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**ANALYSING URBAN FLOOD RISK IN LOW-COST  
SETTLEMENTS OF GEORGE, WESTERN CAPE, SOUTH  
AFRICA: INVESTIGATING PHYSICAL AND SOCIAL  
DIMENSIONS**

A thesis submitted to the  
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## ABSTRACT

The main theoretical question of the research concerns the importance of considering both the physical and social dimensions of urban flood risk. The following analytical questions are therefore considered: i) What constitutes urban flooding? ii) What processes influence the urban flood hazardscape? iii) What makes people vulnerable to urban flooding? iv) How does one assess urban flood risk?

A realist and constructivist society-environment epistemology are considered. In particular, the platform generated through the aforementioned epistemologies for opening up the opportunity to incorporate an integrated hazardscape and vulnerability paradigm for integrated urban flood risk management is considered.

The research adopts an analytical framework that includes elements of the Pressure and Release model, the Sustainable Urban Development framework and the Extended Alternative Adjustments framework to study flood risk in low-cost settlements. The research incorporates a review of the damage following three extreme weather events over George during 2006 and 2007. It selects a worst affected low-cost settlement for further flood risk analysis. In the flood risk assessment the research investigates the flood hazardscape of the settlement and physical adjustments undertaken by residents. Human flood vulnerability and vulnerability adjustments undertaken by the residents are also investigated. The research adopts a *participatory hazardscape* methodological approach drawing from hydrological methods within the physical sciences and qualitative methods from within the social sciences. Both primary and secondary sources are considered. The findings allow for a guiding Urban Flood Risk Circulation framework that explains the importance of considering both the flood hazardscape and human vulnerability in urban flood risk management.

The study demonstrates that traditional physical science approaches to urban flood risk management are not sufficient for understanding the complexity of the hybrid character of the urban flood hazardscape in low-cost settlements. A broader definition of the urban flood hazardscape that considers more localized forms of flooding becomes necessary. Such localized forms of flooding require both hydrological as well as qualitative methods for assessment. The study is able to trace the root causes of the flood hazardscape to the processes of urban development. The study notes that human vulnerability is the product of physical exposure, poor livelihoods and a lack of adjustments that is also rooted in the processes of urban development. Finally, the study reveals innovative physical adjustments that are either purposive or responsive, to the hazardscape as well as adjustments to the vulnerability.

The study concludes that for effective integrated urban flood risk management, especially in low-cost settlements, it is necessary to understand the hazardscape and human vulnerability. This should be accompanied by an understanding of the human adjustments to the hazardscape as well as the human vulnerability. In this respect, an integrated urban flood risk management plan should be incorporated into the broader integrated development and environmental management planning of a city.

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University of Cape Town

## ACRONYMS

<b>ADPC</b>	Asian Disaster Preparedness Centre
<b>AMF</b>	Annual Maximum Flood Peaks
<b>ASCE</b>	American Society of Civil Engineers
<b>BEE</b>	Black Economic Empowerment
<b>CBDRM</b>	Community Based Disaster Risk Management
<b>CBO</b>	Community Based Organisation
<b>CN</b>	Curve Number
<b>CRA</b>	Community Risk Assessment
<b>CSIR</b>	Centre for Scientific and Industrial Research
<b>DiMP</b>	Disaster Mitigation for Sustainable Livelihoods Programme
<b>DLGH</b>	Department of Local Government and Housing
<b>DMC</b>	Disaster Management Centre
<b>DMP</b>	Disaster Management Plan
<b>DR</b>	Disaster Risk
<b>DRA</b>	Disaster Risk Assessment
<b>DRI</b>	Disaster Risk Index
<b>DRR</b>	Disaster Risk Reduction
<b>DWAF</b>	Department of Water Affairs and Forestry
<b>ECLAC</b>	Economic Commission for Latin America and the Caribbean
<b>EDM</b>	Eden District Municipality
<b>EIA</b>	Environmental Impact Assessment
<b>EV I</b>	Extreme value Type 1
<b>EV II</b>	Extreme value Type 11
<b>FEWS</b>	Flood Early Warning System
<b>FLODISM</b>	Flood Damage Simulation Model for Irrigation Areas
<b>GEV</b>	General Extreme Value Distribution
<b>GIS</b>	Geographic Information System
<b>GPS</b>	Global Positioning System
<b>H</b>	Hazard
<b>HFA</b>	Hyogo Framework for Action
<b>HFVAL</b>	Household Flood Vulnerability Adjustment Level
<b>HFVL</b>	Household Flood Vulnerability Level
<b>HIV</b>	Human Immunodeficiency Virus
<b>HPAL</b>	Hazardscape Physical Adjustment Level
<b>HRU</b>	Hydrological Research Unit
<b>IDNDR</b>	International Decade for Natural Disaster Reduction
<b>IFRC</b>	International Federation of Red Cross and Red Crescent Societies
<b>IFRM</b>	Integrated Flood Risk Management
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>IWM</b>	Integrated Watershed Management
<b>JOC</b>	Joint Operations Centre
<b>LAL</b>	Learning about Livelihoods
<b>LC</b>	Livelihoods Capital
<b>LDCs</b>	Least Developed Countries
<b>LED</b>	Local Economic and Development
<b>LM</b>	Local Municipality

<b>LN</b>	Log-normal
<b>LP3</b>	log-Pearson Type 3
<b>MDG</b>	Millennium Development Goals
<b>NDMA</b>	National Disaster Management Act (57 of 2002)
<b>NDMC</b>	National Disaster Management Centre
<b>NDMF</b>	National Disaster Management Framework
<b>NGOs</b>	Non-Government Organisations
<b>P3</b>	Pearson Type 3
<b>PAR</b>	Pressure and Release
<b>PD</b>	Partial Duration
<b>PDRA</b>	Participatory Disaster Risk Assessment
<b>PE</b>	Physical Exposure
<b>POT</b>	Peaks Over Threshold
<b>R</b>	(South African) Rands
<b>RCBA</b>	Risk Cost Benefit Analysis
<b>RDP</b>	Reconstruction and Development Programme
<b>RIA</b>	Rapid Impact Assessment
<b>SA</b>	South Africa
<b>SANRAL</b>	South African National Roads Agency
<b>SANZAF</b>	South African National Zakaah Fund
<b>SAWS</b>	South African Weather Service
<b>SCS</b>	Soil Conservation Services
<b>SIA</b>	Social Impact Assessment
<b>SL</b>	Sustainable Livelihoods
<b>STD</b>	Sexually Transmitted Disease
<b>SUD</b>	Sustainable Urban Development
<b>T.B</b>	Tuberculosis
<b>TEWA</b>	Computer Model for Tangible Economic Flood
	Water Damage Assessment
<b>UCT</b>	University of Cape Town
<b>UNDP</b>	United Nations Development Programme
<b>UNESCO</b>	United Nations Educational, Scientific and Cultural Organization
<b>UN/ISDR</b>	United Nations/ International Strategy for Disaster Reduction
<b>V</b>	Vulnerability
<b>VCA</b>	Vulnerability and Capacities Assessment
<b>WCPDMF</b>	Western Cape Disaster Management Framework
<b>WHO</b>	World Health Organization
<b>WRC</b>	Water Research Commission

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## Chapter 1

### Introduction

“Water: Too much ... Too little ... A leading cause of ... disasters ...” (Domeisen, 1997: in title).

The prelude to the introduction alludes to the fact that floods are the leading form of disasters. In this respect, focused analysis on flooding – through the work of leading scholars (e.g. White, 1945; 1974; White and Haas, 1975; Burton et al, 1978, 1993) – has also significantly led the disaster risk field. These thinkers were the first to critique and present alternatives to the traditional approach of flood risk management.

With an increasingly urbanizing world, flood disasters are reportedly increasing in urban areas and particularly negatively impacting on poor people (Alam et al, 2008) and urban development in general. However urban flood risk research was strongly influenced by the concept of floods within the natural, rural environment (also see Zevenbergen, 2007). Consequently there is a growing need to revisit urban flood risk knowledge with a focus on understanding the interaction between urban development and urban flood risk. In this way urban flood risk should also be informed by focusing on the physical, technological, social, economic and political parameters. Such an understanding should ideally contribute to appropriate urban flood risk management strategies and policies.

#### 1.1 Identifying the Problem

The majority of flood risk research has been informed by conventional physical science approaches, drawing predominantly from the fields of flood hydrology and hydraulics. Thus, floods have historically been conceived of as large areas of land being inundated with water because of rivers overflowing. This conceptualisation of flooding, primarily drawn from physical and natural science, has also significantly informed our understanding and approaches to flood

adjustments. As a result, the types of flood adjustments applied were informed by the understanding and conceptualisation of floods according to primarily physical science models. Such flood adjustments were oriented towards technical and physical structural adjustments that often (unintentionally) increased the flood risk.

However recent research, particularly in poor urban environments, and adopting a more socially-oriented lens, has indicated that traditional physical science models are not adequate for defining flood risk in all environments. As the nature and form of flooding in poor urban environments does not qualify as “flooding” according to conventional physical science models, this has resulted in poor urban settlements exposed to flooding not being considered as being vulnerable to flood risk. Furthermore, flood risk reduction measures or flood adjustments in such poor urban environments cannot be solved through adopting the technical and physical structural measures typically associated with a physical science approach to flood risk.

## **1.2 An Integrated Analytical Approach**

Flood risk research has historically been approached from either a physical science or a social science discipline, but seldom within an integrated approach. The conceptual question of the research is therefore concerned with identifying a robust epistemological approach that enables an integrated understanding of urban flood risk, its determinants and consequences.

In this context, the research explores the realist and constructivist society-environment epistemology. It particularly explores the platform generated through the aforementioned epistemologies for opening up the opportunity to incorporate an integrated hazardscape and vulnerability paradigm for integrated urban flood risk management. However the proposed analytical lens is not intended to neatly bound the research into a social science discourse as this would be regressive to disaster risk knowledge. Instead the two paradigms (hazardscape and

vulnerability) that emerge through the aforementioned epistemologies are intended to demonstrate the academic and applied validity and relevance of adopting a transdisciplinary approach for disaster risk research.

### **1.3 Theoretical and Analytical Questions**

The main theoretical question seeks to understand why it is important to consider both the physical and social dimensions of urban flood risk. To answer the main theoretical question the following analytical questions are answered: What constitutes urban flooding? What processes influence the urban flood hazardscape? What makes people vulnerable to urban flooding? How does one assess urban flood risk? These are explored through the lenses of a hazardscape and vulnerability paradigm that builds on the pressure and release (PAR) model (figure 1.1) of Wisner et al (2004). The hazardscape paradigm draws from hydrological models and participatory methods. The vulnerability paradigm includes elements of the sustainable livelihoods framework and access model. Since the research is located in an urban context, the hazardscape and vulnerability paradigm is located within the sustainable urban development (SUD) framework (figure 1.2) by Drakakis-Smith (1996).

A secondary theoretical question seeks to understand human agency in relation to urban flood risk. Here it is considered what human adjustments are made to both the physical and social dimensions of urban flood risk. This requires the research to draw from Hewitt's (1997) framework of extended alternative adjustments. The research analytical framework is illustrated in figure 1.3.

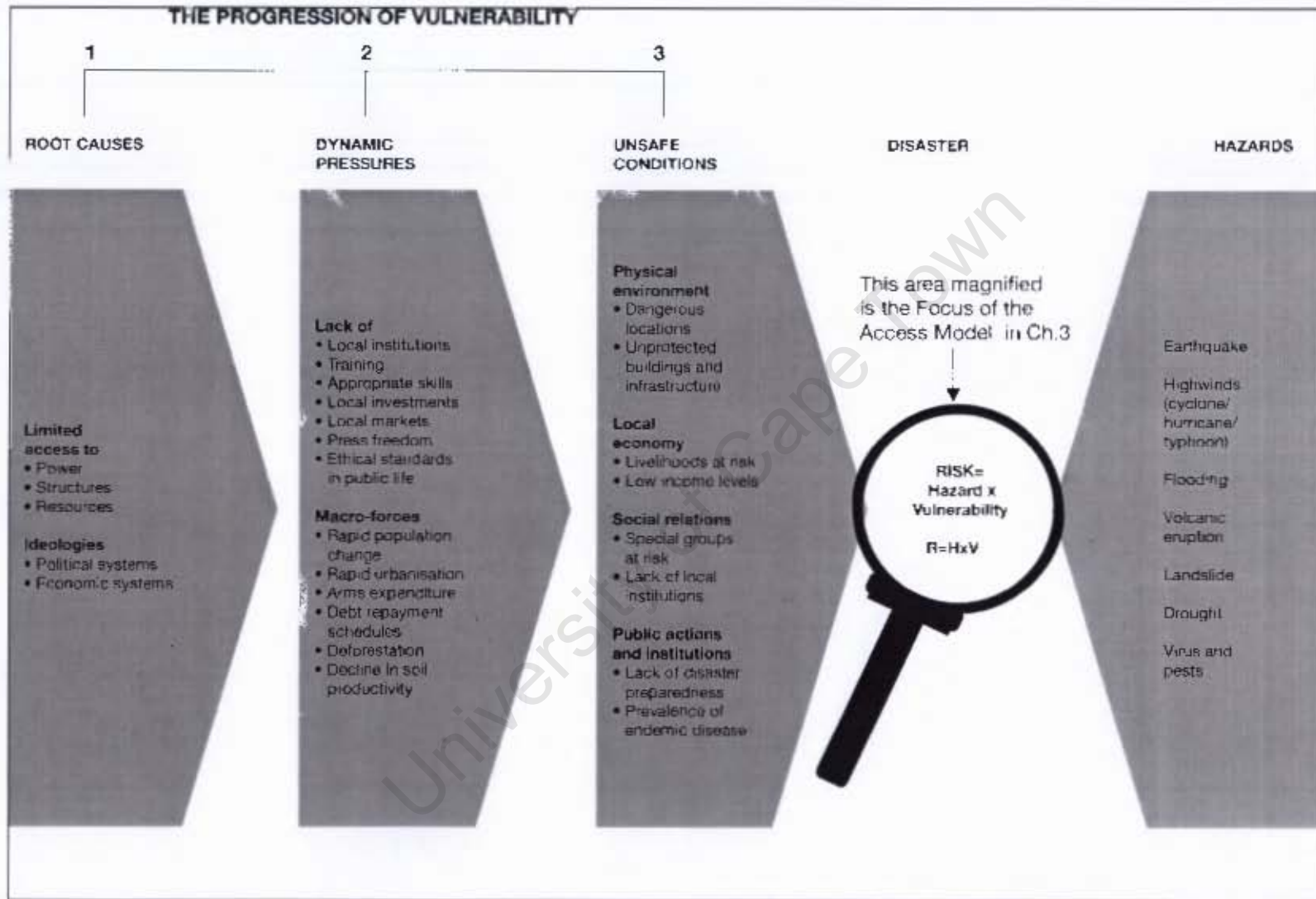
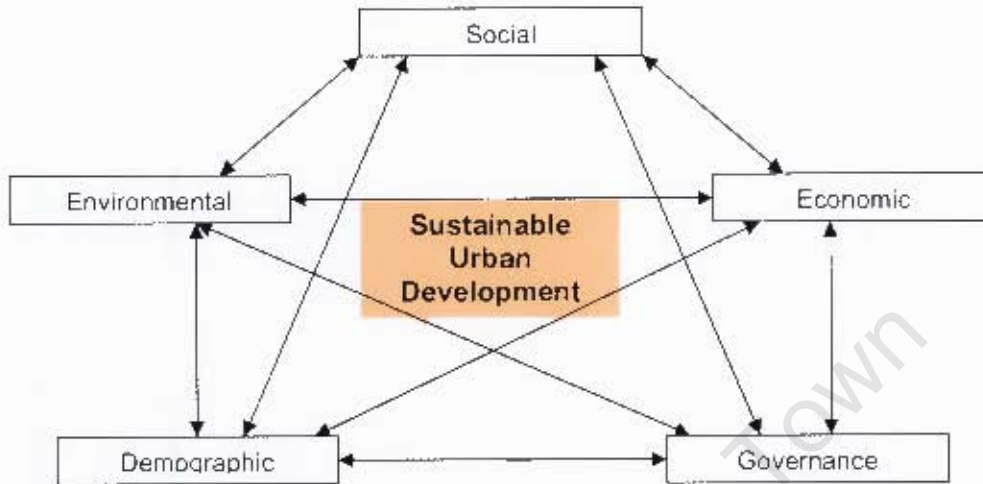


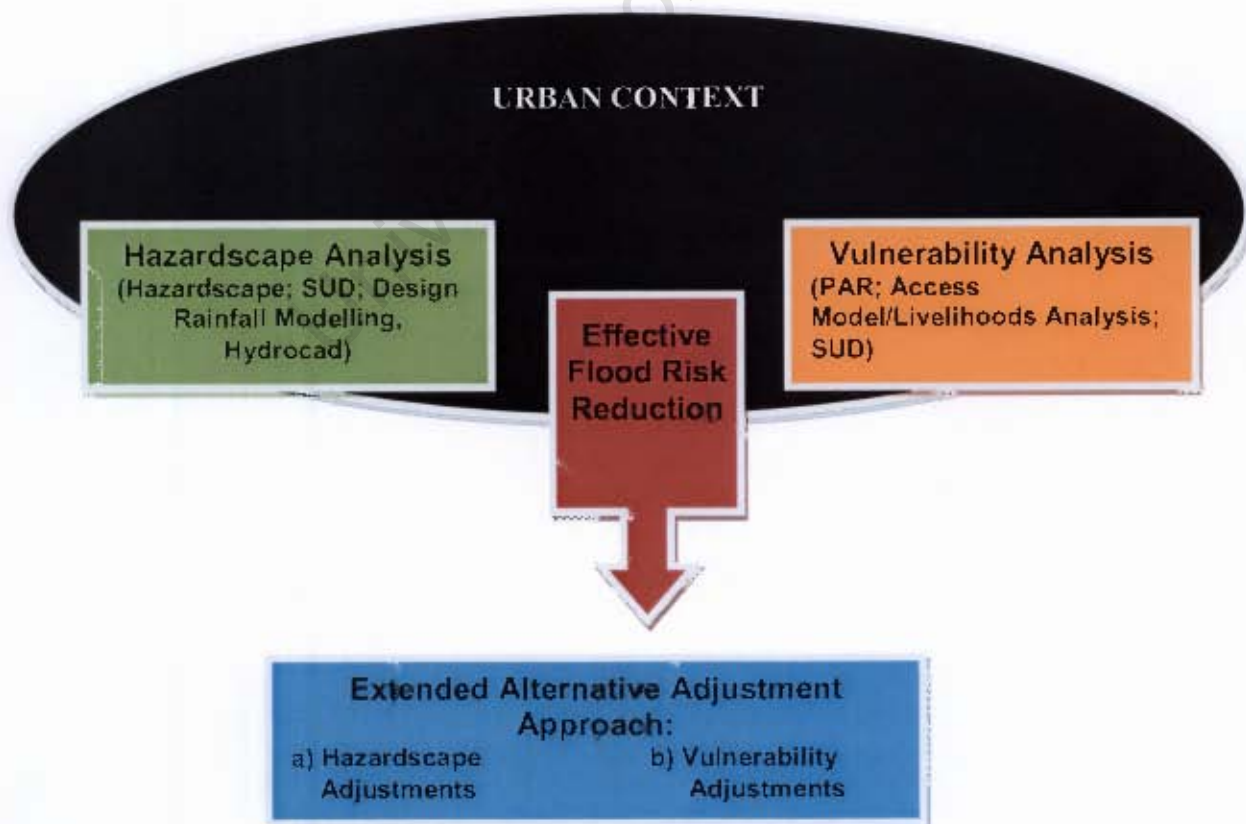
Figure 1.1: Pressure and Release Model

Figure 1.2 Main Components of Sustainable Urbanization



(Modified from reproduced version in Pelling, 2003)

Figure 1.3 Analytical Framework of Research



#### **1.4 Empirical Questions**

The empirical questions of the research are concerned with how the processes of urban development have influenced urban flood risk. They concern the role of unsustainable urban development in generating the varied physical forms of the flood hazardscape. Furthermore they concern the role of unsustainable urban development in generating and exacerbating the conditions of vulnerability of the population that exposes them to urban flood risk.

#### **1.5 Aim and Objectives**

The aim of this research is to develop a guiding framework for integrated flood risk management in Thembaletu, George, Western Cape Province, South Africa. It is intended that such a guiding framework would serve as a pilot that could later be applied to urban areas across South Africa.

Specific research objectives include:

1. To review current international and South African literature on flood risk management, especially urban flood risk management.
2. To comparatively analyse the damage assessments of the July-August 2006 two consecutive extreme weather events and the November 2007 extreme weather event. The two consecutive events in 2006 in particular will be analysed to identify the most vulnerable low-cost settlement for further study.
3. To undertake a hazard(scape) assessment of the identified most vulnerable low-cost settlement of Thembaletu.
4. To undertake a vulnerability and capacities assessment of the identified most vulnerable low-cost settlement of Thembaletu.
5. To integrate the hazardscape, vulnerability and capacities assessment findings.

## 1.6 Structure of Thesis

The thesis is structured into 3 parts. The literature review spans chapters 2 to 5. Chapter 2 argues that the field of disaster risk science is inherently transdisciplinary in nature, thereby justifying the rationale for drawing from many academic discourses and disciplines within the disaster risk discourse. Chapter 3 discusses the development of critical disaster risk concepts within the field of hazards geography through a *society-environment* lens. This research adopts a society-environment lens that enables the research to employ integrative concepts for flood risk management. In chapter 4 critical concepts around floods, urban risk and urban flood risk are discussed. The chapter ends with an integrative framework for conceptualising urban flood risk based on the literature review of this subject. Chapter 5 discusses flood risk research in South Africa. The chapter begins with presenting what a flood risk assessment should entail and then presents how flood risk research is approached in South Africa. A discussion of international best flood risk management practice is also discussed. This is followed by a discussion of the South African flood management legal policy and current flood management practice in the country.

The research component spans chapters 6 to 8. Chapter 6 presents the research context of the study area. Here the geographical, developmental and disaster risk context of the study area are presented. The methodological approach of the research is presented in chapter 7. Chapter 8 presents the findings of the flood risk assessment of the study area. This includes key findings of the post-event assessment of the two extreme weather events in August 2006. The hazardscape and vulnerability analysis of Thembaletu follows this. Finally the chapter presents the overall flood risk of Thembaletu.

The research findings are discussed within the prevailing disaster risk theories in chapter 9. This chapter also presents the guiding framework for flood risk management including recommendations for George. Finally the thesis concludes in chapter 10.

## Chapter 2

### Transdisciplinarity of the Disaster Risk Discourse

“... risk is a truly interdisciplinary, if not transdisciplinary, phenomenon” (Renn, 2008: xv).

#### 2.1 Introduction

This chapter explores the scope and evolution of the Disaster Risk discourse underscoring its transdisciplinary character. Transdisciplinarity refers to the “articulation between disciplines rather than their relations” (Ramadier, 2004: 424). Here elements of methodologies are drawn from different disciplines and combined with a single approach (Sime and Jones-Horlick, 2004: 444). “That is, inputs and outputs are exchanged across disciplinary boundaries, in an evolved methodology which transcends ‘pure’ disciplines. In epistemological terms, transdisciplinary involves an integration of knowledge” (ibid: 444). Transdisciplinarity has been argued to be a potentially effective approach of addressing increasingly complex social patterns that transcends borders between different orthodox disciplinary knowledge (ibid).

The chapter begins by providing an overview of discourses that have contributed to contemporary understanding on disasters. It continues by describing prevailing global approaches to disaster risk reduction and concludes by pointing out the theoretical approach adopted in this research.

#### 2.2 Discourses and Disciplines informing Disaster Risk thinking

The origin of the concept *Disaster Risk* is not formally documented. Its first use is attributed to the disaster research undertaken by *La Red* in Latin America in the mid-1990s (*pers comm.* Holloway, 2008). Disaster Risk emerged as a probabilistic construct to consolidate the disparate theoretical elements of the disasters discourse –those concepts drawn from different disciplines which enhance understanding of the antecedents and consequence of disasters –with the wide ranging methodological and application elements that minimise disaster loss (*pers comm.* Ibid). This conceptualisation provided a valuable transdisciplinary vehicle that incorporated appropriate elements drawn from the physical, social and health sciences (*pers comm.* Ibid). Similarly, it offered a

means to accommodate relevant application elements drawn from those technical and management disciplines responsible for responding to and reducing disaster losses (*pers comm. Ibid*).

The above is consistent with Renn (2008) and McEntire (2004: 1-2) who also observed that risk is a popular topic in many sciences including the natural, medical, engineering, social, cultural, economic and legal disciplines. Renn is of the opinion that none of the aforementioned disciplines can fully grasp the entire substance of risk, except through combining forces would an adequate approach emerge for understanding and managing risks. This opinion is consistent with Gao's (2008) observation of the shortcomings with disciplinary thinking in understanding whole systems. Gao (2008) stated that "We live in a world which cannot be separated into natural world, man-made systems or human society. They are interconnected and influence each other. They should be studied as a whole. It is due to the limitation of human ability that the whole is separated into different parts and studied in different areas and disciplines (*ibid*: 134). Similarly, Geis (2001: 152) observed that, "everything is interconnected and a holistic, integrated ... approach is required" (quoted in McEntire, 2004: 10). Investigating risks therefore requires a multidisciplinary approach (Renn, 2008). Complicated questions about risks necessitate a transdisciplinary vision of the risk concept where representatives of several disciplines need to agree on a common methodology and research agenda (*ibid*).

### *2.2.1 Physical, Social and Health Science discourses*

Disaster risk was conceptually approached and theorised from within six disciplinary schools of thought (Alexander, 1993), which interact or overlap with each other in one way or another. These include:

a.) A **geographical approach** (*ibid*) that draws mainly from theories around society-environment relationships in the form of the *Human Ecology* school of thought (*ibid*; Mileti 1980 and 1999; Hewitt (ed.), 1983; Hewitt, 1997) and the *Political Ecology* school of thought. This mainly concerns theories into how societies influence the environment, especially in terms of generating hazardous environments, and how the (hazardous) environment influence society. This approach is further explored in chapter 3.

b.) An **Anthropological approach** that focuses on “the role of disasters in guiding the socio-economic evolution of populations in dispersing them and in causing the destruction of civilisations” (Alexander, 1993: 13). According to Oliver-Smith and Hoffman (2002) an anthropological approach to disasters was previously primarily based on the focus of human structuring of the disaster experience. However, in its application, anthropology offers a great contribution to disaster management and research particularly with regards to disaster relief aid and reconstruction (ibid). Furthermore, since disaster victims are most often from the most vulnerable sectors of society, anthropologists “assume a special charge of being a voice for people and places that cannot always be heard” (ibid: 14). This approach also draws from and feeds into *human [and political] ecology* (also see ibid). Bruhn (1972) for example historically reviewed human ecology as it developed through geography, anthropology, sociology and psychology. Within anthropology, human ecology emerged mainly through the lens of how cultural behaviour was influenced by environmental phenomena and how environmental phenomena were influenced by cultural behaviour (ibid). Human ecology in anthropology is also commonly referred to as cultural ecology.

c.) A **Sociological approach** where vulnerability and the impacts of disasters are “considered in terms of patterns of human behaviour and the effects of disasters upon community functions and organization ...” (Alexander, 1993: 13). The first part, “patterns of human behaviour”, is very similar to the “cultural behaviour” considered in anthropological human ecology. From (b) above we note that this approach also draws from and feeds into *human ecology*. From Bruhn (1972) it is seen that human ecology from a sociology perspective was more concerned with understanding how the environment influences the form of social organisation. The last part of Alexander’s (1993) explanation, the concern of disaster impacts on social or community organisation is therefore similar to how human ecology was approached in sociology. This approach to disaster studies therefore also has strong ties with human ecology.

Tierney (2006: 109) explained that classical sociological research on disasters emphasized “the pro-social and adaptive dimensions of disaster-related behaviour.” Renn (2008) observed that there are seven sociological theoretical approaches to risk. These include the rational approach, the reflexive modernization approach,

the systems theory approach, the critical theory approach, the post-modern perspective, a cultural theory approach and the framework of social amplification of risk (ibid). All of these theoretical approaches contributed to the body of risk management knowledge.

Mileti (1999) traced the influence of the pioneer in disaster studies, namely Gilbert F. White. Mileti explained how White's schooling in both Geography and Sociology influenced his adoption of a more integrative human ecology approach to disaster studies but that started to adopt a more geographical way of thinking. Mileti also observed that more traditional sociologists studying disasters developed an independent approach known as the *Disaster Research School* that focused on theories around the social psychology of collective behaviour and theories of social organisation (cf. Alexander, 1993: 13 above). This "the concern on theories of social organisation", is consistent with Bruhn's (1972) description of the way human ecology was approached within sociology. Mileti (1999) continued, by the 1970s in the United States efforts were directed to merging the two schools –*Human Ecology School* and *Disaster Research School*, which led to the path breaking and influential publication "*Assessment of Research on Natural Hazards*" by White and Haas (1975). This led to an integrated approach to hazards research and management (Mileti, 1999). A major hallmark of this approach was the hazards adjustment paradigm where it was understood that individuals and groups choose how they cope with or adjust to extremes in the environment (ibid). The evident link that exists between human ecology and sociology was arguably what led to the realisation of this merge.

d.) A **Developmental Studies approach** that considers issues of aid and relief in developing countries (Alexander, 1993). The development studies approach is closely linked with geography as well as human and political ecology approach (see for example Watts, 1983 as well as the many works by Piers Blaikie [see for example Muldavin, 2008], Ben Wisner and Mark Pelling who were schooled in human and political ecology, as discussed in chapter 3, but who also are recognised in development and disaster studies). The development studies approach has its roots in economics and social theories (see discussions in 3.3.5 below).

This interpretation of the role played by development studies to the disaster research field is open to critique recognising that Alexander (1999) fails to point out the concern of development studies around issues of vulnerability and livelihoods security (e.g. the works of Sen, 1981; Swift, 1989 and subsequent researchers on the subject of assets-based livelihoods, see for example de Satgé et al, 2002 and de Satgé, 2004 as well as Pelling, 2003 for a review of the subject –see 3.3.5 below). Moreover, issues of relief and aid are today more robustly understood as a result of the emergence of humanitarian studies since the 1990s (*pers comm.* Holloway, 2008).

e.) A **Disaster medicine and epidemiological approach** that is concerned with the “management of mass casualties, the treatment of severe physical trauma and the epidemiological surveillance of communicable diseases whose incidence rates may increase during the disruption of public health measures following a disaster...” (Alexander, 1993: 14). Also see McEntire (2004: 12). Although this lens on disasters is led by medical practitioners there also exist an element of influence by anthropologists especially the branch of anthropology known as *medical anthropology*. Medical anthropology is concerned with how different cultural and social groups explain causation of ill health and the different treatment and techniques they use for illnesses (Helman, 2001). It also concerns itself with how those beliefs and practices influences biological, psychological and social changes in the human organism (*ibid*). For disaster medicine then, medical anthropology played an influential role in considering cultural specific approaches to health treatment (see *ibid*: 9).

f.) A **Technical approach** that is prevalent among natural and physical scientists (example seismologists, volcanologists, geologists) and engineers (Alexander, 1993). The emphasis here is therefore on the nature, scale and intensity of natural phenomena and possible impacts on engineering or human structures (see for example *ibid*; Bryant, 1991; Tobin and Montz, 1997). A technical approach may also have elements of human ecology especially if the natural and physical scientists have strong groundings in physical geography (example Alexander, 1993; Tobin and Montz, 1997; Bryant, 1991; White [ed.], 1974).

All of the above approaches to disasters made relevant contributions to disaster risk studies (cf. Pyle, 2006). It is also evident that these different perspectives complement and interact with each other. This specifically applies to those disaster risk studies that consider society-environment interactions.

g) **Other disciplines** such as psychology, philosophy and economics have also contributed to the disaster risk field. The psychological perspective on risk contributed to understanding subjective judgements about the nature and magnitude of risks (Renn, 2008). Philosophy contributes to the field by clarifying important practical questions about risk and to improve responses to those questions (Lewens, 2007). Renn (2008) identified two contributions of Economics to risk management. The first includes the conceptualisation of risk as a cost factor that can be exchanged, treated or mitigated like any other cost factor (ibid). This involves Risk Cost Benefit Analysis (RCBA), a method that uses money for measuring the consequences of very different kinds by asking how much people are willing to pay to have (or to avoid) those consequences (Lewens, 2007). Renn (2008) observed from Kunreuther (1995) that the second contribution of economics to risk involves the recognition of opportunities and limits of exchanging different types of costs and offering compensation. This involves for example the impossibility of placing a monetary value on health or life (Lewens, 2007; Renn, 2008) and the possibility of risk insurance and liability laws (Renn, 2008) to encourage preventative measures. A third contribution of economics is its role as one of the roots for the development studies discourse that also influenced disaster risk theory (see d above).

### *2.2.2 Management Disciplines*

Disaster Risk as a transdisciplinary discourse also draws heavily from the management disciplines. It is not clearly explained what constitutes a management discipline per se. However management comprises two types of organizational knowledge: a) *organizational static substance knowledge* and b) *organizational dynamic process knowledge* (Gao, 2008). Of relevance to a management discipline is organizational static substance knowledge. This is further classified into visionary knowledge, scientific knowledge, technical knowledge, managerial knowledge, information and data (ibid). These are

“abstracted, codified, organized, created, applied or transformed into services, products, technical innovation, and process innovations through organizational dynamic process knowledge (i.e. various human activity systems) ...” (ibid: 133). The disaster risk discourse draws from the following management disciplines:

- a) **Actuarial Science**;
- b) **Business Management**;
- c) **Public Administration**;
- d) **Emergency Management**;
- e) **Environmental Management** (*pers comm.* Holloway, 2008).

Actuarial Science and Business Management have contributed to areas such as loss estimation, microfinance, (re) insurance and risk management or business continuity (*pers comm.* Ibid). This is similar to the contribution from Economics (see 2.2.1 g above).

Public Administration has contributed significantly particularly where governance and legislation are involved in implementing Disaster Risk Management [DRM] and Disaster Risk Reduction [DRR] (*pers comm.* Ibid). It specifically contributed to strengthening response and recovery capabilities through preparedness measures, improved policy implementation and increased code enforcement (McEntire, 2004).

In Emergency Management scholars are interested in accidents, crises, emergencies, disasters, catastrophes and calamities (McEntire, 2004). Emergency Management recognises and acknowledges its roots in Geography and Sociology but also acknowledges contributions from other disciplines (ibid) mentioned in 2.2.1. The traditional theory underpinning this discipline was that of Comprehensive Emergency Management (CEM) which organised emergency management functions into useful but overly simplified disaster phases (ibid). Through its traditional theory, Emergency Management has contributed to effective emergency or crisis response. However, currently there is no single overarching theory in Emergency Management (ibid). Emergency Management has now shifted to a focus on proactive measures (see McEntire, 2004). In this respect Emergency Management becomes synonymous to Disaster (Risk) Management. Disaster Risk Management refers to a “continuous

and integrated multi-sectoral, multi-disciplinary process of planning and implementation of measures aimed at–

- (a) preventing or reducing the risk of disasters;
- (b) mitigating the severity or consequences of disasters;
- (c) emergency preparedness;
- (d) a rapid and effective response to disasters; and
- (e) post-disaster recovery and rehabilitation” (National Disaster Management Act 57 of 2002: chapter 1).

Environmental Management plays an important role in disaster risk reduction in assisting to reduce risk from unsustainable natural resource use while protecting the environment (McEntire, 2004; UN/ISDR, 2007b). Risk assessments in environmental management evaluate risks to species (including people), natural communities and ecosystem processes (Burgman, 2005) that builds on the principle of the ‘precautionary principle’ in sustainable development (Lewens, 2007).

### *2.2.3 Introducing the Hyogo Framework for Action [HFA]*

Prevailing conceptions associated with disaster risks increasingly reflect the evolution and synthesis of a diverse range of disciplinary responses (2.2.1 above) and risk management interventions (from 2.2.2 above) for example, good governance, business continuity and catastrophic risk insurance (*pers comm.* Holloway, 2008). Furthermore, highly visible domains such as disasters are not only framed by academic discourse and scholarship but are also powerfully shaped by international agendas and strategies (*pers comm.* Ibid). In this context there have been two global initiatives which have shaped international enterprise related to disasters since 1989. These were the United Nations (UN) International Decade for Natural Disaster Reduction (IDNDR) during the 1990s and the Hyogo Framework for Action (HFA) since 2005.

The HFA (UNISDR, 2005a) is a global policy document and framework that informs guidance for action to address and reduce disaster risks. Addressing this from global, regional, national and local levels from 2005 to 2015, it is considered to be the latest significant intervention in the field of disaster risk reduction. This reflects the support the framework has received from many influential stakeholders in the environment and development fields as well as

nation-states in the developing world (see UNISDR, 2005b). Furthermore, most disaster related research and papers since 2005 acknowledge the framework.

The evolution of the thinking that informed the HFA is not formally documented. However, its origin builds on previous developments including the “Yokohoma Strategy” adopted in 1994, the “Rio Summit” in 1992 and the International Decade for Natural Disaster Reduction [IDNDR] during the 1990s (see UNISDR, 2004a; UNISDR, 2005a; also see Pyle, 2006: 10 for a brief review and UNISDR, 2004a for many papers explaining the developments to the HFA and UNISDR, 2007a for United Nations documents related to disaster reduction from 2003 to 2005). The substantiation for the thematic priorities profiled by the HFA is most clearly documented in the UNISDR publication *Living with Risk* (UNISDR, 2004b). This inductive global review of disaster risk reduction was compiled by the ISDR secretariat with early submissions further refined through a series of professional dialogues and international commentary. Those headings were then consciously applied to the substantive planning of the World Conference for Disaster Reduction in Kobe, and the related discussions among Member States that resulted in the formulation of the HFA (*pers comm.* Holloway, 2008; Terry Jeggle, 2008).

The expected outcome of the HFA by 2015 is the “*substantial reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and countries*” (UNISDR, 2005a: 3). This will “require the full commitment and involvement of all actors concerned, including governments, regional and international organizations, civil society including volunteers, the private sector and the scientific community” (ibid: 3).

In order to achieve the expected outcome the HFA adopts the following strategic goals (ibid: 3-4):

- a. *The more effective integration of disaster risk considerations into sustainable development policies, planning and programming at all levels, with a special emphasis on disaster prevention, mitigation, preparedness and vulnerability reduction;*

- b. *The development and strengthening of institutions, mechanisms and capacities at all levels, in particular at the community level, that can systematically contribute to building resilience to hazards;*
- c. *The systematic incorporations of risk reduction approaches into the design and implementation of emergency preparedness, response and recovery programmes in the reconstruction of affected communities*

Through the synthesis of knowledge and experience the HFA identifies the following five priorities for action (ibid: 6):

1. *Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.*
2. *Identify, assess and monitor disaster risks and enhance early warning.*
3. *Use knowledge, innovation and education to build a culture of safety and resilience at all levels.*
4. *Reduce the underlying risk factors.*
5. *Strengthen disaster preparedness for effective response at all levels.*

### **2.3 Conclusion**

This chapter has demonstrated that the emerging field of *Disaster Risk* studies has evolved through two pools of knowledge. The first pool involves conceptual approaches for understanding and addressing disaster risks from various academic disciplines. The second pool includes risk-related applications and interventions drawn from diverse management disciplines. The diversity of disciplines that has shaped the disaster risk field reflects its transdisciplinary character. For the purpose of this research specifically, the conceptual dimension of disaster risk studies is considered. The theoretical lens that guides this research is derived primarily from a society-environment perspective within Geography. The theoretical lens opens up the opportunity to incorporate methodologies from other relevant disciplines through an analysis of the hazardscape and vulnerability concepts that consequently emerge from a realist (human ecology) and constructivist (political ecology) society-environment epistemology.

## Chapter 3

### Disaster Risk Theory in Society-Environment Context

"Yet to understand the significance of research in any field of inquiry is partly to appreciate the development of that field" (Bryant and Bailey, 1997: 10).

#### 3.1 Introduction

This chapter seeks to inform the theoretical paradigm of the research as it explores theoretical and conceptual developments within geography and how these inform disaster risk studies. In this context, the chapter discusses critical concepts in understanding disaster risk. These include a 'hazard(scape) paradigm', a 'vulnerability paradigm', 'resilience' and 'extended alternative adjustments'.

#### 3.2 Society-Environment in Hazards Geography

Hazards geography is that area within resource geography that is concerned with studying disaster risk from a geographical perspective. Although referred to as 'hazards geography' this discourse concerns itself with both hazards and vulnerability paradigms and therefore involves a transparent approach between human and physical geography. Hazards geography is here argued to be the most influential sub-disciplinary school that allowed for an emphasis on both natural/physical hazards and social vulnerability for disaster risk studies. Furedi (2007) argued that the way disasters are viewed and hence disaster risk studies are informed today is based on social constructions (see 1.3). This is consistent with Blaikie (1999) who states that environmental issues are not dependent on 'real' changes in nature,

"but are socially constructed and become issues through developments in scientific research and political and economic circumstances which shift and reform already established representations of nature .... They also are shaped by the imprint of dominant narratives from which they drew their intellectual inspiration and legitimacy" (ibid: 133).

Furedi (2007) therefore asserted that the shift in disaster risk studies away from resistance of society to disasters towards a focus on vulnerability is because of the move of disaster studies from sociology to ecology. This was

achieved by employing a society-environment approach to understanding disaster risks. The society-environment approach was founded within the school of thought referred to as *Human Ecology*. Gilbert F. White (as pointed out in 2.2.1 c above) is said to be the pioneering geographer who over 60 years ago employed a human ecology approach to studying *natural hazards* initially with a focus on flood hazards where he realised that it is not only the hazard that should be adjusted but also the human exposure to the hazard (Hewitt, 1983; Mileti, 1999; Watts, 1983a; White, 1945; White, 1974: 3-4; White and Haas, 1975).

### 3.2.1 *Human Ecology in Hazards Geography*

What is human ecology and how has it influenced studies of disaster risk from a geographical perspective? Human ecology, as Bruhn (1972) in his review of the development of the discourse demonstrated, is too complex to define since it has its roots in geography, anthropology, sociology and psychology and that it extends back to the early thinkers within each of the above mentioned disciplines in the nineteenth and early twentieth centuries. Human ecology however can be said to be a science, a unique discipline, a philosophy, a point of view, and an approach for studying a specific problem when humans become the central focus (ibid). Human ecology has therefore developed as a speciality within each of the above-mentioned disciplines in studying human-environment interrelationships, except for geography (ibid). Bruhn noted from Barrows (1923) that the entire field of geography was considered human ecology.

The analytical capacity provided by geography makes the field ideal for integrating the biological, physical and social sciences for developing a framework in which to study and understand human-environment relationships (Bruhn, 1972). It is for this reason that a human ecological approach from within geography (inspired by the work of Burton and Hewitt, 1974, Burton *et al*, 1978; White, 1974 [mentioned in Hewitt (ed.), 1983]; White and Haas, 1975) has assisted geographers to place emphasis on both the physical or natural hazard and the human vulnerability (cf. Pyle, 2006 and Vogel, 1992). This led to an increasing awareness during the 1970s to move

away from explaining disasters as natural occurrences and 'Acts of God' to viewing it as the consequence of failed development. Much has already been written with regards to the implications of viewing disasters as 'Acts of God', but suffices it to say this view saw disasters as natural occurrences and therefore allowed blame to be shifted away from governments and businesses to nature (Alexander, 1993: 342; Furedi, 2007). The more recent perspective (viewing disasters as a consequence of failed development) reversed this apportionment of blame. The publication of *Interpretations of Calamity* edited by Hewitt, 1983 was intended to explain disaster risk from a human ecological perspective and also showed the success of the human ecology approach at the time for disaster risk<sup>1</sup> research. The thesis was that to comprehensively understand the problem of environmental hazards required a deep understanding of human's relationship with nature and the nature of human society (Burton, 1983).

Hewitt (1997) and later Wisner et al (2004) [but earlier in their first edition by Blaikie et al (1994)] critiqued the dominant view of disaster research that focused on the hazards where the damaging agents and events were emphasized. This view saw disasters as exceptions (Hewitt, 1997) and 'Acts of God' (Burton, 1983; Watts, 1983a). Hewitt (1997) proposed an alternative approach through adopting a human ecology perspective to disaster risk that prioritised the distribution of human vulnerability, intervening conditions and responses. Hewitt argued that rather than being exceptions, disasters are developed from everyday normal life and living. Thus for Hewitt it was necessary to identify and consider the vulnerability of people rather than only concentrating on the triggering agent of a disaster (i.e. the hazard). Hewitt's human ecology of risk identified four conditions or 'elements' of risk that included:

1. *hazards* –the physical phenomenon in the natural or artificial environment;

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<sup>1</sup> The term "disaster risk" was only coined in the late 1990s as mentioned in chapter 2. During the period under discussion the term natural hazards and natural disasters were widely used. Presently many of the scholars of that generation still use the terms natural hazards and natural disasters. In an effort to be consistent in language the term "disaster risk" will be used throughout.

2. *vulnerability and adaptability* –the inherent conditions that may increase danger
3. *intervening conditions of danger* –aspects of the habitat and society (e.g. soil type, topography, vegetation cover, water table etc.); and
4. *human coping and adjustments* –capacities to respond (i.e. resiliency).

Blaikie et al (1994) and now Wisner et al (2004) also offered an alternative approach to the dominant view that similarly emphasised the importance of vulnerability to people (hence the title *At Risk: Natural Hazards, People's Vulnerability and Disasters* [own emphasis]). Their approach also adopted a *society-environment* discourse, but rather than being human ecology it is argued that their alternative approach is embedded within *Political Ecology* that too has roots in human ecology as will be discussed in 3.2.2 below.

#### *Critique of Human Ecology perspective*

Bruhn (1972) observed that human ecology would remain a debatable, ambiguous and fragmented science unless the different disciplines mentioned earlier united in their approach. Bruhn's prediction of the fragility of the human ecology discourse was certainly realised. The ambiguity that Bruhn warned of can be seen today where the name of the discourse is interchangeably referred to as *social ecology* as well<sup>2</sup>. Here for example, Bookchin's (1990) publication, *The Philosophy of Social Ecology: Essays on Dialectical Naturalism* (own emphasis) which proposed a philosophical approach of "dialectical naturalism" with which to understand the socio-nature relationship is in essence human ecology. Goldstein (2008) for example, employing a human ecology approach, incorporates Bookchin's philosophy of dialectical interaction to demonstrate how resilience to bush fires can be boosted. Bruhn (1972: 109) also loosely in his review used the term social ecology. The reason for the interchangeable use of the term human and social ecology can be attributed to the wider adoption of the approach within the social sciences, particularly anthropology and sociology. The journals *Human Ecology* and

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<sup>2</sup> Dr. Kevin Winter is thanked for his contribution to this comment.

*Human Ecology Review* for example have many papers that deal with human ecology from either an anthropological or sociological perspective.

The application of a human ecology perspective to disaster risk studies has been vigorously critiqued. Ironically the publication of *Interpretations of Calamity* was intended to promote the value of the human ecology approach to disaster risk research. However, a critical piece by Michael Watts (1983a) within the respective publication was the first to challenge the human ecology approach and raised concerns with using the human ecology approach<sup>3</sup>. Watts proposed that a Marxist theoretical approach be used to critique conventional hazards research as well as for placing hazards research into the broader social theory of the time. Watts illustrated that because of the structural-functionalist approach traditionally adopted in human ecology there was a tendency towards an 'ecological'/'biological' (or 'naturalist') view to the environment. This realist view of nature that was reinforced by logical positivist methodologies to establish clear patterns of cause and effect remained prevalent among most natural scientists (Blaikie, 1999). The Marxist view proposed by Watts (1983a) was based upon the "structure of societies or cultures, and how those societies or cultures are able to respond to changes in the natural environment" (Bryant, 1991: 8). Piers Blaikie (among others) for example also adopted a Marxist theoretical approach in his earlier works (Muldavin, 2008). This view therefore enabled hazards to be viewed as disruptions in the socioeconomic system and has therefore placed emphasis on assessing how socioeconomic systems were [un]able to cope with unfavourable ecological conditions rather than fatalistically viewing disasters as 'Acts of God' (Watts, 1983a).

From Bryant and Bailey (1997) it is clear that Watts' theoretical base (ibid particularly cites Watts, 1983b) was Neo-Marxism that was critical of Neo-Malthusianism and cultural ecology. The explanatory model adopted in such a Neo-Marxist approach is structural that seeks to explain local conflict or change as an outcome of production processes (Bryant and Bailey, 1997).

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<sup>3</sup> Professor Bill Mosely is gratefully acknowledged for pointing this out.

While this is not the place to critique a Marxist perspective, it should be recognised that Watts' critical piece of the human ecology school has seen many (human) geographers engaged in hazards geography shift to a more radical political ecology approach for studying disaster risk within a socio-nature lens. The radical geography field particularly raised important questions on 'natural' hazards and disasters (Bryant and Bailey, 1997). Ibid observes from Susman et al (1983) and Watts (1983a) that radical scholars such as O'Keefe (1975) and Wisner (1976, 1978) "initiated a process of inquiry into the interaction of political-economic structures with ecological processes that culminated in alternative research agenda published on the subject of disasters and hazards in the early 1980s" (Bryant and Bailey, 1997: 12). These works strongly influenced "the need for work on the political economy of environmental change in the Third World" (ibid: 12) giving rise to the emergence of a political ecology perspective.

