder-Parks & Gardens Section, 2015). This was the case as Respondent 12: LG Stakeholder-Flood Liaison Committee Member (2015) further clarified that,

> I have seen the real floods in the past where the cars floated in the water, electric poles being washed away, bridges being ripped off, homes inundated and properties washed away, grocery in the stores spoilt by flood waters, farms eroded, to name but a few. From seeing that in the past, I realised that- there is an amazing force carried by the floodwaters.

This means that hard engineering solutions, such as the *Qedusizi* flood attenuation dam, and other flood control schemes in Ladysmith have meaning and value to the stakeholders and citizens of the area. In the 'eyes of the people', i.e. those directly affected stakeholders that still have memories of the major flood impacts and previous trauma, and the current citizens the technological fixes or the structural solutions have given them hope to continue their activities in the rich floodplain of Ladysmith town.

Some of the old respondents believe that the flash floods that happen almost every year in Ladysmith are normal events (Respondent 12: LG Stakeholder-Flood Liaison Committee Member, 2015). According to Respondent 12, some people [referring to the new stakeholders] are romanticising the flooding events, as they have never seen the real flooding events from the Klip River.

This means that there is a general trust of the resilience of the engineered technology [dam] as they value the protection they obtain from the Klip River that made them suffer in the past by the flood control schemes. Endorsing its effectiveness or power, Respondent 6: LG Stakeholder-Disaster Management Unit (2015) further stated that, "*Qedusiz*i Dam has stopped the floods of up to 12,5m height which happened in six hours". According to his view, this is an indication that the dam is properly designed and that it is an effective strategy in flood risk management.

Even though this is true, the studies on Ladysmith flooding and other areas in the world (i.e. INR, 1988., *Qedusizi* Dam: Flood Control Scheme Manual cited in the DWAF, 1998a., and Scott *et al*, 2013) show that engineering solutions in flood risk management cannot work alone. A study by Botes *et al* (2011) on the recent flooding events in Ladysmith in 2011 shows that there is a significant impact that

relatively minor flooding can have on people and infrastructure. Therefore, the minor floods should not be underestimated and must be planned for.

This section has revealed the significant difference in perceptions among older respondents who experienced severe floods and the newer residents who experienced flash floods or heard about the flooding of Ladysmith town. Due to their previous traumatic experience, the older respondents have shown that they are in support of the *Qedusizi* flood control scheme as they believe that it has stopped the floods coming from Klip River.

5.2.2. Spatial planning and the cause of flood risk and EI mismanagement

Planning and the management of environmental resources plays a significant role in the cause and mitigation of flooding. According to Respondent 4: LG Stakeholder-Town Planning Unit, (2015) the causes of flood risk and degradation of EI is that there is no formal planning (i.e. schemes) followed in rural areas especially in the areas falling under the traditional authorities (former Bantustans). Due to informal development mostly in the areas under the traditional authority, residents and small scale developers settle in unsafe areas such as those that are susceptible to flooding and prone to natural disasters (Respondent 4: LG Stakeholder-Town Planning Unit, 2015). Most of the literature in the communal land in KwaZulu-Natal has revealed that the Amakhosi[10] and Izinduna[11] are not fully capacitated in dealing with technical issues required in the allocation and management of land in these areas. The technical issues may include an understanding and interpretation of flood risks and the maps of environmentally sensitive areas that can be used to guide land use planning. For example, the allocation of land for housing and agricultural practices needs to take into account environmental risks. Respondent 4: LG Stakeholder-Town Planning Unit (2015) further states that there is still no rangeland management plan to assist with the grazing of the livestock. Overgrazing leads to loss of vegetation and soil erosion, which exacerbates flooding.

Lack of compliance with the zoning guidelines and scheme controls is one of the challenges faced by the ELLM and this leads to increased flood vulnerability of citizens. When it comes to the peri-urban areas, Respondent 4: LG Stakeholder-Town Planning Unit (2015) also revealed that there are households that are susceptible to flood risks or inundation because of political interference and poor leadership. For instance, warnings about the importance of recognising environmentally sensitive areas such as the flood-lines in land allocated for housing were given to the ward councillors in

[10] **Amakhosi** are Zulu tribal leaders or chiefs leading certain clans
[11] **Izinduna** are headman or commanders for the tribal leaders and the people of the Zulu clan

Steadville (located near Ladysmith town in the South) but they did not respond to these guidelines. Due to the pressure for development and delivery of housing in these areas, the ward councillors preferred to ignore the advice from the professionals and municipal officials and this has put the lives (and properties) of the communities at risk of flooding (Respondent 4**:** LG Stakeholder-Town Planning Unit, 2015). In this way, they are also disrespecting the planning and environmental legislation aimed at protecting the citizens of South Africa from flooding (See Appendix F1**:** Flood line Map showing flood line area encroached by human settlements colored in pink).

This section has revealed that the town planning department understands the importance environmentally sensitive areas and flood risk areas as these areas are clearly mapped in their municipality (DWAF, 1998a; Botes *et al*, 2011). However, the respondent has not revealed that the degradation of EI in the sensitive areas could cause more flood vulnerability. However, there is an understanding that these areas should be protected from the pressure of development. Despite their effort, these areas are used illegally especially in the rural and peri-urban areas due to the political interference of the ward councillors and poor capacity of the traditional leaders.

5.2.3. Response of the Rural Communities (RC) to floods

Cultural and spiritual beliefs play a major role in shaping individual and community responses to disasters and risks. The results of the interviews with the RC Stakeholder respondents (15 respondents from the two focus groups and two individual interviews) in the ELLM have indicated that some of the older Zulu communities hold the belief that the people who conflict with the values and norms of society will be disciplined by God or the ancestors while still alive on earth. They will be punished through misfortunes and disasters such as flooding and droughts. In the context of Emachibini within the ELLM, many of the Zulu people believe that disasters such as flooding, are caused by the anger of *uNomkhubulwana* (angel or the goddess of rain) who is now abandoning them. Due to their misbehaviour and disrespect for sacred water sites, *uNomkhubulwana* is now leaving them with misfortunes. They believe that the disasters such as flooding and droughts are a reminder for them to take wiser decisions and for correcting the way they live in harmony (or dis-harmony) with each other, nature, and their great ancestors (dead). These views are also supported by Benard, (2003), Borrows, (2006), Msimang cited in (Nkosi, 2011), and Salvador and Norton, (2011) who have written on the subject of non-secular societies and perceptions of water related disasters in the western societies and in Africa. However, the result from one focus group consisting of five young participants) showed mixed reactions about whether the knowledge they gained from their parents and community is entirely true as they get another truth at school and television.

This section has revealed that some of the rural communities such as the Emachibini in ELLM believe in the cultural and religious explanations in addressing flood risks and other water related disasters. The abandoning of the powerful ancestors such as the *uNomkhubulwana* has been identified as a cause of water related disasters. Further discussion of this practice will be presented in details in the upcoming sections based on the stakeholders' reflections on the solutions to flooding and environmental changes. The more detailed presentation and analysis of their cosmologies and knowledge will further be discussed in chapter 6.

5.2.4. The role of Ladysmith storm water system in generating flood risk

Since Ladysmith town has already been identified as having the highest risk of flooding in comparison to any other area in the municipality, many stakeholders in the town agree that the failure of the storm water system is the main cause of the continuing flash flooding events (Respondent 4: LG Stakeholder-Town Planning Unit, 2015., Respondent 5: LG Stakeholder-Environmental Hygiene 2015., Respondent 6: LG Stakeholder-Disaster Section, 2015., Respondent 7**:** NG Stakeholder-Environmental Affairs, 2015., Respondent 11: FT Community Stakeholder-Elder, 2015., and Respondent 21: LG Stakeholder- Engineering Municipal Official., 2015). According to their responses, the reason for this is that the *Qedusizi* flood attenuation dam has been able to deal with the major Klip River flooding events, as a result of its design capacity, which is to deal with a 1: 100-year major flood. They also indicate that these major floods (river floods) were responsible for dangerous flooding events of Ladysmith town as the immediate bursting of the Klip River banks caused a serious threat to their livelihoods and the citizens. With the emergence of dam flood control scheme as a major intervention, it is now clear that the remaining problem are the flash floods which are exacerbated by the failure of the storm water system given that the major river flooding is now largely controlled by various engineering solutions in place.

According to Respondent 11**:** FT Community Stakeholder-Elder (2015) **"**the whole town of Ladysmith no longer experiences the issue of flooding *per se,* however the remaining issue is the flooding problem associated of the failure of the storm water drainage in the Central Business District (CBD)". This argument is supported by Respondent 7**:** NG Stakeholder-Environmental Affairs (2015), and Respondent 12**:** LG Stakeholder-Flood Liaison Committee Member, (2015) who have acknowledged that the Ladysmith storm water drainage system is unable to cope with even small rainfall events given the reality of Ladysmith being positioned on the floodplain or flat terrain. The ELM SDF (2012)

and the IDP Review (2006/2007) also verify this argument as they both state that Ladysmith experiences minor floods almost every year and also that there is a problem of storm water flooding (ELLM, 2006b, and 2011c). Many factors contribute to the failure of the storm water system in Ladysmith. These factors include but are not limited to flat terrain, high runoff due to hardened surfaces such as tarmac roads and cement building that discourage infiltration, litter and waste that block the storm water pipes, and failure to inspect the storm water system. These factors will be discussed in detail in the following sections.

5.2.5. The natural causes of flood vulnerability

In order to have a deeper understanding of what cause the floods, the natural factors must be taken into account and understood. All the municipal and the national stakeholder's interviewed agreed that the main cause of flood vulnerability in Ladysmith town is its positioning in the flat terrain, also known as middle stage of the river, or gentle slope of the flood plain of the Klip River. As a result of the town's location, flooding has occurred in Ladysmith for a very long time (Respondent 4: LG Stakeholder- Town Planning Section, 2015; Respondent 5: LG Stakeholder-Environmental Hygiene Section, 2015; Respondent 6: LG Stakeholder-Disaster Section, 2015; Respondent 7: NG Stakeholder-Environmental Affairs, 2015; Respondent 12: LG Stakeholder-Flood Liaison Committee Member, 2015; Respondent 13: LG Stakeholder-Parks and Gardens Unit, 2015). Respondent 11: FT Community Stakeholder-Elder, (2015) and Respondent 8: FT Business Stakeholder-Store Manager (2015) also share this view.

Explaining the positioning of Ladysmith town on the banks of the Klip River, Respondent 12: LG Stakeholder-Flood Liaison Committee Member (2015) further elaborated with a rough sketch and said that [pointing to his rough sketch], "as you can see that Ladysmith is located where the velocity of the water decreases. Due to the fact that the water finds its contours when it reaches Ladysmith town, the water then starts to snake around (or meanders) as it spreads in this gentle slope". He added that the young stage of the river [located in the catchment areas], is where the Klip River starts to develop and obtain its water near the Drakensberg, whereas the old stage of the river happens in the dissipating stage of the River at the confluence of the Klip River with the Tugela River ". From a design perspective of the town, the positioning of the town in the floodplain results in immediate runoff even when there is normal rainfall" (Respondent 7**:** NG Stakeholder-Environmental Affairs, 2015). Due to these facts related to the poor layout of Ladysmith in the floodplain, Respondent 11: FT Community Stakeholder-Elder (2015) further stressed that, "… the planners in the past did not foresee the danger

of establishing the town in the floodplain and this is the main reason that we are talking about the continuous flooding events in this town".

5.2.6. What are other indirect drivers of continued flood risks in the ELLM?

After the direct causes of floods were identified, the respondents further identified other interlinked problems that perpetuate the problem including land pollution and illegal waste disposal. The section below discusses the responses of the stakeholders in relation to how they view factors such as the pressure for development and modernisation, and the nature of our acculturation (including socialisation) in the face of urbanisation.

There are two stakeholders residing in Ladysmith town who shared their insights as to why there is a continuous problem of human-made flood risks, in particular those linked with land pollution, illegal disposal of waste in the river and storm water infrastructure in Ladysmith (Respondent 12: LG Stakeholder-Flood Liaison Committee Member, 2015., Respondent 11: FT Community Stakeholder-Elder., 2015). Their views are discussed and compared below.

In understanding the problem of illegal dumping and the disrespect for nature, Respondent 12: LG Stakeholder-Flood Liaison Committee Member (2015) emphasised that this problem is caused by "the nature of our acculturation and a drive to modernisation or civilisation of our societies". He further stated that the notion of residing in conflict with nature is due to civilisation and urbanisation. He believes that our development path is against nature and it is not getting better. According this respondent,

> …. all men who are civilizing [and throughout history], they have shown little appreciation of nature as they build on the floodplains, cultivate, and engineer nature's right of way. Therefore, controlling their behavior will be hard and I do not see this happening in the near future. Even though I believe in the environmental solution - at least in theory, I really do not see how environmental solutions can be featured and help in practical terms unless adequately demonstrated (Respondent 12**:** LG Stakeholder-Flood Liaison Committee Member, 2015).

From this response, it can be concluded that the processes that come with modernisation under the system of industrial capitalism (and more recently neo-liberal capitalism) are technocratic and attempt to socialise humanity to believe that humans are more powerful than nature. According to Respondent 12**:** LG Stakeholder-Flood Liaison Committee Member, (2015), achieving development, civilisation, and modernisation is not yet sustainable and this is evident in the flood events which shape life in Ladysmith.

By contrast, Respondent 11: FT Community Stakeholder-Elder (2015) states that the nature of our acculturation or socialization in the face of western models of democracy is a problem because this undermines community's own ways of organizing their own societies. For example, to teach and control the behavior of their children as they grow up is no longer in the community domain, as the system of education in the country is too western. He further elaborated his point and said,

> …. you can see the rubbish all around the town and also blocking the storm water pipes but, as parents and teachers we have lost control to raise the children that understand that throwing rubbish anywhere and living in the dirty environment is not good. The kids in schools especially those that come outside throw even the condoms in the built or the natural environment and not much we can do as they are protected in terms of the Constitution: the Bill of Rights (Respondent 11: FT Community Stakeholder-Elder, 2015).

In this way, the issue of urbanization and migration comes into play suggesting that cities and urban areas inherit some of the negative impacts and risks created by the formal systems that govern these areas, shifting the responsibility of learning from parents to school systems.

Respondent 11: FT Community Stakeholder-Elder (2015) also noted that one of the causes of litter and land pollution by the people is due to migration to or urbanisation of the major urban centres. The 'outsiders' or 'migrants' have a negative impact on urban spaces as they do not feel that they are stewards of these lands and thus they adopt a detached approach, as they do not feel responsible for maintaining these new places. This is the case as they come here [town] for employment and other short-term needs and do not perceive these areas to be 'home'. However, a community stakeholder argues that as "residents living in the flood risk area; some of us are keen to live in the clean environment and we are upset when we see the litter in our public places" (Respondent 11: Flooded Town Community Stakeholder-Elder, 2015).

This section has revealed that there are divergent views about the nature of our acculturation, urbanisation, and the cultural shift from traditional societies undermining the structures of Zulu rural way of life. This shift has a negative impact in the management of the water and land causing more land pollution and river pollution in the urban areas due to illegal waste disposal. However, there is still a huge importance of culture as some hold on to the traditional way of life even today. In the era of multiculturalism and multiple identities (Watson, 2003), the effort to preserve traditional knowledge is carried by those who value its conservation. The in-depth discussion of communal values and the rich understanding of their traditions will be discussed in the following sections. As a result of transition and quest for development, the cities are becoming more vulnerable as there is a pressure for the development and growing population resulting from rural urban migration.

5.2.7. Reflections on the threats to flood risk management infrastructures

Flood management Infrastructure can mitigate or reduce flood vulnerability but these solutions can also cause increased flood vulnerability. This section deals with the identified threats to the town's flood resilience infrastructure which include factors such as lack of maintaining the infrastructure in the inundated areas, crises relating to river health and lack of monitoring or environmental enforcement, illegal occupation and its impact to the inspection of flap gates[12].

While the flat terrain of the town and its location on the river floodplain is the main cause of continual flooding, the research has shown that the lack of maintenance of the flood control infrastructure including the sewer system has been mentioned as a cause of the flood risks with the negative impact on health of the people and the environment (i.e. aquatic animals). According to Respondent 11: FT Community Stakeholder-Elder (2015), the relevant municipal departments are responsible for taking care of pollution and maintaining the infrastructure including taking care of the health of the river. This pollution was witnessed during the site visit as some areas adjacent to the Klip River were found to have a leaking sewer system (See Plate 5.1 below). This increases health risks (i.e. cholera and vector diseases) when flooding occurs as the leaking sewers will increase pathogens in the river.

[12] **Flap gates** are hard engineering strategies to drain surface storm water flooding in the town of Ladysmith and take it to Klip River. However, drainage gates must be kept clean if they are to function correctly and periodic inspection and cleaning should be scheduled in order to ensure that it is not clogged up with the floating material happened during the previous flood events (Respondent 12: LG Stakeholder-Flood Liaison Committee Member, 2015). This ensures that, it is prepared for other floods.

Plate 5.1: Leaking sewer pipe will cause health related flood risks *(Photograph by Njabulo Ngcobo, 2015)*

As an elder was pointing to the leak he showed the researcher (See Figure 5.1 above), Respondent 11: FT Community Stakeholder-Elder, (2015) further explained that,

> "… this leak has been reported a long time ago [i.e. a year ago] but the municipality is not coming to fix it. So, imagine when there is a rain and the impact this will have on the health of the river. It is simple, the implication will be severe and the health risks will be high to the aquatic life such as fish [i.e. catfish] and those who fish in Klip River. It will put the lives of the communities and families at the risk".

Improved river health, monitoring and environmental enforcement play a crucial role in addressing the risk of flooding to the surrounding communities and also benefit the aquatic life. However, the outcome of the interviews and site visit have shown that this is not the case and the river's EI is disturbed.

Respondent 11: FT Community Stakeholder-Elder, (2015) stated that the municipality is supposed to inspect the river but they do not see them doing their job. The outcome of the site visit and participant observation in the study area, as well as the interviews with some of the stakeholders have shown that another serious issue causing flood risks in Ladysmith is illegal dumping. Illegal dumping is due to poor law enforcement by the municipality and also the irresponsibility of the citizens or the

users. As a result, the Klip River is subject to contamination, which results in health risks of floods (ibid). (See Plate 5.2)

Plate 5.2: Illegal waste disposal in the tributary of the Klip River, Ladysmith between Illing Road and the Cemeteries (Photograph by Njabulo Ngcobo, 2015)

The implication of illegal dumping, poor law enforcement and lack of maintenance of the flood management infrastructure adjacent to the Klip River not only causes the death or decline of the health status of the aquatic animals living in the water (including the health risks to those who fish in the polluted water) but also leads to the blockage of the storm water pipes, thus making them fail when there are rains.

Respondent 5: LG Stakeholder-Environmental Hygiene (2015) highlighted that illegal dumping is a problem in the municipality and this happens mostly during the weekends when there is no scheduled waste collection. Due to this, the residents prefer to throw the rubbish in the built up areas or the natural areas next to the Klip River and other waterscapes. Respondent 5: LG Stakeholder-Environmental Hygiene (2015) further clarified that there are also concerns that rubble[13] and domestic refuse (i.e. waste generated at a household level comprising of garbage and rubbish such as bottles, cans, clothing, food packaging, food) contributes to the pollution in Ladysmith. During the floods, the waste located in and outside the residential areas can be washed away in to the flood

[13] **Rubble** is a waste generated during the construction and demolition of buildings. Material such as bricks is a good example of a rubble.

control infrastructure of the town such as the storm water pipes and flap gates. As a consequence, this causes immediate runoff and flooding of Ladysmith even with normal rains that would have been controlled. The cause of this problem is that the there is a lack of adequate awareness by Ladysmith citizens that there are available home refuse services such as the "Why Waste". In addition, the municipality is not always managing the waste collection services and disposing of waste in the landfill site (Respondent 5**:** LG Stakeholder-Environmental Hygiene, 2015).

Why Waste is one of the privately owned companies in Ladysmith. It is in partnership with the municipality and helping it to manage waste by offering the waste management services the municipality cannot. This helps the Department of Environmental Hygiene in realising the same goal (or vision) to motivate the ELLM community in contributing to recycling, awareness and environmental conservation (See plate 5.3 below).

Plate 5.3: Services offered by the Why Waste Company in Ladysmith. These services contributes to the reduction of illegal waste disposal in the municipality *(Source: http://www.whywasteladysmith.co.za/)*

Another issue causing the failure of the town's flood resilience infrastructure is that during inspection of the storm water systems and other flood infrastructure in the town, the engineering inspectors find informal homes established over the flap gates located next to Klip River (Respondent 19: LG Stakeholder-Informal dialogue with the Department of Engineering Services Municipal Official, 2016). Unfortunately, when the floods happen, one finds that this infrastructure fails due to the fact that it is clogged by the waste and not maintained on time.

However, riparian urban vegetation can regulate urban waste and avoid the excessive pollution of the river by buffering and purifying the dirt before it enters the stream (INR, 1988). For example, the Vermont Agency of Natural Resources, (2005) states that riparian areas are very important in keeping pesticide application away from streams, rivers, and lakes, and preventing direct contamination of the water body and reducing the health related danger such as drift[14]. With the wider riparian setbacks, this increases the retention time for chemicals, allowing more opportunity for contaminants to decompose before reaching the waterbody (Vermont Agency of Natural Resources, 2005). This is important as Asmussen (1977) cited in Vermont Agency of Natural Resources, (2005: 6) discovered that "a 78-foot grassed buffer reduced pesticide levels in surface runoff by about 70%". In this way, the wider riparian vegetation can play a significant role as it safeguards the quality of the river's water and protects aquatic life.

However, the stakeholders did not mention the role of riparian habitat in regulating the waste before it reaches the Klip River. Not even one official and community member stated the dangers and health risks that could happen if the vegetation along the Klip River is cleared. Due to this, the researcher concludes that the respondents showed a poor understanding of the Klip River EI and its value. Having reviewed the literature on the role of EI (i.e. riparian vegetation), it has become clear that investing in its value it will also mitigate the health risk that will be high when there are more rains.

5.3. Stakeholders' perception of solutions to flood risks

There are several national and provincial legislations and policies that require the ELLM to incorporate these steps in their development plans in order to protect the citizens from the floods and environmental changes. This is important because it helps decision-making processes about the use of land for water and urban development clearer, and thus making the relationship between the two more smoother when achieving sustainable growth in the Ladysmith and the ELLM at large. As part

[14] **Drift** can be defined as the movement of the pesticide at time of application away from the application target to the surrounding environment (Vermont Agency of Natural Resources, 2005).

of the analysis of the primary documentary data, this sub section will be based on the analysis and discussion of the baseline information done for (and by) the municipality to address flood risks using EI and other solutions.

Environmental Management Framework and Strategic Environmental Planning tool and its relationship with the IDP and the SDF, and Disaster Management Framework and recent DMPs and their relationship with the IDPs and SDFs will be examined. There will also be a review of the policy of the Emnambithi/Ladysmith Open Space System including other plans than cover the Cntral Business District and areas in the upper catchment of Klip River, Nor of Ladysmith town (Driefontein Local Area Plan) and lower catchment areas of Klip River in the Southern parts of Ladysmith (St Chad, Mthandi, and Mcitsheni LAP). From this, areas with low and some level of participation in flood management are discussed. Using Ladysmith Gazette data archives (Gazette, 1996:2), the researcher also reveals evidence about some of Ladysmith Stakeholders who showed a deeper understanding of EI and elaborated its role in reducing Ladysmith flood vulnerability.

