
Riverine Flood Risk Reduction in the Western Cape

A Case Study of the Baths River

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Declaration

In accordance with the stipulation of the University of Cape Town, I hereby declare that:-

except where specific acknowledgement is made, this dissertation is my own original work.

Caryn Jennifer Durham

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1. Introduction

1.1 Background to thesis

1.1.1 International Flooding Context

Globally, floods are viewed as the most destructive of all naturally triggered disasters. This is indicated by reported flood losses that exceed one third of the estimated total cost associated with all disaster events triggered by natural hazards. Additionally, flood events account for two thirds of the global population affected by all naturally triggered disaster events (UNDP, 2004).

Initiatives such as the International Strategy for Disaster Risk Reduction have recognised the urgency to reduce such flood losses and are as such, advocating for greater attention to integrated flood risk management as an integral aspect of sustainable development. In this context the ISDR reports that nations and communities that have successfully reduced their flood losses effectively balance the potential consequences of flood risk with the value of other beneficial, socio-economic goals. Such countries also reportedly make informed management decisions based on reliable information, promote principles of self-help and self-reliance and support traditional mitigation methods along with new technologies.

1.1.2 National and Provincial Flooding Context

Land immediately surrounding South African rivers is often perceived to be ideal for agricultural, industrial and residential development as it is typically flat and fertile with a close water supply (Twiggs, 2004). It is estimated that more than 100 000 people in South Africa reside beside rivers below the water-level reached during the river's previous flooding event, the majority of whom live in unplanned settlements. The frequency of flooding within the Western Cape and KwaZulu Natal provinces highlights the exposure of these populations to recurrent flood events. Within these areas a maximum of 28 and 36 flood events respectively have been recorded from 1800 – 1995 (Department of Water Affairs and Forestry, 2006). Events such as these have resulted in costly losses for the Western Cape specifically with damage costs related to flooding exceeding R210

million in 2003 (DiMP, 2003) and R602 million in 2006 (Department of Local Government and Housing Western Cape Province, 2006).

In this context, many areas within the Western Cape have experienced more than one of the severe flood events over the past four years. As a result, large investments have been made from personal to governmental levels to repair and re-repair flooding damage (DiMP, 2005). Such strategies, of covering flood losses and restoring flood victims to their previous state of being, are clearly unsustainable (du Plessis, 2002). This is particularly apparent in situations where there is evidence of poor infrastructural development planning and investment. However, inadequately planned infrastructure is not the only factor that increases losses associated with flooding events. Post-flooding assessments in the Western Cape (DiMP 2003, 2005) have revealed that flood risk is also significantly exacerbated by the lack of co-ordinated river management and poor communication between relevant institutions.

Enabling legal and policy processes to strengthen flood risk management within the Western Cape as well as other South African provinces does exist; they are, however, unfortunately, poorly integrated. For instance, the National Water Act (Act 36 of 1998) requires the formation of Catchment Management Agencies (CMA), composed of catchment stakeholder representatives and relevant government officials. Similarly, the National Disaster Management Framework requires that “all national, provincial and municipal organs of state must, according to their functional area of jurisdiction” prioritise the protection of, among others, “communities in areas exposed to extreme weather or other natural and technological hazards” (National Disaster Management Framework, Section 3.2.4). Despite this, the CMAs do not consider flood risk management as part of their mandate. Until now, this has discouraged the integration of flood risk management with sustainable catchment management planning.

1.1.3 Baths River, Study Site, Context

The Baths River, within the Theewaterskloof Local Municipality of the Overberg District Municipality provides an excellent platform for examining flood risk management in greater depth. This river runs through the town of Caledon approximately 110km east of Cape Town and lies within the boundaries of the Theewaterskloof local municipality which is situated in the Overberg District Municipality in the Western Cape Province of South Africa (refer Fig 2.1). The Baths River faces significant flood risk (DWAF interview, 2006). In addition, it was identified as one pilot site for the development of integrated catchment management guidelines. In this context the Baths River was viewed as a valuable opportunity for investigating the policy interface between risk reduction and catchment management.

1.2 Aims and Objectives

This study aimed to strengthen prevailing understanding of contemporary flood risk and its management in the Western Cape, South Africa, by applying the ISDR's Disaster Risk Reduction Framework to the Baths River, Caledon.

Specifically, the study's objectives were to:

- 1) Conduct a detailed flood risk assessment of the Baths River from its source to the point where it exits the town of Caledon.
- 2) Consolidate flood risk assessment findings according to the ISDR Risk Reduction Framework.
- 3) Critically evaluate the local applicability of the ISDR Risk Reduction Framework for flood risk management in South Africa.
- 4) Identify strategies that strengthen the integration of flood risk reduction within DWAF Riverine Management Guidelines.

1.3 Ethical Considerations

Four important ethical considerations guided this research. These included: protecting the confidentiality of participating respondents; ensuring transparency

within the research process; ensuring accountability of the research to both the residents and local authorities; ensuring the inclusiveness of respondents.

1.3.1 Confidentiality

With respect to protecting the confidentiality of respondents, the field research component of the thesis does not contain names of participants in interviews and the workshop. Additionally, without permission, names are not used within the final document or any of the report-back documents.

1.3.2 Transparency and Accountability

All data and information provided by the various institutions involved which has been included within this thesis, has been referenced. The field research section of this thesis was undertaken in collaboration with the Department of Water Affairs and Forestry (DWAF). Thus, there was regular feedback to the liaison within the Department.

A representative from the municipality was specifically invited to attend the workshop so that there would be transparency between the municipality and the residents of Caledon. The Environmental Officer for Theewaterskloof Municipality, as the municipal official deemed responsible for the Baths River, was continuously updated on the progress of the field research, where findings were presented and discussed.

The appropriate district municipal officials within whose jurisdiction the field research took place were notified of the study and when an interest was expressed, they were informed of the findings and an agreement was reached whereby they had access to any material produced through the study. The final conclusions of the field research were reported back to the participants

1.3.3 Measures to ensure inclusiveness of respondents

Participants for the workshop were not chosen specifically but residents were invited through a series of phone-calls and an advertisement placed in a number of editions of the local newspaper. This was done so that there would be minimal bias as to who participated in the workshop.

1.4 Organisation of this Thesis

This thesis is organised into eight chapters.

Chapter One introduces the international and national contexts of flooding risk as well as background information on the study site. It outlines the Aims and Objectives of this thesis and describes the ethical considerations which guided the field research.

Chapter Two describes the context for the study with a particular focus on flood risk policies and the town of Caledon in the Overberg District Municipality of the Western Cape.

Chapter Three is a review of the literature supporting this thesis. Literature pertaining to Disaster Risk and Disaster Risk Reduction, the legal policy frameworks for the reduction of flooding risk within South Africa, prevailing Integrated Catchment Management strategies and the ISDR Disaster Risk Reduction Framework, is examined. The section concludes with the conceptual framework for this study.

Chapter Four describes the methods employed during the generation of this thesis. This includes an explanation of the secondary data collection methods, field research undertaken along the Baths River, the consolidation of the data collected and the data analysis.

Chapter Five presents the study's findings and an analysis of these findings. The findings are outlined according to the ISDR Disaster Risk Reduction Framework

under the titles Political Commitment and Institutional Development; Risk Identification and Assessment; Knowledge Management; Risk Management Applications and Instruments; and Disaster Preparedness, Contingency Planning and Emergency Management. Analysis of the findings is displayed in a comparative table at the end of the chapter.

Chapter Six is dedicated to discussion surrounding the findings. This involves an analysis of the compatibility of the findings and the ISDR Framework; a critical reflection on the local applicability of this framework for risk management in South Africa and recommendations for the Department of Water Affairs and Forestry's Catchment Management Guidelines and future research and policy development.

Chapter Seven outlines the limitations related to this study and the final chapter, Chapter Eight, presents the conclusions of this study.

2 Study Context

2.1 Introduction

This chapter outlines the policy context for the study. It also introduces the geographic context for the research and the history of the area studied.

2.2 Policy context for the study

Both the National Water Act (36 of 1998) and the Disaster Management Act (57 of 2002) require that flood risk is robustly managed. Despite this, the implementation of the management required by the Acts has proven to be extremely difficult.

Effective flood risk management implies that an entire catchment is managed as a single entity. In principle therefore, Integrated Catchment Management is the logical vehicle for integrated flood risk management. While the National Water Act was modelled on the principles of Integrated Catchment Management, the Department of Water Affairs and Forestry (DWAF) is legal custodian only of the actual water resources within a catchment, such as the water itself and 'water infrastructure'; for instance, dams. This is problematic as DWAF has no legal jurisdiction over activities within a catchment that may directly or indirectly affect the water resources and subsequent flood risk. These activities are managed individually or sectorally. For instance, farming practices fall within the jurisdiction of the Department of Agriculture. Thus there is no single institution that manages an entire catchment and its related flood risk. This has created substantial difficulty for DWAF and other catchment stakeholders on how best to manage and reduce flood risk.

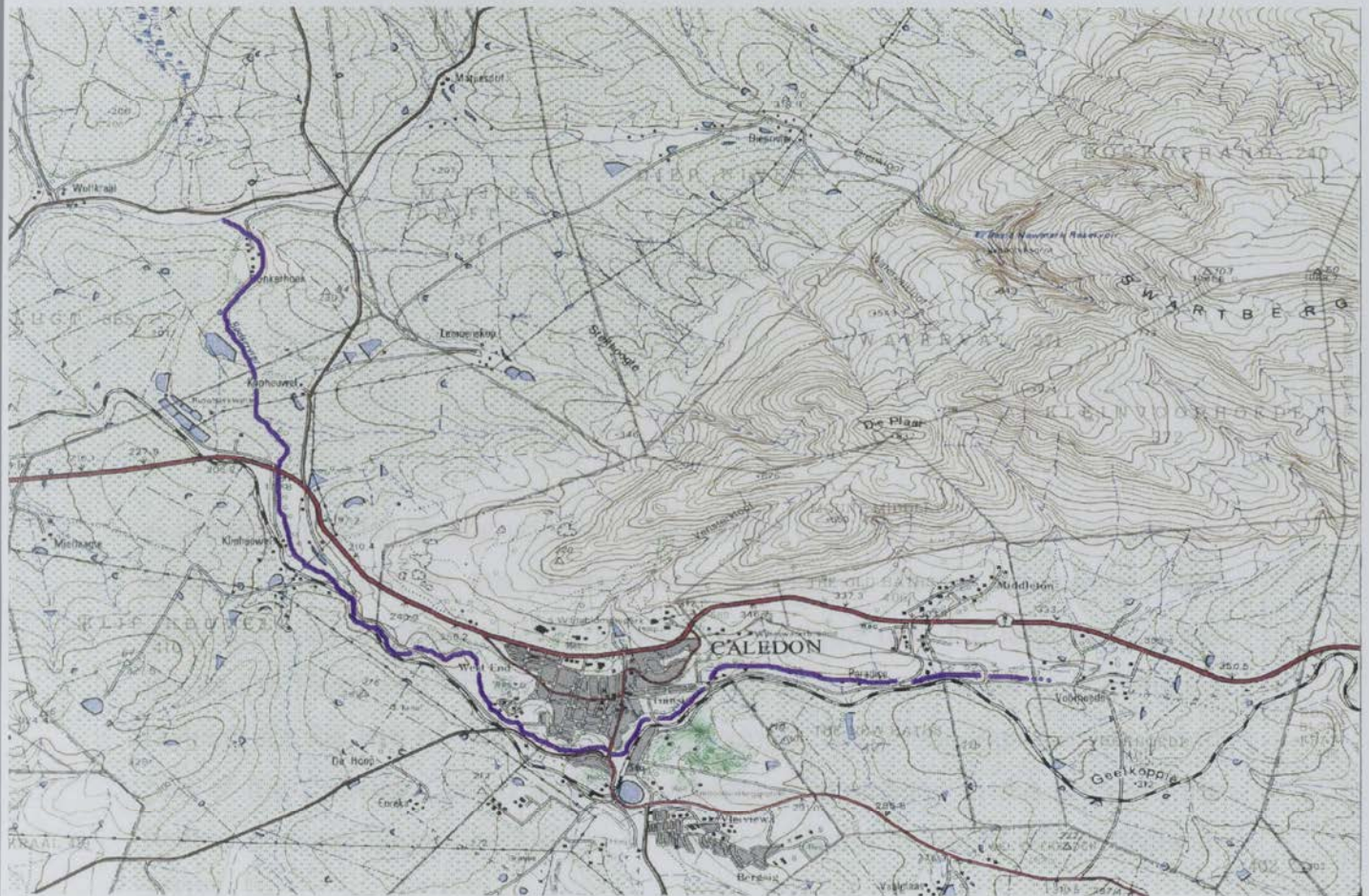
This uncertainty has led to considerable constraints in the implementation of the Disaster Management Act, which specifically requires measures to be undertaken to reduce the vulnerability of disaster prone areas, communities and households (Act 57 of 2002).

The perceived institutional disconnect between the implementation of these two Acts is an important context for this study. While the two Acts share an awareness of the importance of managing flood risk, they highlight the difficulties of implementing policy which traverses both government departments and spatial jurisdiction.

2.3 Introduction to Caledon and the surrounding area

Figure 2.1: Caledon and the Baths River

With the Baths River marked in purple



Caledon was originally named "Kleijne Zwarte Berg" when it was founded in 1811. The village's name was changed to Caledon in 1813 and by 1817 there were 15 houses in existence. Figure 1.6 shows the plan for the original 17 plots in Caledon in 1823. 14 of the plots along Mill Street were bisected by the street

itself, with the house-plot above the street and the garden-plot below leading down to the Baths River. (Burrows, 1994)

Figure 2.2 Original Plan of Caledon, 1823 (Source Burrows, 1994)

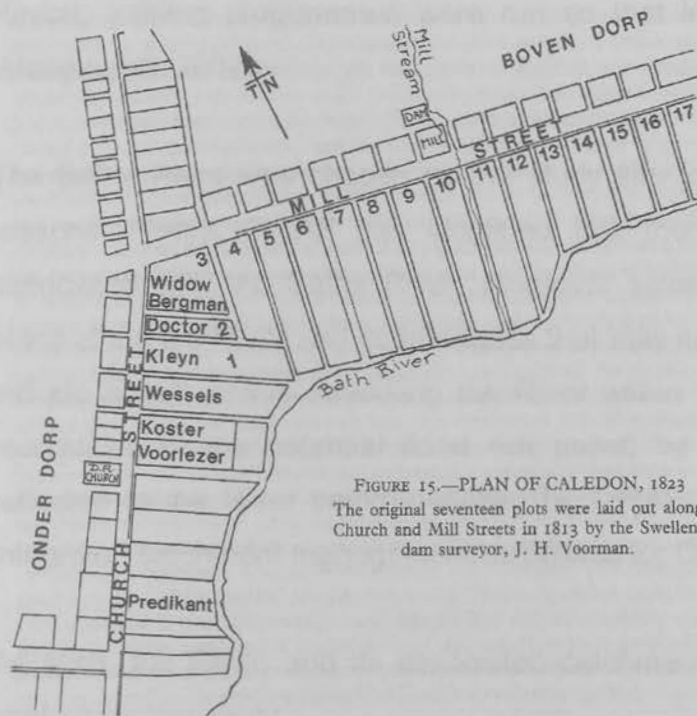


FIGURE 15.—PLAN OF CALEDON, 1823
The original seventeen plots were laid out along Church and Mill Streets in 1813 by the Swellendam surveyor, J. H. Voorman.

A prominent factor for the original development of Caledon was the hot-springs which are situated in the Zwarte Berg Mountains. These hot-springs were originally used by the Khoi-Khoi residing in the area until the land rights were granted to Ferdinand Appel in 1708 who was under instructions to construct a building for the use of visitors to the hot-springs. The hot-springs currently form part of the Caledon Casino and Spa. Additional attractions to the area are the fynbos and the largest population of the Blue Crane in South Africa (Wilson, 2002).

Agriculture is the primary land-use within the Baths River catchment with successful large scale Merino sheep farming, wheat and barley production and dairy farming. Lucrative canola farming is also undertaken and the production of the Caledon Globe Onion has resulted in Caledon being one of South Africa's

largest onion-producing areas. SAB Mulsters, located in the town of Caledon, purchases 75% of the barley produced in the district resulting in Caledon being the principal malt producer in South Africa. The Caledon Casino and Spa Resort is a primary employer of the residents of Caledon. Prior to the opening of the Resort, training programmes were run so that local staff could be employed (Mangiagalli, 2002).

The Baths River was chosen as the study site for this thesis for a number of reasons. Firstly, DWAF has identified that there is significant flooding risk associated with the Baths River. Moreover several development plans are in place along the River and its tributaries that may increase this risk further. These include a golf course straddling the River within the Casino property. DWAF's recognition of the potential flood risk posed by the Baths River was further reflected in the River being identified by DWAF as a pilot site for developing integrated catchment management guidelines for CMAs.

As such, the River, and its associated catchment provide a highly appropriate context for this study.

3 Supportive Literature and the Conceptual Framework

3.1 Introduction

This study is informed by a wide range of subjects including global trends in flood occurrence, South Africa's flood risk profile, disaster risk and the evolution of disaster risk reduction as an organising framework. It is directed by the legal and policy frameworks for reduction of flooding risk in South Africa in addition to national approaches to integrated catchment management.

3.2 Global Trends in Flood Occurrence

Globally, considering all natural disasters, flooding is singly the most destructive that affects people and their livelihoods. Flooding results in more than one third of the estimated total cost resulting from natural disasters and accounts for two thirds of the global population affected by all naturally triggered disaster events (UNDP, 2004). EM-DAT data indicates that on average an estimated 196 million people are exposed to flooding on an annual basis (UNDP, 2004).

Figure 3.1: Distribution of Disaster Events Associated with Hazard Types per region, 1975 – 2001 (Source: ISDR, 2004.p 40)

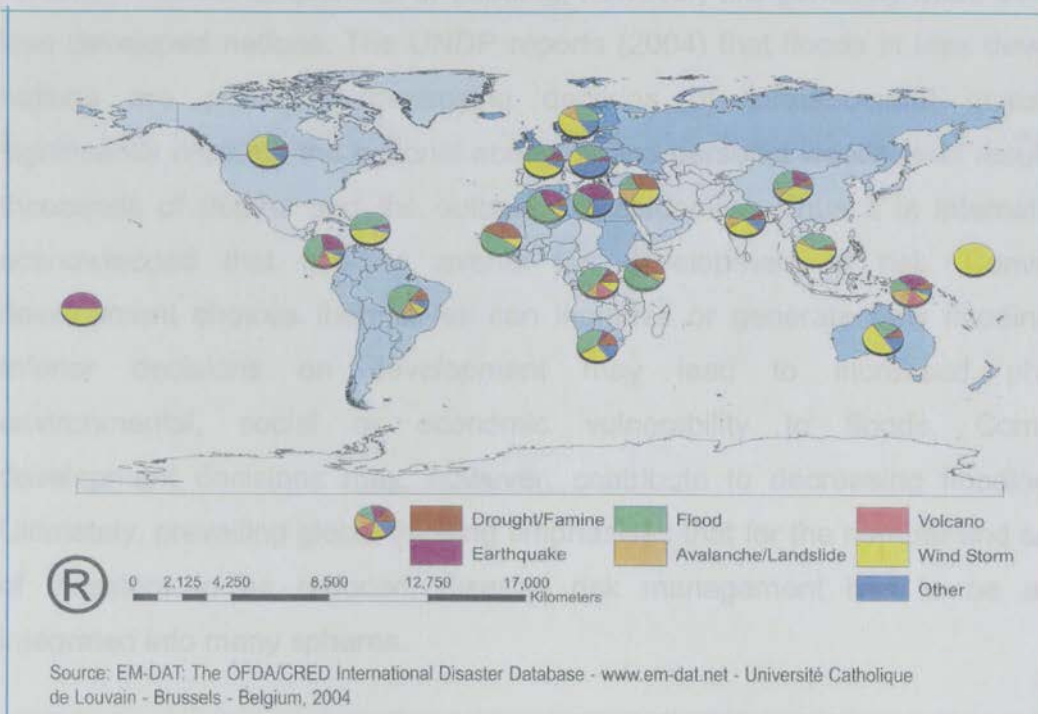
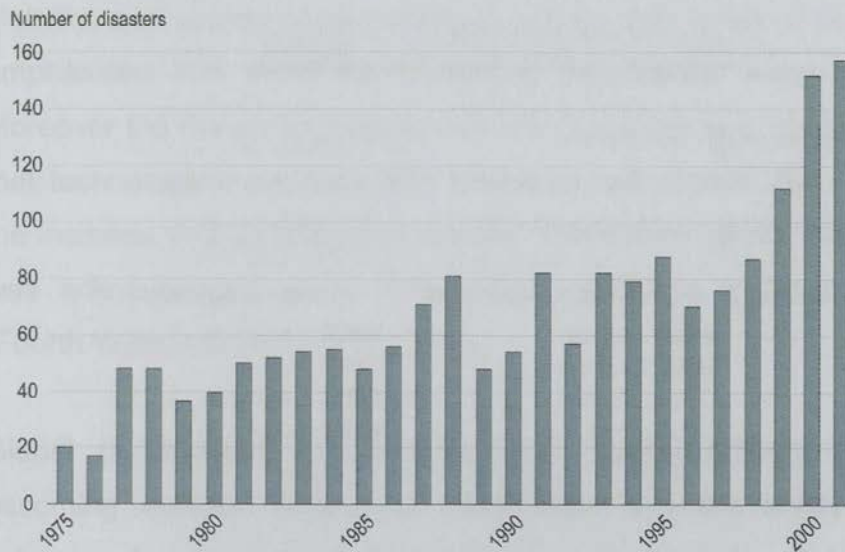


Figure 3.2: Number of Disasters Attributed to Flooding Globally, 1975–2001 (Source: UNDP, 2004 page 5)



Source: EM-DAT, CRED, University of Louvain, Belgium

Extreme flooding events do not only affect less developed nations. Over the last decade devastating flooding has occurred in countries such as Germany, Bangladesh, China, India, Poland, Mozambique and the United States of America. The consequences of flooding, however, are generally more severe in less developed nations. The UNDP reports (2004) that floods in less developed nations are prone to destroying decades of infrastructural investment, significantly crippling the national economy and personal wealth, and resulting in thousands of deaths and the outbreak of epidemics. Thus it is internationally acknowledged that flooding events put development at risk. Conversely, development choices themselves can increase or generate new flooding risk. Inferior decisions on development may lead to increased physical, environmental, social or economic vulnerability to floods. Competent development decisions may, however, contribute to decreasing flooding risk. Ultimately, prevailing global thinking emphasises that for the number and severity of disasters to be reduced, disaster risk management has to be actively integrated into many spheres.