### 3.2.2 Political Ecology in Hazards Geography

Blaikie (1999) observes from Zimmerer (1993) that human geography has through its history used ecological concepts in five different ways, of which political ecology is the most recent. Bryant and Bailey (1997) identified ten different environmental research fields in relation to what they termed *Third World political ecology* (the term *Third World political ecology* was however first mentioned in Bryant, 1992), the tenth one being [third world] political ecology. Here they highlighted several key characteristics of each of the ten research fields in terms of whether it focuses on the developed or developing world, the main discipline(s) the research field is located in, the date of origin, whether it has a main academic journal, the key themes of focus, whether it has any affinities with 'Third World political ecology', and the type of environmental outlook (i.e. ecocentric or technocentric) it promotes. Four of the research fields locate their main disciplines within geography and therefore differing to Zimmerer's (1993) five ecological concepts within human geography. However, like Zimmerer, Bryant and Bailey's (1997) also state that political ecology is the most recent with its origins in the early 1970s when human-environmental interaction was increasingly criticised by the public and scholars alike. However the discourse only really developed in the early

1980s within the fields of human/cultural ecology and radical development geography (ibid) as discussed in 3.2.1 above. Note that cultural ecology refers to a human ecology approach within anthropology (see ibid table 1.2). It is for this reason, the fact that political ecology has its roots in human/cultural ecology and radical development geography, that Robbins (2004: 16) asserted that the roots of political ecology is much deeper extending back to “the nineteenth- and twentieth century environmental research in geography, anthropology, and allied natural and social sciences.” Likewise Blaikie (1999: 131) stated that: “Much of political ecology could, in an inclusive definition of the field, just as well be labelled environmental sociology, environmental anthropology, environmental economics, and the political science of the environment, and as such, is produced by a number of disciplines outside geography too.”

The above is consistent with the review of Bruhn (1972) discussed earlier and it would also be consistent to state that political ecology is then an evolution of the human ecology approach –that is political ecology emerged as refined theoretical developments took place within the social sciences of the environment<sup>4</sup>. Human ecology then adopted a structuralist, realist epistemology whereas political ecology adopts a post-structuralist, constructivist epistemology (Blaikie, 1999; Bryant and Jarosz, 2004; Pelling, 2007 *pers. comm.*). The result is that political ecology opens the opportunity to analyse the ways in which competing discourses (as well as material relations –the focus of the human ecology) shape people’s relationship with the environment (Pelling, 2007 *pers. comm.*). This has allowed for the questioning of powerful environmental knowledge based on scientific, formal and state sponsored assessments (Blaikie, 1999).

Robbins (2004) noted that many definitions for political ecology are to be found and for this reason Blaikie (1999) maintained that there is no clear limits to what constitutes political ecology making it susceptible to ‘outsiders’ from geography to lay claims to it. Robbins (2004) however noted that all of the definitions suggest, “that it works from a common set of assumptions, and that it employs

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<sup>4</sup> This builds on a point that Dr. Mark Pelling raised in an email correspondence on the 22 October 2007. Dr. Pelling specifically stated that the two schools (human and political ecology) reflect changing approaches in the social science of the environment.

a reasonably consistent mode of explanation” (ibid: 5). This mode of explanation “evaluates the influence of variables acting at a number of scales, each nested within another, with local decisions influenced by regional policies, which are in turn directed by global politics and economics” (ibid: 11). Political ecology therefore does two simultaneous things (ibid). Firstly, it critically explains the problem with dominant accounts of environmental change and secondly, it explores “alternatives, adaptations, and creative human action in the face of mismanagement and exploitation” (ibid: 12). Political ecologists therefore try to establish the root causes of environmental problems. Furthermore political ecology adopts a radical ethical position that is more concerned with the rights of the poor over those with power (Bryant and Bailey, 1997; Bryant and Jarosz, 2004).

Robbins (2003 and 2004) observed the growing importance of political ecology within hazards geography, where political elements of social-environment systems are increasingly considered. Political ecology has certainly had a powerful influence on the discourse of disaster risk studies. Blaikie’s et al (1994) and the revised second edition of Wisner et al (2004) of their book ‘*At Risk...*’ mentioned in 3.2.1 above offered an alternative view to the dominant view of disaster studies. Their book was well received in the disaster risk community and has been referenced in the majority of papers and theses on the subject of disaster risk science since 1994. Muldavin (2008) also noted that ‘*At Risk*’ is widely used in university courses as well as by policy makers and practitioners to the extent that it has been translated into a number of languages. Wisner et al (2004) for example pointed out that during the decade of the 1990s (following the first publication) there has been a convergence of thinking and, to a limited extent, practice concerning natural hazards, people’s vulnerability and disasters as presented in Blaikie et al (1994). It is argued here that the alternative view presented by Blaikie et al (1994)/ Wisner et al (2004) drew heavily from political ecology and in this way political ecology has strongly influenced the disaster risk field.

Although emerging in the human ecology discourse of human geography, both Piers Blaikie and Ben Wisner developed into political ecologists and in fact were critically influential in developing the field of political ecology (see for

example Blaikie, 1999; Bryant, 1992; Bryant and Bailey, 1997; Bryant and Jarosz, 2004; Muldavin, 2008; Rocheleau, 2008). Muldavin (2008), a physical geographer now political ecologist, wrote a tribute to Blaikie's lifework and its contribution to the field of political ecology as well as Muldavin's own work. Similarly, Rocheleau (2008), a feminist political ecologist traces the intellectual and professional influence of her work to Blaikie. Bryant and Bailey (1997) and Bryant and Jarosz (2004) also listed both Blaikie and Wisner as political ecologists. Wisner (2001) for example adopted a political ecology lens to explain why the different spheres of governments in El Salvador failed to learn from hurricane Mitch in 1998 with regards to the devastating earthquakes in 2001 that hit the country. Muldavin (2008) stated that other authors also see 'At Risk' as constituting political ecology.

The alternative view presented in 'At Risk', the progression of vulnerability model (PAR) is clearly political ecology in origin for four clear reasons. The main elements of the PAR model (figure 1.1) include the *root causes* (the well-established, widespread processes within a society and the world economy), the *dynamic pressures* (which channel root causes into particular forms of insecurity), and the *unsafe conditions* (the specific forms in which the vulnerability of a population is expressed in time and space in conjunction with a hazard). Firstly, it was mentioned earlier that political ecologists seek to establish the root causes of environmental problems. The first element of the PAR model –root causes –clearly seeks to do this.

Secondly, it was mentioned above that political ecologists adopt a radical ethical position in favour of the poor and marginalised. Bryant and Bailey (1997) for example emphatically stated that political ecologists do not really support the notion of sustainable development because the term itself is a scapegoat for government and is also unrealistic. However, they asserted that political ecologists support and want to see radical social change. Wisner et al (2004) also noted the dubious nature of the notion of sustainable development. Furthermore, one of the criticisms of Blaikie et al (1994) as observed in Wisner et al (2004) is that the focus on root causes is of no practical use "and amounts to a call for social revolution" (ibid: 30).

Thirdly, Robbins' (2004) observation of the common trends in political ecology work can clearly be seen in the PAR model. This is illustrated in table 3.1 below. Fourthly, building on the preceding point, the PAR model draws much from Bryant's (1992) framework for understanding Third World political ecology as a research agenda. Here Bryant presents three areas of critical inquiry: i) the contextual sources of environmental change; ii) conflict over access; iii) the political ramifications of environmental change. The relationship between Bryant's framework and the PAR model is illustrated in table 3.2 below.

It is therefore clearly observable that the alternative approach to disaster risk studies presented in 'At Risk', a strongly influential text in the disaster risk field especially within hazards geography, has its roots in political ecology. Political ecology has deeper roots in various ecological models of which human ecology is one. A political ecology approach to disaster risk studies within hazards geography is gaining momentum (see for example Muldavin, 2008).

**Table 3.1 Wisner's et al (2004) PAR model vis-à-vis Robbin's (2004) common characteristics of political ecology**

<b>Common characteristics of political ecology</b>	<b>PAR model</b>
Works from a common set of assumptions and employs a reasonably consistent mode of explanation	The common set of assumption is that disaster is the intersection of two opposing forces: the processes generating vulnerability and the hazard event. The consistent mode of explanation employed to explain the processes generating vulnerability is the progression of vulnerability from root causes, to dynamic pressures and finally unsafe conditions.
The mode of explanation evaluates the influence of variables acting at a number of scales, each nested within another, with local decisions influenced by regional policies, which are in turn directed by global politics and economics	The root causes explain the distribution of local power, structure and resources as influenced by political and economic systems at the global, regional and national scales.
Criticizes dominant accounts of environmental change	Criticizes the dominant view of disaster studies that emphasises the 'trigger' role of natural and technological hazards.
Explores alternatives, adaptations, and creative human action in the face of mismanagement and exploitation	The accompanying model to the PAR model –the 'Access Model' –allows one to consider how households' access to resources and coping strategies enable households to become resilient to disasters.

**Table 3.2 The relationship of the PAR model with Bryant's (1992) framework for understanding Third World political ecology**

<b>Framework for understanding Third World Political Ecology</b>	<b>PAR Model</b>
<b>Contextual sources of environmental change:</b> reflects growing impact of national and transnational forces on the environment	<b>Root causes:</b> explains the distribution of local power, structure and resources as influenced by political and economic systems at the global, regional and national scales
<b>Conflict over access:</b> emphasises location-specific struggles over the environment.	<b>Dynamic pressures:</b> the processes and activities that 'translate' the effects of root causes both temporally and spatially into unsafe conditions. Examples: epidemic, violent conflict, foreign debt and certain structural adjustment programmes.
<b>Political ramifications of environmental change:</b> focuses on the important effects of environmental change on socio-economic and political relationships	<b>Unsafe conditions:</b> the specific forms in which the vulnerability of a population is expressed in time and space in conjunction with a hazard. Examples: living in hazardous locations, unsafe building materials etc.

### *Critique of Political Ecology Perspective*

Brown and Purcell (2005) criticised political ecologists for failing to view the issue of scale as being socially constructed and therefore falling into the "local trap". The "local trap" here refers to the assumption that organization, policies and action at the local scale intrinsically herald more desired social and ecological effects than activities organised at other scales (ibid). To overcome this trap they argued that political ecology requires a theoretical underpinning to analyse how scale and scalar politics are essential to understand human-environment relationships in development processes. This theoretical underpinning they suggested should include:

1. an explicit examination of scale as an object of theoretical and empirical analysis
2. an investigation of how scales and scalar interrelationships are socially constructed through political-ecological struggle
3. an analysis of how scales and scalar relationships become fixed, un-fixed and re-fixed due to that struggle
4. an investigation into the political interests that advocate particular scalar arrangement
5. an analysis of how the realised political agenda constructs social and ecological outcomes.

For DRR a focus on macro and meso (social, ideological, political and economic) policies is very useful to understand the underlying factors contributing to lived realities of risk as Wisner's (2004) model aptly does. However, concurring with the criticism levelled at this approach of a focus on

'root causes' –especially that at a macro- and meso-scale –does little to assist in reducing risk for those at risk. Awareness of those macro and meso policies may assist in powerful activist lobbies protesting these policies, but whether activism at those scales is 'listened to' and 'translates into' risk reduction for those at risk remains limited. This therefore differentiates between knowledge generation as a focus versus developmental interventionism as a focus<sup>5</sup>.

A political ecology approach to disaster risk is indeed valuable but may also lead to an imbalance in approach. The political ecology approach is applauded for criticising the dominant view of disaster studies to focus on the physical hazard and shifting emphasis towards a deeper analysis of the progression of vulnerability. However, an imbalance may arise here in that an explicit focus may be geared towards understanding vulnerability with limited analysis of the physical hazard. The PAR model of Wisner (2004) is victim of this where the authors argue that the approach does not discard the importance of physical hazards as the trigger, but that the main emphasis is "on the various ways in which social systems operate to generate disasters by making people vulnerable" (ibid: 10). Although it allows for a description of the physical hazard event the model does not place due emphasis on the hazard event that merits further in-depth analysis of the hazard. What is required is a balance in approach as suggested by Hewitt (1997) and Renn (2008).

### **3.3 Critical Concepts in Understanding Disaster Risk**

#### *3.3.1 Introduction*

Approaching disaster risk studies from a society-environment paradigm enables the consideration of the following critical concepts: hazards or hazardscape, vulnerability, resilience and extended alternative adjustments. Incorporating these critical concepts in disaster risk research affords a comprehensive understanding of the disaster risk faced by a given society.

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<sup>5</sup> Dr. Ailsa Holloway is acknowledged for her observation here.

### 3.3.2 Conceptualisation of Disaster Risk

Lewis (1999) distinguished **risk** as being actuarial –i.e. it is a probability. Burgman (2005) identified two kinds of probabilities. The first includes statistical frequency or relative frequency with which an event is expected to occur (ibid). The second involves the degree of belief which is warranted by evidence (ibid) –i.e. subjective probability. He further distinguished between two kinds of subjective probability where (a) meaning is based on a lack of knowledge about a process or bias, or (b) meaning indicates purely personal degrees of belief. This feeds into the debate to whether risk is a social construction or real phenomenon (see Renn, 2008). Burgman (2005) observed that it is complicated to understand statements about probability. “A proposition may be stated in probabilistic terms, but there may be no underlying fact. Language may allow borderline cases or ambiguities so that it is hard to know what the statement means” (ibid: 8). He continued that “statements may have frequency interpretations, but the assignment of a probability may be subjective. Understanding what is meant may not depend on repeated trials (ibid: 8). Here for example the statement: “It will probably rain tomorrow” does not require repetition to be understood (ibid: 8).

Many words are used around the concept of probability (ibid). These words are used to capture a component of the broader concept (ibid). Burgman (2005) cautioned that these words are used carelessly and interchangeably. The following words according to Burgman are currently used in risk assessments: *chance, belief, tendency, credibility, possibility, plausibility, confidence, bounds, likelihood, and risk*. Risk refers to “the chance (within a time frame) of an adverse event with specific consequences” (ibid: 9).

With regards to the field of disaster risk studies risk refers to the probability of a hazard occurring and creating loss (Smith, 2004). However, a disaster cannot occur if a hazard exists but there is no vulnerability or if a vulnerable population exist but there is no hazard (Wisner et al, 2004). Risk to human populations is determined by the frequency of a hazard event, its intensity and people’s vulnerability (O’Brien et al, 2006). Risk to a disaster or disaster risk therefore refers to the probability of harmful consequences, or expected

losses (such as deaths, physical injuries, property damages, livelihoods and economic activity disruption, or environment damaged) resulting from the interaction between natural or human-induced hazards with the physical, environmental, social and economical vulnerabilities of society (UNISDR, 2004a and 2005a). This relationship is represented as follow (UNISDR, 2004a; Wisner et al, 2004: 49):

$$DR = H \times V$$

### 3.3.3 Hazard(scape) Paradigm

From the discussion on disaster risk in 3.3.2 above it is noted that the hazard is one of two important elements when considering disaster risk. Many hazard geography textbooks have detailed accounts of the different types of hazards (e.g. Alexander, 1993; Bryant, 1991; Hewitt, 1997; Smith, 2004; Tobin and Montz, 1997 to name but a few). Section 3.2 of this chapter discussed the shift in thinking within hazards geography over time. Smith (2004: 4-8) also documented the changing paradigms of hazards and divided these changing perspectives into three distinct eras:

i) *Pre-1950* –where great catastrophes were seen as ‘Acts of God’, where the damaging event (hazard) were considered as divine punishment for moral misbehaviour overlooking the point that hazards are a consequence of human use of the earth.

ii) *1950-1999* –this era is further divided into two:

- a. the dominant (behavioural) paradigm where the role of human actions in exacerbating hazards were recognised and consequently solutions sought in applied science and technology through the ‘technical fix’ (or ‘tech-fix’) methodology. This paradigm generated many methods of loss reduction from site-specific physical protection to advanced forecasting and evacuation procedures.
- b. the radical (structuralist) paradigm emerging from the mid-1970s that challenged the dominant view above. This resulted in the study of multiple or cross-hazards (e.g. Hewitt, 1983; Hewitt, 1997; Tobin and Montz, 1997; Alexander, 1993).

This second era has seen a growth in knowledge with regards to understanding hazards where it was realised that hazards has an interactive and evaluative meaning (Hewitt, 1997). Consequently a hazard has been defined as “[a] potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation” (UNISDR, 2004a). This interactive and evaluative meaning depends on the source of danger and the nature and concerns of the society at risk (Hewitt, 1997). Hazards can have two broad origins that include either natural or human processes (UNISDR, 2004a). Within these two realms of hazards, unique types of hazards are produced, based on the specific sub-origin within the natural or human realms. These hazards that are determined by their specific sub-origin are further classified into different physical forms or events by which the hazards are experienced or witnessed. It should be noted that the earth’s system comprises of different spheres. These include the atmosphere, hydrosphere, lithosphere, cryosphere, and biosphere. Hazards that occur from natural processes can be classified according to where in the natural realm they originate –or which of the above spheres they originate from. Table 3.3 below illustrates the natural hazards sphere of origin and the physical forms or events it produces.

Hazards originating from human processes have been classified as technological hazards and social violence (Hewitt, 1997). Technological hazards result from “technological or industrial accidents, dangerous procedures, infrastructure failure or certain human activities” (UNISDR, 2004a). Some examples include industrial pollution, structural collapses (e.g. dam failures), industrial or technological accidents (e.g. explosions, mining), and release of dangerous materials (e.g. radioactivity) etc. (Hewitt, 1997; UNISDR, 2004a). Smith (2004: 227) defined technological hazards as “accidental failures of design or management relating to large-scale structures, transport systems or industrial processes that may cause the loss of life, injury, property or environmental damage on a community scale”. Social violence includes the weapons used (e.g. firearms, nuclear, gas, biological, chemical warfare) during the type of violence (e.g. war, terrorism, subversion, sabotage, genocide, coupe), by whom (e.g. armed forces,

governments, terrorist groups, rebels etc.) and how they are carried out (Hewitt, 1997: 57).

**Table 3.3 Classification of hazards with natural origins**

<b>Earth System's Sphere</b>	<b>Hazard Type</b> (Source: Hewitt, 1997: 56)	<b>Physical Forms or Events</b> (Source: Hewitt, 1997: 56)
Atmosphere	Atmospheric hazards: Temperature, fog, rain, strong winds, lightning, hail, snowfall, freezing rain (glaze)	Thunder/hailstorms, tornadoes, rain and wind storms, tropical cyclones, blizzards, glaze storms
Hydrosphere	Hydrological hazards: Runoff (overland, stream) snow on the ground, ground water, freeze-thaw, sea ice, icebergs	Floods (of different types), glacier advance and 'surges', ice-infested waters
Hazards of the type originating from either the atmosphere or hydrosphere are commonly referred to as <i>hydrometeorological hazards</i> (see UNISDR, 2004a).		
Lithosphere and Cryosphere	Geological/Geomorphological hazards: Seismicity, volcanoes, tsunami (seismic sea wave), earth/rock materials (quickclay, quicksand), mass movements, radioactivity, geothermal heat	Earthquakes, volcanic eruptions, rockslides, rock avalanches, debris and mud flows, submarine slides, subsidence, domestic radon gas hazards
Biosphere	Biological and disease hazards (processes of organic origin or those conveyed by biological vectors [UNISDR, 2004a]): Viruses (e.g. measles, HIV), bacteria (e.g. pneumonia), protozoa (e.g. giardia, malaria), fungal (e.g. pneumocystas), algae, plants (‘weeds’), insects (‘pests’), animals (‘pests’)	Disease outbreaks/epidemics: bubonic plague, yellow fever, influenza pandemics, sexually transmitted diseases, ‘red tide’ (toxic algal bloom), plant infestations, ‘invasions’, insect plagues/infestations, locust/grasshopper plagues, rat infestations, shellfish poisonings

Hazards have physical dimensions by which they are characterised. Typically the hazard's location, intensity, frequency and probability of occurrence are considered. Hewitt (1997) further classified the dimensions of a hazard according to its spatial dimensions, temporal dimensions and compound parameters. The spatial dimensions of the hazard refer to its areal extent or reach of coverage (ibid), therefore its location. However, Hewitt cautioned that the significance of its areal extent is not meaningful without considering the intensity of the hazard. The temporal dimensions of the hazard include its rate of onset (how fast or slowly it occurs), its duration (the period which it persists) and its frequency (how often it occurs) (ibid). Where compound parameters

are concerned, Hewitt noted that the combined spatial, temporal and intensity or magnitude and frequency parameters should be considered as any one of the dimensions may be offset or intensified by the others.

iii) *2000 to present* –

In this present era it is realised that what were previously referred to as 'natural' hazards are so heavily influenced by technology, and the failures thereof, that they are in essence 'environmental' (or 'hybrid' or 'na-tech') in origin (Smith, 2004). Furthermore, Smith noted that natural and technological hazards are related in varying degrees to wider 'context' hazards resultant of global environmental change. Thus, from Smith, in this present era the major categories of environmental hazards include:

- a.) natural hazards (as in table 3.3 above)
- b.) technological hazards (as discussed in ii above)
- c.) context hazards (global environmental change e.g. international air pollution and resultant climate change, environmental degradation, land pressure resultant of urbanisation, super hazards such as catastrophic earth changes).

The term environmental hazard depicts “the threat potential posed to man or nature by events originating in, or transmitted by, the natural or built environment” (Kates, 1978 quoted in Smith, 2004: 9). The potential threat “can be rated according to natural processes or human actions and the extent to which hazards are *voluntary* or *involuntary* ...” (Smith, 2004: 9). Hazards become voluntary if they have a strong human influence or origin and involuntary if they originate from uncontrolled, extreme natural events (ibid). Based on this, environmental hazards can be defined as “extreme geophysical events, biological processes and technological accidents, which release unusually high concentrations of energy or materials into the environment and pose largely unexpected threats to human life and economic assets” (ibid: 11).

Mustafa (2005), using flood hazard in the Rawalpindi/Islamabad conurbation as an example, noted that various physical, social, and technological factors intersect to make flood hazard a “hybrid hazard”. A flood hazard analysis cannot therefore only consider the natural physical parameters of the hazard

thereby rendering a purely physical science approach insufficient. Mustafa therefore combined insights from three intellectual thoughts within resource geography – pragmatism, political ecology and human ecology – coupled with the landscape idea within cultural geography to develop the integrative concept of a **hazardscape**. He defined a hazardscape as both an analytical way of seeing that asserts power and as a socio-environmental space where the gaze of power is contested and struggled against to produce the lived reality of hazardous places.

Understanding the origin and classification of hazards as well as the different dimensions that characterise a hazard is critical in hazard analysis. Hazard analysis refers to the “identification, studies and monitoring of any hazard to determine its potential, origin, characteristics and behaviour” (UNISDR, 2004a). Hazard analysis is rooted in the traditional technocratic model of disaster studies that concerns itself with the natural, scientific and technical analysis of a hazard. A problem arises in the classification of hazards as either natural or human in origin for the purpose of hazard analysis. This is because where ‘natural hazards’ are concerned the analysis that is informed by a technocratic approach will only be focused on the natural characteristics or dimensions of the hazard. To overcome this dilemma the research adopts the concept of a hazardscape. The hazardscape concept engages the social structural basis of vulnerability as well as the power-knowledge dynamic governing policy and popular discourses on flood hazard (Mustafa, 2005). Mustafa asserted that analysis through the lens of the hazardscape helps expand the range of choice and suggests practical solutions to hazardous situations. **Hazardscape** substitutes for the term ‘**natural hazards**’, which alludes to some “external nature as the key causative element in the hazardousness and vulnerability of life” (ibid: 569). The term is therefore an integrative concept to analyse the material, discursive and policy factors contributing to the continuous production and reproduction of the geography of vulnerability (ibid).

#### *3.3.4 Vulnerability Paradigm*

Vulnerability comprises the second important element with regards to disaster risk. **Vulnerability** refers to the inherent “conditions determined by physical, social,

economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards” (UNISDR, 2004). This definition is consistent with many authors writing on the subject who outline the main components of vulnerability (see for example Alwang et al, 2001; Hewitt, 1997; Lewis, 1999; McEntire, 2004; Pelling, 2003; Twigg and Bhatt (ed), 1998; Varley (ed), 1994; Wisner et al, 2004 to name but a few). From the aforementioned authors vulnerability consists of many interrelated components that include environmental, economic, social, demographic, political, [and psychological] variables.

The most influential recent thinking around vulnerability in the disaster risk field stems from Blaikie et al (1994) and now Wisner et al (2004). The PAR model by Wisner et al (2004) as discussed earlier seeks to trace the progression of vulnerability from its root causes, dynamic pressures to the unsafe conditions. Wisner et al (2004) noted that there has been much writing on the subject of vulnerability just before and since their first publication of ‘At Risk’ (also see Varley [ed], 1994). As a result there have been multiple meanings of the term ‘vulnerable’ (Wisner et al, 2004). Alwang et al (2001) for example, reviewed the literature across several disciplines (viz. –economics [including poverty dynamics, asset-based and sustainable livelihoods literature], sociology, anthropology, disaster [risk] management, environmental science and health nutrition) on how these fields define and measure vulnerability. They noted that differences between disciplines exist because of a tendency to focus on different components of risk, household responses to risk and welfare outcomes. They further stated that disciplines focus either only on the risks or the underlying conditions.

Alwang et al (2001) heavily criticised the disaster risk management literature for the imprecision in terminologies. They raised the point that these definitions have a tautological nature (with particular reference to Blaike et al, 1994), which creates confusion. They asserted that definitions suggest that, “risk determines vulnerability, but vulnerability also determines risk” (Alwang et al, 2001: 21). Alwang et al (2001) however overlooked Lewis’ (1999) distinguishing between

vulnerability as actual and risk as actuarial. Risk and vulnerability can be further differentiated as follow:

“vulnerability refers to the potential for casualty, destruction, damage, disruption or other form of loss in a particular element: risk combines this with the probable level of loss to be expected from a predictable magnitude of hazard (which can be considered as the manifestation of the agent that produces the loss” (Alexander, 2000a: 13, quoted in Wisner et al, 2004: 50).

Manyena (2006) went further to state that risk and vulnerability have not been conceptualised in an all-inclusive manner and further stated that vulnerability as a concept does not have an underlying well-developed theory therefore the plethora of definitions. The lack of theory around vulnerability as a concept as suggested by Manyena contradicts this chapter that seeks to “root the theories” as well as the review by Alwang et al (2001).

Wisner et al (2004) acknowledged and welcomed the increased work on the subject of vulnerability. They particularly acknowledged four streams of recent work:

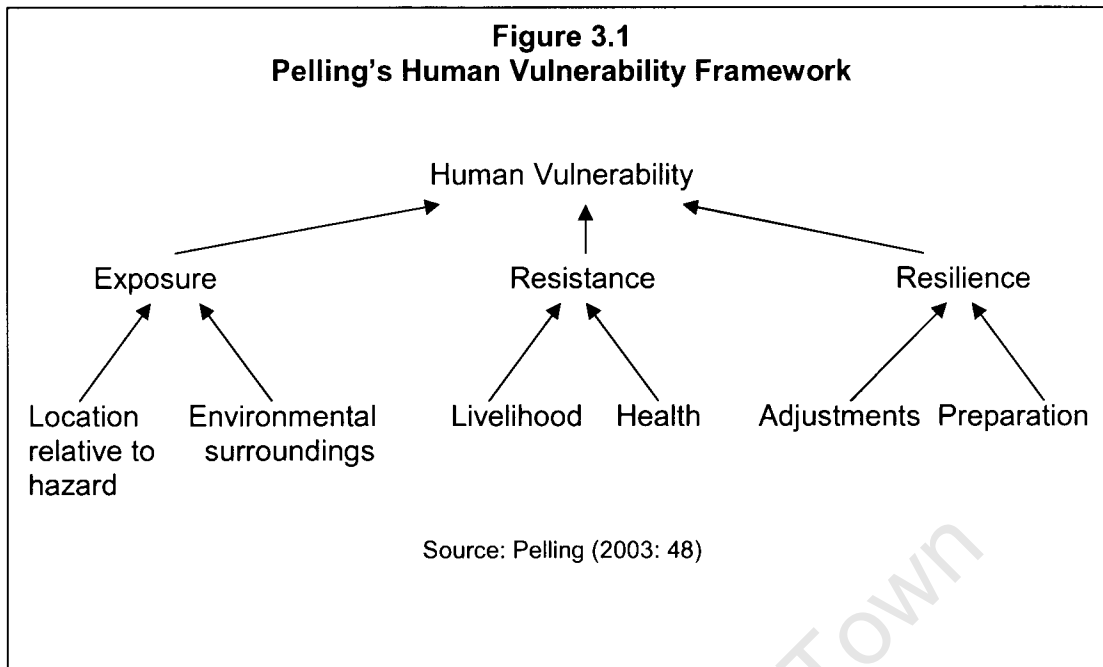
1. The emphasis of recent studies on the **capacity** of people to protect themselves instead of just the vulnerability that limits them. The concept of capacity is substituted with the concept of resilience. This is discussed further in 3.3.5 below;
2. There is increased interest in trying to quantify vulnerability as a planning tool and for policy making. This has resulted in debates around the correct balance between quantitative and qualitative data and whether it is indeed possible to quantify vulnerability;
3. There has been an increase in writers suggesting the importance of the cultural, psychological and subjective impacts of disasters. Twigg and Bhatt (ed), 1998 for example in their definition of vulnerability included the economic, social, psychological and demographic dimensions. They asserted that the many dimensions to vulnerability makes it very complicated to be captured by models and frameworks;

4. “[T]here is a movement away from simple taxonomies or checklists of ‘vulnerable groups’ to a concern with ‘vulnerable situations’, which people move into and out of over time” (Wisner et al, 2004: 15).

### 3.3.5 *Resistance, Resilience and Extended Alternative Adjustments*

Pelling (2003), building on the work of Blaikie et al (1994), in his framework divided vulnerability into three components: *exposure*, *resistance* and *resilience*. These three components each are further made up by two products. In this respect, “exposure becomes the product of the physical location and the character of the surrounding built and natural environment. ... Resistance reflects economic, psychological and physical health and their system of maintenance, and represents the capacity of an individual or group of people to withstand the impact of a hazard. ... Resilience to [a] hazard is the ability of an actor to cope with or adapt to hazard stress. It is a product of the degree of planned preparation undertaken in the light of potential hazard, and of spontaneous or premeditated adjustments made in response to felt hazard, including relief and rescue” (ibid: 48). This framework is presented in figure 3.1.

A consideration of a vulnerability paradigm necessitates an understanding of the livelihoods concept. According to Pelling’s (2003) framework, livelihoods become a function of resistance. The livelihoods concept is used in most development fields including disaster risk reduction (de Satgé et al, 2002; de Satgé, 2004). The livelihoods approach is rooted in various economic and social theories (Brouwer and Nhassengo, 2006) and is divided into two main approaches: the asset livelihoods approach (originating from the work of Sen, 1981, from Pelling, 2003) and the sustainable livelihoods (SL) approach (originating from the work of Chambers and Conway, 1992, from de Satgé et al 2002 and de Satgé, 2004).



The SL approach has received much currency of recent development and disaster risk reduction work (see Wisner et al, 2004: 95-96). Key to the SL framework is the understanding of how a household draws from five types of 'capital' to secure a livelihood. These include:

1. human capital (skills, knowledge, health and energy);
  2. social capital (networks, groups, institutions);
  3. physical capital (infrastructure, technology and equipment);
  4. financial capital (savings, credit);
  5. natural capital (natural resources, land, water, fauna and flora)
- (de Satgé et al, 2002; de Satgé, 2004; Wisner et al, 2004).

The *Learning about Livelihoods Framework* (LAL) by de Satgé et al, 2002 drew on the original work of Chambers and Conway (1992). The LAL demonstrated the dynamic interplay between different factors, located in different spheres ranging from the local to the global and located in different sectors that may either increase or decrease a household's resilience to disaster risk. The factors in the framework include: economic, institutional/political, social, and natural/built environment. The LAL framework drew on scalar properties, similarly as political ecologists tend to do. The framework may receive some scrutiny in light of the recent debate on whether

resilience is the inverse or a factor of vulnerability (see Manyena, 2006) and discussion in 3.3.5 below.

From the SL and LAL frameworks there appears to be a clear relation between vulnerability and livelihoods as the same components that constitute vulnerability also constitute livelihoods. Wisner et al's (2004) 'Access to Resource Model', which acts as a complement to their PAR model is said to be much similar to the SL framework (Wisner et al, 2004). The PAR model is said to be a static model as:

"[o]ne of its weaknesses is that the generation of vulnerability is not adequately integrated with the way in which hazards themselves affect people. It exaggerates the separation of the hazard from social processes in order to emphasise the social causation of disasters. In reality, nature forms a part of the social framework of society, as is most evident in the use of natural resources for economic activity. Hazards are also intertwined with human systems in affecting the pattern of assets and livelihoods among people ... " (ibid: 91-92).

The 'Access' model is concerned with:

"the way unsafe conditions arise in relation to the economic and political processes that allocate assets, income and other resources in a society. But it also allows us to integrate nature in the explanation of hazard impacts, because we can include nature itself, including its 'extremes'.... In short, we can show how social systems create the conditions in which hazards have a differential impact on various societies and different groups within society" (ibid: 92).

The 'Access' model serves the same function of resistance as livelihoods does in Pelling's (2003) framework of vulnerability.

*Resilience* according to Pelling's framework indicates the ability of people to cope with or adapt to hazard stress which is the outcome of planned preparation undertaken or **adjustments** made. Manyena (2006) observed that the concept of resilience has gained currency in the disaster risk discourse. Manyena noted that two views have emerged with regards to the relationship between vulnerability and resilience. One views disaster resilience and vulnerability as factors of each other, while the other views them as separate entities (ibid). The framework presented by Pelling (2003) is classified by the former view. Manyena (2006) further noted that the concept of resilience exposes a shortcoming of the prevalent disaster risk equation in

3.3.2 above. Thus the disaster risk equation should factor resilience (based on the former view that is consistent with Pelling's framework) into the vulnerability component of the disaster risk equation as such: **DR = H × (V / Resilience)**. The calculation of resilience in the disaster risk equation is proven to be a complicated concept, because how does one quantify resilience? This question may feed into the debate around whether it is indeed possible to quantify vulnerability raised in 3.3.4 above. It is for this reason that the SRK (2006) disaster risk assessment of the Eden District Municipality in the Western Cape Province of South Africa did not factor resilience into the risk assessment despite acknowledging the importance of resilience to the equation. UNDP (2004) also excluded resilience out of the equation in calculating the global Disaster Risk Index (DRI). Gary (1997) however maintained that resilience (or management) of both the hazard and vulnerability was factored into the calculation of disaster risk in Thailand.

Hewitt (1997) built on White's (1945) concept of 'alternative adjustments' and human choice as a framework for reducing disaster risk. Adjustments involve choosing from a range of possible choices (Burton et al, 1993). Burton et al (1993) maintained that in theory the range of adjustments available to collectives is always greater than that available to individuals. They identified four modes of coping by human societies: i.) loss absorption (where the society absorbs the impacts of environmental extremes); ii.) loss acceptance (where the society arranges to bear the loss usually with the wider group than those directly affected); iii.) loss reduction (where positive action is taken to reduce loss); and iv.) radical change (when loss is no longer tolerable and change is actively pursued). They note that changes result from "the cumulative individual, collective, and national choices ..." (ibid: 222). Burton et al continued to distinguish the ways of coping as either *adaptation* (biological or cultural adaptations) or *adjustments* (that is incidental [responsive] and purposeful). Thus coping mode (i) is that of adaptation and coping modes (ii – iv) is that of adjustments (ibid). These adjustments however only concern adjustment to the hazard(s). Hewitt's (1997) framework of *extended alternative adjustment* however took the concept of adjustments further by including adjustments to

both the hazard as well as the vulnerability of society. This he is able to do because of a focus on both a hazard(scape) and vulnerability paradigm.

The climate change literature tends to speak of adaptations to climate change whereas the disaster risk literature tends to speak of adjustments (see for example Satterthwaite et al, 2007). According to Satterthwaite et al (2007: 51) adaptation refers to actual adjustments made. Coping strategies or “coping” alludes to a stressful situation where the subject seems to be ‘just, just’ getting by. This reinforces the “‘helpless victims’ of disaster that are in desperate need of outside relief assistance” view that tend to dominate the way disaster victims in developing countries are seen especially by northern aid agencies and the media. However, as the urban risk literature indicates (see for example Bull-Kamanga et al, 2003; Satterthwaite et al, 2007), the vulnerable populations in developing countries find themselves in everyday disaster situations that necessitate they learn to live with the situation and therefore adjust their lifestyle accordingly. Thus if adjustments and adaptations refer to the same thing, it is suggested here that the terms “adjustments” or “alternative adjustments” are applied. This sets aside use of the language of coping strategies and avoids confusing the term of “adjustments” and “adaptations” (that allude to survival and reinforce Darwinist theories of ‘survival of the fittest’ common among natural scientists).

Adjustments then translate into resilience. However, the concept of extended alternative adjustments refers to adjustments to both the hazardscape and vulnerability paradigms. Bearing this in mind, the view that resilience is the inverse of vulnerability (Manyena, 2006) becomes questionable. This is because resilience then is applied to both the hazardscape (through measures that reduce the impact hazards are felt) and the vulnerability (through measures that improve the inherent vulnerability conditions of society) as was demonstrated in the assessment by Gary (1997). Thus disaster risk may be calculated as follows:

$$\mathbf{DR = (H \div \text{Adjustments}) \times (V \div \text{Adjustments})}$$

OR

$$\mathbf{DR = (H - \text{Adjustments}) \times (V - \text{Adjustments})}$$

The equation is ambiguous as indicated above because it does not clearly describe the relationship between the adjustment and respective hazard and vulnerability components – i.e. whether it is a linear or exponential relationship<sup>6</sup>. This relationship can only be ascertained based on ground-truthing. Since the quantification of vulnerability and therefore disaster risk is a much debated topic as indicated by Wisner et al (2004), the concern should not be so much with the statistical results but rather with the indication of how adjustments lessen the impact of a hazard by increasing the resilience of a society. It is this benchmark indication that should concern and inform policy makers with regards to development priorities.

A useful example of an intervention in increasing resilience of a society involves social protection. Social protection is rooted in development and welfare economics theories (Davies et al, 2008). Social protection is the direct product of the “safety nets” discourse of the late 1980s and early 1990s (which focused on raising the consumption of the poor through publicly-provided transfers [Morduch and Sharma, 2002]). However, during the 1990s there was greater emphasis on livelihoods, risk and vulnerability and the multi-dimensional nature of poverty. This led to criticisms of the safety nets discourse as being residualist and paternalistic, while on the other hand social protection discourse started receiving greater attention (Devereux and Sabates-Wheeler, 2004) particularly by the World Bank (for example Barret and Carter, 2005). Social protection can be defined as “all public and private initiatives that provide income or consumption transfers to the poor, protect the vulnerable against livelihood risks, and enhance the social status and rights of the marginalized, with the overall objective of reducing the economic and social vulnerability of poor, vulnerable and marginalized groups” (Devereux and Sabates-Wheeler, 2004: 9). There are four main types of social protection, these include: protective measures, preventative measures, promotional measures and transformative measures (ibid). The concept of social protection may be incorporated as an interventionist measure under alternative adjustments provided by society to increase the resilience of individuals and households.

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<sup>6</sup> Personal communication with Leigh Sonn at DiMP, UCT.

### **3.4 Conclusion**

This chapter concerned itself with tracing the roots of current disaster risk discourse through the disciplinary root of geography (of which hazards geography is one branch). Geography was found to have roots in human ecology (where physical and human geography meet) and political ecology (where there seemed to be less physical geography and a greater human geography and social science orientation) as well as other ecological models within resource geography.

The contribution of human ecology and political ecology to disaster risk theory were found to be very powerful in shaping the scope of the field –in particular the emphasis on both a hazard(scape) and vulnerability paradigm as well as the importance of resilience to the disaster risk equation. Furthermore, human and political ecology, along with other discourses in research geography have been influential in informing a new way of looking at hazards –the hazardscape concept. Thinking from within political ecology especially strengthened vulnerability analysis. Vulnerability analysis was also further improved by development studies thought, particularly with regard to issues around livelihoods and social protection. Finally, the human ecology approach especially has been influential on the concept of resilience by extending the idea of adjustments to both the hazardscape and vulnerability components of disaster risk research. Therefore to generate a balanced approach to disaster risk research requires both a hazardscape and vulnerability analysis, best achieved through a society-nature theoretical context.

## Chapter 4

### Urban Flood Risk Context in Cities of the South

“Urbanization affects disasters just as profoundly as disasters can affect urbanization” (Pelling, 2003: 7).

#### 4.1 Introduction

This chapter deals with the subject area of the research, that being urban flood risk. The chapter specifically considers urban flood risk in developing countries or ‘cities of the South’ as this is reflective of the research area. The chapter introduces a discussion on floods as a global hazard. It continues by presenting prevailing approaches to flood research. It then provides an overview on the urban risk context and concludes with a discussion on what is termed ‘urban flood risk’.

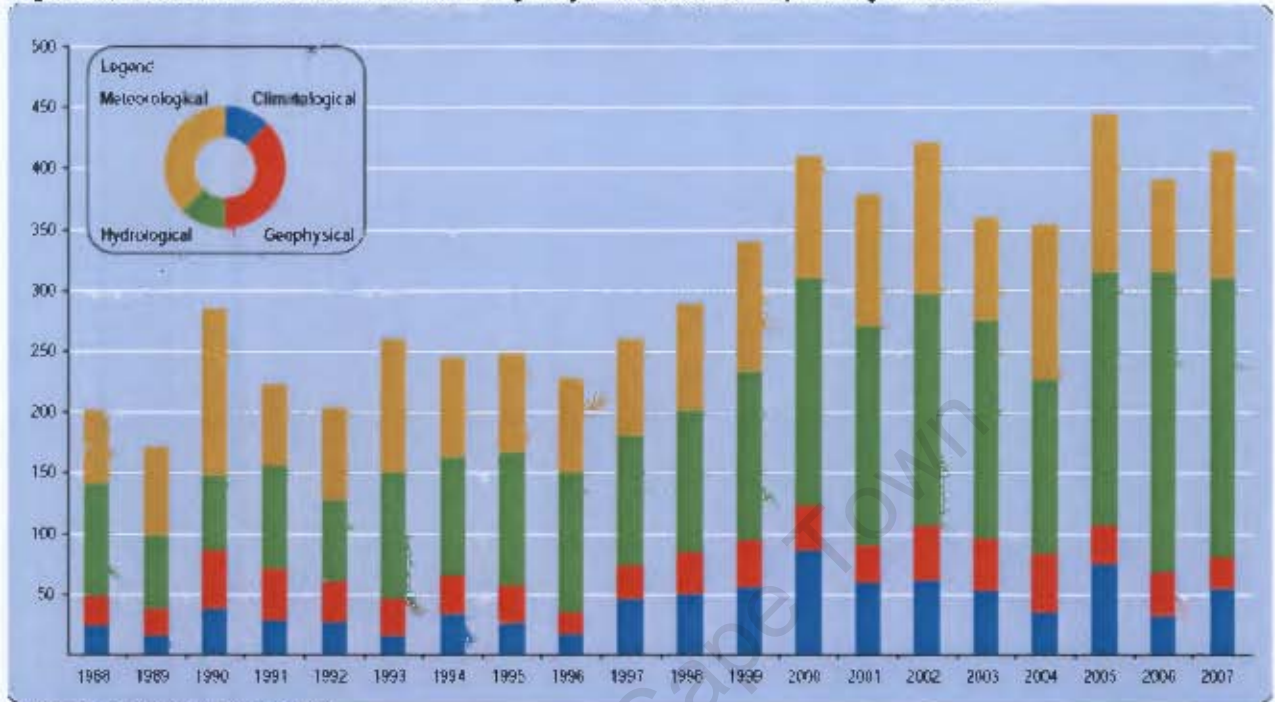
#### 4.2 Floods

##### 4.2.1 *Floods, a global threat*

Flooding is widely viewed to be the most endangering source of disaster risk. This is evidenced by a wide range of literature spanning the insurance industry (Munich Re, 1997, 1998), international humanitarian and development agencies (IFRC, 1999; UNDP, 2004; UN/ISDR, 2004a), global disaster databases (Guha-Sapir, 2008; Scheuren et al, 2008; <http://www.dartmouth.edu/~floods/>) and academia (Alexander, 1993; Parker, 2000; Smith, 2004; Wisner et al, 2004).