5.3.1. Strategic Planning/baseline information produced for and by the LM

In order to protect the value and sustainable use of EI in the municipality, the ELLM has create d its Environmental Management Framework and Strategic Environmental Planning tool (EMF & SEPT) as a bigger framework. The purpose of the EMF and SEMPT is to help the municipality achieve its environmental obligations in terms of NEMA, which requires that the SDF and the IDP include a section on the environment. The municipality has complied with this requirement as it has created its IDP and the SDF, which include sections deriving from the EMF and SEMPT. This ensures that the health of EI is protected and sustainably used, at least on paper. This is the case as it appears in section 10.7 of the SDF where an Environmental Management section is included (See map in Figure 5.1 below).

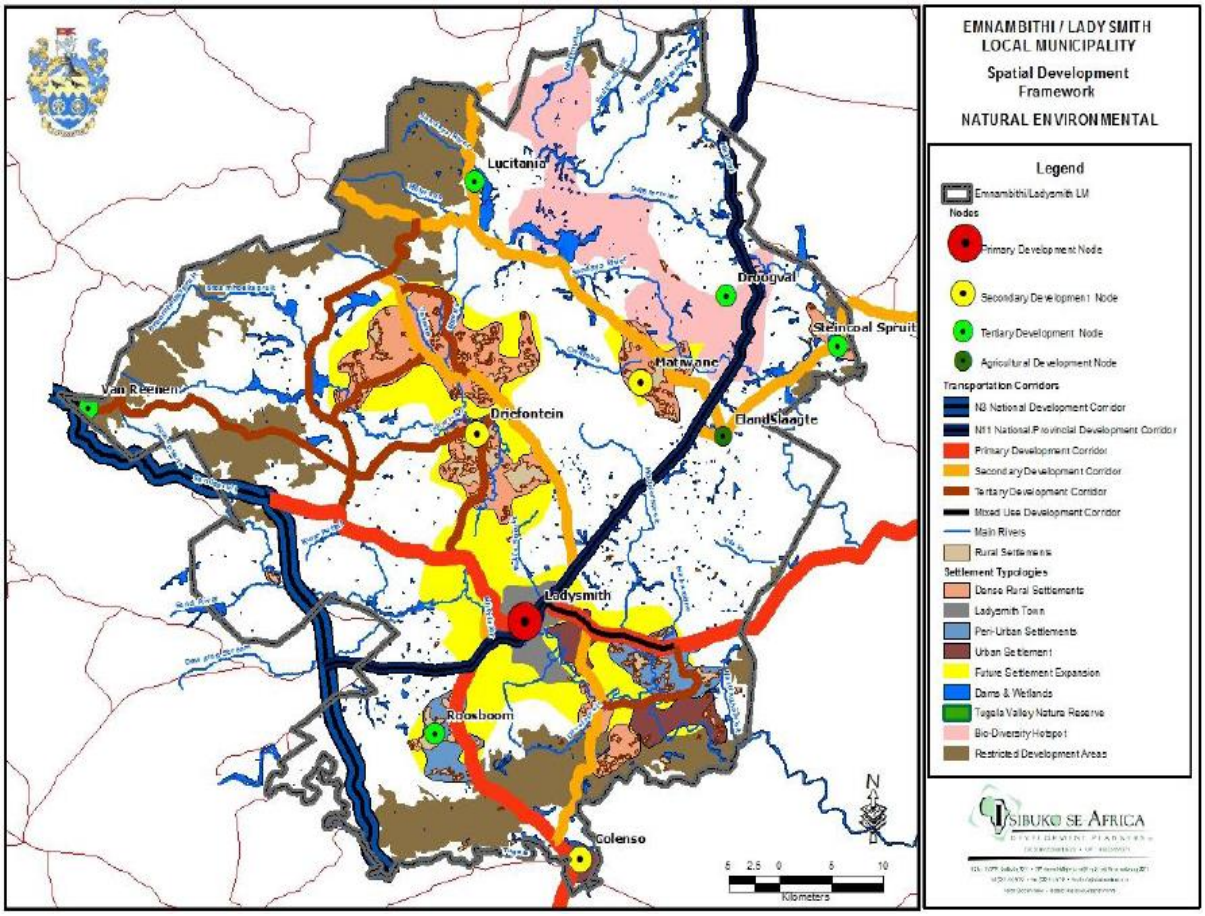


Figure 5.1: Natural Environmental Framework Plan of the ELLM *(Source: ELLM, 2012c:101)*

The map shows that the dominant environmental assets (i.e. wetlands) are located in the north section of the municipality. There is only one formallyInter protected area in the south of the municipality, near Colenso. It is known as Tugela Valley Nature Reserve. In addition, the identified high biodiversity hotspots (coloured in pink) are located in the north and these areas are located outside of the Klip River floodplain. As a result, these assets were excluded from the case study. The northern parts of the Klip River catchment and edges of the municipality near the Klip River confluence with the Tugela River in the south are characterised by areas identified as restricted for development (coloured in brown). The Emachibini settlement under Mthembu Tribal Authority (MTA) is located in an area identified as having restrictions for development due to the steepness of the slope and the soil conditions, to name but a few. The case study site of Ladysmith town as a primary development node is located in the floodplain of the Klip River. Areas in the northern part of the town (along the Klip River) have various settlement types such as semi urban and rural land use, amongst other activities.

5.3.1.1. Towards Risk Reduction Approach in the DMP and its influence the IDP

The National Disaster Management Framework (2005) requires that there is a shift in the policy in South Africa from a hazard based approach, which is more reactive, towards risk reduction approach, which is more proactive. In this quest, the local government municipalities around the country are supposed to play a crucial role in making sure that this goal is implemented in policy and practice. After reviewing the ELLM Disaster Management Plan (2005), Disaster Management Plan 2015/2016 review and the IDP 2015/2016 review, it is evident that there is now a shift from a hazard based approach (i.e. flood protection) towards more of a risk reduction approach by integrating socio-economic aspects in disaster management (ELLM, 2015b., section 3.5. of the ELLM 2015a). In the case of the ELLM, the reason for their shift was due to the realisation that socio-economic issues such as poverty cause flood vulnerability.

The Disaster Management Plan (DMP) in the municipality should advocate for the inclusion of disaster management funding and ensure that the disaster section is included in the ongoing municipal development plan. Fortunately, the ELM has created its own DMP and the IDP of the Municipality and these are renewed in every five years. These plans are also reviewed every year, thus making it possible to examine the key principles set out in the National legislative and policy framework. Comparing the Disaster Management Plans of 2012 and 2015, it is noted that poverty has been identified as a new disaster facing the ELLM and it has also been recently ranked as the number one priority in the recent Disaster Management Plan of 2015. However, flooding [a crisis happening in the town] has dropped and become number four in the disaster rankings (Respondent 6: LG Stakeholder-Disaster Management Section, 2015., Disaster Management Plan 2012, and section 3.5 of the IDP review 2015/2016).

In order to give the IDP an indication of how much to spend on prevention and mitigation strategies of the disasters in the ELLM, a risk assessment analysis was undertaken and the results were graphically displayed (See Figure 5.2).

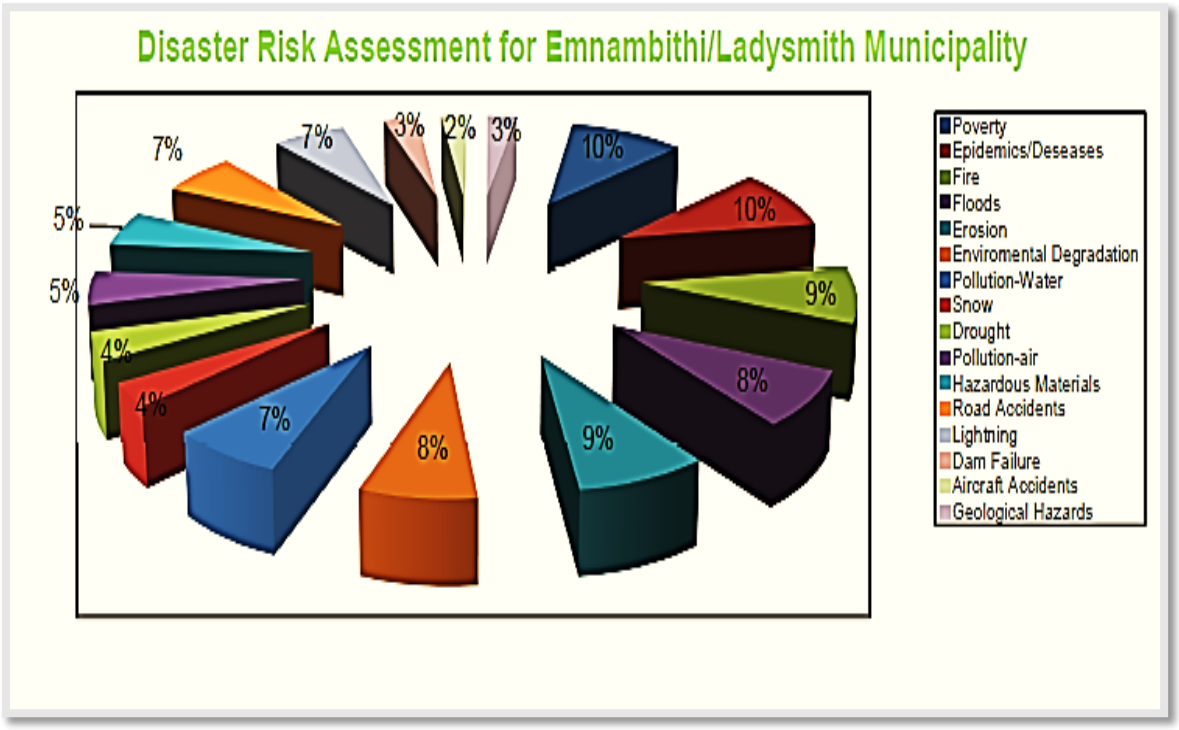


Figure 5.2: Percentage of total capital budget to be spent on prevention and mitigation Strategies *(Source: ELLM, 2015: 143)*

The results presented in Figure 5.2 represent the worst-case scenario for all identified hazards in the municipality. As part of the first round indication to guide their IDP in the allocation of funds to line departments, the pie-chart displayed in Figure 5.2 (DMP review 2015/2016 on the IDP Review 2015/2016) shows that about 10% of the total municipal budget may be spent on poverty alleviation programmes. It further states that, 27 % (9% on each) can be spent on epidemic, veld fire and flood relief measures.

In terms of the methodology used in the assessment of the ELLM risks displayed in Figure 5.2, the DMP review 2015/2016 reveals that this was obtained from calculating the risk and costs according to population numbers within a two square kilometres radius in the ELLM. The calculations were based on the probability on a scale of 500 persons per two square Kilometres (ELLM, 2015b).

The IDP Review 2015/2016 cited in (ELLM, 2015a:142) further clarified that;

> Not only does poverty give an indication of the vulnerability of a community, it also gives an indication of the capacity of the community to cope with disasters. When a threshold value is linked to poverty, it is clear from the above table that poverty received the highest score. Hence, the alleviation of poverty is the highest priority, above all identified hazards, as this should also have a positive impact on the aspects listed above.

Due to these aforementioned issues,

> the *Emnambithi*/Ladysmith LM has identified the need to prioritise and also to reallocate its resources to eradicate poverty interrelated matters above all other recognised troubles because when vulnerable communities have the capacity to survive with disasters (either by building durable houses or having insurance on property), it would uplift the rehabilitation processes after a disaster occurred (IDP Review 2015/2016 cited on ELLM, 2015a: 142).

When vulnerable communities have the capacity to cope with disasters, it would elevate the rehabilitation process after a disaster occurred (ELLM, 2015a).

The groundtruthing done by the researcher in the field complements the Disaster Risk Assessment percentage for the ELLM. For example, interviews also indicated that there are stakeholders who believe that the socio-economic aspects play a crucial role in disaster management. This is the case as Respondent 6: LG Stakeholder-Disaster Management, (2015)., Respondent 7: NG Stakeholder-Environmental Affairs, (2015)., and Respondent 2: RC Stakeholder-Elder, (2015) all agreed that the socio-economic issues are an indirect cause of flood vulnerability in the ELLM. For instance, Respondent 2: RC Stakeholder-Elder, (2015) stated that, unemployment [which leads to poverty] in the municipality can be identified as a disaster problem. According to his response, the adaptation and recovery to any type of a disaster (such as flooding or drought) will require a person with good financial resources in order to support the solutions to be implemented at a household level and above. It is therefore evident, although not explicitly stated by many, that the IDP prioritised socio-economic issues and poverty as this is a true reflection of the challenges faced by their citizens that are most likely to suffer the flood risks.

5.3.1.2. Driefontein LAP Intervention in the Upper catchment areas of Klip River

The neglect or the lack of formal planning in the former homeland areas, which are now under the traditional authority, also contributed to the flood vulnerability of Ladysmith as the land uses were not controlled in the sensitive areas and flood line areas. However, in the post-apartheid era the current government is trying to address these past injustices by trying to create the so called wall to wall schemes incorporated as per the requirements of the SPLUMA and MSA and other previous legislation. In order to deal with these areas outside of the existing town planning schemes, the ELLM has created a temporary solution, a Local Area Plan. This solution helps land use planning avoid development in the areas susceptible to floods. After reviewing three Local Area Plans developed for the municipality in order to control the sprawling development areas outside of the town planning schemes, the Driefontein region was found to be most progressive when it comes to the integration

of EI in to their planning. This region is important because it is located in the upper stream areas of the Klip River. In its LAP (section 3.6.5 on the ELLM, 2011a), there is an Environmental plan and this indicates that the EI ideas are incorporated in the development strategies of the municipality (See Figure 5.3. below).

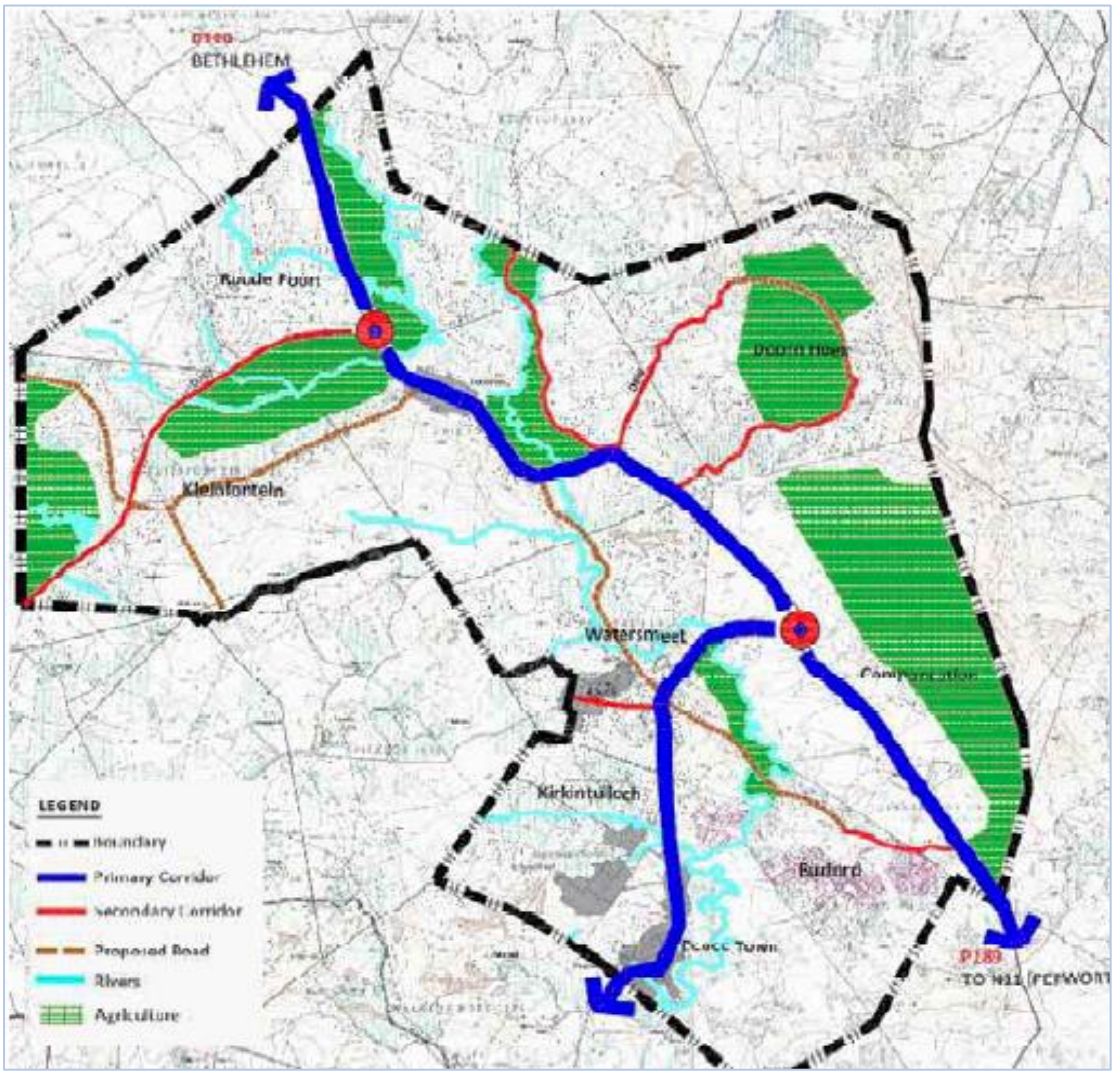


Figure 5.3: Driefontein Environmental Management Concept Plan *(Source: ELLM 2011a: 17)*

According to Driefontein LAP, the

> Klip River and its tributaries have been delineated as the riparian zones. This implies that no development should occur within these areas. The households that have constructed structures within these areas may need to be relocated. The agricultural land that has remained undisturbed by land invasion (settlements) has also been earmarked for appropriate commercial agricultural projects (ELLM, 2011a: 17).

With this plan, it is evident that commercial agriculture land uses are promoted next to the Klip River buffers. In relation to the functions of EI, it is evident that there is more support for the provisioning services provided by the Klip River. In order for this function to operate sustainably, consideration must be given to minimising the negative effects that the impact of the poorly managed farming activities might have on the functioning of the river (i.e. soil erosion towards the river).

However, the environmental plan provides a useful framework to help the municipality, communities, private sector or the developers, and other stakeholders in land development. With the LAPs, it is clearly specified where the areas for Activity Nodes are (section 3.6.6), Rural Human Settlements (section 3.6.7), and Urban Consolidation priority areas (section 3.6.8) are located as these are the most desired options for using this land in this area or region. With these key areas for priority development being identified, it is then clear that the remaining lands are for the functioning of EI and they are not for priority development.

It is also clear that the reason that there is an environmental plan for a region such as Driefontein is because there is a demand by the municipality that the area be developed and become a priority for investment (ELLM, 2015). The increasing population also justified the creation of such plans, and this plan aimed to help the municipality protect sensitive areas, while directing growth to less sensitive areas. Isibuko SeAfrica, the planning consultants, were appointed to do the LAP and they had capacity to determine how the environment can be integrated into the development plans of the municipality. The LAP also includes the concept of sustainable development[15] and Local Agenda 21[16] (including the compliance with NEMA). This is important as it compliments what is reflected in the Environmental Management Framework and Strategic Environmental Planning tool of the ELLM, ensuring that the soft engineering solutions are integrated into planning and development.

5.3.1.3. ELMOSS Policy and other plans supporting the integration of EI concept

In 2007, the ELLM Department of Community Development Town Planning Unit; Environmental Hygiene, Parks & Gardens embarked on a project to create a document to outline the main policy guidelines for the Emnambithi/Ladysmith Municipal Open Space System (ELMOSS). It clarifies the

[15] **Sustainable development** is defined as an ability of human development to meet their current social, economic, and environmental needs without compromising the needs of present and future generations (UN, 1992)

[16] ***Local Agenda 21*** is the strategy and action programme for implementing sustainable development at a *local* level (UN, 1992)

general regulations and rationale for protecting EI functions within the municipality. Within the document, a template (See Appendix D) has been created to help the developers align their development proposals with the policy or guidelines of the municipality of the areas classified as EL'MOSS (ELLM, 2007).

After citing and using relevant legislation that underpin sustainable development of the proposed projects, the applicant must provide a motivation to the Council and elaborate why the change in ELMOSS zone would be justified. ELLM, (2007: 12& 13) provides the guidelines to develop in these areas if there is a real need or if it is supported as an interim measure. Appendix C shows what is a minimum requirement for developing in a declared ELMOSS area. In these developments, the environmental issues should be addressed in a form of Scoping or Environmental Impact Assessment (EIA) reports.

It is also clear with the Ladysmith CBD Design guidelines that the concept of EI is integrated (at least on paper) as per the proposed Green Network Plan developed by Walker Smith Architects (ELLM, 2011c) (See Figure 5.4 below).

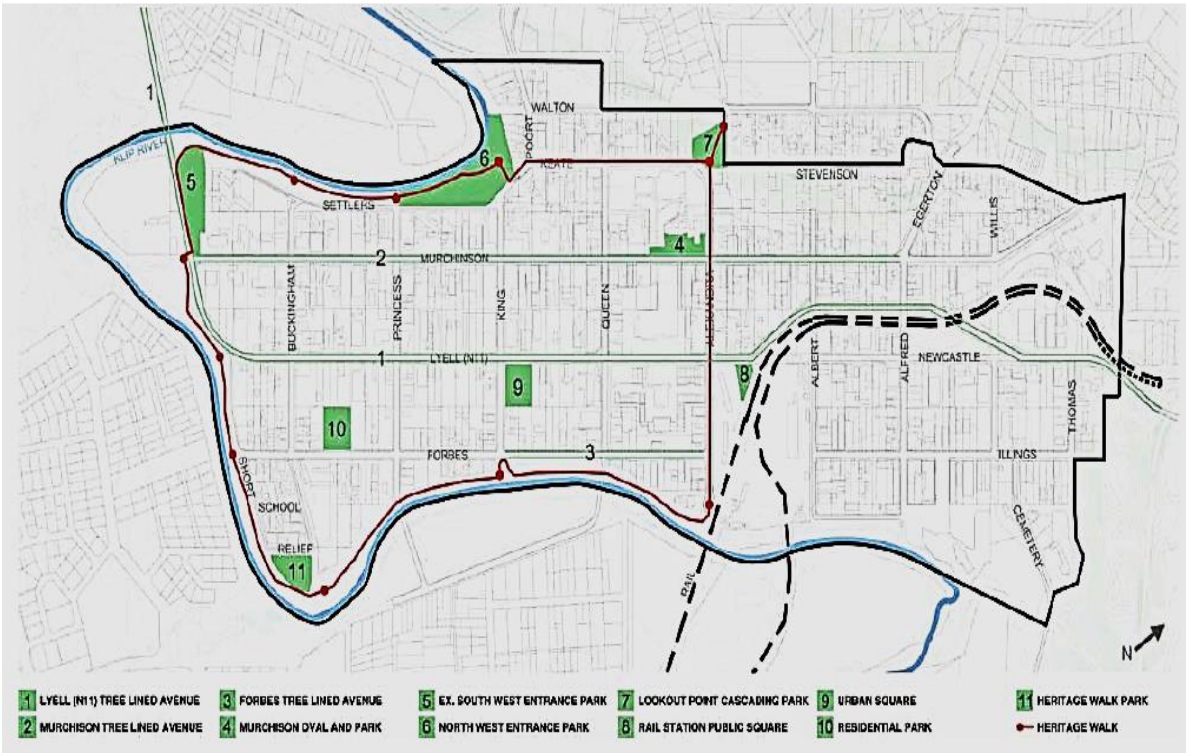


Figure 5.4: The Green Network Plan of Ladysmith CBD *(Source: ELLM, 2011c: 9)*

Based on the same case study of the Ladysmith CBD in the project executed by Vuka Africa in collaboration with Walker Smith Architects to develop a CBD Regeneration Strategy for the ELLM (2010b), the idea of preserving EI was prioritised as per section 3.1.7 of the document (See Figure 5.5 below).