There are several challenges for managing flooding risk. Four of these challenges were highlighted at the Fourth World Water Forum in 2005. Firstly, globally, civil society is less willing to accept high levels of risk. Secondly, it was emphasised that there are increasing populations living in high risk areas. Moreover the Forum expressed concern that there is a misconceived perception that technological and scientific advances will provide flood protection. Finally, the increase in frequency and severity of extreme events due to climate change was acknowledged as a considerable challenge to flood risk management. (Fourth World Water Forum, 2005)

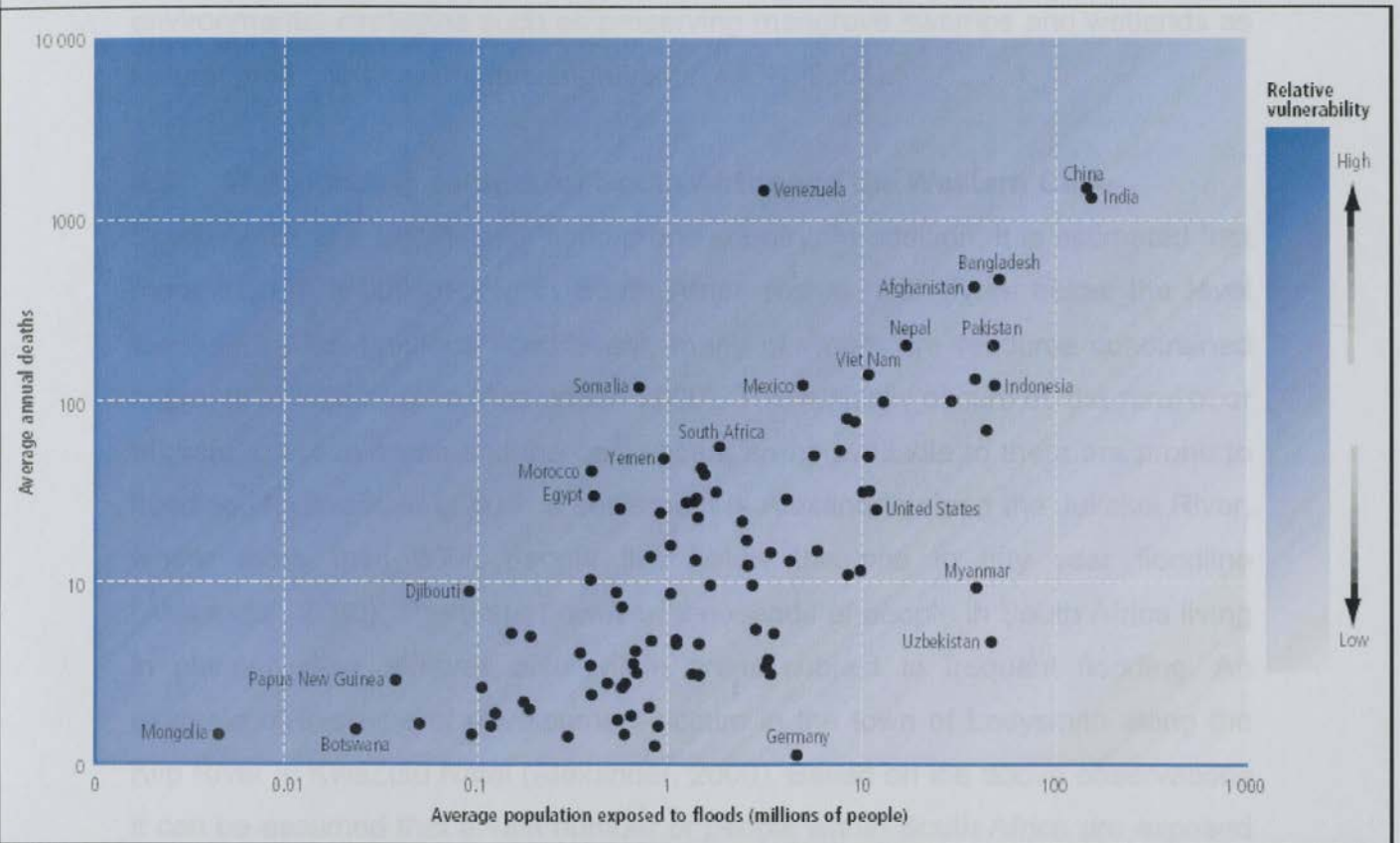
Global temperature is increasing and correspondingly the atmosphere is becoming warmer. A warmer atmosphere has the ability to absorb higher volumes of water vapour thus increasing the humidity. This increase in water moving through the hydrological cycle is resulting in higher volumes of precipitation release per event. Additionally there is an increase in frequency and variability of climate extremes. Although there is much debate surrounding climate change, these climate change issues are accepted globally by the majority of scientists. (ISDR, 2004).

Within the 2001 report of Working Group II of the Intergovernmental Panel on Climate Change, impacts of climate change and their likelihoods were discussed. The report shows that more intense precipitation events are expected in many areas of the globe. Expected impacts of these events are increased flood damage and more pressure on government and private flood insurance systems and disaster relief. Additionally the report indicates that the precipitation and variability of the Asian monsoon are likely to increase resulting in a probable increase in flood magnitude and consequential damages in temperate and tropical Asia (IPCC, 2001).

As a consequence of climate change the frequency and intensity of extreme hydro-meteorological hazards are expected to increase globally. This does not bode well for nations with populations already vulnerable to flooding. Stephenson (2002) notes that compounding the issue of increased precipitation is the matter of decreased infiltration resulting from the construction of impermeable surfaces within catchment areas. The alteration of natural groundcover to impermeable surfaces is increasing catchment vulnerability to rainfall with the potential to trigger flooding, thus increasing the likelihood of a flood event.

This is directly relevant to the UNDP's Disaster Risk Index (DRI) which indicates the national risk of death from disasters triggered by natural events. Part of this index is vulnerability to flooding which is based on the number of deaths associated with flooding events relative to the population exposed to these events. Fig 3.3 is a graphic representation of this vulnerability where the highest vulnerability is experienced within countries closest to the top left corner. This graph allows for the comparison of vulnerability to flooding, based on recorded deaths, between nations. There are a number of limitations with this particular representation such as a single exceptional event occurring within the period considered may result in a country representing a higher vulnerability than is reality. This is the case with Venezuela. Additionally death is not a complete indicator of risk as it is a significant but small portion of the losses associated with flooding (UNDP, 2004)

Figure 3.3: Relative Vulnerability to Flooding (Source UNDP, 2004)



Increasing frequency and intensity of flooding events coupled with relatively high vulnerability to floods increases the necessity and urgency for flood risk management. An international limitation of flood risk management is that within most nations, water management is institutionally compartmentalised (UN, 2004). In addition it is realised that response and recovery are not sufficient to successfully manage disaster risk. Thus for successful flooding risk management the mitigation of flooding effects is required through an integrated approach (UN, 2004). There are several methods for alleviating flood damage. These include: avoiding, adapting to and protection from the hazard. In areas of Malaysia, for instance, adaptation strategies to flood conditions have long been employed. An example of these strategies is the building of houses on stilts. Social measures are also prevalent, such as subscribing to the principle of mutual aid responsibilities where, for example, households within a community support each

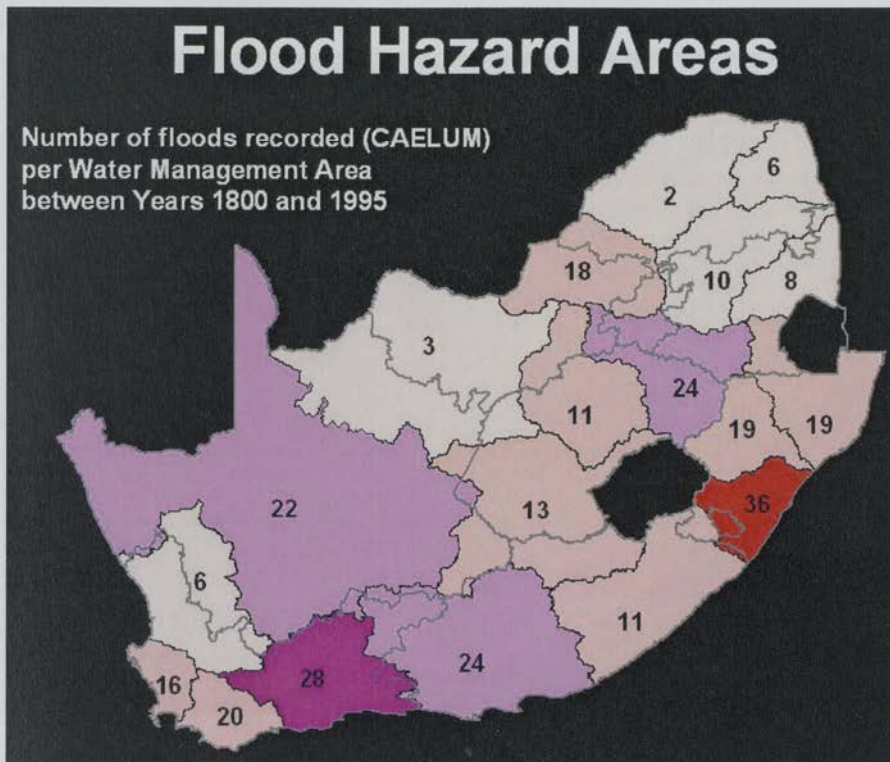
other in time of need. Internationally, while there is a historical preference for structural flood defence mechanisms, the focus is gradually shifting towards environmental strategies such as preserving mangrove swamps and wetlands as natural protection against flooding events (ISDR, 2004).

3.3 The Flooding context for South Africa and the Western Cape

South Africa is a significantly flood-prone country. In addition, it is estimated that more than 100 000 people in South Africa reside near rivers below the level reached by the previous flood event, many of whom are resource constrained migrants to urban areas (Alexander, 2000). This typically occurs as the rural poor migrate to urban areas and the only vacant areas available to them are prone to flooding. An example of such a settlement is Alexandria along the Jukskei River, where more than 6000 people live below the one in fifty year floodline (Alexander, 2000). There are however, thousands of people in South Africa living in planned developments also within areas subject to frequent flooding. An example of this type of development occurs in the town of Ladysmith along the Klip River in KwaZulu Natal (Alexander, 2000). Based on the above observations it can be assumed that a vast number of people within South Africa are exposed to flooding.

Figure 3.4 displays the number of significant flooding events that exposed populations within each water management area of South Africa have been susceptible to between 1800 and 1995. The number of events is displayed within each area and the colour of the area intensifies relatively. From this map it is observed that the two regions within South Africa that have experienced the greatest frequency of significant flooding events are within KwaZulu Natal and the Western Cape Provinces.

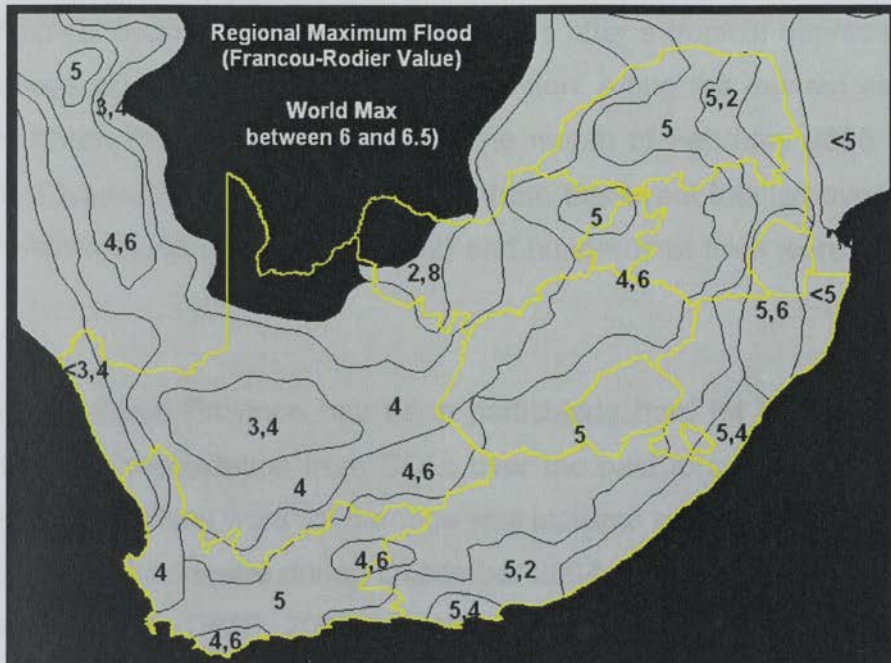
Figure 3.4 Flood Hazard Areas 1800 – 1995 (South Africa)



(Source: DWAF website)

Figure 3.5 is a map of the Regional Maximum Flood (RMF) in South Africa. RMF are the upper limits of flood peaks that can be realistically expected at a given site. They were established through observation of recorded flood peaks since 1856 at over 500 sites. The relative flood peak magnitude is expressed by the Francou-Rodier regional coefficient K , the range of which is 0 to 6.5. (DWAF website). From figure 1.5 it is observed that highest RMF values are experienced within KwaZulu Natal and along the east coast.

Figure 3.5: Regional Maximum Flood in South Africa (Source Zoltan Kovacs on the DWAF website)



Since the 1980s, there have been a number of severe flooding events recorded within South Africa which have been responsible for costly human and economic losses.

During January of 1981 a cut-off-low (COL) triggered substantial flooding in the Laingsburg area. Three years later, in January of 1984, Tropical Cyclone Domoina crossed into Mozambique near Maputo, curved in a typical anticlockwise direction and returned to the ocean in the vicinity of St Lucia (Alexander, 2000). The resulting flooding was devastating. Tropical cyclones very rarely affect the rainfall of South Africa but when this occurs, the effects are extreme (Alexander, 2000). During September 1987 the Natal Floods occurred. This flooding event was considered South Africa's worst natural disaster until 2000. Over R 1 billion worth of damage occurred and over 300 people were killed. This flooding event was also induced by rainfall from a COL which continued across the country to pass through the Free State. At the time, flooding was not experienced in the Free State but five months later, in February 1988,

rainfall did trigger a flooding event (Alexander, 2000). Twelve years later, in February 2000, a tropical cyclone made landfall in Mozambique/South Africa again. Tropical cyclone Eline followed ten days after a tropical depression which had released significant amounts of precipitation. Along the eastern escarpment of the Northern Province the rainfall for the month of February 2000 exceeded 1000mm. (Dyson, 2000). Losses resulting from this event totalled over R3 billion in South Africa alone (du Plessis, 2002) and hundreds of lives were lost (Dyson, 2000).

The Western Cape Province has been particularly hard hit by flooding events associated with precipitation from COLs over the past four years. During March 2003 over R210 million worth of damage was incurred relating to a flooding event (DiMP, 2003) with a repeat during December 2004 resulting in an estimated R47 million in damages (DiMP, 2005). Flooding associated with heavy rainfalls was experienced in the Western Cape yet again in April 2005 and August 2006 with estimated losses over these years exceeding R 600 million (Department of Local Government and Housing, 2006)

Specifically considering economic losses associated with South Africa's flood profile, the most costly impacts are often suffered by government and private sector infrastructure. Dams are the riverine structures within South Africa with the potential to cause the highest losses if they were to fail. Nevertheless a greater number of lives have been lost due to functional and structural failure of bridges. This can be attributed to the fact that the safety requirements for the construction of dams are more rigorous than those for bridges (Alexander, 2000). The location of bridges is predominantly determined by the area that is optimal for the road route and not particularly the optimum foundation conditions for the bridge. When a bridge fails the direct cost of repair is large but the indirect costs associated with the failure are often extremely higher. An example of this was the bridge over the Buffels River which failed during the 1981 Laingsburg floods. The location, topography and design of the bridge ultimately substantially increased

the damage and loss of life sustained in its vicinity. 104 lives were lost in the town downstream while sixteen people were trapped and died on the bridge itself (Alexander, 2000).

3.4 Disaster Risk as a Critical Concept

This study is conducted through a Disaster Risk Science lens. Holloway (2005) defines Disaster Risk Science as “the systematic study of disaster risks, their determinants and consequences in order to inform effective disaster risk management and promote sustainable development.” When referred to within this document, risk is always considered to be disaster risk.

In this context, disaster risk and its underpinning determinants are critical concepts that underline the study. Disaster risk is broadly referred to as “the probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human induced hazards and vulnerable conditions.” (ISDR, 2004 p 16). Within this context risk can be quantified as a function of Hazard and Vulnerability which may be expressed as: (ISDR, 2004 p 16)

$$\text{Risk} = \text{Hazard} \times \text{Vulnerability}$$

Risk, in this conceptualisation, always reflects the interaction of external “hazard” conditions and “internal” conditions of vulnerability.

Simply defined, a hazard is a physical event which has the potential to cause loss and/or damage. According to Wisner *et al* (2004) “hazard refers to the natural events that may affect different places singly or in combination at different times.” Hazards can be described in terms of their location, intensity, frequency and probability of occurrence (Wisner *et al*, 2004). Natural hazards can be divided into three wide categories, geological; biological; and hydrological, the

last of which is the most common with floods alone accounting for two thirds of people affected by natural hazards (ISDR, 2004). Fig 3.6 illustrates the categorisation of hazards. This classification of hazards is a simplification of reality where one hazard may trigger a secondary hazard or evolve into a hazard classified as a different type. An example of this would be a landslide becoming a mudflow as a landslide is classified as a geological hazard while a mudflow is generally classified as hydro-meteorological (ISDR, 2004).

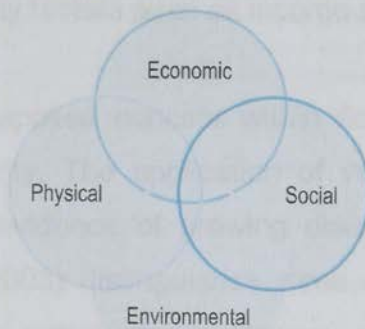
Figure 3.6: Hazard Types (Source ISDR, 2004)

HAZARD	
A potentially damaging physical event, phenomenon or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.	
NATURAL HAZARDS	
Natural processes or phenomena occurring in the biosphere that may constitute a damaging event. Natural hazards can be classified according to their geological, hydrometeorological or biological origins.	
ORIGIN	PHENOMENA / EXAMPLES
Hydrometeorological hazards Natural processes or phenomena of atmospheric, hydrological or oceanographic nature.	<ul style="list-style-type: none"> • Floods, debris and mudflows • Tropical cyclones, storm surges, wind, rain and other severe storms, blizzards, lightning • Drought, desertification, wildland fires, temperature extremes, sand or dust storms • Permafrost, snow avalanches
Geological hazards Natural earth processes or phenomena that include processes of endogenous origin or tectonic or exogenous origin, such as mass movements.	<ul style="list-style-type: none"> • Earthquakes, tsunamis • Volcanic activity and emissions • Mass movements, landslides, rockslides, liquefaction, sub-marine slides • Surface collapse, geological fault activity
Biological hazards Processes of organic origin or those conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances.	<ul style="list-style-type: none"> • Outbreaks of epidemic diseases, plant or animal contagion and extensive infestations
TECHNOLOGICAL HAZARDS	
Danger associated with technological or industrial accidents, infrastructure failures or certain human activities which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation, sometimes referred to as anthropogenic hazards. Examples include industrial pollution, nuclear release and radioactivity, toxic waste, dam failure, transport, industrial or technological accidents (explosions, fires, spills).	
ENVIRONMENTAL DEGRADATION	
Processes induced by human behaviour and activities (sometimes combined with natural hazards) that damage the natural resource base or adversely alter natural processes or ecosystems. Potential effects are varied and may contribute to an increase in vulnerability and the frequency and intensity of natural hazards. Examples include land degradation, deforestation, desertification, wildland fires, loss of biodiversity, land, water and air pollution, climate change, sea level rise and ozone depletion.	

While the occurrence of most natural hazard events cannot be prevented, the same is not true for disaster events (ISDR, 2004). While hazard processes shape the “external” aspect of disaster risks, vulnerability or vulnerable conditions reflect the “internal” dimensions of risk. A disaster event is likely to ensue where a hazard event takes place and there is high vulnerability to that hazard.

As a critical concept of Disaster Risk Science, the term vulnerability has been defined in a number of ways. Wisner *et al* (2004, p11) defines vulnerability as “the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard.” Corresponding with this the ISDR describes vulnerability as “the conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards” (ISDR, 2004. p41). Fig 3.7 is a representation of the ISDR’s conceptualisation of vulnerability.

Figure 3.7: Integration of Vulnerability Factors (Source ISDR, 2004)



The physical factors of vulnerability are those that increase the exposure. Examples of these are population density levels and design materials used for critical infrastructure and housing. High population levels may result in people residing in areas prone to hazards while poor or inappropriate design materials may give rise to structural damage or failure when a hazard event occurs. (ISDR, 2004)

Social factors are linked to the 'level of well-being of individuals, communities and societies' (ISDR, 2004. p 42). Literacy levels and education, access to basic human rights, peace and security, social equity, systems of good governance, and positive traditional values, customs and ideological beliefs are examples provided by the ISDR of elements related to social vulnerability (ISDR, 2004).

Vulnerability levels are highly dependent on individual, community and national economic conditions. This is the economic factor of vulnerability where the poor are generally more vulnerable to hazards due to the higher proportional losses they experience and their more restricted recovering capacity. Additional economic factors are economic diversity and access to socio-economic infrastructure (ISDR, 2004).

Key features of environmental vulnerability are the extent to which natural resources have been depleted and the state to which they have been degraded (ISDR, 2004). As can be observed in figure 3.7 the four vulnerability factors are well integrated within each other. An example of this is where decreased access to natural resources, due to depletion or degradation, will result in an increase in socio-economic vulnerability factors such as income and health.

Vulnerability is a widely applied concept within fields ranging from structural engineering to food security. The application of vulnerability within the urban context is increasing as evidence of growing disaster risk within this context comes to light. Pelling (2003) distinguishes three components of vulnerability within the urban context: exposure; resistance; and resilience. Exposure is defined predominantly as the product of physical location and the character of the surrounding built and natural environment while resistance refers to the ability of a group or individual to withstand the impact of a hazard based on their economic, psychological and physical health. Finally, resilience refers to the ability of those exposed to hazards to cope or adapt to the associated hazard stress (Pelling, 2003).

Thus it is understood that the comprehension of disaster risk relies on an understanding of the conditions of vulnerability to a hazard, the hazard itself and the interaction between these two components.