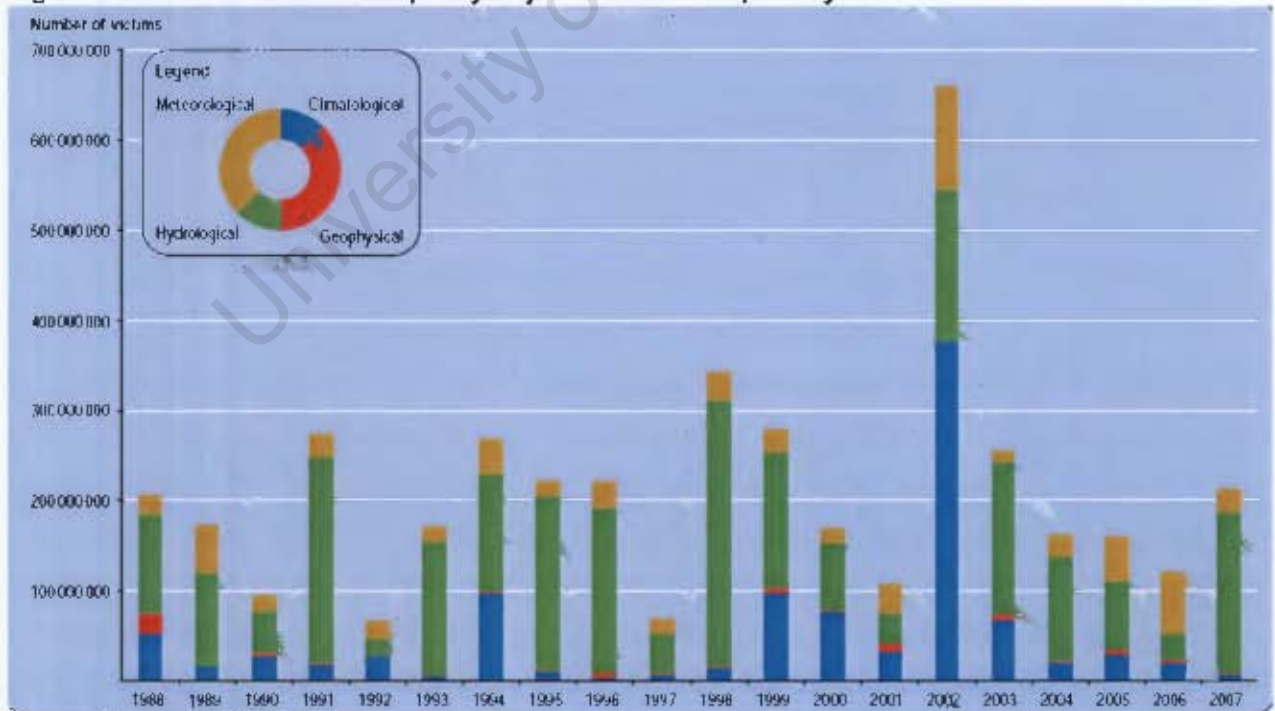
Scheuren et al (2008) classified the major natural disasters as biological, geophysical, climatological, hydrological and meteorological disasters (also see table 3.3). Biological disasters, in their view, include epidemics, insect infestations and animal attacks. Climatological disasters, similarly include

Figure 4.1 Natural Disaster Occurrence by Major Disaster Groups: 20 year trend



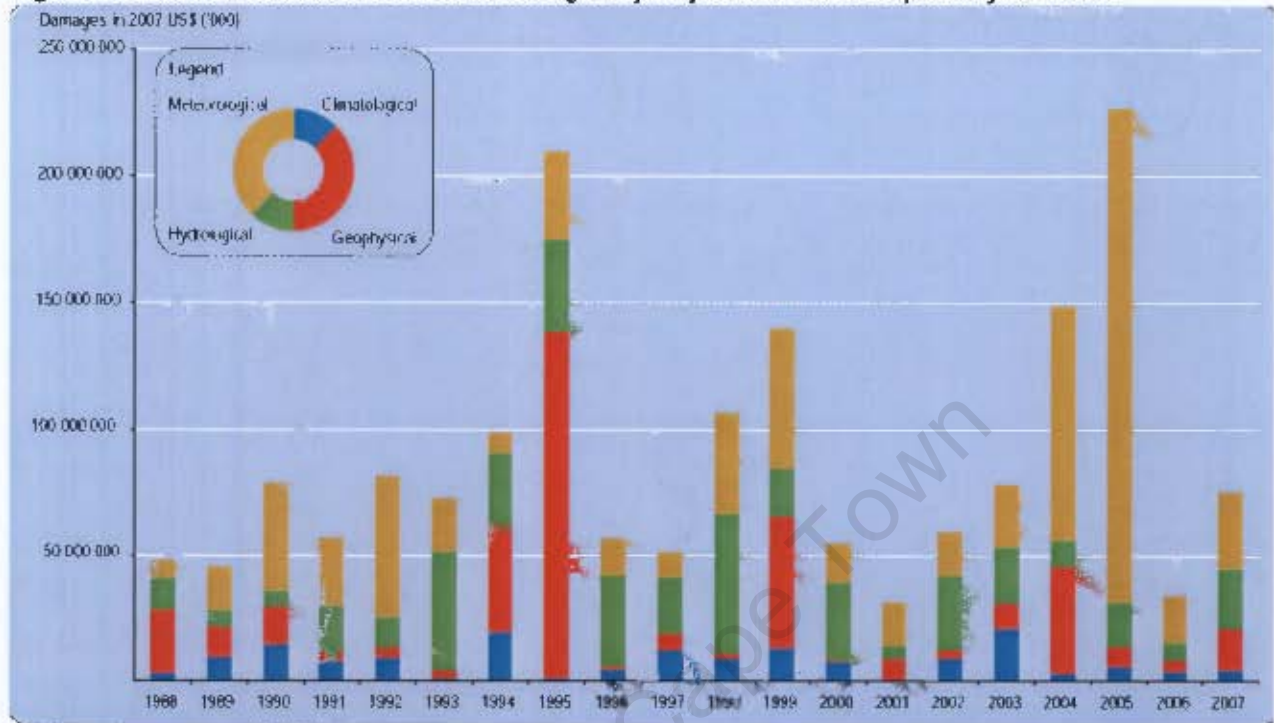
Source: Scheuren et al (2008: 16)

Figure 4.2 Disaster-Affected People by Major Disaster Groups: 20 year trend



Source: Scheuren et al (2008: 17)

Figure 4.3 Natural Disasters Economic Damages by Major Disaster Groups: 20 year trend

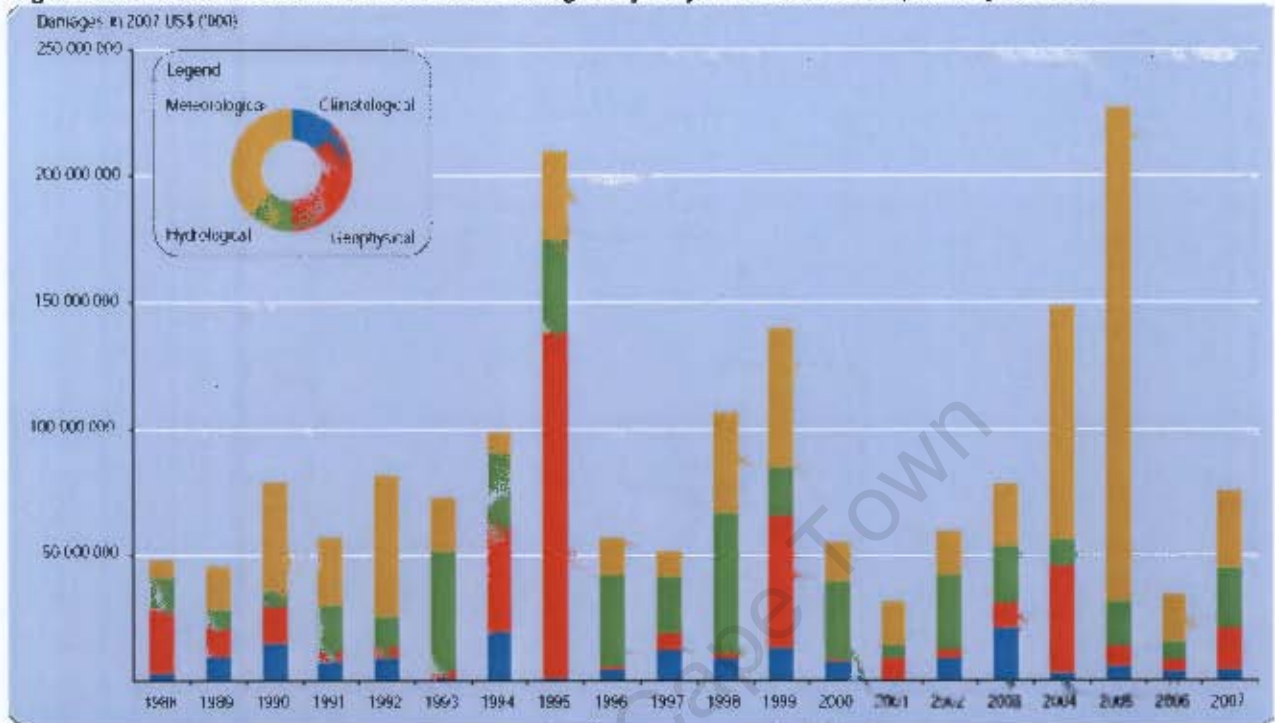


Source: Scheuren et al (2008: 17)

earthquakes, volcanoes and dry mass movements. Climatological disasters include droughts, extreme temperatures and wildfires. Hydrological disasters are viewed as floods and wet mass movements. Meteorological disasters consist of storms. Climatological, hydrological and meteorological disasters are classified together as hydro-meteorological disasters (Scheuren et al, 2008).

From this classification of natural disasters Scheuren et al (2008) used the EM-DAT global disaster database to present natural disaster occurrences by the major disaster groups for a 20 year period from 1988 to 2007 (figure 4.1). Similarly, they presented the number of disaster-affected people (figure 4.2) and the economic damages (figure 4.3) of natural disaster occurrences by the major disaster groups for the same 20 year period. It is clear that hydro-meteorological disasters, especially floods, are the most recorded disaster type globally for the last 20 years. Furthermore hydro-meteorological disasters affected the most people and caused the greatest economic damage in the last 20 years. Here

Figure 4.3 Natural Disasters Economic Damages by Major Disaster Groups: 20 year trend



Source: Scheuren et al (2008: 17)

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flood disasters were a major cause for affecting people and causing economic damage.

The data presented in Scheuren et al (2008) indicate that hydro-meteorological disasters, and specifically flood disasters, occur both in the developed and developing world where most occurrences are experienced in Asia. Flooding in the developing and least developed countries (LDCs) during this period appeared to be increasingly frequent and intense, where supposedly 100-year floods were occurring almost annually in Bangladesh and China, and severe floods afflicted south-east Asia over several years (especially 1996, 1998, 1999 and 2000) and Africa, including Mozambique and Malawi (2000 –see Christie and Hanlon, 2001 for an in-depth analysis of the 2000 Mozambique floods), Ethiopia and Somalia (1997) (Wisner et al, 2004). During 2007 in Africa specifically, floods were the leading causes of disasters and economic damage (Scheuren et al, 2008: 25-26). These intense and frequent floods have increasingly been associated with climate change which has gained both media and popular interest (Wisner et al, 2004). Climate change discussions are taken up in the recent IPCC (2007) and Stern (2006) Reports. Besides posing a threat to life the literature clearly indicates that floods also pose a major threat for development especially in poorer nations where livelihood impacts may increase the vulnerability of households and communities to future threats (ActionAid, 2007; ADPC, 2001; ADPC, 2005; Alam et al, 2008; Alam and Rabbani, 2007; Brouwer and Nhassengo, 2006; Christie and Hanlon, 2001; Rashid, 2000; Smith, 2004; Wisner et al, 2004).

The above statistics should be read with caution as floods are linked to several other environmental processes making it difficult to classify (Smith, 2004; Wisner et al, 2004). Furthermore Tschoegl et al (2006) recognised the following six problems for comparative analysis with global disaster databases. Firstly, there is a lack of standard terminology (ibid). Secondly, complications exist in classifying disaster types and sub-types (ibid). Thirdly, with regards to geo-referencing it is

not clear how to locate large scale disasters such as floods that cross political borders (ibid). Fourthly, there is inaccuracy in reporting the date of occurrence of an event (ibid). Fifthly, the lack of availability of detailed methodologies limits the transparency of databases but also complicates comparisons because of ambiguity in definitions (ibid). Finally, the availability of data sources between developed and developing countries differs where developed countries face complications of integrating data from many sources and developing countries face bias because of receiving data from few sources (ibid).

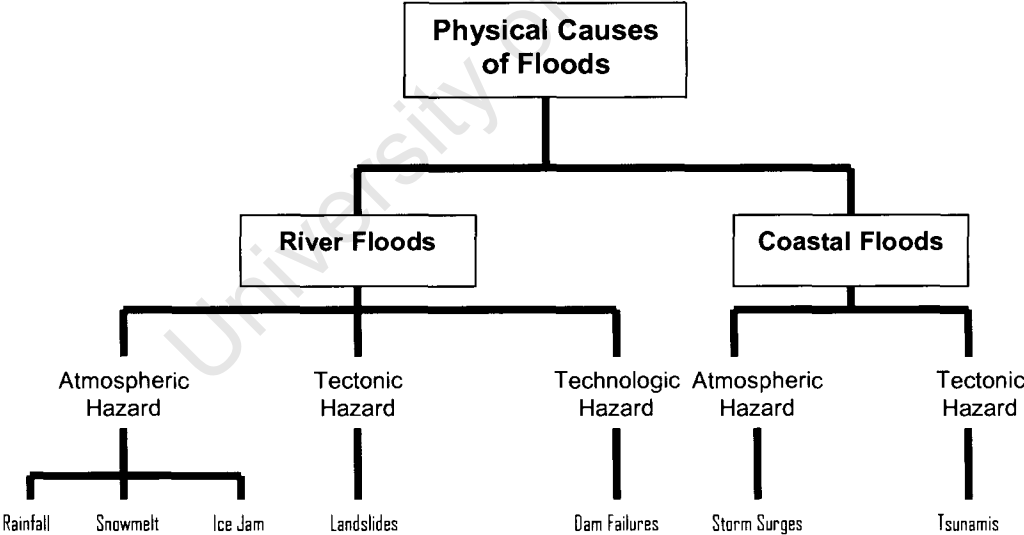
#### *4.2.2 Common Approaches to Flood Research*

Wisner et al (2004) noted that the significant impact of floods on wealthy countries opened up a new debate around the need to allow rivers to run unconstrained by earthworks, embankments, artificial levees, concrete and walls. Rather it was argued that rivers should flow freely in their valleys enabling the flood plains to play their original role. This thinking influenced the types of policies that developed countries could advocate in LDCs –i.e. it became difficult to advocate for ‘tech-fix’ (engineering) solutions because of opposition by NGOs and people’s organisations. A crucial element to this shift in thinking was the growing awareness that flood disasters are caused by people and not just water. This saw the media and popular conceptions of floods shifting “significantly to suggestions that the disasters were happening because people and buildings were in the wrong places on flood-prone land” (ibid: 202).

Approaches to flood research can be divided into two main categories: (i) a purely physical science approach and (ii) a more integrated approach that has a strong social element. The physical science approach to flood studies is concerned with the physical nature of floods where cause and effect is studied. Consequently this approach results in the classification of floods according to natural parameters or physical causes and resultant risk reduction or mitigation measures are focused on technical structural solutions for controlling the physical parameters. Smith (2004) for example classified the physical causes of floods

into two types: (i) *river floods* and (ii) *coastal floods* and further indicated the triggers or environmental hazards that can offset flooding within these physical causes (figure 4.4). Atmospheric hazards that create large amounts of rainfall are the most important cause of floods (ibid). Smith's (2004) classification of two primary causes of floods differs from Alexander's (1993) four principal causes of floods that includes: (i) *riverine floods*; (ii) *estuarine floods*; (iii) *coastal floods*; and (iv) *catastrophic causes* that include dam bursts or the effects of earthquakes or volcanic eruptions. This could be understood by the fact that Smith grouped the two main 'natural' causes in relation to other environmental hazards such as Alexander's catastrophic causes. Developments that took place within hazard studies since Alexander's era of writing as discussed in 3.3.3 above (i.e. the idea of hybrid hazards) enabled this.

**Figure 4.4 The physical causes of floods in relation to other environmental hazards**



Source: Smith, 2004: 195

The following environments are classified as flood-prone environments by Smith (2004):

- low-lying parts of major floodplains
- low-lying coasts and deltas
- small basins subject to flash floods

- areas below unsafe or inadequate dams
- low-lying inland shorelines
- alluvial fans

The physical science approach to studying floods can be divided into three further approaches or models that are determined on the disciplinary area of inquiry. These include:

- a. **Hydrological models** of floods utilised by geologists, physical geographers, hydrologists and engineers. Hydrological modelling is predominantly applied to riverine type flooding, where discharge forms an important concept (Alexander, 1993). Discharge, or stream flow quantity is graphically represented by hydrographs. When hydrographs are applied to floods these are known as flood hydrographs (ibid).
- b. **Hydraulic models** utilised by engineers where stream channel cross-sections are studied and how this transmits water flow (Alexander, 1993). This is particularly important to urban stormwater design. Hydraulic models are however used in relation with hydrological models particularly to relate the hydrograph to the flood hazard (Alexander, 1993).
- c. **Ecological models** utilised by ecologists where flooding is viewed as part of the natural ecosystem and therefore viewed to be important for the sustained natural functioning of freshwater systems (Alexander, 2000b; Allanson and Whitfield, 1983; Day and Davies, 1998).

The hydrological model is the most commonly used model for studying floods particularly with relation to the significant impacts of floods to human society. According to this model of floods, floods can be explained as “water ‘in the wrong place’, or ‘at the wrong time’” (Hewitt, 1997: 80). Alexander (1993: 120) defines floods as “**the height, or stage, of water above some given point ...**” The shortcoming to this model however is the fact that it only considers riverine-type flooding as is evident in Alexander’s (2000b: 11) definition of a flood: “the discharge that causes damage, or overtops the river banks, or exceeds a specified value”. This

shortcoming is particularly noticed in the context of urban flood risk as discussed in 4.3.2 below. Within this hydrological model Alexander (2000b) identified the following factors in influencing flood severity: rainfall characteristic; fixed catchment characteristics; catchment processes; and antecedent catchment moisture status. Rainfall characteristics involve depth, area, duration and movement of storm rainfall (ibid). Fixed catchment characteristics involve catchment size and slope, "shape, drainage system density, cover, and the direction of the catchment slope relative to the direction of movement of the severe rainfall producing weather systems. The cover includes the surface material which may vary from pervious sand through to impervious rock, and vegetation ...." (ibid: 18). Catchment processes involve the potential infiltration rate, pondage and channel storage (ibid). Potential infiltration is the function of permeability and moisture content of the soil. Pondage is "the proportion of the surface runoff that is trapped in pools caused by unevenness of the ground surface" (ibid: 17)". Channel storage is "the proportion of the runoff that is necessary for the passage of the flood through the system" (ibid: 17). Antecedent moisture status refers to the state of 'wetness' of the catchment immediately before the commencement of the flood-producing rain (ibid).

The integrated more social-orientated approach to flood risk research predominantly focuses on the vulnerability of people with minimum emphasis on the physical parameters of the flood hazard. Consequently the responses to risk reduction measures under this approach are more oriented towards non-structural measures of human adjustments, preparedness, awareness and capacity building. The social approach to flood risk research can be categorised into four specialised approaches that are differentiated according to ideological, empirical and methodological knowledge. The two approaches based on ideological knowledge include a **human ecology** and **political ecology** approach.

The **Human ecology** approach considers the physical parameters but also place emphasis on human exposure and vulnerability (e.g. Burton et al, 1993; Hewitt,

1997; Tobin and Montz, 1997). However the root causes of vulnerability are not adequately addressed in this approach.

The **Political ecology** approach places emphasis on considering social and economic assets together with physical resources as key dynamic pressures in examining vulnerability to flooding (e.g Wisner et al, 2004; Pelling, 1997; Pelling, 1998; Pelling, 1999; Pelling, 2003). This approach however does not adequately analyse the physical flood hazard.

A **Hazardscape** approach (Mustafa, 2005) that combines three approaches within resource geography –pragmatism, human and political ecology –along with the landscape idea in cultural geography is based on empirical knowledge. In this approach flood hazard is seen as a hybrid hazard where various physical, social and technological factors intersect. The hazardscape concept engages the social structural basis of vulnerability as well as the power-knowledge dynamic governing policy and popular discourses on flood hazard (Mustafa, 2005).

The approach based on methodological knowledge includes the **Participatory Disaster Risk Assessment** (PDRA) approach also referred to as Community Risk Assessment (CRA) or Vulnerability and Capacity Assessment (VCA). This approach analyses the physical flood hazard as well as the social, cultural, economic and political vulnerabilities of an at-risk population using the knowledge of the at-risk population by employing participatory assessment tools (e.g. Action Aid, 2007; ADPC, 2001; 2005; Alam et al, 2008; Moench and Dixit (eds), 2007; Puzon-Diopenes and Murshed, 2006). CRA forms part of the larger process of Community Based Disaster Risk Management (CBDRM)<sup>1</sup>. Pelling (2007) categorised CRA approaches into three continuums: (i) *procedural* –where differences in the assessment approaches are based on the distribution of power and ownership of the assessment; (ii) *methodological* –where assessments are

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<sup>1</sup> The Provention Consortium website has many resources and references to this growing approach of CBDRM. See [www.proventionconsortium.org](http://www.proventionconsortium.org)

differentiated according to whether methods of data collection, aggregation and analysis are to be quantitative or qualitative; and (iii) *ideological* –where assessments are either emancipatory (concerned with creating self-reflection and empowerment among the at-risk population) or extractive (concerned with the results of the data –i.e. results orientated).

## **4.3 Urban Flood Risk**

### *4.3.1 Urban Risk Context*

Urbanization refers to an increase in the proportion of national populations living in urban areas (Satterthwaite et al, 2007). Pelling (2003) as quoted in the prelude to this chapter noted that a relationship exists between urbanization and disasters as “urbanization affects disasters just as profoundly as disasters can affect urbanization” (ibid: 7). This therefore gives rise to the widely used term of ‘developmental risk’ where it is realised that disaster risk is largely an outcome of poor (or unsustainable) developmental practices. Satterthwaite et al (2007) stated that if disasters are seen as unusual events (usually ‘natural’ events), that requires rapid response then it is not seen as conventional urban research. However, if disasters are understood to be caused by urban development (or exacerbated by urban development) then these would form part of urban research (ibid). “Indeed, any urban researcher with an interest in poverty and vulnerability needs to integrate an understanding of the current or potential impact of extreme weather events into their work” (ibid: 13).

Satterthwaite et al (2007) suggested that it is important to understand how the processes that shape urbanization create or increases risk to a range of hazards. This therefore raises a discussion around the “vulnerability of city populations and of specific groups within them to environmental hazards ...” (ibid: 4). Pelling (2003) stated that risk in cities is the outcome of a variety of processes and ideas that are best represented in the metaphor of a city as an evolving biological system. “Here, there is no simple one-way line of causality in the production of human or environmental conditions: ‘nature’ does not cause ‘natural disasters’; rather risk in the city is an outcome of a myriad of feedback loops and thresholds and competing ideas, mechanisms and forms” (ibid: 7). Pelling

found Drakakis-Smith's (1996) framework on the five components of sustainable urbanisation (figure 1.2 above) that includes social, economic, political, demographic and environmental components to be useful in illustrating the interrelationship of the five components. This therefore demonstrates the necessity of placing any policy to mitigate risk in the broader context of urban life including within the larger regional and global physical and human systems (Pelling, 2003).

The *Urban Vulnerability framework* developed by the PeriPeri initiative (Nomdo and Coetzee (eds), 2002), which drew on the LAL framework, facilitates thinking within the "urban context". This framework attempted to understand, monitor and address urban vulnerability by emphasising the following: urban livelihood systems, the impact of household relations on the former, the 'asset base' of households, the influence of macro processes and structures, the different interconnected structures and processes in the urban environment, how urban governance facilitates the above, and how urban strategies either increase or decrease households' security in the urban environment. Lewis and Mioch (2005) further observed that urban disasters are the result of a combination of inefficient urban management, inadequate planning, poorly regulated population density, inappropriate construction practices, ecological imbalance, and infrastructure dependency to name but a few (also see Pelling, 2003; Satterthwaite et al, 2007). They therefore argued that good governance is a necessity in reducing urban vulnerability. Good governance to them involved inclusive decision-making by all stakeholders (national and local government, private sector, media, and civil society).

Renn (2008) differentiated between governance at national and global levels. He further promoted the concept of *Risk Governance*. Risk governance is explained as follow: "[it] looks at the complex web of actors, rules, conventions, processes and mechanisms concerned with how relevant risk information is collected, analysed and communicated, and how management decisions are taken. Encompassing the combined risk-relevant decisions and actions of both governmental and private actors, risk governance is of

particular importance in ... situations where there is no single authority to take a binding risk management decision, but where ... the nature of the risk requires the collaboration of, and coordination between a range of different stakeholders. [It] not only includes a multifaceted, multi-actor risk process but also calls for the consideration of contextual factors such as institutional arrangements ... and political culture, including different perceptions of risk" (ibid: 9). Nomdo and Coetzee's (2002) urban vulnerability framework, Lewis and Mioch's (2005) discussion on good governance for risk reduction and Renn's (2008) promotion of risk governance strengthens Pelling's (2003) statement that policies to reduce risk should be placed in the broader context of urban life including within the larger regional and global physical and human systems.

There is an abundance of published and unpublished literature echoing the sentiments that due to poverty and a lack of resources in the urban environment, it is the urban poor who are most vulnerable to hazards. These urban poor are most often located on the periphery in poor housing conditions in unsanitary and dangerous environments and are less often able to cope with these hazards (Benjamin, 2005; Hardoy et al, 2001; Lewis and Mioch, 2005; Mustafa, 2005; Pelling, 1997, 1998, 1999, 2003; Rashid, 2000; Satterthwaite et al, 2007; and Tipple, 2005, to name but a few).

#### 4.3.2 Urban Floods

Smith's (2004) concept of *environmental hazards* and Mustafa's (2005) concept of a *hazardscape* where hazards are seen as being hybrid since physical, social and technological factors intersect are most clearly evident with respect to urban floods. Mustafa's hazardscape was in fact developed through studying urban floods. The published and unpublished literature clearly indicate that processes of urban development, particularly unsustainable urban development, plays a significant role in shaping and exacerbating urban floods by increasing artificial hard surfaces, inappropriate land use, and inappropriate waste and (storm)water management. (Action Aid, 2007; Alexander, 2000b; Benjamin, 2005; Domeisen, 1997; Drowley, 2007; Huq et al, 2007; Lee et al, 2006; Mustafa, 2005; Nchito, 2007; Pelling, 1997; 2003; Satterthwaite et al, 2007; Scott and Benjamin, 2005;

Skilodimou et al, 2003; Smith, 2004; Sowman and Urquhart, 1998; Stephenson, 2002).

Eight types or forms of flooding can be identified as relevant to cities of the south, especially with reference to Africa. Action Aid (2007) identified four types of urban flooding in six selected African towns and cities. The first type is referred to as "localised flooding due to inadequate drainage". This leads to ponding (Benjamin, 2005) and overland surface run-off (DiMP, 2008). Secondly, such urban areas experience flooding from small streams whose catchment areas is almost entirely within the built-up area (Action Aid, 2007). The third type of flooding in these urban areas are from major rivers on whose banks the towns and cities are built (ibid). Fourthly, such urban areas experience coastal flooding from the sea, or by a combination of high tides and river flows from inland (ibid). Action Aid (2007) noted that the first and second types of flooding occur more frequently in African towns than the third type. The fourth type occurs where settlements are built on coastal wetlands and mangrove swamps (ibid).

An additional four forms of urban flooding may be included in the above list based on research by DiMP (Disaster Mitigation for Sustainable Livelihoods Programme) in ten informal settlements in the Western Cape Province of South Africa (DiMP, 2008), Benjamin (2005) and Scott and Benjamin (2005). It should be noted that using the conventional hydrological model of viewing floods might challenge the eligibility of the following forms of flooding, to qualify as flooding (particularly the last type). However the concept of a flood hazardscape would be more appropriate to include the following as floods. In this context, a fifth type of flooding includes flooding from wetlands where dwellings are built on the fringes of wetland ecosystems. A sixth type of flooding includes flooding from stormwater channels where dwellings are built on the fringes of stormwater channels. Consequently the stormwater, following heavy rainfall, overflows these channels resulting in the nearby dwellings to be flooded. This type of flooding is particularly exacerbated due to solid waste pollution in the open stormwater systems.

Stormwater (also referred to as run-off) is “the portion of water that does not infiltrate or percolate into the ground and remains as surface water” (ADPC, 2005: 85). A seventh type of flooding includes flooding where groundwater upwells through the floors of dwellings due to high water tables and a lack of solid foundations within dwellings. This is referred to as “seepage”. The eighth type of flooding includes flooding within dwellings due to water leaking through poorly constructed roofs, walls and doors.

The main impact of urbanisation with regards to flood risk is by altering the hydrology (of rivers and streams) and the geomorphology of the natural landscape (Lee et al, 2006). This is illustrated in table 4.1.

**Table 4.1 Impact of Urbanisation on Flood Risk modified from Lee et al (2006: 152-153)**

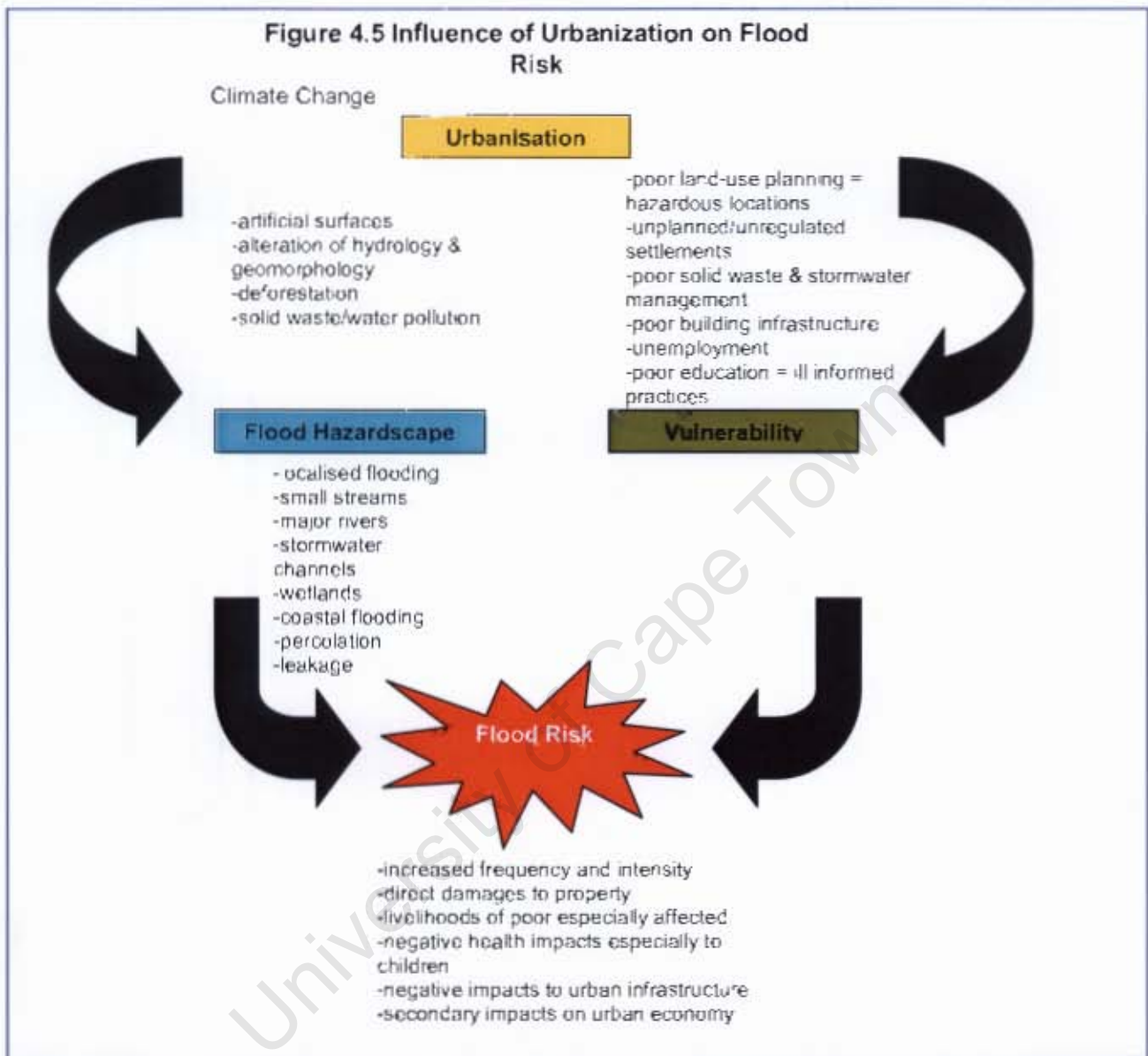
<b>Alter hydrology of rivers &amp; streams</b>	<b>Alter geomorphology of natural landscape</b>
Increased run-off peak flows and total volumes	Increased erosive force of stream channels may in the long-term change the stream profile.
Increased impervious surfaces (roads, pavements) which prevents infiltration of precipitation thereby changing the hydrology	
Impervious surfaces channel sediments and pollutants into drainage networks and in so doing increases stormwater run-off	
Decreased surface storage of stormwater results in increased surface run-off	Increased cross-sectional area of stream channels (through artificial channels) increases erosion along banks
Increased stormwater discharge relative to base-flow discharge results in increased erosive force within stream channels	
Culvert, outfalls etc. replace low-order streams resulting in more variable base-flow and low-flow conditions	Upland deforestation due to urban development increases soil erosion within catchments and therefore increasing the sediment load of streams
Decreased groundwater recharge results in decreased groundwater flow, which reduces base flow and may eliminate dry-season stream flow	
Increase in range of flow rates	

From the literature it becomes evident that urbanization exacerbates urban flood risk through local human factors. These include urban growth, the occupation of flood plains, and poor solid waste and stormwater drainage management exacerbated by the negative practices of dumping into river and stormwater systems by ill-informed residents. Unplanned or poorly regulated or informal settlements in particular that are often located on flood plains and wetland or

river fringes and where no organised stormwater drainage systems exist are susceptible to flood risk. Poor housing construction materials and building standards, coupled by poor site locations either close to rivers or wetlands or areas with high water tables increase the susceptibility of especially poor residents to flood risk.

As a result “*urban flooding is becoming an increasingly frequent and severe problem for the urban poor*” (Action Aid, 2007: 8 [own italics]) where their livelihoods are negatively impacted. Consequently the poor also suffer of ill-health especially respiratory infections, colds and flu where children are often the most vulnerable (see Benjamin, 2005). There are also disruptions to the urban infrastructure that may have negative secondary impacts to the urban economy. The literature also warns of the potential negative impacts of climate change of increased intensity and frequency of severe storm events to urban flood risk where increased flooding and losses are to be expected (Action Aid, 2007; Alam et al, 2008; Huq et al, 2007; IPCC, 2002; 2007; Midgley et al, 2005; Satterthwaite et al, 2007). Urban flood risk based on the above is schematically represented in figure 4.5.

**Figure 4.5 Influence of Urbanization on Flood Risk**



#### **4.4 Summary**

The chapter outlined that floods are the leading forms of disaster impacts globally in both developed and developing nations. Historically floods have been studied through a purely physical science approach where either a hydrological, hydraulic or ecological model is adopted or through a more integrated social-orientated approach where a human ecology, political ecology, hazardscape or participatory (PDRA) approach is adopted. A focus drawn from a purely physical science approach tends to lead to an emphasis on technical, structural solutions to flood risk reduction whereas a focus on a more integrated social-orientated approach encourages both structural (though limited) and non-structural solutions to flood risk management. It is proposed that an integrated approach to flood risk should be adopted since flood risk is defined by the function of three inter-related elements: the flood hazardscape, vulnerability and capacity of the population living within the impact area and the level of exposure of various elements located within the area (ADPC, 2005). Where urban risk is concerned, the chapter also outlined that a relationship exists between urbanisation and disasters where the processes of urbanisation may exacerbate disasters and in turn disaster impacts negatively obstructs sustainable urban development. It therefore becomes necessary to understand how the processes that shape urbanization create or increase risk to a range of hazards. The urban poor are usually those most vulnerable to urban risks. Within the context of urban risk the chapter also indicated how processes of urbanisation exacerbate urban flood risks by both worsening the flood hazardscape as well as generating the conditions of vulnerability to the flood hazardscape. The most vulnerable to the urban flood hazardscape are usually the poor urban dwellers.

## Chapter 5

### South African Flood Risk Research Context

"It is estimated that at least 50 000 people, and possibly more than 100 000 people are living along rivers and streams in South Africa below levels reached by previous floods. Most of these live in unplanned settlements within the jurisdiction of local or regional authorities" (Alexander, 2000b: 4).

#### 5.1 Introduction

This chapter outlines what a flood risk assessment should entail followed by a discussion of flood risk research in South Africa. Current flood risk reduction best practices in the developing world are then examined, with the chapter concluding with a discussion of the prevailing legal framework and strategies for flood risk management in South Africa.

#### 5.2 Flood Risk Assessment Approach

Risk assessments form the basis for developing and implementing flood risk reduction strategies, plans and actions (ADPC, 2005). A flood risk assessment has three components: hazard assessment, vulnerability and capacities assessment (VCA) and damage assessment (ibid). Flood risk assessments should also consider the occurrence of resultant secondary hazards (ibid). Risk assessments should be participatory and can be a starting point for flood risk awareness raising in the community (ibid).

##### 5.2.1 Hazard Assessment

ADPC (2005: 50) explained that the **hazard assessment** "[d]etermines the nature of flooding based on meteorological and hydrological parameters and river basin conditions. The information can be used to determine relationships between meteorological and hydrological parameters and create flood models. Studies also outline the frequency and general magnitude of floods." Here methods such as those discussed in 5.3 are employed. Methods can be either quantitative (e.g. number of people affected, hydrological and

meteorological data and economic losses) or qualitative (types of areas, damage caused, severity of floods) (ADPC, 2005). ADPC (2005: 58) listed various sources of data collection such as government records, media reports, existing documentation for construction and other projects, information or assessment data obtained through PDRAs. Further sources include hydrological information from monitoring stations, stream flow and rainfall maps, interviewing the public and experts, site investigations, geophysical tests, vegetation analysis and photos and satellite images of past flood impacts (ibid). The most suitable techniques and methods to employ depend on the nature of the flood hazard, the availability of data, feasibility of collecting additional data and resources available for analysis (WMO, 1999 in ADPC, 2005). ADPC (2005) mentioned three main types of maps for presenting flood data. These include flood inundation maps that show the variation in flood depth over the floodplain, flood duration maps which are similar to inundation maps but also consider the duration of the flooding and flood comparison maps that show the difference between two flood maps (ibid).

### *5.2.2 Vulnerability and Capacities Assessment (VCA)*

**Vulnerability and capacities assessment (VCA)** “[h]ighlights the people and infrastructure most vulnerable to flooding and the potential damages that may be incurred” (ADPC: 50). VCA is synonymous with CRA where vulnerability and capacities of the at-risk population with the at-risk population are also assessed. VCA is more commonly used by the International Federation of Red Cross and Red Crescent Societies (IFRC) and its partner agencies.

ADPC (2005) from IFRC (2004) supported the view that the SL approach can be used to determine people's ability to withstand a disaster. Thus a vulnerability and capacity assessment should assess the levels of the various capitals mentioned in the SL approach (see 3.3.5 above) as these will determine how vulnerable people are to flood impacts. Data collection may be quantitative or qualitative. There are various participatory tools available to assess vulnerability

(see for example Abarquez and Murshed, 2004; DiMP, 2005b; DiMP, 2008; and the Provention Consortium website: [www.proventionconsortium.org](http://www.proventionconsortium.org) ).

### 5.2.3 Damage Assessment

A **damage assessment** is an “[a]ssessment and analysis of potential loss due to flooding” (ADPC: 50). Loss estimation can be regarded as a form of risk assessment (ibid) especially in assisting in selecting high risk areas based on areas sustaining highest losses. Furthermore, the damage assessment may also be used as part of the hazard assessment (see 5.2.1) and vulnerability assessment. The most widely respected and applied disaster loss estimation approach, based on more than 30 years of application, is the ECLAC (Economic Commission for Latin America and the Caribbean) model for estimating the socio-economic and environmental effects of disasters (ECLAC, 2003). The ECLAC model provides methods for estimating direct damages and indirect losses to the social sectors, services and physical infrastructure sectors, economic sectors and the overall effects of damages to the environment, the impact on women, macroeconomic effects and the impact on employment and income. The ECLAC methodological approach provides guidelines to the sources of information for each of the categories and the techniques employed to gather the information.

### 5.3 Flood Risk Research in South Africa

The majority of the published flood research in South Africa is commissioned by the Water Research Commission (WRC). The WRC operates in terms of the Water Research Act (Act 34 of 1971) whose mandate it is to support water research and development as well as building a sustainable water capacity in South Africa (<http://www.wrc.org.za>). The floods of 1988 and the revision of the National Flood Management Policy in South Africa resulted in *ex ante* (risk reduction/mitigation) flood damage research in South Africa (Viljoen et al, 2001). The aim of *ex ante* research (that comprised 3 phases) was to develop flood damage management aids (loss functions, computer programmes, and questionnaires) to assist planners and authorities involved in flood damage

assessment and management (ibid). Flood risk estimation models were also viewed as essential for developing such flood damage management aids, especially in determining potential flood-prone areas. Consequently the majority of flood risk-related research in South Africa has historically focused on the physical parameters of the flood hazard that drew heavily from hydrological modelling. Only a limited number of predominantly unpublished studies in South Africa focused on the vulnerability of those at risk to flood hazards or extreme weather events.

### *5.3.1 Flood Risk Estimation Models in South Africa*

The weather systems responsible for extensive flooding over South Africa include tropical cyclones; cut-off low and ridging high pressure systems; large scale, near stationery wave patterns; intense mid-latitude cyclonic systems; and squall lines, mesoscale convective systems (Alexander, 2000b also see SAWS, 2007; Taljaard, 1995 and 1996; Tyson and Preston-Whyte, 2000 for a detailed overview of South Africa's climate). Flood risk estimation models in South Africa draw heavily from hydrological models used internationally. Standard techniques for flood estimation exist for many countries and include statistical analysis of observed peak discharges (if available) and event modelling using rainfall-runoff techniques (Smithers and Schulze, 2003). Estimating design flood events are critical for the planning and design of engineering projects (Smithers and Schulze, 2003 from Rahman et al, 1998). Flood estimation methods in South Africa (as illustrated in figure 5.1) can be classified as:

- deterministic or rainfall-runoff methods;
- statistical methods, either site specific or regional
- empirical and pseudo-statistical or empirical-probabilistic methods (Alexander, 2000b; Smithers and Schulze, 2003; van Bladeren et al, 2007).

**Deterministic methods** transform rainfall data into run-off, normally on a rainfall event basis, using different models by taking into consideration catchment

characteristics: area, length and slope of the main watercourse, catchment slope, land-use, soils etc. Examples of these include the *rational method* (the oldest); SCS (Soil Conservation Services); *unit hydrograph*, *synthetic unit graph*; and the *Gradex method* (not applied in South Africa) (van Bladeren et al, 2007).

Deterministic flood hydrology was initiated in South Africa by the Hydrological Research Unit (HRU) as a response to the devastating floods of May 1959 and March/April 1961. Van Bladeren et al (2007) criticised these methods for assuming that the “run-off and rainfall input have the same probability of exceedance” (ibid: 5). Secondly, they argued, the methods are very data intensive and so generalised regional coefficients based on simplifications are provided. The use of these methods can be applied to sites with “no flow data, for a range of storm durations, changing catchment conditions and provide an indication of the expected hydrograph shape for a storm event” (ibid: 5).

**Statistical methods** “are based on the fitting of theoretical probability distributions to data for a site .... [T]he distributions selected do not relate to any characteristics of the flood producing rainfall or the catchment” (Van Bladeren et al, 2007: 5). Data extracted for flood frequency analyses are either annual maximum flood peaks (AMF) or partial duration (PD) series data also known as peaks over threshold (POT). AMF data are received from abstracting the maximum flood peak for every hydrological year. POT data is received by selecting all flood peaks above a certain threshold and may include more than one peak in a specific hydrological year. Distributions generally used for flood estimation include: log-normal (LN), Pearson Type 3 (P3), log-Pearson Type 3 (LP3), extreme value distributions such as the extreme value Type 1 and 11 (EV I and EV II) and the general extreme value distribution (GEV). In South Africa LP 3 and GEV are most commonly used and most applicable. There is also an increasing importance of parameter estimation techniques (ibid).

**Empirical methods and pseudo-statistical methods** “typically use observed or analysed flood information and relate these to certain catchment and rainfall characteristics and rainfall to provide estimates of the requested flood event discharges” (Van Bladeren et al, 2007:

7). These methods are then applied using regions that are determined to be hydrologically homogenous (ibid; ICOLD, 1992). The main advantages of empirical methods are their simplicity (ICOLD, 1992). However, because they are “derived for particular catchments with given topographic, geomorphological, geological and meteorological characteristics, they can have significant errors when applied to other catchments or regions with different hydrological characteristics, and so the values obtained should be used with caution” (ibid: 97).

From figure 5.1, methods for estimating design floods in South Africa can be categorised into two groups based on the sources of data collection that include: i) *analysis of streamflow data* and ii) *rainfall based methods*.

The *analysis of streamflow data* draws on:

- a) empirical methods; and
- b) statistical methods (that include flood frequency analysis and flood envelopes).

A **flood frequency analysis** of observed data is used if long records of streamflow are available at a site (Smithers and Schulze, 2003). If there are insufficient site data, then regional data are analysed. To undertake direct at-site frequency analysis of observed peak discharge requires the appropriate selection and fixing of theoretical probability distribution to the data (ibid). “There are many different theoretical probability distributions or laws in hydrology .... These probability distribution functions have either two or three parameters which can be estimated by different methods (least squares, moments, maximum likelihood, maximum entropy etc.)” (ICOLD, 1992: 101-103). There are a number of limitations associated with direct statistical analysis (see Smithers and Schulze, 2003: 117-118). Insufficient data for a given site necessitates the use of data from similar and nearby sites, known as regional frequency analysis. This approach is usually more appropriate than at-site analysis (ibid).

**Flood envelopes** (maximum envelopes/ envelope curves) refer to plotting the largest observed discharge against catchment area on logarithmic axes

(Smithers and Schulze, 2003). An envelope curve is drawn to include all the data points (ibid; ICOLD, 1992). This curve reflects the upper limit of expected flood peaks for the region under study (ICOLD, 1992). "The envelope tends to increase as the record length increases and larger floods are observed" (Smithers and Schulze, 2003: 120).

### *Rainfall based methods*

These are used when no or inadequate streamflow data are available at the site of interest (Smithers and Schulze, 2003). The choice of this approach falls into two broad methods:

- a) **continuous rainfall based methods**; and
- b) **design rainfall**.

a) **Continuous simulation modelling** attempts to "represent the major processes which convert rainfall into runoff. Historical data or stochastic rainfall series are used to generate outflow hydrographs over long time periods and the simulated flow can be subjected to standard frequency analysis techniques" (ibid: 125). The advantages of these models include "the simulation of the complete hydrograph and continuous simulation of antecedent moisture conditions" (ibid: 127). Van Bladeren et al (2007) for example integrated systematic, historic and palaeoflood data to provide estimates of flood growth curves that were scaled using an index flood to provide estimates of flood peaks and their associated probabilities for all the regions of South Africa.

b) **Design rainfall** uses both deterministic and probabilistic models. The term design rainfall therefore refers to the "rainfall depth and duration, or intensity, associated with a given probability of exceedance, which in turn is inversely related to the commonly used term, return period" (ibid: 1). Many regional and national scale studies in South Africa have focused on estimating design rainfalls for durations of 24 hours and less (ibid). Smithers and Schulze (2003) in their research developed reliable and consistent estimates of design rainfall for durations ranging from 5 minutes to 7 days at any location in South Africa. This was done using a regionalised approach and scale invariance properties of rainfall (RLMA and SI procedure). This design rainfall is now widely used throughout South Africa. Design rainfall

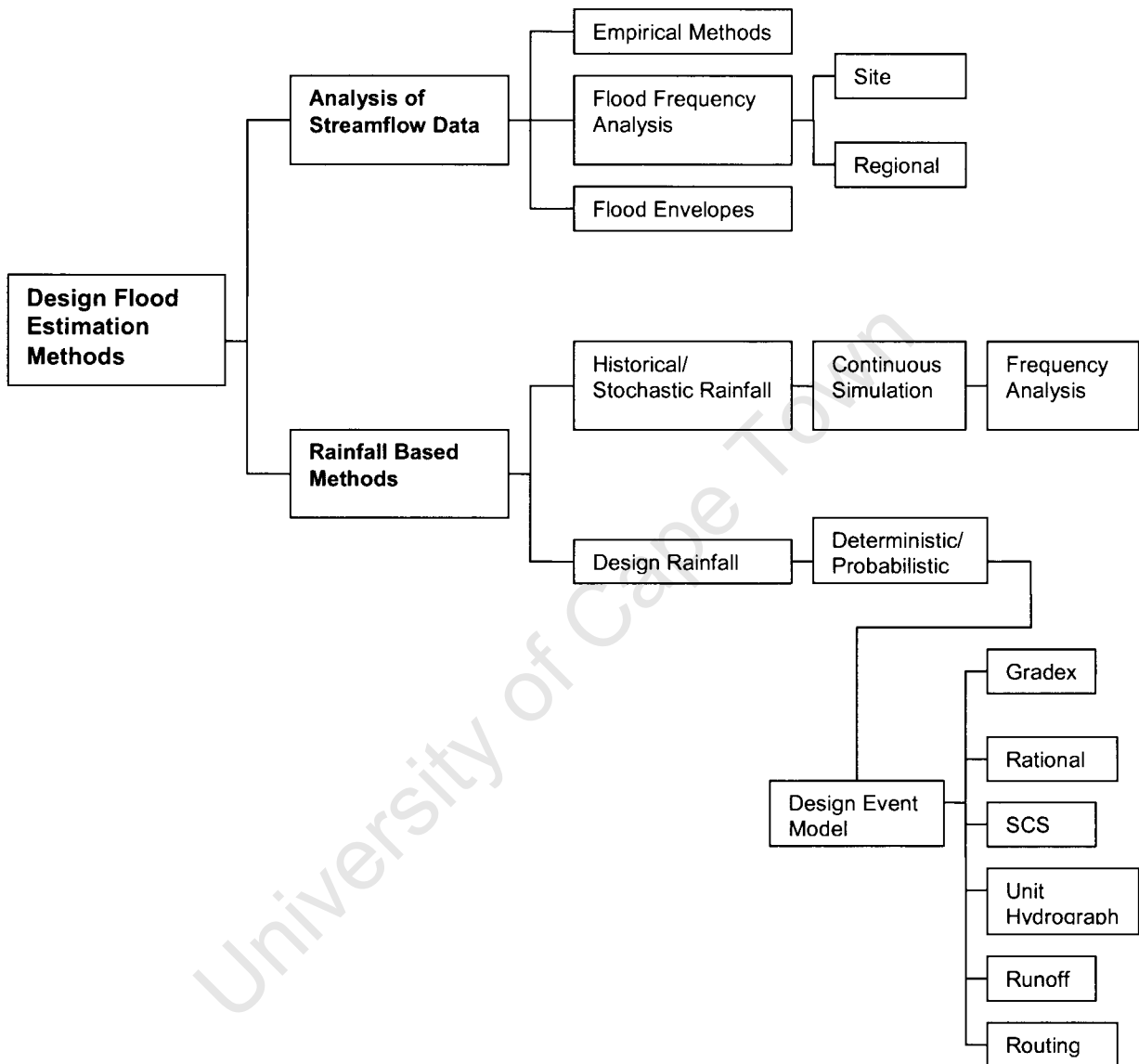
data are then used to model floods, known as design event models. *Design event models* assume that “the frequency of the estimated flood is equal to the frequency of the input rainfall” (ibid: 121). This model has shortcomings with respect to the accuracy of estimates as it only considers the nature of rainfall and ignores other parameters (e.g. soil, topography, vegetation etc.) (ibid). The methods used include those listed in the discussion of deterministic methods above.

The rational method is widely used internationally for both rural and urban catchments (Pilgrim and Cordery, 1993 in Smithers and Schulze, 2003). “The method is an approximate deterministic method and a major weakness is the judgement required to determine the appropriate run-off coefficient and the variability of the coefficients between different hydrological regimes. ... [The method only calculates flood peaks] and is sensitive to the input design rainfall intensity, the selection of the runoff coefficient, the experience of the user and should not be used for catchments [greater than] 15 km<sup>2</sup>” (from Pilgrim and Cordery, 1993 in Smithers and Schulze, 2003: 122).

In the U.S.A, the SCS method has replaced the rational method because of the wider database and the way in which the physical catchment characteristics are incorporated (Pilgrim and Cordery, 1993 in Smithers and Schulze, 2003). The SCS method was adapted for South Africa and it was found that the models performed satisfactorily to be recommended for design on a variety of land use and catchment size categories (Smithers and Schulze, 2003).

The unit hydrograph method “assumes a characteristic linear response from a catchment and hence may not be accurate for calculating large floods” (ibid: 124). A limitation to the approach is that it assumes spatial uniformity of rainfall. Its advantage lies in the estimation of the entire hydrograph, “which is important where storage in a catchment is found” (ibid: 124).