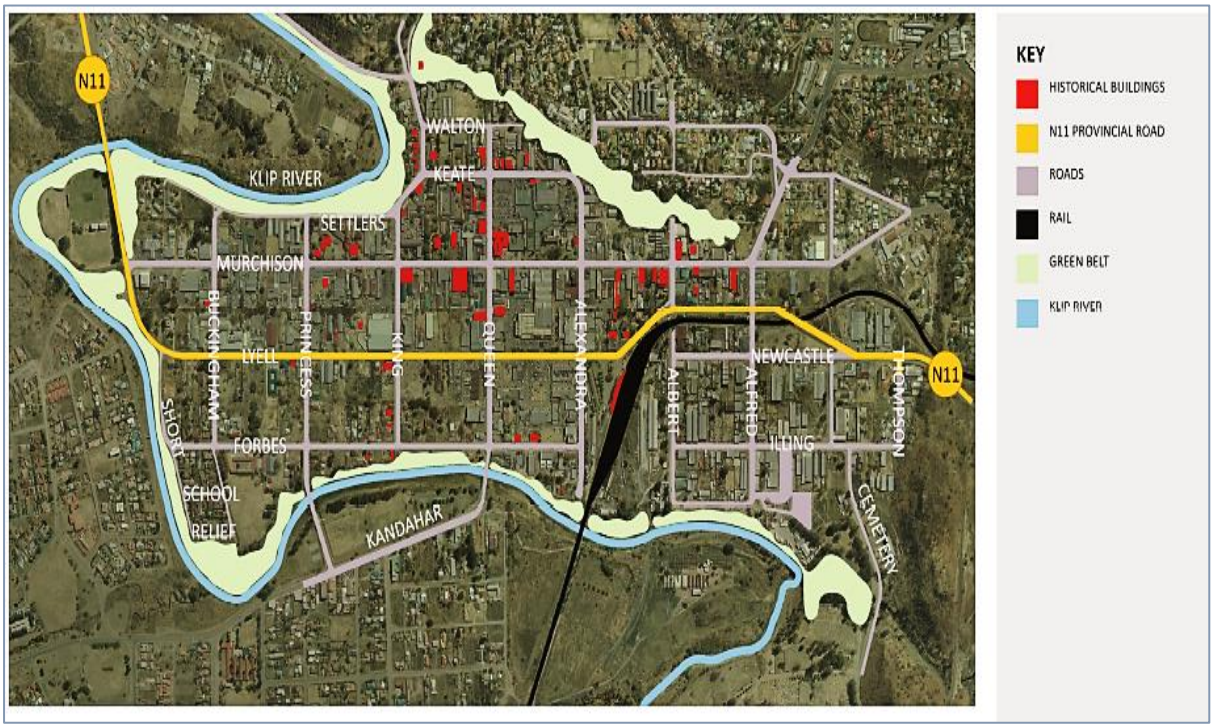


Figure 5.5: The Greenbelt of Ladysmith CBD along Klip River and the steep areas *(Source: ELLM, 2010b: 34)*

Complementing the green belt and soft engineering strategies in Ladysmith CBD, the document also includes the suggested vegetation list within the CBD as suggested by the Department of Parks and Gardens (*ELLM, 2010b: 46*) (See Figure 5.6 below).

Figure 5.6: The greenbelt and the recommended vegetation of Ladysmith CBD *(Source: ELLM, 2010b: 46)*

The map above indicates that there is an integration of soft engineering in flood management and such concepts associated with landscaping which forms part of managing the growth of the town.

More broadly, CBD Design guidelines (section 3.3.5 on *ELLM, 2011c)* on the "open space system & environmentally sensitive areas" emphasise the role of the open spaces in flood regulation and also in providing other co-benefits. According to the document, open spaces "… manage possible disasters such as floods, through provision of uninhabited floodplains, thus protecting properties and human life (*ELLM, 2011c: 48*).

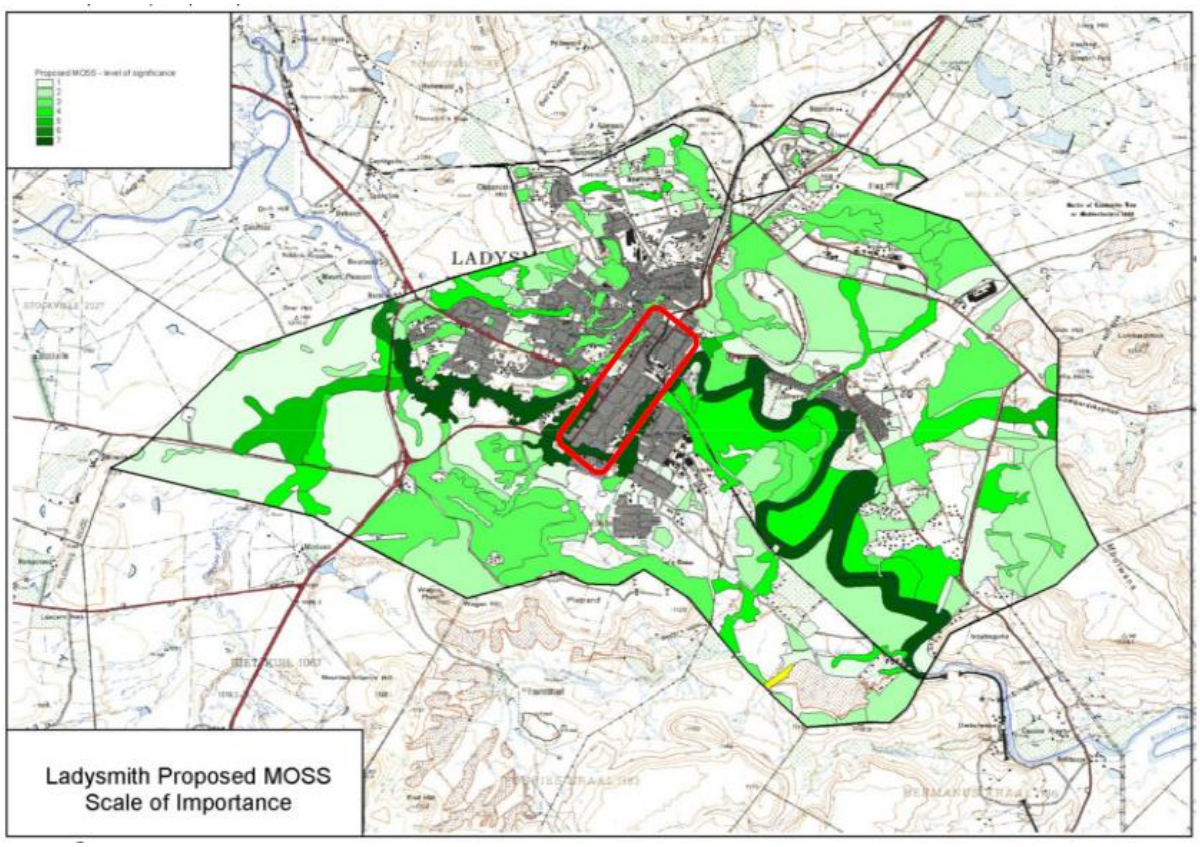


Figure 5.7: Ladysmith town's Open Space System *(Source: ELLM, 2011c: 48)*

In terms of the Figure 5.7, the darker green shades indicate areas of most importance, of which the Klip River is the most significant feature (ELLM, 2011c: 47). As such, stream rehabilitation, with cleaning, planting and selective appropriate development is recommended. According to ELLM (2011c: 47), it is further stated that "Green belts abound around the periphery of the CBD and this greening may be pulled through the CBD along the primary north-south corridors of Murchison, and Lyell Streets". In terms of the identified environmental risks in specific areas, there may be a requirement for higher development costs.

The LAP of the Mcitsheni, Mthandi, and St Chad 2012 (section 10.10 about Flood Risk Management cited in ELLM, 2012b), it is stated that development in the areas of high flood risk is heavily controlled if not altogether avoided. This includes the identified areas in the Environment and Constraints Maps (not shown in the LAP). The controls in compliance with Strategic Management Policies are discussed as is shown in Table 5.1 below.

No.	Core Policy	Explanation
14	**Policy: Flood Risk Management** It is the policy of the Council to restrict high-risk developments in areas historically prone to flood waters, and on land directly adjacent to the Klip River. High risk developments are those that would represent an unacceptable threat to public safety or are likely to cause unacceptable levels of pollution or contamination of flooded waters if inundated. Examples included hospital and emergency services, special residential care developments for the elderly or physically impaired, or commercial developments that involve polluting or contaminating processes or materials e.g. saw mills, chemicals, acids, or fuel storage. In such locations, the Council shall require proposals for development to: a) Carry out a flood risk analysis for the development in potential flood risk areas; b) Be designed to minimise the risk of flooding and that would not result in, or increase the risk of flooding elsewhere; c) Adopt reasonable measures to assist the protection of property from flood waters; and d) Incorporates building design measures and materials to assist evacuation and minimise damage from flood waters.	The policy on flood risk management is intended to protect the amenity and property of the study area's residents by ensuring that future development does not have a negative impact on the study area's flooding environment. In addition, the policy is aimed at safeguarding the environmental resources of Mcitsheni, Mthandi and St Chads and in particular the low-lying banks of the Klip River represent a significant natural amenity that will be protected from inappropriate development for the long-term benefit of the study area.

Table 5.1: Policy framework guiding the public to preventing susceptibility to flood risk in the downstream areas of Klip River *(Source: ELLM, 2012b: 61)*

In the Mcitsheni, Mthandi, and St Chad LAP, the section on the policies of the natural environment state that "within the plan area there is a presumption against the removal of landscape features, such as trees. These are part of the fabric and history of the landscape. Apart from their visual contribution they are also important habitats in their own right (ELLM, 2012b: 63)". In the case where developers need approval to use these areas, they will be asked for management plans for both the retention and management of field boundary and landscape features within their site areas. However, the maps such as the Environmental Management Concept or framework was not shown on the Mcitsheni, Mthandi, and St Chad LAP. This is constraining the developers and those interested in learning about the area, as they are not able to calculate the environmental costs and benefits of investing in the area.

Despite this, after reviewing the Flood Control Scheme Manual the researcher noticed that some sections of the manual are not up to date. For example, the incorporation of the contact details of the

business and the farmers in the upper stream or informers were last updated in 2005. In terms of the agreement enshrined in the *Qedusizi* Dam: Flood Control scheme: Flood Control and Maintenance Manual, it is required that it be updated every five years (DWAF, 1998a). The contact details were last updated in 2005.

5.3.1.4.1. Consultation and participation in flood management decision making of the upper stream stakeholders

Because the flood control scheme includes a map of the informants such as the farming and other emergency stakeholders located in the upper catchment of the stream, this is an indication that the scope of flood management decision making is relatively large (i.e. the inclusion of the floodplain and the upper catchment areas of the Klip River). However, the areas downstream of the town such as the Ezakheni are not fully included in the flood control scheme manual of Ladysmith. It is important that the scope of the flood management stakeholders covers the whole catchment of the Klip River so as to improve the health and the proper functioning of the river. This will improve the level of participation of the stakeholders in rehabilitating the Klip River and ensuring that the flood risks (and the opportunities) are balanced.

This is important as the DMP 2015/2016 review also revealed that these areas are affected by flood risk. However, from this research it is not evident why similar attention was not paid to the stakeholders in the downstream areas around Ezakheni as it is evident that flooding also happens in these places (See Appendix E1). The Ezakheni is highlighted in an orange colour. Just like the clearly mapped informants located in the upper catchment areas, they should be mapped as vulnerable stakeholders in the downstream areas to be informed when water disasters happen in the town of Ladysmith. The assumption about its lack of inclusion could be that there was a lack of budget and time to include all the affected areas and these lower stream areas were found to be least vulnerable to Klip River flooding. Further discussion and recommendations about these areas are discussed in Chapter 6.

5.3.1.5. Reflections on the flood attenuation functions of the EI before the *Qedusizi* dam flood control scheme

Although EI is not adequately recognized by many respondents in the interviews, the documentary evidence suggests that EI is recognized by the stakeholders as of value to flood risk management. For example, the local newspaper article (Ladysmith Gazette, 02/02/1996) wrote that, "… a warning was given that unusual high levels of water were expected, with flooding beyond the normal flood line."

By midday the entire town was prepared for the disaster … and then came the miracle… said the Flood Liaison Committee Chairman, Cassim Sardiwalla" (Ladysmith Gazzette, 1996: 2). After realizing that there might have been the possibility of the calculation of the velocity and volume of floodwaters in the Klip River, the authorities decide to fly the helicopter and inspect both the Klip River and Sand Spruit more carefully. Near the place called Watersmeet above the town, it appeared that the river had spilled over into a flood plain of about a square kilometer of the open field. It appeared that the level of the river, which had reached 8.4 m was in fact not miscalculated, but that there was a flood plain above Ladysmith that attenuated the axcess water. Mr Sadiwalla further alluded that, "it was as though nature decided the community of Ladysmith did not in fact deserve this horrible punishment and stored the access water" (Ladysmith Gazette, 1996: 2).

This proves an argument that prior to the installing of the engineering solutions such as the *Qedusizi* dam, the EI solutions (i.e. wetlands) were already playing a crucial role in Ladysmith in terms of flood attenuation (INR, 1988). Therefore, this alternative (old-fashioned natural approach) solution must be respected and rehabilitated as it is part of the flood risk management strategies.

5.4. Conclusion

This chapter on data analysis and discussion dealt with the stakeholder's reflections on the causes or drivers of ELLM flood vulnerability and the baseline information. The results showed that the respondents understand that there are natural factors that contribute to the continued flood vulnerability of the town of Ladysmith but most of the interviewees indicated that flood vulnerability in Ladysmith is human made. The failure of Ladysmith hard engineering solutions, poor planning, illegal waste disposal, and the lack of enforcement were identified as threats to the resilience of Ladysmith to flooding. However, the response from the rural community respondents differed as they claimed that water related disasters are caused by the disrespect of sacred water sites. They state that these places are shaped by their powerful ancestors, such as *uNomkhubulwana*. The second section discussed the stakeholder's perceptions of the solutions to flood risks. It did this by critically evaluating the baseline information done by (and for) the municipality to address flood risks. The development plans, disaster management plans, and the *Qequsizi* flood control scheme were reviewed and assessed in order to check whether they support EI as required by the legislative and policy framework of the South Africa.

CHAPTER 6: SOLUTIONS TO FLOOD RISK IN EMNAMBITHI/LADYSMITH LM AND THE VALUE OF ECOLOGICAL INFRASTRUCTURE

6.1. Introduction

This chapter on the second part of data analysis and discussion focuses on stakeholders' reflections on the solution to flood risks, specifically the hard engineering and the soft engineering strategies which have been put in place to strengthen flood resilience in the ELLM communities. It further discusses other solutions in place that cannot be grouped as hard nor soft engineering strategies such as flood warning. The last section focused on the use (and understanding) of EI in flood risk. Driven by his background and interest in spatial planning and environmental management, the researcher will summarise and interpret the responses obtained from the interviewees. This is important as the researcher aims to understand what shapes their attitude and behaviour towards flood risks and the use of EI.

This chapter subdivided into four main section starts with the critical analysis and discussion of the stakeholder's perceptions towards hard engineering strategies (mainly the *Qedusizi* dam: flood control scheme) in flood risks management. The second section is based on stakeholders reflection on the use of soft engineering strategies in flood risk management revealing law enforcement and compliance between ELLM Parks and Gardens versus the Department of Water Affairs. Other solutions such as the flood warning system is also discussed in this section. In terms of section three, there is analysis and the discussion of the stakeholder's perceptions of using EI strategies in flood management. In order to assess and check these perceptions of EI with what is happening on the ground, the researcher presents the evidence derived from the site visit. It further looks at how the rural community within the ELLM perceive flooding and environmental changes that is unique from a scientific way. The last section presents the findings derived from the Stakeholders regarding solutions and recommendations towards flood risks. The researcher also use literature to support and analyse some of the primary oral and documentary data presented by the stakeholders.

6.2. Stakeholders' reflections on the use of hard engineering

6.2.1 Reflections on the awareness and use of the dam's solutions

The *Qedusizi* flood control scheme shows the role that hard engineering plays in the construction and maintenance of flood management infrastructure in the town of Ladysmith. This is based on the construction of the dams, river embankment, installation of the storm water infrastructure, flap gates, bridges, and other well acknowledged built up plans aiming to address flash or riverine flooding (See Figure 6.1 below).

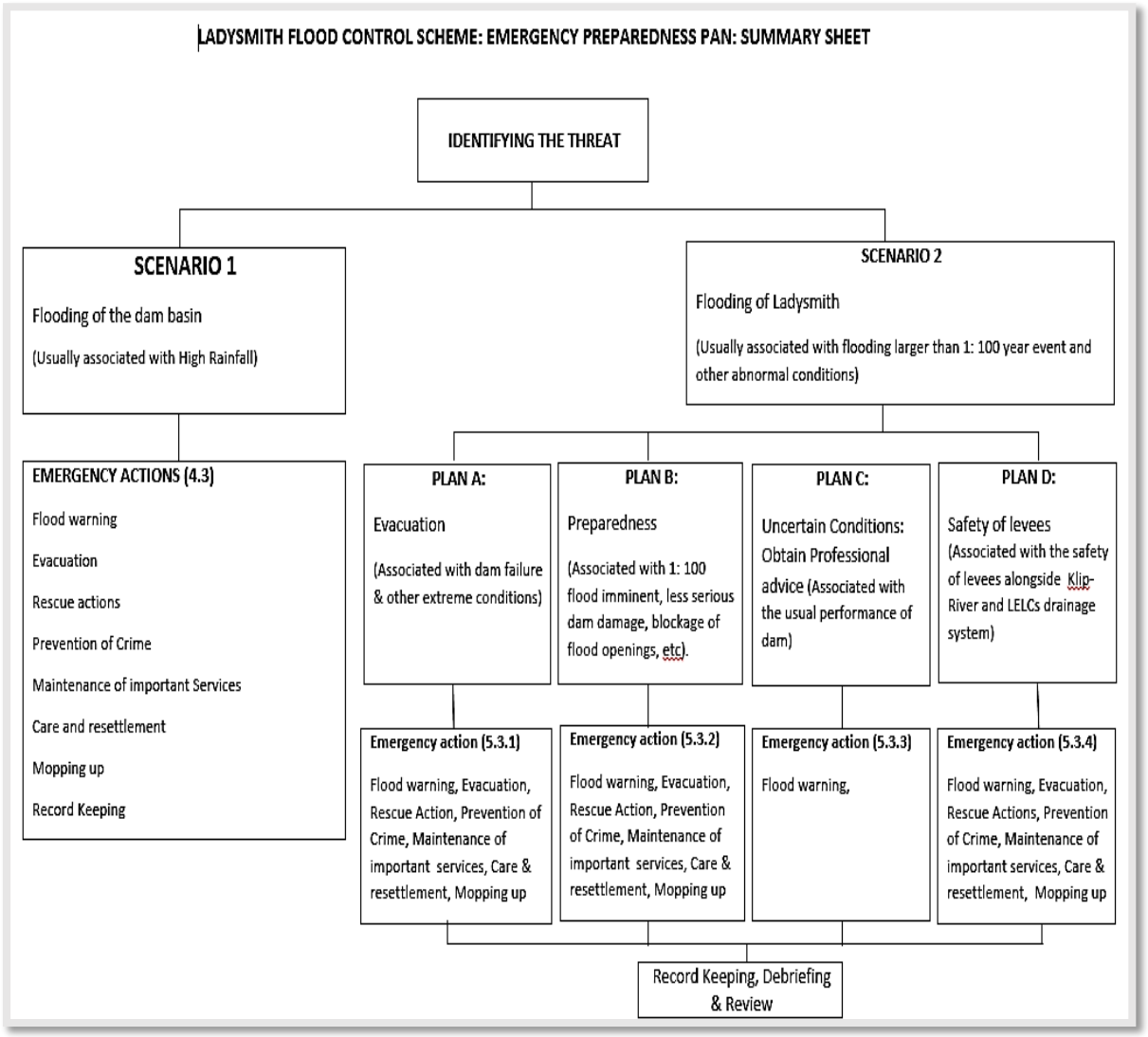


Figure 6.1: Governance and Emergency Preparedness Plan to Resolve Flood Risks/disasters in Ladysmith Town *(Source: DWAF, 1998a).*

The use of hard engineering solutions is supported by the implementation of governance process as shown by the Ladysmith emergency preparedness plan. This plan shows that different strategies and plans are put in place in the event of flood disaster. For example, in scenario 1 where the dam basin get flooded; the emergency action involve the activation of the flood warning system such as sirens and radio, evacuate the citizens and properties under threat, rescue actions must be put into place, prevention of crime by the police, care and resettlement, mopping up, and record keeping. Scenario 2 caused by the flooding of Ladysmith as a result of burst of Klip River banks (1: 100 floods) and other abnormal conditions, various plans are activated depending on what caused the floods. For example, plan A (evacuation) is activated when the dam has failed whereas Plan B (Preparedness) is activated for instance with there are floods reaching to 1: 100. Plan C is based on uncertain conditions while

plan C is based on the failure of levees and drainage system. Except for plan C that require only flood warning, the emergency action for all other types of floods in scenario 2 are the same as those in scenario 1. However, all plan A, B, C, and D of flood scenarios will not only need record keeping at the end on the floods but it will further require debriefing and review of the plan effectiveness. There are different actors responsible for these tasks and this is enshrined in the *Qedusizi* Dam: flood control scheme manual that is internal.

The discussion of stakeholders' understanding of the use of hard engineering solutions play a crucial role in this research as it reveals tell us if the stakeholders know the existence of these solutions but also whether they support its use in flood risk management. The section below will first discuss the stakeholders' awareness of the dam's solutions, and their support and critiques levelled against the dams in Ladysmith. It further discusses the researcher's own reflections and the recommendations based on the integration of EI.

While there is adequate awareness of the dam's solutions in flood risk management in Ladysmith, Respondent 4: LG Stakeholder-Town Planning Section, (2015) cautioned that the dams are prone to fail as happened with Windsor Dam which silted up and became inefficient (see Chapter 3 on the background of the case study). Respondent 4 also mentioned that climate uncertainty will be a threat to the dams' as a solution to flooding. This view was supported by Respondent 7**:** NG Stakeholder-Environmental Affairs (2015) who further clarified that "even though the dams are useful to attenuate flooding in Ladysmith but, one cannot run away from the fact the Ladysmith still demands more alternative solutions as the Klip River is still going to be tested in the face of uncertain climate change".

Due to the ineffectiveness of Windsor Dam after the 1980s, Respondent 11: FT Community Stakeholder-Elder, (2015) proposed that there be a de-siltation of Windsor Dam so that it can help in reducing flood vulnerability and support the provision of water. However, he then stated that the municipality does not have adequate finances to desilt the dam, as now it has remained underutilized for many years. However, Respondent 6: LG Stakeholder-Disaster Management, (2015) argued that the Windsor Dam was poorly planned or designed, whereas the recent *Qedusizi* Dam is a well-designed dam.