3.5 The Emergence of Disaster Risk as a Development Concern

Disasters were traditionally viewed as temporary setbacks to the direct process of development. It was understood that this process was continuously leading to enhanced standards of living and that when it was 'interrupted' by disasters humanitarian aid would restore elements to their previous conditions and the linear process of development would continue (Twigg, 2004). Some of the first attempts at understanding disasters were however focused on the physical rather than social sciences thus analysis and policy recommendations were skewed in this regard (Pelling, 2003). Hewitt was one scholar who altered this thinking when he proposed that natural disasters should be viewed as an ongoing interaction between society and nature and that this relationship is a fundamental aspect of development (Pelling, 2003).

The alteration in style of thought associated with natural disasters led not only to a change in the character of the discipline but additionally to the frameworks that have evolved for the purpose of implementing the management of natural disasters.

The concept of reducing the impacts of hazards stretches far back in human history. There are records of many risk reduction methods that included anticipating the occurrence of hazard events and investing in measures to protect assets from them (ISDR, 2004).

The UNDP notes that from the early 1970s the disaster risk field was led by technical experts such as engineers and architects who predominantly prescribed structural interventions to strengthen infrastructure so that it became more resistant to hazards (UNDP, 2004). From the 1980s though, the disaster

risk field was enhanced by the involvement of social scientists who highlighted the importance of human capacity and vulnerability as factors of disaster risk. Additionally social science involvement brought to light the relationship between development and disaster risk. Relatively recent evidence is now promoting investigation into the interaction between the natural environment and disaster risk. Abramovitz (2001) describes this relationship explaining how human activities decrease the resilience of ecosystems to withstand and mitigate the affects of natural hazards thus increasing the opportunity for and losses from disasters. Abramovitz depicts natural features such as wetlands and mangroves as “complex ecological safety nets” (2001. p123) where wetlands act as water purifiers and areas that retain flood peaks and mangroves as buffers for storm surges. Not only does human activity often diminish the capacity of ecosystems to reduce the affects of hazards but frequently interventions, attempting to prevent or mitigate natural disasters, which interfere with natural process result in exacerbating them instead. An example of this would be the channelling of sections of a river which ultimately leads to an increase in the rate of river flow through the channelled area thus potentially exacerbating flood risk downstream (Abramovitz, 2001. p128).

From the evolution of understanding of the concept of disaster risk it can be understood that this multi-faceted discipline requires a multi-dimensional approach.

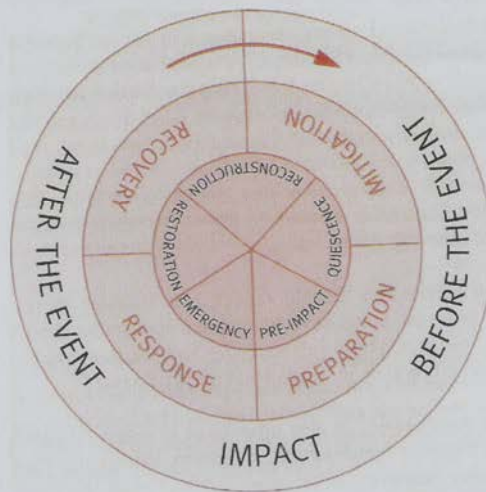
3.6 The Evolution of Disaster Risk Reduction as an Organising Framework

3.6.1 Disaster Management

Prior to the last five years, the emphasis of disaster management was on the disaster event itself which all activities were organised around (Holloway, 2003). This may have been relevant to disaster management and civil protection professionals, who anticipate and respond to disaster events, but effectively

excluded development practitioners and development priorities (Holloway, 2003). The focus was essentially event-driven stressing preparedness and response to emergencies as apposed to a systematic approach that inserted disaster reduction as a development priority.

Figure 3.8: Disaster Management Cycle (Source Twigg, 2004.p 14)



The Disaster Management Cycle in Fig 3.8 illustrates how this concept of disaster management focused on the event, as the entire diagram revolves around a disaster event. Although it may be explained otherwise, the diagram visually presents the processes involved in disaster management as progressive and exclusive of one another. This progressive, exclusive process however does not lead to effective reduction of losses associated with naturally triggered disaster events.

3.6.2 Disaster Risk Reduction

Modern concepts of risk reduction evolved from these earlier efforts in disaster management, that were themselves products of civil defence responses where disasters were perceived to be events that simply required reaction and as such any pre-disaster preparation was focused on aid, response and the restoration of urgent services (ISDR, 2004). Contemporary views however, recognise the need

to reduce the social, economic and environmental costs associated with natural hazards. Risk reduction measures as defined by the ISDR (2004) are “the development and application of policies, procedures and capacities of the society and communities to lessen the negative impacts of a possible impact of natural hazards and related environmental and technological disasters. This includes structural and non structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse impact of hazards, as well as the development of coping capabilities”. Fig 3.9 compares these approaches where one is more orientated towards disaster or emergency management and the other towards risk reduction.

Figure 3.9: Different Management Approaches (Source Jeggle, 2001 cited in ISDR 2004. p 13)

Emergency assistance, crisis management		Disaster risk reduction strategies
1. Primary focus on hazards and disaster events	Emphasis	1. Primary focus on vulnerability and risk issues
2. Single, event-based scenarios		2. Dynamic, multiple risk issues and development scenarios
3. Basic responsibility to respond to an event.		3. Fundamental need to assess, monitor and update exposure to changing conditions
4. Often fixed, location-specific conditions	Operations	4. Extended, changing, shared or regional, local variations
5. Responsibility in single authority or agency		5. Involves multiple authorities, interests, actors
6. Command and control, directed operations		6. Situation-specific functions, free association
7. Established hierarchical relationships		7. Shifting, fluid and tangential relationships
8. Often focused on hardware and equipment		8. Dependent on related practices, abilities, and knowledge base
9. Dependent on specialized expertise		9. Specialized expertise, squared with public views, priorities
10. Urgent, immediate and short time frames in outlook, planning, attention, returns	Time horizons	10. Comparative, moderate and long time frames in outlook, planning, values, returns
11. Rapidly changing, dynamic information usage, often conflicting or sensitive	Information use and management	11. Accumulated, historical, layered, updated, or comparative use of information
12. Primary, authorized or singular information sources, need for definitive facts		12. Open or public information, multiple, diverse or changing sources, differing perspectives, points of view.
13. Directed, 'need to know' basis of information dissemination, availability		13. Multiple use, shared exchange, inter-sectoral use of information
14. Operational, or public information based on use of communications		14. Matrix, nodal communication
15. In-out or vertical flows of information		15. Dispersed, lateral flows of information
16. Relates to matters of public security, safety	Social, political rationale	16. Matters of public interest, investment and safety

Source: T. Jeggle, 2001.

To obtain the goal of reducing the risks associated with natural hazards of social, environmental and economic assets, measures must be taken and policies introduced to increase the resilience of societies to natural hazards and ensure vulnerability to the hazards is not increased through development (ISDR, 2004). It is now recognised that development plays a defining role in determining levels of risk. Poor or inappropriate development has a high probability of increasing vulnerability to natural hazards while conversely well informed development has the potential to reduce risk. As such, risk reduction should be a central component of all development planning and programmes (Twigg, 2004). An

additional understanding for the successful reduction of disaster risk is that disaster risk reduction is not a separate and unconnected entity. To be effective, disaster risk reduction needs to be embedded within all relevant sectors of society before a disaster event (ISDR, 2004).

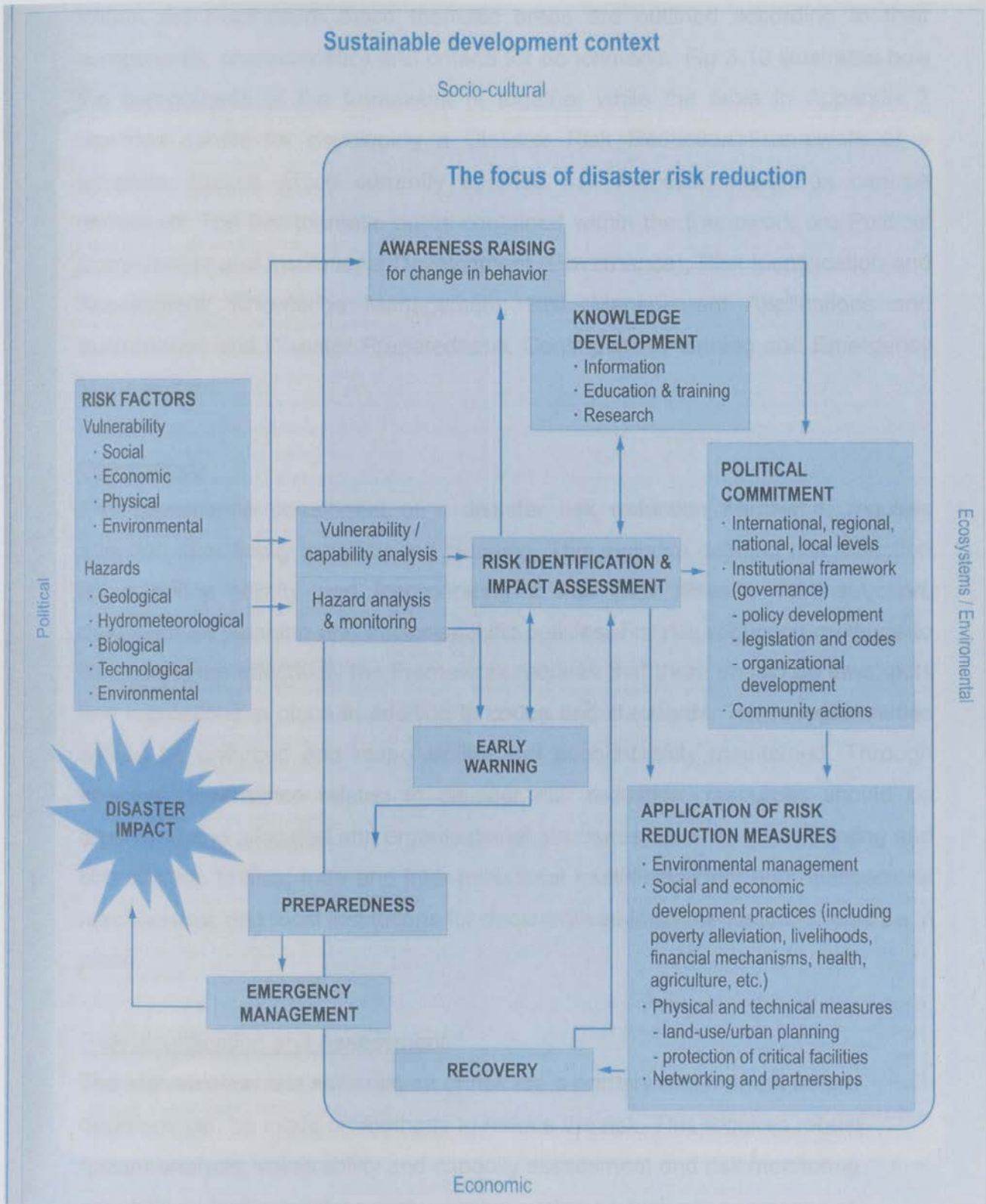
Disaster Risk Reduction has been widely adopted as a global approach. This was reflected by the World Conference on Disaster Reduction (WCDR), convened in January 2005 which resulted in the Hyogo Framework for Action.

3.6.3 Components of the Disaster Risk Reduction Framework (ISDR, 2004)

Throughout the ISDR's global review of disaster risk reduction initiatives it became evident that there was need for a globally formalised framework for disaster risk reduction. It was believed that such a framework would better synchronise and standardise various elements and achievements in the field of disaster risk management. For the development of this framework, the ISDR in conjunction with the UNDP collaborated with a large number of stakeholders internationally. The resulting framework is aimed at guiding action and monitoring progress of disaster risk reduction initiatives. The disaster risk reduction framework is intended to be applied at a national level through which the setting of global goals and targets, identification of gaps and defining of national priorities and the action plans to meet these priorities, can be achieved.

The framework is outlined in Fig 3.10 below and a table of the complete framework, its components, characteristics and tentative criteria for benchmarks are included in Appendix 2.

Figure 3.10: Disaster Risk Reduction Framework (Source: ISDR, 2004. p15)



There are five key thematic areas in the Disaster Risk Reduction Framework. Within the Framework these thematic areas are outlined according to their components, characteristics and criteria for benchmarks. Fig 3.10 illustrates how the components of the framework fit together while the table in Appendix 2 provides details for developing a Disaster Risk Reduction Framework or a template against which currently adopted risk reduction measures can be compared. The five thematic areas contained within the framework are Political Commitment and Institutional Development (Governance); Risk Identification and Assessment; Knowledge Management; Risk Management Applications and Instruments; and Disaster Preparedness, Contingency Planning and Emergency Management.

Governance

The governance component of a disaster risk reduction framework requires attention specifically to policy and planning. This includes defining risk reduction as a policy priority and incorporating it into post disaster reconstruction, development planning and sector-specific policies. For risk reduction methods to be undertaken effectively the Framework requires that there should be laws, acts and regulations in place in addition to codes and standards. These legal entities should be enforced and responsibility and accountability maintained. Through effective governance related to disaster risk reduction, resources should be organised and allocated and organisational structures, such as implementing and coordinating bodies; intra and inter-ministerial multidisciplinary and multisectoral mechanisms; and local institutions for decentralised implementation, should be in place.

Risk Identification and Assessment

The identification and assessment of risk are a primary requirement before decisions can be made on methods to reduce the risk. This requires robust hazard analysis, vulnerability and capacity assessment and risk monitoring capabilities. It also involves early warning systems which are composed of

monitoring and forecasting, risk scenarios, warning and dissemination and response to warning.

Knowledge Management

This thematic area of the Framework specifically focuses on information management and communication, with the emphasis that these should take place through information and dissemination programmes and channels; public and private information systems; and networks for disaster risk management. The inclusion of disaster reduction at all levels of education; programmes to train trainers; professional training; dissemination and use of traditional knowledge; and community training programmes, into disaster risk reduction will ensure that the criteria for education and training of the Disaster Risk Reduction Framework are met. This component stresses the importance of public information and awareness attained through the formation of public awareness policy, programmes and materials, along with media involvement. Due to the multidimensional, continuously altering nature of disaster risk, this component accentuates the importance of constant research which should be accomplished through research programmes and institutions for risk reduction; evaluation of and feedback on risk; and cooperation in research, science and technology development at the national, regional and international levels.

Risk Management Applications and Instruments

This focuses on three main clusters of interventions to reduce disaster risks. Specifically, risk reduction is achieved through the management of environmental and natural resources and social and economic development practices. In addition, physical and technical measures such as land use applications, urban and regional development schemes; structural interventions; and soil conservation and hazard resistant agricultural practices are to be applied.

Disaster Preparedness, Contingency Planning and Emergency Management

Finally, where disaster risk cannot be drastically reduced to the point where it is insignificant, disaster preparedness, contingency planning and emergency management are to be undertaken. Preparedness and contingency planning are to be carried out through the development of contingency plans, national and local preparedness plans, effective communication and coordination systems and the rehearsal of the plans. Emergency management is the function of civil protection and defence organisations and volunteer networks.

Although the Disaster Risk Reduction Framework developed by the ISDR is intended for national use, it was applied by this study at the local level to assess risk reduction along the Baths River, South Africa.

3.7 Legal and Policy Frameworks Relevant to the Reduction of Riverine Flooding Risk

South Africa's current national disaster management legislation is predominantly consistent with the prevailing global disaster risk reduction framework. Within this section the laws and policies that are relevant to flood risk management are focused on through a review of the Disaster Management Act and Framework, along with the National Water and Municipal Systems Acts. In conclusion this section describes areas where the above legislation relates to each other.

3.7.1 Disaster Related Law and Policy

The Disaster Management Act, promulgated in January 2003, and the National Disaster Management Framework, gazetted in April 2005 give explicit priority to risk and vulnerability reduction. A critical dimension of the Disaster Management Act is its emphasis on co-operative governance as a priority in meeting Disaster Management objectives. Additionally, in view of reducing the likelihood and negative consequences of disasters, the Framework stresses the importance of the inclusion of stakeholders "in strengthening the capabilities of national, provincial and municipal organs of state" (Government of South Africa, 2005).

Each national government department is required through the National Disaster Management Framework to develop a departmental disaster management plan relative to their function. Additionally this requirement is present in the pending Western Cape Provincial Disaster Management Framework. This pending Framework will also require that within the Western Cape every organ of state has a representative on the Western Cape Disaster Management Advisory Forum (WCDMAF).

The Disaster Management Act and its implementing Framework are “coordinating” and “enabling” legal instruments which are intended to facilitate transversal engagement in disaster risk reduction by many stakeholders.

3.7.2 The South African National Water Act (Act 36 of 1998)

In contrast to the Disaster Management Act and its Framework, the National Water Act (Act 36 of 1998) is focused predominantly on the functions of its lead governmental department, the Department of Water Affairs and Forestry (DWAF), and water users in water resource management, which is predominantly limited to the controlling of water extraction and pollution. The purpose of the National Water Act is to “ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled” (Section 1.2 Act 36 of 1998) and as the Act states, in section three, the National Government acting through the minister is the public trustee of the nation's water resources, thus the minister is ultimately responsible for its development. For the practical management of river systems however, chapter seven of this Act discusses the formation of Catchment Management Agencies (CMA) with the purpose of designating water resource management to the catchment level in addition to allowing local community participation within management processes. Under section 80 of the National Water Act, functions of the CMAs, relevant to this study, are:

“(a) to investigate and advise interested persons on the protection, use, development, conservation, management and control of the water resources in its water management area;

(b) to develop a catchment management strategy;

(c) to co-ordinate the related activities of water users and of the water management institutions within its water management area;”

Specifically within the context of managing the actual water element of water resources the National Water Act also undertakes a transversal coordinating role.

3.7.3 Municipal Systems Act (Act 32 of 2000)

Within its scope the Municipal Systems Act (Act 32 of 2000) similarly requires all municipalities to undergo the Integrated Development Planning process through which they are required to develop a five year strategic development plan which should be reviewed on an annual basis in consultation with the community and stakeholders. This process was developed to ensure the best allocation of resources. The result is an Integrated Development Plan (IDP) obtained through the following five steps (ISDR, 2004 p131-133):

- i The Analysis phase, wherein the existing levels of development are assessed and communities without access to basic services are identified.
- ii The Strategic Development phase, during which the municipality has the opportunity to establish the components of their development approach such as the council’s vision, development priorities and objectives, and their strategies for development.
- iii During the Project phase the planning and scheduling of project activities that are to be undertaken to implement the strategies developed in the previous phase, is completed.
- iv The Integration phase is the stage wherein it is ensured that all projects are synthesised and the wisest use of the limited resources available to the municipality is taken into account. Plans and tools that are to be used to assist this process are a spatial development framework, disaster

management plan, integrated financial plan, key performance indicators and targets and linkages with other integrated programmes.

- v The Integrated Development Plan is adopted and submitted to various bodies designated in the Municipal Systems Act (32 of 2000).

An IDP is developed to guide and inform all planning, budgeting, management and decision making within a municipality. Through the IDP resources are known and allocated to priority areas so that institutional capacity to implement basic responsibilities is not compromised (ISDR, 2004)

3.7.4 The Relationship between the Three Acts

There are several sectors where the National Water Act, the Disaster Management Act and Framework, and IDPs relate to one another. Of these four legal policy instruments the Disaster Management Act and Framework are the most recent and were thus subordinate to both the National Water and Municipal Systems Acts in their development. This is demonstrated where the Disaster Management Act specifically requires that disaster risk management is integrated throughout the IDP formulating process. One channel for ensuring this is that each representative of an organ of state on the WCDMAF is the designated focal point for their disaster management and has the responsibility of ensuring that their disaster management plan is integrated with the provincial IDP process.

The requirements of the Disaster Management Act on the IDP process appear to be relatively compatible with current IDP practices. The same, however, is not true for perceptions of the National Water Act and CMAs specifically. Legally there appears to be no conflict between the requirements of the two Acts, the problem of implementing the requirements of the Disaster Management Act by the bodies governed by the National Water Act seems to be one of perception. There are a number of areas where the National Disaster Management and Water Acts are required to interact.

The Catchment Management Agencies report directly to the Department of Water Affairs and Forestry Minister and are accordingly national organs of state. A national organ of state is required by the National Disaster Management Framework, under section 1.2.3, to “determine its role and responsibilities in relation to disaster risk management”. A person from the organ of state must be designated to lead their disaster risk management actions and take responsibility for “facilitating and co-ordinating the relevant department’s disaster risk management arrangements and planning for risk reduction, response and recovery” (National Disaster Management Framework, Section 1.2.3). With respect to the formation of CMAs, the National Water Act states that within their proposal they have to outline their Catchment Management Strategy. The Breede River CMA proposal does not indicate that this planned organ of state considers itself responsible for disaster risk management and thus is an example of where this requirement of the Disaster Management Act is not being met by a CMA.

Part of the duties designated by the National Water Act to a CMA is the development of water resources within the CMAs management area. Similarly, under section 1.2.2.1 of the National Disaster Management Framework the NDMC is required to monitor the integration of disaster risk reduction initiatives with development plans. Presumably, as is obliged by the National Water Act, the CMAs will have development plans for their management areas, which, to ensure compliance with the Disaster Management Act, should include risk management plans, the integration of which should be monitored by the NDMC.

Despite this, CMAs currently understand their primary purpose to be the management of water resources within their catchment. At present, managing water resources is predominantly interpreted as the management of water allocation and pollution control. Issues of extra effort or lack of capacity may be an explanation of the concern CMAs have with including riverine risk management within their mandate. If the CMAs collaborate on the IDP

procedures within their catchment with respect to some of the processes required for riverine risk management, work would be reduced, technical assistance supplied, duplication of effort avoided and possible avenues of attaining funding revealed.

Based on the requirements of these three Acts presumably, ultimately disaster management plans would be incorporated into the development of IDPs and Catchment Management Plans, District Disaster Management would be represented in relevant CMAs, and CMAs would participate in provincial or district Disaster Management Advisory Forums.

3.8 Prevailing Philosophies and Strategies to Integrated Catchment Management (ICM)

The South African National Water Act (Act 36 of 1998) was established on the ICM principles dominant during its time of development.

Integrated Catchment Management (ICM) is established in the concept that social, environmental and economic activities, cycles, processes and resources within a catchment are related to one another. A catchment is a single system and should thus be managed as one (DWAF and WRC, 1996). The aim of ICM is to obtain the 'optimum possible mix of sustainable benefits for future generations and the communities in the area of concern whilst protecting the natural resources which are used by these communities and minimising possible adverse social, economic and environmental consequences' (DWAF and WRC, 1996. p20).

There are three aspects to ICM, the Philosophy, Process and Product (DWAF & WRC, 1996. p20). The Philosophy emphasises sound natural resource management based on the consideration of natural systems as a whole entity and the recognition that a catchment system responds to disturbances or utilisation as a single system.