**Figure 5.1 Methods for Estimating Design Floods**



Source: Smithers and Schulze (2003: 116)

### 5.3.2 Urban Flood Risk Estimation in South Africa

The main concern in urban areas is the disposal of stormwater since the lack of efficient stormwater disposal systems may result in the flooding of houses, properties and roads (Alexander, 2000b). In this context drainage systems are viewed as essential in urban areas where the flooding of properties and roads

needs to be avoided (ibid). As such, analytical methods are required to determine optimum pipe, culvert and channel sizes, as well as the “required sizes of detention works where these are needed to reduce flood peaks; provide temporary storage of stormwater where this exceeds the capacity of the drainage system; or to control water quality” (ibid: 103-104).

Alexander (2000b) observed that a number of computer models are used in South Africa for the design of urban drainage systems that draw from international models and have been adapted for South African conditions as well as models designed in South Africa. These models fall under the broad category of rainfall based methods, and more specifically, are derived from continuous simulation models (ibid). They may also be classified as distributed models “as the catchment is broken down into a number of sub-catchments and the flood hydrograph is calculated for each sub-catchment separately and then the combined discharges are routed through the drainage system” (ibid: 104). The hydrological components of these models are usually highly deterministic since they closely model the actual hydrological processes (ibid). Being deterministic they may be calibrated by “comparing the predicted discharge from the system with the measured discharge for a given storm” (ibid: 104). A good deterministic model that closely resembles the catchment processes for a given storm produces better results than a good empirical or statistical model whereas a good statistically based model provides better estimates of flood probability than a good deterministic model (ibid). Stephenson (2002) for example used statistical modelling to determine flood frequencies and modelling of the Vaal river in the Witwatersrand region of the Gauteng province. Alexander (2000b) stated that the Rational Method is most widely used internationally for flood estimation particularly in urban areas, however, from Smithers and Schulze (2003) we learnt that this method is now replaced by the SCS method.

Alexander (2000b) argued that accurate hydraulic calculations are more important in urban drainage problems than accurate hydrological analysis. “This is because under-design will result in the inconvenience of functional failure and not the costly consequences of structural failure or possible loss of life” (ibid). However for urban

development and emergency response planning hydrological modelling is more applicable for determining flood-prone areas.

### *5.3.3 Integrated Hazard and Vulnerability Approach to Flood Risk Research in South Africa*

There remain a limited number of “near-flood risk” studies in South Africa that integrate both a hazard and vulnerability approach. The term “near-flood risk” is used here because not all of the research adopting a hazard and vulnerability approach solely focused on flood risk but included extreme weather events such as convective storms, cut-off low pressure systems and even drought (i.e. hydro-meteorological risks).

Pyle’s (2006) research suggested that Myburgh’s (1991) PhD research should be seen as pioneering work to integrated hazards research in South Africa. Myburgh used an integrated hazards framework to explore the physical, behavioural and social aspects of flood and drought hazard in order to gain a more comprehensive understanding of the complex interrelationships at play in defining the hazardousness of the arid and semi-arid regions of the previously-called Cape Province of South Africa. The focus of Myburgh’s research was to identify the range of human adjustments and adaptations to the hazard (Pyle, 2006). Myburgh’s research adopted a human ecology approach because of his focus on the physical hazard and human adjustments and adaptations to the hazard.

Mgquba’s (2002) Masters research investigated the physical and human dimensions of flood risk in Alexandra township of Johannesburg. This study applied Blaikie et al’s (1994) PAR model to unpack the root causes, dynamic pressures and unsafe conditions of severe flooding of the Jukskei River in the township that increased vulnerability and associated risk of the urban poor living in the floodplain. Mgquba’s research adopted a political ecology approach to flood risk because of the PAR model utilised.

Research by DiMP (2003; 2004; 2005a; 2007) of severe weather events in the southern-Cape region of the Western Cape Province of South Africa adopted a disaster risk conceptual framework to allow for a focus on the interplay between natural or other threats and conditions of socio-economic, environmental or infrastructural vulnerability to be illustrated. These studies required a multidisciplinary conceptualisation and associated methodology. The shortcoming though of these studies is that they do not adequately investigate the root causes of vulnerability as they studied the post-event socio-economic and environmental impacts of the extreme weather events. In essence, these studies can be classified as human ecology because of their emphasis on how development patterns have contributed to risk (especially DiMP, 2003 and 2007). Furthermore these studies also propose human and institutional adjustments. Along with a human ecology approach, it can also be said that the research (especially DiMP, 2007) employed a PDRA approach where participatory methods were employed in the field research.

Similarly, Pyle (2006) in his PhD employed a conceptual framework that emphasized the combined role played by hazard and vulnerability conditions in defining risk. This enabled him to investigate the temporal, spatial and impact characteristics of severe convective storm hazard and associated risk in the Eastern Cape Province of South Africa. Through this he was able to assert that severe convective storms can occur throughout the province, but with clearly demarcated areas of higher frequency and concentration and that the impact of storms are more severe on poor and vulnerable rural populations in the eastern parts of the province. The vulnerability analysis of his study depended heavily on census data because of the analysis being at a municipal scale. While Pyle did ground-truth the census data through field research, this was not quantified through household sampling surveys but depended on individual interviews. As this constrained the study's explanation of the root causes of vulnerability, Pyle's research adopted a human ecology approach.

Durham's (2007) Masters research adopted a disaster risk reduction framework to assess the effectiveness of existing flood risk reduction efforts along the Baths River of the Western Cape Province. In so doing she conducted a risk assessment that considered the physical hazard as well as the human, financial, technical and institutional capacity to manage the flood risk along the respective river. Durham undertook a flood risk assessment using participatory approaches of interviews, focus groups and consultations with the community and key stakeholders thereby making her approach that of PDRA. The participatory component however provided limited input to the hazard analysis. Other participatory approaches to flood risk research include that by Benjamin (2005) in an honours thesis that built on research from Scott and Benjamin (2005) in an honours project. DiMP (2008) in a participatory facilitator's guide documents approaches to community risk assessments based on eleven CRAs conducted in informal settlements of the Western Cape during the period of November 2005 to June 2007 where flood risk appeared in all eleven settlements. Recurrent aspects of flood risk in informal settlements are also discussed in this publication.

Within South Africa, it is evident then that there is an emerging body of flood risk research that combines both a hazard and vulnerability paradigm. These studies reflect human ecology, political ecology and PDRA approaches (table 5.1). However a hazardscape approach to flood risk research is yet to be applied. This study contributes to an emerging thrust in flood risk research in South Africa that places a particular focus on urban flood risk. The study combines elements of the human ecology and political ecology approaches in the form of the hazardscape approach as well as elements of the PDRA approach. This research therefore employs a *participatory-hazardscape* approach to urban flood risk.

**Table 5.1 Approaches of Flood Research in South Africa that focus on Integrated Hazard and Vulnerability Analysis**

	<b>Political Ecology</b>	<b>Human Ecology</b>	<b>PDRA (Participatory)</b>	<b>Hazardscape</b>
<b>Characteristics</b>	Addresses root causes and dynamic pressures of vulnerability; limited emphasis on physical hazard	Strong analysis of physical hazard; vulnerability analysis fails to address root causes and dynamic pressures but concentrates on human adjustments	Employs participatory approaches to analyse the hazard (usually limited as scientific analysis is more robust) and vulnerability of at-risk population	Flood hazard viewed as a 'hybrid' hazard; addresses social vulnerability and dominant understanding of flood hazard; allows for structural and non-structural risk reduction measures
<b>Examples</b>	Mgquba (2002)	DiMP (2003; 2004; 2005a; 2007); Myburgh (1991); Pyle (2006)	Benjamin (2005); DiMP (2007; 2008[forthcoming]); Durham (2007); Scott & Benjamin (2005)	None

#### 5.4 Current Flood Risk Reduction Strategies

Flood risk reduction strategies can be classified as structural and non-structural measures. Structural measures are those measures supported by scientific, technical and engineering solutions (tech-fix) that were promulgated during the dominant (behavioural) paradigm of hazards research discussed in 3.3.3 above. Structural measures rely on the building of physical structures to avoid flooding of the floodplain in the case of rivers (Miller, 1997) or urban areas in the case of stormwater systems. Non-structural measures include those measures that involve proper development planning, awareness/preparedness and social protection that gained increasing importance during the radical (structuralist) paradigm era of hazards research where the 'tech-fix' (structural) solutions were criticised for being inadequate and even in some cases responsible for exacerbating the flood risk. Increasingly during the 1990s of the radical paradigm emphasis was placed on community participation in selecting the most appropriate structural and non-structural measures. This is reflected in the efforts of the second half of the United Nations' (UN) *International Decade for Natural Disaster Reduction (IDNDR)*, where dissatisfaction to top-down, technocratic approaches to disasters during the first half of the UN's decade's activities were voiced (Wisner et al, 2004). Currently community participation in the form of Community Based Disaster Risk Management (CBDRM) is gaining popular currency. A key component of CBDRM is also to use local technology and

expertise. The ADPC's (2005) flood primer reflected on how even structural measures may be conducted by locals (as opposed to engineering firms) where construction costs are less expensive.

Structural measures include the following:

- Embankments, dykes, levees, floodwalls or stopbanks;
- Channel improvements;
- Bypass channels and floodways;
- Discharging drainage water by pumping; and
- Infrastructure for community flood protection

*Embankments, dykes, levees, floodwalls or stopbanks* –these are earth banks built along both sides of the river that offers protection up to the height or design limits of the particular floods (ADPC, 2005; Miller, 1997; Smith, 2004). There are several limitations to these measures. Firstly, the structures can only provide protection up to the height of the structure (ADPC, 2005). Secondly, embankments occupy a lot of space as the width depends on the height of the structure (ibid). This becomes a major challenge in urban areas where land is limited and highly sort after for development as well as 'green-belt' purposes (see for example Stephenson, 2002). Thirdly, they provide a false sense of security (ADPC, 2005). Fourthly, if the structures are built from earth they become highly susceptible to erosion (ibid). Finally, informal dwellers often occupy embankments where spacious often free land is available, building large slum settlements such as in Bangladesh (ibid).

*Channel improvements* –to increase or improve the carrying capacity of the river or stream that was obstructed especially by development and urbanisation so that flood flows are contained within the banks (ADPC, 2005; Smith, 2004). There are different forms of channel improvements that include: widening and deepening the channel; removing of debris and vegetation restricting the flow; straightening the channel; removing or altering obstructions; deepening

(dredging) the channel; lining the channel; widening the channel mouths; and raising and/ or widening of bridges, culverts and barriers that prevent free flow (ADPC, 2005). Some limitations to channel improvements include the following. Firstly, through straightening the channel and cutting off the meander, the slope is increased thereby increasing the water flow velocity and reducing the flood stages (i.e. the onset of flooding increases). Furthermore increased velocity may result in uncontrollable erosion that eventually may produce new meanders and damaging adjacent land and property (ibid). Secondly, straightening of a meandering alluvial river may only be successful if the channel is lined or the banks reinforced (ibid). Thirdly, dredging the channel will only decrease the flood height according to how far the channel is deepened (ibid).

*Bypass channels and floodways* –involve using tunnels or open channels to divert water elsewhere (ADPC, 2005). These diversion systems serve two purposes in flood mitigation: (i) they provide storage through reservoirs which decreases the flow in the main channel below the diversion (these reservoirs are known as *flood control dams/ reservoirs* (Miller, 1997; Smith, 2004); and (ii) they provide an extra outlet for water discharge from upstream (ADPC, 2005). Methods of diversion include: (a) spillway that enables water to flow naturally over into a channel when it reaches the height of a spillway; (b) sluice gates in control structures; and (c) intentionally breaching a dyke to divert water during an emergency (ibid). The following limitations exist with these measures. Firstly, floodways are limited by topography (ibid). Secondly, in rural areas to optimise agricultural land, diversion channels are only used during major flood times. However, in urban areas where land is limited, this option is not viable because the land cannot be developed (ibid). Thirdly, informal dwellers may occupy the land exposing them to increased risk when the diversion channels are in use (ibid). Fourthly, people living behind the floodwall become vulnerable since these structures only protect up to a certain flood level (ibid).

*Discharging drainage water by pumping* –this is however not a very effective approach on its own (ADPC, 2005). Limitations to this approach include that pumps are dependent on electricity or generators which may fail during floods. Secondly, the working components of the pump are susceptible to failure and clogging (ibid).

*Infrastructure for community flood protection* –structural interventions can be implemented at community level where people have been doing this throughout history applying indigenous knowledge (ADPC, 2005). Such methods vary according to cultural practices and the flooding environment (ibid). A limitation to these methods is that they become extremely vulnerable to larger than normal floods (ibid).

ADPC (2005: 134) highlighted a number of environmental and social concerns that arise with large-scale structural solutions such as dams and embankments. These include:

- i) resettlement issues;
- ii) creation of a false sense of security;
- iii) loss of natural and environmental value;
- iv) lack of community participation;
- v) transboundary concerns, particularly where rivers cross political boundaries; and
- vi) dependency that discourages human resilience.

Non-structural measures aim to keep people and their property away from floods and are often portrayed as “working with nature” compared to the structural measures (Miller, 1997) mentioned above. The following are non-structural measures:

- Integrated watershed management;
- Flood proofing; and
- Preparedness planning

*Integrated watershed management (IWM)* is the most important non-structural measure for flood risk management (ADPC, 2005). This involves the management of activities within the watershed to ensure they do not increase the risk of flooding through effective land-use planning and zoning that requires good governance to enforce (ADPC, 2005). A watershed refers to the “land area that drains water to a particular stream, river, or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large watersheds can contain thousands of smaller watersheds” (USGS Glossary, 2004 in ADPC, 2005: 85). The approach is effective in managing the contributing factors and impacts of flooding and involves a multi-sectoral and often transboundary (across either district, provincial or national boundaries) approach (ADPC, 2005). The goals of IWM in terms of flood mitigation are related to the hazard and environmental protection (ibid). There are four main strategies in implementing IWM each with specific tools. These include *floodplain* management (ADPC, 2005; Miller, 1997); *land use* planning (ADPC, 2005; Miller, 1997; Smith, 2004); *urban development planning* (ADPC, 2005); and *rural development planning* (ibid). Table 5.2 summarises the different strategies and tools employed in IWM, excluding that of rural development planning. There are several limitations associated with an IWM approach. Firstly, the problems that are worsening flooding downstream may be occurring upstream which may be in another district, province or country which makes the management of the water resource a politically sensitive issue (ibid). Secondly, it can become difficult to meet all the needs of the various stakeholders necessary in an IWM approach thus producing the possibility of conflict arising between stakeholders (ibid). Thirdly, a lack of political will at national level to address floods through an IWM approach means that policy and legislative tools may be limited to encourage this approach (ibid). Finally, policies, legislation, agreements and cooperation can only be effective through good governance (ibid).

**Table 5.2 Different strategies employed in Integrated Water Management** (adapted from ADPC, 2005)

<b>Strategy</b>	<b>Aims</b>	<b>Tools</b>	<b>Supporting Mechanisms</b>
<b>Floodplain management</b>	To reduce vulnerability of flooding & the losses that occur through effective use of the flood plain to minimise risk	Land use planning; zoning; building codes; urban and rural planning	Pilot programmes; institutional arrangements & capacity to enforce legislation; developing capacity of local staff to enforce the law; training staff to use appropriate tools (e.g. GIS); monitoring & evaluation
<b>Land use planning</b>	To guide settlement expansion & redevelopment away from flood-prone areas	Zoning; encroachment lines; urban development planning; building codes; relocation & resettlement; and conservation	As above; NGOs; CBOs
<b>Urban development planning</b>	To plan settlements away from high risk areas	Urban stormwater drainage planning; infrastructure design & development	Finance; technical expertise; good governance; legislation

*Flood proofing* involves adjusting or modifying the design of individual structures to reduce flood damages and includes long-term, non-structural or minor structural measures to mitigate the effects of flood (ADPC, 2005; Miller, 1997; Smith, 2004). It includes permanent, contingent and emergency measures (ADPC, 2005). The SEI/ASCE (2000) in their design standard provides minimum requirements for flood-resistant design and construction of structures located in flood hazard areas. The following are key approaches to flood proofing:

- Relocation –temporary moving away from the flood-prone area (ADPC, 2005; Miller, 1997; Smith, 2004)
- Elevation –raising the building above the flood level by piles, bamboo or timber stilts, land-fill, or making basements water tight (ADPC, 2005; Miller, 1997; Smith, 2004)
- Flood walls –concrete or steel walls to keep the flood out (Miller, 1997; Smith, 2004)
- Dry flood proofing –sealing the property to prevent flood water from entering using waterproof sheeting, shields, sandbags, and other material that prevent water from entering doors and windows (ADPC,

2005; Miller, 1997; Smith, 2004). This is only suitable in shallow water with a low velocity and should only be applied to buildings constructed of brick, concrete blocks or brick veneer on a wood frame (ADPC, 2005).

- Wet flood proofing –allowing the basement and ground floor to flood while keeping the habitable portion of the building above flood level (ADPC, 2005; Miller, 1997; Smith, 2004).
- Demolition –demolishing a damaged property and rebuilding it more securely on the same site or a safer location (Smith, 2004).

There are several limitations and disadvantages associated with flood proofing. Firstly, flood proofing is not suitable in areas subjected to fast moving water or violent wave action during flooding (ADPC, 2005). Secondly, the additional costs involved in land filling or reclamation, or applying other flood proof techniques is one of the disadvantages of flood-proofing (ibid). Some disadvantages are that there may be a short supply of earth for fill material, the poor aesthetics associated with flood proofing of houses, and the restricted usage of areas where people tend to migrate during floods (ibid). Fourthly, flood proofing may cause further flooding problems, for example earth mounds and dykes may reduce the infiltration and retention capacity of the given area, or may divert flood waters causing flooding elsewhere (ibid). Fifthly, flood proofing is only safe up to a certain flood level (ibid).

*Preparedness planning* comprises of a variety of activities that includes emergency planning, early warning, and specific actions to reduce risk (ibid). Flood disaster preparedness considers the following: (i) flood response and emergency planning; (ii) flood forecasting and early warning systems with effective dissemination of information especially to the at risk community; (iii) review and revision of systems and plans, providing specific training in areas needing capacity building to ensure timely and effective response (ADPC, 2005 from UNDMTP, 1994). Public awareness of flood risks is also an important

component of preparedness (ADPC, 2005) as people's understanding of flood risks will influence effective community responses. ADPC (2005) highlighted four limitations to preparedness planning that included:

- i) complications in preparing plans;
- ii) uncertainty around effective risk communication;
- iii) ineffectiveness in early warning communication; and
- iv) problems in obtaining cross-border Flood Early Warning Systems (FEWS).

It can be seen that there are various structural and non-structural measures for managing flood risks. However there are various limitations associated with the different types of structural and non-structural measures. An effective flood risk management strategy would therefore be to adopt both appropriately selected structural and non-structural measures (cf. Miller, 1997). Appropriate structural measures should be based on design flood estimates, available resources and social acceptance. Non-structural measures should be based on cultural practices, the natural environment and available resources. Miller (1997) presents a strategy framework (box 5.1) that would be useful to consider in designing a flood risk management strategy.

## **5.5 South African Flood Risk Management Policy, Institutional Arrangements and Strategies**

### *5.5.1 Flood Risk Management Policy in South Africa*

#### **a) National Disaster Management Act (Act 57 of 2002) and Framework (2005)**

Pyle (2006) documented the historical development of South Africa's National Disaster Management Act (NDMA) and National Disaster Management Framework (NDMF) from the Green Paper in 1998 to the White Paper in 1999 and the resultant act in 2002 and framework in 2005. The Act and framework are "coordinating" and "enabling" legal instruments which are intended to facilitate transversal engagement in disaster risk reduction by different stakeholders (Durham, 2007). The Act has ensured a paradigm shift to disaster management

**Box 5.1 Strategies and tools for floodplain management** (modified from Miller, 1997: 26)

<b>STRATEGY I: REDUCE FLOODING</b>	
Dams and reservoirs Dykes, levees, flood banks Channel improvements	High flow diversions Land treatment measures On-site detention
<b>STRATEGY II: REDUCE SUSCEPTIBILITY TO DAMAGE</b>	
<b>Integrated Watershed Management</b>	
<b>Floodplain regulations</b>	
Zoning Subdivision regulations Building Codes	Housing codes Sanitary codes Other regulations
<b>Development and redevelopment policies</b>	
Design and location of facilities Land rights, acquisition and open space	Redevelopment Permanent evacuation
<b>Flood proofing</b>	
<b>Flood forecasting and early warning systems</b>	
<b>STRATEGY III: REDUCE THE IMPACT OF FLOODING</b>	
Information and education Disaster preparedness Disaster assistance	Tax adjustment Flood emergency response Post-flood recovery
<b>STRATEGY IV: RESTORE AND PRESERVE THE NATURAL AND CULTURAL RESOURCES OF THE FLOODPLAIN</b>	
<b>Floodplain and wetland regulations</b>	
Zoning Subdivision regulations Building codes	Housing codes Sanitary codes Other regulations
<b>Development and redevelopment policies</b>	
Design and location of facilities Land rights, acquisition and open space	Redevelopment Permanent evacuation
<b>Information and Education</b>	
<b>Tax adjustments</b>	
<b>Other administrative measures</b>	

in South Africa from “reactive” to “proactive” activities. The Act gives explicit emphasis to risk and vulnerability reduction particularly of the most vulnerable in society. An important aspect of the Act is its emphasis on cooperative governance as a priority in meeting disaster management objectives. Here a critical aspect is the formulation of disaster management plans at the provincial and municipal level that needs to be integrated into provincial development planning and local municipal Integrated Development Plans (IDPs).

The NDMF is the legal instrument specified by the Act to address the need for consistency across multiple interest groups and gives priority to developmental measures, disaster prevention and mitigation (Pyle, 2006). The four key performance areas focus on institutional arrangements; disaster risk assessment and monitoring; disaster risk reduction and disaster response; and recovery and rehabilitation. The following three enablers are set out to attain the objectives: information management and communication; education, training, public awareness and research; and funding arrangements.

The Western Cape Province has its own framework in addition to the NDMF –the Western Cape Provincial Disaster Management Framework (WCPDMF) that was drafted even before the NDMF was gazetted. The WCPDMF requires that within the Western Cape every organ of state has a representative on the Western Cape Disaster Management Advisory Forum (Durham, 2007).

b) National Water Act (Act 36 of 1998)

The purpose of this act is to ensure that the country's water resources are protected, used, developed, conserved, managed and controlled in ways which take into consideration amongst other factors (as listed in section 2 of the act) the managing of floods and droughts.

With respect to flood management there are several important chapters within this act for example chapter 2, part 2 that outlines the legal requirements of catchment management strategies. This should be read in relation to chapter 7 of the act that is concerned with catchment management agencies. Section 80, in particular, outlines the functions of the catchment management agencies. Finally chapter 14, part 3 is also specifically relevant to flood management. Here section 144 stresses the importance of floodlines on township plans. Furthermore section 145 stresses the importance of making flood related information available to the public.

c) South African Weather Services Act (Act 8 of 2001)

This act concerns the objectives, functions and method of work of the South African Weather Service (SAWS). Section 4, subsection 3 of this act stipulates that only the South African Weather Service may issue severe weather-related warnings over South Africa.

d) Municipal Systems Act (Act 32 of 2000)

A key feature of this act is the requirement of Integrated Development Planning by all municipalities where 5 year strategic development plans are to be drawn up and annually reviewed in consultation with local communities and stakeholders. The resultant Integrated Development Plans (IDP) is to guide and inform all planning, budgeting, management and decision making within a municipality. The IDP identifies resources and allocates these to priority areas so that institutional capacity to implement basic responsibilities is not compromised. This act is important for flood risk management since disaster management plans need to form part of the IDP of a municipality and therefore any efforts to reduce flood risk should be incorporated into the integrated development plans.

e) National Building Regulations and Building Standards Act (Act 103 of 1977)

With regards to flood management this act concerns development within the 1:50 year floodline area where requirements are based only on safety considerations without proper consideration and understanding of the underlying natural streamflow process (CSIR, 2003).

f) Town Planning and Townships Ordinance (Ordinance 15 of 1986)

This ordinance makes provision in Regulation 44 (3) for the extension of floodline areas up to 32 metres from the centre of a stream in cases where the 1:50 year floodline is less than 62 metres wide in total (CSIR, 2003).

### 5.5.2 Institutional Arrangements to Flood Risk Management in South Africa

From a meeting in Bethlehem in May 2005, the South African Weather Service (SAWS) accepted responsibility for Flash Flood Forecasting in the country. This meeting saw the following institutional arrangements for flood forecasting in South Africa take effect:

- SAWS weather forecasters became the channels of warning to local metropolitan and district Disaster Managers for both severe weather and flash floods;
- SAWS began to deploy soil moisture probes at selected sites to telemeter rainfall information on a daily basis to their data-base that will allow for ground-truthing of satellite remote sensing of soil moisture indicators;
- DWAF (Department of Water Affairs and Forestry) continued to work with large rivers and dam releases to issue flood warnings and monitor their progress;
- The “division of labour” between SWAS and DWAF was determined by the response time of the catchments of interest. In South Africa, on average, flash floods occur in catchments with response times less than 6 hours. Predicting these floods is the responsibility of SAWS. Predicting floods in catchments with response times exceeding 6 hours became the responsibility of DWAF who agreed to work through the National Disaster Management Centre (NDMC), (Pegram et al, 2007).

The response to floods and emergency evacuation of citizens are the responsibilities of local disaster management (ibid). In this context, municipalities need to undertake flood inundation analyses if their disaster management plan suggests this is a significant risk (ibid). It is not clear which department is responsible for handling floods which have a longer lead-time but the Disaster Management Act mandates local authorities to provide proactive disaster mitigation strategies including early warning systems (ibid). While prevailing policy views this responsibility lying with local authorities, it is also recognised that this is unlikely due to capacity and budgetary constraints

at the local/Metro level (ibid). Pegram et al (2007) suggested that while DWAF should develop the necessary skills and capacity to do hydrological modelling of the larger catchments which pose a threat, they acknowledge that DWAF lacks a mandate to act (and spend) to achieve this. In this regard, the NDMC is mandated only to play a coordinating role and not to provide skills and services to local disaster managers (ibid).

### *5.5.3 Flood Risk Management Strategies in South Africa*

Alexander (2000b) outlined that the objectives of a flood preparedness policy are to (i) limit the loss of life and direct damage to property as well as indirect damage to the national or local economy; (ii) ensure the acceptance of risk is equally shared between national and local authorities and the public; (iii) develop and implement flood management criteria for local authorities and the public. Thus a flood management policy is to be formulated within the framework of these objectives (ibid). The selection of the appropriate method for reducing flood risks is dependent on the nature of the development (ibid).

There are three criteria used to determine the optimum method for reducing floods. The first concerns determining the *economic optimum size* of a design structure for example urban drainage systems, which can be calculated fairly easily (ibid). Secondly, the acceptable level of public inconvenience or *public acceptance optimum* which is a subjective assessment (ibid). The third criterion concerns development of risk reduction measures for unplanned residential occupation of flood prone areas where *social, political and economic criteria* become important (ibid). All of this indicates “the wide range of knowledge and analytical methods required for the development of flood risk reduction measures, and the large measure of experience-based judgement required for devising solutions” (ibid: 225). Most local authorities in South Africa have developed design standards based on judgement and experience rather than optimisation criteria (ibid).

The *ex ante* (risk reduction/mitigation) stage of flood damage research in South Africa has contributed to the knowledge base of determining flood risk reduction measures. Here, research by Viljoen et al (2001) that stretched over the three phases of *ex ante* research resulted in the development of the *Flood Damage Management Aids for Integrated Sustainable Development Planning in South Africa*. The aids were intended to be applied as part of a holistic approach to integrated hydrological catchment management. They developed a *continuous flood disaster management system* that comprised a proactive, reactive and post (event) component. The three phases are informed by computer programmes for design modelling, loss functions and questionnaires for damage assessments. Within this continuous disaster management system, the key area, particularly with regards to flood risk reduction, concerns the proactive component.

The features of note within this proactive component concern the computer models of FLODISM (Flood Damage Simulation Model for Irrigation Areas) and TEWA (Computer Model for Tangible Economic Flood Water Damage Assessment). The purpose of these models is to optimise certain structural flood mitigation measures. FLODISM concerns rural areas, thus rural flood risk whereas TEWA is dedicated to concentrate on urban flood risk. TEWA calculates tangible flood damages and enables evaluation of different flood damage mitigation options. The inputs into the model required to calculate flood damage include flood damage functions, geographical data, land use data and hydrological data. The deliverables from these inputs include flood maps, land-use data base, economic data base, and GIS data base. The outputs of TEWA enables the determination of the flood damage potential, the area under risk and the impact of different flood mitigation options for a specific urban flood plain. Thus the deliverables of the outputs includes that of flood plain management, emergency and sustainable flood action plans.

The study by Viljoen et al (2001) used an economic-engineering approach with an emphasis on hydrological modelling of rivers. This therefore places more emphasis on the hazard component and limited emphasis on vulnerability reduction that allows for participatory approaches. The research did include a sociological study that highlighted certain social aspects to be considered in the flood management model. However, the sociological study failed to mention that emphasis should also be placed on existing local non-structural measures.

Pegram et al (2007) observed that in most metropolitan areas of South Africa, flood studies are limited to static flood assessments designed for zoning and risk assessment. They also noted that considerable work has gone into defining flood-lines (see for example City of Cape Town, 2003; 2004). Pegram et al (2007) stated that it is only recently that a series of flood forecasting related projects (funded by WRC) resulted in awareness that there are data available that can assist in anticipating a flood rather than waiting for it to happen (see for example Pegram and Sinclair, 2002; Sinclair and Pegram, 2004; Mkwanzani and Pegram, 2004). Building on previous research and development Pegram et al (2007) developed a *National Flood Nowcasting System* in order to develop an integrated flood mitigation strategy for South Africa.

The flood nowcasting system is heavily dependent on hydrological (especially the TOPKAPI model) and hydraulic modelling. It draws from rainfall estimation, historical rainfall data and streamflow data along with catchment characteristics and satellite radar data to produce the flood forecasts. The model was thus far installed in the offices of *Umgeni Water* and *Durban Metro's Flood Management Centre*. The research resulted in a proposed framework for the lines of communication from forecasters to disaster managers to the at-risk communities. However there has been no research to date exploring efficient means of communication from disaster management

centres to the at-risk communities which remains a problem in many metros and local municipalities across South Africa. Hall (2007) for example notes this to be an international problem with regards to early warning research where funding is channelled towards the current capabilities and developments in science and technology thereby shifting focus away from the central issue of addressing the real needs of the communities and people at risk.

CSIR (2003) published guidelines for human settlement planning and design, known as the “Red Book” based on its colour. Previously this was known as the “Blue Book” under the reference CSIR (1994). The Red Book contains many guidelines relevant for flood risk reduction. Here for example there are guidelines to the ideal geological conditions for urban development in terms of soil and slope profile. There are also guidelines around floodplain development especially the importance of identifying the 1:50 year floodline. The guide also contains in-depth guidance and design specifications for stormwater management as well as available structural technologies for flood reduction.

In terms of local strategies of flood proofing, these have been very poorly documented where some examples occur in DiMP (2007 and 2008), Scott and Benjamin (2005) and Sowman and Urquhart (1998). Thus the majority of risk reduction measures in South Africa focus on structural measures and non-structural measures are more orientated towards early warning systems that often do not assist the at-risk communities as warnings fail to reach them timeously.

## **5.6 Conclusion**

This chapter presented what a flood risk assessment should entail and then explored the nature of flood risk related research in South Africa. It was found that the majority of flood research in South Africa has adopted a hazards

approach that is concerned with hydrological modelling of floods. These typically employ deterministic or rainfall-runoff methods; statistical methods, that are either site-specific or regional; and empirical and pseudo-statistical or empirical-probabilistic methods. Very limited research has employed an integrated hazards and vulnerability paradigm to flood risk. Consequently the majority of risk reduction research and practice in the country is orientated towards structural measures or the technical, hydrological component of the non-structural early warning systems. Limited emphasis has been placed on community-based approaches to flood risk reduction practices. There are various legal instruments in South Africa that support flood risk management and the Disaster Management Act and associated framework, in particular, promote consideration of community-based approaches.

In accordance with international best practice, an effective flood risk management strategy should strike a balance between appropriately selected structural and non-structural measures that involve the at-risk community throughout the design of such a strategy –from conceptualisation to implementation. Thus a focus on both an assessment of the flood hazard and the vulnerability conditions of an at-risk population is essential in achieving such a balanced flood risk management strategy.

## Chapter 6

### Research Context

In the democratic South African city we find that “the spatial patterns of apartheid are effectively being recreated” (Berrisford, 1999:4; quoted in Huchzermeyer, 2001: 319).

#### 6.1 Introduction

This chapter outlines the geographical, developmental and disaster risk context of George. Such an overview is essential to any disaster risk assessment of an area particularly when bearing in mind the discussions in section 4.3.1 around the urban risk context. Finally key findings of the three extreme weather events from which the research emerges are presented.

#### 6.2 Geographical Context of George

George is a small city along the south coast of the Western Cape Province of South Africa. It falls under the Eden District Municipality (EDM) of the Western Cape Province, also referred to as the Southern Cape or often the Garden Route because of its pristine natural landscape. The exact geographical position of George is at 34°00'S; 22°23'E (see map 6.1).

The EDM is divided into seven local municipalities these include: Bitou Municipality, Knysna Municipality, George Municipality, Kannaland Municipality, Hessequa Municipality, Mossel Bay Municipality, and Oudtshoorn Municipality. George is a large town, but its local government for economic reasons refer to it as a city. Furthermore, George is the economic hub of the EDM and the second largest urban settlement after Cape Town in the Western Cape Province (Thomas, 2005). The George municipality includes not only the 'town' of George but also other surrounding settlements, resorts and rural areas which collectively are referred to as the George Municipality.

George is comprised of twenty wards<sup>1</sup>. These are the locality of George, Wilderness, Herold's Bay and a number of small coastal resort settlements (these include Kleinkrantz, Victoria Bay and Wilderness National Park) and rural settlement areas (including Geelhoutboom, Herold, Hoekwil, Waboomskraal, Wilderness and Wilderness East) (Thomas, 2005; <http://www.thedplg.gov.za>). The municipality covers a total area of 1068 km<sup>2</sup> which is less than one percent of the total provincial area (Thomas, 2005). For the purposes of the research this area will be considered as the 'city of George' since the local government of George Municipality itself introduces their municipality in this way. Furthermore, Kammeier (2002) suggests that to study small cities we should consider their importance and relationship with their surrounding rural environment. Therefore consideration of the entire George Municipality as comprising the 'city of George' seems justified.

The 2001 census data placed the population of the greater George Municipality at 135 500. Population estimates for 2005 are based on projections by Thomas (2005) factoring population growth at an annual average rate of just below 4.6% before 1996, while between 1996 to 2001, Africans, Whites and Coloureds constituted 10.1%, 1.1% and 4.4% respectively. Thomas, noting the continued high in-migration of Africans from the Eastern Cape and retirees from Gauteng, projected the total population for 2005 to be at 160 000. However, the 2001 census data indicate that the population comprised 51% Coloured and Asian, 27.5% African and 22.5% White<sup>2</sup> (table 6.1). The Coloured population comprised the largest part of the population, yet this proportional percentage is lower than the provincial average. The African population comprised the second largest

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<sup>1</sup> A ward is an area that can include a part of a settlement if the settlement is very big or can comprise one or two whole suburbs/ residential areas, depending on the size of a suburb or residential area. In a single ward a particular councillor representing a particular political party who secured a ward during local elections would be in charge of the interests (in terms of service delivery, local developments etc.) of the residents in that ward.

<sup>2</sup> During the apartheid regime South African citizens were classified according to the following racial groups: African (from the traditional southern African tribes, namely Xhosa, Zulu, Sotho, Tswana, Venda), Coloured (either of mixed descent or from the indigenous Khoi-San ancestry), Indian (from the Indian subcontinent) and White (of European descent). Those with Asian descent, excluding Indian, were classified as Asian.

population group, at a percentage higher than that of the province but significantly lower than that of the country. Although the White population comprised the smallest population group, this total is higher than the provincial average and significantly higher than that of the country as a whole. Males constitute 49.9% and females 51.1% of the population. George accommodates about one-third of the population of the EDM and contributes between 30 to 35 per cent to the District's Gross Regional Product (Thomas, 2005).

**Table 6.1: Population Composition of George relative to the Province and Country**

	Coloured & Asian %	African %	White %
<b>George</b>	51.0	27.5	22.5
<b>Western Cape</b>	54.6	27.0	18.4
<b>South Africa</b>	11.2	79.2	9.6

Source: StatSA, 2001 in Thomas, 2005: 19

**Map 6.1 Map of South Africa indicating location of George**



Source: Johan Stander, SAWS

### *6.2.1 Overview of the Western Cape Climate*

The Mediterranean climate of the Western Cape distinguishes it from the rest of South Africa in that it receives winter rainfall and drier summers whereas the opposite is true for the rest of the country. This is due to its latitudinal position in relation to the band of westerly waves of air circulation and the associated low pressure systems that move from west to east at about 40° and 50° south. These westerly waves contribute to the climate of the Western Cape, bringing rain in the form of cold fronts (Midgely et al, 2005). The extensive mountain ranges, referred to as the escarpment, intensify this rainfall by causing rain to fall on the coastal side (windward side) of the mountain and therefore leaving the leeward side (the interior) dry (ibid). The Atlantic and Indian oceans surrounding the Western Cape, with their associated high pressure systems, also influence these westerly waves and therefore causing the frontal systems to be more frequent during winter (ibid).

Other significant weather systems that affect the climate of the Western Cape include the coastal low pressure systems which results in berg winds – warm dry winds that move from the escarpment down to the coast (ibid). The descending air, coming from the interior down the escarpment, warms up as it descends down to the coast. This occurs mostly along the southern part of the province and usually during late winter and early spring causing associated veld fire risk (ibid).

Another significant weather system that affects the province's climate includes that of cut-off lows. A cut-off low refers to a cold low frontal depression that occurs in mid-latitudes where air of polar origin is intercepted or 'cut-off' from the main subpolar belt of low pressure and cold air which normally moves from west to east. A cut-off low is characterised by heavy rainfall and gale force winds and is most common during spring (September and October) and autumn (March and April), when heavy rain is often experienced (Midgely et al, 2005; SAWS, 2007). This causes extreme rainfall and flooding in the province, particularly to the

southern part (see for example DiMP, 2003; 2004; 2005a; 2007; Midgely et al, 2005).

Midgely et al (2005) assessed historical trends in the Western Cape climate in order to inform a basis for future climate predictions for the province. Where future rainfall patterns are concerned they predicted that there will be an increase in total rainfall over the eastern regions of the Western Cape during late summer (January to March) and a decrease in rainfall, particularly over the western regions of the Western Cape, during early winter (April to June). This tendency for decreased rainfall continues throughout the winter season. Overall, there will be winter drying and changes in late summer rainfall will be mainly due to an **increase in the intensity of the rainfall**. There will also be increases in temperature of about 1.5°C along the coast and 2-3°C over the interior (ibid). In summary, the province of the Western Cape will see an increase in climate variability.

#### *6.2.2 Overview of George's Climate*

In the context of the Western Cape Province, George is located along the south coast of the province. George also falls under the region known as the 'Cape South Coast' which includes a part of the neighbouring Eastern Cape Province to the east (regions 8 and 11 in map 6.2). The South Coast receives predominantly winter rainfall, but this trend changes towards the east of the South Coast region where rainfall is characterised by a tendency towards summer rainfall (Tummon in DiMP, 2007). George is found to the west of the South Coast (region 8 in map 6.2) and as such has a tendency towards winter rainfall (ibid). By considering average monthly precipitation for an 85-year period from 1921 to 2006 it is apparent that the annual average rainfall is relatively high (see graph in figure 6.1) experiencing heavy downpours compared to most other regions in the rest of South Africa (Tummon in DiMP, 2007 also see Walton [ed.], 1984: 19 for maps indicating different rainfall areas across southern Africa).

In the broader rainfall region of George (i.e. region 8), the rainfall is similar to the rainfall in George for the same period (1900 to 2006) as can be seen by comparing figures 6.2 and 6.3. The precipitation cycle for region 8 is bimodal in that high rainfall occurs twice annually in March-April and August-November respectively (Tummon in DiMP, 2007). The average August rainfall for region 8 (figure 6.4) is 41.5mm, which compared to figure 6.2 is slightly lower than that of George. This difference between George and its broader rainfall region (region 8) is due to topographic influences. To the north of George are the relatively high Outeniqua Mountains, which are higher than 1450 metres above sea level (<http://www.oudtshoorninfo.com>). George is located on the windward side (i.e. the coastal side) of the Outeniqua Mountains. This mountain range influences climate in George causing orographic rainfall, as moist air is forced up the windward side of the mountain. As explained in 6.2.1, the resultant rain falls on the coastal side (the windward side) whereas the leeward side only receives the rain shadow (i.e. the shadow of the rain clouds can only be seen from the interior on the leeward side of the mountain).

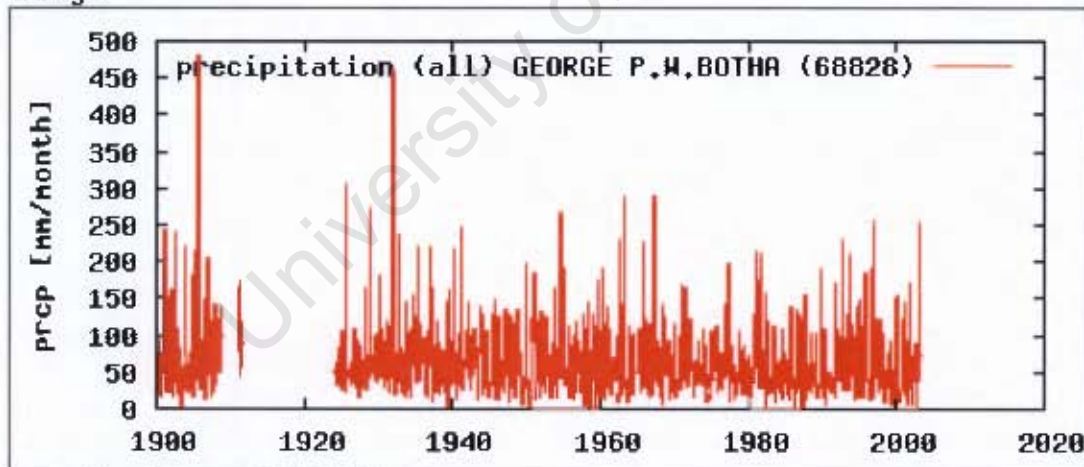
A number of intense rainfall events have occurred over region 8 during the period 1921 to 2006. In 1962 and 1986 intense weather events occurred where rainfall was greater than 140mm (figure 6.4). Precipitation peaks over 100mm occurred in 1954 and 1981 (figure 6.4).

Map 6.2 Map dividing South Africa into 94 rainfall regions



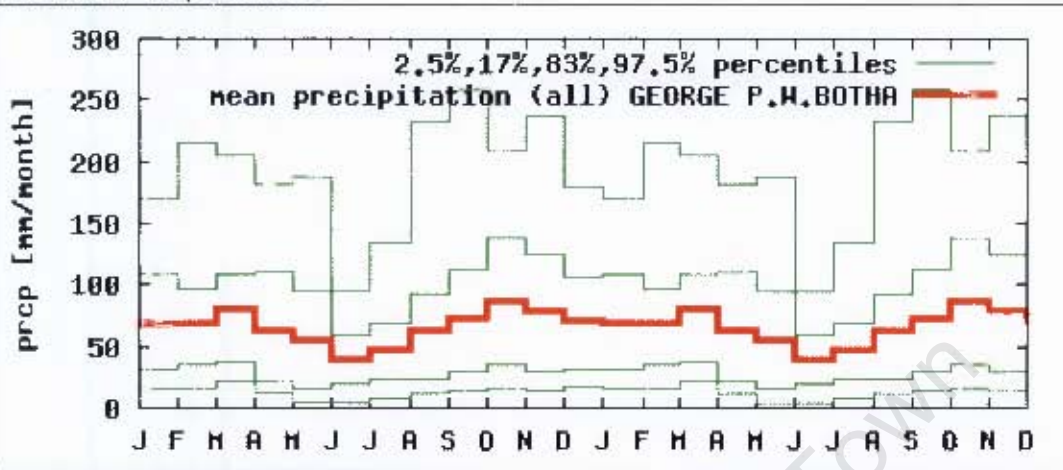
Source: Fiona Tummon in DiMP (2007)

Figure 6.1 Recorded Precipitation Readings from 1900 to 2006 at P.W. Botha Airport, George



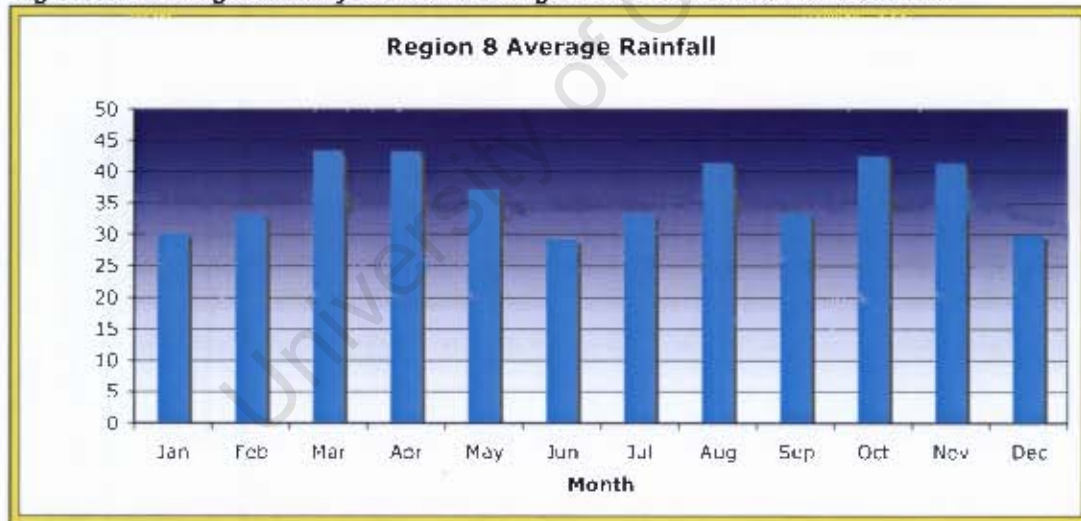
Source: Fiona Tummon in DiMP (2007)

Figure 6.2 Average Annual Cycle of Precipitation for George between the period 1900 to 2006. The red line indicates the annual cycle and the green lines indicate the 2.5%, 17%, 83% and 97.5% percentiles



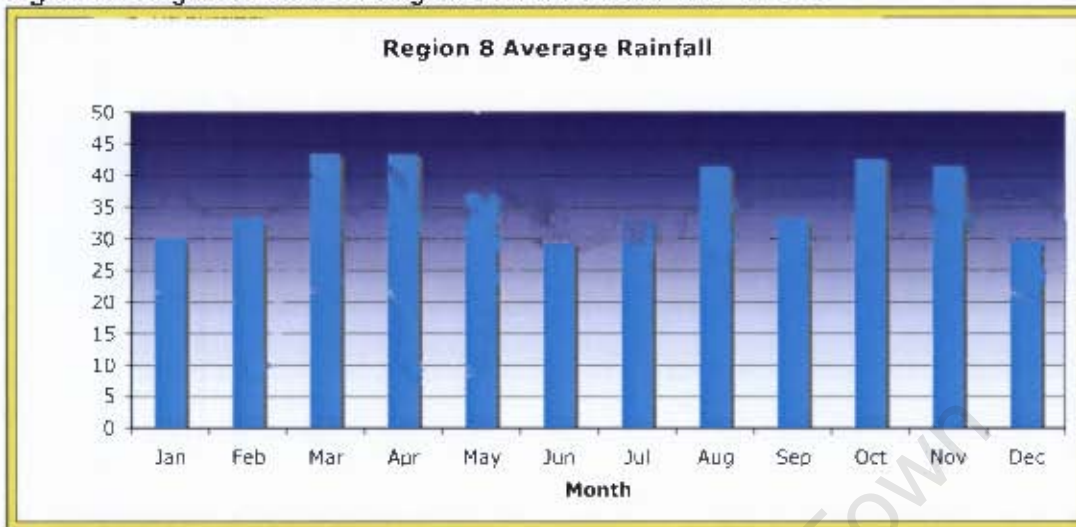
Source: Fiona Tummon in DiMP (2007)

Figure 6.3 Average Monthly Rainfall for Region 8 for the Period 1900 to 2006



Source: Fiona Tummon in DiMP (2007)

Figure 6.4 August Rainfall for Region 8 for the Period 1921 to 2006



Source: Fiona Tummon in DiMP (2007)

### 6.3 Development Context of George

In presenting the development context of George the following areas will be discussed:

- Influence of broader regional, national (and global) policies over developments in George;
- Demographics and economic inputs of the George urban environment;
- Population growth patterns within George;
- Current socio-economic situation of the urban environment; and
- Spatial development of George.