There are also respondents who criticised single purpose dams [flood attenuation only] given the multiple challenges arising in the face of climate change. Even though they are important in terms of flood attenuation, single purpose dam infrastructure has been criticised for many reasons. Seeing the droughts, the needs of the poor agricultural communities in the municipality, and underutilisation of

the single purpose flood attenuation dam structures, some stakeholders thought that the current single purpose dams (i.e. *Qedusizi* flood attenuation) be changed into a multipurpose use (i.e. serve the needs of the water scarce communities in the upper catchment stream or be used for recreational purposes) (Respondent 4: LG Stakeholder-Town Planning Unit, 2015., and Respondent 7**:** NG Stakeholder-Environmental Affairs, 2015).

Even though Respondent 7**:** NG Stakeholder-Environmental Affairs, (2015) stated that a flood attenuation dam can be used as a multi- purpose dam due to water scarcity in the municipality and the district, this did not imply that the current use of the dam (flood attenuation) is insignificant or it is not effective. However, the impression of his response was that in order to ensure flood resilience, the engineering solutions cannot be used alone as they are going to fail under the uncertainty presented by climate change. In addition, Respondent 4: LG Stakeholder-Town Planning Unit, (2015), also mentioned that it will be after further investigations and relevant feasibility studies in which his views can be verified in relation to the change of the dam's use into a multi-purpose dam.

Despite these perceptions, there is another driver that influences change in practice. This is in terms of the Flood Control Scheme manual. Within this document, there is a section about the agreement between DWAF (Department of Water Affairs and Forestry) (recently changed to Department of Water and Sanitation) and the ELLC- *Emnambithi*/Ladysmith Local Council about the change of the functions of the *Qedusizi* Dam. According to the agreement between the ELLC and DWAF, it is clearly stated that in order to change the current use of the dam from single purpose (flood attenuation only) to multipurpose use, the municipality must write to the department and motivate the feasibility of the new dam 'project' based on detailed studies. Unfortunately, the binding responsibility of DWAF would cease, as the contract would terminate after the approval of the dam away from its primary function of solving the water disasters and flooding in Ladysmith (Flood Control Scheme cited in the DWAF, 1998a). This means that the ELLM will be responsible for the maintenance and other responsibilities of the dam and not DWAF. However, if the municipality has the capacity and strong need to change the use of the dam, they must do the studies and write the application requesting for approval from DWAF. Due to the failure of Windsor Dam, the change of land use of *Qedusizi* flood attenuation dam (and transfer of ownership of the dam) into a multipurpose dam use under the ELLM is not foreseeable in the near future due to complex reasons which includes the lack of capacity and to a lesser extent, the lack of finances.

This section has revealed that even though Ladysmith stakeholders are aware of the threat caused by degrading EI, thereby causing more flood vulnerability, the stakeholders do not realise that an investment in EI such as catchment rehabilitation and the utilisation of vegetation buffers (either on site or beyond) can conserve soil before it reaches and accumulates in the dams. From this perspective, one realises that desilting is not addressing the core issue but is only dealing with the symptom (Bell and Mason, 1998). However, the investment in the value of EI at the catchment scale has the ability to reduce the silt and increase the lifespan of the dams as inappropriate activities will be monitored and regulated. This is the case as the press release stated that, "respecting the Wetland could have spared many lives" in the floods of 2011 in Ladysmith (WESSA/WWF Mondi Wetlands Programme, 2011). This indicates that intact wetlands and appropriate land use can play an important role in flood management such as dealing with siltation and soil erosion.

6.2.2. Other hard engineering solutions to deal with flooding

The outcome of the research based on the researcher's observations and interviews further showed strong support for other hard engineering solutions in the town of Ladysmith. These include pedestrian bridges, raising of the building level, vegetation clearance and sand mining. This section discusses these solutions in more detail.

Respondent 8: FT Business Stakeholder-Store Manager, (2015) and Respondent 11: FT Community Stakeholder-Elder, (2015) have shown that pedestrian bridges are the solution to flash floods and riverine flooding as they help businesses, communities, and other stakeholders when transport routes and pavements are frequently inundated by water in Ladysmith. According to the interview with Respondent 8: FT Business Stakeholder-Store Manager, (2015), the outcome has indicated that some of the business stakeholders use of the pedestrian bridge in town because it allows the customers to cross the road and purchase goods in their stores despite the flash floods. This is particularly the case as the minor floods caused by immediate runoff close the roads while the floodwaters do not reach their stores. With the construction of the pedestrian bridge, Respondent 8: FT Business Stakeholder-Store Manager, (2015) stated that the shoppers will come to the business and they can operate and continue their business despite of minor flooding (See Plate 6.1 below).

Plate 6.1: Comparison of the past flooding and the current solution based on pedestrian bridge

Plate 6.1 above indicates that the bridge would have saved the customers from the flash floods in 2011 as not all the stores would have closed down. Although it is mostly underutilised when there are no floods, the bridge also helps those who want to cross the road safely.

There are many pedestrian bridges in the town and one of the historical bridges built was at the Sofi Mosque. Due to the realisation that Ladysmith is experiencing flood vulnerability and community is impacted by the flooding, the Muslim Society (NGO) donated the bridge at Sofia Mosque in order to help the communities cross the Klip River and reduce their vulnerability to flood risks (Respondent 11: FT Community Stakeholder-Elder, 2015) (See Plate 6.2 below).

Plate 6.2: Bridge donated to the frequently flooded communities next to Sofi Mosque *(Photograph by Njabulo Ngcobo, 2015)*

This pedestrian bridge has been in Ladysmith for many years and it helps the communities cross the Klip River safely. Other NGOs donate foodstuffs, tents, among other things (see Ladysmith Gazette Data Archives, 1994 and 1996) in order to help the communities impacted by the floods. This reveals that there is a good community response and community identity around flooding in the town.

Another engineering strategy used by businesses and schools (and other stakeholders) in the town of Ladysmith is to raise the building floor levels (Respondent 11: FT Community Stakeholder-Elder, 2015). For instance, the newly established stores (See plate 6.3) have raised building floor levels with the space in the second floor where the stock can be moved during times of floods. This is true with the new Shoprite Store (Coordinates: 28°33'41.80"S 29°47'1.21"E) which is located next to the frequently flooded rank in the CBD of Ladysmith (See plate 6.3 below).

Plate 6.3: Shoprite established on a raised floor level site in Ladysmith *(Photograph by Njabulo Ngcobo, 2015)*

Windsor High School has built its library on the second floor in order to avoid flooding of the books and other property (Respondent 11: FT Community Stakeholder-Elder, 2015). This indicates that the stakeholders such as businesses and the schools (education centres) are aware of the flood risks in the town and are adapting to them. This is true as Respondent 11: FT Community Stakeholder-Elder, (2015) has emphasised that,

> …due to the floods, the schools such as Windsor Secondary were closed, the books inundated by water, and furniture in the schools was damaged. After the rain is over, the floodwater could stay up to more than two days or even a week. During this period, the learners do not go to school and they are delayed.

This verifies that the residents, businesses (among other) of the town are adapting to the flood risk, using hard engineering solutions to support them.

There were two respondents of the town who supported the view that vegetation clearance of the Klip River banks forms part of the solutions to reducing flood risks (Respondent 11: FT Community Stakeholder, 2015., and Respondent 12: LG Stakeholder- Flood Liaison Committee Member, 2015). The responses of the stakeholders indicate that the lack of clearing of the stream is causing an immediate discharge of the Klip River, storing more water where it is not supposed to be (See plate 6.4: a) and b).

Plate 6.4 (A and B): Vegetation clearance or river's maintenance along Klip River *(Photograph by Njabulo Ngcobo, 2015)*.

This generalised response was a clear indication of how some of the stakeholders misunderstand how rivers work. Maintaining the river as shown plate (a) and (b) above does not simply allow the floodwater to flow fast but removes the alien plants that cause environmental problems in the river. Most importantly, this strategy contributes to employment creation and improving the socio-economic condition in the municipality

Due to modified streams (i.e. construction of dams), DWAF (1998) supports the clearing of the vegetation along the river because of the flood attenuation dam which changed the natural flows to Ladysmith and adjacent areas. There are very few examples where EI could threaten the hard infrastructures such as pipes and dams (i.e. long roots from tall trees could cause the leaks). However, the flood control scheme (DWAF, 1998a) failed to explain that natural vegetation is important for the functioning of the river and that the alien vegetation should be cleared as it is responsible for the excessive deposition of debris and clogging the stream stopping it from functioning properly. In this manner, the clearing of alien vegetation will form part of the rehabilitation or the maintenance of the river (See Plate a) and b).

Even though the responses from the stakeholders are mixed it was clear from most of them that they had a clear understanding that the problem of water collecting in some places is due to their town being located in the flood plain. The purpose of the flood plain is to hold and store floodwater. The remaining low parts of Ladysmith (i.e. near Sofi Mosque) is a remaining symbol of failure of

engineering solutions including the *Qedusizi* Flood attenuation dam in dealing with the conquest of flood water in the town of Ladysmith. Therefore, the clogging and sand deposition in these low lying areas is not caused by EI per se but it is due to the installation of the dam and the change in the natural flow of the river. However, blaming EI is a misunderstanding of how EI functions.

This misunderstanding is evident in Respondent 11: FT Community Stakeholder-Elders, (2015) response as he said, "... let's say, there is an immediate rainfall in the upper catchment areas such as Van Reenen; the lower parts of Klip River get discharged immediately because of the sand deposits". Due to poor understanding of how natural river work, he blamed the un-cleared vegetation next to the river as he believed that it is slowing the movement of the water to the downstream. This was a problem because the respondent never mentioned the alien invasion plants and the manner in which it is clogging up the river from flowing naturally. However, he expressed his gratitude of having a short or medium term solution (Qedusizi dam) in place because he believed this would reduce the flood risks because very few environmental solutions (if at all), have been put in place in this area so that communities would be aware of them.

Another engineering solution put in place to address the Klip River flooding in Ladysmith is instream sand mining There is one interviewee who supported the use of sand winning as a strategy to resolve flooding in the lowest parts of Ladysmith near Sofi Mosque and his views are similar to those enshrined in the Qedusizi Flood control scheme (Respondent 11: FT Community Stakeholder-Elder, 2015). (See Plate 6.5 below based on the observed sand mining).

Plate 6.5: Sand mining in Klip River next to Ladysmith Town, KwaZulu-Natal *(Photograph by Njabulo Ngcobo, 2015)* .

Sand-winning has resulted in sediment movement, removing islands in the riverbed at low flow but it is also physically altering the nature of the riverbed and causing removal of marginal (buffer) vegetation. Plate 6.5 shows that the vegetation is removed during mining operations, causing the widening of the stream and therefore disturbing the geometry of the river.

Sand wining has a complex relationship with flooding as it changes the natural river channel while on the other hand it speeds up the floodwater as part of an engineering solution. Heath *et al*., (2004) argue that instream sand mining may contribute additional sediment to downstream reaches due to the disruption of substrate stability. They further clarify that once the sediment enters the stream, it is best to let natural geomorphological and hydrological processes reach a dynamic equilibrium, rather than further exacerbating the situation by additional disturbance. The literature also revealed that increased erosion (which results in the deposition of sediment in the rivers) is mainly the result of natural vegetation removal, poor riparian land use management, and encroachment of exotic vegetation (Heath, *et al,* 2004). The section below discusses the complexity and sand mining and its relationship with the stakeholders in the ELLM. It does this by comparing strategic municipal documents such as the LAP, representing the perceived

condition and realities of the upper catchment river as constructed by the stakeholders, with the Ladysmith (subject site) community responses.

The consultant who prepared the Driefontein LAP for the upper catchment communities (on behalf of the ELLM) and Respondent 11: FT Community Stakeholder-Elder (2015) representing the citizens of Ladysmith town have a different understanding of how rivers function. Firstly, the Driefontein LAP (ELLM, 2011a) has revealed that the Klip River Catchment is currently under threat from over-grazing, inappropriate fire regimes, alien plant infestations, inappropriate arable, plantation development, unsustainable harvesting, which in turn leads to groundcover and biodiversity loss and soil erosion. Due to these inappropriate land uses, the downstream areas will suffer increased flood vulnerability due to ineffective catchment management. It is even worse when the floodplain or downstream area environment is also under stress from development pressure such as the increased in tarmac roads and concrete surfaces. These perpetuate runoff and increase the immediate discharge of the Klip River. The response from the community member in the town of Ladysmith (Respondent 11: FT Community Stakeholder-Elder, (2015) was in contrast with or not aligned with the Driefontein LAP as he stated that the vegetated catchment will lead to the flooding of the town of Ladysmith. With this response, Respondent 11 did not show a robust understanding that the excess deposition of sand in the lower parts of Ladysmith is due to development pressure and poor catchment management of the Klip River.

Even though sand mining and stream maintenance is seen as forming part of the structural solutions called channelization (i.e. speeding of the flood waters to the downstream), the stakeholders have also realised many other flood opportunities created by the modified EI of the Klip River. For example, the scouring of sand and selling it to customers in the construction industry is one of the provisioning services produced by the modified Klip River catchment. In addition, the river also provides food such as fish, which can improve the livelihoods and create economic benefits for the surrounding fishers.

This section reveals that stakeholders such as businesses, government (including the schools), and NGOs in the town of Ladysmith have developed a number of engineering strategies to protect their properties from flooding. These include the raising of the floors of the buildings, and the pedestrian bridges, to name but a few. However, the section also revealed that even though the literature points to the fact that excess sediment may be the result of poor watershed and riparian land use, the ELLM authorities prefer to invest more in flood mitigation measures as they ignore the scientific studies that the problem must also be prevented by investing in the value of EI (INR, 1988., Bell and Mason, 1998., and Batuca and Jordaan, 2000). With the adoption of temporary solutions in engineering, it is advised

that they reduce the environmental impacts in the implementation of flood control measures. This is the case as Heath *et al* (2004) advised that an effort must be put in place to reduce the severe environmental impacts of human activities. For example, instream mining activity should be monitored closely so that it can avoid the removal of more sediment than the river system can replenish.

Given all the ecosystems benefits, the responses from the stakeholders' perceptions of the Klip River EI also revealed the perceived ecosystems disservices by some of the respondents. The evidence from engagement with the stakeholders and site visits however, has revealed that the majority of the identified ecosystem disservices were in fact because of the failure of government entities to do their job. For instance, they fail to maintain and monitor the river and its riparian area. This is the case as some parts of the river have grown alien plants (as well as a forest). As a consequence, this allows citizens to dispose their litter in these hiding places with poor surveillance. Respondent 11: FT Community Stakeholder-Elder, (2015) stated that the forest is not in a desired state of their preferred vegetation of their river as it is responsible for creating a hiding position for snakes and criminals. However, the respondent did not mention that the snakes are following the rubbish thrown along the river and also that there are alien plants responsible for the increased trapping of the sediment. Despite this the responses have shown that the clearance of the stream is not only used as a strategy to control the water flows but it is part of increasing the safety and surveillance of the communities near the lower parts of the river.

6.3. Stakeholder's reflections on the use of soft Engineering in Flood Risk Management

Due to the partial failure of hard engineering solutions and a lack of recognition of the value of EI, there is now an increased attention in the literature on the use of soft engineering strategies in flood risk management as discussed in Chapter 2. This section focuses on stakeholders' understanding of the use of soft engineering in managing floods. Even though some of the soft engineering solutions are not specifically related to EI they reduce environmental impacts which further reduce the need for hard engineering solutions. Some of the soft engineering solution are not exactly ecological infrastructure solutions but they reduce the impact of development to rivers and reduce the rate of runoff as compared to other hard engineering solutions.

The following sub sections discuss some of the low impact development options followed in the ELLM in order to manage flooding in the town. This is based on the development of parks and following the stream geometry in some portions of Klip River, the use of Upper Catchment Informants (offsite) in the flood warning, and other solution (not environmental neither structural approach) such as mapping and flood warning systems.

6.3.1. National DWAF legal enforcement

Even though DWAF favours engineering solutions for solving the flood risks of Ladysmith town, there are also elements of soft engineering incorporated in to the flood control scheme for Ladysmith town and the adjacent areas next to Klip River. This is important, as the protection of EI is part of the requirement to comply with in terms of the practices of environmental laws enshrined in the international, local policy and legislative frameworks.

This is true even though Respondent 12: LG Stakeholder- Flood Liaison Committee Member (2015) stated that **"**environmental solutions were not part of the recent flood management solutions that are in place in Ladysmith [*Qedusizi* Dam: Flood Control Scheme: Control and Maintenance Manual by the DWAF and the ELLM]". In a response that emerged while interviewing Respondent 13: LG Stakeholder-Parks and Gardens Unit (2015) it was indicated that the environmental or soft engineering solutions are indeed part of the solutions even though its role is heavily controlled**.** This is the case as Respondent 13: LG Stakeholder-Parks and Gardens Unit (2015) clarified that,

> We as part of Parks and Garden unit have been warned that we are not allowed to flatten the area while providing our park in some of the areas located up the river bend. This came from the Department of Water Affairs. However, we need to follow the pattern and never to change the stream geometry.

This indicates that even though the vegetation is controlled along the Klip River and this approach is based on channelization when it comes to scouring and extending the stream bed of the Klip River, extensive consultation and detailed studies must come into play as the stream is the territory and the responsibility of DWAF (and to some extent, the ELLM).

With the authorisation from DWAF, the in-stream sand mining (coordinates: 28°34'10.72"S 29°46'58.75"E) was allowed in the town of Ladysmith and there are previous feasibility studies that approved this activity (DWAF, 1998a, and Botes *et al*, 2011). The reason for its approval was based on the reason that the sand mining formed part of the engineering solutions to control and maintain the disturbed river basin

(speeding the water and removing the deposited sand) as it was realised that the river replenishes more sand than it degenerates. In the lowest parts of Ladysmith where the risks of flooding are still high, the specialist studies show that the system would recover itself in a long term whereas the damages caused by poor catchment management will continue to accelerate the supply of the excessive sand deposits than the system cannot deal with. Though it is clear that it was not the best decision for the functioning of the river itself, the instream sand mining activity was in accordance with the Flood control scheme to regulate the floodplain and thus allow the water to move downstream (DWAF, 1998a). However, the flood control scheme clearly shows that the excessive deposition of sand was the result of the construction of the *Qedusizi* Flood attenuation which changed the natural river flows (DWAF, 1998a).

Although there are some successes of the municipality in complying at least within the controlled purchased area of DWAF as well as many other developments (with potentially low environmental impacts) proposed by big developers (i.e. 'Heritage Survey of a Proposed Quarry in Ladysmith for Afzalea' by Anderson, 2011., and Environmental Management Plan for the Ingula (Braamhoek) Integration Project by Savannah Environmental 2008) in accordance with the regulation for Environmental Impact and Heritage Impact Assessments, this is not always the case. The results of the site visit in the Emachibini (rural community) and the analysis of primary documentary data of the peri-urban areas above Ladysmith (i.e. Driefontein LAP by ELLM, 2011a) mostly under control of traditional authorities and the municipality, there is no adherence to environmental controls. Unfortunately, most of the citizens do not have the capacity to control and sustainably use the rich natural resources they depend on for their livelihood for their present and future generations. The research has also indicated that the rural and peri-urban agrarian communities lose the resilience of their EI due to poor management which constrains the environment to continue providing ecosystems services for the fulfilment of their socio-economic and livelihood opportunities. For example, they harvest wood for their own consumption or for selling, use vegetation for medicinal purposes, and use grass for roofing and selling to name but a few uses. Poor land management practices such as overgrazing, deforestation, poor farming methods removed land cover and exposing the soil to runoff. Soil runoff is a biggest threat to the river systems as it threatens the aquatic life and filling the river banks with sand. During the heavy rains, the rivers cause floods and spreads untreated storm water to the downstream communities. In more urban context, the site visit has shown that the biggest threat is illegal waste disposal as explained in section 5.2.7.

6.3.2. Map of the Informers (i.e. farmers) in dealing with the impact of localised rains

In order to increase the participation of stakeholders in the upper stream, there was an inclusion of informants such as the farmers. These key actors help inform the authorities in the town of Ladysmith about the possible rainfall events that could lead to flooding. This strategy is important as it reduces the negative impact of the "localised rains" (Respondent 12: LG Stakeholder-Flood Liaison Committee, 2015). The key stakeholders [farmers along the river and the Police in Van Reenen and Driefontein] in the upper stream of the Klip River and Sand Spruit have been mapped and also included in the *Qedusizi* flood control scheme manual of Ladysmith. Their role is to help inform the authorities in Ladysmith about the possible floods that may affect the town. Their warning system is helpful for the flood management team as they are informed six to seven hours before the floods reach the town (Respondent 12: LG Stakeholder-Flood Liaison Committee Member, 2015). The readiness and preparedness becomes high and the plans are activated in advanced (Respondent 6: LG Stakeholder-Disaster Management, 2015., and Respondent 12: LG Stakeholder-Flood Liaison Committee Member, 2015) (See Figure 6.1)

Farming along the rivers and wetlands in the Klip River Catchment plays a significant role not just in terms of fulfilling the duty of the municipality of "conservation through production" (Strategic Environmental Planning Tool cited on ELLM, 2010a), but the farmers play a significant role in making the town a safer place as they inform the authorities about the possibility of dangerous floods. In this way, they become the "eyes on the river". The theory behind using this term is derived from the work of Jane Jacobs on the people being the "Eyes on the Streets" enshrined in her book titled, "*The Death and the Life of Great American Cities* (1961)". Due to the relevance of this work in the past, the researcher then chose to apply her ideas in order to explain the case of the Klip River flooding towards Ladysmith. In this case, the informers such as farmers in the Klip River in the upper catchment of the stream play a crucial role as they are ensuring that there is proper surveillance of the possible water disasters, thus ensuring the safety of the downstream area of Ladysmith town located in the floodplain. When there are 'no eyes on the river' and the nearby wetlands are degraded (if left untouched), the town will flood and there would be no informers about the upcoming flood risks in Ladysmith town. In this way, the town would be more at risk.

6.3.3. Other solutions- flood warning system

As part of strengthening the flood warning and land use controls, authorities in Ladysmith use the flood line maps and also the maps for the elevated centres for evacuation. These measures reduce the risks of flooding. The older respondents have shown awareness about the previous flood line risk in Ladysmith town as they identify it in a similar way to what the flood control scheme manual shows (DWAF, 1998a), (Respondent 2: RC Stakeholder-Elder, 2015., Respondent 6: LG Stakeholder- Disaster Management, 2015., Respondent 11: FT Community Stakeholder-Elder, 2015., Respondent 12: LG Stakeholder-Flood Liaison Committee Member, 2015., Respondent 19: LG Stakeholder-Department Engineering Services, 2016).

Respondent 11: FT Community Stakeholder-Elder, (2015) stated that, "… there are mapped incidences of previous floods marked on electricity poles [showing the pole marked in yellow in approximately 1.5 metres] and in this way, the respondent indicated that he is aware of where the floods used to reach. When the floods do occur, we evacuate to the elevated centres [pointing the direction in which the nearest evacuation centre is located].

These responses were well aligned with what the municipal officials have said about the strategies they use when there are floods and this involved:

(a) Flood warning sirens and the radio that warns the flood victims
(b) The elevated centres are known or announced by the radio when there are floods and the emergency team help during evacuation,

There are instructions announced in each phase of the floods and different stakeholders are informed what they need to do (See Figure 6.1).