A Process is provided for 'engaging the community and government in a "people-orientated" partnership'. This is designed to accomplish better natural resource management at the local catchment level, and take account of the needs and aspirations of the whole community.

The Product is an ICM strategy that can be practically implemented. This is a regional scale strategy and management plan that incorporates environmental, social and economic considerations. It is founded on a set of development objectives that have been mutually identified by the public and government. These development objectives are to be established on identifying and recognising the environmental or resource capacities that are required to be protected. In addition a guideline for implementing the strategy is provided.

The South African National Water Act (Act 36 of 1998) is established on ICM principles. Table 2.1 indicates how the National Water Act corresponds to the international concept of ICM.

Table 3.1: An overview of how the South African National Water Act (Act 36 of 1998) corresponds to ICM.

ICM (DWAF & WRC, 1996)	National Water Act (Act 36 of 1998)
Philosophy of managing a catchment as a single entity	The development of CMAs is required by the Act. CMAs are required to manage the entire catchment as a single entity
The Process of involving all stakeholders	Under Section 80, one of the initial functions of CMAs on conception is '(e) to promote community participation in the protection, use, development, conservation, management and control of the water resources in its water management area.'
The Product of a strategy	Under section 80, on establishment an initial function of CMAs is '(b) to develop a catchment management strategy'
Central government must play a leadership role with one of its functions being the provision of financial support	<p>CMAs report directly to the Minister. The Minister retains ultimate control and has the power to:</p> <ul style="list-style-type: none"> • delegate responsibility and power • overrule decisions made by the CMAs • permission for various CMA functions must be granted by the Minister <p>Funding for CMAs may be:</p> <ul style="list-style-type: none"> • money appropriated by parliament • water use charges • money obtained lawfully by the CMA for the purpose of executing powers

Ultimately, as the focus of ICM is however primarily on water abstraction and pollution control, CMAs have adopted this limited focus. Yet this limited view to ICM does not entirely meet the ICM aim outlined previously. The objective of sustainable water and environmental resources cannot be met without considering the management of relevant risks associated with the catchment, including flooding and fires. Additionally, some of the severest 'adverse social, economic and environmental consequences' on water resources are disaster events. It is therefore not possible to 'minimise possible adverse social, economic and environmental consequences' on water resources without minimising disaster risk.

In addition, risks associated with riverine systems cannot be effectively managed in sections along a river. Rivers do not adhere to political boundaries and as such current entities undertaking riverine risk management do not have the capacity to manage this risk for an entire catchment as a single system. This rationale shows the mutual benefits for integrating disaster risk management into ICM.

3.9 Conceptual Framework for the Study

It has been widely recognised within the Disaster Management community and Department of Water Affairs and Forestry of South Africa that there are currently considerable institutional and other challenges to integrating flood risk management transversally across relevant institutions. This is pertinent specifically as current CMAs do not consider risk reduction within their mandate, as is displayed by the Breede River CMA proposal. In addition, river catchments do not adhere to political boundaries with the consequence that a CMA is the only entity operating specifically throughout a complete catchment. An entire river catchment is one system. Losses experienced as a result of past flooding events have revealed the danger of misunderstanding this concept and managing river systems segmentally.

At present within South Africa there is no single body that manages the disaster risks associated with riverine systems. This is highly problematic as each of these systems act as a single unit with all processes within their catchments related to one another. Additionally, river catchments do not adhere to political boundaries with the consequence that a CMA is the only entity operating specifically throughout a complete catchment. An entire river catchment is one system. For this reason it is imperative that the system and risks associated with it are managed as one.

In this context, the Disaster Risk Reduction Framework was selected as the organising frame with which to assess the effectiveness of existing flood risk reduction efforts along the Baths River. The application of this conceptualization

was intended to build insight on how flood risk management might be better integrated into the proposed CMA structures.

With specific reference to each of its five thematic areas (governance, risk identification, knowledge management, risk applications and instruments, disaster preparedness, contingency planning and emergency management), particular attention was focused on the degree to which local risk management capacities ‘enabled’ or ‘inhibited’ flood risk reduction.

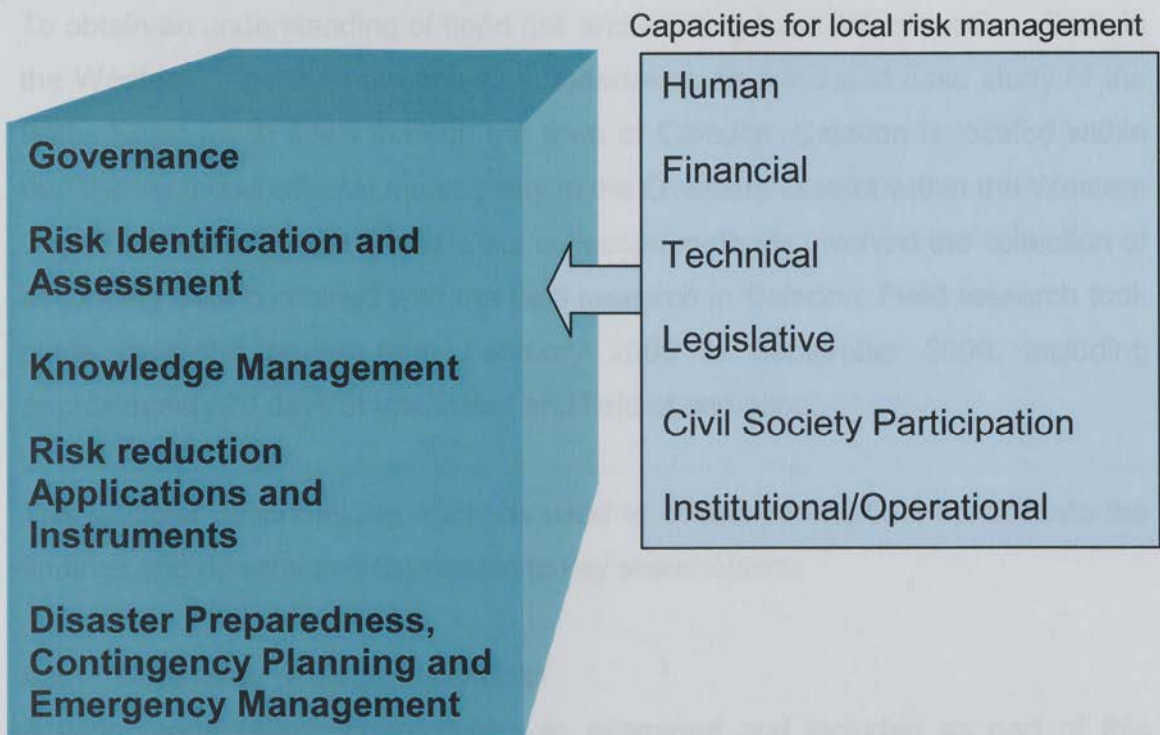
This was facilitated by incorporating UNDP’s approach to Local Risk Management (UNDP, 2006), which specifies six mutually reinforcing ‘capacities’ that enable effective local risk management. These are listed below in Table 2.2.

Table 3.2 Key capacities for local risk management (UNDP, 2006)

Capacity Type	Description
Human Capacity	Knowledge, attitudes and skills around flood risk reduction
Financial Capacity	The availability and accessibility of financial resources for flood risk reduction
Technical Capacity	The capability to implement engineering and environmental flood risk reduction measures
Legislative Capacity	The existence of enabling legislative frameworks for flood risk reduction
Civil Society’s Participation Capacity	Both the degree to which civil society has been engaged actively in flood risk reduction processes and the level of awareness
Institutional/Operational Capacity	The degree to which institutions are enabling/disabling flood risk reduction

The integration of the thematic areas that characterise the disaster risk reduction framework with the six defined capacities that enable local risk management provided the overall conceptual frame for the study and is represented below (Fig. 3.11)

Figure 3.11: Study conceptual framework, integrating the disaster risk reduction framework and UNDP's capacities for local risk management



Thematic areas from the disaster risk reduction framework

...was examined and included as part of this ... modelled data from the South African Weather ... of government policy and other documents. Additionally photographs and maps related to flood risk in Caledon provided further information for the research. This secondary data collection is specifically described below.

4.2.1 Quantitative Data

The South African Weather Service (SAWS) entire record of daily rainfall data for the Caledon station was requested from SAWS. This record ran from 1st November 1877 to the month before the data was delivered, 30th September 2006.

4.2.2 Government Legal, Policy and other Documents

Flood event assessment reports submitted by DIMP on the March 2003 and December 2004 flooding events within the Western Cape along with the

4 Methods

4.1. Introduction

To obtain an understanding of flood risk and existing flood risk reduction efforts in the Western Cape the research was undertaken as a focused case study of the Baths River which flows through the town of Caledon. Caledon is located within the Theewaterskloof local municipality in the Overberg District within the Western Cape Province of South Africa. Data collection methods involved the collection of secondary data combined with the field research in Caledon. Field research took place over the period from February 2006 to September 2006, including approximately 20 days of interviews and field observation.

This Chapter describes the methods used to collect information, consolidate the findings and disseminate the results to key stakeholders.

4.2 Collection of Secondary Data

A wide range of secondary data was examined and included as part of this research. This included quantitative rainfall data from the South African Weather Service and a wide range of government policy and other documents. Additionally photographs and maps related to flood risk in Caledon provided further information for this research. This secondary data collection is specifically described below.

4.2.1 Quantitative Data

The South African Weather Service (SAWS) entire record of daily rainfall data for the Caledon station was requested from SAWS. This record ran from 1st November 1877 to the month before the data was delivered, 30th September 2006.

4.2.2 Government Legal, Policy and other Documents

Post event assessment reports composed by DiMP on the March 2003 and December 2004 flooding events within the Western Cape along with the

Department of Local Government and Housing report to cabinet on the August 2006 flooding event were obtained, and a review of the National Water and Disaster Management Acts (Act 36 of 1998 and 57 of 2002 respectively) was conducted. Due to collaboration with the Department of Water Affairs and Forestry (DWAF), guideline documents referred to and provided by DWAF were consulted. Additionally historical documents and books within the Caledon museum were referred to.

4.2.3 Spatial Information

The Department of Agriculture and DWAF provided large laminated and digital geo-referenced copies of aerial photographs of the study site in addition to the Theewaterskloof Spatial Development Framework map which were utilised extensively throughout the field research. Additionally hard copy and JPEG copies of floodlines for the Baths River were obtained from SRK Consulting

4.2.4 Photographic Information

Photographs of the April 2005 flood event along the Baths River were obtained from the local photo-developer

4.3 Field Research in Theewaterskloof municipality along the Baths River

A participatory flood risk assessment was conducted along the Baths River. Much of the hazard data were collected through secondary sources. The vast majority of the information collected on vulnerability to flooding, and a lesser portion of the hazard information, was obtained through several field observation sessions, semi-structured interviews, a workshop with interested and affected Theewaterskloof residents and a focus group discussion with officials from the Overberg District Municipality. Significant interviews took place with a total of 21 respondents over the eight month period. Of these, repeats consultations were undertaken with ten key informants.

4.3.1 Field Observation

With respect to field observation, five site visits were undertaken between February and April 2006.

7th February 2006

A preliminary site visit was made with a conservation farmer from KwaZulu Natal with more than 50 years experience who was formally chairman of the KwaZulu Natal Soil Conservation Committee and the recipient of numerous conservation awards. The purpose of the visit was to become technically acquainted with the site in an atmosphere free of local bias.

28th February 2006

The Theewaterskloof Environmental Officer provided a brief orientation of the Baths River, indicating areas of concern to him

7th and 8th March 2006

Over a period of two days a large section of the river was walked, beginning upstream above the settlement of Mydleton, the first settlement along the river, and concluding below the town of Caledon. This was carried out with the aid of a research assistant. Wherever points related to flood risk were observed, a photograph was taken and the coordinates marked using a portable GPS.

27th March 2006

Voorhoede Farm, the source of the Baths River, was visited and orientation provided by a farmer. Ecological systems and other points related to flooding were indicated.

12th April 2006

A representative from the Caledon Casino and Spa provided a tour of the Baths River where it crosses through the Casino property, pointing out areas of concern and those areas proposed for development.

4.3.2 Semi-Structured Interviews

A total of 21 significant semi-structured interviews were conducted.

On commencement of the project an initial meeting was held with the DWAF official operating in Theewaterskloof on the 6th February 2006. Discussion surrounded his expectations of the project and the factors that he considered were exacerbating flooding risk associated with the Baths River. The DWAF official provided contact details of the Theewaterskloof Environmental Officer and a Department of Agriculture Representative based in the area.

The Theewaterskloof Environmental Officer was interviewed on the 17th February 2006. Questioning pertained to his function, capacity to perform his function including perceived constraints, elements he understood to be increasing flood risk, what he believed could and should be undertaken to reduce flooding, and general information about past events and local laws relevant to the Baths River.

Residents beside the Baths River were approached and interviewed during the process of the observation walk on 07th and 08th March 2006. The contents of most questions were determined by the surrounding environment but a general discussion was held with each interviewee around past flooding events, elements they perceived to be increasing flooding risk and what they believed should be undertaken to reduce this risk.

During a site visit on the 09th March 2006 contact was made with a reporter from the local newspaper, Die KontreiNuus. She provided contact details of several Caledon residents who she felt would be able to provide relevant information on the Baths River. These included the owner of a nursery situated on the river's banks, farmers along the river, the retired chairman of the Mill Street Conservation Group and the Caledon Museum curator. Additionally an article about this study was published in the paper to inform readers of the project and

to request that if they were interested in providing information or expressing an opinion on the study they should leave their contact details with the reporter.

Interviews were conducted through the contacts provided by the KontreiNuus reporter. The content of questions was determined by the relationship of the interviewee to the River. General questions asked pertained to the details of past flooding events, perceived flood risk, elements exacerbating this risk and currently employed risk reduction methods, and communication with relevant authorities.

A meeting was conducted with a representative of the Caledon Casino and Spa on the 11th April 2006. The Casino's proposed golf course was discussed in addition to their river management strategies and future plans. Questions were then asked relating to communication between the Casino, Caledon residents and the Theewaterskloof Municipality

4.3.3 Consultative Workshop with Local Residents

A workshop was conducted on the 3rd July 2006 with local residents of Theewaterskloof. The aims of the workshop were to present the findings to this point to interested members of the community in addition to allowing the residents to compile a consolidated list of priority concerns relating to the river as well as a proposal of solutions.

All residents of Theewaterskloof were invited to participate in the workshop. A notification and description of the workshop was placed in several editions of the local newspaper and phonecalls were made to all residents previously interviewed through the study. The Environmental Officer of Theewaterskloof was invited to attend the workshop to ensure transparency between residents and the local municipality. The invitation was accepted but the Officer did not attend. (A copy of the workshop agenda is included in Appendix 3).

During the workshop an outline of the study procedures and findings was presented following which a prioritisation exercise was carry out. Through the prioritisation exercise, participants were required to individually write on cards the issues associated with the Baths River that they perceived as problematic. The cards were then displayed on a board and duplicate issues removed. Following this the issues were prioritised and a discussion was held around each issue to determine possible solutions or remedial measures. This was consolidated into an “Agenda for the Baths River, Proposed by the Residents” and representatives were then chosen from the participants to present this agenda to the Casino and local municipality.

4.3.4 Focus Group Discussion

A focus group discussion was held with representatives of the Overberg District Municipality, including the Disaster Manager. Initial research findings were presented and discussed.

4.4 Data Consolidation and Analysis

4.4.1 Interactive GIS Map

A geo-referenced aerial photograph of the study area obtained from DWAF was overlaid with floodlines that were geo-referenced manually along with the flood risk related points obtained through the field observation. These points were then individually hyperlinked to their relevant photographs and descriptions.

4.4.2 Application of the Disaster Risk Reduction Framework

The analysis component of the study required that data collected from field research and secondary sources were consolidated in tabular form for each thematic component (Tables 5.2 to 5.6). They were then assessed against indicators specified for components and sub-components of the disaster risk reduction framework to determine the degree to which risk reduction actions in

the Baths River Catchment effectively achieved the desired flood risk management outcomes.

The capacities analysis framework drawn from UNDP's Local Level Risk Management approach (2006) was then applied to each of the thematic subcomponents to determine the degree to which the specific capacity categories enabled or inhibited effective flood risk management action (indicated respectively as (+) for enabling capacity and (-) for inhibiting or constraining capacity. This information was colour-coded as represented below.

Table 4.1: Colour classification for local risk management capacities

: Key: Capacity Type, Colour Code and Description

(Adapted from Pluut, 2006)

Capacity Type	Description
Human Capacity	Knowledge, attitudes and skills around flood risk reduction
Financial Capacity	The availability and accessibility of financial resources for flood risk reduction
Technical Capacity	The capability to implement engineering and environmental flood risk reduction measures
Legislative Capacity	The existence of enabling legislative frameworks for flood risk reduction
Civil Society's Participation Capacity	Both the degree to which civil society has been engaged actively in flood risk reduction processes and the level of awareness
Institutional/Operational Capacity	The degree to which institutions are enabling/disabling flood risk reduction

4.5 Dissemination of Findings

A number of methods were used to communicate the findings of this research to a wide range of stakeholders including residents, government departments and the local municipality, local business and the research funding agency.

During the workshop held on the 3rd July 2006, residents were informed of the research findings up to that point. Relevant updated findings were presented in hardcopy format to a member of the Mill Street Conservation group at his request.

As this research was initially undertaken in collaboration with DWAF, the DWAF correspondent was continuously updated through meetings, e-mail and phone calls. DWAF appointed the Theewaterskloof Environmental Officer as the designated representative of the local municipality thus he was updated regularly in a similar fashion to the DWAF official.

Rather than rely on government channels to disseminate findings from the local to the district municipalities, district officials were updated on the findings of this study during a focus group discussion.

Both the Theewaterskloof Local Municipality and the Overberg District Municipality have requested access to the interactive GIS map which has been provided

This project was funded by the ProVention Consortium through a grant programme. A conference was held in Johannesburg on 10th July 2006 for the ProVention grantees from Africa and the Middle East. This conference was attended by the grantees in addition to representatives from the Universities of the Witwatersrand and Cape Town, Rhodes University, LBE/University of Bab Ezzouar and the University College of Lands and Architectural Studies, Dar Es Salaam, ProVention, USAID/OFDA, DFID's Regional Hunger and Vulnerability Programme, UNISDR/Africa and South Africa's National Disaster Management Centre. Throughout the conference grantees were offered the opportunity to present their projects and receive international feedback. As required by the grant programme, a final project report was sent to ProVention.

5 Findings and Analysis

5.1 Introduction

The findings from this research have been located within the ISDR's Disaster Risk Reduction Framework and are presented in both narrative and tabular forms.

A narrative subsection has been dedicated to each thematic area of the Framework and the findings pertaining to each component of that thematic area are described within the relevant subsection. The findings relate to the case study along the Baths River as an indication of conditions throughout the small town municipalities within Western Cape. Where appropriate, reference has been made to conclusions from DiMP's post event assessment reports for the March 2003 and December 2004 Cut-Off Lows, to corroborate these findings.

For each thematic component, the findings are then represented in tabular format. As outlined in section 4.4.2, these findings reflect the degree to which flood risk management policies, strategies and actions in the Baths River Catchment comply with the criteria or indicators specified for subcomponents of the thematic areas identified in the disaster risk reduction framework.

The third column of the assessment tables describes the capacities that enable or inhibit flood risk reduction, drawn from UNDP's Local Level Risk Management document (UNDP, 2006).

Finally, a fourth column within each assessment table is provided, to indicate a proposed strategy for the mobilisation of these capacities. The implementation of these strategies should result in closer adherence to the Disaster Risk Reduction criteria. Although directly developed in response to the issues outlined in the preceding columns, the strategies may ultimately be classified as components of thematic areas other than the table within which they were identified. The

following are used to identify the thematic area to which these strategies are related:

PCID - Political Commitment and Institutional Development

RIA - Risk Identification and Assessment

KM - Knowledge Management

RMAI - Risk Management Applications and Instruments

DCE - Disaster Preparedness, Contingency Planning and Emergency Management

5.2 Political Commitment and Institutional Development (Governance)

Governance has become increasingly important to prolonged risk reduction. Good governance is defined in terms of a high level of political commitment and strong institutions. These are required to advance disaster risk reduction as a priority policy concern, allocate adequate resources for risk reduction, ensure accountability in the event of failure, and coordinate public and private sector participation in disaster risk reduction. (ISDR, 2004)

5.2.1 Policy and Planning

As required by the National Disaster Management Act (Act 57 of 2002), a Disaster Management Framework for the Western Cape is in the final process of being developed. Within Theewaterskloof along the Baths River, as with many municipalities in the Western Cape, there is no flood risk reduction strategy in place; in fact, there is no management plan for the River at all. Measures for reducing flood risk are implemented on a project-by-project basis as there is no overall coordination of flood risk reduction nor a long-term plan or even goal. Since these projects are implemented singly and once-off, the effects are short-term and on occasion actually exacerbate flood risk. The Environmental Officer currently refuses to implement most river management projects proposed by the municipality on the grounds that they are once-off and thus not cost effective nor effective in the long term. Ultimately his plan is to form short-, medium- and long-term plans for the overall management of the Baths River. These plans will

include flood risk management. Unfortunately due to constrained support from the local municipality, funds are not available for the development of these plans.

Risk reduction is currently scarcely incorporated into post-disaster reconstruction. Within the Western Cape, an example of this is evident in the town of Heidelberg where during two consecutive flooding events the sewerage works were severely damaged. Reconstruction of the sewerage works restored the facility to its exact previous condition. Following recommendations from DiMP's December 2004 post event assessment, the council responsible is finally examining possibilities for the repositioning of the sewerage works. Within Caledon, the clinic is located directly beside the river, slightly upstream from a disused and a new bridge. Local residents and some municipal representatives vehemently opposed the initial construction of the clinic due to the local knowledge that the area flooded regularly. This opposition was ignored and the Health Department continued with their construction plans in the area. According to residents of Caledon and nursing sisters working at the clinic, the day the clinic opened, it was flooded. The facility was repaired with no additional flood protection measures and has, as such, flooded on average, once every five years since. Towards the end of the fieldwork component of this project the river was widened above the bridge to allow for an increased water capacity. It is hoped that this will increase the flow through the bridge as opposed to around it, thus reducing the clinic's exposure to flood occurrences.

Figure 5.1: The Caledon Clinic in relation to the Baths River, taken from the old bridge



Figure 5.2: The Caledon Clinic post April 2005 flooding event



Both the construction of the Heidelberg Sewerage works and the Caledon clinic in flood-prone areas are examples of how disaster risk reduction is not integrated into development planning in the Western Cape.