#### 6.3.1 Influence of Broader Regional, National (and Global) Policies over Developments in George

The historical economic and political processes that occurred at a global, regional, national, provincial and district level –viz. colonisation, globalisation and neo-liberal economic policies, the apartheid regime and the consequent apartheid city planning, national socio-economic and housing strategies post apartheid, and socio-economic strategies of the Western Cape Province and the EDM (Bond, 1997; Dewar et al, 1982; Goodland, 1996; Hjort and Ramadiro, 2004; Huchzermeyer, 2001; Lehulere, 1997; Parnell and Hart, 1999; Rogerson,

1996; Swilling, 1991; Thomas, 2005; Thompson, 2001) –played a role in the development of George on a more localised scale (George IDP, 2002; Thomas, 2005). Consequently the current developmental context of George is reflective of the broader regional and national (where global policies have a strong influence) socio-economic policies of past and present. This is evident in the discussions that follow.

### *6.3.2 Demographics and Economic Inputs*

Thomas (2005) provided three explanations as to why George is experiencing high population growth. These include:

1. High in-migration from the neighbouring Eastern Cape Province;
2. The above is due to the Eastern Cape having the second lowest per capita income levels in the country
3. Despite the first point above, the southern Cape experienced the lowest per capita income levels in the Western Cape (20% lower than the national average). However, George is considered one of the wealthiest southern Cape towns. This explains high population growth rates of George relative to other towns in the vicinity since the 1980s –because George appears to be relatively attractive for in-migration from the Eastern Cape into the southern Cape (George IDP, 2002).

### *6.3.3 Population Growth Patterns*

Population growth patterns for George for the period 1921 to 2005 are as follows:

- 1921 – 1960 →stable growth rates
- 1960 – 1970 →first population boom – high growth among Coloureds. This can be attributed to the local economy improving between 1968 and 1975.
- 1980 – 96 →second population boom (below 4% growth rate) – high in-migration from African population<sup>3</sup>. This had strong implications for the provision of social services and housing.

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<sup>3</sup> This may be due to the abolishment of the influx control legislation that placed restrictions on African migration into urban areas in order to control the African population in urban areas.

- 1996 – 2001 →third population boom (highest growth rate -4.6%) – high in-migration from the African population from the Eastern Cape and White population from Gauteng Province.
- 2001 – 2005 →fourth population boom – continued in-migration from the Eastern Cape (George IDP, 2002; Thomas, 2005).

#### 6.3.4 Current Socio-Economic Situation

By discussing the current socio-economic situation within George the following elements will be considered:

- the population growth and structure of George;
- the employment and unemployment figures of George's population;
- the housing situation of George's population;
- the education and skills levels of the population; and
- the health standards of the population.

##### 6.3.4.1 Population Growth and Structure

It was mentioned in 6.2 that the total population for 2005 was estimated at 160 000. Table 6.2 (Annex 2) indicates that there is an almost equal representation of males and females in the population. Coloured household sizes appear to be much larger than both African and White. Thomas (2005) attributed this to several factors. First, many Coloured households tend to absorb extended family members from surrounding rural areas. Second, many of the African family members still reside in the Eastern Cape. Third, the size of informal dwellings accommodates less people. Finally, the majority of White households are retirees. The future estimates provide insight into the housing expectations for the future (ibid). The estimates for 2015 indicate that the African population will grow to comparable levels with the Coloured population because of continued in-migration from the Eastern Cape (ibid). Table 6.3 (Annex 2) indicates that the majority of the population (46.8%) is young (24 years and below in age) which may have implications for the economy in terms of the productively active group.

#### 6.3.4.2 Employment and Unemployment

Table 6.3 summarises 2001 census data on the basis of key age groups by race group for George. The economically productive age group relevant (25 to 54 years) is virtually equally distributed among the three race groups, with the share highest among Africans (44.6% compared to 41.0% for the other two groups). This indicates the migration impact viz. “income-seekers” are relatively overrepresented in the local population. Above this age group the pattern changes, with the number of Whites exceeding the other race groups, clearly reflecting the often-quoted (pre)-retirement settlement pattern (Thomas, 2005).

Comparing totals, the relatively large size of the 15- to 24-years age group (18.2% of the total compared to 42.2% for the 25- to 54-years group) is particularly striking. “This reflects the challenge of ‘youth employment’ and the need for more education and training facilities” (Thomas, 2005: 28).

Table 6.4 (Annex 2) presents the projected 2005 employment totals. Based on the estimated total population of 160 000 for 2005, the labour force total of 66 500 constitutes 41.5 per cent of the population, which is similar to trends in the Western Cape (Thomas, 2005). The estimated unemployment of 14 000 constitutes 21 per cent of the labour force, which is also similar to Western Cape patterns (ibid). “The level has remained constant since 2001, which suggests significant new job creation *and* substantial job losses, in addition to the regular increase of the labour supply due to natural population growth and in-migration” (ibid: 30).

The racial breakdown of these different magnitudes reflects the region’s socio-economic past and present: “The coloured community has a share of 47.5 per cent in the 2005 population of George, a 50.6 per cent share in the labour force, a 48.9 per cent share in employment and a 56.8 per cent share in unemployment. In contrast whites have a population share of 21.1 per cent, yet an unemployment share of only 4.6 per cent whereas the African share in the labour force is 28.9 and in unemployment 38.6 per cent” (ibid: 30).

A further analysis of the actual employment pattern [the distribution of the 52 500 (self-) employed people in 2005] becomes possible with reference to table 6.5 (Annex 2) which provides a relatively detailed matrix showing estimated employment of people from the different race groups in a 16-sector breakdown of the George economy. Table 6.5 reflects “widely divergent racial employment shares in line with different skill needs, sector development patterns and formal/informal-sector mixes” (ibid: 30).

Table 6.5 reflects that trade plays the largest role (13.8 per cent) in the economy (George IDP, 2002). This is followed by the tourism sector with a 12.2 per cent contribution to the economy. The manufacturing sector constitutes the third largest sector with 10.3 per cent (ibid). Most Coloureds are employed in the manufacturing sector, whereas most Africans are employed in the construction sector and the majority of Whites are employed in the tourism sector. This sector by race distribution reflects apartheid strategy planning where Africans were channelled into low-skilled manual labour, Coloureds into semi-skilled manual labour and Whites into the tertiary sector.

Table 6.6 (Annex 2) presents the 2001 Census data on household-income distribution for George. The income categories range from no income to an annual household income of R300 000 and higher. The four biggest categories (with 12 to 18 per cent of the households falling into each category and a total coverage of 65 per cent of the 35 000 households) fall into the range of R400 to R6 400 per month. “If one takes a conservative level of R800 household income per month as a ‘poverty line’, about 30 per cent of George households fall below that line” (Thomas, 2005: 32). The census data appear to have errors in data capturing because it appears unrealistic to have nearly 14 per cent of households earning no income (ibid).

Thomas (2005) observed that South Africa is going through a process of widening rather than narrowing wealth inequalities. This trend he noted also holds true for George. Thomas further observed that being a relatively well

developed and mature urban area, George's income and wealth inequalities are not as large as those of developing rural areas and in some metropolitan areas.

#### 6.3.4.3 Housing

Where housing and basic services are concerned, Thomas (2005) noted that George seems to be far better off than many other urban areas, with the category "proper (brick or timber) house structure on a separate stand" dominant among all three race groups. Basic services such as "toilets connected to sewerage system" and "refuse removal at least once a week" reflected in table 6.7 (Annex 2) are relatively impressive. Categories 3 to 5 covering 'informal or make-shift accommodation' accounts for 18 per cent of Coloured and 36 per cent of African households, "which may be a reasonable indication of the 'poverty-cum-housing' challenge facing George" (ibid: 35).

#### 6.3.4.4 Education and Skill Levels

Table 6.8 (Annex 2) presents the Census 2001 statistics reflecting education levels of the George population (Part A of the table) and about registration in educational institutions during 2001 (Part B of the table). Part A of the table confirms an expected pattern, "given the migration process and past inequities of opportunities.... Compared to other urban and rural areas in South Africa the overall pattern (shown in the last column of Section A of the table) looks relatively good, with almost 70 per cent of all race groups together having completed at least 'some' high-school education and only 7.8 per cent of those beyond school-going age having 'no schooling'" (Thomas, 2005: 35).

However differences become apparent if race groups are compared, showing almost all Whites having completed primary school, with 46.4 per cent having completed secondary school and 27.3 per cent completing higher education. In contrast, almost half the African group (beyond school-going age) have only had education up to primary-school level and just less than 20 per cent had completed high school or more. The share of Coloured people who completed high school or more is only marginally above the level of Africans (21.2 per cent compared to 19.5 per cent). "This would seem to indicate that many of those better

educated have actually moved away from George to take up opportunities elsewhere in the country. In fact, the percentage breakdown of the different education levels is very similar for the coloured and African groups, which just accentuates discrepancies between 'white' and 'black'" (ibid: 35).

Part B of table 6.8 shows enrolment in the different educational institutions during 2001, indicating very low engagement in post-school education. This may not be completely accurate, since many learners from George may have been engaged in (post-) school education outside George at the date of the census, i.e. might not have been included in the data (ibid). The enrolment at adult-education centres is similarly low, "which may in part be an undercounting, but also reflects the absence of such facilities in a clearly visible way" (ibid: 36). All of these statistics reflects the challenges that face George's local economic development strategy (ibid).

#### 6.3.4.5 Health Standards

No substantial health census data exist for George. However Thomas (2005) presented some useful basic information about the general health standards of George. These are presented in box 6.1 (Annex 2).

#### *6.3.5 Spatial Development*

A basic outline of the spatial planning of George and how this planning shapes development is presented here. By looking at the spatial planning of George legacies of South African apartheid city planning become evident. The following spatial elements will be considered:

- general land use pattern of George;
- the natural surrounding environment of George;
- the built environment resources of George;
- residential areas and housing within George; and
- spatial development and poverty within George.

#### 6.3.5.1 General Land Use Pattern

The main land categories in the George Municipality include areas of human settlement (urban and rural settlements), productive areas (agriculture and forestry) and pristine natural areas (national parks, indigenous vegetated areas, coastline and ocean), (Thomas, 2005) – see Annex 1. The four key land uses in the city of George include the central business district (CBD), decentralised commercial nodes, industrial areas, and residential areas or suburbs. The CBD is centrally located in the town and has maintained a level of vibrancy and economic activity despite the ongoing decentralisation of economic activities and the many underutilised land (ibid). There has however been a decline in investment in the CBD where investors prefer the decentralised, suburban locations (ibid). George also has one fairly centralised industrial area where there is still substantial vacant land (ibid).

The residential areas reflect a striking similarity with many South African towns and cities (ibid), on the basis of race, income and proximity to urban opportunities (ibid). The remnants of apartheid can be seen in that many Africans and Coloureds are residing in areas distant from the CBD and other urban opportunities (ibid). “The majority of the coloured population live in Pacaltsdorp and surrounding areas, in the southern part of the town. The majority of African people live in Thembaletu, in the south-eastern part of the town. The majority of the white population live in locations close to urban opportunities and in spectacular natural settings in the eastern, northern and north-eastern parts of the town and in exclusive coastal resorts” (ibid: 42).

#### 6.3.5.2 Natural Environment

George has a strong natural resource base that includes the Outeniqua Mountains, the Indian Ocean, numerous river valleys, coastal cliffs, bays and beaches, valuable agricultural land (see Annex 1) and a moderate climate (Thomas, 2005). These natural resources are important for the significant contribution made by the tourist, forestry and agriculture sectors to the economy (ibid). The economic infrastructure related to the natural environment includes protected areas (private and public nature reserves and national parks),

numerous golf courses, and the Outeniqua Choo Tjoe train that takes tourists from George through the natural landscape towards Knysna to the east (ibid).

#### 6.3.5.3 Built Environment Resources

Thomas (2005) supported the view that the physical infrastructure of a locality is one of the most critical factors that shapes the locality's local economic development due to its role in ensuring the supply of basic infrastructure services and to secure investments. The existing infrastructure and service networks in George include roads and engineering, water and sanitation, electricity supply, waste disposal and telecommunications (ibid).

The municipality is well served by an integrated intra-municipal road network that enables reasonable access between settlements within the municipality (ibid). Gravel roads occur in predominantly rural areas and poorer suburbs in Pacaltsdorp and Thembalethu (ibid). There is sufficient water available to supply the demands of the population, however not all households have effective connections to water supplies (ibid), especially in informal settlement areas. Electricity supply has not reached the entire population, especially in informal settlements and low cost housing areas where it is prohibitively expensive. A number of solar panels have been set up in the low cost housing areas of Thembalethu to alleviate the costs of electricity to the poor<sup>4</sup>.

#### 6.3.5.4 Residential Areas and Housing

Thomas (2005) observed that the demand for residential land by the high-income households is influenced by the economic development of George as well as the quality of life offered by the natural environment. Similar to national trends this segment of the property market has received strong upward pressure over recent years (ibid).

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<sup>4</sup> Personal observations and discussions with local ward councilors.

As a response to this high demand, land for this segment of the property market is to be made available on the periphery of the city, "in the most desirable locations and removed from medium-low or low cost categories of housing" (ibid: 44). This process however will not answer the "land for housing" needs of the low income population of George or help with the process of social integration of George's population and it does not constitute efficient use of scarce land resources (ibid).

There is also a stronger need for the provision of safe housing to low-income households (ibid). This demand is fuelled by local population growth and high rates of in-migration (ibid) particularly from the neighbouring rural Eastern Cape. The 2001 census revealed a housing backlog of 5 875 housing units (ibid). This backlog increased dramatically over a three-year period according to a social survey undertaken for the municipality in 2004 which revealed an immediate demand for 9 800 units as well as 5 500 units for an additional category of young adults and the aged (ibid). With an estimated growth in demand of 800 to 850 units annually, this means that the demand for low-income housing may grow to 16 000 units by 2010 (ibid).

The municipality currently has plans for large-scale housing developments located on the periphery of George, far from the CBD (ibid). Average densities for future developments are between ten and twenty units per hectare, which is far below what should be aimed for in such urban areas (ibid). There is also no mention of improved housing quality in these plans, with a focus on only alleviating the backlog (ibid). This is contrary to the objectives of the National Housing Policy. The national housing policy provides a once-off subsidy to households that have never received state assistance for housing and have met income and family-size criteria (Oldfield, 2000). A graded subsidy is provided to families earning less than R3 500 per month (Mackay, 1999; Oldfield, 2000; Tomlinson, 2007) for the purchase of land and the development of a serviced house, usually less than 25 square metres (Oldfield, 2000).

This dualistic supply of housing (i.e. focusing on high-income and low-income households) makes no provision for middle-income households who cannot afford the “upmarket” properties and who would not be satisfied with the low-cost housing schemes (Thomson, 2005). There is therefore no continuous range of housing options on the market, which will hamper the ability of the city to attract better skilled operators or junior to middle management staff for local firms (ibid).

#### 6.3.5.5 Spatial Development and Poverty

Map 6.3 shows the location of low-, middle- and high-income suburbs around the George municipal area, whereas map 6.4 depicts areas of concentrated poverty. Map 6.4 includes all the areas identified as “disadvantaged” in the 2004 Spatial Development Framework for George. The following are the poor settlements/ residential areas/ suburbs: Ballotsview, Blanco, Borchards, Bossiesgielt, Conville, Golden Valley, Kleinkrantz, Maraiskamp, New Dawn Park, Pacaltsdorp, Palana Valley, Syferfontein, Thembaletu, Touwsrante, and Wilderness Heights. In many of these areas poverty in terms of low household income is exacerbated by “poor-quality basic services, long distances to health, welfare and other basic services as well as to main employment opportunities” (Thomas, 2005: 49).

From this it becomes clear that the spatial planning of the city has an immediate relationship to the city’s economic development. Therefore the areas furthest from the CBD and urban opportunities are in most cases also the areas of poverty. This spatial planning in many senses reflects the ripple effects of the apartheid system urban planning and the transition of South Africa into a democratic era.



#### 6.4 The Study Area: Thembaletu<sup>5</sup>

Thembaletu, a majority African settlement, comprises 5 wards, with an approximate population of 18 000. There are about 8 000 RDP (Reconstruction and Development Programme<sup>6</sup>) houses and over 2 000 informal dwellings in the settlement<sup>7</sup>. The settlement is located on a topographically inappropriate landscape for human settlements (Annex 3). The settlement has a somewhat hilly landscape and is surrounded by peripheral rivers on either side, the Skaapkop River to the west and an unnamed stream to the northeast. The result is that dwellings (both RDP and informal) are situated on slopes of hills and in the valleys of the two rivers and its tributaries. The land consequently has a high water table and in some areas there are underground springs.

Most of the informal areas are under-serviced, especially in terms of water and sanitation. There are very high people-to-toilet and -tap ratios, one communal tap for example is to be shared among 35 families. As an alternative, the majority of residents use the bush to relieve themselves while some build their own bucket-toilets within dwellings. People stand in long queues for water collection, particularly on weekends. Refuse removal occur once a week, where black refuse bags are handed to the people for the up-coming week. However, there are weeks when refuse is not removed. The result is dumping of household refuse in the surrounding environment. Furthermore, the informal areas are poorly drained and therefore the ground is always saturated long after heavy rains. There is also no formal electrical connection available for informal dwellers.

The RDP houses are built on a somewhat “awkward” landscape. This generates a juxtaposition of houses built on elevated hill tops, others on the slope of hills and on the foot of hills. Because of this “awkward” landscape, infrastructure is ill-

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<sup>5</sup> This section is based on fieldwork conducted in the settlement (see chapter 7).

<sup>6</sup> The term Reconstruction and Development Programme (RDP) is used for government subsidised low-cost formal houses after the socio-economic strategy ‘Reconstruction and Development Programme’ of South Africa following democracy under which such subsidised houses were conceptualised.

<sup>7</sup> Information from personal communication with Ward 12 councillor and informal dwelling information from DLGH report.

sited in a somewhat uncoordinated and clumsy manner, reflected, for instance, in roads being located above housing developments. A few of these roads are tarred but given the topography this does not seem to be an appropriate approach as run-off tends to erode these tarred roads relatively quickly. Stormwater drainage also seems to be uncoordinated, as outlets of some stormwater channels flow directly onto the roads, but worse still, some of them directly exit toward RDP houses. Much of this uncoordinated siting of infrastructure is a result of poor integrated development planning.

Other development constraints in the settlement include the absence of any community hall, library or playground. Furthermore, there is only one clinic supposed to service 18 000 people, situated on the outskirts of the settlement, where it is virtually inaccessible to those most vulnerable (the elderly and children) living in the centre of the settlement. This is because, in the absence of personal transport and inadequate public transport, vulnerable residents requiring medical assistance have to walk 1 to 2km across hilly terrain towards the clinic, which reportedly takes about half an hour to an hour for elderly people<sup>8</sup>. If they do manage to reach the clinic they are then faced with long winding queues of patients waiting to be treated.

There are also no real community development projects, only meagre efforts by some dedicated teachers and parents.

### **6.5 Disaster Risk Context of George**

The EDM Disaster Management Centre (DMC) contracted SRK Consulting to conduct a user-friendly Disaster Management Plan (DMP) as part of the ongoing process to improve its disaster risk management service delivery for the EDM residents, and in accordance with the provisions of the NDMA and the NDMF. This resulted in the SRK (2006) disaster management plan and risk assessment

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<sup>8</sup> However, some younger people claim it takes them anything between 1 to 2 hours. A reliable elderly woman however commented on this claim stating that people like to exaggerate.

for the EDM report. Unfortunately the risk assessment was wholly based on a desk review of existing (secondary) data on hazards and while mostly Census 2001 data was used for the vulnerability analysis. No evidence of any “ground-truthing” was found in the assessment, either with regards to fieldwork, or consultations to assess the hazards, and household interviews or participatory approaches to assess community vulnerability and capacity. As a result, the assessment lacked a thorough hazard and vulnerability analysis. According to discussions in chapter 3, this risk assessment was constrained by the use of a limited range of inappropriate and technically-biased approaches.

#### *6.5.1 Priority Risks*

Despite the above constraints the SRK (2006) report identified the following priority risks for the George Local Municipality (LM), in order of priority:

- Flooding – especially in low-lying areas such as lagoons. Previous floods were experienced in George in 1996 (where the 1 in 100 year cycle flood was experienced), 1998, 2004<sup>9</sup>, 2006 and now 2007.
- Hazardous materials transport – air traffic disasters and hazardous materials road transport disasters pose a risk in the George LM. Hazardous materials transport is of particular concern along the mountain passes and where the N2 passes through residential areas and over low-lying bridges along the coast. An alternative route through less vulnerable areas was proposed for the N2 but the construction of such a route is yet to be confirmed.
- Key services disruption – The impact of a major disruption of key services in the LM is high because of the many industries and tourism resorts in the area. Water supply is problematic and projects to identify alternative sources of fresh water for residential and industrial use are planned. The road network, especially minor roads is very concerning. Many roads are degraded and show evidence of potholes and disintegration of the tarred

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<sup>9</sup> From the 11 August 2006 flood disaster debriefing.

surface. Since the roads are important for the local economy especially with regards to access, this needs urgent attention.

- Communicable diseases<sup>10</sup> – The George LM has a combination of industrial, formal and informal residential areas, holiday resorts, institutional establishments, schools and hospitals, which may all be subject to the outbreak of epidemics. HIV/AIDS and TB is expected to be high among especially the lower income groups in the LM, in informal settlements such as Touwsrante and Kleinkrantz, and informal settlements such as “Wilderness Heights”. The George airport may provide a route for infectious disease to enter the EDM, especially if it is opened for international travellers.
- Veld and plantation fires – veld fires in the Outeniqua mountain range and forest plantations are particularly problematic to the George LM and EDM.

#### *6.5.2 Current Disaster Risk Reduction Priorities and Initiatives and Compliance with Legislation*

According to the George (2002 and 2006) IDP (Integrated Development Plan), disaster management is an unfunded mandate. For this reason, disaster management becomes an extended line function of the fire service department. Consequently the office of the disaster manager for George LM sits in the local fire-fighting department and is occupied by the local fire-fighter chief. This is the case with most municipalities in the EDM. In other local municipalities in the province this position is occupied by the local chief traffic officer in the traffic department. As the disaster management function within local municipalities is often “added” to those undertaken by technical officers such as fire fighters or traffic officers, local municipal disaster managers often lack the necessary skills required for disaster risk management – the capacity to facilitate co-ordination of disaster management activities and to develop disaster management plans with

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<sup>10</sup> This is incorrectly classified in the report as **human epidemics**. However HIV and TB are not epidemics.

a focus on integrated risk reduction and awareness especially of the at-risk communities, in accordance with section 52 and 53 of the NDMA.

According to the George LM disaster manager, the municipality does have a disaster management plan. However the LM disaster manager was unable to provide a copy and did not have a digital copy available. The disaster manager claimed that the plan is not an in-depth strategy to manage floods but was only a step-by-step procedural guideline on what to do in responding to floods (or any other disaster) which also included relevant contact information.

The George LM disaster management therefore do not have a disaster risk reduction priority and strategy in place as required by section 52 and 53 of the NDMA. The EDM disaster management plan, based on the deliverables of the SRK (2006) report, does have a proposed risk management and a priority risk reduction plan in place for the district as a whole. This proposed plan is in accordance with the National and Provincial Disaster Management Frameworks. The priorities relevant to flood management include:

- all developments should include environmental impact assessments to ensure environmental sustainability as well as a disaster risk assessment.
- the protection of wetlands
- maintenance of local infrastructure
- floodlines and indicative floodlines should be developed for the highest risk zones and development should not be allowed take place within these zones without adequate flood mitigation measures. Furthermore, more specific land uses within floodplains should be delineated, e.g. high hazard zones could have parks, medium hazard zones for example could be allocated as parking lots, and low hazard zones could be residential gardens.
- the realisation of an adequate early warning system that would communicate warnings to the local population. The EDM disaster management has indicated the need for research into appropriate

approaches to ensure early warnings involve and reach the at-risk populations<sup>11</sup>.

## **6.6 Three Extreme Weather Events over George during 2006-7**

The research took place in the context of three extreme weather events that hit the southern Cape, including George during (i) 31 July to 3 August 2006, (ii) 21 to 24 August 2006, and (iii) 19 to 24 November 2007. Events (i) and (ii) were assessed in DiMP (2007). The DiMP (2007) post-event assessment of the two events in 2006 found negative impacts to the infrastructural, social and environmental sectors of the George municipality. The DiMP (2007) report revealed that critical infrastructure and agriculture seem to suffer the most damage when exposed to extreme weather events. These sectors were again worst affected during the 2007 events (Office of the Premier, 2007).

This section presents the following key findings of the three extreme weather events that affected George:

- a comparison of economic and infrastructural losses during 2006 and 2007 following the three events;
- impacts to the social sector;
- preparedness planning for extreme weather events

### *6.6.1 Comparison of Economic and Infrastructural losses during 2006 and 2007*

Table 6.9 (Annex 4) presents the total reported direct economic losses by all stakeholders in the EDM for the August 2006 floods as collected by DiMP. Table 6.10 (Annex 4) presents the preliminary total reported economic losses by most stakeholders in the EDM for the November 2007 floods. From the two tables it is clear that more damage was sustained during the 2007 flood events (R746 358 680.24 in losses) than the 2006 events (R509 763 497.56 in losses), bearing in mind that the 2007 estimates were still to be finalised. For the 2006 events, the

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<sup>11</sup> 29 November 2007 Disaster Debriefing – Damage Assessment by the Eden District Municipality.

George local municipality sustained the highest economic losses associated with damage to roads, bridges and stormwater drainage infrastructure within the EDM. For the 2007 event George sustained the second highest damage in the EDM (after the Knysna Municipality – table 6.10) where damage was sustained to roads and stormwater systems, water pipes and sewerage systems<sup>12</sup>. As the department of Civil and Technical services is responsible for the above infrastructure, table 6.11 (Annex 4) reflects how these impacts have affected this department's annual budget. Table 6.11 indicates that the damage sustained by the August 2006 floods alone took up 37.9% of the maintenance and repair budget of the department and just over 5% of the planned expenditure budget.

Table 6.9 reveals that SANRAL (South African National Road Agency) incurred the highest losses (17.21%). The damage sustained to the Kaaimans Pass (a portion of the National Route 2 connecting Cape Town to the eastern seaboard) in the George Municipality contributed 54 % of these losses to a value of R47 600 000 (DiMP, 2007). This is a very important route for commuters between Knysna and George and also for trucking from the eastern seaboard to Cape Town. The timber industry in George is particularly dependent on this pass, with at least four truck loads of timber passing through each hour. As such the temporary closure of the pass led to a slow down of traffic and therefore negatively impacted on businesses and tourism as people were held up in traffic up to four hours each day travelling to and from George or Knysna. These losses however have not been calculated requiring a further in-depth assessment of the secondary impacts suffered by businesses. With respect to rail infrastructure, the George-Knysna Choo Tjoe railway line/train service was negatively affected during the August 2006 events and further damaged by the November 2007 floods (Maposa, 2008). SANRAL compiled a report where damage to the railway line was estimated at R 100 million (ibid). The report has been criticised for not being

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<sup>12</sup> Report submitted to the National Disaster Management Centre on the 26 November 2007.

conducted by rail experts (ibid). The closure of the railway line has resulted in about 200 job losses and has also negatively affected tourism<sup>13</sup>.

The Provincial Department of Local Government and Housing sustained 5.67 % of the total reported losses of the 2006 events amounting to nearly twenty-nine million rand (table 6.9). Comparatively, during the 2007 events the same department sustained 14.05% of the total reported preliminary losses (table 6.10). It was reported that from the 2006 events 50.43 % of these losses totalling R 14 568 485 were experienced in the George Municipality (DiMP, 2007) resulting principally from poor siting, poor integrated planning where houses were built lower than road levels, poor construction standards, inferior building materials and non-weather proofing of dwellings.

The Provincial Department of Education sustained 0.38 % of the total estimated losses of the 2006 events which amounted to nearly two million rand. A high school and a primary school in George contributed R 165 000 to the department's losses (DiMP, 2007).

Insurance losses from the 2006 events amounted to 3.50 % of the overall losses totalling R 17 818 253.16. Insurance claims from the population of George as a result of the August 2006 weather events comprised 12.75 % of all the insurance losses to the value of R 2 271 136.32, which is by far the most claims from all the municipalities within the EDM (figure 6.6 – Annex 4). The causes of the damage included flood losses (R 722 392.32), storm impacts (R 1 535 999.68), subsidence and landslide impacts (R 3 492.42), water impacts (R 4 385.05), and wind impacts (R 4 866.85).

In total, the documented direct losses from the 2006 events from the George Municipality (see table 6.12 – Annex 4) contributed 15.97 % of the total direct losses sustained to the EDM. George municipality contributed 16.09% of the

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<sup>13</sup> Input by one of the attendance at the 22 February 2007 debriefing.

losses sustained by all the Eden District municipalities in 2006. Comparatively from the 2007 events the George Municipality contributed 16.94% of the losses sustained to all the municipalities in the district. More losses were sustained during the 2007 flood events, attributed in part to the fact that the rainfall event experienced during 2007 was more intense than those in 2006.

In these severe weather events, numerous indirect impacts were not quantified. These include lost work productivity due to traffic delays and disrupted road services. The tourism industry was also affected, particularly with the damage to the railway line between George and Knysna on which the popular tourist Outeniqua Choo Tjoe train used to travel.

#### *6.6.2 Social Impacts of 2006 Events*

The DiMP (2007) Social Impact Assessment (SIA) report found that several suburbs and settlements were seriously affected during the 2006 events. These included both affluent residential areas (including coastal resorts) and poor settlements. The vulnerability of residents in affluent residential areas and coastal resorts was due to their choice of location on high slopes, rivers and beaches. Such developments are approved by town planners in efforts to attract wealthy residents to the municipality despite warnings from environmental impact assessments and other activists<sup>14</sup>. The vulnerability of residents in poor settlements was due to them choosing to live in such settlements because of a lack of alternative options. Furthermore poor integrated development planning by the local municipality increased the vulnerability of residents in poor settlements. Thembaletu was identified as the most affected settlement in George.

#### *6.6.3 Preparedness Planning to Extreme Weather Events*

At the Provincial Debriefing in George on the 11 August 2006 the Eden Disaster Manager stated that a Flood Committee established in February 2006 was planning for extreme weather events, but that planning was clearly not enough.

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<sup>14</sup> Interview with a retired geographer.

Where forewarning and dissemination are concerned, Eden Disaster Management stated that on the 1 August 2006 at 17:06 PM they received a warning from South African Weather Service (SAWS) to expect heavy rain. SAWS disseminated this information to all relevant departments via text messages (SMS –Short Messaging Service). Eden Disaster Management kept all the municipalities updated with weather reports and advice on what to expect. None of the warnings for the first event were communicated to local communities. In the municipality of George, residents from settlements in Thembaletu and Touwsrante claimed that they received no warning, although some residents with access to radio and T.V. and who are able to interpret the weather forecasts received their 'early warning' through weather forecasts on the news. However, some residents from the informal settlement of Wilderness Heights claim that they received early warnings for the second event by the police and fire services.

At the 29 November 2007 debriefing following the November 2007 event, Johan Stander of SAWS presented the Flood Early Warning System (FEWS) that was applied during both the 2006 and 2007 events. This FEWS system will be improved in the near future when more accurate information becomes available from the proposed future radar network.

As part of SAWS' FEWS, warnings were issued via SMS, e-mail and phone call by SAWS to the Western Cape, Overberg and Eden District disaster managers (see Annex 5). According to Johan Stander, good communication exists between SAWS and Disaster Management but a major continuing challenge is the strengthening of institutional communications. The Eden Disaster Manager commented (based on the DiMP, 2007 report) that a second continuing challenge includes ensuring effective communication of warnings to vulnerable communities. He agreed with DiMP (2007) that research need to be conducted on how best to develop community-based early warning systems.

For all three events there appeared to be no contingency or preparedness planning in place by the George municipality despite experience from previous severe storms. Furthermore, the SIA report highlighted minimal levels of preparedness by residents where negative social behavioural patterns (of alcohol abuse), poverty and low levels of education and skills contributed to this.

## **6.7 Conclusion**

The geographical context of George indicates that its unique natural environment and strategic location are key factors in its continued growth and development. The geographical location of George relative to the Western Cape determines the type of climate the city experiences and consequently George's local climate has direct consequences to the risks (particularly hydro-meteorological in occurrence) to which the city is exposed. Thus berg wind conditions during summer increase veld fire risks (SRK, 2006) and cyclonic frontal weather systems, particularly cut-off low pressure systems increase flood risk. SRK underline this point by ranking flooding as the highest priority risk in George.

The flooding risk George is exposed to (urban flood risk) needs to be considered in combination with the development context of George where vulnerability emerges. The development of George and its surrounds was influenced by every historical development that South Africa experienced. Furthermore, developments at the provincial and district levels also shaped the current economic and demographic situation of George. The demographic, economic, health and spatial data that was analysed reveal that George is a medium-sized city, which in many ways is better positioned than many other South African towns, but there are also major challenges evident which need to be addressed in order to improve the welfare of its low-income population (Thomson, 2005).

The processes from the macro, meso and micro levels have therefore left George characterised by relatively high unemployment levels that may still be rising, especially among the African population (ibid). There have also been

considerable job losses or retrenchments in many companies where certain manufacturing sectors are particularly badly affected (ibid). There is an uneven spread of unemployment across the different suburbs and urban areas within the municipality and no progress to social integration since democracy has taken place (ibid). Furthermore, poverty levels are quite high and racially stratified (ibid). Property has become virtually unaffordable for low-income households (ibid). Black economic empowerment (BEE) has made little progress in George's White dominated business sphere (ibid). Following this, business and economic advancement is often impaired by inappropriate skills among the greater labour force (ibid). Finally, large areas within low-income suburbs/settlements within the municipality still lack adequate basic services (ibid).

The development context of George indicates that the most vulnerable portion of the population to urban flood risk is the same part of the population that were previously disadvantaged during apartheid. This development context is further exacerbated by a municipal disaster risk management structure that is unable to ensure that integrated development incorporates risk reduction priorities and initiatives in its planning. Consequently the municipal disaster management structure lacks the intuition to develop a comprehensive integrated flood risk management plan for the municipality to reduce repeated flood and storm related losses.

## Chapter 7

### Methodology

“The starting point for reducing risk and for promoting a culture of disaster resilience lies in the knowledge of the hazards and the physical, social, economic and environmental vulnerabilities to disasters that most societies face, and of the ways in which hazards and vulnerabilities are changing in the short and long term, followed by action taken on the basis of that knowledge” (Priority 2 of the HFA – UNISDR, 2005a: 7).

#### 7.1 Introduction

This research builds on fieldwork conducted during the period 8 to 24 August and 8 to 17 November 2006 as well as 24 to 26 January 2007 to assess the impacts of two extreme weather events that affected the southern Cape between the 31<sup>st</sup> July to 3<sup>rd</sup> August and 21<sup>st</sup> to 24<sup>th</sup> August 2006. The flood post-event assessment formed part of a larger official commissioned assessment for the Eden District funded by the Provincial Department of Public Works and Transport as well as National and Provincial Disaster Management (see DiMP, 2007).

Following the above post-event assessment it was possible to select the most seriously affected settlement (i.e. Thembalethu) where a fourth component of fieldwork was undertaken from between 22<sup>nd</sup> November to 4<sup>th</sup> December 2007. This fourth component of fieldwork found itself exposed to a third extreme weather event that hit the southern cape from between the 19<sup>th</sup> to 24<sup>th</sup> November 2007. This planned fieldwork, which was designed for a VCA assessment could not have been delayed on account of the extreme weather event. While the scheduled fieldwork was more difficult during the event, it afforded the researcher personal experience of flooding associated with heavy rainfall and provided a more realistic picture of the vulnerability of the at-risk population. This provided what anthropologists refer to as “thick description”. Altogether, this research draws from 43 fieldwork days spanning a 15-month period.

## **7.2 Overview of Sequence of Flood Risk Assessment Components and Methods**

Chapter 5 described the components of a flood risk assessment to include a hazard assessment, vulnerability and capacities assessment and a damage assessment that informs both the hazard and vulnerability assessment. This research follows suit where a hazardscape, flood vulnerability and capacities assessment was conducted in Thembaletu. The capacities assessment is referred to as “adjustments” and includes an analysis of adjustments undertaken both to the hazardscape and household vulnerability. The SIA component of the post-event assessment from DiMP (2007) written by the researcher informs both the hazardscape and vulnerability assessment for Thembaletu. Furthermore, the SIA from DiMP (2007) informed the selection of Thembaletu as the worst affected settlement.

The research employed both qualitative and quantitative methods that drew from both primary and secondary sources. These methods were used to assess the hazardscape at both macro (settlement) and micro (household) scale. The methods were also used to assess household flood vulnerability and household adjustments that were undertaken in response to both the hazardscape and vulnerability. In summary the research methodology was conducted in a sequence of four stages (Steps I, II, III and IV) summarised below and represented in Tables 7.1, 7.2, 7.3 and 7.4.

- Step I: Selection of worst affected settlement from the August 2006 extreme weather events;
- Step II: Flood hazardscape assessment of worst affected settlement (i.e. Thembaletu) and related household physical adjustments to the flood hazardscape;
- Step III: Household flood vulnerability assessment and related adjustments in Thembaletu
- Step IV: Determining household flood risk levels

**Table 7.1: Step I – Selection of Worst Affected Settlement from 2006 Extreme Weather Events (Refer 7.3)**

<b>Scale</b>	<b>Assessment Objective</b>	<b>Methods and Procedures Used</b>	<b>Data Sources Consulted</b>	<b>Data Consolidation &amp; Analytic Steps</b>
<b>Macro (Municipal) Level</b>	Select worst affected settlement for further study	Review documented Social Impact Assessment of the two extreme weather events during 2006 over George	Benjamin, A in DiMP (2007)	Comparison of three affected settlements. Thembaletu identified as worst affected settlement.

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**Table 7.2: Step II – Assess Flood Hazardscape and Physical Adjustments (Refer 7.4)**

<b>Scale</b>	<b>Assessment Objective</b>	<b>Methods and Procedures Used</b>	<b>Data Sources Consulted</b>	<b>Data Consolidation &amp; Analytic Steps</b>
<b>Macro (Settlement) Level</b>	1. Determine rainfall intensity	Observed rainfall data of the three extreme weather events (2006-7)	July-August 2006 rainfall data extracted from DiMP (2007); November 2007 rainfall data from SAWS	Observed rainfall data of the three events were corroborated with the design rainfall for George in order to determine the rainfall return periods of the three events. These are presented in tabular form.  Summary of catchment data in tabular form and a 24-hour 100-year storm hydrograph. These were interpreted and further substantiated through 'ground-truthing' to determine the risk potential posed by the Skaapkop river.
		Design rainfall data for George	Smithers and Schulze (2003)	
	2. Determine severity of riverine flooding	Hydrological modelling of the Skaapkop River using the HydroCad software	Rainfall data from 1 above; 1:50 000 topographic map obtained from Department of Land Affairs: Chief Directorate – Surveys and Mapping	
		50 structured household interviews and observations	Local ward councillors, community leaders, and settlement residents	
<b>Micro (Household) Level</b>	3. Determine the different physical forms of the flood hazardscape resulting from the intense rainfall	Review of SIA	Benjamin, A in DiMP (2007)	
		PDRA methods, particularly hazard mapping and transect walks included in the SIA	Local ward councillors and community leaders (Benjamin, A. in DiMP [2007])	
		Site observations	Fieldwork	
		Photography	Fieldwork	
	4. Determine household physical adjustments to flood hazardscape	50 Structured interviews	Settlement residents living in RDP and informal dwellings	
		50 Structured interviews	Settlement residents living in RDP and informal dwellings	
		Photography and illustrations	Fieldwork	
	Handheld GPS	Households interviewed	A scoring system was developed using Excel to determine the levels of adjustments undertaken by each household.	

**Table 7.3: Step III – Assess Household Flood Vulnerability and Adjustments (Refer 7.5)**

<b>Scale</b>	<b>Assessment Objective</b>	<b>Methods and Procedures Used</b>	<b>Data Sources Consulted</b>	<b>Data Consolidation &amp; Analytic Steps</b>
<b>Micro (Household) Level</b>	1. Determine household vulnerability to flood impacts	Review documented SIA of the impacts of the 2006 two extreme weather events in Themba lethu	Benjamin, A in DiMP (2007)	Descriptive overview of how Themba lethu RDP and Informal dwelling residents were impacted by flooding resultant from the two extreme events
		50 structured household interviews that is consistent with Pelling's (2003) vulnerability framework, the SL framework and Pyle's (2006) vulnerability indicators	RDP and Informal dwelling residents in Themba lethu	
		Participant observation	Fieldwork	
	Handheld GPS	Households interviewed		
	2. Determine household vulnerability adjustments	50 structured household interviews that is consistent with Hewitt's (1997) extended alternative adjustment framework	RDP and Informal dwelling residents in Themba lethu	A scoring system was developed using Excel to determine the levels of adjustments undertaken by each household.

**Table 7.4: Step IV – Determining Household Flood Risk Levels (Refer 7.7)**

<b>Scale</b>	<b>Assessment Objective</b>	<b>Methods &amp; Procedures Used</b>	<b>Data Sources Consulted</b>	<b>Data Consolidation &amp; Analytic Steps</b>
Household	Calculating household flood risk levels	Results from steps II & III	Fieldwork results	Application of DR formula. Flood Risk Index developed
		Flood risk GIS-maps using ArcGIS 9.1	Household GPS-coordinates	Spatial representation through risk maps

### **7.3 Selection of Worst Affected Settlement from August 2006 Extreme Weather Events (Refer table 7.1)**

A macro (municipal) scale assessment was necessary to identify the worst affected settlement from the two extreme weather events in July-August 2006 for further analysis. The SIA in DiMP (2007) was therefore reviewed. This review found that both affluent and low-cost settlements were affected by rainfall related damage. However low-cost settlements were found to be more vulnerable because of their lack of social protection coupled with their poor economic situation. Three low-cost settlements were selected in the DiMP (2007) report for further analysis. These settlements included Thembaletu, Touwsrante and Wilderness Heights. This review found that of the three settlements, the worst affected was Thembaletu, which was selected for further analysis.

### **7.4 Flood Hazardscape Assessment and Hazardscape Adjustments in Thembaletu (Refer table 7.2)**

#### *7.4.1 Determining Rainfall Intensity*

Rainfall data collected from weather stations and SAWS were used. Rainfall data for the first two events were derived from Fiona Tummon's research in DiMP (2007) obtained from SAWS. Rainfall data for the third event were collected directly from SAWS. This information was necessary to understand the intensity of the weather phenomenon responsible for the flooding. By corroborating the observed rainfall data with the design rainfall data for George from Smithers and Schulze (2003) it was possible to establish the severity of the rainfall events in

terms of their respective return periods. Since the data reflects on observed rainfall for George, this part of the assessment was applied at the macro (municipal/settlement) scale.

#### *7.4.2 Determine Severity of Riverine Flooding*

Drawing from the design flood estimation methods discussed in 5.3.1 above, the rainfall data were used to generate a hydrograph of the Skaapkop River that runs through the settlement of Thembaletu. Since the river runs along the entire settlement, this part of the assessment was at a macro (settlement) scale. HydroCAD software was utilised to do this. HydroCAD is a Computer Aided Design tool used by Civil Engineers for modelling stormwater runoff. It is an integrated solution for the analysis, design and documentation of complete drainage systems using standard hydrograph techniques. It generates complete runoff hydrographs using the SCS Unit Hydrograph procedure.

The software package was used to determine the weighted curve number (CN) and percentage pervious/impervious area of the Skaapkop River catchment. The CN data provide an indication of how much water is likely to pass through the hydrological systems as run-off (or a catchment respond index to rainfall). A high CN value has a higher run-off potential than a lower one.

HydroCAD requires some basic input data in order to generate the desired hydrographs. These include:

##### a) design rainfall data

By corroborating the observed rainfall data of the three extreme weather events with the design rainfall data for George from Smithers and Schulze (2003), it was found that between the three extreme weather events, George experienced a 50, 75 and 100-year cycle rainfall event. The 24-hour 100-year rainfall event was therefore modelled.

b) drainage area and size of different land-use areas of the catchment

An outlet point (Point A) was determined along the Skaapkop River near Ward 12 of Themablethu. The drainage area of Point A was determined using a 1: 50 000 topographic map (map 3322CD and 3422AB George, 1998 –acquired from Department of Land Affairs: Chief Directorate: Surveys and Mapping see annex 1) and overlaid with a 0.5cm grid. The extent of each of the different land-use classes was then calculated according to the number of cells that defined them (DiMP, 2003 and Drowley, 2007). A 50% rule was then applied to individual cells in determining the total area occupied by both of the land-use classes (DiMP, 2003 and Drowley, 2007). If a cell was occupied by less than 50% of the specific land-use class the cell was not counted, and if a cell was occupied by more than 50% of a land-use class the cell was included in the total area calculation for that land-use class (DiMP, 2003 and Drowley, 2007).

c) average gradient of a cross-section of the catchment

Gradient is calculated by the formula:

$$\text{Gradient} = \frac{\text{Height (in metres) of inclination between point A and B}}{\text{Distance (in metres) between point A and B}}$$

d) hydraulic length of the river

This is measured from the 1:50 000 topographic map.

e) soil type

To assist in determining the CN, it is necessary to know the soil type. Soils are classified into hydrologic soil groups (HSG) to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. The HSG's, which are A, B, C, and D, are one element used in determining runoff curve number.

The infiltration rate is the rate at which water enters the soil at the soil surface. It is controlled by surface conditions. HSG also indicates the transmission rate -

the rate at which the water moves through the soil. This rate is controlled by the soil profile. The four groups are defined by SCS soil scientists as follows:

Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands and gravels, and have a high rate of water transmission (greater than 0.30 inches/hr).

Group B soils have moderate infiltration rates when thoroughly wetted, and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 inches/hr).

Group C soils have low infiltration rates when thoroughly wetted, and consist chiefly of soils with a layer that impedes downward movement of water, and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 inches/hr).

Group D soils have high runoff potential. They have very low infiltration rates when thoroughly wetted, and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 inches/hr).

HSG Soil Textures provided by HydroCAD

- A Sand, loamy sand, or sandy loam
- B Silt loam or loam
- C Sandy clay loam
- D Clay loam, silty clay loam, sandy clay, silty clay, or clay

The interpretation of the hydrological modelling of the Skaapkop River in terms of the river's impact on residents was further substantiated with ground-truth information based on the review of the SIA in DiMP (2007) and the 50-structured household interviews in November-December 2007.

#### *7.4.3 Determine Physical Forms of Flood Hazardscape*

The flood hazardscape resulting from the heavy rainfall was experienced in different physical forms by residents. These different physical forms were described during a focus group discussion with community leaders and the ward 12 councillor in Thembaletu during August 2006 where participatory disaster risk assessment methods, particularly hazard mapping were employed. Transect walks through the different wards of Thembaletu with the respective ward councillors further provided additional detailed information. Site observations and photography during all three fieldwork visits provided further detailed information. Finally, the review of the SIA in DiMP (2007) and the 50-structured household interviews in November-December 2007 provided further insight to the different physical forms of the flood hazardscape.

#### *7.4.4 Determine Household Physical Adjustments to Flood Hazardscape*

Residents implemented physical adjustments to their dwellings that assisted in reducing the impacts of the different physical forms of flooding. The levels of physical adjustments undertaken by households were determined from the 50-structured household interviews of 25 RDP dwelling households and 25 informal dwelling households during November-December 2007. These were accompanied by photographs and illustrations of the physical adjustments. The households interviewed were geographically located with a GPS for GIS mapping purposes.

A distinction is made between adjustments to the hazardscape for RDP dwellings and those made for informal dwellings. Both RDP dwellings and informal

dwellings have what are here termed **purposive adjustments** and **responsive adjustments**.

**Purposive adjustments** include such adjustments that where at least an innovative (usually in the case of informal dwellings) or proper/formal design to a particular structure has been undertaken. It also includes such adjustments where resistant and/or appropriate building/construction materials were utilised.

**Responsive adjustments** include such adjustments where no real planning went into the implementation of the adjustment. It involves such actions that are rudimentary and require little or no technical skills and can be achieved by using very basic resources (financial, technological and human resources). It may also include simple 'coping' strategies that result from impulsive responses to the shock.

In order to calculate the level of adjustments, based on the 50-structured household interviews, a standard scoring system was developed (Annex 6). The full weighted score for the total hazardscape adjustments amounted to 495 points. Sub-adjustments included measures taken against rain leakage (this include adjustments to the roof, walls and door), seepage, ponding, stormwater run-off, overland run-off, riverine flooding and wetland flooding. It was also considered whether the adjustments were purposive or responsive, who implemented the adjustments, the effectiveness, and costs of the adjustments. Each sub-adjustment was weighted at 63 points.

Two further sub-adjustments included ascertaining whether adjustments had been promoted by the municipality or the community. These were weighted at 27 points each. With informal dwellings, it was necessary to establish whether a household had an innovative idea as an adjustment but had yet to implement it. If a particular problem (e.g. wetland flooding) was not experienced by a household, therefore no measures taken to remedy such a problem, that sub-adjustment

category would not be considered in the total weighted score. In this case an *adjusted total weighted score* was considered. The adjusted total weighted score refers to the total weighted hazardscape adjustment score that has excluded those categories which were not applicable to a given household. The household hazardscape adjustment score is then weighted against this adjusted total weighted score.