The presence and the utilisation of flood line maps and their influence in land use planning could play an important role in addressing flood vulnerability in Ladysmith and in the municipality at large. The most recent flood line mapping was undertaken by Bote *et al* (2011) after Ladysmith experienced the floods in 2011 (See Figure 6.2).

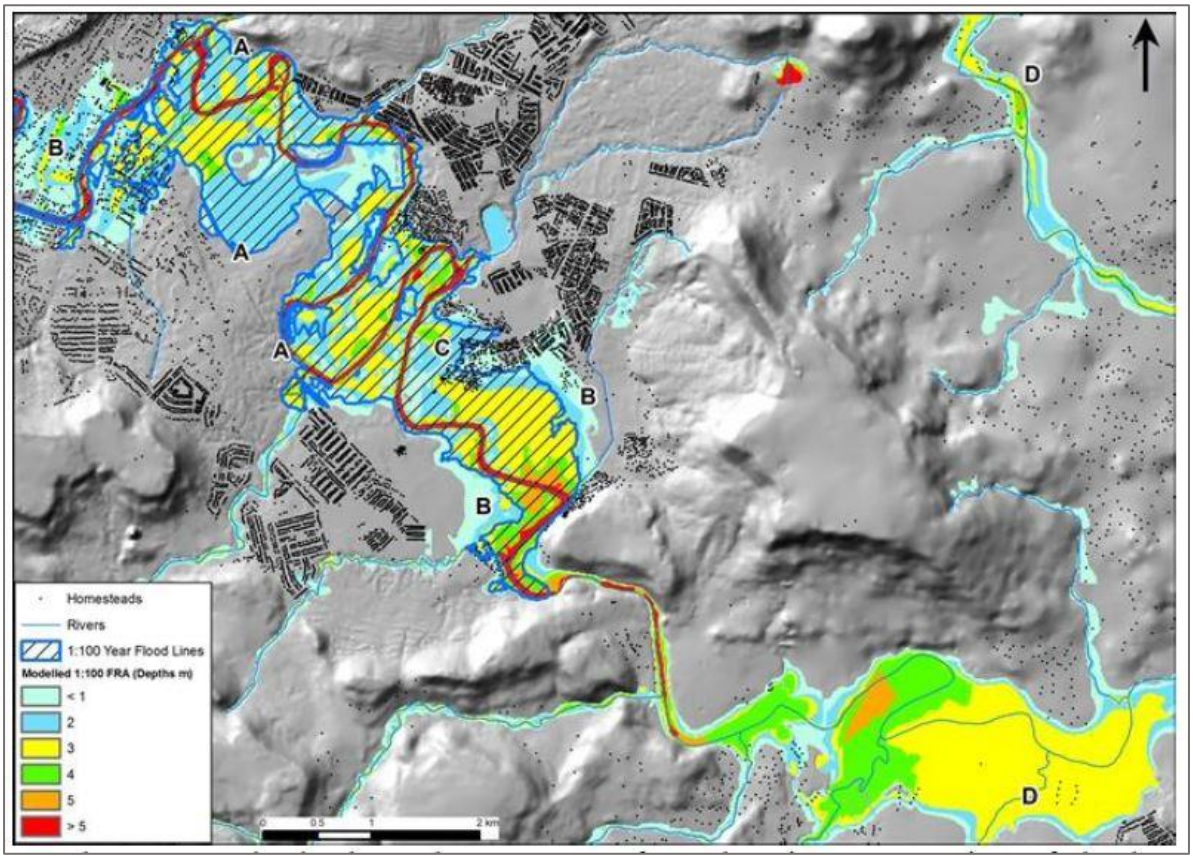


Figure 6.2: Ladysmith Modelled 1:100-year Flood Risk Area displayed as depth of flow- the engineering 1:100 year flood line is overlain for comparison *(Source: Botes et al, 2011: 12)*

In the study, Botes *et al*, (2011) calls for (and proposed) a cost effective flood line technology (i.e. GIS) to assist in the mapping of the flood risks areas in South Africa. They also revealed that, the current engineering methods to create flood maps are very expensive and unaffordable for rural municipalities. Fortunately, Ladysmith was part of the area that was studied and there were lessons learnt for spatial planners. In addition, the ELLM Disaster Management Unit also have a map of the 1:100 year floods in the town and other adjacent flooded areas next to the Klip River. This shows that flood line mapping in Ladysmith is relatively advanced when compared to other places in the country, but there are problems that were noted.

It shown that there are many studies and mapped flood risk maps of the urban environment whereas the representation and documentation of flooding of the rural or remote areas of the municipality is very weak (DWAF, 1998a; Botes *et al*, 2011). This places a challenge to the planners, environmentalists, and water governance professionals, as there is a lack of data that can be used when guiding the development of the areas outside of the cityscape (Botes *et al*, 2011). This is challenging as the development of settlements and other land use activities will encroach upon the

flood risks areas and other environmentally sensitive areas aiming to protect the citizens from water related disasters. However, there is a need to address urban bias as it contributes to the inequality and the exclusion of the rural areas from the programmes to address flooding and other water related disasters. In this way, a holistic approach which takes into account the whole catchment, is needed.

6.4. Reflection on the use of EI in addressing flood risks

This section is based on the analysis and the discussion of the stakeholder's perceptions of using EI strategies in flood management. It commences with the perceptions stakeholders have on the use of ELMOSS in regulating the floods. In order to assess and check these perceptions of EI with what is happening on the ground, the researcher presents the evidence derived from the site visit. It further looks at how the rural community within the ELLM perceive flooding and environmental changes that is unique from the scientific way.

6.4.1. Perceptions of Emnambithi/Ladysmith Municipal Open Space System in regulating the floods

Just like the eThekwini Municipality, the ELLM has also established their own Open Space System that would help the municipality mitigate the impacts of climate change and increase other related ecosystem services. The policy guidelines on EL'MOSS clearly states that:

> If open space systems are conceptualised as a piece of 'green infrastructure' containing ecosystems that deliver a service much like a municipal water systems, town's road system, or community health system, then it becomes possible to value the open space system in terms of its replacement cost as a town's asset. In other words, what would it cost to build a canal to prevent flooding following the destruction of a wetland (i.e. natural, existing and free flood attenuation asset)? (ELLM, 2007: 12)

Even though there is still a demand to purchase and own more open space system by the municipality in order to increase e ecosystem functionality (at-least in theory), some areas of the municipality near Ladysmith town have been mapped out for inclusion in the EL'MOSS (see figure 5.7). The section below discusses the stakeholders' perceptions of the EL'MOSS in regulating floods (and providing other co-benefits).

There were only three respondents representing two main institutions who indicated their awareness that the area in Forbes Street has been zoned as "no primary development" due to its susceptibility to flooding (Respondent 3: LG Stakeholder-Town Planning Section, 2015; and Respondent 5: LG Stakeholder-Environmental Hygiene Section, 2015; and Respondent 11: LG Stakeholder, FT-

Community Stakeholder, 2015). According to Respondent 5: LG Stakeholder-Environmental Hygiene Section (2015), the area near Forbes and Lyell Street is included in the municipal open space system (EL'MOSS) and this is a confirmation that the floods in Ladysmith are still a problem and Ladysmith is still a floodplain irrespective of the *Qedusizi* dam. This response challenges the claim that after constructing *Qedusizi* flood attenuation dam, the 1: 100 floods have been avoided while not acknowledging that there are remaining floodplains in the lower parts of Ladysmith Town (ELLM, 2012c). According to the SDF draft (2012), these remaining floodplains in some portions of Ladysmith are also located near Sofi Mosque where the scouring or sand mining takes place (ELLM, 2012c) (See Figure 5.3).

However, it must be also noted that even though the Forbes and Lyell Street have been identified as forming part of the EL'MOSS, the area has been allowed to establish a new taxi rank (coordinates: 28°33'48.53"S 29°47'1.20"E). According to them, little will be lost in the taxi rank when there are floods and therefore it is not perceived as a high risk property development. However, the establishment of a taxi rank and the widening of the stream are forming part of the hard engineering approaches. This also looks at the economic and social sustainability of the municipality and its growth. Based on the interviews with the municipal officials, the results have shown that the urban vegetation along the stream is not seen as a strategy to resolve Ladysmith flooding. However, the review of the ELLM strategic development documents and own observations has shown that they are aiming to use the EL'MOSS around the town for attracting economic growth and investors in their aesthetic environment which forms part of the vision of the district. This contributes to the tourism growth in the municipality and the region by showcasing their endemic species in the strategic entrance areas of the municipality such as Windsor Park in the South West of the town.

Except for Respondent 7: NG Stakeholder-Environmental Affairs (2015), all other officials do not see the riparian habitat (mostly, the bush) as a way of addressing the floods as they claim that it is responsible for bringing more negatives in flood risk management and causing more security threats. For example, some of the respondents have argued that it traps the water in the flood risk environment, making the town unprepared for the upcoming floods (Respondent 11: FT Community Stakeholder-Elder, 2015). Also the protection of the riparian habitat was criticised as it limited surveillance causing the lack of safety (Respondent 11: FT Community Stakeholder-Elder, 2015). This shows poor understanding of how rivers work as with the uncultivated EI along the river, the velocity of the flood water can be reduced. Most importantly, the EI can also regulate the geometry of the stream and also avoid the further expansion of the river to where it is not supposed to be.

Even though Respondent 4: LG Stakeholder-Town Planning Section (2015) has mentioned that the problem with their EL'MOSS is that it is not linked (and operates in isolation), it was not mentioned that these areas can regulate flooding. Unfortunately, even with the stakeholders coming from Parks and Gardens, the respondents (Respondent 13 and 16) did not see how they contribute to reducing flood risks with their investment in EI (i.e. Parks) next to the Klip River. However, the response has shown that the parks are acting as a strategy to regulate land pollution and illegal dumping in the abandoned open public spaces, encouraging tourism, and promoting recreational spaces (Respondent 13 and 16). The stakeholders also knew that their open spaces play a crucial role in soil conservation (ibid). Therefore, it was realised that their strategies are indeed part of soft engineering strategies to resolve flood risks but the key informant interviews with the municipal officials (Respondent 4, Respondent 5: Respondent 13 and 16) are unaware of the flood regulation brought about by their urban parks. Despite this, the results from all the community and municipal official key informant interviewed in Ladysmith indicated that they are not responsible (anyhow) for flood risk decision making or reduction because this is a responsibility of Department of Disaster Management and Engineers are the main actors when it comes to flood control and response. This indicates that there is a need for the inclusions and awareness of sociological and political dimensions of flood risks management in Ladysmith as this will consider various types of knowledge in flood governance decision making.

6.4.2. Observations and the inclusion of urban EI in flood risk management

After interviewing Ladysmith officials and its citizens, the researcher in a site visit walked and observed the land uses activities to see what is happening along or next to the Klip River in Ladysmith town. This was important because these observations helped to verify whether or not the concept of EI was incorporated in land use planning and in practice. The site visit has shown that some elements of EI are incorporated as some of the developments along Klip River have low environmental impacts and improve the condition of the river under stress of impervious surfaces and pollution.

Irrespective of the perceived poor understanding of the role of EI in flood management among the government officials and the citizens in Ladysmith, the observation and land use survey done by the researcher has also revealed that there are also environmental engineering and related specialists who are playing a significant role in the installation and the maintenance of the flood management infrastructures (i.e. providing active and inactive open spaces, designing Sustainable Urban Drainage System (SUD) in the city). Unfortunately, their role is unrecognised as the suppliers are outsourced (i.e. consultants). This is particularly the case as the officials of the municipality lack capacity and do

not have skills to deal with the provisioning and planning of the interlinked functioning of EI in their vicinity. In this way, the respondents indicated that they are unaware about the issues of how EI contributes to the reduction of flood risk in Ladysmith (See plate 6.6 below).

Plate 6.6: The well-maintained extension of Wimpy Public Park adjacent to Klip River in Ladysmith (Photograph by Njabulo Ngcobo, 2015).

The park near the flood risk area is an example of artificial EI because it absorbs the floodwater (rather than to encourage run off). It also contribute directly to land use planning because it create a buffer zone that separate urban development and its properties from the risk of flooding. The open spaces zoning allowing low impact development such as parks near the floodline are a good practice because they are reducing the flood vulnerability of the properties and human settlements in these high risks areas. Unlike concrete or tarmac development, the soft engineering strategies encourage the infiltration of water reducing the immediate run-off of the surface floodwater to the Klip River. The functioning of these areas have even higher impacts if they are owned by the municipality which cleans and maintain it for recreational or flood attenuation functions.

6.4.3. RC Stakeholder reflections on the solutions to floods and environmental changes

The results of the interviews and interaction with the community members in the *Emachibini* rural village has shown that there is a strong support for cultural and spiritual ecosystem services linked to

their understanding of EI. This is important as it shapes their understanding of the water disasters and how environmental changes could be managed. For instance, the outcome of the interviews with the RC stakeholders in the ELLM Indicated that the respondents believed "it is with the satisfaction or the respect of the ancestors such as princess *uNomkhubulwana* that the misfortunes of droughts, floods, and lightning (including the protection against the evil forces) are prevented. In this way, the resilience of the community can ensured, but not absolutely guaranteed".

In order to preserve their tradition, the interviewees also revealed that Wednesday is a select holy day (or the holiday) to pray to the *uNomkhubulwana*. During this day, the Zulu community members in Emachibini village would not work their land. This holiday is a sign of respect or gratitude to the angel of rain called *uNomkhubulwana* (Interview 15: RC Stakeholder, Focus Group-Elders, 2015., and Respondent 3: RC Stakeholder-Elder 2015). This confirms that *uNomkhubulwana* is a powerful ancestor (or goddess) who is well respected in the Zulu oral history as she is safeguarding them against famine by providing rain (Nkosi, 2011).

The belief in the *uNomkhubulwana* plays a crucial role in the culture of the Zulu communities as the understanding of the cause and the management of the misfortunes such as floods and droughts is deeply imbedded in this cultural tradition. Despite their rich history and cosmology in sacred water governance or climate change adaptation, the literature has shown that this culture or tradition is declining due to political and other reasons. However, the general understanding of who and what the function of *uNomkhubulwana* is*,* also known as the *Inkosazana yezulu,* is that she is an angel of rain, whose function it is to give them rain, good fortunes, and also address the misfortunes of their land such as droughts and floods (Interview 15: RC Stakeholder, Focus Group-Elders, 2015., and Respondent 3: RC Stakeholder-Elder, 2015).

There are also widespread creative stories shared by the majority of the interviewed RC stakeholder representatives in *Emachibini* (within the ELLM). *UNomkhubulwana* is perceived as a magical water snake or a mermaid like creature found in the sacred water sites (Respondent 2: RC Stakeholder-Elder, 2015., and Interview 15: RC Stakeholder, Focus Group-Elders, 2015). Based on their belief and cosmology, the identified areas known to have water spirits must be feared, respected, and protected. Even though this is shared by many, only a few people (the chosen) can see the angel of rain but there is no real evidence to prove its existence.

Even though the stakeholders understand the power of *uNomkhubulwana* as they claim to see her in the *sacred water sites* (See Figure 5.18), they are unaware that she also lived as a human in the past.

Tracing back the history from the leading scholars in the subject of *uNomkhubulwana* such as Ngobese cited in Henning (2012) and Nyembezi and Nxumalo (1995) cited in Nkosi (2011: 77), they all agreed that princess *uNomkhubulwana* was a daughter of *Mvelinqangi (Godfather)* since she appeared after God.

From understanding the RC key informants' stories, the assumption and conclusion made is that in order to maintain the sacred value of these spiritual or sacred water sites, the respected community leaders first needed to identify these sites. Secondly, they then disseminated the information about the importance of respecting and fearing these sites for current and future generations. However, the mythical stories associated with the snakes and mermaids (most sacred and powerful creature associated with their ancestors) were the strategies used to ensure that these sacred water sites were not disrespected. This sacredness served the key needs of the Zulu communities in terms of spiritual, heritage, and religious practices that kept them together with mother earth (See plate 6.9. and 6.10. for the identified sacred water sites and the primary use of them)**.**

Plate 6.7: The well-recognised sacred water site or pond known as the *uNomjikili* in the Emachibini, MTA (Photograph by Njabulo Ngcobo, 2015)

Plate 6.8: The fallow garden of *uNomkhubulwana* next to the sacred pond, *uNomjikilili* (*Photograph by Ngcobo, 2015*).

The garden in plate 6.8 is an evidence that the practice of *uNomkhubulwana* due to many reasons such as that the Elders have passed on; people have migrated to the urbanising areas, community breakdown, among other things. There are myths and stories about these sacred areas. The cosmologies of the people and their way of understanding environment helped in reducing the degradation or disrespect of the sacred areas which then renew their spirits (and helped them) during the crises such as droughts.

Respondent 3: RC Stakeholder-Elder (2015) argued and challenged some of his colleagues and community members as he stated that,

> …. the sacred water site or pond of *uNomjikilili* [pointing down to the pond shown in plate 6.7] does not have the snakes that people always claim it has. However, *the site of the living Gods and our powerful ancestors* protects our land and us. This site [pointing the sacred water site] must be respected in this community, as it is the biggest one in this Isigodi of the Emachibini. This is important as it is forming part of culture, religion, and oral history that we the majority of the elder know and share to one generation to the other

This argument is supported by Benard (2003) who stated that the Southern African people, such as the abeNguni, believe in the water spirits and this form part of their indigenous knowledge systems.

Back in the olden days, the elders in the community (and parents in the households) socialised their children especially the young boys not to disturb the sacred sites as they were told that there would be negative environmental impacts that change the weather and create misfortunes. This was important as Hester (2006: 364) cited on Harker (2012) further stated that,

> By seeing entire habitats and landscapes as embodiments of personal and cultural identity and history, people are motivated to be stewards of the land, taking action to maintain, restore, and improve [their] community, the landscape, and larger ecosystems. Such efforts also have the potential to bring community members together for a common cause.

Therefore, one realises that some community members have the spiritual attachment to the value of the sacred ecological sites [i.e. sacred waters] as it is happening in the case of Emachibini rural village.

The research has also revealed that, the practice of *uNomkhubulwana* practice has declined in the Emachibibi, MTA residing in the ELLM. The reasons for this decline are complex and they include; urbanisation and migration, loss of the divine elders who administered the knowledge and who were respected and who have now passed on, climate change and migration, technology and telecommunication romanticising western way of life and thus contributing to cultural breakdown, Christianity and the missionary establishment communities such as Kholwa, among other issues also led to the demonization of these beliefs (Respondent 2: RC Stakeholder-Elder, 2015., Respondent 3: RC Stakeholder-Elder, 2015., Interview 14: RC Stakeholder, Focus Group-Youth, 2015., Interview 15: RC Stakeholder, Focus Group-Elders, 2015). In addition, there are now very few respondents (Respondent 3: RC Stakeholder- Elder 2015) who still understand or use the term *Unomhhoyi* to refer to the name as the *uNomkhubulwana*. This indicates that the people with the deep understanding of the traditions and knowledge are disappearing.

According to the interviews in Emachibini, all the stakeholders agreed that the dominant land uses in (and in close proximity) to these areas are family and community rituals, baptism, praying for the rain, working of the *uNomkhubulwana* garden, to name a few (ibid). They further clarified that these areas are attended to by those who are connected to nature and the ancestors such as priests and traditional healers whose aim it is to do the activities for good fortunes. However, the activities such as laundry, swimming, and bathing are prohibited as they are responsible for polluting the sites, causing noise, and are also unsafe to the unsupervised community members such as young boys.

6.5. Perceived solutions and recommendations on flood risks

In order to investigate whether the stakeholders integrate EI solutions in to flood risk management, some of the respondents were interviewed in order to share their views and show their attitude with the effective utilization of EI.

In order to improve the manner in which EI is managed in Ladysmith, Respondent 7: NG Stakeholder-Environmental Affairs, (2015) called for a paradigm shift from the state led approach to community led approach. He clarified that the national government, as the key agent in environmental laws [National Water Act of 1998 and the National Environmental Management Act of 1998] is not successful (or at least not successful enough) in the areas where the poor citizens reside with EI such as wetlands. According to him, the restoration and protection of wetlands by the community as a whole is important because they are those who originally resided and used these places (ibid). When he was further explaining the provisioning services of the wetlands to the poor communities, he stated that "the wetland also regulates the evaporation of water resources as it does not drain fast when it is hot and in this way, it conserves water to be used during the droughts and times of water poverty". Therefore, the recommendation is to adopt a people centred approach where communities will be capacitated and empowered. This is important in managing their important national resources (i.e. wetlands) so that they will use them in a more sustainable manner (ibid).

Respondent 7: NG Stakeholder-Environmental Affairs (2015) also mentioned the risks of using the community led approach to the management of EI such as wetlands. The first problem he noted was that no one is taking a lead responsibility and the first challenge is to map or clearly identify the responsibilities when trying to rehabilitate and manage EI such as wetlands and rivers. Thus, when adopting a community led approach, these issues must be addressed as he believed they are main cause of many failures.

There was also consensus deriving from the two stakeholder representatives (Respondent 7: NG Stakeholder-Environmental Affairs, 2015., and Respondent 11: FT Community Stakeholder-Elder., 2015) that there is poor enforcement of the environmental bylaws of the ELLM. They further elaborated that the result of this failure by the municipality is causing the continued illegal dumpinin the city and the Klip River. Though working in the UThukela district within which ELLM falls, Respondent 7: NG Stakeholder-Environmental Affairs, (2015) stated that he is not aware of the existence of the Environmental by-laws used by the municipality. According to Respondent 7: NG Stakeholder-Environmental Affairs (2015) the by-laws could be a good strategy to enforce the citizens and

business to comply with environmental and water legislation (ibid). Policing and imposing fines could reduce the illegal dumping that could result in the blockage of the town's storm water system.

Other approaches proposed by Respondent 7: LG Stakeholder-Environmental Affairs (2015) are that there must be more emphasis towards environmental education and awareness to talk about climate risks as these directly affect flooding. This also involves the dissemination of the risks and opportunities emerging from the sustainable and unsustainable use of the EI as this can provide certainty and options in relation to the use of EI in different scenarios presented by uncertainties.

> …. due to the shift towards a new geological period known as Anthropocene[17]; our awareness campaign is also aiming towards behavioural change on reducing our impact to climate change and also adapt to the environmental changes without severely affecting our natural resources that protects us from the extreme climatic events. As for me, I do presentations and raise awareness about the sustainable use of the natural resources. For example, I am focusing mainly on; waste and pollution. We are targeting the schools or educational centres, churches, NGOs, associations of agriculture, among other users. Our aim is to educate and to also disseminate the information about the risks and the adaptation strategies in the EIs they use. In this way, we can ensure that we promote capacity building through community participation at large (Respondent 7: LG Stakeholder-Environmental Affairs, 2015).

In return for this effort, the respondent claimed that they get more compliance. For instance, he stated that "even though there are some problems, people are reporting the environmental crimes such as illegal sand mining Therefore, it can be concluded that the awareness is going well in comparison to doing nothing" (Respondent 7: NG Stakeholder-Environmental Affairs, 2015).