International climate research has indicated that an increase is expected in the number of extreme weather events in the Western Cape (IPCC, 2001). Although average precipitation is expected to decrease, the precipitation events that do occur are expected to have a higher intensity. Thus it is widely believed that the amount of rainfall released during a single event will increase (IPCC, 2001). This fact, combined with the effects of proposed development on runoff, indicate that overall flood risk associated with the Baths River will increase. An overall increase in runoff, due to increased rainfall intensity in addition to reduced absorption resulting from changing land-use, has not been considered within any of the development planning within the Baths River catchment. This includes the Casino's proposed golf course/estate and the settlements proposed within the municipal spatial development framework.

According to the Theewaterskloof Spatial Development Framework, Spatial Development Principle (iv) is to "Maintain the open space corridors created by the Baths River". Additionally under Land Use Proposals section 7.2.4, LPL 8 of the Framework, the Baths River is designated as an area that "should be protected" and where "an alien clearing programme should be implemented". Interviews with the Environmental Officer, a representative of DWAF and local residents indicate that Principle (iv) and section 7.2.4 LPL 8 of the Framework are not being upheld. Informed by this study, a member of the Mill Street Conservation Group queried this lack of action with the Theewaterskloof Municipal Manager who responded that he had no knowledge of these sections of the Spatial Development Framework.

5.2.2 Legal and regulatory framework

Within the town of Caledon there are no bylaws pertaining to the Baths River. Everything associated with the River, deemed under the council's jurisdiction, is dealt with on a case-by-case basis. Consequently there are no codes or

standards other than those imposed by a higher sphere of government. Thus no one can be held accountable for flood and other risk occurrences, with blame continuously passed between different government departments and the municipal council. This is another area where the jurisdiction of river management is unclear as, for instance, the municipal council gives permission for water related activities such as allowing water abstraction from the Baths River where DWAF believes this is within their mandate.

5.2.3 Resources

Local municipalities throughout the Western Cape are being dedicated an increasing amount of responsibility. Although control and decision making is often best at the local sphere due to local knowledge and interest, the resources to manage this increasing responsibility have either not been assigned to the municipalities or they do not know how to access them. Consequently the responsibilities are managed poorly. Within Theewaterskloof, proposals for the development of a management plan for the Baths River are continuously rejected on grounds of limited funding. For the first time however, funds were budgeted for the River within the 2006/2007 Theewaterskloof budget. Regrettably though, these funds were reallocated to repair damage caused elsewhere in the municipality during the heavy rains of August 2006. There are however, active groups within the Theewaterskloof municipality who focus on areas of management of the Baths River, such as the removal of alien vegetation. One such group is the Mill Street Conservation Group. They are a self-funded organisation comprising of local residents who provide the tools and knowledge to other residents for the removal of alien vegetation along the River. Those involved sell the wood they have removed, thus providing an incentive for involvement.

There appear to be resources available, however limited, but a primary factor now limiting the progress of implementing any programme is the lack of co-ordination and overall control.

5.2.4 Organisational structures

A principal factor hindering coordination of flood risk reduction activities along most rivers of the Western Cape is that no one body has been designated control over entire systems for this purpose. As has been discussed previously within this paper, river catchments operate as a single system thus for effective management, an overall catchment plan and coordination of catchment activities is required. As with most rivers throughout the Western Cape, there are several organisations responsible for activities related to flood risk of the Baths River. These include DWAF, the Department of Agriculture and the Caledon Casino. Additionally no catchment management agency (CMA) has been formed for the greater catchment, the Bot River catchment.

Currently no single government department or organisation deems flood risk management of an entire catchment as their responsibility. Subsequently, due to the fact that the activities associated with flooding risk of the Baths River are not coordinated by a single body and that there is no overarching plan to guide the various organisations functioning within the catchment, any ability to reduce the Baths River's flooding risk is undermined.

The above findings are analysed in the following table, Table 5.1: Political Commitment and Institutional Development (Governance). Tabular analysis is completed according to the outline in sections 4.4.2 and 5.1 of this paper.

Table 5.1: Political Commitment and Institutional Development (Governance)

Risk Reduction Thematic Component	Research findings in relation to specific risk reduction component/outcome	Assessed capacities/resources for specific risk reduction outcomes	Recommendations for mobilising capacities/resources to achieve risk reduction outcomes
Policy and Planning	The Western Cape Disaster Management Framework is in the final development process	Unknown	Training should be undertaken for key role-players on their obligations in implementing the National Disaster Management Framework (KM)
	Theewaterskloof has no flood risk reduction planning or policy	<p data-bbox="953 454 1474 587">The potential to develop short-, medium- and long-term management plans for the Baths River by the local Environmental Officer (+)</p> <p data-bbox="953 617 1474 750">Lack of capacity, along with the municipal council's support and funding (-)</p>	The Environmental Officer should draw on evidence from this research so that any future plans will be informed in-part by this assessment. (KM)
	Risk reduction is rarely incorporated into post disaster reconstruction. e.g. Heidelberg sewerage works and Caledon Clinic	Increasing municipal awareness of flood risk as a development priority due to repeated damage to infrastructure in high risk areas (+)	Records of damage and losses should be kept and critically evaluated to identify infrastructure at high risk to floods and advocate risk reduction in their reconstruction. (RIA and KM)

Risk Reduction Thematic Component	Research findings in relation to specific risk reduction component/outcome	Assessed capacities/resources for specific risk reduction outcomes	Suggested recommendations for mobilising capacities/resources to achieve risk reduction outcomes
	<p>The Baths River is included in the Theewaterskloof Spatial Development Framework stating the River should be maintained, protected and alien vegetation removed</p>	<p>Lack of knowledge by the local Municipal Manager of these sections of the Framework (-)</p>	<p>Flood risk reduction should be directly included within the IDP and Spatial Development Framework. (PCID)</p> <p>Municipal officials should be well acquainted with the Spatial Development Framework as well as the rest of the IDP (KM)</p>
<p>Legal and Regulatory Framework</p>	<p>Absence of bylaws pertaining to the Baths River and therefore no codes or standards. Decisions related to the River are made on a case by case basis</p> <p>CMA's currently appear to have the greatest capacity to manage entire catchment systems and their related flood risk. Where CMA's have not formed the National Water Act calls for the formation of River Management Committees in the interim.</p>	<p>Unclear management roles associated with the Baths River, resulting in uncertainty of who is responsible for creating and enforcing related laws (-)</p>	<p>Priority should be given to establishment of a Baths River Committee due to the character of the catchment, its exposure to extreme rainfall and high flood risk potential. (PCID)</p>

Risk Reduction Thematic Component	Research findings in relation to specific risk reduction component/outcome	Assessed capacities/resources for specific risk reduction outcomes	Suggested recommendations for mobilising capacities/resources to achieve risk reduction outcomes
Resources	Increased responsibility has been delegated to local municipalities	<p>Lack of access to funding to successfully implement flood risk reduction (-)</p> <p>Lack of knowledge by local municipalities on how to access flood risk reduction funding(-)</p>	<p>Investigations into transversal or 'value adding' funding options related to flood risk reduction should be undertaken. (PCID)</p> <p>Alternative funds should be considered such as Municipal Infrastructural Grants (MIG) for incorporating risk reduction into post event reconstruction (but is predicated on a risk assessment having been undertaken) (PCID)</p> <p>Resources for the removal of alien vegetation should be potentially sourced through Working for Water (PCID)</p>
	There are groups within Theewaterskloof that undertake projects to reduce flood risk	Lack of overall coordination of projects (-)	A Baths River Committee should be formed to manage the River including the planning and coordination of flood risk reduction efforts (PCID)

Risk Reduction Thematic Component	Research findings in relation to specific risk reduction component/outcome	Assessed capacities/resources for specific risk reduction outcomes	Suggested recommendations for mobilising capacities/resources to achieve risk reduction outcomes
Organisational Structures	<p>Although there are many various organisations managing the various activities related to flood risk within catchments of the Western Cape, there is no coordinated flood risk management within these catchments.</p> <p>CMA's however, have the spatial jurisdiction, potentially the capacity, and appear to be required to assume this responsibility according to the National Disaster Management Act</p>	No single government department or organisation, including CMA's, deemed responsible for flood risk management of the entire Baths River catchment (-)	<p>CMA's should be designated this responsibility and provided with the training and resources required to perform this function adequately (PCID).</p> <p>Where CMA's have not formed, River Management Committees should undertake this task in the interim. (PCID)</p>

5.3 Risk Identification and Assessment

The assessment of social, economic and environmental losses is vital for identifying which elements are at risk, where they are situated and which of these are priorities. Additionally, for development to be sustainable, the potential effects of disaster risk on development and development on disaster risk need to be understood. A method of ensuring that disaster risk assessments are undertaken would be to include them within environmental impact assessments (EIA). This is not currently an international trend but the popularity of this concept is increasing (ISDR, 2004). In addition to the assessment of disaster risk it is essential that the onset of a hazard with disaster potential is identified and timely warning disseminated so that public and professional action can be taken to reduce possible effects thus potentially avoiding a disaster.

5.3.1 Risk Assessment and Data Quality

No risk associated with any natural hazard has been assessed within Theewaterskloof including a flood risk assessment of the Baths River. A participatory flood risk assessment of the Baths River performed through this study. The components of the assessment were hazard and vulnerability assessments.

For a detailed flood hazard assessment to be performed, a hydrologist is required. Unfortunately the constraints on this project were such that a hydrologist could not be employed.

The Baths River catchment is relatively small, covering an area of 21.4km² (Caleon Resort and Spa, 1997). The river characteristics are those of a perennial transitional river in the fynbos bio-region having a mixed-bed alluvial channel composed of bedrock, sand and cobble/gravel. There are indications of anthropogenic disturbances. Listed in order of decreasing occurrence, these include the removal of indigenous riparian vegetation and the invasion of the riparian strip by alien trees, mostly Black Wattle; water abstraction, both formal

and informal; infilling of the river channel to extend agricultural land; discharge of effluent into the system; and litter in the lower reaches.

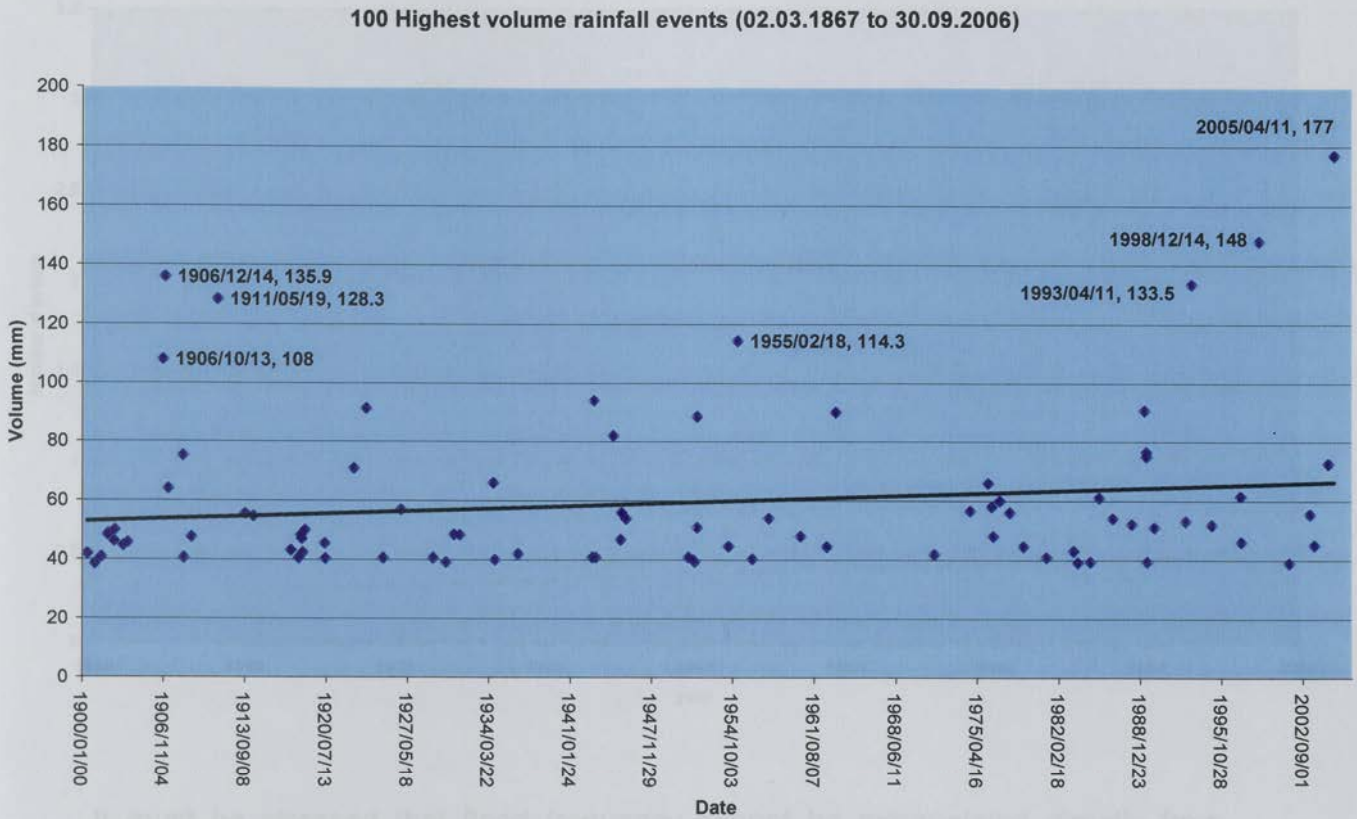
The predominant indigenous vegetation type in the area is south-coast renosterveld which has a higher proportion of grass-cover to other types of renosterveld and co-dominates with Asteraceae (daisy) and Sterculiaceae (Caledon Resort and Spa, 1997). Due to its high proportion of grass-cover, Renosterveld aids infiltration thus reducing runoff. Unfortunately though, this habitat type is severely threatened particularly in the Western Cape. Of the original area covered by this vegetation type only 4.08% remains of which a meagre 0.14% is conserved (Caledon Resort and Spa, 1997). Within the Caledon area 156 species of renosterveld were recorded; the region is, however, infested with alien vegetation. (Caledon Resort and Spa, 1997) Situated between the Baths River, the Caledon golf course and the urban edge is a section of land marked "sensitive vegetation" in the Theewaterskloof Spatial Development Framework. This land is predominantly covered by renosterveld and has been allocated for the conservation thereof.

There is no flooding record of the Baths River but interviewees unanimously mentioned the April 2005 and December 1998 flooding events. The rainfall recorded during the April 2005 event was fed, by Arthur Chapman of the CSIR, into a programme written at the University of KwaZulu Natal. The output of the program is the estimated return period of that volume of rainfall. The rainfall triggering the April 2005 event was indicated to be a 1:200 year rainfall event.

Rainfall data from SAWS was requested for trend analysis. Appendix 5 includes graphs of this data. Clearly visible in these graphs are the high rainfall events that have occurred over the period from 2nd March 1867 to 30th September 2006. Fig. 5.3 represents the top 100 rainfall events, based on volume, for the same period (the entire SAWS record for the region). A trendline was inserted from which it can be seen that the volume of rainfall released during these extreme events has, on average, increased over the specified period.

Figure 5.4: The number of the top 50 rainfall events occurring per year (1867 to 2006)

Figure 5.3: (Source: calculated from data provided by SAWS)

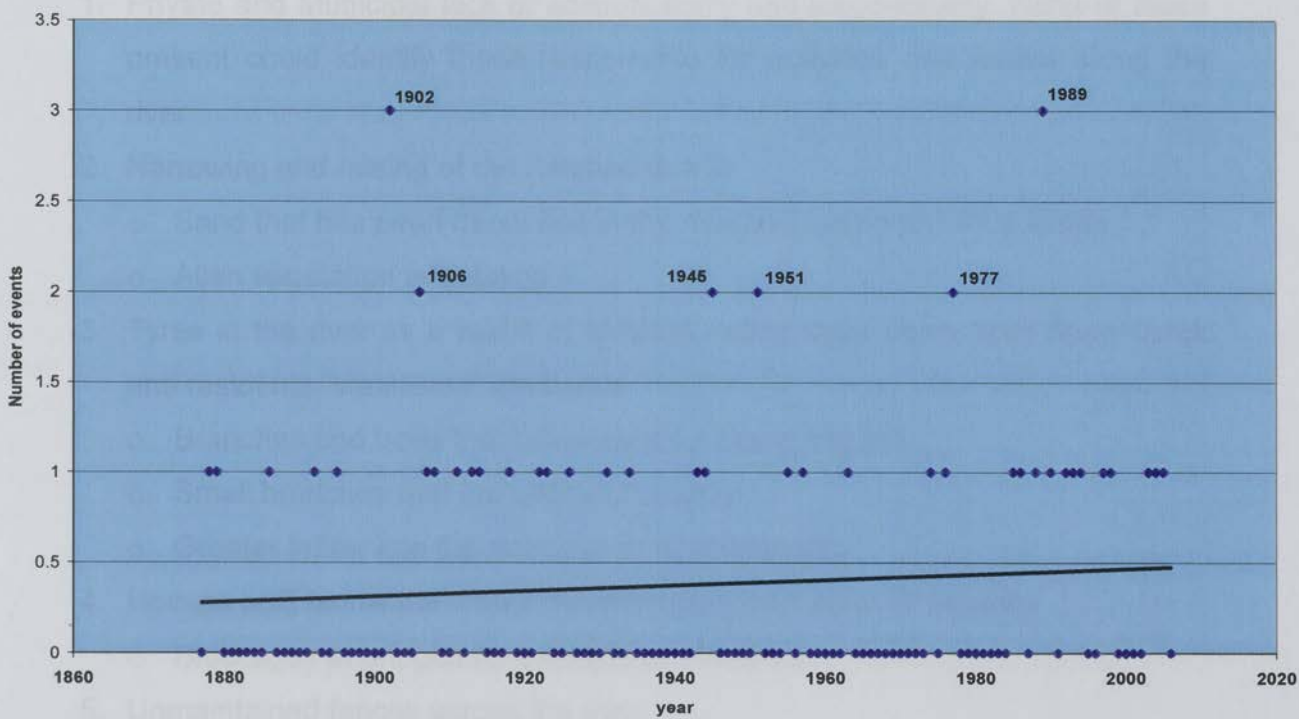


It must be stressed that flood frequency cannot be extrapolated directly from rainfall data.

Fig. 5.4 indicates the number of the highest fifty rainfall events that have occurred within each year over the period 1867 to 2006. The trendline reveals whether more of the top fifty events have occurred recently or not. From the incline in the trendline it can be seen that more of the top fifty rainfall events have occurred recently. Thus it can tentatively be supposed, based on this data, that the number of extreme rainfall events occurring within Caledon have increased over this period. Both Figs 5.3 and 5.4 concur with international climate change expectations that the frequency and extremity of rainfall events in the Western Cape will increase over time.

forty issue is a lack of funding for management planning, projects and programmes.

Figure 5.4: The number of the top 50 rainfall events occurring per year (1867 to 2006) (Source: calculated from data provided by SAWS)



It must be stressed that flood frequency cannot be extrapolated directly from rainfall data.

Additionally, where there is no social vulnerability to flooding there will be no flooding risk regardless of rainfall and flood volumes. Through interviews, a workshop and field observations, it was determined that vulnerability to flooding along the Baths River is perceived to be relatively high. According to the residents of Theewaterskloof, the primary ‘problem’ associated with the river is the lack of accountability and responsibility. None of those interviewed could identify officials responsible for specific issues along the river. The municipality however, believes that the priority issue is a lack of funding for management planning, projects and programmes.

The following are the issues, related to flood risk associated with the Baths River, outlined and prioritised by the residents of Theewaterskloof during the workshop:

1. Private and Municipal lack of accountability and responsibility. None of those present could identify those responsible for activities and issues along the river
2. Narrowing and raising of the riverbed due to
 - Sand that has been deposited in the riverbed during previous floods
 - Alien vegetation infestation
3. Tyres in the river as a result of children rolling them down from SuperQuick and residents “stabilising” the banks
 - Branches and trees that have been cut down and left
 - Small branches that are difficult to pickup
 - Greater inflow into the river due to developments
4. Houses built below the 1:50yr floodline (approximately 10 houses)
 - Blockages at bridges for example at the clinic
5. Unmaintained fences across the river

Residents were clearly aware of the increase in the volume of water as a result of increased development thus more runoff, and they perceived it as problematic while officials did not appear to be aware of this potential problem.

Additionally, social vulnerability to flooding of the Baths River is increasing due to informed and uninformed inappropriate development; a deficiency of general river management and maintenance and the lack of knowledge about local flood risk. The example of the inappropriate development of the clinic has been discussed in section 5.2.1 of this paper. Infrastructure, such as bridges, has to be regularly maintained to avoid a decrease in their flow capacity. Maintenance of riverine infrastructure along the Baths River is virtually non-existent and a build-up of debris is visible against or underneath many structures. An example of this is displayed by Fig. 5.5. Some of the debris underneath the bridge in figure 5.5 has since been removed.

Figure 5.5: A build-up of debris underneath 'The Old Bridge' in Caledon



Approximately where the riverbed was when the bridge was originally built

5.3.2 Early Warning Systems

A flood early warning system has the potential to relieve a certain amount of fear associated with flooding. Regrettably there is no such system for the Baths River. SAWS however, currently issue severe weather warnings to Disaster Managers, relevant officials and appropriate line functions throughout the Western Cape. The rivers in the Western Cape are generally relatively short and steep; consequently riverine flooding occurs quickly and early warning is problematic. An effective early warning system requires a good quality forecast, dissemination channels and participation of end-users, and effective response to the warnings. During this study residents expressed a keen interest in developing an early warning system based on weather forecasts produced by a local weatherman. Farmers in the area currently use these weather forecasts, which are available on the internet, to plan their daily farming activities including the removal of livestock to higher ground. They claim that "If the forecast says it will rain around four 'o clock, we move our livestock out of the riverside lands at quarter to four".

Findings from this research thus highlight that the need, willingness and capacity for a severe weather early warning system along the Baths River is present within Theewaterskloof.

The above findings are analysed in the following table, Table 5.2: Risk Identification and Assessment. Tabular analysis is completed according to the outline in sections 4.4.2 and 5.1 of this paper.