It was also possible for a household to exceed the total weighted score for each sub-category if many measures were taken to minimise a particular problem. In this way it becomes possible for a household to exceed the full total hazardscape adjustment score. The percentage point that is calculated to determine the levels of household adjustments refer to the percentage which the household has scored for undertaking adjustments.

Consequently for analytic purposes a graded hazardscape adjustment level was developed. This is presented in table 7.5.

**Table 7.5 Hazardscape Physical Adjustment Level (HPAL)**

<b>Percentage Adjustments</b>	<b>Adjustment Level</b>	<b>Implication</b>
0 – 25.99%	HPAL – A	Offers limited protection
26 – 50.99%	HPAL – B	Offers reasonable protection
51 – 75.99%	HPAL – C	Offers reliable protection
76 – 100%	HPAL – D	Offers extensive protection

#### *7.4.5 Determine Residual Flood Hazardscape for Individual Dwellings*

Since individual households implemented different levels of physical adjustments to their dwellings, the residual flood hazardscape differed for individual households. It was possible to determine the residual flood hazardscape for individual dwellings for a 50-year, 75-year and 100-year cycle flood.

A 50-year flood was scored as 50%, a 75-year year flood as 75% and a 100-year flood as 100%. Formula 1 below illustrates how to calculate the residual flood hazardscape for individual dwellings. The first step involves determining the

percentage of the flood hazardscape that will be absorbed. This requires multiplying the level of physical adjustments (both purposive and responsive) of an individual dwelling by the total flood hazardscape intensity (the rainfall event). It should be noted that the natural environment also has an absorptive capacity that ought to be included in the first step of calculations<sup>1</sup>. However, this research included the role of the natural environment under physical exposure in the flood vulnerability analysis. The second step in the calculation involves determining the residual flood hazardscape for an individual dwelling. This requires the subtraction of the absorbed flood intensity from the total flood intensity.

### **Formula 1<sup>2</sup>**

**Formula for calculating the residual flood hazardscape:**

**Step 1 – Absorbed Flood Intensity: HPAL × Total Flood Intensity**

**Step 2 – Residual Flood Hazardscape: Total Flood Intensity - Absorbed Flood Intensity**

## **7.5 Flood Vulnerability and Capacity Assessment Methods (Refer table 7.3)**

The household vulnerability and flood vulnerability adjustment analysis drew from various methods. These included a review of the SIA report on Thembaletu in DiMP (2007), 50-structured household interviews that were spatially referenced (see 7.4.4) and participant observation.

### *7.5.1 Review of SIA report on Thembaletu*

The review in 7.3 provided information with regards to the section of the population most worst affected by the July-August 2006 extreme weather events. Furthermore the report provided insights into why the particular section of the population was most affected.

### *7.5.2 Structured Household Interviews*

For the VCA assessment, the 50-structured household interviews (see Annex 7) were divided into three sections: a) physical exposure; b) livelihood analysis; c)

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<sup>1</sup> Mihrit Bahry is acknowledged for pointing this out.

<sup>2</sup> Mihrit Bahry is acknowledged for reviewing and simplifying my original formula.

vulnerability adjustments (the resilience component according to Pelling's model –figure 3.1). Sections (a) and (b) were designed in accordance with the SL framework, namely the five different capitals (human, social, natural, physical and financial capital). From the different capitals it was possible to generate vulnerability indicators (see Annex 8). The indicators developed were found to be very similar to those used in Pyle (2006). However the specific indicators were selected based on findings from the first three fieldwork phases and some were based on knowledge from previous community risk assessment work in informal settlements in the Western Cape. The interviews were structured so as to generate quantitative data for comparative purposes in determining flood risk levels. However, they were open-ended and accommodated discussion. This allowed for explanatory models on the rationale of each indicator (see Annex 9). The classification of vulnerability adjustments was adapted from Hewitt's (1997) framework of extended alternative adjustments (see Annex 10).

### *7.5.3 Participant Observation*

In Anthropological ethnographic methods, the process whereby the researcher engages in the daily activities of the study population is referred to as participant observation. However this usually refers to living in a community usually for several months or years. Participant observation in this research did not take the traditional form of anthropological ethnographic methods that involved living with the people, but rather involved the researcher assisting a number of respondents with some of their normal tasks. Furthermore the researcher also personally experienced a rescue operation when his car became stuck in the mud in Thembaletu. All this provided enhanced insights into the vulnerability of the population.

## **7.6 Determining Residual Household Flood Vulnerability Levels**

In order to quantitatively determine household flood vulnerability levels (HFVL) it was necessary to develop a scoring system to grade each indicator for physical exposure (see Annex 11), livelihoods capital (see Annexure 12, 13, 14 and 15),

and vulnerability adjustments (Annex 16). Each indicator under the subcategories was scored based on the significance to which each indicator increases or decreases the vulnerability to flood risk. Each indicator was scored on a scale of 0 to 10 where 0 is least vulnerable and 10 is most vulnerable (figure 7.1). Indicators that were considered as comprising resilience were awarded negative values to -10. With 12 indicators, the total for physical exposure is 120 points. Livelihoods analysis includes 33 indicators and therefore the total for this category is 330 points. This is further divided by the different livelihood capitals where physical capital with 7 indicators constitutes 70 points, human capital with 17 indicators constitutes 170 points, financial capital with 7 indicators constitutes 70 points and social capital with 2 indicators constitutes 20 points. The total weighted score for vulnerability is 450 points. The total weighted score for vulnerability adjustments is 250 points.



Formula 2 below illustrates how to calculate the residual household flood vulnerability. The HFVL were first calculated by considering only the physical exposure (PE) and livelihoods capital (LC) of households. The absorbed HFVL was then calculated by multiplying the household flood vulnerability adjustment levels (HFVAL) by the HFVL. Finally the residual HFVL was determined by subtracting the HFVL from the absorbed HFVL.

Consequently for analytical purposes a vulnerability grading system was developed that distinguishes between four different levels of vulnerability. This is illustrated in table 7.6. The same grading scheme in table 7.6 is applied for the residual HFVL. It was also necessary to develop an HFVAL grading system – table 7.7.

## Formula 2

Formula for determining Residual HFVL:

Step 1 – Calculate household PE:  $\Sigma$  Indicator 1 to 12 (see 1 in Annex 9 and list in Annex 11)

Step 2 – Calculate household LC: Physical Capital (Phy C) + Human Capital (Hum C) + Financial Capital (Fin C) + Social Capital (Soc C)

Step 2 a – Calculating Phy C:  $\Sigma$  Indicator 1 to 7 (see 2 in Annex 9 and list in Annex 12)

Step 2 b – Calculating Hum C:  $\Sigma$  Indicator 1 to 17 (see 2 in Annex 9 and list in Annex 13)

Step 2 c – Calculating Fin C:  $\Sigma$  Indicator 1 to 7 (see 2 in Annex 9 and list in Annex 14)

Step 2 d – Calculating Soc C:  $\Sigma$  Indicator 1 to 2 (see 2 in Annex 9 and list in Annex 15)

Step 3 – Calculate HFVL: PE + LC

Step 4 – Calculate HFVAL:  $\Sigma$  Indicator 1 to 5 (see 3 in Annex 9 and list in Annex 16)

Step 5 – Calculate Absorbed HFVL: HFVL  $\times$  HFVAL

Step 6 – Calculate Residual HFVL: HFVL – Absorbed HFVL

Table 7.6 Key for HFVL

Percentage Vulnerability	Vulnerability Level	Implication
0 – 25.99%	HFVL - A	Low flood vulnerability
26 – 50.99%	HFVL - B	Medium flood vulnerability
51 – 75.99%	HFVL - C	High flood vulnerability
76 – 100%	HFVL - D	Extremely high flood vulnerability

Table 7.7 Key for HFVAL

Percentage Adjustments	Adjustment Level	Implication
0 – 25.99%	HFVAL - A	Limited social protection
26 – 50.99%	HFVAL - B	Reasonable social protection
51 – 75.99%	HFVAL - C	Reliable social protection
76 – 100%	HFVAL - D	Extensive social protection

## 7.7 Calculating Flood Risk

It was mentioned in 3.3.5 that the formula for calculating disaster risk reads as follows:  $DR = H \times V \div \text{Resilience}$ . However this research encourages a move away from the term resilience to adjustments (see 3.3.5). Furthermore the research considers adjustments both to the hazardscape and the vulnerability. For this reason the formula for calculating DR should read as follow: **DR = Residual Household Flood Hazardscape (formula 1) × Residual Household Flood Vulnerability (formula 2)**.

From 7.4.5 and 7.6 it was possible to determine the individual household flood risk levels for a 50-year, 75-year and 100-year cycle flood. Since the individual households were geographically positioned it was possible to spatially represent these data in the form of GIS-generated **Risk Maps** using ArcGIS 9.1.

Consequently a flood risk index was developed in order to determine flood risk severity levels. The qualitative component of this index was informed by the four fieldwork components spanning the 15 month period. Table 7.8 presents the flood risk index.

**Table 7.8 Flood Risk Index**

<b>Risk Percentage</b>	<b>Risk Level</b>	<b>Implication</b>
0 – 0.99%	A	Very safe
1 – 25.99%	B	Minor interruptions to infrastructure, assets, possessions and daily routine to be expected
26 – 50.99%	C	Interruptions to infrastructure, assets, possessions and daily routine to be more serious
51 – 75.99%	D	Interruptions to infrastructure, assets, possessions and daily routine may seriously interrupt the capacity of the household. Some health consequences to be expected.
76 – 100%	E	High risk. Capacity of household would definitely be disrupted. Serious health and economic consequences to be felt.

## 7.8 Ethical Considerations

Where fieldwork is concerned, many informants shared emotional and personal experiences. In the interest of confidentiality no real names of informants appear in the research. There is also sensitivity with regards to photographically

representing affected informants' dwellings both from the interior and exterior. However, informants' consent was sought prior to capturing photographs.

Finally, it is a major concern for researchers in the field not to simply 'extract' information from 'subjects' for purely academic objectives and without real direct immediate or even in many cases long-term benefits to the 'subjects'. This ethical concern has been addressed because the research was undertaken on behalf of national and provincial government departments with the intention to inform recovery responses, future development and disaster mitigation planning and also budget allocations. Furthermore, the academic component of this research was partially funded by the private sector, namely the George Business Chamber. In this way the research contributes to the evolving concept of Corporate Social Responsibility (CSR) that affords an opportunity for encouraging business to participate in disaster risk reduction activities (see Warhurst, 2006). In addition, since the research was also co-funded by the National Disaster Management Centre (NDMC), a condensed version of the research will be made accessible to disaster managers nationwide. Finally insight from this research is expected to inform urban flood management in Cape Town through the "Cities Lab" initiative of the Centre for African Cities at the University of Cape Town.

### **7.9 Limitations and Challenges to Research**

The research may come under scrutiny for academic integrity because of the broad approaches adopted. However in chapter 2 it was highlighted that the field of disaster risk science is transdisciplinary in nature and therefore from a disaster risk perspective such a broad approach has currency. A particular area that may receive some scholarly scrutiny is around the application of the concept 'hazardscape'. The research applied the concept beyond its original intended implication to include physical parameters in assessing the hazardscape.

A further limitation to the research is its focus on a sample population and therefore caution needs to be taken in applying the results to all low-cost settlements in George and to George as a whole. A major challenge to the fieldwork component of the research was its implementation during extreme weather events. However, this also provided the researcher with opportunities that would otherwise not have emerged. The greatest difficulty during fieldwork was the language barrier, especially the isiXhosa speaking informants, which often limited the depth and at times the accuracy of some interviews. Most respondents could not adequately answer the 'extended alternative adjustment' component of the household interviews.

It was mentioned in 7.5.3 that the researcher gained experiential insight into the vulnerability of the population. However it should be cautioned that as an outsider one will never experience the true reality of the hardships experienced by an at-risk population since the outsider will always return to a place of comfort outside the at-risk environment, whereas the local residents whose conditions the outsider tries to document have no such alternative.

The fieldwork also posed the challenge of respondent fatigue because of the length of the interviews as well as the researcher's fatigue. Where language posed a problem the interviews took the form of a standard structured interview that lasted between 30 to 45 minutes. However, in situations where respondents showed willingness to speak the researcher built on this opportunity to allow the interviews to turn into open discussions which lasted from 1 to 1½ hours.

Finally in terms of the methodology for calculating vulnerability, a major limitation resides in the fact that equal grading schemes were applied to all indicators. That is, it was assumed that all the vulnerability indicators contributed an equal weight of 10 points. This illustrates the challenge of quantifying vulnerability described earlier (see 3.3.4).

## Chapter 8

### Flood Risk Assessment of Themba lethu, George

“I believe that the norms and standards of rainfall predictions have changed. Rainfall frequency has changed and will therefore require new models” (Eden District Municipal Manager at the November 2007 Disaster Debriefing).

#### 8.1 Introduction

This chapter presents the findings of the flood risk assessment of Themba lethu. The chapter begins by presenting the key findings of the SIA (DiMP, 2007) review for Themba lethu, followed by the flood hazardscape and physical adjustment assessment. Themba lethu’s vulnerability and vulnerability adjustment analysis is then presented. Finally the chapter concludes with the overall flood risk analysis for Themba lethu. It should be noted that the assessment distinguishes between flood risk faced by *informal dwelling households* and *RDP dwelling households*.

#### 8.2 Key findings from Social Impact Assessment of the August 2006 Extreme Weather Events in Themba lethu

Based on the review of the SIA report in DiMP (2007) of the impacts of the August 2006 extreme weather events in Themba lethu, the following conclusions were drawn about who was most affected, why they were most affected and how they were affected. The SIA also included a detailed account of the impacts sustained.

##### 8.2.1 The Most Affected

Both informal dwellings and RDP houses were affected. All informal dwellers were affected because they are located in poorly drained areas. However some were more seriously affected than others. Among informal dwellers, the most seriously affected were those located in vulnerable locations such as on the slopes of hills and in the valleys of the rivers and tributaries as well as those in

poorly drained locations with high water tables. For RDP houses, the most seriously affected were those houses located lower than the street level. This constitutes approximately 60% of all RDP dwellings.

For informal dwellers the most affected were women-headed households. A further analysis revealed that particularly elder women (50 years and older) with young children or grandchildren were most affected. These households often have a very small income base and therefore have to settle with poor building materials and site location. Furthermore, these households, as a livelihoods strategy, used child labour to secure income (see also Thomas, 2005).

For RDP houses the gender of the household head is less significant in placing residents at risk, than other determining factors such as poor site location, lack of integrated planning and poor structural integrity of dwellings.

### *8.2.2 Reason for being the Most Affected*

Among the most seriously affected informal dwellers, the root cause was their abject poverty where the average monthly income was reportedly only R2 164<sup>1</sup>. As a result, these people find themselves forced to locate in the most vulnerable locations mentioned earlier and to construct dwellings comprising of inferior building materials. These informal dwellers lacked the capacity to undertake any adjustments. By contrast, those informal dwellers less seriously impacted had undertaken adjustments, digging drainage channels to facilitate drainage, using plastic sheets (gumplastiek) and stabilising their roofs. In some instances dwellings had proved more resilient because the occupants had laid concrete floors<sup>2</sup>.

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<sup>1</sup> Combined figures of the November 2006 and 2007 informal dwelling household interviews conducted in Thembaletu.

<sup>2</sup> The November 2007 fieldwork revealed more adjustments that were overlooked during previous fieldwork. These are discussed in 8.3.4 below.

In the case of RDP house income was less important than issues around siting and poor integrated planning. The root cause of vulnerability for these dwellers was more attributable to poor governance, reflected in poor regulation of building standards and inadequate communication between municipal and district departments. The result was that houses were built lower than streets on a high water table, where underground springs were also present, and with no or very few drains, which were often blocked. In some cases dwellings were built directly under the stormwater drainage outlets. Furthermore, as all housing construction projects were outsourced to private contractors there seemed to be very little control over their activities. A municipal engineer, for example commented that while housing development must accord with the guidelines set out in the CSIR (2003) manual, it is difficult to monitor the activities of private contractors. Contractors are often not held accountable for using the cheapest possible building material and methods which contribute to the poor structural integrity of these houses.

There also seemed to be a lack of awareness on how to risk-proof individual dwellings. Most residents simply just 'cope' with the risk by using buckets to catch leaking water from roofs, scooping the water out or trying to keep the doors closed. Some dwellers carve out holes in the wall of their houses to drain out water. This practice in turn makes them more vulnerable especially if heavy rain is received before the hole is repaired, as in the case where the second event occurred soon after the first.

There were however some good examples of risk-proofing. One was the use of 'mestick', a type of putty that was placed around the nails and screws of the roofs. Other measures included placing plastic in the gaps of the roofs, filling the cracks of walls before and after rains, or painting walls with a protective coating. A further example is elevation of the dwelling's foundation on stilts.

### *8.2.3 How they were Affected*

Since the informal dwellings were located in poorly drained areas with high water tables, constructed of poor building materials in an often unstable manner, with a foundation lower than ground level, all the informal dwellings were affected by flooding in two dominant forms. The two dominant ways in which damage was sustained by informal dwellings was through seepage of ground water and run-off water as well as rain water leaking through poorly constructed roofs. Run-off water also entered through the doors and in some cases rainwater also entered through walls. In some isolated cases strong winds also contributed damage.

Because RDP dwellings were poorly constructed and poorly sited with dwellings below street level and sometimes facing run-off from stormwater, they were affected by flooding as explained in the following discussion. Damage was sustained to RDP dwellings because of run-off from the road entering dwellings through the doors. In cases where dwellings had to contend with proximity to stormwater outlets, this resulted in stormwater run-off also gushing through the walls. The majority of RDP dwellings experienced water entering through the walls. Due to the high water table, water not only entered houses through the sides of the walls but also through poor foundations. The poor quality of construction, accompanied by the inferior quality building materials, meant that rain water also entered through the cracked walls and poorly sealed roofs.

### *8.2.4 Type of Impacts*

Flooding resulting from the extreme weather events had the following social impacts:

- Damages to the physical structure of dwellings
- Damages to personal belongings
- Health impacts
- Missing work days
- Negative impact on household income

a) Damage to the physical structure of dwellings

Only in isolated incidents were informal dwellings completely destroyed. However, most informal dwellers had to reconstruct a small or large part of their dwelling. RDP dwellings sustained serious damage to their physical structure. Damage involved walls washing away resulting in the collapse of the house, cracked walls, walls becoming damp and mouldy causing the paint to peel off, foundations of dwellings subsiding or rising, roofs breaking and doors swelling.

b) Damage to personal belongings

Damage was sustained by personal belongings of both RDP and informal dwellers. These included furniture (beds, cupboards, couches) as well as clothing and bedding.

c) Health impacts

There were impacts to human health where children were mostly affected. The type of illnesses experienced by both RDP and informal dwellers included respiratory infections such as asthma attacks, pneumonia and whooping cough; colds and sinus problems; arthritis worsened; skin rashes because the water remaining in the houses contained bacteria and insects; physical injuries sustained from slippery conditions; and high blood pressure due to the stressful circumstances.

d) Missing work days

The heavy rains affected the ability of a large proportion (36.36 %) of Thembaletu's working population to attend work. Reasons for absenteeism included the need to 'patch' up dwellings (both informal and RDP) and in, some cases, fear for personal safety travelling in the heavy rains.

e) Household income negatively impacted

All the above impacts (a to d) had a negative impact on household income for both informal and RDP dwellers. Some small scale farmers in Thembaletu lost

livestock totalling an estimated R39 500. An uneven pattern in estimation of losses indicated that the residents would suffer the impacts of their losses for some time. This is because estimated losses for both informal dwellers and RDP dwellers far exceeded their monthly average income. This suggests that in the absence of social protection or assistance, informal residents could take a period between 1½ to 3½ years to recover and for RDP residents this could take at least 4 months.

### **8.3 Flood Hazardscape Assessment and Hazardscape Adjustments in Themba lethu**

This section presents the following findings of the flood hazardscape assessment:

- Rainfall intensity of the three extreme weather events;
- The physical forms of the flood hazardscape;
- Severity of riverine flooding from the Skaapkop River;
- The household physical adjustments to the flood hazardscape; and
- The residual flood hazardscape for individual dwellings

#### *8.3.1 Rainfall Intensity of the Three Extreme Weather Events*

Tables 8.1 presents the daily rainfall experienced in George respectively during the 31 July to 4 August 2006 (extreme event 1), 21 to 24 August 2006 (extreme event 2), and 22 to 27 November 2007 (extreme event 3). The rainfall data were recorded at the George airport weather station. The rainfall data indicates that the most rainfall was experienced during event 3, where 369.3mm of rainfall was observed. However, event 3 took place over six days, whereas rainfall event 1 (327.8mm) took place over five days and with rainfall event 2 (111.7mm) occurring over four days.

The most intense one-day rainfall was experienced during event 1 with 230.1mm recorded on the 1 August 2006. The most intense two-day rainfall was experienced during event 3 with 320mm recorded between the 22 and 23

November 2007. The most intense three-day rainfall was also experienced during event 3 with 331.4 mm recorded between the 22 and 24 November 2007. Although no rain was recorded on the fourth day of event 3, this event reflects highest rainfall for a four-day period with 331.4mm recorded between the 22 and 25 November 2007. The most intense five-day rainfall was also attributed to event 3 with 331.8mm recorded between the 22 and 26 November 2007. As a result, event 3 experienced the most intense six-day rainfall with 369.3mm recorded for the entire event between the 22 and 27 November 2007.

Table 8.2 below shows the design rainfall for George for rainfall durations of 1 to 7 days based on rainfall data over several years from the George airport weather station. This was done by Smithers and Schulze (2003) using the RLMA and SI procedure (see 5.3.1). Rainfall intensity in mm for the 2-, 5-, 10-, 20-, 50-, 100-, and 200-year return periods for rainfall duration of 1 to 7 days are shown.

By corroborating the design rainfall of George (table 8.2) with the recorded daily rainfall intensity of the three extreme weather events it was possible to determine the return periods of each rainfall day of the three events (table 8.3 below). Event 1 equalled a 50-year return period rainfall intensity, with a 75-year return period rainfall intensity for its 2- and 3-day rainfall period.

Event 2 was less threatening due to its characterisation with a 2-year return period rainfall intensity. Event 3 was the equivalent of a 100-year rainfall intensity with some of its rainfall day durations experiencing a 50-year return period rainfall intensity. From the rainfall intensity data it can be said that George, and therefore Thembalethu, experienced 2-year, 50-year, 75-year and 100-year flood cycles. For the purpose of this risk assessment the 50-year, 75-year and 100-year floods were considered.

**Table 8.1 Daily Rainfall Observations for the first (31 July to 4 August 2006), second (21 to 24 August 2006) and third (22 to 27 November 2007) cut-off low pressure system over George**

Event	Day						Total
	1	2	3	4	5	6	
1	(31 Jul) 45.5mm	(1 Aug) 230.1mm	(2 Aug) 47.3mm	(3 Aug) 4.3mm	(4 Aug) 0.6mm		327.8mm
2	(21 Aug) 0.2mm	(22 Aug) 71.5mm	(23 Aug) 4mm	(24 Aug) 36mm			111.7mm
3	(22 Nov) 206mm	(23 Nov) 114mm	(24 Nov) 11.4mm	(25 Nov) 0mm	(26 Nov) 0.4mm	(27 Nov) 37.5mm	369.3mm

Source: Fiona Tummon in DiMP (2007) and Johan Stander, SAWS

University of Cape Town

**Table 8.2 Design Rainfall for George indicating the Return Period (in years) of Rainfall Intensity (in mm) for 1 to 7 days duration**

L = Lower Quartile; U = Upper Quartile

D A Y S	Return Period (Years)																				
	2	2L	2U	5	5L	5U	10	10L	10U	20	20L	20U	50	50L	50U	100	100L	100U	200	200L	200U
1	68.5	67.5	69.2	101.2	100.2	102.1	127.0	125.2	129.1	155.5	151.1	160.1	198.5	188.6	209.4	236.1	219.6	254.3	278.8	254.0	306.9
2	93.3	91.9	94.6	137.1	135.8	138.4	170.6	167.5	174.0	206.6	200.0	213.6	259.6	246.0	275.4	304.5	282.3	329.2	354.4	320.7	392.7
3	102.9	101.4	104.3	153.2	151.8	154.7	192.6	189.0	196.1	235.5	228.0	243.8	300.1	283.8	319.3	356.1	327.7	388.4	419.1	377.6	470.9
4	108.0	106.5	109.3	160.2	158.7	161.8	200.7	196.8	204.4	244.9	236.8	253.3	310.7	294.5	330.0	367.3	338.6	399.3	431.0	388.2	484.2
5	112.0	110.2	113.5	164.4	162.9	166.0	204.5	200.4	208.4	247.4	239.0	256.4	310.4	292.1	331.1	363.7	335.1	397.4	422.7	380.8	474.9
6	115.3	113.4	117.1	167.8	166.3	169.5	207.6	203.6	211.9	250.1	241.6	259.2	311.8	293.5	332.7	363.9	335.4	396.5	421.1	379.4	473.2
7	118.7	116.6	120.7	171.3	169.7	173.3	211.0	206.9	215.5	253.2	244.1	263.3	314.5	294.9	335.4	366.0	337.3	398.8	422.4	378.9	474.7

Source: Smithers and Schulze (2003)

**Table 8.3 Return Period ( in years) of Daily Rainfall Intensity (in mm) of the 31 July-4 August 2006, 21-24 August 2006 and 22-27 November 2007 Weather Events over George**

Event	1-Day	2-Day	3-Day	4-Day	5-Day	6-Day
1. 31Jul-4 Aug 2006	45.5mm	275.6mm	322.9mm	327.2mm	327.8mm	N/A
Return Period	Normal	75 year*	75 year*	50 year	50 year	N/A
2. 21-24 Aug 2006	0.2mm	71.7mm	75.7mm	111.7	N/A	N/A
Return Period	Normal	Normal	Normal	2 year	N/A	N/A
3. 22-27 Nov 2007	206mm	320mm	331.4mm	331.4mm	331.8mm	369.3mm
Return Period	50 year	100 year	100 year**	50 year	50 year	100 year

\*Above the 50U therefore classified as 75 year.

\*\* Above the 100L therefore classified as 100 year.

### 8.3.2 Physical Form of Flood Hazardscape

The intense rainfall was experienced in Thembaletu as flooding because of *ponding, overland surface run-off, upwelling, riverine/streams flooding, wetland flooding, stormwater channels overtopping and rain leakage*. These are explained in table 8.4 below. Table 8.4 indicate that the various forms of the flood hazardscape results from the natural environment as well as political, collective and individual action. Furthermore, the forms of the flood hazardscape at settlement scale should be viewed as the cumulative experiences of individual households<sup>3</sup>.

**Table 8.4 Form and Causal Factors of Flood Hazardscape in Thembaletu**

<b>Form of Flood Hazardscape</b>	<b>Causal Factors</b>
Ponding	Poor drainage and a high water table
Overland surface run-off	No or inadequate stormwater systems comprising of flat channels that cannot carry more than 100mm of rainfall per day or because of houses located below street level or on steep slopes
Upwelling (seepage)	High water tables or underground springs causing ponding of water outside dwellings or underground water to seep into dwellings
Riverine/stream flooding	Flooding from tributary streams leading to the Skaapkop River because of dwellings located in the valleys along the river and tributaries of the river. No flooding however was caused by the Skaapkop River itself because of its steep slope embankments
Wetland flooding	Dwellings built on the fringe of wetlands
Stormwater channels overtopping	Dwellings built on the fringe of stormwater channels or directly opposite to stormwater outlets. Run-off in channels exacerbated by dumping of household refuse thereby impeding the flow of run-off causing water to rise and spill over much faster
Rain leakage	Rain water leaking through poorly constructed roofs, walls and doors

### 8.3.3 Severity of Riverine Flooding from the Skaapkop River

It was found that the total drainage area of Point A of the Skaapkop River was 11.06 km<sup>2</sup> or 1106 ha. The total urban area of the drainage area of Point A of the river is 5.5 km<sup>2</sup> or 550 ha. This means that 49.72% of the drainage area is urban.

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<sup>3</sup> Dr. Holloway is acknowledged for this observation.

The total cultivated land of Point A of the river is 1.63 km<sup>2</sup> or 163 ha. This implies that 14.69% of the drainage area is cultivated. The total natural vegetation/environment of Point A of the river is 3.94 km<sup>2</sup> or 394 ha. In this respect 35.60% of the drainage area comprises natural vegetation. The soil type for the majority of the drainage area was found to be a C (sandy clay loam) soil type. Where slope is concerned, the average gradient (in meters) of the drainage area was found to be 1:25. The hydraulic length of the entire catchment of Point A is 4 000m.

The 24-hour rainfall for a 100 year cycle rainfall event in George is 236.1mm (table 8.4). Figure 8.1 presents the summary of the output data for the hydrological modelling of the Skaapkop River catchment conditions under conditions of a 24-hour 100-year rainfall event. Figure 8.2 presents the hydrograph for a Type II 24-hour 100-year rainfall of the river. A Type II rainfall pattern characterises rainfall conditions experienced in George<sup>4</sup>.

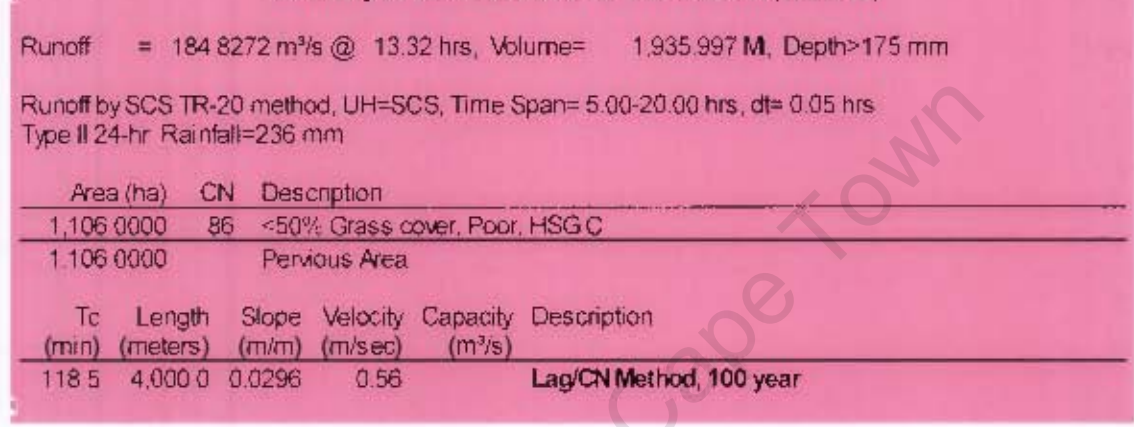
From figure 8.1 and 8.2, there was a lag time of 13.32 hours before the peak discharge. It was determined that the peak discharge generated a volume of 184.8272 m<sup>3</sup>/s. There was a lapse time of 3 hours before the peak discharge was experienced. In summary, this means that run-off in the Skaapkop River for a 100 year cycle 24-hour storm does not pose a major threat to residents of Thembaletu (Ward 12) because there is a reasonable lapse time of the peak discharge for such an event. Furthermore, the gradient of the slope near point A is quite steep where the average gradient is 1:21 and the steepest gradient being 1:10. Consequently, the concern is not so much the actual run-off of the Skaapkop River to residents of Ward 12, Thembaletu but rather the overland run-off of rainwater flowing towards the Skaapkop River because of the steep slopes on which dwellings are built. This is consistent with documented accounts,

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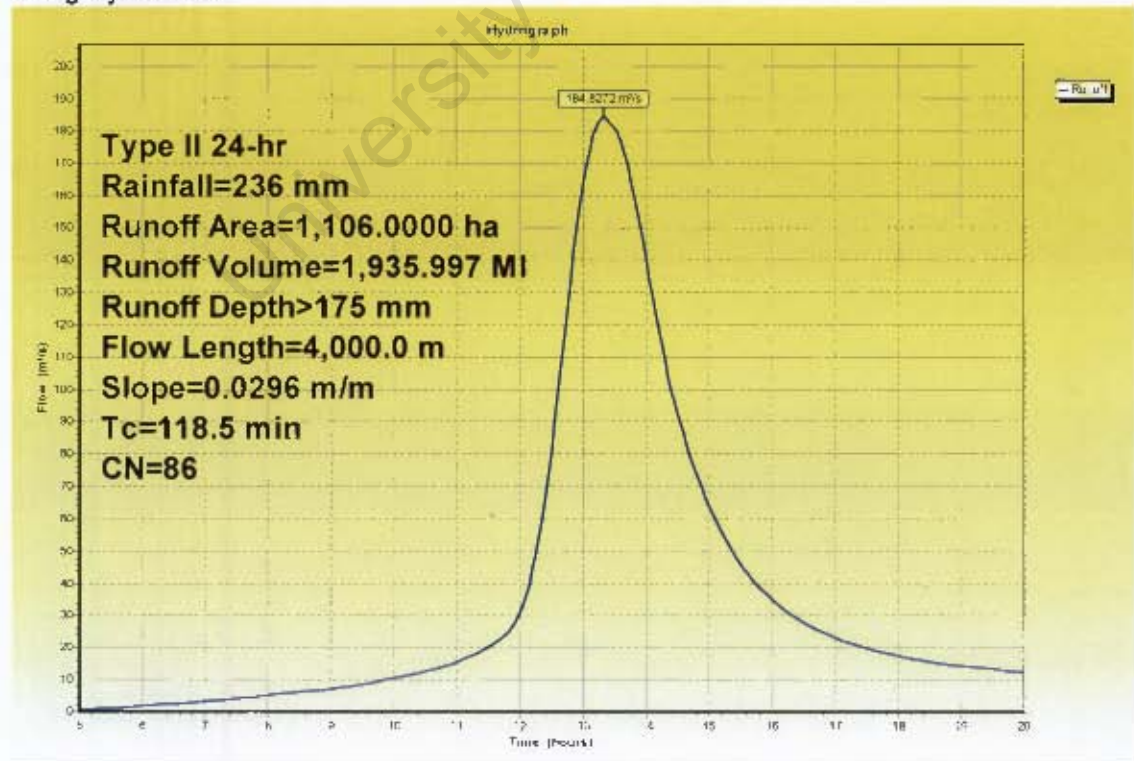
<sup>4</sup> Agreed upon by Arthur Chapman, a hydrologist at the CSIR.

through fieldwork observations and household interviews, where no threat or damage from the actual Skaapkop River was observed or reported. The above results are typical for a small river with a small catchment. However significant damage from overland and tributary stream run-off were observed and reported.

**Figure 8.1 Summary of Catchment Data for Point A of Skaapkop River using HydroCAD**  
**Summary for Subcatchment 1S: Thembaletu (Ward 12)**



**Figure 8.2 Hydrograph of a 24-hour 100 year return period storm for the Skaapkop River using HydroCAD**



#### *8.3.4 Household Physical Adjustments to Flood Hazardscape*

For both RDP and informal dwellings, observed purposive and responsive adjustments may include adjustments made to the roof, wall/s and door/s of the dwelling in order to prevent rain leakage or seepage through the door. Adjustments may also include measures to prevent or reduce seepage, ponding, stormwater run-off, overland run-off, riverine flooding, and wetland flooding. Adjustments, (particularly responsive adjustments) were predominantly undertaken by individuals and occasionally by the municipality and seldom a community effort. In many cases, purposive adjustments require partial or complete assistance from skilled outsiders.

Table 8.5 provides examples of adjustments to RDP dwellings and table 8.6 provides examples of adjustments to informal dwellings. Annexure 17 and 18 provide illustrative and photographic examples respectively of RDP dwelling purposive adjustments. Annexure 19 and 20 provides illustrative and photographic examples respectively of informal dwelling purposive adjustments.

##### a) RDP dwelling physical adjustments

It is evident from table 8.5 that purposive adjustments for RDP dwellers usually take the form of renovations or new installations to either part of or the entire dwelling. Responsive adjustments usually take the form of coping strategies, or impulsive responses to the impacts of flooding. Some responsive adjustments (e.g. carving a hole in the wall) may seem to be a contradicting approach that actually causes more damage to the dwelling.

Annex 21 presents the RDP household adjustments based on the household interviews. Findings reflected in Annex 21 indicate that no RDP dwellings have extensive physical protection (HPAL-D) to their dwellings in relation to the flood hazardscape. Only 4% of RDP dwellings have adjustments that offer reliable protection (HPAL-C) against the flood hazardscape. Nearly a quarter of RDP dwellings have adjustments that offer reasonable protection (HPAL-B) to

Table 8.5 Examples of Adjustments to RDP Dwellings

Adjustment Focus	Purposive Adjustments			Responsive Adjustments		
	Type	Effectiveness	Costs	Type	Effectiveness	Costs
<b>Roof Leakage</b>	a) strengthen roof by replacing corrugated iron roofing with roof tiles b) install a ceiling  c) proper construction d) fill nail holes with silicone	a) very effective  b) very effective  c) very effective d) not very effective	a) R26 000  b) R3 000  c) original construction cost d) R400	a) use wires to secure wood frames of roof	a) prevents roof from being blown away by strong winds	a) none
<b>Wall (including windows) Leakage</b>	a) plaster wall with sand & cement mix  b) paint inside &/or outside walls with oil paint  c) install new window frames	a) limited effectiveness  b) very effective  c) very effective	a) R610 to R1 500  b) R100 to R3 500  c) R300 for installation	a) stuff clothes into wall and windows  b) place black plastic bags in cracks in wall  c) secure window frames with nails d) replace missing window panes with cardboard e) carve hole in wall to drain water out	a) not effective – constrained by absorptive capacity of the clothes b) limited effectiveness  c) secures window  d) prevents rainwater from entering e) drains out rainwater in house	a) damage to clothes  b) none  c) unknown d) none e) damage to wall
<b>Door Leakage/Seepage</b>	a) paving around house	a) limits water from entering through doors	a) R600	a) stuff clothes & blankets around door  b) place black plastic bags or newspaper at side of door	a) not effective – constrained by absorptive capacity of clothes & blankets b) limited effectiveness	a) damage to clothes & blankets  b) R18 for black bags
<b>Seepage</b>	a) original concrete foundation  b) elevate concrete foundation & include plastic sheeting under foundation c) build steps to front door where foundation is elevated	a) many houses experience seepage despite having foundation because of high water table or underground spring  b) very effective  c) very effective	a) cost included in original construction  b) R3 800  c) R200			

	d) dipping concrete floor built around some houses (Annex 17 and 18)	d) very effective	d) municipal costs			
	e) vegetable garden	e) helps absorb water	e) R260			
<b>Ponding</b>	a) grass or lawn on front property (Annex 18)	a) reasonably effective	a) none to R50	a) dig informal gullies	a) not very effective – allows water to drain away to a certain extent	a) none
	b) pavings	b) reasonably effective	b) R600	b) gravel and soil to level ground and fill holes/ditches	b) not very effective	b) none to R415
	c) vegetable garden	c) helps absorb water	c) R260	c) sweep away pooled water with broom	c) only gets rid of water already present	c) none
	d) sloping concrete floor (Annex 17 and 18)	d) very effective	d) municipal costs	d) ensure yard remains clean so that rubbish does not impede run-off	d) very effective	d) none
<b>Stormwater run-off</b>	a) open channels	a) effective according to the carrying capacity of channels (100mm/day)	a) municipal costs			
<b>Overland run-off</b>	a) garden & lawn	a) reasonably effective –helps stop run-off from road from entering house	a) none to R50	a) dig informal gullies	a) reasonably effective –allows water to drain away to a certain extent	a) none
	b) paving in front of some properties	b) very effective	b) municipal costs	b) trench around house	b) effective according to capacity of trenches	b) municipal costs

Table 8.6 Examples of Adjustments to Informal Dwellings

Adjustment Focus	Purposive Adjustments			Responsive Adjustments		
	Type	Effectiveness	Costs	Type	Effectiveness	Costs
<b>Roof Leakage</b>	<p>a) layer roof with ceiling board</p> <p>b) secure construction of roof built from corrugated iron and plastic sheets (Annex 20)</p> <p>c) build wooden ceiling with off-cut wood</p> <p>d) synthetic material covering (similar to sandpaper)</p>	<p>a) helps a little</p> <p>b) very effective</p> <p>c) effective</p> <p>d) very effective</p>	<p>a) R150</p> <p>b) included in the cost of construction</p> <p>c) none –off-cut wood from work</p> <p>d) R15-25/m (R150 total costs)</p>	<p>a) place putty around nail holes</p> <p>b) place plastic sheets over roof</p> <p>c) replace corrugated iron roofing</p> <p>d) buckets to collect rainwater</p> <p>e) seal plastic of roof with glue</p> <p>f) seal holes in roof with silicone</p>	<p>a) not effective</p> <p>b) helps a little</p> <p>c) helps a bit</p> <p>d) impulsive response to cope with existing problem</p> <p>e) not very effective</p> <p>f) helps a bit</p>	<p>a) unknown</p> <p>b) R100/m &amp; municipality provides during storms</p> <p>c) 1 X 3m sheet = R140</p> <p>d) none</p> <p>e) R21 for glue</p> <p>f) R90 - R150</p>
<b>Wall Leakage</b>	<p>a) paint exterior wall with black oil paint</p> <p>b) install proper window frames (Annex 20)</p>	<p>a) protects the wood from quick deterioration</p> <p>b) very effective</p>	<p>a) R90/ 5 litre can</p> <p>b) included in the cost of construction</p>	<p>a) layer the inside walls with cardboard &amp;/or plastic sheets</p> <p>b) remove lower planks or carve hole to drain out water</p>	<p>a) helps a little</p> <p>b) drains rain collected water out of dwelling</p>	<p>a) R50 – R100</p> <p>b) damage to wall</p>
<b>Door Leakage/Seepage</b>	<p>a) install proper door and door frame (Annex 20)</p>	<p>a) water can't seep in</p>	<p>a) included in costs of construction of house</p>	<p>a) metal frame mounted on top or bottom of roof to prevent water entering underneath (Annex 19)</p>	<p>a) effective in preventing rainwater from roof entering from underneath door</p>	<p>a) scrap metal used –no costs involved</p>
<b>Seepage</b>	<p>a) place corrugated iron sheets into the ground on the outside of the dwelling and securing this with sand (Annex 20)</p> <p>b) build concrete floor (Annex 20)</p>	<p>a) very effective</p> <p>b) helps stop water from seeping</p>	<p>a) R30/sheet</p> <p>b) R60 for cement and sand</p>	<p>a) mop up</p> <p>b) excavate a chunk of earth around house (Annex 20)</p>	<p>a) impulsive response to cope with existing problem</p> <p>b) helps a bit</p>	<p>a) none</p> <p>b) none</p>

	c) build dwelling on stilts (Annex 19) d) paved pathway through front yard (Annex 20)	c) very effective if built correctly & if water level does not reach height of elevation d) very effective	c) ± R300 d) included in construction costs	c) place gravel on the floor inside the house d) dig trench around house (Annex 19)	c) not effective d) effective only until the point when trench gets filled with water	c) R150/load d) none
<b>Ponding</b>	a) paved pathway through front yard (Annex 20) b) garden &/ or lawn (Annex 20)	a) very effective b) very effective	a) included in construction costs b) none	a) dig informal gullies b) elevate ground with sand/soil/gravel c) place concrete slabs outside the entrance to dwelling	a) helps reduce ponding b) helps reduce ponding c) allows to walk safely in and out of dwelling	a) none b) none c) received for free through contacts
<b>Stormwater run-off</b>	a) dwelling built on stilts	a) very effective	a) ± R300	a) dig trench with front loader	a) helps divert water	a) municipal costs
<b>Overland run-off</b>	a) build low levee in front of house using gravel b) paving in front yard (Annex 20) c) dwelling built on stilts	a) helps a bit b) very effective c) very effective	a) none b) included in construction costs c) ± R300	a) dig informal gullies b) dig trench around house (Annex 19) c) dig trench around house (Annex 19)	a) helps divert water b) helps prevent water from entering house until the point when the trench gets filled with water	a) none b) none c) none
<b>Riverine flooding</b>	a) dwelling built on stilts	a) very effective	a) ± R300	a) place gravel right around dwelling b) dig informal gullies c) dig trench around house (Annex 19)	a) not sure –river hasn't reached that far b) not easy for water to reach house c) not easy for water to reach house	a) none b) none c) none
<b>Wetland flooding</b>	a) dwelling built on stilts	a) very effective	a) ± R300	a) dig informal gullies b) dig trench around house (Annex 19)	a) not easy for water to reach house b) not easy for water to reach house	a) none b) none

the flood hazardscape. The majority (72%) of RDP dwellings demonstrate adjustments that offer limited protection (HPAL-A) against the flood hazardscape.

Annex 22 compares monthly household income and average savings against the level of adjustments for RDP dwellers. The average savings were calculated by subtracting estimated monthly household expenses from monthly household income. However, the savings indicated here do not accurately reflect what households save per month as these findings were not consistent with responses to a separate question specifically concerning monthly savings. Respondents were not sure and provided guesstimates, and this is indicated by large discrepancies in the answers provided compared to stated household income and expenditure. It was therefore decided to independently calculate the savings from the stated household income and expenditure.

Annex 22 indicates some consistency with RDP household monthly incomes and the level of adjustments undertaken. For example households with an HPAL-A have the lowest average income. However the average household income for households with an HPAL-C is marginally lower than that of households with an HPAL-B. The levels of household monthly savings indicate some consistency with the level of adjustments. For example households with an HPAL-C have the lowest monthly savings. This could be explained by higher levels of household expenditure to maintain the high level of adjustment. However, this may be disputed as an HPAL-C only represents 4% of households. Furthermore, households with an HPAL-A have lower savings than households with an HPAL-B. It appears therefore, that households with higher savings have more money to invest in better adjustments. Uncertainty regarding the relationship of household financial capital to adjustment levels requires that the other household capitals (physical, human and social) should also be considered.

Household number 4 provides a good example of the complications of interpreting household financial capital in relation to household adjustment levels.

This is the dwelling of a ward councillor, whose house is currently undergoing complete renovations and extensions and for this reason only scored an HPAL-B despite having the highest income level.

Annex 23 indicates that the capacity to which RDP households are able to tap into purposive adjustments depends on their financial, human and social capital. For example, not all RDP dwellers received the dipping concrete floor built by the municipality. Those who were not recipients of the dipping floor were either not aware that the municipality was undertaking such a project or they were not present during the day (because of work) when municipal workers were present to build these dipping concrete floors. Furthermore, some of those who were recipients had actively ensured that they received the adjustment. However, many households were passive recipients of the particular adjustment and in most cases were not aware of its purpose. This was illustrated in interviews where households who had received the particular adjustment did not point it out as an adjustment to the flood hazardscape until the researcher brought it to their attention.

#### b) Informal dwelling physical adjustments

It is evident from table 8.6 that purposive adjustments for informal dwellers usually took the form of innovative strategies, utilising basic resources in the most appropriate and robust manner. The majority of informal dwellers, however, only employed responsive adjustments, which also took the form of coping strategies as impulsive responses to the flood hazardscape. Adjustments provided by the municipality were usually ad hoc responses to the floods such as the provision of black plastic sheets (gumplastiek) for roofing. Purposive adjustments to informal dwellers provided by the municipality involved isolated instances of reconstruction of the dwelling. Adjustments by the community usually involved neighbours helping each other to implement some of the responsive strategies listed in table 8.6.

Annex 24 presents the informal household adjustments based on household interviews. Annex 24 indicates that no informal dwellings had an HPAL-C. The adjustment level with the lowest proportion for informal dwellings (4% of those interviewed) includes an HPAL-D. The second largest proportion (32%) of households had an HPAL-B. The majority of households (72%) had an HPAL-A with limited protection against the flood hazardscape.

Annex 25 compares the monthly household income and average savings against the level of adjustments for informal households. Similar to RDP households, there is some consistency between household income and savings level and the level of adjustments undertaken. For example households with an HPAL-B had higher average incomes and savings than households with an HPAL-A. However, a discrepancy was noted in relation to households reflecting an HPAL-D and who had the lowest average income and savings. This therefore further justifies the need for considering all the forms of household capital in relation to adjustment levels.

Annex 26 indicates that the capacity of informal households to employ purposive adjustments is not really an issue of financial capital but rather around human and social capital, because the materials used in informal dwelling purposive adjustments are inexpensive. It is therefore more relative to the ability of households to think creatively on how to maximise adjustments to the flood hazardscape given their poor circumstances, and on the social network of households in securing certain building materials, tools (e.g. spade and wheel barrow), and skilled assistance in construction or shared innovative ideas. Sometimes a household member would have an innovative idea on how best to adjust the dwelling to the flood hazardscape but was constrained by a lack of financial resources and time. For example, to prevent seepage one particular respondent wanted to build a 'box' around his dwelling filling this with concrete (Annex 27). The box, 400mm wide, would be constructed from wood or zinc plates. He further planned to sink 200mm into the ground. In this way the box

would prevent water from seeping into the dwelling. The respondent could not however implement this idea due to insufficient financial resources being unemployed having recently lost his job due to chronic illness.