There is an alignment between the practices of the stakeholders in the national government (Respondent 7: LG Stakeholder-Environmental Affairs, 2015) and the work of the LG Department: Parks and Gardens based on the concept of Going Green seen in their greening campaigns of the municipality. This is the case as Respondent 7: NG Stakeholder-Environmental Affairs (2015) acknowledged the contribution of the municipality in their strategy and plan to provide the Parks (and active open spaces) in Ladysmith Floodplain and other areas of the LM. Respondent 7: LG Stakeholder-Environmental Affairs, (2015) added that the idea of landscape design and the concept of "going green" is forming part of good practice. It is symbolising the interest in tapping into the value of environmental services in which the EI of the municipality provides.

[17] **Anthropocene** as defined by Respondent 7 is a period where the extreme climate change events are linked with the activities of the human. These activities include but not limited to deforestation, industrial emission which exacerbate human suffering to the activities of climate change.

Due to excitement when the engineering solution was delivered to the public, the incorrect message was painted, as some believe that these solutions can end the floods whereas in fact the future is not predictable. In this sense, the dams as main example of human-made hydraulic systems are not just technological installations but they are symbols of power that human use to conquer water. In some cases, the conquest of water can be used to subjugate other humans with less power (Tvedt, 2015).

However, in the context of Ladysmith it is not quite clear if high authority to subjugate others [public and minorities] led to the installation of the dams. The study showed that there is public support and previous public request for the dam in order to resolve flooding in the town of Ladysmith. From understanding this meaning of the dam when I was a participant in the study area, reading the newspapers about the flood complaints (before the completion of the dam in 1998), and also listening to the lyrics of the local music albums (i.e. the Ladysmith Black Mambazo double time Grammy award winning musicians) after the completion of the *Qedusizi* dam, indicates that there was a public and business request for the flood attenuation dam. The *Qedusizi* flood attenuation dam aimed at increasing the resilience of Ladysmith residents and business in order to address the historical flood risk.

In the track list of the album of *The Very Best of Ladysmith Black Mambazo* (Disc 2 of song 3), the Ladysmith Black Mambazo recorded a song named after *Qedusizi* which was based on the newly designed flood control dam (Shabalala, 2004). From interpreting the meaning and the message carried by this song, the researcher argues that this song shows that this dam is seen as a symbol of conquest of the floods due to the overflow of the Klip River. This becomes even more clear in the lyrics of this song when they say *Zonkeziny'izinyanga zehlulekile* which means that all other flood control schemes have failed. Unlike other solutions previously adopted in Ladysmith, *Qedusizi* represents a symbol of conquest of flood suffering caused by the Klip River in the town of Ladysmith. With the introduction to *Qedusizi* dam which was welcomed as a flood protection technology, there was hope that previous flood suffering will be ended (Shabalala, 2004). In this sense, Qedusizi is seen as traditional healer or doctor whose skills overpower all others on dealing with the 'disease' thus far. Even though this song is an indication of joy and celebration of the hard engineering solution, it over-estimated the conclusion or the merits of the dam. This means that some of the residents did not understand the power of flooding especially under the uncertainty of climate change, as the dam may not resolve the floods in the long term.

By contrast, the research has also revealed that the high authority to subjugate others [public and minorities] of their cultural and social practices used the installation of the huge dams indirectly. As there are Zulu Communities which form part of the tribes studies by Bernard (2003), it has been argued that the Southern African Bantu tribes were subjugated or alienated through modernisation from their cultural water use practices during colonialism, apartheid and even in the post- apartheid area (via privatisation of water sites for commercial practices or damming of the rivers). The damming of the river subjugates the communities offsite as it stops the water from flowing to the downstream communities. In this sense, the groups of African black communities were subject to evacuation either forcefully removed or manipulated to leave their rich water sites because huge water projects, such as the construction of Inanda Dam in the eThekwini municipality would take place. However, this control of water resources in South Africa denied them access to their cultural water use practices.

This section on the perceived solutions and recommendation on flood risks management by using EI have shown that some respondents propose an integrated approach in managing EI where the knowledge of government and the community meets and work in harmony. This means that the management of the EI of the Klip River should be community based, allowing the residents to build capacity and be educated about the sustainable management of the important ecosystems services. The section has also revealed that Ladysmith, KZN is one of the places where the flood control dams were compared with the work of the most skilled traditional doctors who cure the most difficult diseases because few other human interventions here have as much potential to symbolize power and the conquest of flood water. By relating the World Systems Approach (WSA) in these results, one gets to understand how people tamed the power of water, and how water shaped society and inspired innovation in response to its threat (i.e. floods) (Tvedt, 2015).

6.6. Conclusion

The stakeholders in Ladysmith town showed a relatively weak understanding of how EI operates in general and most importantly, in terms of flood attenuation services. This also includes the poor understanding of the role of intact EI in riverbank stabilisation as explained by the literature reviewed. Even though there is no absolute neglect of the EI solutions in flood management, the stakeholders are unaware that they still employ these solutions in the form of artificial or modified EI (i.e. parks and sustainable urban drainage solutions). Due to the perceived conflict between EI and the flood attenuation dam, EI suffers the consequent impact of flood regulation and therefore is unable to effectively deliver other functions of ecosystem services. In this way, there is a need to disseminate how EI works in order to improve the way in which stakeholders perceive its use. Currently, the

municipal framework plans such as EMF, Driefontein LAP, IDPs, ELMOSS, among others shows that the EI concept is featured in the municipal and district visions, but the users (municipal official and the public) does not fully understand these policy frameworks, as they are created by the consultants for their use. By contrast, rural stakeholders (i.e. Emachibini) and Respondent 7: NG- Environmental Affairs have shown good understanding of role of flood attenuation functions of the EI and relatively strong cultural understanding of EI in regulating disasters and environmental change. However, it is important to protect the already declining knowledge (and cosmology) of the Zulu communities. This is important because it will determine the role this have in environmental management and risk reduction and ensure that culture and religious values are preserved for future generations.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

7.1. Introduction

Climate change, development pressure, and the rise in urbanisation will increase the risk of the Klip River flooding, and cause more storm water failures which means that Ladysmith needs to strengthen its flood resilience. This study on the current flood risk management shows that an optimum way to increase the benefits of risk reduction measures may be reached by the implementation of both structural and non-structural solutions. However, this research has revealed that the non- structural solutions (a category in which EI falls) are poorly understood by many stakeholders in Ladysmith.

This chapter draws on the theoretical framework and the main findings of this research to highlight the perceptions of the ELLM stakeholders on the subject of flood risk and EI. It also highlights what planning implications can be drawn from this research. This will be done by discussing the main outcomes of each chapter elaborating to what extent these attempted to address the set objectives and questions asked. The final section of this chapter presents the recommendations.

The overall aim of the study is to understand the behaviour and attitude of government and civil society stakeholders towards using EI for flood risk management and spatial planning in Ladysmith. This includes the role of indigenous knowledge regarding the value of EI and use of ecosystem's services. In order to meet this aim, the following objectives were established:

(a) To understand the role and perceptions of the selected key stakeholders in flood risks;

(b) To identify the solutions to flood risks management and the extent to which the concept of EI has been integrated into flood risk management;

(c) To explore the value of EI in addressing flood risks in Ladysmith;

(d) To determine the implication of using EI for environmental management and spatial planning

7. 2. Stakeholder's Perceptions

There is a need for a change in attitude and behaviour of the municipal officials, businesses, and public stakeholders with regard to the understanding of how the rivers and EI function in Ladysmith. Environmental consultants and the environmental affairs participants have a broader understanding of why EI is important in flood attenuation as well as providing other ecosystems services. They also have a good understanding of the contribution of EI in the face of climate change and the predictions of heavy and more rain. Despite the strong understanding of the role of wetlands in the upper

catchment in addressing Ladysmith flooding on paper, there were no respondents who supported the use of riparian vegetation as a strategy to address flood risks.

This makes it difficult for the guidelines for riparian management in the ELMOSS and EMF and SEMPT of the municipality to be implemented in practice if not understood by the clients (municipality and public) in the context of Ladysmith. Due to the formal establishment of Ladysmith in the floodplain, the affected stakeholders have shown more support for the hard engineering strategies such as the *Qedusizi* Dam Scheme, vegetation clearance along the Klip River, and the storm water system. This further includes but is not limited to flood warning, raised buildings, and evacuation plans that are activated in various stages of flooding (see Chapter 5).

The *Qedusizi* flood control scheme clearly indicates the role of hard engineering in the construction and maintenance of flood management infrastructure in the town of Ladysmith. This is based on the construction of the dams, river embankments, installation of the storm water infrastructure, flap gates, bridges, inspection, and other hard engineering plans aimed at protecting the town from the flash or riverine flooding (See Appendix F2 & F3).

The research has also shown that colonialism, apartheid history (which later been accelerated by commodification economic system in the post-apartheid era) has led to the suppression of the culture and indigenous practices of the African communities in the former homeland areas as there are lack of institutions to protect their cosmology on water governance. Bernard (2003) has argued that Southern African Bantu tribes were alienated from their water use practices during colonialism, apartheid and even in the post-apartheid area (via privatisation of water sites for commercial practices or damming of the rivers and stopping water flows to the downstream areas). This control of water resources in South Africa alienated them (traditional Bantu tribes) from their key cultural and traditional way of life that was key in conserving the sacred water sites as well as the riparian habitats.

From the Interview (in the context of the *Emachibini* rural village), the researcher discovered that churches and religious leaders play a minimal role in eroding the traditional way of life as they do not demonise the *uNomkhubulwana* tradition (Respondent 15: RC Stakeholder- Focus Group- Elders, 2015). The elder RC- Stakeholders have shown that their Christian related Churches (i.e. Shembe and Zion) support many African religious practices including the belief in the ancestors to live in the sacred water sites (ibid).

However, there is also a strong claim that some of the community members in the missionary areas (rapidly urbanising areas such as Driefontein) are examples of the places where the Zulu cultural and traditional way of life has been eroded as a result of colonisation, apartheid, Christianity, and modernisation. There is only one participant who expressed his criticism about the betrayal by Zulu members residing in the missionary areas as he claimed that they do not participate in the tribal Zulu activities due to their support of modernisation, and use Christianity to demonise their ancient practices like *uNomkhubulwana*. According to him, this is a sign of submission to the western cultural way of life, thus abandoning their own ancestors or Gods. Due to limited time, resource constraints and difficulty obtaining consent (gatekeeping); the researcher was not able to interview the church leaders (i.e. Catholics) in the missionary areas to get their view about the ancient practices to understand and manage water disasters.

When trying to help the government gauge and respond to public opinion when designing and conducting projects along the EI; officials and consultants must be aware of the structures in place so that they do not undermine the local control. For example, consideration must be given to the potential negative impacts of the cultural, heritage, historical, palaeontological, archaeological, and religious characteristics that make up the EI environment. With strong commitment and wisdom, the planners and other decision makers must keep the option open for public scrutiny, try to balance the competing interests and resolve dispute problems. One of the common practices by the government is to allow the developer to address community concerns in order to reduce the site negative impacts.

After discussing water stewardship practices by international and local precedents, it becomes clear that there are a few more things that can be done to make proposed soft engineering programs to withstand water, limit the negative environmental impacts, and avoid soil transportation during the heavy rains. The research has shown that it is not always an option to keep people away from the natural features that they value for its services.

7.2.2. Absence of flood risks information in remote areas and the consequent implications

When people and authorities have access to information about the areas zoned for residential, environmental sensitive areas, and have a better understanding of the setbacks and regulations guiding the development near the natural features such as wetlands; the riparian habitats can be protected and serve the lasting function for human wellbeing. However, complying with these standards in the rural areas under the traditional authority seems to be a problem due to the lack of information and awareness. This was caused mainly by the spatial injustice of the past which left these

areas unplanned and leaving them in the hands of the traditional leaders. Until recently, the problem now lies with the complex land allocation processes.

Unfortunately, the traditional authorities are not experts in understanding the technical and deep environmental issues required in the protection of natural features for land management. With the change to the democratic government after 1994, the municipalities were expected to change the spatial injustices to accommodate the previously neglected areas in the so called wall-to-wall scheme as per the PDA (replaced by SPLUMA), MSA, among others. From this shift, progress in the rural areas has been difficult due to the differences between the traditional and municipal system in the institutions for managing land, delaying the process to plan the natural areas to be protected and those to be used by humans.

This research reveals that there are more studies and mapped flood risks areas for the urban environment whereas the representation of risk in rural or remote areas of the municipality is very weak (see DWAF, 1998a., and Botes *et al*, 2011). This challenges the planners, environmentalists, and water governance professionals, as there is a lack of data to be used when guiding the development of the areas outside of the cityscape (Botes *et al*, 2011). This is challenging as the development of the housing settlements and other land use activities will encroach into the flood risks areas and other environmentally sensitive areas which will protect the citizens from the water related disasters.

7.2.3. History of poor (or Lack) of Planning in remote areas

It is accepted by the municipal officials that the rural community are at risk of disasters due to poor planning (i.e. no schemes) guiding their land uses activities which results in the disrespect of the environmentally sensitive areas. This is a problem as the IDP review 2015/2016 clearly stated "… cognisance is taken of the fact that there is no formal structure or mechanism of consultation between the municipality and traditional leaders" (ELLM, 2015: 333). The researcher also recommends that there be an improvement in this regard. For example, Nkosi Nodada/Mthembu leading the Abathembu including Emachibini (Ward 7), Mcitsheni, and other areas was not mentioned in the IDP". From the interviews conducted, it was not stated whether the traditional authorities are trained in order to have the meaningful input in decision-making and also influence compliance in their areas.

The improvement of the department of the traditional authorities may be in a form of development of a common framework to deal with the land allocation processes in the areas outside the urban areas [former homelands] especially those under traditional authority and the Ingonyama Trust. This process could be

supervised by the professionals and, the traditional leaders should receive training to improve their capacity to deal with the land allocation (if at all, they receive powers to continue with the responsibility to allocate land). This is important as a tool to assist the municipalities in complying with the PDA and SPLUMA legislative frameworks in terms of the Wall-to-Wall scheme requirements. It is suggested that by educating the ward councillors and traditional leaders, who then can educate the public there will be much greater acceptance and buy in of the municipal schemes.

In her suggestion and vision about the importance of disseminating the information regarding flood risks and environmental changes (including climate adaptation), Respondent 4: LG Stakeholder-Town Planning Unit (2015) stated that,

> Communities and developers must be encouraged to be aware of the importance of aligning their developments with our SDF- Spatial Development Framework and in this way, we avoid urban sprawl and make an effort to avoid the encroachment of the flood lines. As we are well aware of the macro-scale problems such as climate change and the implication this will have to our municipality, the environmentally sensitive areas are mapped and taken into account in our SDF.

Respondent 4: LG Stakeholder-Town Planning Unit, (2015) also expressed her concerns about the dongas in the municipality (i.e. Roosbom) which eats up land for housing. Her recommendation was that there be a plantation of trees and other indigenous vegetation types by the communities and the Department of Parks because this will prevent soil erosion. This proved that some of the officials are aware of the ecosystems services to regulate erosion but little knowledge exists about how the important natural features are disturbed due to the lack of investment in the soil conservation strategies to boost the value of the EI.

It may be recommended that the planners must be educated about other ecosystems benefits or functions. For example, the provisioning, cultural, and supporting services. These are very important as they form part of climate change adaptation and planning and public policy is affected by these factors. They must also be encouraged that there are lands that must be zoned for ‘no use’ as they will serve the purpose of protecting their citizens from the disasters and serve the needs of future generations. The researcher argues that spatial planning is not only about always using land. The focus must also be oriented to the measures aiming to restrict the use of land.

7.3. Value of Ecological Infrastructure

As highlighted in Chapter 2, the theories about advocacy for the integration of ecological aspects in design and land use development are not new in the planning profession as evident from the work of Ebenezer Howard (Garden City: To tomorro, 1898) and work of Ian McHarg (Design with Nature, 1969) (Yu et al, 2008; Youzhen and Longlong, 2012; Augastine and Methew, 2013). Similarly, the broad concepts such as the hinterlands, greenbelt and buffers are very common and they were used mostly to distinguish the sensitive natural features that should not be under stress of urban development. In terms of urban planning, the concept such as smart growth[16] and Eco city design incorporate the EI at least in theory.

The research has shown that significant EI responsible for flood attenuation are intact wetlands and vegetated riparian corridors, also known as buffer zones. Vegetated riparian corridors play a critical role in upholding channel morphology through bank stabilization, flood attenuation, and providing the space necessary for the expression of meander geometry and the maintenance of channel slope (Agency of Natural Resources, 2005: 24). These riparian corridors also decrease the effects of storm events on river channels and speed, and retain sediment transport (Kotze, 2000; and DWAF, 2013).

During the flooding events in rivers, the riparian areas allow floodwaters to spread out horizontally over the land, thereby reducing the force and velocity with which the floodwaters move down the stream (Kotze, 2000). This reduction in stream power is important for not only the hydrological patterns of the channel/stream flow but also it is also useful in the protection of human investments in and around the floodplain. Besides the flood attenuation function of the EI concerned, there are many other benefits that EI brings to the people to contribute to their economic, social, cultural, and other benefits.

Since the publication of the MEA (2005), research in ecosystem functions in terms of cultural, regulatory, provisional, and supporting services have increased significantly (De Groot *et al*, 2010; TEEB, 2011, Gómez-Baggethun and Barton, 2013; Costanza *et al*, 2014, among others). Until recently, there are many critiques levelled against the market led and commodification of EI as an infinite resource. In this way, this called for the alternative financial institutions to manage EI benefits for common or public benefits (i.e. Payment of the Ecosystems Services) (Costanza *et al*, 2014). This dissertation has also highlighted how EI can be integrated in the planning processes as evident in the several precedent cases discussed in chapter 2.

Even though the primary focus of this research is based on flood risks, the literature also reveals that there are also flood opportunities brought *inter alia* by flooding events. This is to say that what can be seen as a risk for one person, is in fact an opportunity to another. Similarly, this also applies to the stakeholder's perceptions of the Klip River ecosystem services onsite (Ladysmith town) and adjacent areas. For example, the role of urban vegetation along the river may be seen as a strategy to reduce the speed of flood waters, avoid soil erosion, increase biodiversity, store more water, and reduce heat, to name but a few. However, the un-cleared urban vegetation along the river may be perceived as a cause of urban insecurity resulting in more vulnerability to snakes, breaking of the storm water pipes, causing leakages to the dam infrastructure, provide a hiding place for criminals and snakes, and the provide suitable place for throwing of waste or pollutants. These are examples of ecosystems disservices.

Given the perceived threats caused by the ecosystems disservices in Ladysmith town, the following solutions are suggested; environmental officers responsible for environmental by-law enforcement for the municipality, river watch community or civil groups may be formed in order to safe-guard and report illegal dumping to the authorities. There should be more environmental awareness or campaigns may be formed with the local music artists, and the message can be transferred with music and storytelling, to name but a few. From the literature reviewed, it has been shown that it is possible to create water (river, wetlands, among others) stewards through high sense of activism, political buy-in, partnership, and strong sense of volunteerism. Though it is no easy task, the success of EI projects in the local and international case studies reviewed (i.e. Oslo and Seattle) discussed in this research are proof that ecological design not only benefits humans and nature, but the expenditures are not as much to implement and sustain are less

7.4. Implication of using EI for environmental management and spatial planning

The DMP review (2015) clearly indicates that land-use planning could play an important role in flood risk management by reducing the dangerous, uneconomical and undesired properties designed by humans in the areas known to be flooding environments (ELLM, 2015b). This is in terms of respect and compliance with planning and township establishment procedures (i.e. taking into account the 1: 100 flood- line information). Other simple measures may include ensuring the compliance with zoning and building regulations. The main regulations and guidelines to protect and sustainably use the flood attenuation infrastructures (i.e. wetlands and riparian vegetation) is the NWA and NEMA (See Chapter 2).

Due to urban development in the floodplains, the undermining of natural flood attenuation features has led to the urban areas being increasingly vulnerable to surface runoff and thereby increasing the likelihood of damages by flooding (Gómez-Baggethun and Barton, 2013., and TEEB, 2011). Factors such as the rise in climate uncertainty, development pressures, urban sprawl and increasing public expectations are influencing the manner in which flood risks are managed (see Chapter 2).

In policy, there is also widespread support for this concept and the importance of integrating it in to planning (Phillips, 2014. SANBI, 2014., Quayle and Pringle, 2014). In the IDP, it is a requirement that both the sections about the environment and disaster be incorporated in the development plan of the municipalities (RSA, 2000b). All disaster risk management plans must give explicit priority to the core principles of disaster prevention[18] and other mitigation measures as required by the NDMA and the ELLM Disaster Management Plan review 2015/2016 (UNEP (2007, cited in Walters 2012 :17) further states that "an investment in ecosystems and incorporating disaster risk reduction and ecosystem management into development planning, not only offers protection against natural disasters but can also provide a major contribution to achieving sustainable livelihoods for the poor".

7.5. Recommendations

Ćosić *et al*, (2011: 52) outlines that,

> "Disaster risk management seeks to reduce the vulnerability of those communities most at risk through improved access to services, development opportunities, Information, education and empowerment. Once the vulnerability is assessed; standards, regulations and programmes to raise awareness need to be determined with the ultimate goal to reduce existing vulnerabilities and minimize their future appearance."

Given the comprehensive Environmental Management Framework and Strategic Environmental Planning tool of the ELLM, there appears to be a strong advocacy for maintaining EI in the Driefontein LAP, based on the protection of environmentally sensitive sites (ELLM, 2011a)**.** Due to these examples, some of the recommendations for this research were drawn from this document as it clearly indicates its support for the EI. It stated that well managed catchments can perform their important ecological services in a far more effective and resilient manner than those which are under stress from

[18] **Disaster prevention measures** are strategies aiming to lessen the likelihood of harmful losses by avoiding endangering hazards or reducing vulnerability.

development pressures (ELLM, 2011a: 5). The following interventions are suggested over a short-term period:

(a) Educate current users and those located within wetlands and riparian corridors of the possible socio-cultural and environmental impacts on sensitive areas;
(b) Restrict development in pristine areas such as grasslands;
(c) Develop guidelines and by-laws for use of areas identified as development exclusion zones;

Over a medium-term period the municipality should focus on facilitating the following:-

(a) Develop inter-governmental and inter-sector relationships for the management of development exclusion zones;
(b) Engage with relevant sector departments programmes such as 'Working for Water and Working for Wetlands' to maintain riparian corridors; and engage with the Alien Plant Control Programme to remove alien plants within wetlands and riparian zones. The Development planning must respond to the recommendations suggested by the *Emnambithi*/Ladysmith DMP review 2015/2016 as it clearly states that the programmes enshrined in the development and spatial plans of the municipality must incorporate the regularity and severity of the disaster events. This includes the following: replanting indigenous grasses or trees on a recently burned slope near roads or dwellings to stabilise the soil and prevent damaging land subsidence. It must be noted that the Parks and Recreation Department is responsible for the replanting of the degraded vegetation (indigenous plants species) and coordinating related projects in the ELLM.
(c) The least favourable option for decision making on land use in floodplain site of Ladysmith is based on permanent evacuation of the communities and properties in the wetlands, floodplains, and riparian areas (ELLM, 2015b). The reason for the lack of support with permanent evacuation is that, it does not only lead to significant reallocation of development projects but it also leads to social disruption and impacts on the culture of people. In this way, it is seen as a sensitive issue that cannot be adequately justified.
(d) As Ladysmith experiences storm water failure, it is suggested that it should focus on the careful positioning of storm water drainage and its ongoing maintenance to prevent destructive flooding during heavy rain (ELLM, 2015b). The municipality must also consider alternative solutions based on soft engineering. For example, the Sustainable Urban Drainage Systems (SUDS) may be considered as a medium or long term solution for the town. The example of this in good practice has been highlighted in Chapter 2 where it is shown how one

of the European cities (Oslo) used Blue-green storm water management as a cost effective strategy over hard an engineering piped solution.