Table 5.2: Risk Identification and Assessment

Risk Reduction Thematic Component	Research findings in relation to specific risk reduction component/outcome	Assessed capacities/resources for specific risk reduction outcomes	Suggested recommendations for mobilising capacities/resources to achieve risk reduction outcomes
Risk Assessment and Data Quality	<p>No risk assessment of any kind has been undertaken in Theewaterskloof</p>	<p>Legally imperative through the Disaster Management Act (Act 57 of 2002) for every district municipality to have a disaster management plan, which (according to the NDMF) should be based on a risk assessment. (+)</p> <p>Lack of capacity in the majority of districts within the Western Cape to perform these assessments themselves – resulting in outsourcing of assessments and often minimal local participation in these processes (-)</p>	<p>Consultation between provincial and local authorities should be undertaken to identify the methods and support processes needed for local authorities to complete this requirement (as required by national policy). (PCID)</p> <p>Proposed resources and methods to perform risk assessments within districts should include mechanisms that ensure local municipal participation in the assessment process (PCID)</p>
	<p>Hazard events (floods) are not recorded within the Theewaterskloof Municipality</p> <p>Past events may have been recorded in the local newspaper for which there is an archive dating back to the 1800s</p>	<p>Absence of a clearly defined individual/job function or organisation responsible for recording information associated with flooding events. (-)</p>	<p>The Municipal Environmental Officer or the proposed Baths River Committee should be assigned responsibility to assimilate relevant information associated with flood events such as the date, amount of rainfall and area affected. (PCID)</p> <p>Action should be taken to identify a repository to store this information locally (for instance, in the Museum archives). RIA/PCID/KM</p>

Risk Reduction Thematic Component	Research findings in relation to specific risk reduction component/outcome	Assessed capacities/resources for specific risk reduction outcomes	Suggested recommendations for mobilising capacities/resources to achieve risk reduction outcomes
	No vulnerability or capacity assessments, or risk monitoring has taken place within the Theewaterskloof municipality	<p>Lack of awareness or recognition by the local municipality that this is necessary (-)</p> <p>Lack of flood risk knowledge available with which the risk could be monitored.(-)</p>	<p>Vulnerability and capacity assessments should form part of the district risk assessment. (RIA)</p> <p>A flood risk assessment should be undertaken to provide a baseline for future risk monitoring. (RIA)</p>
Early Warning	There is no flood early warning system related to the Baths River. SAWS issues severe weather warnings to disaster managers, relevant officials and appropriate line functions throughout the Western Cape.	<p>Expression of interest by farmers and Caledon residents along the Baths River in a severe weather early warning system. (+)</p> <p>Access to a local weather forecast on the internet, daily (+)</p>	A simple severe weather early warning system should be developed using the proposed Baths River Management Committee to disseminate information it obtains from the local forecast available on the internet. (KM/DCE/RIA)

5.4 Knowledge Management

Understanding a risk is an essential component to managing and reducing it. Those parties at risk increase their risk if they are not aware of it or lack knowledge on methods by which they might reduce it. The following are required within this thematic area of the risk reduction framework if risk reduction is to prove effective: disaster risk reduction should be included in education; there is a need for public awareness and information campaigns; the media should be utilised to promote and disseminate information on risk reduction; training of communities at risk and professional staff should be carried out; in addition to targeted research.

5.4.1 Information management and Communication

There appears to currently be a complete lack of communication between the different stakeholders associated with flood risk within the Baths River catchment. A committee was formed after the April 2005 flooding event but the committee has not met since their formation. Residents do not feel they can successfully communicate their needs associated with the Baths River to the Local Municipality as there are no channels available for this. Every stakeholder operating in the Baths River catchment currently operates independently without communicating with each other.

Certain information is required by law to be available to the public. For instance the National Water Act (Act 36 of 1998) requires that the 1:100 year floodline of a river passing through a township has to be available for public viewing. When the floodlines for the Baths River were requested from the Theewaterskloof Municipality they could not be found. These floodlines were eventually obtained three months later from the consulting firm that originally produced them. The National Water Act additionally requires that "A water management institution must, at its own expense, make information at its disposal available to the public in an appropriate manner, in respect of - (a) a flood which has occurred or which is likely to occur;" and "(e) levels likely to be reached by floodwaters from time to

time” (Act 36 of 1998 section 145. (1)). The primary factor limiting adherence to this law associated with the Baths River is that there is no institution that has been appointed responsible for the Baths River thus responsible for informing the public on these issues.

5.4.2 Education and Training

At the local municipal level there is no apparent education and training in disaster risk reduction or management. Within Theewaterskloof, interviews revealed the presence of various skills and knowledge which are potentially useful for flood risk management within the catchment, among residents, farmers and municipal officials. These included knowledge on constructive methods for alien vegetation removal, soil conservation, ground stabilisation and civil engineering. Skilled people within Theewaterskloof not only have the general knowledge associated with their skill but are thoroughly knowledgeable of local conditions

5.4.3 Public Awareness

As was mentioned in section 5.4.1 communication between stakeholders associated with flood risk within the Baths River catchment appears to be nonexistent. Related to this is a lack of public awareness. Additionally, there was no evidence within the municipality of any existing or planned public awareness policy, programmes or material on flood risk associated with the Baths River.

A complete lack of flood risk awareness became obvious through interviews with Caledon residents. An interviewee who resides along the lower stretch of the river reported that their family had only recently purchased the property they live in. At the time of purchase there was no mention of flood risk and insurance companies were more than willing to insure the house. Since the 2005 flooding event they have learnt from neighbours and friends that their property floods regularly. The family is at present attempting to sell the house but realise that they will not be able to obtain even close to their purchasing price. They currently live in fear of flooding with most of their undamaged possessions stored elsewhere to prevent further loss from future flooding events. A constant fear is

that an extreme rainfall event will occur at night resulting in a flood they are not aware of, thus endangering their lives. More than a year has passed since the last flood event along the Baths River but these residents claim that if it rains during the night they remain awake until the morning. Such an example stresses the importance of flood risk awareness.

There is a local newspaper, Die Kontreinuus, with a wide readership among the residents of Theewaterskloof which publishes all the information they can obtain on flood risk associated with the Baths River. Unfortunately there is very little information available on this topic.

5.4.4 Research

The research component outlined within the ISDR's Risk Reduction Framework is particularly focused on international, regional and national collaboration on research. This level of collaboration does not apply directly to the local level context of this study. There is however a need for research cooperation between different groups at this level. This becomes particularly pertinent as rivers are cross boundary features and although the Baths River flows entirely within the Theewaterskloof Municipality, this is not true for most other rivers in the Western Cape, which generally cross district or even provincial boundaries.

Research associated with flood risk within Theewaterskloof, as with most Western Cape local municipalities, has not been undertaken. This study is the only example of such research within the Theewaterskloof Municipality. When flood risk research is carried out within the Western Cape it is most often performed by engineering firms or DiMP based at the University of Cape Town. Research carried out by engineering firms invariably does not involve local officials or a vulnerability assessment within the process.

The above findings are analysed in the following table, Table 5.4: Knowledge Management. Tabular analysis is completed according to the outline in sections 4.4.2 and 5.1 of this paper.

Table 5.3: Knowledge Management

Risk Reduction Thematic Component	Research findings in relation to specific risk reduction component/outcome	Assessed capacities/resources for specific risk reduction outcomes	Suggested recommendations for mobilising capacities/resources to achieve risk reduction outcomes
Information Management and Communication	There is no apparent communication between stakeholders associated with flood risk in the Baths River Catchment	Expression of interest by farmers, Caledon residents along the Baths River and a representative of the Casino, in forming communication channels between catchment stakeholders. (+)	The proposed Baths River Management Committee with representatives from the farmers, residents of Caledon, the Caledon Casino and Spa, Theewaterskloof municipality and relevant government departments should be formed as it would be a practical means of communication between all stakeholders (KM)
	Information required by National law to be available to the public is not easily accessible	A competent, centrally located information storage facility available in the form of the Caledon Museum. (+)	Information, such as the Baths River floodlines and flood risk reduction best practices, that requires easy access by the community should be stored at the Museum and disseminated, where necessary by the proposed Baths River Management Committee (KM)
Education and Training	There is currently no flood risk education and training within the Theewaterskloof Municipality	Various skills and local knowledge related to flood risk reduction are possessed by the many residents of Theewaterskloof (+)	Disaster risk reduction training of relevant local officials and potentially the proposed Baths River Management Committee should be undertaken. Furthermore, through this training local knowledge and skills should be shared (KM)

Risk Reduction Thematic Component	Research findings in relation to specific risk reduction component/outcome	Assessed capacities/resources for specific risk reduction outcomes	Suggested recommendations for mobilising capacities/resources to achieve risk reduction outcomes
Public Awareness	As a result of the lack of communication between stakeholders associated with flood risk in the Baths River Catchment there is limited public awareness of this risk. Moreover, there are no policy, programmes or materials for public awareness on flood risk in Theewaterskloof	<p>The local newspaper, Die Kontreinuus, which has a large readership among the community is enthusiastic about promoting flood risk reduction (+)</p> <p>The proposal of the formation of a Baths River Management Committee (+)</p>	Schools, the newspaper and the proposed Baths River Management Committee should be utilised to distribute information on the flood risk of the Baths River (KM)
Research	This study is the only apparent flood risk related research to have taken place in Theewaterskloof	<p>Research institutions such as the University of Cape Town (UCT) located within the Western Cape (+)</p> <p>More holistic risk assessments by engineering firms as they are gradually employing people trained in social sciences (+)</p>	<p>Increased communication between local municipal officials from differing municipalities should be encouraged so that best practices may be shared (KM)</p> <p>There should be closer collaboration between municipalities and research institutions such as UCT (KM)</p> <p>Where flood risk related research is contracted to outside organisations, local municipal participation should be insisted upon (RIA/KM)</p>

5.5 Risk Management Applications and Instruments

The different risk management applications and instruments available relate to the factors of vulnerability namely, environmental, social, economic and physical factors. Many opportunities for risk reduction have become available with the recognition of the benefits of utilising the instruments and tools developed within these respective fields. The relationship between the environment and flood risk reduction is internationally recognised particularly in the area of reducing risk exacerbated by climate change. An example of this is the restoration and protection of wetlands which, in addition to promoting biodiversity and water decontamination, act as attenuation areas for flood waters thus reducing flood peaks and the related risk.

Poverty is a primary factor that exacerbates disaster risk thus the management and reduction of this social factor may ultimately lead to the mitigation of risk. Additionally poor economic conditions from the local to international levels intensify risk through an increase in vulnerability. Instruments such as micro-lending, public-private partnerships and insurance can be used to secure economic conditions consequently reducing risk.

The use of technical measures, such as gabion structures, to reduce physical vulnerability and ultimately exposure to hazards was historically a widely employed risk reduction technique. Increasingly many of these physical techniques are used in conjunction with environmental instruments with the purpose of including a sustainability element to the risk reduction measure employed. (ISDR, 2004)

5.5.1 Environmental and Natural Resource management

The Baths River catchment covers a relatively small area, 21.4 km² (Caledon Resort & SPA, 1997). With such a relatively small catchment, changes that may be perceived as insignificant may in actuality result in major consequences for the catchment system and riverine flooding risk. This predominantly relates to

land-use and infiltration. The natural vegetation occurring within the catchment is south-coast renosterveld which has a relatively high grass component. As such, under its original land-use conditions the catchment had a means for reducing the velocity of runoff resulting in an increase in infiltration and a smaller volume of water reaching the Baths River directly. The land-use/cover of Baths River catchment is currently predominantly agricultural lands, urban areas and alien vegetation. The donga erosion occurring throughout the catchment, such as that illustrated in Fig. 5.6, is an indication of the negative changes in land-use patterns and the consequent increase in runoff.

Figure 5.6: A donga within the Baths River catchment



Although alien vegetation is notorious for utilising huge quantities of water, Black Wattle is not a competent soil-binding and runoff velocity reducing agent. Thus, not only does the prolific Black Wattle within the Baths River catchment absorb copious amounts of precious water but it does not decrease erosion or reduce runoff. The extreme alien infestation is the primary environmental concern within the catchment.

Figure 5.7: An example of the alien vegetation occurring throughout the upper reaches of the Baths River channel



Alien vegetation blocks many sections of the river channel, as indicated in Fig. 5.7, with the consequence of a reduced river channel capacity and increased likelihood of flooding. Much of the alien vegetation from the upper reaches of the river is washed downstream where it damages and/or blocks structures such as bridges. Where a structure is blocked, flow is impeded and 'backs up' behind the structure leading to increased likelihood of flooding. Risks associated with natural hazards seldom function separately from one another. Under these circumstances flood and fire risk are both exacerbated by the alien vegetation. The alien vegetation debris deposited down river not only exacerbates future flooding risk by reducing the river's flow capacity but increases immediate fire risk through the increase of available fuel. The development of the proposed Casino golf course would require the removal of extensive areas of alien

vegetation and the replacement of this predominantly Black Wattle environment with grasses. As the Casino property contains the largest section of alien vegetation this proposed change of vegetation cover would significantly increase the infiltration thus reducing runoff, and decrease the amount of alien vegetation debris carried downstream.

In addition to alien vegetation and inferior farming practices, runoff is increased by spreading development. An increasing proportion of the Baths River catchment is becoming hardened through development thus drastically reducing the potential for infiltration with a consequent increase in runoff. Urbanisation of 50% of the catchment can increase the frequency of floods from 1:100 years to 1:5 years (Abramovitz, 2001). Before a development is permitted to take place an environmental impact assessment (EIA) is required. The sections of the EIA for the proposed Casino golf course development reviewed for this study did not indicate that the effect of the development on runoff had been considered. On a slightly larger scale, the same was true for the areas proposed for development in the spatial development framework for Caledon. As a result of the size of the catchment, virtually any additional cemented area will have a significant affect on runoff and thus flooding risk associated with the Baths River.

The Baths River is a relatively small river with a reasonably small catchment. It is however a scaled down example of a typical Western Cape catchment with the characteristically short river, steep catchment, development and farming practices that do not consider flood risk, and an infestation of alien vegetation.

5.5.2 Social and Economic Development Practices

It appears that all those exposed to flooding associated with the Baths River have the relevant insurance. Since the founding of the town of Caledon properties along the Baths River have been sought after. As such there is no low cost or informal housing, or low income households exposed to flooding associated with the Baths River. This is not predominantly the case throughout

the Western Cape as those considered to have the highest flooding risk within this province are of low income, residing in low cost or informal dwellings. Their flooding risk however, is often not associated with rivers but poor stormwater drainage and related infrastructure (DiMP, 2005).

Access to insurance is an instrument recommended by the ISDR (2004) to reduce economic vulnerability to hazards. Within Caledon however, access to insurance has led to a false sense of security and the impression of low risk. When interviewed about awareness of flooding risk when purchasing their property, an interviewee explained that they presumed that the house did not have high exposure to flooding, despite its proximity to the river, as insurance for the house was easily and relatively cheaply acquired and included cover for flood events. Once the floodlines had been overlayed with the aerial photograph of Caledon, it became apparent that their house was within the 1:50 year floodline.

5.5.3 Physical and Technical Measures

The ISDR's Risk Reduction Framework includes land use applications and urban development schemes within the physical and technical measures component of the Framework. This has been dealt with to some extent under section 5.5.1, the environmental and natural resource management component of this theme, in that the lack of consideration of the affects of development on runoff when developing the spatial development framework was discussed. It became evident through interviews and examination of the Theewaterskloof Spatial Development Framework Map, that very little or no consideration of flooding risk had been incorporated into the development of the Spatial Development Framework of this area.

Another physical and technical measure required by the ISDR Framework is structural intervention such as hazard resistant construction, retrofitting existing structures and employing flood control techniques. Of these three structural interventions the only one visibly employed in the Western Cape is flood control

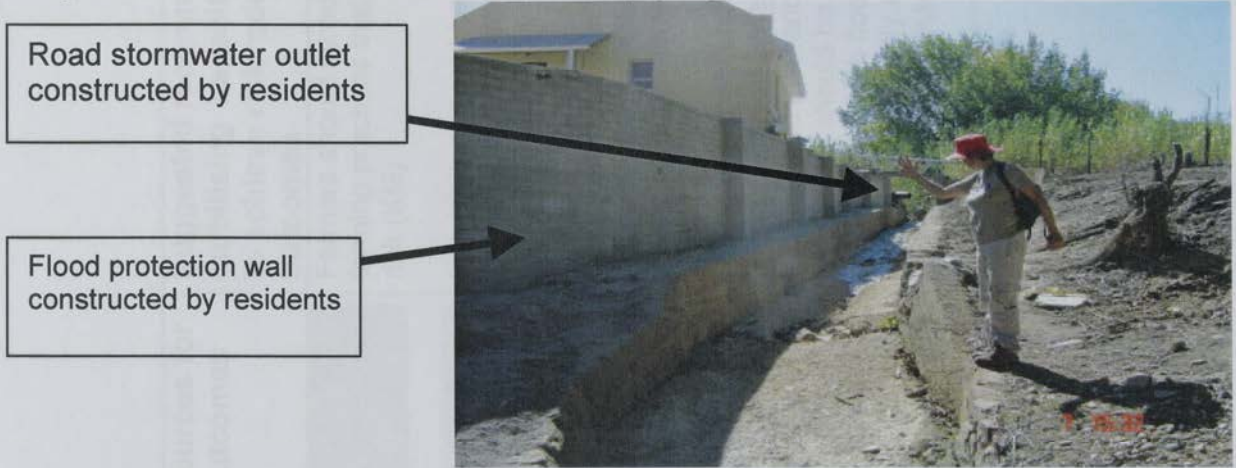
techniques. Within urban centres, particularly Cape Town, there is extensive canalisation of rivers in addition to evidence of the employment of gabions. Along the Baths River few structural interventions have been utilized. There are sections of the river where significant erosion is occurring, endangering and reducing residential property. Examples of this are illustrated in Fig. 5.8 below. The Environmental Officer for Theewaterskloof has suggested that gabion structures be constructed in these areas as a measure of flood protection.

Figure 5.8: Two areas along the Baths River and its tributaries where erosion is damaging property



A portion of a tributary has been canalised where it meets the Baths River. This section of the river is displayed in figure 5.9. Indicated in the photograph are the stormwater outlet and flood protection wall constructed by the residents living within the property adjacent to the canalized section. These protection measures were constructed after a large portion of their property was damaged during the 2005 flooding event. They were constructed without the consultation of an engineer and it is unclear whether the wall will be able to withstand flooding such as that experienced in 2005.

Figure 5.9: A section of a canalised tributary of the Baths River



The ISDR Framework for Risk Reduction specifies that “public buildings (health facilities, schools, lifelines, etc) at high risk [are] retrofitted”. The interactive map constructed during this study indicates that the Caledon Clinic lies within the 1:50 year floodline. Thus based on the framework and its flooding history, this building should be retrofitted to withstand flooding events. Throughout many areas of the Western Cape, critical infrastructure has been identified as being at high risk to flooding (DiMP, 2005). Examples of these are the previously mentioned sewerage works in Heidelberg, the main water supply pipeline to Suurbraak and the only road access to Droëheuwel. Following the December 2004 flooding event, the Heidelberg sewerage works were scheduled to be moved and the Suurbraak pipeline was reconstructed below the riverbed thus reducing the likelihood of incurring damage as a result of flooding. (DiMP, 2005)

The above findings are analysed in the following table, Table 5.4: Risk Management Applications and Instruments. Tabular analysis is completed according to the outline in sections 4.4.2 and 5.1 of this paper.

Table 5.4 Risk Management Applications and Instruments

Risk Reduction Thematic Component	Research findings in relation to specific risk reduction component/outcome	Assessed capacities/resources for specific risk reduction outcomes	Suggested recommendations for mobilising capacities/resources to achieve risk reduction outcomes
Environmental and natural resource management	Land-use changes such as poor farming practices, altering the riverbed, alien vegetation infestation and development, are increasing flood risk associated with the Baths River	<p>Willingness of farmers and local residents to learn and implement good flood risk reduction practices (+)</p> <p>The requirement of EIAs before development can proceed (+)</p>	<p>Farmers should be educated on farming practices that will reduce flood risk (KM)</p> <p>Information should be provided to residents on flood risk reduction methods (KM)</p> <p>Coordinated, long term programmes for the removal of alien vegetation should be implemented (RMAI)</p> <p>Risk assessment should be included into the required EIAs (PCID)</p>
Social and Economic Development Practices	There are no low-income households or informal housing at risk to flooding associated with the Baths River Most households at risk to flooding are covered by flood insurance but this has instilled a false sense of security	Insurance is owned by households at risk (+,-)	Property and insurance sales companies should be informed of property with high flooding risk and should consequently inform potential buyers of this risk (KM)

Risk Reduction Thematic Component	Research findings in relation to specific risk reduction component/outcome	Assessed capacities/resources for specific risk reduction outcomes	Suggested recommendations for mobilising capacities/resources to achieve risk reduction outcomes
Physical and Technical Measures	<p>There are few structural flood risk reduction measures implemented along the Baths River</p> <p>Several properties have been damaged by erosion triggered by flooding of the Baths River</p> <p>The Caledon Clinic is within the 1:50 year floodline and is not hazard resistant or retrofitted</p>	<p>No municipal engineer in Theewaterskloof (-)</p> <p>DWAF official assigned to the area is a civil engineer with a demonstrated interest in the Baths River (+)</p> <p>The Interactive Map produced by this study highlights areas of concern along the Baths River (+)</p>	<p>Priority areas and infrastructure at risk to flooding should be identified through the Interactive Map and local knowledge of the DWAF official and proposed Baths River Management Committee. (RIA)</p> <p>Appropriate risk reduction measures should then be implemented (RMAI)</p>

5.6 Disaster Preparedness, Contingency Planning and Emergency Management

Preparedness and contingency planning are the last two elements before disaster impacts on the ISDR's Risk Reduction Framework diagram figure 3.10. These components of risk reduction have proven to be effective in reducing losses from both the direct and indirect impact of disaster events and are the components of this Framework that have most widely been implemented throughout history and within most areas. This thematic area is required to be informed by a high quality early warning; have in place a rehearsed reaction plan, communication system and method of coordination; and have funds and infrastructure sufficient to support response.

5.6.1 Preparedness and Contingency Planning

Disaster management within the Western Cape has a history of emergency response. Consequently many officials in authoritative positions within this sector have a background in an emergency response line-function such as the Fire Department. Disaster Risk Assessments are required to be completed for every district municipality. During the December 2004 post flooding event assessment a district disaster manager was questioned as to how he would apply the disaster risk assessment for risk reduction purposes within his jurisdiction. From his reply it became clear that he intended to use the outcome of the assessment for the sole purpose of informing the preparedness, contingency and emergency response planning within his district. (DiMP, 2005). Although this is an under-use of the risk assessment for risk reduction purposes it does reveal the level of understanding of several Western Cape district disaster managers of the disaster risk field in addition to suggesting their background and training. The same post event assessment exposed miscommunication between different sectors during the disaster event. An example of this was when a South African National Defence Force helicopter was placed on standby by one of the districts during the event but cancelled due to intervention from Cape Town as it was believed it would be better to use a Russian helicopter standing in George. However, after

arrangements were made, it was found that the Russian helicopter did not contain a hoist and evacuation had to be performed by alternative organisations such as Skynet. The December 2004 flooding event additionally exposed a communication weakness as cellular phones were the predominant means of communication. These however became wet and stopped functioning during critical periods of emergency response. As a result there has been a move towards the installation of radio towers and the use of two-way radio communication at the local level during these events. (DiMP,2005) Concerning flooding events associated with the Baths River, there appears to be no preparedness and contingency planning.