### 8.3.5 Residual Flood Hazardscape Intensity for Individual Dwellings

Table 8.7 presents the residual flood hazardscape intensity experienced by RDP dwellers for a 50-year, 75-year and 100-year cycle flood. Table 8.8 presents the same for informal dwellers.

**Table 8.7 Residual Flood Intensity for 50-year, 75-year and 100-year Flood Experienced by RDP Dwellings**

House Number	Projected Residual Flood Intensity					
	50-Year	Intensity Level	75-Year	Intensity Level	100-Year	Intensity Level
1	44.77 %	45-Year	67.15 %	67-Year	89.54 %	90-Year
2	44.77 %	45-Year	67.15 %	67-Year	89.54 %	90-Year
3	44.77 %	45-Year	67.15 %	67-Year	89.54 %	90-Year
4	33.25 %	33-Year	49.87 %	50-Year	66.50 %	67-Year
5	43.30 %	43-Year	64.95 %	65-Year	86.60 %	87-Year
6	45.42%	45-Year	68.14 %	68-Year	90.85 %	91-Year
7	35.78 %	35-Year	53.68 %	54-Year	71.57 %	72-Year
8	38.07 %	38-Year	57.10 %	57-Year	76.14 %	76-Year
9	42.73 %	43-Year	64.10 %	64-Year	85.47 %	85-Year
10	38.07 %	38-Year	57.10 %	57-Year	76.14 %	76-Year
11	40.11 %	40-Year	60.16 %	60-Year	80.22 %	80-Year
12	36.45 %	36-Year	54.67 %	55-Year	72.90 %	73-Year
13	37.26 %	37-Year	55.90 %	56-Year	74.53 %	75-Year
14	29.01 %	29-Year	43.65 %	44-Year	58.02 %	58-Year
15	46.21 %	46-Year	69.31 %	69-Year	92.42 %	92-Year
16	38.34 %	38-Year	51.69 %	52-Year	76.69 %	77-Year
17	38.89 %	39-Year	58.33 %	58-Year	77.78 %	78-Year
18	42.18 %	42-Year	63.27 %	63-Year	84.36 %	84-Year
19	45.26 %	45-Year	67.89 %	68-Year	90.52 %	91-Year
20	50 %	50-Year	75 %	75-Year	100 %	100-Year
21	29.22 %	29-Year	43.83 %	44-Year	58.44 %	58-Year
22	17.90 %	18-Year	26.85 %	27-Year	35.80 %	36-Year
23	40.55 %	41-Year	60.83 %	61-Year	81.11 %	81-Year
24	38.27 %	38-Year	57.40 %	57-Year	76.54 %	77-Year
25	29.83 %	30-Year	44.75 %	45-Year	59.67 %	60-Year

**Table 8.8 Residual Flood Intensity for 50-year, 75-year and 100-year Flood Experienced by Informal Dwellings**

House Number	Projected Residual Flood Intensity					
	50-Year	Intensity Level	75-Year	Intensity Level	100-Year	Intensity Level
1	45.60 %	46-Year	68.40 %	68-Year	91.20 %	91-Year
2	35.50 %	36-Year	53.26 %	53-Year	71.01 %	71-Year
3	50 %	50-Year	75 %	75-Year	100 %	100-Year
4	34.80 %	35-Year	52.21 %	52-Year	69.61 %	70-Year
5	40.19 %	40-Year	60.29 %	60-Year	80.39 %	80-Year
6	44.09 %	44-Year	66.14 %	66-Year	88.19 %	88-Year
7	36.34 %	36-Year	54.52 %	55-Year	72.69 %	73-Year
8	35.18 %	35-Year	52.78 %	53-Year	70.37 %	70-Year
9	43.21 %	43-Year	64.81 %	65-Year	86.42 %	86-Year
10	30.06 %	30-Year	45.10 %	45-Year	60.13 %	60-Year
11	31.37 %	31-Year	47.06 %	47-Year	62.75 %	63-Year
12	43.30 %	43-Year	64.95 %	65-Year	86.60 %	87-Year
13	3.92 %	4-Year	5.88 %	6-Year	7.84 %	8-Year
14	30.10 %	30-Year	45.14 %	45-Year	60.19 %	60-Year
15	43.05 %	43-Year	64.58 %	65-Year	86.11 %	86-Year
16	37.74%	38-Year	56.92 %	57-Year	75.49 %	75-Year
17	47.71%	48-Year	71.56 %	72-Year	95.42 %	95-Year
18	40.36 %	40-Year	60.54 %	61-Year	80.72 %	81-Year
19	33.47 %	33-Year	50.20 %	50-Year	66.94 %	67-Year
20	43.21 %	43-Year	64.81 %	65-Year	86.42 %	86-Year
21	43.95 %	44-Year	65.93 %	66-Year	87.91 %	88-Year
22	44.45 %	44-Year	66.67 %	67-Year	88.89 %	89-Year
23	38.21 %	38-Year	57.31 %	57-Year	76.42 %	76-Year
24	37.42 %	37-Year	56.13 %	56-Year	74.84 %	75-Year
25	41.01 %	41-Year	61.52 %	62-Year	82.03 %	82-Year

Tables 8.7 and 8.8 indicate that the residual flood intensity of a 50-year, 75-year and 100-year cycle flood will be determined by the level of adjustments undertaken by a household. In this way the respective flood cycle (or rainfall event) is absorbed by the level of physical adjustments undertaken. For example for a 100-year return period of a 6-day rainfall duration the rainfall intensity is 363.9mm (table 8.2). Should a household have undertaken 25% adjustments against the hazardscape (e.g. household number 13 in Annex 21) then the 100-year event would be experienced as a 75-year event by the respective household. Thus only 332.8mm (the 6-day rainfall intensity of a 75-year return period – table 8.2) of the 100-year event will negatively affect this specific household.

The extent to which adjustments reduce the intensity of the flood hazardscape significantly reflects the extent to which respective households sustained impacts

from the three events. A more detailed comparative analysis of damage sustained by individual households from the sample interviews is necessary to extrapolate the accuracy of physical adjustments to reduce the flood hazardscape intensity. This was beyond the scope of the third leg of interviews.

#### **8.4 Flood Vulnerability and Vulnerability Adjustments Analysis in Thembaletu**

This section presents the flood vulnerability and vulnerability adjustment analysis of RDP and informal dwelling households in Thembaletu followed by the residual flood vulnerability.

##### *8.4.1 Flood Vulnerability Analysis*

The flood vulnerability analysis considers the physical exposure and livelihoods capitals of both RDP and informal households.

##### 8.4.1.1 Household physical exposure

Annex 28 presents the physical exposure of RDP households in Thembaletu. Annex 29 presents the same for informal households. The findings from Annex 28 and 29, summarised in table 8.9 below, suggest that in relation to physical exposure to flood risk, informal households are far more vulnerable than RDP households.

**Table 8.9 Household Physical Exposure to Flood Hazardscape in Thembaletu**

<b>Level of Exposure</b>	<b>RDP Households</b>	<b>Informal Households</b>	<b>Total</b>
0%	4%	0%	2%
1 – 25%	40%	4%	22%
26 – 50%	56%	16%	36%
51 – 75%	0%	64%	32%
76 – 100%	0%	16%	8%

##### 8.4.1.2 Household livelihood capitals

The vulnerability excluding the vulnerability adjustments of households is presented in Annex 30 for RDP households and Annex 31 for informal households. These findings, excluding the physical exposure column of both tables, are summarised in table 8.10 which reflects the relative contribution of

household livelihoods to household flood vulnerability. Table 8.10 suggest that on average informal households are marginally poorer than those in RDP households making them more vulnerable than RDP households.

**Table 8.10 Contribution of Household Livelihood Capitals to Household Flood Vulnerability of Thembaletu Households**

<b>Level of Contribution</b>	<b>RDP Households</b>	<b>Informal Households</b>	<b>Total</b>
1 – 25%	32%	4%	18%
26 – 50%	68%	76%	72%
51 – 75%	0%	20%	10%
76 – 100%	0%	0%	0%

The livelihoods of each household are made up by its physical, human, financial and social capital. The contribution of each of these capitals is discussed below.

a) Physical capital

Annex 32 presents the physical capital of RDP households in Thembaletu. Annex 33 presents the same for informal households. The findings from Annex 32 and 33 are summarised in table 8.11 which reflects the importance of physical capital in the overall households' livelihoods contribution to flood vulnerability. Table 8.11 suggest that where physical capital is concerned, informal households are worse off than RDP households.

**Table 8.11 Contribution of Physical Capital in severing Households' Livelihoods Contribution to Flood Vulnerability**

<b>Level of Contribution</b>	<b>RDP Households</b>	<b>Informal Households</b>	<b>Total</b>
-1% and below	52%	0%	26%
0%	0%	4%	2%
1 – 25%	28%	4%	16%
26 – 50%	20%	52%	36%
51 – 75%	0%	24%	12%
76 – 100%	0%	16%	8%

b) Human capital

Annex 34 presents the human capital of RDP households in Thembaletu. Annex 35 presents the same for informal households. The findings from Annex 34 and 35 are summarised in table 8.12 which reflects the importance of human capital

in the overall households' livelihoods contribution to flood vulnerability. Table 8.12 suggest that RDP and informal households are made vulnerable to almost the same degree by their human capital, with RDP households being slightly worst off than informal households.

**Table 8.12 Contribution of Human Capital in severing Households' Livelihoods Contribution to Flood Vulnerability**

<b>Level of Contribution</b>	<b>RDP Households</b>	<b>Informal Households</b>	<b>Total</b>
1 – 25%	4%	12%	8%
26 – 50%	76%	72%	74%
51 – 75%	0%	0%	0%
76 – 100%	20%	16%	18%

c) Financial capital

Annex 36 presents the financial capital of RDP households in Thembaletu. Annex 37 presents the same for informal households. The findings from Annex 36 and 37 are summarised in table 8.13 which reflects the importance of financial capital in severing the overall households' livelihoods contribution to flood vulnerability. Table 8.13 suggest that RDP and informal households are made vulnerable to almost the same degree by their financial capital, with informal households slightly worst off than RDP households.

**Table 8.13 Contribution of Financial Capital in severing Households' Livelihoods Contribution to Flood Vulnerability**

<b>Level of Contribution</b>	<b>RDP Households</b>	<b>Informal Households</b>	<b>Total</b>
-1% and below	4%	0%	2%
1 – 25%	24%	24%	24%
26 – 50%	24%	44%	34%
51 – 75%	48%	28%	38%
76 – 100%	0%	4%	2%

d) Social capital

Annex 38 presents the social capital of RDP households in Thembaletu. Annex 39 presents the same for informal households. The findings from Annex 38 and 39 are summarised in table 8.14 which reflects the importance of social capital in adding to the overall households' livelihoods contribution to flood vulnerability.

Table 8.14 suggest that in terms of social capital RDP households are far better off than informal households, where over half (68%) of RDP households' social capital does not contribute to vulnerability compared to only 16% of informal households.

**Table 8.14 Contribution of Social Capital in severing Households' Livelihoods Contribution to Flood Vulnerability**

<b>Level of Contribution</b>	<b>RDP Households</b>	<b>Informal Households</b>	<b>Total</b>
-1% and below	40%	12%	26%
0%	28%	4%	16%
1 – 25%	28%	44%	36%
26 – 50%	4%	40%	22%

#### 8.4.1.3 Household Flood Vulnerability Pre-Adjustments

From Annex 40 and 41 the following can be observed with regards to households' flood vulnerability in Thembaletu that excludes the adjustments of households. An HFVL-A is held by 20% of households. This comprises 36% of RDP households and only 4% of informal households. These households have low flood vulnerability even prior to vulnerability adjustments. The majority of households (66%) have an HFVL-B, representing the majority of both RDP (64%) and informal (68%) households. These households have medium flood vulnerability. Only 14% of households have an HFVL-C, representing 0% of RDP households and the second largest proportion (28%) of informal households. These households have high flood vulnerability. No households have an HFVL-D. It is evident that informal households are more vulnerable to flood risk than RDP households without any flood vulnerability adjustments.

#### *8.4.2 Flood Vulnerability Adjustments*

In general, flood vulnerability adjustments were lacking among RDP and informal dwellers. Only one individual (the councillor) was aware of the relevant disaster management act. Where the existence of any adjustments was reported, these were more general social measures not specific to flood risk. For example community rules and regulations were more generally related to issues such as curbing uncontrolled drunken behaviour. However, rules more specifically applied

to flood risk included prevention of dumping of both household waste and grey water.

Special measures to protect the most vulnerable existed in some households and at community and municipal levels. At the household level, such measures included extra parental caution, for example “keeping an eye” so that children would not “wander off”. Households with disabled members also reportedly gave special attention to these individuals. Certain households also ensured that elderly household members always had someone (including neighbours) nearby to watch over them. Although one household claimed to have a preparedness plan, households generally did not show many signs of readiness for flood preparedness and response except for household coping strategies in a flood event and associated evacuations.

At the community level, measures included having day care centres for children whose parents work during the day as well as weekly soup kitchens for children. There was also mention of a weekly soup kitchen for pensioners. Community members also always watch over children playing in the streets should any strangers wander in the neighbourhood. Young men would assist elderly neighbours on physical adjustments to cope with floods (e.g. digging of trenches) or to recover from flood damage (e.g. reconstruction of damaged parts of informal dwellings). However, the community had essentially no flood preparedness plan. Despite this, it is clear that a number of informal, largely unrecognised measures were in place.

At the municipal level, measures included predominantly those of emergency services such as the police. The police for example have special trauma units that deal with victimised women and children. The Disaster Manager for George indicated that they had a flood preparedness and response plan. However the Disaster Manager was unable to locate a copy of the plan which is simply a contact and procedural list.

Annex 42 presents the vulnerability adjustments of RDP dwelling households in Themba lethu. Annex 43 presents the same of informal dwelling households. The findings from Annex 42 and 43 are summarised in table 8.15 which reflects the household flood vulnerability adjustment levels.

Table 8.15 indicate that informal households have much higher vulnerability adjustments than RDP households. This could perhaps be explained by the characteristic crowded and poor conditions that force informal households to create social mechanisms to mediate these conditions, resulting in more social structures in place among informal households than RDP households.

**Table 8.15 Household Flood Vulnerability Adjustment Levels in Themba lethu**

<b>Flood Vulnerability Level</b>	<b>RDP Households</b>	<b>Informal Households</b>	<b>Total</b>
HFVAL-A	72%	64%	68%
HFVAL-B	24%	20%	22%
HFVAL-C	4%	12%	8%
HFVAL-D	0%	4%	2%

#### *8.4.3 Residual Household Flood Vulnerability Levels*

Table 8.16 presents the residual household flood vulnerability levels of RDP households in Themba lethu. Table 8.17 presents the same for informal households.

From table 8.16 and 8.17 the following can be observed with regards to the residual household flood vulnerability levels. The second largest proportion (34%) of households has an HFVL-A. This constitutes the majority (52%) of RDP households compared to only 16% of informal households. The majority (58%) of households have an HFVL-B. This constitutes 48% of RDP households compared to the majority (68%) of informal households. Only 8% of households have an HFVL-C. This constitutes 16% of informal households compared to no RDP households. No households have an HFVL-D. In summary RDP households tend to have a lower vulnerability level than informal households.

**Table 8.16 Residual Household Flood Vulnerability Levels for RDP dwelling households in Thembaletu in Percentage**

<b>Household Number</b>	<b>Flood Vulnerability (%)</b>	<b>Flood Vulnerability Adjustment (%)</b>	<b>Residual Flood Vulnerability (%)</b>	<b>Residual Flood Vulnerability Level</b>
1	36.67%	32%	24.94%	HFVL-A
2	34.22%	34%	22.59%	HFVL-A
3	22.89%	74.40%	5.41%	HFVL-A
4	8.22%	46.80%	4.37%	HFVL-A
5	22.44%	0%	22.44%	HFVL-A
6	24.67%	0%	24.67%	HFVL-A
7	10.44%	7.20%	9.69%	HFVL-A
8	14.22%	40%	8.53%	HFVL-A
9	34.44%	2%	33.75%	HFVL-B
10	21.78%	41.20%	12.81%	HFVL-A
11	11.56%	0%	11.56%	HFVL-A
12	39.78%	2.80%	38.67%	HFVL-B
13	43.56%	2%	42.69%	HFVL-B
14	34.44%	1.6%	33.89%	HFVL-B
15	42.67%	2%	41.82%	HFVL-B
16	30%	4%	28.80%	HFVL-B
17	35.33%	1.6%	34.76%	HFVL-B
18	25.56%	25.20%	19.12%	HFVL-A
19	41.33%	0.80%	41%	HFVL-B
20	31.33%	0%	31.33%	HFVL-B
21	41.11%	29.60%	29.94%	HFVL-B
22	32.44%	22%	25.30%	HFVL-A
23	24.89%	8%	22.90%	HFVL-A
24	28.67%	1.6%	28.21%	HFVL-B
25	33.56%	0%	33.56%	HFVL-B

**Table 8.17 Residual Household Flood Vulnerability Levels for Informal dwelling households in Themba lethu in Percentage**

Household Number	Flood Vulnerability (%)	Flood Vulnerability Adjustment (%)	Residual Flood Vulnerability (%)	Residual Flood Vulnerability Level
1	56.44%	64.80%	19.87%	HFVL-A
2	37.56%	2.80%	36.51%	HFVL-B
3	37.11%	0%	37.11%	HFVL-B
4	46.44%	4%	44.58%	HFVL-B
5	51.56%	0%	51.56%	HFVL-B
6	36.89%	3.60%	35.57%	HFVL-B
7	57.56%	2%	56.41%	HFVL-C
8	49.78%	30%	34.85%	HFVL-B
9	60.67%	0%	60.67%	HFVL-C
10	41.11%	28%	29.60%	HFVL-B
11	56.89%	69.60%	17.29%	HFVL-A
12	43.11%	21.60%	33.80%	HFVL-B
13	24.89%	90.80%	2.29%	HFVL-A
14	48.22%	32.80%	32.40%	HFVL-B
15	50.44%	6%	47.42%	HFVL-B
16	48.89%	28%	35.20%	HFVL-B
17	56%	6.40%	52.42%	HFVL-C
18	43.78%	60.40%	17.34%	HFVL-A
19	50.44%	0%	50.44%	HFVL-B
20	44.67%	20%	35.74%	HFVL-B
21	41.56%	0%	41.56%	HFVL-B
22	63.33%	0%	63.33%	HFVL-C
23	49.11%	33.60%	32.61%	HFVL-B
24	44%	11.20%	39.07%	HFVL-B
25	41.11%	2%	40.29%	HFVL-B

### 8.5 Flood Risk in Themba lethu

Table 8.18 presents the flood risk levels of RDP households in Themba lethu. Table 8.19 presents the same for informal households. The flood risk percentage in tables 8.18 and 8.19 should be read as follows: “A 100-year cycle flood will probably have an impact of 22.33% on the overall livelihood and infrastructure of household number 1 (from table 8.18). Since this constitutes a level B risk, household number 1 can expect minor interruptions to infrastructure, assets, possessions and daily routine.”

Map 8.1 presents the level of risk for a 50-year cycle flood of the RDP and informal households, assessed from the household interviews in Themba lethu. Map 8.2 presents the same for a 75-year cycle flood and map 8.3 presents a 100-year cycle flood. Due to difficulties with the colour grading within the GIS

software, informal dwellings with risks between 0 to 0.99% were not reflected on the maps. Figure 8.3 contains the legend for the three maps. The flood risk maps only reflect households interviewed in Thembaletu.

**Table 8.18 Flood Risk Level of RDP Dwelling Households in Thembaletu for a 50-, 75- and 100-year Rainfall Event**

Household Number	50-Year Cycle		75-Year Cycle		100-Year Cycle	
	Risk Percentage	Risk Level	Risk Percentage	Risk Level	Risk Percentage	Risk Level
1	11.17%	B	16.74%	B	22.33%	B
2	10.11%	B	15.17%	B	20.23%	B
3	2.42%	B	3.63%	B	4.84%	B
4	1.45%	B	2.18%	B	2.91%	B
5	9.72%	B	14.57%	B	19.43%	B
6	11.21%	B	16.81%	B	22.41%	B
7	3.47%	B	5.20%	B	6.94%	B
8	3.25%	B	4.87%	B	6.49%	B
9	14.42%	B	21.63%	B	28.85%	C
10	4.88%	B	7.31%	B	9.75%	B
11	4.64%	B	6.95%	B	9.27%	B
12	14.10%	B	21.14%	B	28.19%	C
13	15.91%	B	23.86%	B	31.82%	C
14	9.83%	B	14.79%	B	19.66%	B
15	19.33%	B	28.99%	C	38.65%	C
16	11.04%	B	14.89%	B	22.09%	B
17	13.52%	B	20.28%	B	27.04%	C
18	8.06%	B	12.10%	B	16.13%	B
19	18.56%	B	27.83%	C	37.11%	C
20	15.67%	B	23.50%	B	31.33%	C
21	8.75%	B	13.12%	B	17.50%	B
22	4.53%	B	6.79%	B	9.06%	B
23	9.29%	B	13.93%	B	18.57%	B
24	10.80%	B	16.19%	B	21.59%	B
25	10.01%	B	15.01%	B	20.03%	B

**Table 8.19 Flood Risk Level of Informal Dwelling Households in Thembaletu for a 50-, 75- and 100-year Rainfall Event**











Household Number	50-Year Cycle		75-Year Cycle		100-Year Cycle	
	Risk Percentage	Risk Level	Risk Percentage	Risk Level	Risk Percentage	Risk Level
1	9.06%	B	13.59%	B	18.12%	B
2	12.96%	B	19.45%	B	25.93%	B
3	18.55%	B	27.83%	C	37.11%	C
4	15.51%	B	23.28%	B	31.03%	C
5	20.72%	B	31.09%	C	41.45%	C
6	15.68%	B	23.53%	B	31.37%	C
7	20.50%	B	30.75%	C	41%	C
8	12.26%	B	18.39%	B	24.52%	B
9	26.22%	C	39.32%	C	52.43%	C
10	8.90%	B	13.35%	B	17.80%	B
11	5.42%	B	8.14%	B	10.85%	B
12	14.64%	B	21.95%	B	29.27%	C
13	0.11%	A	0.17%	A	0.23%	A
14	9.75%	B	14.63%	B	19.50%	B
15	20.41%	B	30.62%	C	40.83%	C
16	13.28%	B	20.03%	B	26.57%	C
17	25%	B	37.51%	C	50.02%	C
18	7%	B	10.50%	B	14%	B
19	16.88%	B	25.32%	B	33.76%	C
20	15.44%	B	23.16%	B	30.89%	C
21	18.27%	B	27.40%	C	36.54%	C
22	28.15%	C	42.22%	C	56.29%	D
23	12.46%	B	18.69%	B	24.92%	B
24	14.62%	B	21.93%	B	29.24%	C
25	16.52%	B	24.79%	B	33.05%	C

**Figure 8.3 Legends for Flood Risk Maps 8.1, 8.2 and 8.3**




 20m Contour Line

 **Rivers**



**Roads**

-  ARTERIAL ROUTE
-  HIKING TRAIL
-  INTERCHANGE
-  MAIN ROAD
-  NATIONAL FREEWAY
-  NATIONAL ROUTE
-  OTHER ACCESS
-  SECONDARY ROAD
-  STREET
-  TRACK FOOTPATH

**Water Bodies**

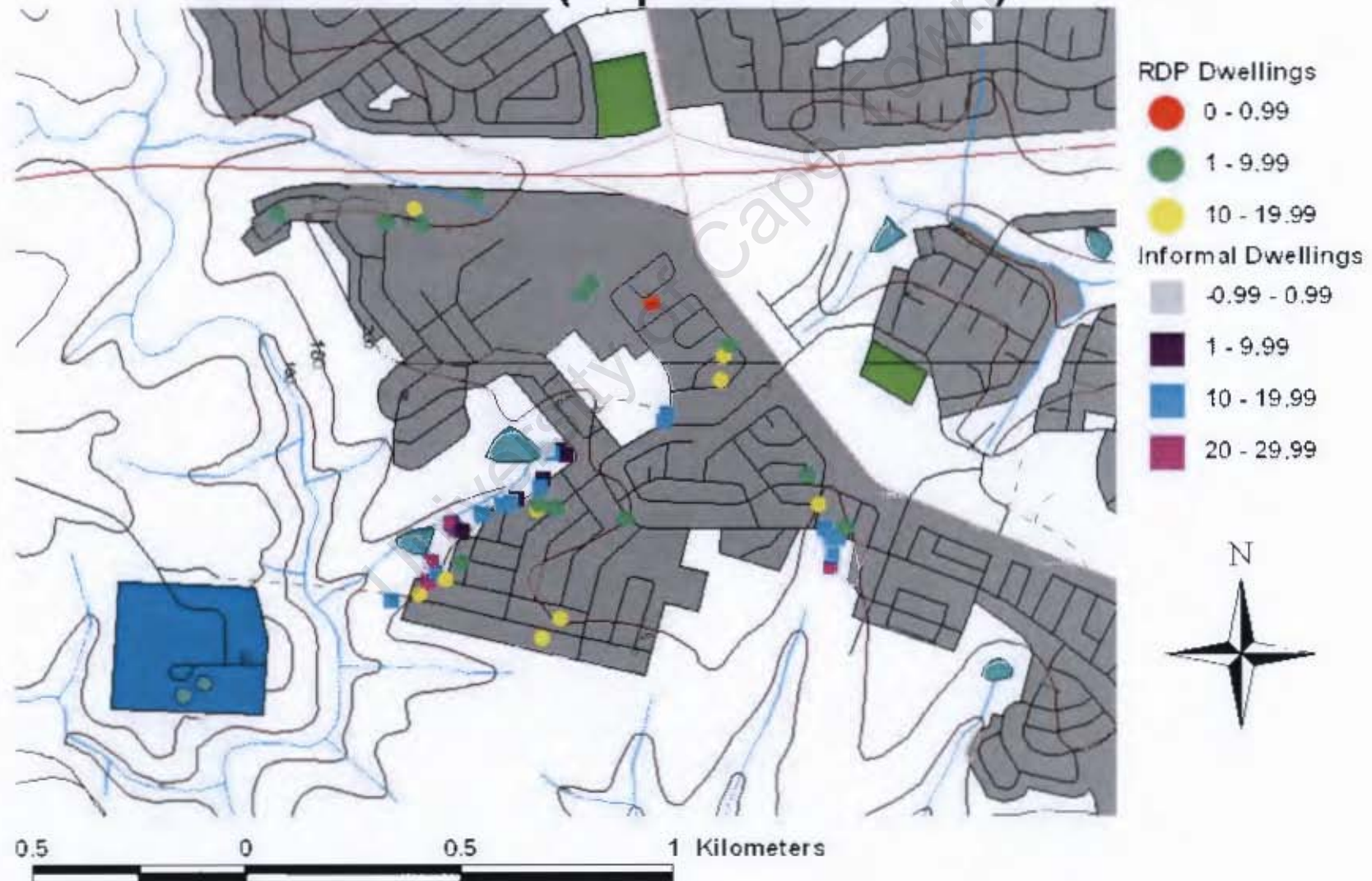
-  DAM
-  LAKE
-  SEWERAGE WORKS

**Land Use**

-  HIGH URBAN DENSITY
-  RECREATION AREA

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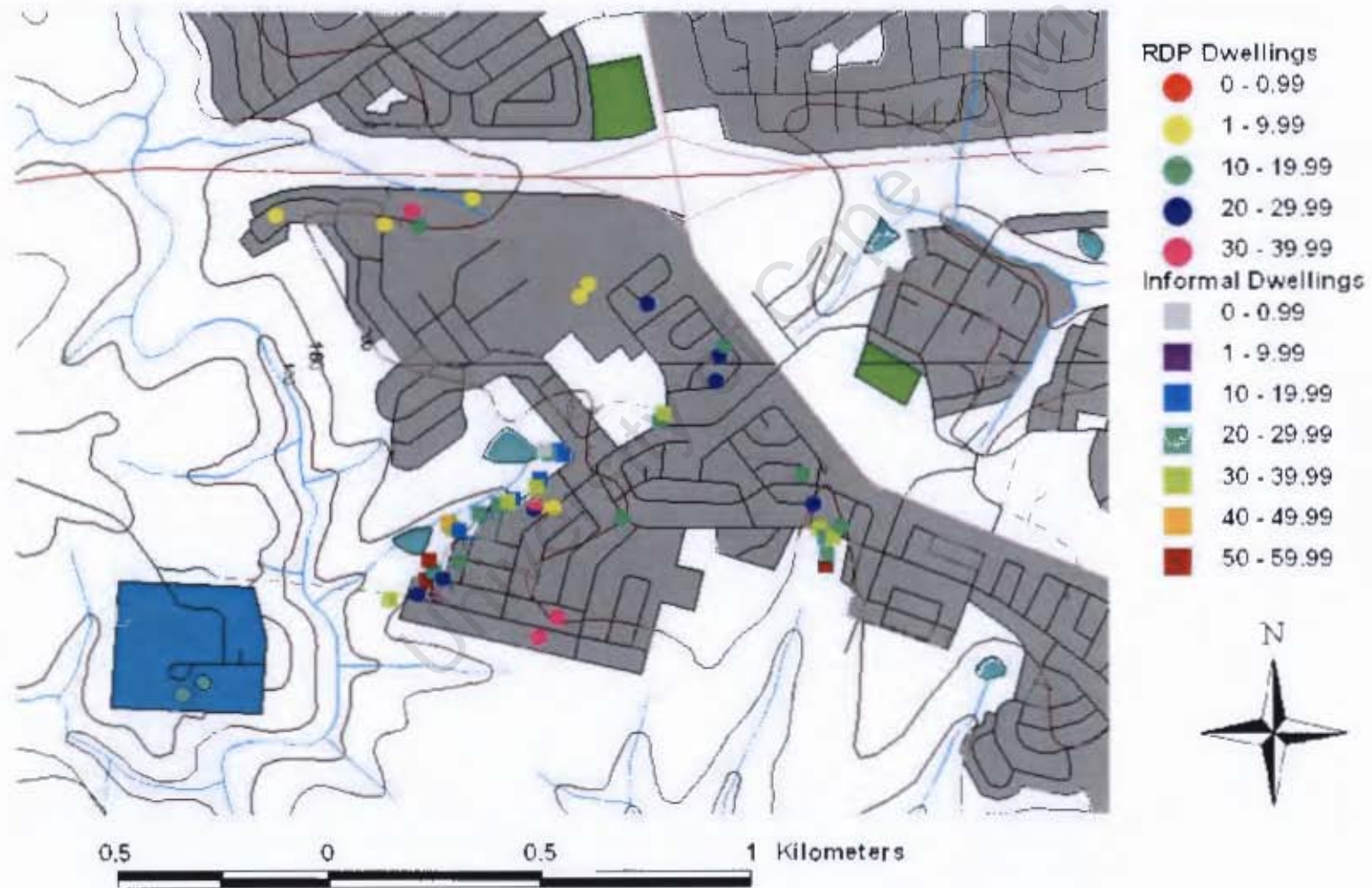
# Map 8.1 50 Year Flood Risk Map of Thembalethu (expressed as %)



# Map 8.2 75 Year Flood Risk Map of Thembalethu (expressed as %)



# Map 8.3 100 Year Flood Risk Map



Tables 8.18 and 8.19 indicate that for both RDP and informal households the flood risk levels are relatively low for a 50-year, 75-year and 100-year cycle flood. The tables further reflect that as the flood cycle increases, the flood risk levels for both RDP and informal households would increase. However flood risk levels for informal households tend to be higher than that of RDP households.

Map 8.1 indicates that where a 50-year cycle flood is concerned most households with a Level B risk are dispersed across ward 12, Thembalethu. Likewise, Map 8.2 indicates that where a 75-year cycle flood is concerned most households with a Level B risk are dispersed across ward 12, Thembalethu. Where a 100-year cycle flood is concerned, Map 8.3 indicates that all of the households with a Level D risk are located along relatively steep sloping valleys of tributary streams of the Skaapkop River.

## **8.6 Summary**

The findings presented indicate that Thembalethu has a realised risk of experiencing a 50-year, 75-year and 100-year cycle floods. However, despite experiencing a 100-year cycle flood, the settlement is not seriously at-risk to riverine flooding. Instead, the flood hazardscape in Thembalethu takes on various localised forms that are cumulatively experienced by individual households. Further, residents undertake purposive and responsive physical adjustments that assist in absorbing the intensity of the flood hazardscape. Purposive adjustments differ between formal and informal dwellers and implementing such adjustments depends on the livelihoods capacity of both formal and informal dwellers. Consequently, the level of household physical adjustments will determine the intensity of the residual flood hazardscape intensity.

The findings further confirm that households become vulnerable to the flood hazardscape due to their physical exposure and various livelihood capitals. In general informal dwellers are slightly more vulnerable to the flood hazardscape

than formal dwellers. This is due to the slightly poorer livelihoods of informal dwellers. In general both formal and informal dwellers undertook limited flood vulnerability adjustments. However, informal dwellers undertook slightly higher flood vulnerability adjustments than formal dwellers. This was due to informal dwellers being forced, because of poor and crowded living conditions, to adopt social measures that enable them to live together.

Finally, the findings also indicate that in general, the flood risk of both formal and informal dwellers is not that high, even for a 100-year flood event. However, informal dwellers have a slightly higher flood risk than formal dwellers. The above are consistent with the documented losses from the SIA report.

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## Chapter 9

### Discussion and Recommendations for Flood Risk Management

“Control over development on floodplains is the most effective means of limiting flood damage”  
(Alexander, 2000b: 221).

#### 9.1 Introduction

This chapter includes a discussion of the research findings in relation to prevailing disaster risk theories and conceptualisation. It proposed a framework for investigating urban flood risk in George that may be adopted for other urban environments. The chapter concludes with specific recommendations for flood risk management in George.

#### 9.2 Discussion

This section discusses the findings with regards to the flood hazardscape, vulnerability and urban flood risk in relation to the prevailing disaster risk theories.

##### *9.2.1 Flood Hazardscape Theory*

Mustafa's (2005) hazardscape concept is a refreshing development in hazards research. Mustafa notes that the flood hazardscape is a hybrid hazard in which various physical, social and technological factors intersect. However, Mustafa's original concept places more emphasis on social deconstruction and limiting the emphasis on physical parameters. Balancing the hazardscape concept to include physical, social and technological concerns allows for a progressive move away from the traditional physical science understanding of hazards, in particular flood hazards where floods are predominantly (at political, academic and popular levels) understood as rivers overflowing their banks, dam walls bursting, or stormwater systems exceeding their capacity.

This research demonstrated that in Thembaletu, a settlement that is typical of low-cost settlements in the Western Cape, the flood hazardscape takes on

various localised forms (over and above that of riverine-type flooding) that are cumulatively experienced by households. These various localised forms of the flood hazardscape, although naturally triggered by heavy rainfall, are influenced by the natural environment, as well as political (e.g. poor planning), collective and individual action (e.g. dumping of household waste, site location, building practices). Furthermore, technological factors (housing, road and stormwater design) also contribute to shaping the flood hazardscape. These technological factors are influenced by the physical environment, political, collective and individual action.

In 3.3.5 it was noted that alternative adjustments to the hazardscape always exist for individuals. Burton et al (1993) further noted that adjustments available to collectives are always greater than that available to individuals. They also distinguished between incidental and purposeful adjustments. This research has demonstrated that there are various physical adjustments, both purposive and responsive (incidental) available to collectives. However the choices of appropriate adjustments were determined according to dwelling type. Adjustments differed for individuals owning low-cost formal dwellings and individuals owning informal dwellings. Furthermore, household physical, human, financial and social capitals dictated the ability of individuals to tap into purposive adjustments.

### *9.2.2 Human Vulnerability*

In 3.3.4 it was indicated that there is consensus that vulnerability comprises various interrelated components that include environmental, economic, social, demographic and political variables. Consequently, in 3.3.5 it was said that, household livelihood assets comprise of the same components as those of vulnerability. These are in the form of household physical, human, financial and social capital. Furthermore, the PAR model demonstrates that human vulnerability is influenced by broader national, regional and global political and economic systems. The SUD framework, for example, demonstrates that in the

urban system there are various components that include social, economic, environmental, demographic and governance (political). In this way the components of the urban system are consistent with those related to that of household vulnerability and their associated livelihoods assets. In 4.3.1 it was indicated that the urban system is influenced by broader national, regional and global processes. Thus the processes of the urban system indirectly influence household vulnerability. These 'root causes' result in challenges over access to resources (dynamic pressures).

Dynamic pressures in this research take the form of settlement planning (political) and choice of site location as well as access to formal housing (political, collective and individual agency). This research has found that households become vulnerable to flood risk because of their physical exposure, robustness of their livelihoods (that includes the physical, human, financial and social capitals), and lack of vulnerability adjustments. This household vulnerability is also directly influenced by poor urban development. Furthermore, vulnerability to flood risk is differentiated according to the dwelling type of individuals where informal dwelling households are more vulnerable than low-cost formal dwelling households.

Wisner et al (2004) noted the debate around whether vulnerability can be quantified and what the correct balance between quantitative and qualitative data should be. The research has demonstrated that quantifying vulnerability, in terms of weighting the various vulnerability variables, remains challenging. Despite incorporating the most qualitative approach in the social sciences (i.e. ethnographic methods) it is still difficult to determine a quantitative value to people's vulnerability for specific threats. How does one quantify for people's experiences? One solution might be to allow people to rate each vulnerability variable themselves, a measure that supports the movement towards participatory approaches. However, this generates another debate around the validity of subjective methods. Yet, it could also be argued that many risk

assessments are indeed based on subjective approaches, reflecting contemporary debates to whether risk is a social construction or real phenomenon (see 3.3.2).

### *9.2.3 Urban Flood Risk*

This research has demonstrated that studies of urban flood risk should consider both the hazardscape and human vulnerability, where physical and vulnerability adjustments are also taken into account. Furthermore the flood hazardscape is not only the domain of physical scientists being a complex interaction of physical, political, social and technological factors. It is therefore not sufficient to only employ hydrological and hydraulic methods in assessing the flood hazardscape as is the case currently in South African flood risk research. Hydrological methods, especially rainfall-based methods should be accompanied with social science methods. A society-environment lens facilitates the process of **integrated urban flood risk research**, adding value to current disaster risk thinking. Such an approach demonstrates that Wisner et al's (2004) PAR model of *root causes* of vulnerability should be extended to include *root causes* of the hazardscape. Such a framework is demonstrated in figure 9.1 below. In this way, integrated urban flood risk management should address the root causes of both the hazardscape and vulnerability in an extended alternative adjustment approach. Integrated urban management should include risk reduction, preparedness, response and recovery.

### **9.3 Framework for Flood Risk Management in George**

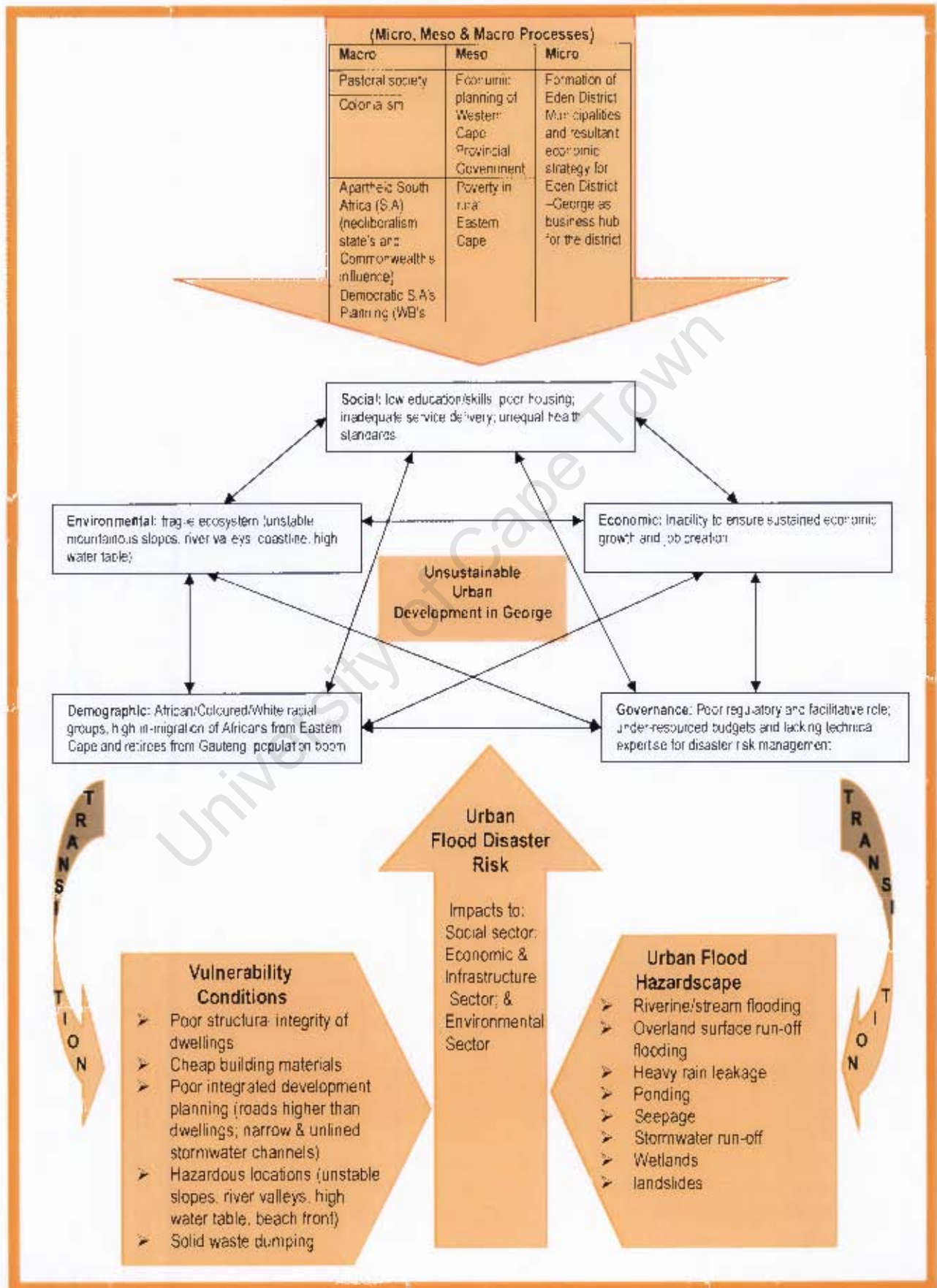
A framework illustrating a flood risk circulation model for George emerges from the research findings. Figure 9.1 presents this framework which should be used as a guide for informing flood risk management especially of low cost settlements in George.

The framework gives credibility to Pelling's (2003) statement that a relationship exists between urbanization and disasters. By adopting an urban flood risk

circulation model it becomes possible to illustrate how poor (or unsustainable) urban development in George influences the generation of flood risk resulting from extreme weather events. In this study, the urban growth of George within its social, demographic, economic, environmental and governance context generates conditions of vulnerability, particularly to those living in low cost settlements, as well as the urban flood hazardscape. It should be noted that the social, demographic and economic contexts of George were influenced by its macro (colonialism within the context of pastoralist society, followed by apartheid and democracy, accompanied by neo-liberal global economic influences), meso (the economic strategy of the Western Cape and growing poverty in the neighbouring Eastern Cape) and micro (District economic strategy that sees George as the economic hub of the Eden District Municipality) processes.

The trigger of heavy rainfall associated with extreme weather events activates the flood hazardscape which intersects with the vulnerable population. The resulting flood disaster impacts on the social sector (household livelihoods), the economic sector (the urban economy of George), the infrastructure sector (that also influences the economic sector) and the environmental sector (urban agriculture, tourism and environmental degradation). Consequently these impacts feed back into the system of poor developmental growth practices. Local government responses repair the damaged infrastructure to the same standards prior to flood damage. Local job losses accompanied by the flood impacts on household livelihoods exacerbate poverty within the population. This results in people remaining in existing vulnerable locations as well as new people entering into such locations. Furthermore no sustained efforts to improve flood risk reduction and management by local government would see the continuation of this cycle of urban flood risk.

Figure 9.1 Urban Flood Risk Circulation Model for George



#### 9.4 Recommendations for Flood Risk Management in George

Flood risk management in George cannot be managed in isolation. An **integrated flood risk management plan** is required that should form part of the broader integrated development and environmental management planning of George and the Eden District Municipality. Such an integrated management plan should consider the following:

- **Integration:** the interconnectedness and linkages between different national, provincial, district and local government departments as well as other stakeholders such as property developers, business and NGOs. Stakeholders would be more than willing to play their role. The George Chamber of Commerce for example has shown willingness to participate in flood risk management by partially financing this research.
- **Political will:** there should be good local governance (risk governance) to implement the relevant legislation that facilitates flood risk management (see 5.5.1). This requires greater incentives for relevant local government officials as well as support through appropriate training programmes.
- **Transboundary concerns:** the entire watershed should be considered and its relationship with other municipalities and districts.
- **Comprehensive approach based on risk assessment:** the flood risk management plan should be informed by an integrated flood risk assessment. This research has presented what flood risk assessments should entail and has also presented a guiding framework (figure 9.1) for conceptualizing flood risk. A municipal-wide flood risk assessment should follow the same procedure. The findings of the risk assessment should inform mitigation, preparedness, response and recovery strategies. In this way strategies should involve both physical structural adjustments that also consider local techniques as well as social adjustments that include locally appropriate and up-to-date early warning systems and social protection mechanisms.
- **Risk reduction:** Floods cannot be eliminated but their impacts can be reduced through appropriate town planning and engineering solutions, adequate service delivery and sound environmental management.

Furthermore adequate and appropriate social protection may also increase the resilience of households. The guidelines and recommendations for roads and stormwater system design in the CSIR's (2003) "Red Book" should be followed. The Red Book also contains guidelines for appropriate settlement and housing locations. Houses, especially low-cost housing should be designed and constructed in an appropriate flood-resistant manner. The American Society of Civil Engineers (ASCE) published a useful standard guide for flood resistant design and construction (SEI/ASCE, 2000), which, although unique to the United States, could be used to inform standards in South Africa. However informal dwellings cannot follow any design standards because of their inherently unplanned and informal characteristics. It is possible however to ensure that informal dwellings are designed and built according to the best informal dwelling building practice where at least 50% of rainfall intensity would be absorbed by the physical structure of the dwelling. This could be achieved by ward councillors, ward committees and/or community leaders taking on the social responsibility of ensuring that those who possess the knowledge and skills of designing and constructing informal dwellings according to best practice standards share their insight with the rest of the informal dwellers. Such a process should be supported and funded where necessary by the municipality.

The municipality should ensure that sectoral departments have clear understanding and communication between each other with regards to one another's roles. These departments should ensure that they fulfil their service delivery duties and that they plan their mandates coherently.

Any settlement or property developments should follow strict Environmental Impact Assessments (EIAs) as well as Disaster Risk Assessments (DRAs). National, provincial, district and municipal departments with a role in the natural environment (i.e. Department of Agriculture, Department of Environmental Affairs and Tourism, Department of Water Affairs and Forestry

[DWAF] and Disaster Management as well as Park Boards and Game Reserves) should ensure that catchments and natural vegetated (especially forest) areas are managed in an integrated manner. Here it should be ensured that the fire season (during summer) does not result in the burnt biomass entering into catchments that may increase the flood risk during the rainy season.

Social protection that includes preventative, promotional and transformative measures should exist to increase the resilience of poor households. Preventative measures include those that seek to avert deprivation in various ways (Devereux and Sabates-Wheeler, 2004). Promotional measures include measures that aim to enhance real income and capabilities (ibid). Transformative measures include measures that seek to address concerns of social equity and exclusion (ibid).

- **Preparedness:** Early warning systems should be further improved so that early warnings reach district and municipal disaster managers and other departments timely and in a clear language. There have been many complaints for example by certain municipal departments within the Eden District that early warning messages either reached them too late or the message was sent to the wrong department or personnel or was ambiguous. Early warnings should be communicated to local communities in a timely and appropriate manner. Disaster managers should take the responsibility of communicating the early warning message to all ward councillors, ward committee members, community leaders, religious leaders and resident's associations. These point persons should then communicate the message to their broader community via loud speakers and or runners (preferably youth from Boy Scouts, sports clubs or youth groups if possible) that go door to

door with the message or place clear notices in places of worship, supermarkets, community halls, spaza shops and shebeens<sup>1</sup>.

- **Response:** The district and municipality should ensure that a Joint Operations Centre (JOC) is in place and that each member clearly understands their role. There have been complaints for example by the Eden District Disaster Manager that most municipalities had no JOCs in place, and that the members of those who did were unsure of their roles and responsibilities. The Eden District Disaster Manager should therefore be responsible for ensuring that all municipalities have a functional JOC in place. The JOC should coordinate the entire response operation ensuring no duplication of services and resources but rather to ensure that services and resources are utilised in a maximum appropriate manner. The role of the JOC is therefore to ensure that protective measures are in place. Protective measures should have the specific objective of guaranteeing relief from deprivation (ibid).
- **Recovery:** The JOC should also be responsible for coordinating recovery operations to ensure that all affected communities receive appropriate recovery assistance and that preference is given to the most affected communities. This should be established by a Rapid Impact Assessment (RIA) that identifies the most affected communities.
- **Simulation exercises:** Flood simulation exercises should be carried out at the beginning of every rainy season, so that early warning systems, response and recovery plans should be tested.
- **Monitoring and Evaluation:** The flood risk management plan should be regularly monitored, regarding implementation and functioning of each stage of the plan. Following flood impacts, comprehensive disaster impact assessments should be undertaken to assess the extent of damages in order

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<sup>1</sup> These are informal liquor outlets within low cost settlements.

to inform the success of the flood risk management plan. The plan should constantly be reviewed and updated.