(e) Address language barriers that will bring clarity in defining the main concepts such as EI

Over the medium to long-term, the municipality would need to establish measures to prevent future settlements in wetlands, riparian zones and flood plains (ELLM, 2011a: 7). The long-term desired situation would be the protection of rivers and wetlands. With this, the focus will be on monitoring and reviewing the programmes that have been put in place.

One-way of communicating the activities aimed at raising awareness on the issues of disaster risk reduction among decision makers and the general public are: Radio spots and radio communication in communities; TV broadcasts; Media interaction in newspapers, journals, magazines, IEC5 materials; leaflets, posters, billboards, brochures etc., conferences, symposia, seminars, workshops, peer – to-peer awareness initiatives; awareness campaigns: street drama, theatre, song, simulation exercises and mock drills (ELLM, 2015b: 38).

It is deemed necessary to formulate appropriate Standing Operating Procedures (SOP's)[19] and contingency plans[20] for flood hazards, which can be activated during an event to enable all Emergency Departments to react timeously during such an event (ELLM, 2015b). Until recently, there is a comprehensive disaster response plan (See Appendix E2) but it is argued that it would not respond timeously to the remote communities. This is the case because the municipal departments and other government structures are mostly the last resort and take time to reach into these areas. It is even worse when there is rain because the roads would be filled with mud thus making it impossible for the emergency vehicles to come in (i.e. the Emachibini access road made up of gravel and lack of storm water pipes). In this way, it may be concluded that the plan is far easier to implement or respond to in the urban setting.

[19] A **Standard Operating Procedure** (SOP) is a set of written instructions that document a routine or repetitive activity followed by an organization. They document the way activities are to be performed to ensure conformity to technical and quality system requirements (Goolaup, 2011: 4).

[20] **Contingency Planning** is forward planning process, in a state of uncertainty, in which scenarios and objectives are agreed, managerial and technical actions defined, and potential response systems put in place in order to prevent, or better respond to, an emergency situation. The whole point of contingency planning is to begin the planning before the emergency begins by mapping out objectives and strategies prior to the crisis stage (Goolaup, 2011: 1).

It is recommended that a ladder or hierarchy of leaders be developed who are responsible for disaster response and define clearly what their roles and responsibilities in the community setting are. During the disasters, the team to assess the level of disaster must be easily identified and the citizens must know where to go when encountering these problems. There should be also an openness in case the public want to participate in the solutions to mitigate the disaster faced (See Figure 6.1. for the structures to be taken into account).

Table 7.1: Community level, municipal and other role players to respond to disasters

AREA	List of Hazards		Community Based response/structures	Municipal Based Response/Services	Other Assistance
Emachibini and surrounding areas	Strong winds		Izinduna, Councillor, Traditional healers, Church organisations, small Businesses, Farmers/association, **Stokvel** Societies, teachers, Schools, Relatives & Neighbours, youth leaders, Elders, among others	Public Safety (FIRE) and Uthukela District Municipality; EMRS, ER 24 and Sharaj Ambulance and rescue; SA Army, SAPS and Medical mobile clinics	NGOs; Nambithi Game Reserve, relations with the surrounding communities, banks, componies, and insurances
	Floods				
	Lightning				
	Fire				
	Droughts				
	Diseases				
	Gullies				
	Hailstorm				

Even though the table was created, it may be appropriate to rank the stakeholders according to their powers and develop a diagram which shows how to reach to the top when one experiences a hazard that cannot be solved under the particular level or stage. The same method was used to create Figure 6.1 and it could be helpful to identify who comes in during the particular stages when the disaster develops. It is important to map the community members with the key resources and skills because it can be negotiated what role they can play when it comes to resolving water and environmental disasters.

The research further suggests that decision makers could use scenario planning when planning for urban and municipal uncertainties because the future is becoming more unpredictable due to climate change. With scenario planning (figure 6.1), it is possible to foresee and prepare various plans to deal with multiple futures in case unusual event happen (DWAF, 1998). In this manner, the resilience of the ELLM to flooding and environmental changes could be increased.

7.6. Conclusion

The stakeholders' understanding of the causes and solutions of flood risks (or disasters) are complex [even within the scope of the village or the *Isigodi]* in the ELLM. This also applies with the stakeholder's understanding of the use of EI in resolving flood risks and providing many other related benefits. The aforementioned example clearly indicates that soft engineering can play a significant role in addressing natural hazards (i.e. floods) that are perpetuated by human activities in Ladysmith. This research has made it very clear that it is important to identify the dynamics of EI perceptions and the different uses in the upper stream, floodplain, and lower stream areas of the Klip River. With this in mind it is possible to stimulate a more comprehensive approach to flood risk policy incorporating EI to bring about positive environmental change, and allowing a sustainable investment in flood risk infrastructure throughout the municipality.

The results of this research have shown that the stakeholders' understanding of what the causes (or the drivers) of flood risks are a complex matter. This was the case as the views from the participants were different from one person to another. These perceptions were shaped by the places in which the respondents reside, education background or job specialisation, churches and culture, history of the area they reside in, to name but a few. There is a demand for knowledge, tools and skills to design multiple stakeholder processes in order to deal with conflict and dispute issues, and aim at negotiated outcomes towards positive change in the management of EI to strengthen the resilience of the town and municipality from flood risks. This can be done by examining the different conflict management approaches in the international and local catchment management literature and apply them in the case of the Klip River where feasible.

Another conclusion drawn from studying urban areas is that the environmental compliance and municipal by-laws are enforced using bureaucratic institutions developed by the state such as the Environmental Inspectors and South African Police Service. However, Environmental Inspectors in the rural context are the powerful ancestors (*uNomkhubulwana*) believed to be the guardians of the soil, forest, mountains, and water, to name but a few. These important identified areas are perceived as sacred because people believe that they are home to their powerful ancestors. In this way, rural people became stewards of their lands and protect it during the absence of the state or municipality. Even though the practice of *uNomkhubulwana* tradition has declined due to complex political reasons, some elements of this tradition are still kept alive (at-least in oral history) in the ELLM as evident in the Emachibini, Mthembu clan. This old Zulu culture is important in their cosmology and water

management. It is recommended that this information is protected as it can contribute to environmental management as per the Environmental Impact and Heritage Impact Assessment regulations of the country.

Planners and others who influence decision making in the EI and flood risk management must consider politics, language barriers, culture and heritage, and power dynamics. This research has indicated that there is a demand for knowledge, tools, and skills to plan multiple stakeholder processes.

The researcher further recommends that future research may attempt to investigate the identified sacred water sites and the people's perceptions of using these areas**.** The researcher then can use the knowledge of the few identified informants who might have subjective knowledge would could have been used in a survey at a community scale level. In addition, it must also examine environmental consultants' perceptions of using ELLM EI in addressing flood risks. This investigation would have brought an even deeper understanding of how EI in the ELLM is used in flood risk management and responses that are more positive would have been given.

References

ACAPS. (2011). *Technical Brief: Direct Observation and Key Informant Interview Techniques for primary data collection during rapid assessments*. [Available online] http://acaps.org/img/documents/direct-observation-and-key-informant-interview-techniques-direct-observation-and-key-informant interview-techniques.pdf (Accessed from: 06 June 2015).

Alexander, WJ.R. (2000). Flood Risk Reduction in Developing Countries: An African Perspective. In: Parker, D. J. (ed). *Floods, Volume 1.* Abingdon, Routlege Hazard and Disaster Series. Pg. 260- 270.

Ali, A.I., Bokhari, J.I. and Siddiqui, Q.T.M. (2013). *Modern Approaches in Flood Disaster Risk Management*. Islamabad, Federal Flood Commission, Ministry of Water & Power.

Anderson, G. (2011). *Heritage Survey of a Proposed Quarry in Ladysmith for Afzalea*. Meerensee. Umlando, Archaeological Tourism and Resource Management.

Andjelkovic, I. (2001). International Hydrological Programme Guidelines on Non-Structural Measures in Urban Flood Management. *Technical Documents in Hydrology No. 50*. Paris, UNESCO.

Augustie, A., Methew, V.G.N. (2013). *Design with nature review: Urban Design Methodologies*. Slideshare [available online]: http://www.slideshare.net/ogustians/design-with-nature-review (accessed on: 10/04/2015).

Borrows, P. (2006). Living with Flooding—Noah's Legacy. *Irrig. and Drain*, **55** (1): S133–S140.

Batuca, D.G., and Jordaan, J.M. (2000). *Silting and Desilting of Reservoirs*. Rotterdam, CRC Press.

Bell, F.G., and Mason, T.R. (1998). The problem of flooding in Ladysmith, Natal, South Africa. *The Geological Society of London 2014*, **15**: 3-10.

Benedict, M. A., McMahon, E.T. (2003). *Green Infrastructure: Smart Conservation for the 21st Century*. Washington D.C., Sprawl Watch Clearinghouse Monograph Series. Pg. 1-32.

Bernard, P.S. (2003). *Ecological Implications of Water Spirit Beliefs in Southern Africa: The Need to Protect Knowledge, Nature, and Resource Rights*. USDA Forest Service, Proceedings RMRS-P-27.

Biggan, J. (2008). *Succeeding with Your Master's Dissertation: A step by step handbook.* New York, Open University Press.

Botes, Z.A. Smith, A.M. and Uken, R. (2011). *The Application of GIS Data Models for First Order Regional Flood Risk Determination in Ungauged Catchments for KwaZulu-Natal, South Africa.* Durban, University of KwaZulu- Natal: School of Geological Sciences.

Botha, G.A., and Singh, R.G. (2012). *Geology, geohydrology and Development Potential Zonation of the uThukela District Municipality; specialist contribution towards the Environmental Management Framework*. Pietermaritzburg, Council for Geoscience.

Bureau of Trails, (2004). *Best Management Practices for Erosion Control during Trail Maintenance and Construction*. Concord, State of New Hampshire; Department of Resources and Economic Development: Division of Parks and Recreation.

Burt, J. D., du Toit, D., Neves D., and Pollard, S. (2006). *Participation in Water resource management: Book One - Learning about Participation in IWRM*: A South African Review. WRC Report No. TT 293/06.

City of London, (2007). 5.0 Guidelines for Determining Setbacks and Ecological Buffers, Council Approved April 20, 2004. In: *Environmental Management Guidelines*. Ontario, City of London.

Ćosić, Đ., Popov, S., Sakulski, D., Pavlović, A., Palić, D. (2011). Importance of Vulnerability in Disaster Risk Management. *International Journal of Industrial Engineering and Management (IJIEM)*, **2** (2): 51-60.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neil, R.V., Paruelo, J., Raskin, R.G., Sutton, P., & van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature*, **387**: 253-260.

Costanza, Robert., de Groot, Rudolf., Sutton, Paul.,van der Ploeg, Sander., Anderson, Sharolyn J., Kubiszewski, Ida., Farber, Stephen., Turner, R. Kerry. (2014). Changes in the global value of ecosystem services. *Global Environmental Change*, **26**: 152-158.

Council for Scientific and Industrial Research (CSIR). (2013). *Natural Environment: Merging human inventiveness with nature's ingenuity*. [Available online] http://www.csir.co.za/enews/2013_mar/Gourits1.html (accessed on: 15 November 2015).

Davies, G.R. (2013). Appraising Weak and Strong Sustainability: Searching for a Middle Ground. *Consilience: The Journal of Sustainable Development*, **10** (1): 111-124

De Groot, R.S., Alkemade, R., Braat, L., Hein L., Willemen, L. (2010). Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. *Ecological Complexity*, **7** (3): 260–272.

Department of Provincial and Local Government, (1999). *White Paper on Disaster Management*. Cm 19676. Pretoria, Directorate: Disaster Management.

Disaster Management Task Team, (1998). *Green Paper on Disaster Management in South Africa.* Pretoria, Department of Constitutional Development: Directorate: Disaster Management.

DWAF., (2013). *Draft Guideline: Assessment of Activities/Developments Affecting Wetlands, First Edition*. Pretoria, Department of Water Affairs.

DWAF., (1998a). *Ladysmith Flood Control Scheme, Qedusizi Dam, operations and maintenance manual, volume 1*. Pretoria, Directorate Civil Design, Department of Water Affairs and Forestry.

DWAF, (1998b). *Qedusizi Flood Attenuation Dam: Darinage Region V*. Ladysmith Department of Public Safety, Upublished (pamphlet).

ELLM., (2015a). Integrated Development Plan 2015/2016.

ELLM., (2015b). *Reviewal of the Emnambithi/Ladysmith Disaster Management Plan 2015/2016*.

ELLM., (2012a). *Integrated Development Plan 2012-2017*.

ELLM., (2012b). *Mcitsheni, Mthandi & St Chads Local Area Plan: Development Strategy, Final Report*

ELLM., (2012c). *Spatial Development Framework: Consolidated Report, First Draft*. Scottsville, Isibuko Se- Africa Development Planners Consulting.

ELLM., (2011a). *Driefontein Local Area Plan: Development Strategy Draft***.**

ELLM., (2011b). *Emnambithi/Ladysmith Disaster Management Plan*.

ELLM., (2011c). *Ladysmith CBD Design Guideline*s. Durban, Walker Smith Architects. [Available online] http://www.ladysmith.co.za/docs/plans/2011/design_guidelines110711.pdf (accessed from 02 July 2014).

ELLM., (2010a). *Environmental Management Framework & Strategic Environmental Planning Tool (Draft)*. Morningside, Namai Consulting.

ELLM., (2010b). *Ladysmith CBD Regeneration Strategy*. Ladysmith, Vuka Africa and Walker Smith Architects.

ELLM., (2010c). *Rural Development Strategy – Final Report*. Glenwood, Urban- Econ KZN (Pty) LTD.

ELLM., (2007). *Policy Guidelines on Emnambithi/Ladysmith Municipal Open Space System*. Ladysmith, Department of Economic Development & Community Services.

ELLM., (2006a). *Agricultural Development Plan*. Zimbali, EnvironDev.

ELLM., (2006b). Integrated Development Plan 2006/2007.

Geringer, J. (2008). *The Application of RCC in South Africa*. Brazil, Department of Water Affairs and Forestry.

Gómez-Baggethun, E., and Barton, D. N. (2013). Classifying and valuing ecosystem services for urban planning. *Ecological Economics*, **86**: 235–245.

Goolaup, P. (2011). *Preparing for Severe Weather Emergencies, RTIT Meeting of the SWFDP-Southern Africa*. Vacoas, Mauritius Meteorological Services.

Grobler, R.R. (2002). *A Framework for Modelling Losses arising from Natural Catastrophes in South Africa*. Pretoria, University of Pretoria.

Harker, A. (2012). Landscapes of the Dead: An Argument for Conservation Burial. The Urban Fringe, a Practitioners Blog, from the *Berkeley Planning Journal*. [Available online] http://ced.berkeley.edu/~bpj12/2012/09/landscapes-of-the-dead-an-argument-for-conservation-burial/ (Accessed on: 15 November 2015).

Hanson, C., Ranganathan, J., Iceland, C., Finisdore, J. (2008). *The Corporate Ecosystem Services Review: Guidelines for Identifying Business Risks and Opportunities Arising from Ecosystem Change, Version 1.0*. Washington D.C, World Resources Institute – WRI.

Heath, R. Moffett, M. and Banister, S. (2004). *Water Related Impacts of Small Scale Mining, Final Report to the Water Research Commission*. WRC Report No 1150/1/04.

Henning, D., Phamphe, R., Munshi**,** S. (2014). *UThukela District Municipality Environmental Management Framework: Draft Desired State Report***.** Westville, Namai Consulting.

Henning, D., Phamphe, R., Munshi**,** S. (2012). *UThukela District Municipality Environmental Management Framework Report Status Quo Report: Rivers & Wetlands*. Morningside, Namai Consulting.

Henning, W. (2011). Even the Spirits Need a Menu as a Zulu Goddess. [Available online]: http://www.cuisinenoirmag.com/delicious-life/even-the-spirits-need-a-menu-as-a-zulu-goddess (accessed on: 03 May 2015).

INR- Institute of Natural Resources. (1988). *A Pilot Study of the Role of Wetlands and Land Use in flood attenuation in the Ladysmith Catchment above Ladysmith*. Pietermaritzburg, University of Natal.

Jacobs, J. (1961). *Death and Life of Great American Cities*. New Yok, Random House.

Jha, A., Block, R., and Lamond, J. (2012). *Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century*. Washington, D.C, The World Bank Publisher and Global Facility for Disaster Reduction and Recovery.

Koopman, V. (2011). Respecting wetlands could have spared lives during floods, says. *Wildlife and Environment Society in South Africa: World Wetland Day*, pp.1- 2. [Available online]:

http://www.wetland.org.za/ckfinder/userfiles/files/WESSA%20%20World%20Wetlands%20Day%20Press%20Release.pdf (Accessed 8 on March 2015).

Kotze, D.C. (2000). *The Contribution of Wetlands to the Attenuation of Floods*. University of KwaZulu-Natal, Mondi Wetland Programme. [Available online]: http://www.wetland.org.za/ckfinder/userfiles/files/38%20Scientific%20info_%20wetlands%20&%20%20flood%20research%20paper.pdf (Accessed on: 15 June 2015).

Lubke, V. (2004). *Environmental Discourse in the eThekwini Municipality: The eThekwini Catchments Project*. Unpublished Masters Thesis. Durban, University of KwaZulu-Natal.

Mack, N., Woodsong C., Macqueen, K.M., Guest, G., and Namey, E. (2005). *Qualitative Research Methods: A Data Collector's Field Guide.* North Carolina, Family Health International.

MEA, (2005). *Ecosystems and Human Well-being: Synthesis*. Washington, DC. Island Press.

Messner, F., Penning-Rowsell, E., Green, C., Meyer, V., Tunstall, S., van der Veen, A. (2007). *Evaluating flood damages: guidance and recommendations on principles and methods*. FLOODsite Project Deliverable, FLOOD*site* Consortium.

Mwape, Y.P. (2009). *An Impact of Floods on the Socio-Economic Livelihoods of People: A Case Study of Sikaunzwe Community in Kazungula District of Zambia*. Bloemfontein, University of the Free State.

Nellemann, C., E. Corcoran (eds). (2010). *Dead Planet, Living Planet – Biodiversity and Ecosystem Restoration for Sustainable Development*. A Rapid Response Assessment. UNEP GRID-Arendal.

Newman, P., and Kenworthy, J. (1999). *Sustainability and Cities: Overcoming Automobile Dependence*. Washington D.C., Island Press.

Nkosi, P.M. (2011). "*Ingcwaba Lentombi Lisemzini": A Socio- Cultural and Gendered Construction of Ukuthwala among the Zulu People in Selected Rural Areas in KwaZulu- Natal*. Unpublished PhD Thesis. Durban, University of KwaZulu- Natal.

Ngcobo, N. (2015). Emnambithi/Ladysmith LM Fieldwork [Photographs]. Unpublished Personal Collection.

OSLOpenNESS- Operationalization of Natural Capital ad Ecosystem Services, (2015). *ENSJØ CITY DISTRICT- Blue-green stormwater management*. [Online] Available at: http://www.openness-project.eu/sites/default/files/BYM_Faktaark_A4_%C3%98kosystemtjenester_Ensj%C3%B8byen_ENG_WEB.pdf (Accessed from 15 September 2016).

Pringle, C., Bredin, I., McCosh, J., Dini, J., Zunckel, K., Jewitt, G., Hughes, C., de Winnaar, G. and M. Mander, (2015). *An Investment Plan for securing ecological infrastructure to enhance water security in the uMngeni River catchment.* Midrand, Green Fund, Development Bank of Southern Africa.

Parker, D.J. (ed), (2014). *Floods, Volume II.* New York, Routledge Hazards and Disaster Series.

Phillips, S. (2014). *Medium Term Strategic Framework (MTSF) 2014- 2019*. Pretoria, The Presidency Republic of South Africa: Department of Planning, Monitoring and Evaluation.

Quayle, L. and C. Pringle. (2014). *Assessment of ecosystem services in the Uthukela District Municipality. Report to Afromaison, a project funded under the Seventh Research Framework of the European Union.* Pietermaritzburg, Institute of Natural Resources.

Rail to trails Conservancy, (2016). *Developing Trails in Sensitive Areas*. [Available online] https://www.railstotrails.org/build-trails/trail-building-toolbox/trail-building-and-design/developing-trails-in-sensitive-areas/ (Accessed on 05 October 2016)

Reid, P.M. (2005). *A Model for an Incident Management System for South Africa*. Potchefstroom, North West University.

RSA- Republic of South Africa. (2013). Spatial Planning and Land Use Management Act, 2013 (Act No. 16 of 2013)

RSA- Republic of South Africa. (2000a). Disaster Management Act, 2002 (Act No. 57 of 2002)

RSA- Republic of South Africa. (2000b). Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000).

RSA- Republic of South Africa. (1998). National Water Act, 1998 (Act No. 36 of 1998)

RSA- Republic of South Africa. (1997). National Environmental Management Act, 1997 (Act No. 107 of 1997).

RSA- Republic of South Africa. (1983). Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983).

Salisbury, C. (2016). *Trails Program*s. Seattle Parks and Recreation department, Government Website. [Available Online] http://www.seattle.gov/parks/volunteer/trails-programs (Accessed on 15 August 2016).

Salvador, M., and Norton, T. (2011). The flood myth in the age of global climate change. *Environmental Communication,* **5** (1): 45-61.

SANBI (2014). *A Framework for investing in ecological infrastructure in South Africa*. Pretoria, South African National Biodiversity Institute.

Savannah Environmental, (2008). Environmental Management Plan for the Ingula (Braamhoek) Integration Project: Ingula (Braamhoek) Substation in KwaZulu-Natal, for Eskom Holdings Limited. [Available Online] http://www.eskom.co.za/OurCompany/SustainableDevelopment/EnvironmentalImpactAssessments/Documents/Braamhoek_substation_construction_EMP_final.pdf (Accessed on: 25 March 2016).

Scott , M., White , I., Kuhlicke , C., Steinführer , A., Sultana , P., Thompson , P., Minnery , J., O'Neill , E., Cooper , J., Adamson, M., & Russell, E. (2013). Living with flood risk/The more we know, the more we know we don't know: Reflections on a decade of planning, flood risk management and false precision/Searching for resilience or building social capacities for flood risks? /Participatory floodplain management: Lessons from Bangladesh/Planning and retrofitting for floods: Insights from Australia/Neighbourhood design considerations in flood risk management/Flood risk management – Challenges to the effective implementation of a paradigm shift. *Planning Theory & Practice*, **14** (1): 103-140.

Shabalala, J. (2004). Qed'Usizi. In: *The Very Best of Ladysmith Black Mambazo - Rain, Rain, Beautiful Rain, Disc 2* [CD]. United Kingdom, Gallo Record Company.

Sherbut, G. (2012). Payment for ecosystem services in South Africa: Prospects for programme development. Pretoria, Policy Brief for Trade and Industrial Policy Strategies.

Sigel, K., Klauer, B., and Pahl-Wostl, C. (2010). Conceptualising uncertainty in environmental decision-making: The example of the EU water framework directive. *Ecological Economics*, **69**: 502–510.

Spade, K. M. (2013). *Of Dirt and Decomposition: Proposing a Resting Place for the Urban Dead*. Amherst, University of Massachusetts Amherst.

Steiner, F. R., and Butler, K. (2007). *Planning and Urban Design standards*. New Jersey, John Wiley & Sons.