5.6.2 Emergency Management

As soon as an event presents itself as a potential disaster within a district the Disaster Manager is expected to form a Joint Operations Centre (JOC). The JOC's function is to coordinate line-functions and general actions performed during an event. Currently the JOC should comprise the Disaster Manager, representatives of the line-functions involved and technical experts such as engineers. Over time, however, the technical experts may be replaced with the previously compiled risk assessments. As mentioned above a number of district disaster managers for the Western Cape come from an emergency line-function background, such as the fire department. There are advantages and limitations to this. An example of an advantage is that disaster managers are accustomed to working under emergency conditions. A limitation however, presented itself during the December 2004 flood event when disaster managers were leaving their coordinating roles unfulfilled to be involved more directly by taking action at the ground level. This resulted in a lack of coordination between line-functions with consequent duplication of effort and misuse of time. (DiMP, 2005)

During the April 2005 flooding event, flooding occurred throughout many areas of the Overberg District. As emergency management is a district level function, there was no immediate threat to life and it was perceived that other areas were under higher threat, there was no official action taken associated with the Baths

River. During previous flooding events the only recollected action taken associated with the Baths River was the closing of the N₂, national highway, where it crossed the River.

The above findings are analysed in the following table, Table 5.5: Disaster Preparedness, Contingency Planning and Emergency Management. Tabular analysis is completed according to the outline in sections 4.4.2 and 5.1 of this paper.

Table 5.5: Disaster Preparedness, Contingency Planning and Emergency Management

Risk Reduction Thematic Component	Research findings in relation to specific risk reduction component/outcome	Assessed capacities/resources for specific risk reduction outcomes	Suggested recommendations for mobilising capacities/resources to achieve risk reduction outcomes
Preparedness and Contingency Planning	<p>Where they have been completed within districts of the Western Cape, risk assessments often inform preparedness and contingency planning</p> <p>Communication during events is difficult and miscommunication often occurs</p> <p>There is no local preparedness and contingency planning in Theewaterskloof for flood events</p>	<p>Post event assessments increasingly being undertaken throughout the Western Cape district municipalities (+)</p>	<p>Preparedness and contingency planning should be influenced by procedural findings of post event assessments (DCE/RIA)</p>
Emergency Management	<p>Disaster Managers are generally well trained to operate under the pressure of an emergency situation. They often however, leave their coordinating role unfulfilled during an emergency to take action at the ground level</p>	<p>Outlined within the National Disaster Management Framework are roles for action during emergency response to disaster events (+)</p>	<p>Disaster Managers should be trained in coordination during a disaster event to counter their existing, predominantly action orientated, training (DCE/KM)</p>

6 Discussion

6.1 Introduction

The ISDR's Disaster Risk Reduction Framework was employed to consolidate the findings of this study. Within this chapter the manner in which the findings relate to the Framework is discussed. Additionally this chapter includes a critical appraisal of the Framework based on its use within this study, a discussion surrounding the relationship between the findings and existing international literature, and general recommendations generated from the findings of this study.

6.2 Findings in Relation to the Disaster Risk Reduction Framework

The ISDR Risk Reduction Framework (ISDR, 2004) is designed for application at the national level and global use. For the purpose of this study the Framework was downscaled to the local level to guide the analysis of risk reduction associated with the Baths River. The majority of the thematic areas and components of the Framework transitioned from the national to local scale easily but a few had very little correlation at the local scale resulting in a slightly more complicated analysis.

6.2.1 Findings Related to Thematic Area 1 of the Framework, Governance

The findings illustrate that at the provincial level the policy and planning, legal and organisational structures appear to be progressing towards meeting the standards stipulated by the Framework. This is largely due to the development of the Western Cape Disaster Management Framework and the placement of disaster managers within each district. As such resources for the use of risk reduction at the district level can be advocated by the disaster manager in charge. At the local scale however there is a completely different situation. Local municipalities, such as Theewaterskloof, are required to manage their flooding risk but as is apparent through the Baths River case study, they do not have the policy, planning or organisational structures in place to manage riverine flood risk as is required by international standards (ISDR, 2004). The legal aspects

associated with the Baths River are dealt with in a case-by-case fashion and the human capacity is lacking along with the will to allocate financial resources toward the management of the River. Consequently it is apparent that at the local scale international standards of political commitment and institutional development towards the reduction of flooding risk are not being met.

6.2.2 Findings Related to Thematic Area 2 of the Framework, Risk

Identification and Assessment

The ISDR provides four indicators of whether national risk identification and assessment criteria are being met. These are that the hazard is recorded and mapped, vulnerability and capacity indicators have been developed and are systematically mapped and recorded; risk scenarios have been developed and are employed; disaster risk in development planning is systematically assessed; and there is an effective early warning system in place which is composed of quality forecast data, dissemination channels and participation at the local level and effective response to a warning. (ISDR, 2004). It is relatively simple to apply these particular indicators to the local and district levels. Districts are required by the National Disaster Management Act (Act 56 of 2002) to undergo a risk assessment process. Unfortunately many districts within the Western Cape, including the Overberg, are yet to undergo this process. An initial step towards performing a risk assessment would be the assimilation of hazard and vulnerability information, which in the case of the Baths River study is flooding data and information on vulnerability to riverine flooding. No information concerning these topics is currently recorded and there are no communication channels let alone forecasting and public response systems of any kind in place within the Theewaterskloof municipality. As such the municipality, like many others in the Western Cape, does not even begin to reach international standards of risk identification and assessment.

6.2.3 Findings Related to Thematic Area 3 of the Framework, Knowledge Management

The thematic area of knowledge management does not scale down as simply as the previous two areas. The primary reason for this is that district municipalities within the Western Cape do not currently have the capacity to meet many of the requirements outlined in the international literature (ISDR, 2004). It is true that the district and perhaps the local municipalities should have the capacity to gather and store information concerning past flooding events but they generally lack the influence and knowledge to modify education programmes such as school curricula and staff training. For example, the inclusion of disaster risk reduction into school curricula is within the provincial Education Department mandate, additionally local and possibly district staff and officials require training themselves thus training programmes would have to be developed and managed from a higher sphere such as the province. The same is true for the development of knowledge networks. The formation of networks between officials and specialists within different districts and possibly provinces or countries would require coordination and management from either the provincial or national level. Very little policy is developed at the local level and as such there are few opportunities to link science and policy as is an outlined requirement of the ISDR's Disaster Risk Reduction Framework. Additionally there is very little human and financial capacity at the local level for research but the collection of local knowledge could be coped with at the local level and overall research should be a priority area at the district level.

6.2.4 Findings Related to Thematic Area 4 of the Framework, Risk Management Applications and Instruments

It appears that at the district level in the Western Cape hard engineering solutions are still predominantly considered best by those in positions required to reduce flooding risk. Collaboration between respective government departments and other organisations will need to be improved if environmental, social and economic factors are to be taken into consideration. Factors highlighted as

exacerbating riverine flooding risk within the districts of the Western Cape are a lack of coordinated management, and on occasion any management; alien vegetation infestation; inappropriate development and low income or other social factors forcing households to build inadequate dwellings in high flooding risk areas. The use of instruments from other sectors, such as the EIA, in disaster reduction planning would promote collaboration between different government departments and other organisations, and increase understanding on the factors exacerbating flood risk mentioned above thus generating progress towards reducing or limiting these factors and consequently flooding risk.

6.2.5 Findings Related to Thematic Area 5 of the Framework, Disaster

Preparedness, Contingency Planning and Emergency Management

Disaster preparedness, contingency planning and emergency management are all functions included in the mandate of the district municipalities thus the ISDR Risk Reduction Framework could be applied directly under this theme. It is clear that collaborated and coordinated disaster preparedness, contingency planning and emergency management between different line-functions and municipal officials is a relatively new concept as was revealed during the December 2004 post flooding assessment (DiMP, 2005). Examples of this were that many line-functions believed they should take the coordinating role during a flooding event, there was substantial miscommunication between sectors, as outlined in section 5.6 of this paper, and general understanding of roles and functions was lacking. Roles and functions are outlined within the National and pending Provincial Disaster Management Frameworks but the practical understanding of these in addition to discovering and solving problems associated with planned processes should occur with use. Within this thematic area the district municipalities, who are responsible for this function, are progressing towards meeting international expectations.

6.3 Critical Appraisal of the ISDR's Disaster Risk Reduction Framework

The ISDR's Disaster Risk Reduction Framework applied to this study was developed for application at a national level to promote a global reduction in disaster risk. As this study applied the Framework at the local level, difficulties were expected. The following section is a critical appraisal of the Framework based on its application at the local level.

The ISDR's Disaster Risk Reduction Framework proved to be an ideal structure to guide this study. Although designed for application at the national level, the Framework provided a comprehensive guide for the research component of this study through the guidance of the investigation towards the critical components of risk reduction at the local level. Additionally, there were no research findings from this study that could not be located within the Framework regardless of how broad the scope of the research was within the flood risk reduction field.

Through this study it did however become apparent that the thematic areas of the Framework cannot always be applied at a single level or scale. For instance, networks required by the Knowledge Management area of the Framework at one level will almost certainly have to be developed at a higher level, such as the networking of district Disaster Managers initially being coordinated at a provincial level. This also applies to the training component as training is most often initially required to come from an outside source such as a higher sphere of government. Ultimately this is a question of where capacity has to be developed first in order to continue with the implementation of The Framework.

Just as the level at which The Framework is to be applied may differ, so does the order in which the implementation of thematic areas is to take place. While the two-way arrows in figure 3.10 indicate this to some extent, they do not relate the fact that sections of a thematic area may require implementation at a different stage to other sections within the same thematic area. For instance training, which falls under Knowledge Management, is required before a risk assessment

can be undertaken within a district. Following the risk assessment however, the information generated requires storage and dissemination which again falls under Knowledge Management. The mixed order in which these thematic areas are applied led to the realisation that the boundary between the Risk Identification and Assessment and the Knowledge Management thematic areas is not a distinct one. This stems from the fact that the identification and assessment of risk as a form of research is included within the Knowledge Management area of the Framework.

In addition, there are instances when a thematic area is applied both at different levels and at different stages of implementation of The Framework.

Despite these few complications the ISDR's Disaster Risk Reduction Framework has proven to be holistic guide to researching disaster risk reduction applications currently employed at a local level.

6.4 The Relationship between Findings and Existing Literature

Existing literature reviewed within chapter 3 of this study includes an overview on global and national flood risk, the concept of disaster risk, emergence of disaster risk as a development concern and the evolution of disaster risk reduction as an organising framework. This section discusses the relationship between these literature topics and the findings detailed in chapter 5.

International literature explains that overall the globally most destructive type of natural disaster is flooding (UN, 2004). This is reflected in Caledon where the most destructive natural disasters are flood events related to the Baths River.

According to international literature, for a disaster event to take place both a hazard and vulnerability to that hazard are required (ISDR, 2004). The hazard assessment required as a component of a flood risk assessment should involve the analysis of the related rainfall data. An analysis of daily rainfall recorded at the Caledon station can tentatively be said to correspond with the widely

accepted belief that the volume of rainfall experienced during extreme rainfall events, along with the number of extreme rainfall events, is increasing due to climate change. This is however speculation based on a brief analysis of Caledon's daily rainfall data. Further analysis is required if a definitive statement is to be made that the patterns observed in the data are evidence that the changes in extreme rainfall events are due to climate change.

A combination of Pelling (2003), the ISDR (2004) and Wisner's (2004) definitions of vulnerability proved most useful. As the ISDR developed both their definition of vulnerability and their Disaster Risk Reduction Framework correspondingly, the ISDR's definition of vulnerability best fitted The Framework which was used to guide this study. The four factors of vulnerability defined by the ISDR are included within the Risk Management Applications and Instruments thematic area of the framework. While the ISDR's four factors of vulnerability appear to include Pelling's "Exposure, Resistance and Resilience" components of vulnerability, Wisner's inclusion of the "capacity to anticipate a natural hazard" as a component of vulnerability is included in the ISDR Framework's Early Warning component of the Risk Identification and Assessment thematic area.

The officials associated with the Baths River tend to focus on the physical aspects of vulnerability to flooding. They perceive the primary concerns related to the flood risk of the Baths River to be the invasion of alien vegetation and the lack of technical measures, such as gabion structures, to reduce exposure to flooding. This view overlooks the social aspect of the vulnerability to flooding associated with the Baths River namely principally the lack of coordinated management of The River and limited communication between stakeholders. This limited view on vulnerability to flooding of the Baths River reverts to the system of beliefs associated with disasters before scholars such as Hewitt's alteration of thinking through the inclusion of a social component into the understanding of disaster events (Pelling, 2003. p47). This is despite the fact that South African disaster management policy includes the social component of

vulnerability (Act 57 of 2002). Officials associated with the Baths River are not alone in holding this view within the Western Cape. Although their attitudes are beginning to change, many district Disaster Managers still focus in reducing vulnerability to flooding through technical measures as opposed to building capacity of those at risk to flooding to reduce their flood risk (DiMP, 2005). According to the UNDP (2004) this approach to disaster management was dominant in the 1970's. This implies that South Africa has contemporary policies on disaster risk reduction but in practice, in this regard, districts of the Western Cape are operating on disaster management principles of the 1970's.

Conflicting with these outdated practices, Disaster Managers of the Western Cape districts are increasingly employing environmental means of reducing flood risk. The importance of protecting natural systems such as wetlands, as suggested by Abramovitz (2001), has been recognised by Disaster Managers. Additionally, they are increasingly employing 'softer' options such as retentions dams as opposed to 'hard' engineering solutions such as river canalisation, to reduce flood risk. This is predominantly evident within the city of Cape Town.

Unfortunately, however, the emphasis of flood risk management is still predominantly on the disaster event itself with Disaster Managers still operating on the Disaster Management Cycle, figure 3.8, presented by Twigg (2004). Holloway (2003) describes how this approach limits the involvement of developers in disaster management. This highlights another disconnection between policy and practice in flood risk reduction where national policy requires the inclusion of risk reduction into IDPs but, as the Spatial Development Framework of Theewaterskloof indicates, this required inclusion does not appear to be implemented. An additional example of the lack of risk reduction in development is the Caledon clinic which is located in an area with high flood risk associated with the Baths River. This is an example of the inappropriate development referred to by Twigg (2004) that increases vulnerability to flooding thus increasing flood risk.

Risk reduction measures as defined by the ISDR (2004) are “the development and application of policies, procedures and capacities of the society and communities to lessen the negative impacts of a possible impact of natural hazards and related environmental and technological disasters.” The National Disaster Management Act (57 of 2002) and the related framework meet the policy criteria of this definition. This study, however, indicates that the application of the policy is lacking predominantly due to the limited capacity of those expected to implement the policy.

6.5 Recommended Future Research and Policy Development

This study has revealed primary areas of concern for flood risk reduction in districts of the Western Cape. The following recommendations at the district level and associated with the Baths River, are based on the findings of this study and international literature including the criteria outlined within the ISDR’s Disaster Risk Reduction Framework.

6.5.1 Recommendations for the District Level:

Recommendations intended for application throughout the districts of the Western Cape focus on improving flood risk reduction methods related to Catchment Management Agencies, Risk Identification and Assessment and Knowledge Management.

Catchment Management Agencies

As has been extensively discussed within this paper, for effective riverine flooding risk reduction it is required that the entire catchment is managed as the single system it is. Currently within the Western Cape the only group operating at the catchment scale are the Catchment Management Agencies (CMA). These agencies do not believe it is within their mandate to undertake flood risk reduction. Their duties primarily include managing water extraction and pollution. They are however the only agency with the spatial scope to successfully include

riverine flood risk reduction into their mandate. To undertake this successfully Disaster Managers from the district municipalities through which a catchment passes should be included within the CMA or as technical advisers.

Additionally, the CMAs should actively participate in the IDP processes within the municipalities through which their catchment passes. This will ensure that the IDP and the CMA plans correspond and effort is not duplicated.

As part of the proposal for a CMA a catchment management plan is required. This management plan should be informed by a risk assessment which could be adapted from or done in conjunction with the district risk assessments. It is clear that they should focus on risks associated with their river system but this is not restricted to flooding risk as there tend to be related risks such as fire risk.

Risk Identification and Assessment

Disaster risk assessments are a primary requirement of disaster risk reduction. The district risk assessments required by the Disaster Management Act should thus be completed as soon as possible. Disaster managers and other relevant officials should be largely incorporated into the process as this is a vital method for understanding the risks and their components within their districts. Public participation should be a large component of the risk assessment for the same reason.

Included in Risk Identification and Assessment is the requirement that hazards are recorded. Thus every district municipality should retain a record of information relating to past flooding events such as the volume of rainfall that triggered the flooding; loss information including details on damage to infrastructure and personal property such as housing; and procedures followed during the response and follow-up. This information should be used to inform and update policy, risk assessments, risk reduction strategies, preparedness and contingency planning and emergency management.

Once completed, risk assessments should be integrated into the IDP process through which no development is to be planned without considering the possible relationship it will have with the risk in the area.

An additional requirement of Risk Identification and Assessment are early warning systems. Severe weather early warnings are currently based on SAWS weather forecasts. As these are created at a larger scale they are often not as accurate as local forecasters. Local forecasters deemed accurate and reliable could be approved, possibly through SAWS, to provide early warning to district and local officials such as disaster managers.

Knowledge Management

Environmental, social, economic and physical factors should be considered when assessing and managing flooding risk. For this to occur effectively district and local municipalities and CMAs will be required to network with a variety of departments and agencies operating in their areas. Examples of these would be Working for Water, on alien vegetation removal; Working for Wetlands, on rehabilitating wetlands as water purifiers and flood water retainers; including information from EIAs into risk assessments or visa versa; negotiating with insurance industries with the aim of providing disincentives for development in areas at high risk to flooding; and creating partnerships for the formation of social safety nets and micro financing.

The National Water Act requires that the 1:100 year floodline is available to be observed by the public. When requested for this study, the floodlines for the Baths River took three months to locate. Many Caledon residents are unknowingly living within the 1:50 year floodline of the Baths River. It is recommended that on sale of these properties potential buyers are informed of this. It is understood that the property value may be devalued by this but possible compensation methods may be employed.

6.5.2 Recommendations for Theewaterskloof, concerning the Baths River

The following are recommendations based on the assessment of flood risk reduction associated with the Baths River. These are aimed at improving Political Commitment and Institutional Development; Risk Identification and Assessment; and Knowledge Management associated with the Baths River.

Political Commitment and Institutional Development

Research revealed that there are currently no bylaws pertaining to the Baths River. This is problematic as it has resulted in a case-by-case attitude towards management and particularly development associated with the River. As such it is recommended that bylaws pertaining to the River should be developed. Examples of the laws required would be those declaring the type of development allowed within various floodlines and stating which methods should be utilised or processes followed for the stabilisation of river banks.

There are many small pieces of debris within the river channel and along the river banks that are a fire hazard as well as increase the potential loss during, and the likelihood of flooding events. Many residents collect these pieces of debris into piles but as they are small it is not possible to enlist the services of a company to remove them for firewood. Currently any burning is prohibited within the Caledon urban area. The alternatives are hiring a company to remove them or the hiring of equipment to have them ground down, both of which are costly. The local fire services have agreed to supervise controlled burning of this material on a day when conditions are favourable if the council approves. Unfortunately the council will not consider burning and as such debris builds up. It is thus recommended that this law is reviewed on a case-by-case basis where the fire department has agreed to supervise.

Risk Identification and Assessment

Current severe weather warnings have limited accuracy due to the scale at which they are developed. Within Theewaterskloof, however, a reliable local weather

forecaster has been identified. It is therefore recommended that an early warning system is developed either formally or using the proposed committee who could examine the weather website and alert people within their area to expected severe weather.

There is currently limited funding for the assessment of areas at risk to flooding of the Baths River. The interactive aerial photograph developed through this study could be used to initially identify areas where attention is urgently required to reduce flooding risk. This tool could be updated and used to monitor progress through, for example, the comparison of before and after photographs of an area where measures have been taken and as a simple record of these measures.

Knowledge Management

The fact that communication between stakeholders within the Baths River catchment is extremely limited is a primary impediment to flood risk reduction in this area. It is thus recommended that collaboration between residents, the municipality and local businesses, such as the Caledon Casino and Spa, is increased. This could be achieved through the formation of the Baths River Committee suggested by the residents. This committee could be utilised to form a communication system between the municipality, the Casino, farmers and residents. This would benefit the municipality as they could delegate responsibility and monitor the river without employing extra staff while the residents would benefit through having a communication channel to authorities, and the Casino can involve residents in their development planning which would increase understanding and cooperation thus potentially decreasing opposition to their proposed development.

There are several organisations and efforts along the Baths River for the removal of alien vegetation, for example the Mill Street Conservation Group. It is recommended that these groups' efforts are united, an overall plan is developed for the long-term removal of alien vegetation and possible funding applied for

through Working for Water. This could be accomplished through the proposed Baths River Committee.

7 Limitations

7.1 Time and Information Constraints

Due to time and information constraints, this study only included a riverine flooding risk assessment. For a holistic approach all risks of naturally triggered disasters associated with the Baths River should have been investigated. This is due to the fact that hazards or risks are most often intimately related with one another thus potentially increasing vulnerability to other hazards. An example of this would be the relationship between riverine flooding risk and risk of fire along the River. Fire decreases vegetation cover and hardens soil thus increasing runoff and the probability of flooding in a high rainfall event, while flooding may deposit debris which in turn increases fuel load and thus the risk of fire. Additionally multiple hazard events may erode at capacity thus increasing vulnerability to hazards and ultimately risk.

For a complete flooding risk assessment of the Baths River past records of flooding events are necessary. Unfortunately there are no such records therefore information, such as the number of flooding events and their dates, infrastructure and property damaged, and response procedures, were not available.

The assessment of flood risk and flood risk reduction methods employed within Theewaterskloof were limited further as a consequence of time and capacity constraints which resulted in the assessments associated with the Baths River not including the entire length of the river. The section excluded from the study is the lower section which is predominantly farmland that appears to be at low risk to riverine flooding. Nevertheless, if the Baths River is to be managed as a single system, the entire reach of the river should be included in assessment and management.

Unfortunately, the original floodlines for the Baths River were only available in hardcopy as eight A₀ sheets of paper. The floodlines were later obtained as un-geo-referenced digital images (JPEG files) which were geo-referenced by hand.