Stephens, A. (2011). *Harnessing ecological infrastructure and adapting to risk*. Talk presented to the 'Agri- Food Chain: Vulnerability & Adaptation' NBI Side Event, COP 17. (1 December 2011). [Available Online] www.nbi.org/Lists/Events/Attachments/48/Stephens_Hannessing_Ecological_Infrastructure (Accessed from: 12 December 2015).

TEEB (2011). *TEEB Manual for Cities: Ecosystem Services in Urban Management*. [Available Online]: http://www.teebweb.org/wpcontent/uploads/Study%20and%20Reports/Additional%20Reports/Manual%20for%20Cities/TEEB%20Manual%20for%20Cities_English.pdf (accessed on 10 March 2015).

The Scottish Government, (2011). *Green Infrastructure: Design and Placemaking*. Edinburgh, The Scottish Government.

The Ladysmith Gazette, (1996). '*Qedusizi Dam would have saved the town*'. The Ladysmith Gazette, 01 March 1996.

The Ladysmith Gazette, (1994). '*Mandela's Message to Ladysmith'*. The Ladysmith Gazette, 18 February 1994.

The Water Wheel. (2005). *Land Management: Projects Restoring Land and Water*. WRC- Water Research Council. [Available online]: http://www.wrc.org.za/Knowledge%20Hub%20Documents/Water%20Wheel/Articles/2005/02/WaterWheel_2005_02_Okhombe%20p12-15.pdf (Accessed on: 15 April 2015).

Thornhill, M., Green-Govendor, J., and Khoza, B. (2009). *A Status Quo Analysis on the Impacts of Climate Change in KwaZulu-Natal*. Report to the Department of Agriculture and Environmental Affairs, Provincial Government, KwaZulu-Natal, South Africa.

Tvedt, T. (2015). *Water and Society: Understanding history and development*. London, I.B. Tauris.

UN- United Nations, (1992). United Nations Conference on Environment & Development. Rio de Janerio, United Nations Sustainable Deveplement

Vermont Agency of Natural Resources, (2005). Riparian Buffers and Corridors, TECHNICAL PAPERS. Vermont, Vermont Agency of Natural Resources. [Available online] http://nhanrs.org/Buffer/VT.8.pdf (Accessed from: 16 November 2015).

Waters, H. (2012). Natural assets for flood and cyclone resilience: Review of planning mechanisms used worldwide for mitigation of natural disasters using a natural assets approach. *In:* PROTECTION, D. O. E. A. H. (ed.). Brisbane: The State of Queensland (Department of Environment and Heritage Protection). Pg. 1- 27.

Watson, V. (2003). Conflicting Rationalities: Implications for Planning Theory and Ethics. *Planning Theory & Practice*, **4** (4): 395–407.

WWF- World Wildlife Fund, and AfDB – African Development Bank, (2012). *Africa Ecological Footprint Report: Green Infrastructure for Africa's Ecological Security*. Tunis Belvedere and Glad, Joint Report by WWF- World Wildlife Fund, and AfDB – African Development Bank.

Xuesong, X., Han, H., (2008). Ecological Infrastructure and Urban landscape Identity: A Case Study of Weihai, Shandong. *Ecological Infrastructure and Urban Landscape Identity Conservation*. 44th ISOCARP Congress.

Youzhen, C., Longlong, D. (2012). *From Garden City to Smart Growth: The Evolution and Management of New Urbanism*. Chegnu, Southwest Jiaotong University.

Yu, K., Li, H. Li, D. (2008). *Ecological Infrastructure as a Tool for Smart Preservation and Smart Growth*. 44th ISOCARP Congress. [Available online] http://www.isocarp.net/Data/case_studies/1220.pdf (Accessed on: 08/09/2015).

Yu, L. (2014). *Chinese City and Regional Planning Systems*. Surrey, Ashgate Publishing Limited.

List of Respondents

Respondent 1: SU Stakeholder. (2015). Upper Klip River Catchment Representative, Interview in Town Hall. (Date: 15/05/2015)

Respondent 2: RC Stakeholder- Elder. (2015). Emachibini, MTA (close proximity to Klip River and Tugela Confluence), Household Interview. (Date: 04/05/2015)

Respondent 3: RC Stakeholder- Elder. (2015). Emachibini, MTA (close proximity to Klip River and Tugela Confluence), Household Interview. (06/05/2015)

Respondent 4: LG Stakeholder- Town Planning Unit. (2015). Ladysmith Town (floodplain), Office Interview. (Date: 24/02/2015)

Respondent 5: LG Stakeholder- Environmental Hygiene. (2015). Ladysmith Town (floodplain), Office Interview. (Date: 06/05/2015)

Respondent 6: LG Stakeholder- Disaster Management. (2015). Ladysmith Town (floodplain), Office Interview. (Date: 06/05/2015)

Respondent 7: NG Stakeholder- Environmental Affairs. (2015). Ladysmith town (floodplain) & Ezakheni, office Interview. (Date: 24/02/2015)

Respondent 8: FT Business Stakeholder- Store Manager. (2015). Ladysmith town (floodplain), Interview in the store. (Date: 10/05/2015)

Respondent 9: FT Business Stakeholder- Photographer. (2015). Ladysmith & Acaciaville, Interview in the Urban Park. (Date: 10/05/2015)

Respondent 10: Farming Stakeholder Representative - Farmer. (2015). Ladysmith Town (floodplain), Interview in the farm/agricultural field. (Date: 17/05/2015)

Respondent 11: FT Community Stakeholder- Elder. (2015). Ladysmith Town (floodplain), Community around interview. (Date: 06/05/2015)

Respondent 12: LG Stakeholder- Flood Liaison Committee Member. (2015). Ladysmith Town (floodplain), Office Interview. (Date: 06/05/2015)

Respondent 13: LG Stakeholder- Parks & Gardens Section. (2015). Ladysmith Town (floodplain, Office Interview. (Date: 06/05/2015)

Respondent 14: RC Stakeholder- Focus Group- Youth girls. (2015). Emachibini, MTA (close proximity to Klip River & Tugela confluence). (Date: 06/05/2015)

Respondent 15: RC Stakeholder- Focus Group- Elders. (2015). Emachibini, MTA (close proximity to Klip River & Tugela confluence). (Date: 06/05/2015)

Respondent 16: LG Stakeholder- Parks & Gardens Municipal official. (2015). Ladysmith Town (floodplain), Office informal Interview. (Date: 06/05/2015)

Respondent 17: SU- Stakeholder- Anonymous NG official. (2015). Upper Klip River Catchment, Office interview. (Date: 24/02/2015)

Respondent 18: SU Stakeholder- Anonymous NG official. (2015). Upper Klip River Catchment, Office Interview. (Date: 24/02/2015)

Respondent 19: SU Stakeholder- student. (2015). Upper Klip River Catchment, Informal Interview. (Date: 03/06/2015)

Respondent 20: PG Stakeholder- Amafa AkwaZulu- Natal Official. (2015). Pietermaritzburg, Office Interview. (Date: 27/02/2015)

Respondent 21: LG Stakeholder- Engineering Municipal Official. (2015). Ladysmith Town (floodplain), Office Interview. (Date: 13/05/2015)

Appendix A1: *Emnambithi*/Ladysmith Local Municipality Locality Map (Source: http://www.demarcation.org.za)

Appendix A2: New Municipality (Alfred Duma) resulting from the merger of ELLM and Indaka LM (Source: http://www.demarcation.org.za)

Appendix B1: Ethical Clearance Letter

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

18 February 2015

Mr Njabulo Ngcobo 209530354
School of Built Environment and Development Studies
Howard College Campus

Dear Mr Ngcobo

Protocol reference number: HSS/1575/014M
Project title: Stakeholder's perceptions of using Ecological Infrastructure to address flood risk: A case study eMnambithi / Ladysmith Local Municipality

Full Approval – Expedited Application

In response to your application received on 19 November 2014, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol have been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....

Dr Shamila Naidoo (Deputy Chair)
Humanities & Social Sciences Research Ethics Committee

/pm

Cc Supervisor: Mrs Catherine Sutherland
Cc Academic Leader Research: Professor PM Sithole
Cc School Administrator: Mrs Meera Dalthaman

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
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Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260- 4609 **Email:** ximbap@ukzn.ac.za / snymanm@ukzn.ac.za / mohunp@ukzn.ac.za
Website: www.ukzn.ac.za

1910 - 2010
100 YEARS OF ACADEMIC EXCELLENCE

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

Annexure B2: Declaration for consent to the Participants

I, …… (Full Name) hereby confirm that I have read and understood the contents of the letter and the nature of the research project has been clearly defined prior to participating in this research project. I also understand that I am at liberty to withdraw from the project at any time, should I so desire.

I have also been informed that should I have any queries about the study I can contact his supervisor, Mrs Cathy Sutherland on 0833827271/email: Sutherlandc@ukzn.ac.za, or contact the research office (Senior Administrative Officer- **Premlull Mohun** on: 031 2604557/ email- mohunp@ukzn.ac.za or hassrec@ukzn.ac.za

I hereby do not give my concern for: *(please tick in the box)*

My name,	
My position and organisation, or	
The use of my photographs for research purposes	
Audio-record my interview	
Other …… (specify)	
None of the above	

to be used in the research report?

Signature of Participant Date

_____ _____

Signature of Witness Date

(Where applicable)

_____ _____

Appendix B3: Consent (Gate Keeper's Letter) from the Induna of the Emachibini, MTA

Letter of Consent from the (name of the village chief/Induna) .....to access the area for research purposes

I (full names) ..... foreman of the area of e (name of the village/*isigodi*) ..... a Traditional Authority have been consulted by Mr. Njabulo Ngcobo with a request to conduct a research study which deals with stakeholders participation on Using ecological Infrastructure and flood risk management in the Town and consequently to its LM. After listening to what the research is about, I hereby grant him permission to access my area and my people to get any information that will help him in the study.

Full *name* .....

Signature

.....

Date and Stamp

.....

Incwadi yemvume evela enduneni egunyaza ilungelo lokungena (igama lesigodi) ..... ngenjongo yokuthola ulwazi.

Mina (igama eliphelele) Funokwakhe Madonsela induna sesigodi esibizwa ngokuthi I (igama lesigodi) eMachibini ngivakashelwe nguMnu Njabulo Ngcobo ezocela ukuba ngimvumele endaweni (igama lendawo) eBattenjini ukuthi azokwenza ucwaningo futhi azothola ulwazi mayelana nesihloko sakhe esikhuluma ngemibono yabanikazi noma abathintekayo eksebenziseni iNgqalasizinda ekhiqizwa yimvelo kumbhidlango wokulwa nezikhukhula edolobheni laseMnambithi nakweminye imiphakathi eyakhele umasipala uMnambithi. Emva kokuxoxisana naye ngalolu cwaningo nami ngiyavuma ukuba awenze lo msebenzi kule ndawo nokuba athole lolo lwazi alundingayo ngokukhulumisana nabantu bami.

Igama nesibongo Funokwakhe S. Madonsela

Signature

F.S. Madonsela

Usuku nesigxivizo

01.05.2015

THE MTHEMBU TRIBAL AUTHORITY
INDUN CHIBINI
PRIV X9999
LADYSMITH 3370

THE MTHEMBU TRIBAL AUTHORITY
INDUNA OF EMACHIBINI
PRIVATE BAG X9999
LADYSMITH 3370

Appendix B4: Consent (Gate Keeper's Letter) from the Municipal Manager

Letter of consent from the Municipal Manager of the eMnambithi/Ladysmith LM to access the area for research purposes

I (full names) Mabona Phumula Khathide Municipal manager of the eMnambithi/Ladysmith Local Municipality have been consulted by Mr. Njabulo Ngcobo with a request to conduct a research study which deals with the perceptions of the eMnambithi/Ladysmith Local Municipality in using ecological infrastructure to address flood risks in Ladysmith town and other communities. After listening to what the research is about, I hereby grant him permission to access my area and my people to get any information that will help him in the study.

Full name Mabona Phumula Khathide

Signature

Date and Stamp

06/10/2015

MUNICIPAL MANAGER
EMNAMBITHI/LADYSMITH MUNICIPALITY
P O Box 29
221 Murchison Street
LADYSMITH 3370
Tel: 036-637 2231 FAX: 036-631 1400
Website: www.ladysmith.co.za

Appendix C1: Interview Schedule for the professionals and Officials

Respondent no.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35

Interviewer: ……
Interviewee: ……..
Occupation: ……
Gender: ……
Date: ……
Time: ……
Place: ……..

Thank you for agreeing to this interview or meeting. This interview forms part of my research project for masters into flood risk management and ecological infrastructure. Before we start the interview, I want to request you to sign the declaration form to say that you understood the nature of this research and you are agree to be interviewed

1.1. Where do you reside in Emnambithi/Ladysmith Municipality?	
1.1.1. Where else have you lived or worked in the ELM?	

1.2. How long have you been staying or working in this area?

< 10	11- 19	20- 28	29+

1.3. Have you witnessed any flooding events while working, visiting, and staying in this LM?	Yes/No	Explain where and other memories
1.4. Based on your experience, observations, and opinion; what do you think is the most vulnerable area to flooding in the Emnambithi/Ladysmith municipality?		

1.4.1. What do you think is the main cause of the continued flood vulnerability of this areas in than any other area in the Emnambithi/Ladysmith municipality?
1.5. Do you fear the floods? Explain your answer
1.6. Whose responsibility do you think flood management is for?
1.7. Have you noticed any variation climate during these last years?
1.8. What do you think is the relationship between climate change and flooding?
1.9. Are you aware of any other disaster problem that may lead into more flood vulnerability? Explain

1.10. What are the solutions or strategies to address flood risks in Ladysmith?
1.11. Do any of your flood management programs in Ladysmith include ecological infrastructure?
1.12. Have you heard about ecological infrastructure?
1.13. Is there a place where you have used (or have seen) the concept of EI?
1.13.1. Was it successful?
1.14. In your opinion, do you believe ecological infrastructure can address flooding in Ladysmith?
1.15. Would you recommend the use of ecological infrastructure in addressing flood risks in Ladysmith? Explain your answer

Appendix C2: Interview Schedule for Rural Community Participants

Respondent no.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35

Interviewer: ……
Interviewee: ……..
Occupation: ……
Gender: ……
Date: ……
Time: ……
Place: ……..

Thank you for agreeing to this interview or meeting. This interview forms part of my research project for masters into flood risk management and ecological infrastructure in Ladysmith. Before we start the interview, I want to request you to sign the declaration form to say that you understood the nature of this research and you agree to be interviewed

1.16. Where do you reside in Emnambithi/Ladysmith Municipality?	
1.16.1. Where else have you lived or worked in the ELM?	

1.17. How long have you been staying or working in this area?

< 10	11- 19	20- 28	29+

QUESTIONS ON THE BACKGROUND AND THE PERCEIVED SOLUTIONS TO FLOODING

1.18. Have you witnessed any flooding events while working, visiting, and staying in this municipality?	Yes/No	Explain where and other memories

1.19. Based on your experience, observations, and opinion; what do you think is the most vulnerable area to flooding in this municipality? Explain why
1.19.1. In your opinion, what do you believe is the **cause** of flooding or excess rain in the Emnambithi/Ladysmith municipality?
1.20. Do you know of any **solutions** to address flooding in this area?

QUESTIONS ON COSMOLOGY AND TRADITIONAL FLOOD RISKS MANAGEMENT

1.21. Are there signs to tell that there will be flooding or extreme weather events? Also explain how do you know about these signs
1.22. I have heard from other community members that, many traditional Zulus believed in the *uNomkhubulwana* and also that some of the community members tell that they see her in the rivers and other water sites. So, would you please share with me your knowledge regarding this belief?
1.23. Can you please identify the sacred water sites believed to have lived *uNomkhubulwana*?

1.24. What are the practices performed in and in close proximity to these areas?
1.25. In your opinion, do you think the practice of *uNomkhubulwana* is declining or not? Why
1.26. Can you please recommend some of other community members who can tell use more about uNomkhubulwana?

QUESTIONS OF CLIMATE AWARENESS

1.27. Have you noticed any variation climate during these last years?
1.28. Do you believe there is any relationship between climate change and flooding?
1.29. Are you aware of any other disaster problems that may lead into more flood vulnerability? Explain

QUESTION ON ECOLOGICAL INFRASTRUCTURE

1.30. In your opinion, do you believe ecological infrastructure can address flooding in Ladysmith?
1.31. Would you recommend the use of ecological infrastructure in addressing flood risks and other water related disaster problems? Explain your answer

Appendix D: Application form to apply for Low Impact Development in the ELMOSS

GENERAL REQUIREMENTS FOR THE MOTIVATIONAL REPORT TO BE SUBMITTED TO THE EMNAMBITHI/LADYSMITH MUNICIPALITY TO USE THE OPEN SPACE

1. APPLICATION DETAILS

   a) Name;
   b) Postal Address;
   c) Physical Address;

2. PROJECT DESCRIPTION

   a) Details of the proposed structure- including ancillary uses;
   b) Proposed description of the property;
   c) Physical address of the property;

3. SITE DESRCIPTION

   a) General description of the biophysical environment i.e. land form, flora and fauna, indigenous vegetation) on site;
   b) Description of specific environmental elements that will be affected by the activity and description of these impacts;
   c) Description of the management plan to be implemented if applicable;
   d) Linkage to the existing road network

   Further elaborate on the following Spatial Attributes on and around the subject property:

   - ✓ Determine whether the property is subject to any flood lines, if so, the applicable ratio;
   - ✓ Alignment of the proposed development with the Emnambithi/Ladysmith Integrated Development Plan, Spatial Development Framework, etc;
   - ✓ Is the proposed area covered by the Town Planning scheme Scheme;
   - ✓ Surrounding land uses;
   - ✓ Proximity of an existing active open space;
   - ✓ Nature of the open space and the category;
   - ✓ Is the open space passive or active?
   - ✓ Is the open space maintained;
   - ✓ What benefits will the proposed development bring to its users;
   - ✓ Is the proposed area serviced, if not what is the approximate projection of serving the land?
   - ✓ Need and desirability of the proposed development;

   - ✓ Concept of amenity (Interference or enhancement), i.e. architectural theme of the proposal;
   - ✓ Does the open space fall within the land most worthy for inclusion within a Municipal Open Space System (EL'MOSS);

4. MAPPING
   a) Proposed layout plan or preliminary designs depicting the location of the proposed development;
   b) Site and Locality Plans.

Appendix E1: The ELLM Role Players in flood (and other disaster classes) responses to be activated when required (Source: ELLM, 2015b)

Region within the ELLM	HAZARD	PRIMARY RESPONSE ORGANISATION /SERVICE	SECONDARY RESPONSE ORGANISATION/ SERVICE	OTHER ASSISTANCE ORGANISATION/SERVICE
Driefontein and surrounding areas within a 10km radius	Storm, strong winds and floods	Public Safety (FIRE) and Uthukela District Municipality	EMRS , ER 24 and Sharaj Ambulance and rescue	SA Army, SAPS and Medical mobile clinics Provincial
Watersmeet and surrounding areas within a 10km radius	Storms, strong winds and floods	Public Safety (FIRE) and Uthukela District Municipality	EMRS	SA Army, SAPS and Medical mobile clinics Provincial
Matiwanesk op and surrounding areas within a 10km radius	Storms, strong winds and floods	Public Safety (FIRE) and Uthukela District Municipality	EMRS contingency response plan	SA Army, SAPS and Medical mobile clinics Provincial
Ladysmith CBD and surrounding areas within a 15km radius	Storms, strong winds and floods	Public Safety (FIRE) and Uthukela District Municipality	EMRS and Department of health contingency plan	SA Army, SAPS and Medical mobile clinics Provincial
Roosboom and surrounding areas within a 12km radius	Storms, strong winds and floods	Public Safety (FIRE) and Uthukela District Municipality	EMRS and Department of health contingency plan	SA Army, SAPS and Medical mobile clinics Provincial
Colenso and Surrounding areas within a 15km radius	Storms, strong winds and floods	Public Safety (FIRE) and Uthukela District Municipality	EMRS and Department of health contingency plan	SA Army, SAPS and Medical mobile clinics Provincial
Ezakheni and surrounding areas within a 15km radius	Storms, strong winds and floods	Public Safety (FIRE) and Uthukela District Municipality	EMRS and Department of health contingency plan	SA Army, SAPS and Medical mobile clinics Provincial
Steadville and Surrounding within a 5km radius	Storms, strong winds and floods	Public Safety (FIRE) and Uthukela District Municipality	EMRS and Department of health contingency plan	SA Army, SAPS and Medical mobile clinics Provincial

Appendix E2: Flood management measures and the associated costs of these solutions (Source: ELLM, 2015b)

Flood	Specific Measures	Cost of measures
POLICY & PLANNING ***Building the capacity to*** *Respond*	Implement a plan for protection against flooding, including preparedness and contingency planning	Costs relating to Institutional and Capacity building of appropriate national, regional and local institutions e.g. administrative effort, Professional advice, communications systems etc.
	Land-use planning that better incorporates risk of flooding	(as above)
	Integrated management of flooding and water supply	Costs relating to technical assistance, institutional and capacity building
	Development and implementation of Early Warning System (EWS)	costs of increasing capacity for predicting extreme events for the relevant authorities, through the design and implementation of an effective Early Warning System (EWS)
	Integrated warning and response System	(as above)
	Improving networks / links with local governments	Cost of awareness raising exercises, training etc.
PHYSICAL ***(Prevention)*** *Reducing exposure to and preventing hazards*	Flood defences e.g. Dam (Multipurpose nor flood attenuation)	Capital investment costs; Maintenance Costs
	Natural protection against floods e.g. reforestation of watersheds	Natural protection against floods e.g. reforestation of watersheds
	Installation of drainage pumps	Capital investment costs, Maintenance Costs
PHYSICAL *(Coping / Adaptive)*	Flood shelters next to schools	Capital investment costs, Maintenance Costs
	Flood proofing of latrines and tube wells	Capital investment costs, Maintenance Costs
	Raised platforms(equipped with latrines and drinking water)	Capital investment costs, Maintenance Costs
	More resilient roads and infrastructure, e.g. raised buildings and roads	Capital investment costs, Maintenance Costs
	More resilient water supply systems, e.g. boreholes, raised hand pumps	Capital investment costs, Maintenance Costs
	Design and building of contingency mechanisms for coping with floods, e.g boats for evacuation, escape roads, temporary shelters	Capital investment costs, Maintenance Costs

	Pre-positioning / strategic stock piling of relief material, e.g. life boats, life jackets, tools, first aid etc.	Capital investment costs Maintenance Costs
CAPACITY BUILDING *at Community level*	Community based disaster preparedness: Communities trained in disaster preparedness, e.g. through development of disaster response committees	Training costs through technical assistance: Cost of developing community level initiatives /institutions
	Public warning system (community based)	Costs of increasing capacity for providing warning to the public
	Safety nets to ensure that poor households can rebuild productive livelihoods (through building on existing programmes)	Incremental costs to existing Public programmes aimed at providing these safety nets
	Revolving funds managed by the community used to better cope in disaster situations, e.g. for storing and distributing food	Cost of administering the fund Cost of training community members to manage the fund

Appendix F1: Flood line Map (Source: DWAF, 1998a)

Appendix F2: Map for storm water system (and flap gates) near the low-lying areas of Ladysmith (Source: DWAF, 1998a)

Appendix F3: Map for elevated centres for evacuation and flood siren warnings (Source: DWAF, 1998a)