This decreased the accuracy of the floodline component of the interactive aerial photograph.

7.2 Limited Capacity of those Involved in this Study

This study was intended to be performed in conjunction with a project by DWAF. The DWAF study was however postponed due to staff constraints and as such the study was performed alone, increasing effort and limiting the resources available to this study.

In addition to the restricted capacity of DWAF, limited capacity/high work demands of Theewaterskloof municipal officials resulted in their response and involvement within this study being reduced. This resulted in several critical delays in the project, severely limiting what could be achieved in time allocated for this study.

This study was undertaken with a limited knowledge of engineering and hydrology, both important components of flood risk. The degree to which this limited the study was reduced by the involvement in the study of a DWAF official who is a civil engineer.

8 Conclusion

Over the past four years the Western Cape has annually been affected by devastating flooding events. With the advent of climate change and populations increasingly vulnerable to flooding, flood risk of the Western Cape is set to increase.

A critical factor exacerbating the flood risk of the Western Cape is the mismanagement or complete lack of management of the river catchments with respect to flood risk.

River catchments are a single system and react to the activities taking place within them as such (DWAF and WRC, 1996). Consequently the flood risk management of a catchment must be coordinated for the entire catchment area. As river catchments do not adhere to political boundaries, managing them as a single system has proven difficult. Currently within South Africa the only organisations that cover the entire spatial extent of catchments are Catchment Management Agencies (CMA). These organisations, required by the National Water Act, (36 of 1998) do not currently perceive flood risk management to be within their mandate. The Disaster Management Act (57 of 2002), however, requires CMAs, as an organ of state, to manage flood risk within the catchment under their jurisdiction. Where CMAs have not formed, River Management Committees are required. The Disaster Management Act applies to these Committees in the same way as to the CMAs. It is thus the recommendation of this study that flood risk reduction be included within the mandate of CMAs and River Management Committees of the Western Cape.

Although required by law, (Act 57 of 2002), to do so, Integrated Development Plans (IDP) of the Western Cape do not appear to include risk reduction. IDPs are one area where development is required to include risk reduction. The absence of the consideration of flood risk when undertaking development has proven to be extremely problematic throughout the Western Cape. Examples of

instances where flood risk has been ignored with dire consequences are the Heidelberg sewerage works and Caledon Clinic. Both these critical infrastructures are regularly damaged by flooding. While there are no plans to retrofit the Caledon Clinic, relocation of the Heidelberg sewerage works is underway.

Within South Africa, national disaster risk reduction policy reflects contemporary international standards. The implementation strategies of disaster risk reduction are, however, predominantly outdated as they are event and response orientated and primarily include the use of technical measures. This, it would appear, is a result of lack of capacity. District and local municipal officials seem to lack the training required for successful disaster risk reduction. Additionally, these officials believe that there is a considerable lack of funding and general resources available to them for the required implementation of disaster risk reduction.

The implementation of flood risk reduction in the Western Cape does not meet the standards specified within the ISDR's Disaster Risk Reduction Framework. Several components of the thematic areas outlined by The Framework are simply missing from flood risk reduction in the districts of the Western Cape. For instance, Theewaterskloof does not have any bylaws associated with the Baths River. These laws are required as a Legal and Regulatory Framework component under the thematic area of Governance in The Framework. In addition to this, there are no records of flooding events associated with the Baths River, as required under the Risk Identification and Assessment thematic area of The Framework. These are but two of the components where flood risk reduction efforts associated with the Baths River fall far short of international standards.

The severe lack of capacity to reduce flood risk at the district level has a root in the fact that there is a lack of a coordinating organisation for flood risk management of an entire catchment. This primary limitation could be reduced if the CMAs and River Management Committees were to fulfil their obligation to

reduce the flood risk of the area under their jurisdiction, as required by the National Disaster Management Framework. However, as this study illustrates, prevailing constraints in both human and institutional capacity within the municipal sphere significantly limit the effective implementation of enabling policy. This is true even in areas identified to be especially exposed to the impact of climate change and variability.

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Appendix 1

Acronyms

CMA:	Catchment Management Agency
COL:	Cut-Off-Low
DFID:	Department For International Development
DiMP	Disaster Mitigation for Sustainable Livelihoods Programme
DRI:	Disaster Risk Index
EIA:	Environmental Impact Assessment
GIS:	Geographical Information Systems
ICM:	Integrated Catchment Management
IDP:	Integrated Development Plan
IPCC:	Intergovernmental Panel on Climate Change
ISDR:	International Strategy for Disaster Reduction
MIG:	Municipal Infrastructural Grant
OFDA:	Office of Foreign Disaster Assistance
RMF:	Regional Maximum Flood
SAB:	South African Breweries
SAWS:	South African Weather Service
UCT:	University of Cape Town
UN:	United Nations
UNDP:	United Nations Development Programme
UNISDR:	United Nations International Strategy for Disaster Reduction
USAID:	United States Agency for International Development
WCDMAF:	Western Cape Disaster Management Advisory Forum
WRC:	Water Resource Commission
WSSD:	World Summit on Sustainable Development

Appendix 2: ISDR Disaster Risk Reduction Framework (ISDR, 2004. p393-395)

Thematic area 1: POLITICAL COMMITMENT AND INSTITUTIONAL DEVELOPMENT (GOVERNANCE)

Governance is increasingly becoming a key area for the success of sustained reduction of risks. Defined in terms of political commitment and strong institutions, good governance is expected to elevate disaster risk reduction as a policy priority, allocate the necessary resources for it, enforce its implementation and assign accountability for failures, as well as facilitate participation from civil society private sector.

Thematic areas/ Components	Characteristics	Criteria for benchmarks (very tentative)
Policy and planning	<ul style="list-style-type: none"> • Risk reduction as a policy priority • Risk reduction incorporated into post-disaster reconstruction • Integration of risk reduction in development planning and sectoral policies (poverty eradication, social protection, sustainable development, climate change adaptation, desertification, natural resource management, health, education, etc) 	<ul style="list-style-type: none"> • National risk reduction strategy and plan • Disaster reduction in poverty reduction strategy papers, in national Millennium Development Goals reports • Disaster reduction in National Adaptation Plan of Action (for LDCs) on climate change • National follow up on WSSD Plan of Implementation
Legal and regulatory framework	<ul style="list-style-type: none"> • Laws, acts and regulations • Codes, standards • Compliance and enforcement • Responsibility and accountability 	<ul style="list-style-type: none"> • Requirement of compliance by law • Existence and update of codes and standards • Existence of systems to ensure compliance and enforcement
Resources	<ul style="list-style-type: none"> • Resource mobilization and allocation: financial (innovative and alternative funding, taxes, incentives), human, technical, material, sectoral 	<ul style="list-style-type: none"> • Evidence of budgetary allocation • Staffing allocation • Public-private partnerships
Organizational structures	<ul style="list-style-type: none"> • Implementing and coordinating bodies • Intra and inter-ministerial, multidisciplinary and multisectoral mechanisms • Local institutions for decentralized implementation • Civil society, NGOs, private sector and community participation 	<ul style="list-style-type: none"> • Existence of an administrative structure responsible for disaster reduction • Sectoral programmes in line ministries • Consultation with and role for civil society, NGOs, private sector and the communities. • Existence of "watchdog" groups

Thematic area 2: RISK IDENTIFICATION AND ASSESSMENT

Identification of risks is a relatively well-defined area with a significant knowledge base on methods for disaster impact and risk assessment. Systematic assessment of losses, particularly the social and economic impact of disasters, and mapping of risks are fundamental to understand where to take action. Pre-investment appraisals of disaster risk to development and vice versa, consideration of disaster risks in environmental impact assessments is still to become routine practice. Early warning is increasingly defined as a means to inform public and authorities on impending risks, hence essential for timely inputs to reduce their impact.

Thematic areas/ Components	Characteristics	Criteria for benchmarks (very tentative)
Risk assessment and data quality	<ul style="list-style-type: none"> • Hazard analysis: characteristics, impacts, historical and spatial distribution, multi-hazard assessments, hazard monitoring including of emerging hazards • Vulnerability and capacity assessment: social, economic, physical and environmental, political, cultural factors • Risk monitoring capabilities, risk maps, risk scenarios 	<ul style="list-style-type: none"> • Hazards recorded and mapped • Vulnerability and capacity indicators developed and systematically mapped and recorded • Risk scenarios developed and used • Systematic assessment of disaster risks in development programming
Early warning systems	<ul style="list-style-type: none"> • Monitoring and forecasting • Risk scenarios • Warning and dissemination • Response to warning 	<p>Effective early warning systems that include:</p> <ul style="list-style-type: none"> • Quality of forecasts • Dissemination channels and participation at local level • Effectiveness of response to warnings

Thematic area 3: KNOWLEDGE MANAGEMENT

Information management and communication, education and training, public awareness and research are all parts of improving and managing knowledge on disaster risks and their reduction. Inclusion of disaster reduction with a strong gender balanced approach at all level of education, effective public awareness and information campaigns, media involvement in advocacy and dissemination, availability of training for the communities at risk and professional staff, targeted research are the ingredients to support the knowledge base for effective disaster reduction.

Thematic areas/ Components	Characteristics	Criteria for benchmarks (very tentative)
Information management and communication	<ul style="list-style-type: none"> Information and dissemination programmes and channels Public and private information systems (including disaster, hazard and risk databases & websites) Networks for disaster risk management (scientific, technical and applied information, traditional/local knowledge) 	<ul style="list-style-type: none"> Documentation and databases on disasters Professionals and public networks Dissemination and use of traditional/local knowledge and practice Resource centres and networks, in particular educational facilities
Education and training	<ul style="list-style-type: none"> Inclusion of disaster reduction at all levels of education (curricula, educational material), training of trainers programmes Vocational training Dissemination and use of traditional/local knowledge Community training programmes 	<ul style="list-style-type: none"> Educational material and references on disasters and disaster reduction Specialised courses and institutions Trained staff Evidence of systematic capacity development programmes
Public awareness	<ul style="list-style-type: none"> Public awareness policy, programmes and materials Media involvement in communicating risk and awareness raising 	<ul style="list-style-type: none"> Coverage of disaster reduction related activities by media Public aware and informed Visibility of disaster reduction day
Research	<ul style="list-style-type: none"> Research programmes and institutions for risk reduction Evaluations and feedback National, regional and international cooperation in research, science and technology development 	<ul style="list-style-type: none"> Existence of a link between science and policy (evidence-based policy and policy-oriented research) Indicators, standards and methodologies established for risk identification Regional and international exchange and networking

Thematic area 4: RISK MANAGEMENT APPLICATIONS & INSTRUMENTS

Instruments for risk management have proliferated especially with the recognition of environmental management, poverty reduction and financial management tools as complementary solutions. The role of **environmental and natural resource management** in reducing climatic disaster risks is acknowledged. Wetland and watershed management to reduce flood risks, deforestation to control landslides, ecosystem conservation to control droughts are among the best known applications. For effective results, synergies need to be built between sustainable development and disaster risk management practices. **Social and economic development practices** with proven results in poverty alleviation such as social protection and safety nets are increasingly regarded as ways of reducing risks and instruments for self-reliance in recovery. Financial instruments in the form of micro-financing and public-private partnerships can be of great help. Others such as insurance, calamity funds, catastrophe bonds are useful in spreading risks though still difficult to establish in low-income countries. **Physical and technical measures** such as flood control techniques, soil conservation practices, retrofitting of buildings or land use planning are well known practices and have been implemented with mixed results. Their failure is often due to poor governance rather than knowledge of what to do. Moreover, such measures, while effective in hazard control, can often be inadequate for social protection and economic recovery.

Thematic areas/ Components	Characteristics	Criteria for benchmarks (very tentative)
Environmental and natural resource management	<ul style="list-style-type: none"> Interface between environmental management and risk reduction practices, in particular in coastal zone, wetland and watershed management, integrated water resource management; reforestation, agricultural practices, ecosystem conservation 	<ul style="list-style-type: none"> Use of wetland and forestry management to reduce flood and landslide risk Trends in deforestation and desertification rate Use of environmental impact assessments in disaster reduction planning

Thematic areas/ Components	Characteristics	Criteria for benchmarks (very tentative)
Social and economic development practices	<ul style="list-style-type: none"> • Social protection and safety nets • Financial instruments (involvement of financial sector in disaster reduction: insurance/reinsurance, risk spreading instruments for public infrastructure and private assets such as calamity funds and catastrophe bonds, micro-credit and finance, revolving community funds, social funds) • Sustainable livelihood strategies 	<ul style="list-style-type: none"> • Access to social protection and safety nets as well as micro-finance services for disaster risk reduction • Use of safety nets and social protection programmes in recovery process: Insurance take up • Public-private partnerships for micro-financing and insurance at community level
Physical and technical measures	<ul style="list-style-type: none"> • Land use applications, urban and regional development schemes • Structural interventions (hazard resistant construction and infrastructure, retrofitting of existing structures, drought, flood and landslide control techniques) • Soil conservation and hazard resistant agricultural practices 	<ul style="list-style-type: none"> • Construction reduced/zoning plans enforced in floodplains and other mapped hazard-prone areas • Compliance of public and private buildings with codes and standards. • Public buildings (health facilities, schools, lifelines, etc) at high risk retrofitted • Regular maintenance of hazard control structures
<p>Thematic area 5: DISASTER PREPAREDNESS, CONTINGENCY PLANNING AND EMERGENCY MANAGEMENT</p> <p>Preparedness and emergency management have been effective instruments in reducing life losses from direct and indirect effect of disasters. A well-prepared system is expected to be effectively informed by early warning, have in place national and local preparedness plans regularly rehearsed establish communication and coordination systems, as well as adequate logistics infrastructure and emergency fund to respond from. Local level preparedness, particularly of the communities, including their training deserves special attention as the most effective way of reducing life and livelihood losses.</p>		
Thematic areas/ Components	Characteristics	Criteria for benchmarks (very tentative)
Preparedness and contingency planning	<ul style="list-style-type: none"> • Contingency plans (logistics, infrastructure) • National and local preparedness plans • Effective communication and coordination system • Rehearsal and practice of plans 	<ul style="list-style-type: none"> • Testing and updating of emergency response networks and plans (national/local, private/public) • Coverage of community training and community based preparedness • Emergency funds and stocks
Emergency management	<ul style="list-style-type: none"> • Civil protection and defence organizations and volunteer networks 	<ul style="list-style-type: none"> • Effective response to disasters and mobilization of volunteers, including NGOs, in particular Red Cross/Red Crescent Societies

Source: UN/ISDR, October 2003

Appendix 3
Workshop Agenda

**Caledon Community Consultation:
Meeting with residents on the Bath River**

Date: 3 July, 2006
Time: 7pm – 9pm
Venue: Caledon Town Hall
Facilitator(s): Caryn Durham (BSc honours Disaster Risk Science. U.C.T.)

Purpose of the Meeting

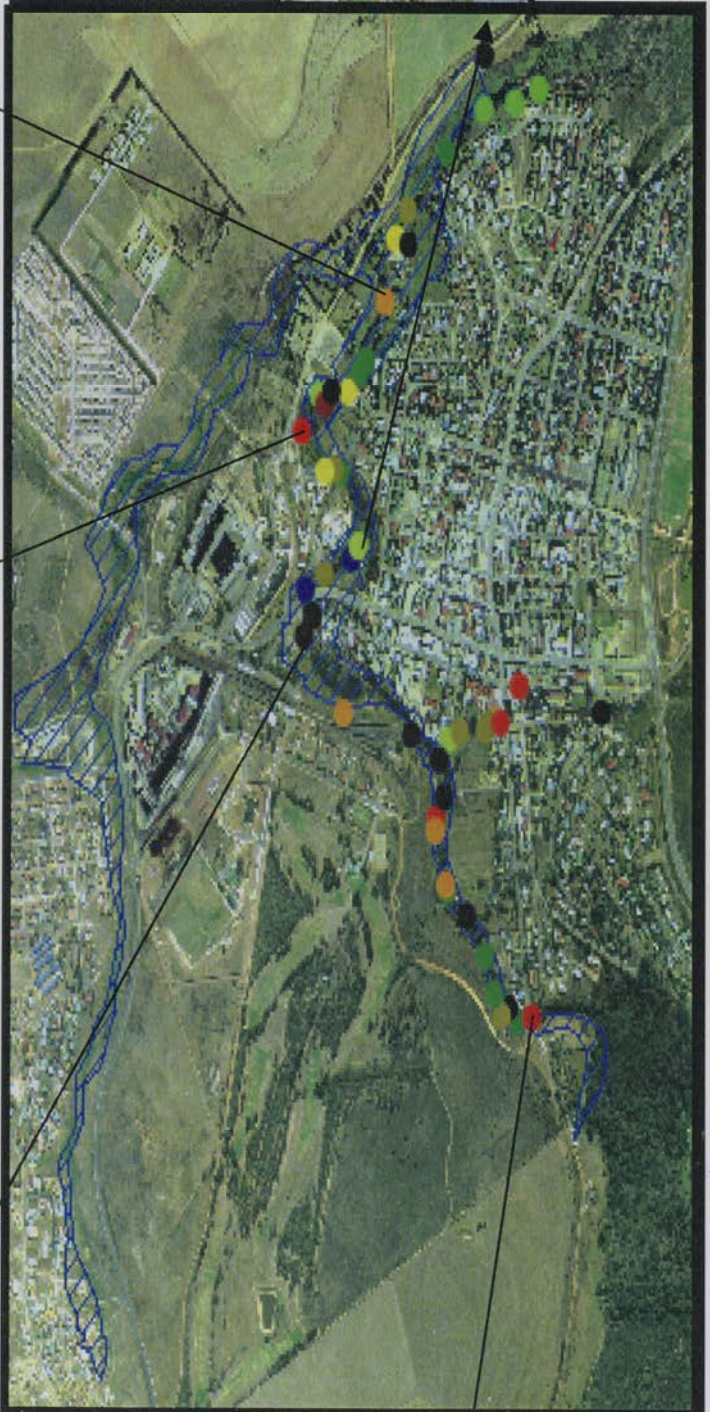
The purpose of the meeting is to understand concerns residents have with regards to the Bath River. Following this, concerns will be prioritised and possible solutions will be discussed for these issues. Ultimately a case will be developed whereby the concerns and possible solutions will be presented by selected residential representatives to the authorities concerned. Subsequently the goal is to develop a management plan for the Bath River in an integrated manner, where all interested stakeholders have a say and responsibility.

Specific objectives for the consultation

Understand residents concerns regarding the Bath River
Prioritise concerns
Discuss possible solutions
Consider representatives for Bath River Management planning meeting

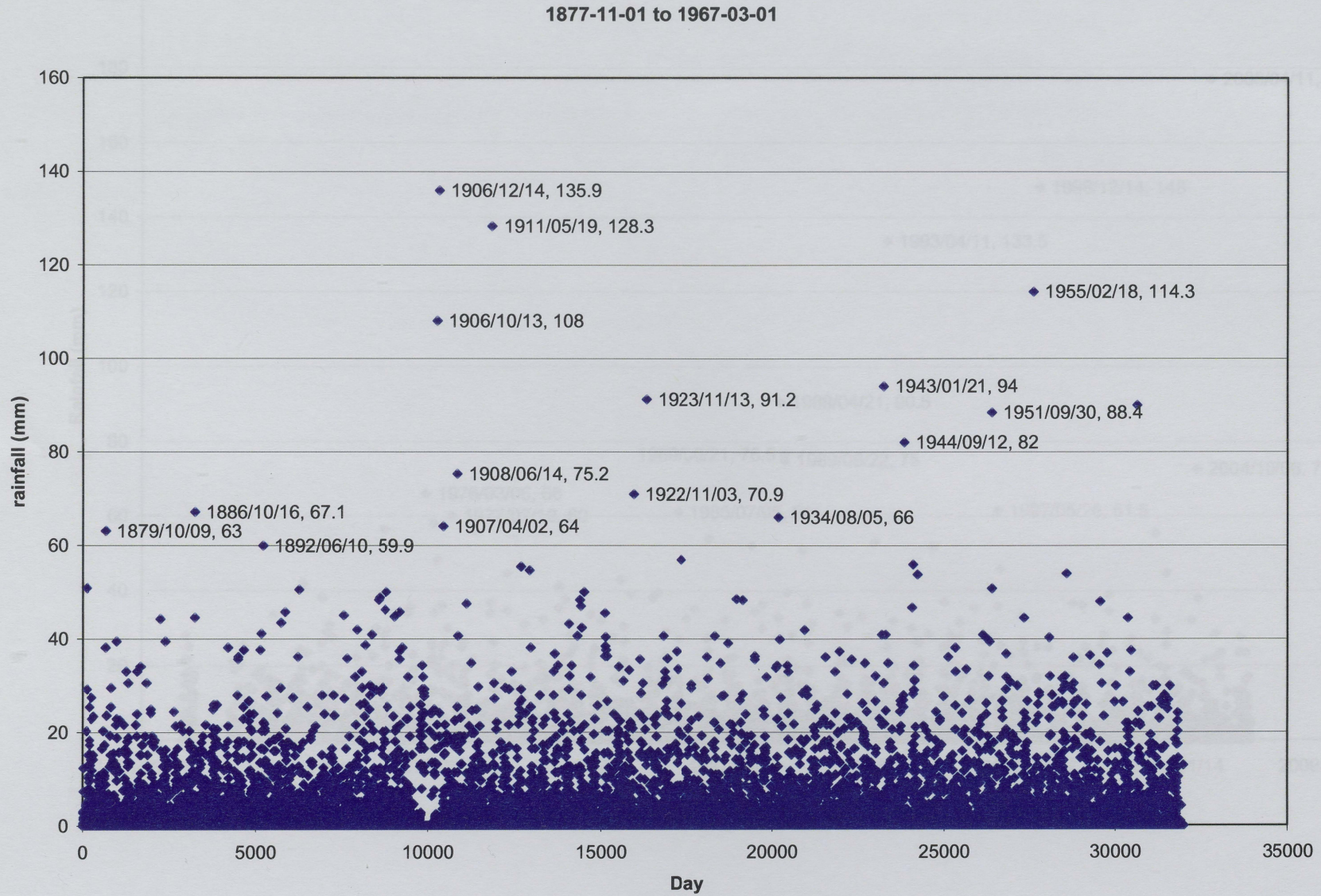
Agenda

Introductions over coffee and tea
Overview of the research project aims and findings
Small group discussion on perceived problems associated with the river
Prioritisation of problems and suggested solutions
Discussion around representation at the Bath River Management Plan development meeting
Other related issues and concerns
Closure of meeting



Appendix 5
Daily Rainfall from the Caledon station

02-03-1967 to 30-09-2006



02-03-1967 to 30-09-2006