- **Participation:** All stakeholders, including the local community and minority groups, should be involved throughout every stage of the formation of the flood risk management plan –from its conception to its implementation and monitoring and evaluation.

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## Chapter 10

### Conclusion

“Disasters are everybody’s business” (Gerhard Otto, Eden District Disaster Manager).

The transdisciplinary nature of the disaster risk science field enables it to provide a valuable contribution to society where disaster risk reduction and management is concerned. Because of its transdisciplinary nature, disaster risk practitioners are able to step across and within various disciplines and discourses in order to develop an evolved approach for disaster risk reduction and management. Navigating through a society-environment discourse within hazards geography has enabled this research to adopt an integrated approach with reference to flood risk management.

Approaching the disaster risk discourse and the subject of urban flood risk through a society-environment lens provided a much needed platform to adopt the concepts of a hazardscape and vulnerability approach. Remaining within the discipline of geography made it possible to draw from the knowledge base of urban (or human) geographers as well as physical geographers. However, since the discourse of society-environment is not confined to geographers but also sociologists and anthropologists and other disciplines, it was possible to adopt social theories and methodologies drawn from other disciplines. The livelihoods concept could be incorporated into the broader research theories because of the role of development studies to the evolution of the disaster risk field. Finally, it was also possible to utilise scientific methodologies for flood risk assessments since physical scientists have an important technical role to play in hazards studies.

All of the above facilitated an **integrated flood risk management approach**. This ensured that flood risk is not managed by focusing only on physical structural engineering measures but also considers social structural measures as well as local physical strategies. More importantly however, the transdisciplinary

nature of the disaster risk field that facilitated a society-environment lens has enabled awareness that the concept of floods is not confined to the conventional understanding of rivers overflowing their banks, dam walls bursting, or stormwater systems exceeding their capacity. Rather, floods take on forms that may be overlooked for their insignificance in terms of scale (e.g. leakage, ponding, seepage) but pose major discomfort and interruptions to poorer households. These forms of flooding occur more frequently and cannot be measured or assessed using conventional scientific models alone. An integrated flood risk management approach that forms part of a broader strategy of integrated development and environmental management planning is therefore necessary for addressing urban flood risk. In this way Pelling (2003) is correct in suggesting the importance of placing any policy to mitigate risk within the broader context of urban life, including the larger regional and global physical and human systems.

The research area of George, South Africa presented an ideal example of the nature of flood risk in cities of the developing world. Here it is shown that urban flood risk has a reciprocal relationship with urban development. Macro, meso and micro processes influence the components (i.e. social, demographic, economic, environmental and governance components) of sustainable urban development. If the influence is negative the result is poor (or unsustainable) urban development. These same urban components therefore inform the vulnerability conditions of the urban population. Through the concept of a hazardscape it becomes evident that the same urban components, because of poor development practice, also shape the form of the flood hazardscape to generate conditions of ponding, overland surface run-off, seepage, riverine/stream flooding, wetland flooding, stormwater run-off and rain leakage.

These forms of flooding cannot be adequately assessed through conventional flood simulation models. Rainfall-based models are appropriate in understanding the intensity of the rainfall event. However, these should be accompanied by

further observations, consultations and interviews for establishing more descriptive narratives of the forms of the flood hazardscape. This should also be accompanied by household livelihoods analysis to establish the vulnerability of the urban population to such forms of flooding. Cognisance of local physical and social adjustment strategies should also be factored into these assessments.

An integrated urban flood risk management approach should form part of the broader strategy of integrated development planning. This would entail the integration of relevant national, provincial, district and local government departments, private business and NGOs in the flood risk management plan. The inclusion of other stakeholders such as CBOs, local residents and minority groups, including immigrants and refugees, is necessary throughout the conceptualisation, implementation, monitoring and evaluation of such a plan. Good urban risk governance should ensure that the political will exists to initiate and implement such a plan in accordance with relevant national, provincial, district and municipal or metro legislation. Incentives and training support should be provided to local government personnel to encourage such a political will. The flood risk management plan should consider transboundary issues in which the entire watershed is considered. This would require negotiations and planning with other municipalities, districts, provinces or countries if the watershed cross-cuts such boundaries. Finally, the flood risk management plan should be informed by a comprehensive flood risk assessment. The flood risk assessment would therefore include a damage assessment of past events in order to identify the most vulnerable areas. This should be followed by a hazardscape and vulnerability analysis of the most vulnerable areas that also considers issues of physical and social adjustments. The flood risk assessment should ideally involve the participation of the local communities. In this way the flood risk management plan should include appropriate and up-to-date mitigation, preparedness, response and recovery strategies.

## Bibliography

- Abarquez, I. and Murshed, Z. 2004. *Community Based Disaster Risk Management: Field Practitioner's Handbook*. ADPC: Bangkok
- ActionAid. 2007. *Unjust Waters. Climate Change, Flooding and the Protection of Poor Urban Communities: Experience from six African Cities*. ActionAid International. URL: [http://www.actionaid.org.uk/doc\\_lib/unjust\\_waters.pdf](http://www.actionaid.org.uk/doc_lib/unjust_waters.pdf)
- Adam, B. and van Loon, J. 2000. 'Introduction: Repositioning Risk; the Challenge for Social Theory', *The Risk Society and Beyond: Critical Issues for Social Theory*, B. Adam, U. Beck and J. van Loon (eds.). SAGE Publications: London, pp 1-31
- ADPC. 2001. *Lessons Learned from Community Based Flood Mitigation and Preparedness Project in Cambodia*, AUDMP Working Paper No. 3. Prepared by the Cambodian Red Cross, IFRC, Pact Cambodia
- ADPC. 2005. *A Primer: Integrated Flood Risk Management in Asia 2*. ADPC and UNDP.
- Alam, K., Herson, M., O'Donnel, I. 2008. *Flood Disasters: Learning from Previous Relief and Recovery Operations*. Provention Consortium and ALNAP
- Alam, M. and Rabbani, G. 2007. *Vulnerabilities and Responses to Climate Change for Dhaka, Environment and Urbanization*, 19 (1): 81-97
- Alexander, D. 1993. *Natural Disasters*. UCL Press: London
- Alexander, D. 2000a. *Confronting Catastrophe: New Perspectives on Natural Disasters*. Oxford University Press: New York
- Alexander, W.J.R. 2000b. *Flood Risk Reduction Measures*. University of Pretoria: Pretoria
- Allanson, B.R. and Whitfield, A.K. 1983. *The Limnology of the Touw River Floodplain*. South African National Scientific Programmes Report No. 79
- Alwang, J. Siegel, P.B. and Jorgensen, S.L. 2001. 'Vulnerability: A View from Different Disciplines', in *Social Protection: Labour Markets, Pensions, Social Assistance*. Discussion Paper No. 0115, June 2001. The World Bank
- Barrett, C.B. and Carter, M.R. 2005. *Risk and Asset Management in the Presence of Poverty Traps: Implications for Growth and Social Protection*. Background note prepared for the World Bank/DFID project, 'Linking Social Protection and Growth: Concepts, Assessing Empirical Evidence, Developing the Future Agenda'. Workshop in Leuven, Belgium, June 23-24, 2005
- Barrows, H. 1923. 'Geography as human ecology', in *Geographic Perspectives on Urban Systems*. Prentice-Hall: Englewood Cliffs, N.J

- Beatley, T. 1998. 'The Vision of Sustainable Communities', in *Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities*, R.J. Burby (ed). Joseph Henry Press: Washington, D.C.
- Benjamin, M.A. 2005. *The Concatenating Nature of Health Risk to Primary School Aged Children in the Informal Settlement of Masiphumelele*. Unpublished Honours Thesis. University of Cape Town.
- Berrisford, S. 1999. 'Redistribution of land rights in South Africa: simply a rural question?', Paper presented at the 6<sup>th</sup> Law and Urban Space Workshop. International Research Group on Law and Urban Space. (IRGLUS)/ Centre for Applied Legal Studies, Wits University, Johannesburg, 29-30 July 1999
- Blaikie, P. 1999. 'A Review of Political Ecology', in *Zeitschrift fur Wirtschaftsgeographie*, 43 (1999): 131-147
- Blaikie, P., Cannon, T., Davies, I. and Wisner, B. 1994. *At Risk: Natural Hazards, People's Vulnerability and Disasters*. Routledge: New York
- Bond, P. 1997. 'The Housing Question Revisited: 'Blacks like shacks', say SA's corporate liberal intelligentsia', *Debate*, No 3: 89-117
- Bookchin, M. 1990. *The Philosophy of Social Ecology: Essays on Dialectical Naturalism*. Black Rose Books: Montreal
- Boonzaier, E., Malherbe, C., Smith, A. and Berens, P. 1996. *The Cape Herders: A History of the Khoikhoi of Southern Africa*. David Phillip: Cape Town
- Brouwer, R. and Nhassengo, J. 2006. 'About Bridges and Bonds: Community Response to the 2000 Floods in Mabalane District, Mozambique', in *Disasters*, 30 (2): 234-255
- Brown, J.C. and Purcell, M. 2005. 'There's nothing inherent about scale: political ecology, the local trap, and the politics of development in the Brazilian Amazon', in *Geoforum*, 36 (2005): 607-624
- Bruhn, J.G. 1972. 'Human Ecology: A Unifying Science?', in *Human Ecology*, 2 (2): 105-125
- Bryant, E.A. 1991. *Natural Hazards*. Cambridge University Press: Cambridge
- Bryant, R.L. 1992. 'Political Ecology –an Emerging Research Agenda in Third-World Studies', in *Political Geography*, 11 (1): 12-36
- Bryant, R.L and Bailey, S. 1997. *Third World Political Ecology*. Routledge: Oxon
- Bryant, R.L. and Jarosz, L. 2004. 'Introduction: thinking about ethics in political ecology', *Ethics in Political Ecology: A special issue of Political Ecology*, in *Political Geography*, 23 (2004): 807-812
- Bull-Kamanga, L., Diagne, K., Lavell, A., Leon, E., Lerise, F., MacGregor, H., Maskrey, A., Meshack, M., Pelling, M., Reid, H., Satterthwaite, D., Songsore, J.,

- Westgate, K., and Yitambe, A. 2003. 'From Everyday Hazards to Disasters: the Accumulation of Risks in Urban Areas', *Environment and Urbanization*, 15 (1)
- Burgman, M. 2005. *Risks and Decisions for Conservation and Environmental Management*. Cambridge University Press: Cambridge
- Burton, I. 1983. 'Foreword', in *Interpretations of Calamity*, Kenneth Hewitt (ed.). Allen and Unwin: Winchester, Mass., pp v-vi
- Burton, I. and Hewitt, K. 1974. 'Ecological dimensions of Environmental hazards', in *Human Ecology*, F. Sargent (ed.). Amsterdam: North-Holland, pp 253-283
- Burton, I., Kates, R.W. and White, G.F. 1978. *The Environment as Hazard*. Oxford University Press: New York
- Burton, I., Kates, R.W. and White, G.F. 1993. *The Environment as Hazard*. The Guilford Press: New York
- Cannon, T. 1994. 'Vulnerability Analysis and the Explanation of 'Natural' Disasters', in *Disasters, Development and Environment*, Ann Varley (ed.). John Wiley and Sons: Chichester
- Caplan, P. 2000. 'Introduction: Risk Revisited', *Risk Revisited*, P. Caplan (ed.). Pluto Press: London, pp 1-28
- Carr, L.J. 1932. 'Disaster and the sequence-pattern concept of social change', in *American Journal of Sociology*, 38: ??
- Chambers, R. and Conway, G. 1992. *Sustainable Rural Livelihoods: Practical Concepts for the 21<sup>st</sup> Century*. IDS Discussion Paper No. 296. Brighton, UK: IDS (Institute for Development Studies), University of Sussex
- Christie, F. and Hanlon, J. 2001. *Mozambique and the Great Flood of 2000*. James Currey: Oxford
- City of Cape Town. 2003. *Salt River Floodline and Danger Line Determination*, (A part of phase 2 of the Salt River Hydrological Study). Directorate: Transport, Roads and Stormwater. Branch: Catchment, Stormwater and River Management. City of Cape Town Project No's. WR 2/2000 and CSRM 020530 BN; Ninham Shand Report No. 3273/8453
- City of Cape Town. 2004. *Salt River Catchment: Quantification of Flood Risk and Evaluation of Ameliorative Measures*. Directorate: Transport, Roads and Stormwater. Branch: Catchment, Stormwater and River Management. Ninham Shand Report No. 3718/400582
- CSIR. 1994. *Guidelines for the Provision of Engineering Services and Amenities in Residential Township Development: A Management Companion*. CSIR: Pretoria

- CSIR. 2003. *Guidelines for Human Settlement Planning and Design*. CSIR: Pretoria
- Coetzee, E. 2002. 'Urban Vulnerability: A Conceptual Framework', *Urban Vulnerability: Perspectives from Southern Africa*, Nomdo, Christina and Erika Coetzee (eds.). Periperi Publications: Cape Town
- Davies, B. and Day, J. 1998. *Vanishing Waters*. University of Cape Town Press: Cape Town
- Davies, M., Guenther, B., Leavy, J., Mitchell, T., Tanner, T. 2008. *Climate Change Adaptation, Disaster Risk Reduction and Social Protection: Complementary Roles in Agriculture and Rural Growth?* Institute of Development Studies
- Deacon, H.J and Deacon, J. 1999. *Human Beginnings in South Africa: Uncovering the Secrets of the Stone Age*. David Phillip: Cape Town
- de Satgè, R. 2004. 'Livelihoods Analysis and the Challenges of Post-Conflict Recovery', *Supporting Sustainable Livelihoods: A Critical Review of Assistance in Post-Conflict Situations*, Jenny Clover and Richard Cornwell (eds.). Institute for Security Studies, August 2004 (102)
- de Satgè, R., Holloway, A., Mullins, D., Nchabaleng, L., Ward, P. 2002. *Learning about Livelihoods: Insights from southern Africa*. Periperi/Oxfam: Cape Town/Oxford
- Devereux, S. and Sabates-Wheeler, R. 2004. *Transformative Social Protection*, in IDS Working Paper 232, October 2004. Institute of Development Studies: Brighton
- Dewar, D., Todes, A., and Watson, V. 1982. *Theories of Urbanization and National Settlement Strategy in South Africa*, Project Report, Working Paper No. 21, Occasional Paper 8. Urban Problems Research Unit: University of Cape Town
- Dietz, T. 1999. 'Radical Human Ecology', in *Human Ecology Review*, 6 (2): 99
- DiMP. 2003. *March 2003 Cut-off Low: Consolidated Report*, Prepared for the Department of Social Services and Poverty Alleviation of the Provincial Government of the Western Cape. Co-financed by the United Nations Food and Agriculture Organisation and the Provincial Development Council of the Western Cape. Disaster Mitigation for Sustainable Livelihoods Programme (DiMP), University of Cape Town, October 2003.
- DiMP. 2004. *Disaster Debriefing –December 2004 Cut off Low*
- DiMP. 2005a. *August 2004 Severe Storm Post Flood Assessment*, Prepared for Directorate of Transport, Roads and Stormwater, City of Cape Town. Prepared by the Disaster Mitigation for Sustainable Livelihoods Programme (DiMP), University of Cape Town, May 2005.

- DiMP. 2005b. *International Workshop on Community Risk Assessment*, 31 May – 2 June, 2005, Cape Town. DiMP and Provention Consortium
- DiMP. 2007. *Severe Weather ... Compound Disaster: August 2006 cut-off lows and their consequences in the Southern Cape, South Africa*. Prepared for the National Department of Public Works and Transport and the Department of Local Government and Housing for the Western Cape. Available at: <http://www.egs.uct.ac.za/publications.html>
- DiMP. 2008. *Weathering the Storm: Participatory Risk Assessment and Planning for Informal Settlements in the Western Cape*.
- Domeisen, N. 1997. *Water: Too much ... Too little ... Leading Cause of Natural Disasters*. UN-IDNDR and QUIPNET Internet Conference 1997: Floods, Drought, Issues for the 21<sup>st</sup> Century: 22 September – 24 October 1997
- Drakakis-Smith, D. 1996. 'Sustainability, Urbanisation and Development', *Third World Planning Review*, 18 (4): iii-x
- Drowley, M. 2007. *Analysis of Land-Use Changes in the Knysna River Catchment and the Associated Flood Risks: A Focus on the Salt River*. Unpublished Honours Thesis. University of Cape Town
- Durham, C. 2007. *Riverine Flood Risk Reduction in the Western Cape: A Case Study of the Baths River*. Unpublished Masters Thesis. University of Cape Town
- ECLAC. 2003. *Handbook for Estimating the Socio-Economic and Environmental Effects of Disasters*, Volumes 1-4. Joint Publication by the UN, ECLAC and The World Bank
- Furedi, F. 2007. 'The Changing Meaning of Disaster', in *Area*, 39 (4): 482-489
- Gao, F. 2008. 'Is Management Science or Art?', *Systems and Behavioural Science*, 25(1): 125-136
- Gary, S. 1997. 'An Assessment of Disaster Risk and its management in Thailand', in *Disasters*, 27 (1): 77-88
- Geis, D. 2001. 'By Design: The Disaster Resistant and Quality of Life Community', *Natural Hazards Review*, 1 (3): 151-160
- George LED. Undated. 'Historical Background', <http://www.george.org.za/LED.htm> (7 July 2007)
- George Municipality. 2002. *George Municipality Integrated Development Plan*, Prepared by Octagonal Development
- George Municipality. 2006. *George Municipality Draft Revised 2006/2007 IDP*, Volume "O": The 2006/7 Review Process, Prepared by the Department of Corporate Services: Strategic Services Branch and assisted by Octagonal Development

- Goldstein, B.F. 2008. 'Skunkworks in the Embers of the Cedar Fire: Enhancing Resilience in the Aftermath of Disaster', in *Human Ecology*, 36 (2008): 15-28
- Goodlad, R. 1996. 'The Housing Challenge in South Africa', *Urban Studies*, 33 (9): 1629-1645
- Guha-Sapir, D. 2008. 'Disaster Data: A Balanced Perspective', *CRED Crunch*, 11 (January 2008). Available at [www.em-dat.net](http://www.em-dat.net)
- Hall, P. 2007. 'Early Warning Systems: Reframing the Discussion', *The Australian Journal of Emergency Management*, 22 (2): 32-36
- Hardoy, J.E., Mitlin, D., Satterthwaitte, D. 2001. *Environmental Problems in an Urbanizing World*. Earthscan: London
- Helman, C.G. 2001. *Culture, Health and Illness*. Arnold: London
- Hens, L. and Devuyt, D. 1994. 'Human Ecology: The European Perspective', in *Human Ecology Review*, 1 (2): 326-334
- Hewitt, K. (ed.). 1983. *Interpretations of Calamity*. Allen and Unwin: Winchester, Mass
- Hewitt, K. 1997. *Regions of Risk: A Geographical Introduction to Disasters*. Addison Wesley Longman: Essex
- Hjort, L. and Ramadiro, B. 2004. 'A Long Walk to Nowhere –Ten Years of Democracy in South Africa', South Africa, March 2004. Published in Swedish in the Swedish Marxist quarterly *Roda Rummet*, No. 1, 2004. <http://www.aidc.org.za/?=book/print/585> (9 May 2007)
- Huchzermeyer, M. 2001. 'Housing for the Poor? Negotiated Housing Policy in South Africa', *Habitat International*, 25: 303-331
- Huq, S., Kovats, S., Reid, H. and Satterthwaitte, D. 2007. 'Editorial: Reducing Risks to Cities from Disasters and Climate Change', *Environment and Urbanization*, 19 (1): 3-15
- ICOLD (International Commission on Large Dams). 1992. *Selection of Design Flood –Current Methods*. ICOLD: Paris
- IFRC. 1999. *World Disasters Report 1999*. IFRC: Geneva
- IFRC. 2004. *World Disasters Report*. Walter, L (ed). IFRC: Geneva
- IPCC. 2002. *The Third Assessment Report*. Published by WMO and UNEP
- IPCC. 2007. *The Fourth Assessment Report*. Published by WMO and UNEP
- Kammeier, H.D. 2002. *Rural-Urban Linkages and the Role of Small and Medium-sized Towns in Development: Issues, Concepts and Policies*. Workshop on Poverty Alleviation Through Rural-Urban Linkages: The Role of

Small and Medium-sized Towns, 16-18 September 2002, Siem Reap, Cambodia. ESCAP/ UN-HABITAT

Kates, R.W. 1978. *Risk Assessment of Environmental Hazard*. SCOPE report 8. New York: John Wiley

Kunreuther, H. 1995. 'Voluntary Siting of Noxious Facilities: The Role of Compensation', *Fairness and Competence in Citizen Participation: Evaluating New Models for Environmental Discourse*, O. Renn, T. Webler and P. Wiedemann (eds). Kluwer: Boston, pp 283-295

Lee, S.Y., Dunn, R.J.K, Young, R.A, Connolly, R.M, Dale, P.E.R, Dehayr, R., Lemckert, C.J, Mckinnon, S., Powell, B., Teasdale, P.R, and Welsh, D.T. 2006. 'Impact of Urbanization on Coastal Wetland Structure and Function', *Austral Ecology*, 31 (2): 149-163

Lehulere, O. 1997. 'The Political Significance of GEAR', *Debate*, No. 3: 73-88

Lewens, T. 2007. 'Introduction: Risk and Philosophy', *Risk: Philosophical Perspectives*, T. Lewens (ed.). Routledge: Oxon, pp 1-20

Lewis, D. and Mioch, J. 2005. 'Urban Vulnerability and Good Governance', *Journal of Contingencies and Crisis Management*, 13 (2): 50-53

Lewis, J. 1999. *Development in Disaster-prone Places: Studies of Vulnerability*. Intermediate Technology Publications: London

Lewis, D. and Mioch, J. 2005. 'Urban Vulnerability and Governance', *Journal of Contingencies and Crisis Management*, 13 (2): 50 - 53

Lourens, P. 2007. 'Floods Ravage SC', *George Herald*, 29 November 2007

Lupton, D. 1999. 'Introduction: Risk and Sociocultural Theory', *Risk and Sociocultural Theory: New Directions and Perspectives*, D. Lupton (ed.). Cambridge University Press: Cambridge, pp 1-11

Mackay, C.J. 1999. 'Housing Policy in South Africa', *Housing Studies*, 14 (3): 387-399

Manyena, S.B. 2006. 'The Concept of Resilience Revisited', in *Disasters*, 30 (4): 433-450

Maposa, S. 2008. 'Choo Tjoe's future uncertain as fight to save the rail line goes on', *Cape Argus*, 13 March 2008

McEntire, D.A. 2004. *The Status of Emergency Management Theory: Issues, Barriers, and Recommendations for Improved Scholarship*. Paper presented at the FEMA Higher Education Conference, June 8, 2004, Emmitsburg, MD

Mgquba, S.K., 2002. *The Physical and Human Dimensions of Flood-Risk: The Case of the West Bank, Alexandria Township*. Unpublished Masters Thesis. University of the Witwatersrand

Midgely, G.F., Chapman, R.A., Hewitson, B., Johnston, P., De Wit, M., Ziervogel, G., Mukheibir, P., Van Niekerk, L., Tadross, M., Van Wilgen, B.W., Kgope, B., Morant, P.D., Theron, A., Scholes, R.J., Forsyth, G.G. 2005. *A Status Quo, Vulnerability and Adaptation Assessment of the Physical and Socio-Economic Effects of Climate Change in the Western Cape*, CSIR Report No. ENV-S-C 2005-073. CSIR Environmentek: Stellenbosch

Mileti, D.S. 1980. 'Human adjustment to the risk of environmental extremes', in *Sociology and Social Research*, 64: 327-47

Mileti, D.S. 1999. 'A Sustainability Framework for Natural and Technological Hazards', in *Disasters by Design: A Reassessment of Natural Hazards in the United States*. Joseph Henry Press: Washington, D.C: 17-39

Miller, J.B. 1997. *Floods: People at Risk, Strategies for Prevention*. United Nations: New York and Geneva

Mkwananzi, N and Pegram, G.G.S. 2004. *A Flood Nowcasting System for the eThekweni Metro*, Volume 2: Modelling Flood Inundation in the Mlazi River under Uncertainty. WRC Report No. 1217/2/04

Moench, M. and Dixit, A. (eds). 2007. *Working with the Winds of Change: Towards Strategies for Responding to the Risk Associated with Climate Change and Other Hazards*. Provention Consortium, Institute for Social and Environmental Transition-International and Institute for Social and Environmental Transition-Nepal: Kathmandu

Morduch, J. and Sharma, M. 2002. 'Strengthening Public Safety Nets from the Bottom Up', in *Development Policy Review*, 20 (5): 569-588

Muldavin, J. 2008. 'The time and place for political ecology: An introduction to the articles honoring the life-work of Piers Blaikie', in *Geoforum*, 39 (2008): 687-697

Munich Re. 1997. *Annual Review of Natural Catastrophe, 1997*. Munich Re Group: Munich

Munich Re. 1998. *Annual Review of Natural Catastrophe, 1998*. Munich Reinsurance Company: Munich

Mustapha, D. 2005. 'The Production of an Urban Hazardscape in Pakistan: Modernity, Vulnerability, and the Range of Choice', in *Annals of the Association of American Geographers*, 95 (3): 566-586

Myburgh, D.W. 1991. *Geographical Perspectives on the Drought and Flood Hazard in the Arid and Semi-Arid Region of the Cape Province*. Unpublished PhD Thesis. University of Cape Town

Nchito, W.S. 2007. 'Flood Risk in Unplanned Settlements in Lusaka', *Environment and Urbanization*, 19 (2): 539-551

O'Brien, G., O'Keefe, P., Rose, J., Wisner, B. 2006. 'Climate Change and Disaster Management', *Disasters*, 30 (1): 64-80

Office of the Premier. 2007. *Report to Cabinet: Status of Floods Which Occurred in the Cape Winelands, Overberg, Eden and Central Karoo District Municipal Areas on 19-24 November 2007*. File: LG /2/3/2/K3/K17/K22/K28, Department of Local Government and Housing

O'Keefe, P. 1975. *African Drought: A Review*, Disaster Research Unit, occasional paper no. 8, University of Bradford

Oldfield, S. 2000. 'The Centrality of Community Capacity in State Low-Income Housing Provision in Cape Town, South Africa', *International Journal of Urban and Regional Research*, 24 (4): 858-872

Oliver-Smith, A. and Hoffman, S.M. 2002. 'Introduction: Why Anthropologists Should Study Disasters', in *Catastrophe and Culture: The Anthropology of Disaster*, Susanna M. Hoffman and Anthony Oliver-Smith (eds.). School of American Research Press: Santa Fe, pp 3-22

Parker, D. (ed). 2000. *Floods*, 2 Vols. Routledge: London

Parnell, S. and Hart, D. 1999. 'Self-help Housing as a Flexible Instrument of State Control in 20<sup>th</sup>-century South Africa', *Housing Studies*, 14 (3): 367-386

Pegram, G.G.S and Sinclair, D.S. 2002. *A Linear Catchment Model for Real Time Flood Forecasting*. WRC Report No. 1005/1/02

Pegram, G., Sinclair, S., Parak, M., Sakulski, D., Nxumalo, N. 2007. *National Flood Nowcasting System: Towards an Integrated Mitigation Strategy*. WRC Report No. 1429/1/06

Pelling, M. 1997. 'What Determines Vulnerability to Floods: A Case Study in Georgetown, Guyana', *Environment and Urbanization*, 9 (1): 203-226

Pelling, M. 1998. 'Participation, Social Capital and Vulnerability to Urban Flooding in Guyana', *Journal of International Development*, 10: 469-486

Pelling, M. 1999. 'The Political Ecology of Flood Hazard in Urban Guyana', *Geoforum*, 30: 249-261

Pelling, M. 2003. *The Vulnerability of Cities: Natural Disasters and Social Resilience*. Earthscan: London

Pelling, M. 2007. 'Learning from others: scope and challenges for participatory disaster risk assessment', *Disasters*, 31(4): 373-385

Pilgrim, D.H. and Cordery, I. 1993. 'Chapter 9: Flood Run-off', *Handbook of Hydrology*. McGraw-Hill: New York

- Pratt, J., Holton, B. and Starr, P. 1994. 'Human Ecology in Practice: Trends in Environmental Consulting', in *Human Ecology Review*, 1 (2): 320-325
- Puzon-Diopenes, V. and Murshed, Z. 2006. *Media Kit: Community-Based Disaster Risk Management and the Media*. ADPC: Bangkok
- Pyle, D.M. 2006. *Severe Convective Storm Risk in the Eastern Cape Province of South Africa*. Thesis submitted in fulfillment of the requirements for the degree of Doctor of Philosophy at Rhodes University
- Rahman, A., Hoang, T.M.T., Weinmann, P.E. and Laurenson, E.M. 1998. *Joint Probability Approaches to Design Flood Estimation: A Review*. Report 98/8. Cooperative Research Centre for Catchment Hydrology. Monash University, Clayton, Victoria, Australia
- Ramadier, T. 2004. 'Transdisciplinarity and its challenges: the case of urban studies', in *Futures*, 36 (4): 423-439
- Rashid, S.F. 2000. 'The Urban Poor in Dhaka City: Their Struggles and Coping Strategies during the Floods of 1998', *Disasters*, 24 (3): 240-53
- Renn, O. 2008. *Risk Governance: Coping with Uncertainty in a Complex World*. Earthscan: London
- Robbins, P. 2003. 'Political Ecology in Political Geography', *Political Geography*, 22 (2003): 641-645
- Robbins, P. 2004. *Political Ecology: A Critical Introduction*. Blackwell Publishing: Malden, MA
- Rocheleau, D.E. 2008. 'Political Ecology in the Key of Policy: From Chains of Explanation to webs of Relation', in *Geoforum*, 39 (2008): 716-727
- Rogerson, C.M. 1996. 'Urban Poverty and the Informal Economy in South Africa's Economic Heartland', *Environment and Urbanization*, 8 (1): 167-181
- Satterthwaite, D., Huq, S., Pelling, M., Reid, H. and Lankao, P.R. 2007. *Adapting to Climate Change in Urban Areas: The Possibilities and Constraints in low- and middle-income nations*. Human Settlements Discussion Paper Series, Theme: Climate Change and Cities –1. IIED: London
- SAWS. 2007  
[http://www.weathersa.co.za/fcastProducts/LongRange/EyeBall/Images/Longrange\\_Forecasting\\_Information\\_System.pdf](http://www.weathersa.co.za/fcastProducts/LongRange/EyeBall/Images/Longrange_Forecasting_Information_System.pdf) (14 August 2007)
- Scheuren, J.M., le Polain, O., Below, R., Guha-Sapir, D., Ponserre, S. 2008. *Annual Disaster Statistical Review: The Numbers and Trends 2007*. CRED: Brussels
- Scott, P. and Benjamin, A. 2005. *Let the Children be Heard: Masiphumelele Community Risk Assessment*. Community Risk Assessment completed as

partial fulfillment of the Disaster Risk Science I course in the Department of Environmental and Geographical Science, University of Cape Town

SEI/ASCE. 2000. *ASCE Standard: Flood Resistant Design and Construction*. American Society of Civil Engineers: Reston, Virginia

SEI/ASCE. 2000. *ASCE Standard: Flood Resistant Design and Construction*. American Society of Civil Engineers: Reston, Virginia

Sen, A. 1981. *Poverty and Famines*. Oxford University Press: Oxford

Sime, J. and Jones-Horlick, T. 2004. 'Living on the Border: Knowledge, Risk and Transdisciplinarity', in *Futures*, 36 (4): 441-456

Sinclair, D.S and Pegram, G.G.S. 2004. *A Flood Nowcasting System for the eThekweni Metro*, Volume 1: Umgeni Flood Nowcasting Using Radar –an Integrated Pilot Study. WRC Report No. 1217/1/04

Skilodimou, H., Livaditis, G., Bathrellos, G., and Verikiou-Papaspiridakou, E. 2003. 'Investigating the Flooding Events of the Urban Regions of Glyfada and Voula, Attica, Greece: A Contribution to Urban Geomorphology', *Geografiska Annaler*, 85A (2): 197-204

Smith, K. 2004. *Environmental Hazards: Assessing Risk and Reducing Disaster*. Routledge: London

Smithers, J.C. and Schulze, R.E. 2003. *Design Rainfall and Flood Estimation in South Africa*. WRC Report No 1060/1/03

Sowman, M. and Urquhart, P. 1998. *A Place Called Home: Environmental Issues and Low-Cost Housing*. University of Cape Town Press: Cape Town

SRK. 2006. *Developing a Disaster Management Plan and Conducting a Risk Assessment for the Eden District Municipality (EDM)*. Report prepared for the Eden District Municipality, Disaster Management Centre. Report No. 364231, December 2006

StatsSA. 2001. South African Census 2001. [www.statsa.gov.za](http://www.statsa.gov.za) (2 July 2007)  
Stephenson, D. 2002. 'Integrated Flood Plain Management Strategy for the Vaal', *Urban Water*, 4 (2002): 425-430

Stern, N. 2006. *Stern Review on the Economics of Climate Change*. Cambridge

Susman, P., O'Keefe, P. and Wisner, B. 1983. 'Global disasters: a radical interpretation', in *Interpretations of Calamity*, Kenneth Hewitt (ed.). Allen and Unwin: Winchester, Mass, pp. 263-283

Swift, J. 1989. 'Why are Rural People Vulnerable to Famine?', in *IDS Bulletin*, 20 (2): 815

Swilling, M., R. Humphries and K. Shubane (eds.). 1991. *Apartheid City in Transition*. Oxford University Press: Cape Town

Taljaard, J.J. 1995. *Atmospheric Circulation Systems, Synoptic Climatology and Weather Phenomena of South Africa. Part 3: The Synoptic Climatology of South Africa in January and July*. Department of Environmental Affairs and Tourism – Weather Bureau, Technical Paper No. 29, November 1995. Government Printer: Pretoria

Taljaard, J.J. 1996. *Atmospheric Circulation Systems, Synoptic Climatology and Weather Phenomena of South Africa. Part 5: Temperature Phenomena in South Africa*. Department of Environmental Affairs and Tourism –Weather Bureau, Technical Paper No. 31, August 1996. Government Printer: Pretoria

Thomas, W.H. 2005. *George Local Economic-Development Strategy: Background Report on the Local Economy and its Challenges*. Report Prepared for the George Municipality by the MCA Senzenina Consortium

Thompson, L. 2001. *A History of South Africa*. Jonathan Ball Publishers: Johannesburg

Thompson, P.M. and Sultana, P. 2000. 'Shortcomings of Flood Embankment Strategies in Bangladesh', *Floods* (vol. 1), D.J. Parker (ed.). Routledge: London

Tierney, K. 2006. 'Social Inequality, Hazards, and Disasters', *On Risk and Disasters: Lessons from Hurricane Katrina*, R.J. Daniels, D.F. Kettl and H. Kunreuther (eds.). University of Pennsylvania Press: Philadelphia

Tipple, G. 2005. 'Housing and Urban Vulnerability in Rapidly-Developing Cities', *Journal of Contingencies and Crisis Management*, 13 (2): 66-75

Tobin, G.A and Montz, B.E. 1997. *Natural Hazards: Explanation and Interpretation*. The Guilford Press: New York

Tomlinson, M.R. 2007. 'The development of a low-income housing finance sector in South Africa: Have we finally found a way forward?', *Habitat International*, 31: 77-86

Tschoegl, L., Below, R., Guha-Sapir, D. 2006. *An Analytical Review of Selected Data Sets on Natural Disasters and Impacts*. UNDP/CRED Workshop on Improving Compilation of Reliable Data on Disaster Occurrence and Impact, March-April, 2006, Bangkok, Thailand. CRED: Brussels

Twigg, John and Mihir R. Bhatt (eds). 1998. *Understanding Vulnerability: South Asian Perspectives*. Intermediate Technology Publications: London

Tyson, P.D. and Preston-Whyte, R.A. 2000. *The Weather and Climate of Southern Africa*. Oxford University Press: Cape Town

UNDMTP. 1994. *Disaster Preparedness*. UNDP/DHA: New York, Geneva

UNDP. 2004. *Reducing Disaster Risk: A Challenge for Development*. UNDP: New York

UN/ISDR. 2004a. *Disaster Risk Reduction: 1994-2004*. 3 part CD

UN/ISDR. 2004b. *Living with Risk: A Global Review of Disaster Reduction Initiatives*. 2004 Version, Vol. 1, United Nations: Geneva

UN/ISDR. 2005a. *Hyogo Framework for Action 2005 – 2015 : Building the Resilience of Nations and Communities to Disasters*, World Conference on Disaster Reduction: 18-22 January 2005, Kobe, Hyogo, Japan. Available at: <http://www.unisdr.org>

UN/ISDR. 2005b. *Progress Report on the Matrix of Commitment and initiatives to support the implementation of the Hyogo Framework*. IATF/DR-12/inf.11 (Revised). Available at: <http://www.unisdr.org>

UN/ISDR. 2007a. *United Nations Documents Related to Disaster Reduction 2003 – 2005*, 3 (April 2007)

UN/ISDR, 2007b. *Words Into Action: A Guide for Implementing the Hyogo Framework*. United Nations: Geneva

USGS. 2004. *Water Glossary of Terms*. United States Geological Survey. Available at: <http://ga.water.usgs.gov/edu/dictionary.html>

van Bladeren, D., Zawada, P.K., Mahlangu, D. 2007. *Statistical Based Regional Flood Frequency Estimation Study for South Africa Using Systematic, Historical and Palaeoflood Data*. WRC (Water Research Commission) Report No 1260/1/07

Varley, Ann (ed.). 1994. *Disasters, Development and Environment*. John Wiley and Sons: Chichester

Viljoen, M.F., du Plessis, L.A., Booyesen, H.J., Weepener, H.L., Braune, M., van Bladeren, D., Butler, M. 2001. *Flood Damage Management Aids for Integrated Sustainable Development Planning in South Africa*. Report to the Water Research Commission. WRC Report No 889/1/01

Vogel, C. 1992. 'The South African environment: horizons for integrating physical and human geography', in *Geography in a Changing South Africa: Progress and Prospects*, Christian Rogerson and Jeffrey McCarthy (eds.). Oxford University Press: Cape Town, pp 173-185

Walton, C (ed.). 1984. *Reader's Digest Atlas of Southern Africa*. Produced in conjunction with the Directorate of Surveys and Mapping, and Department of Community Development

Warhurst, A. 2006. *Disaster Prevention: A Role for Business? An Exploration of the Business Case for Reducing Natural Disaster Risk in Developing Countries and for Establishing Networks of Disaster Prevention Partnerships*. A joint publication by Maplecroft and Provention Consortium

Watts, M. 1983a. 'On the Poverty of Theory: Natural Hazards research in Context', in *Interpretations of Calamity*, Kenneth Hewitt (ed.). Allen and Unwin: Winchester, Mass

Watts, M. 1983b. *Silent Violence: Food, Famine and Peasantry in Northern Nigeria*. University of California Press: Berkely

WCED. 1987. *Our Common Future*. Oxford, England: Oxford University Press

White, G.F. 1945. *Human Adjustment to Floods: A Geographical Approach to the Flood Problem in the United States*. University of Chicago

White, G.F. (ed.). 1974. *Natural Hazards, Local, National, Global*. Oxford University Press: New York

White, G.F. and Haas, J.E. 1975. *Assessment of Research on Natural Hazards*. M.I.T Press: Cambridge, MA

WHO. 1996. *World Health*, 2 (March-April 1996)

WHO. 2002. *Environmental Health in Emergencies and Disasters*. Panamerican Health Organization. Available at: [http://www.disaster-info.net/watermitigation/i/publications/EnvDisaster/index\\_en.html](http://www.disaster-info.net/watermitigation/i/publications/EnvDisaster/index_en.html) (December, 2005)

Wisner, B. 1976. *Man-made Famine in Eastern Kenya: The Interrelationship of Environment and Development*, IDS discussion paper no. 96, IDS, Brighton

Wisner, B. 1978. 'Does radical geography lack an approach to environmental relations?', in *Antipode*, 10: 84-95

Wisner, B. 2001. 'Risk and the Neoliberal State: Why Post-Mitch Lessons Didn't Reduce El Salvador's Earthquake Losses', *Disasters*, 25 (3): 251 - 268

Wisner, B., Blaikie, P., Cannon, T. and Davis, I. 2004. *At Risk: Natural Hazards, People's Vulnerability and Disasters*. Routledge: New York

WMO. 1999. *Comprehensive Risk Assessment for Natural Hazards*. WMO/TD No. 955. Geneva, WMO

Zevenbergen, C. 2007. *Adapting To Change: Towards Flood Resilient Cities*. Inaugral Address by Chris Zevenbergen in Delft, The Netherlands, December 14, 2007. UNESCO-IHE (Institute for Water Education)

Zimmerer, K. 1993. 'Ecology', in *Concepts in Human Geography*, C. Earle and M. Kenter (eds.). Lanham: Maryland, pp 161-188

#### South African Legislation:

Municipal Services Act (Act 32 of 2000)

National Building Regulations and Building Standards Act (Act 103 of 1977)

National Disaster Management Act (Act 57 of 2002)

National Disaster Management Framework 2005  
National Water Act (Act 36 of 1998)  
South African Weather Services Act (Act 8 of 2001)  
Town Planning and Townships Ordinance (Ordinance 15 of 1986)  
Water Research Act (Act 34 of 1971)

Websites:

<http://www.dartmouth.edu/~floods/> (31 July 2008)

[www.egs.uct.ac.za](http://www.egs.uct.ac.za)

[www.un.org/millenniumgoals](http://www.un.org/millenniumgoals)

<http://www.who.int/en/>

<http://www.wrc.org.za>

<http://www.knysna.com/content/view/71/159/> (9 July 2007)

Oudtshoorn Information. Undated.

<http://www.oudtshoorninfo.com/attractions.php?id=86&category=104> (15 August 2007)

Provention Consortium. [www.proventionconsortium.org](http://www.proventionconsortium.org)

Western Cape Department of Local Government. <http://www.thedplg.gov.za>. (7 July 2007)

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## Annex 2

### Socio-Economic Data for George

**Table 6.2 George Municipal Area – Population and household demographics for 2001 to 2015 by gender and race**

	Coloured	African	White	Total	%
<b>2001 Census</b>					
Male	32 905	18 971	14 410	66 286	48.9
Female	35 663	17 964	15 493	69 120	51.1
Total	68 568	36 935	29 903	135 406	100
Percentage (%) Share	50.6	27.3	22.1	100	N/A
Number of households	14 443	10 609	10 466	35 518	N/A
Average size of households	4.7	3.5	2.8	3.8	N/A
<b>Estimate 2005</b>					
Total	75 900	50 300	33 800	160 000	N/A
Percentage (%) Share	47.4	31.4	21.2	100	N/A
Number of households	17 400	12 900	12 500	42 800	N/A
<b>Estimate 2015</b>					
Total	88 500	78 500	38 000	205 000	N/A
Percentage Share	43.1	38.8	18.1	100	N/A
Average annual population growth (%)	1.6	4.5	1.2	2.5	N/A
Number of households	22 000	19 600	15 800	57 400	N/A

Source: StatsSA 2001 and Thomas (2005)

**Table 6.3 Age Breakdown of the Population of George by Race and Gender (2001)**

Age Group	Coloured		African		White		Total			
	No.	%	No.	%	No.	%	Male	Female	No.	%
0-14	21875	31.9	11368	30.8	5442	18.2	19498	19187	38685	28.6
15-24	12883	18.8	7391	20.0	4358	14.6	12239	12393	24632	18.2
25-54	28217	41.1	16440	44.6	12424	41.6	27661	29420	57081	42.2
55-64	3199	4.7	1121	3.0	3459	11.6	3703	4076	7779	5.7
65+	2396	3.5	606	1.6	4198	14.0	3172	4028	7200	5.3
Total	68570	100	36926	100	29881	100	66273	69104	135377	100

Source: StatsSA 2001, in Thomas (2005)

**Table 6.4 Labour Force and Employment in George by Race for 2005**

		Coloured	African	White	Total
		1	2	3	4
	Employment 2001	23 400	11 600	11 700	46 700
a)	Employment 2005	25 700	13 800	13 000	52 500
b)	Unemployment 2005	7 950	5 400	650	14 000
	Percentage	56.8	38.6	4.6	100.0
c)	Labour Force (a + b)	33 650	19 200	13 650	66 500
	Percentage	50.6	28.9	20.5	100.0
d)	Unemployment as percentage of the labour force (b/c)	23.6	28.1	4.8	21.0
e)	Population 2005	75 900	50 300	33 800	160 000
	Percentage	47.5	31.4	21.1	100.0

Source: Estimates by Thomas (2005) based on Census 2001 statistics and current population growth estimates

## Annex 2

**Table 6.5 Employment in George by Sector and Race for mid-2005**

	<b>Sector</b>	<b>Number</b>	<b>%</b>	<b>Coloured</b>	<b>African</b>	<b>White</b>
1	Agriculture	4 200	8.0	2 400	1 180	620
2	Fishing	400	0.8	260	90	50
3	Forestry	1 660	3.1	810	850	200
4	Construction	4 400	8.4	2 180	1 800	420
5	Repairs	1 000	1.9	420	270	310
6	Manufacturing	5 400	10.3	2 750	1 300	1 350
7	Water & Electricity	380	0.7	100	160	120
8	Trade	7 280	13.8	3 980	1 750	1 550
9	Tourism	6 400	12.2	2 230	1 050	3 120
10	Finance & Insurance	2 800	5.3	1 180	580	1 040
11	Business & Property Services	2 300	4.4	810	410	1 080
12	Transport, Communication & Storage	2 230	4.2	720	880	630
13	Education & Training	2 850	5.4	1 710	350	790
14	Health, Government Administration, Municipalities	3 300	6.4	1 860	660	780
15	Non-Profit & Personal Services	3 800	7.3	1 880	930	990
16	Domestic Work	4 100	7.8	2 410	1 640	50
	<b>Total Employment</b>	<b>52 500</b>	<b>100.0</b>	<b>25 700</b>	<b>13 800</b>	<b>13 000</b>

Source: Estimates by Thomas (2005) based on Census 2001 statistics and current population growth estimates

**Table 6.6 Income Distribution in George (2001)**

<b>Household Income</b>			
<b>Income Category Rand/year</b>	<b>Rand/Month</b>	<b>Number of Households</b>	<b>%</b>
Nil	0	4 905	13.7
1 – 4 800	1 – 400	1 426	4.0
4 801 – 9 600	401 – 800	4 300	12.0
9 601 – 19 200	801 – 1 600	6 526	18.3
19 201 – 38 400	1 601 – 3 200	6 526	18.3
38 401 – 76 800	3 201 – 6 400	5 529	15.5
76 801 – 153 600	6 401 – 12 800	3 491	9.8
153 601 – 307 200	12 801 – 25 600	2 051	5.7
307 201 +	25 601 +	951	2.7
		35 705	100.0
		135 408	

Source: StatsSA 2001, in Thomas (2005)

**Table 6.7 Housing-related Indicators for George Households 2001 (percentage of households)**

		<b>Coloured</b>	<b>African</b>	<b>White</b>	<b>Total</b>
	<b>No. of households</b>	<b>14 443</b>	<b>10 609</b>	<b>10 466</b>	<b>35 518</b>
1	“Proper” house on separate stand	72.0	59.5	83.6	71.7
2	Flat or cluster/town house	2.6	0.7	10.3	4.3
3	Flat or room/s in backyard or inside shared property	3.2	1.9	4.1	3.1
4	Informal dwelling in someone else’s backyard	5.7	5.0	-	3.9
5	Informal settlement	9.4	29.4	-	12.7
6	Traditional hut structure	6.5	3.3	1.2	4.0
7	<b>Basic Services</b>				
7.1	Toilet connected to sewerage system	79.5	70.0	90.4	80.0
7.2	Municipal rubbish removal at least once week	87.5	80.3	92.6	86.9

Source: StatsSA 2001, in Thomas (2005)

## Annex 2

**Table 6.8 Education Levels in George (2001)**

		Coloured		African		White		Total	
		No	%	No	%	No	%	No	%
<b>A</b>	<b>Attained level (male and female) –percentage of adults</b>								
1	No schooling	3 534	9.0	2 883	13.1	79	0.4	6 496	7.8
2	Some primary schooling	9 377	23.8	5 290	24.0	200	0.9	14 867	17.9
3	Complete primary schooling	4 074	10.3	2 110	9.6	141	0.6	6 325	7.6
4	Some secondary schooling	14 090	35.7	7 443	33.8	5 302	24.4	26 835	32.3
5	Complete high school	6 751	17.1	3 623	16.5	10 100	46.4	20 474	24.6
6	Higher education	1 619	4.1	661	3.0	5 928	27.3	8 208	9.8
<b>Total</b>		<b>39 445</b>	<b>100</b>	<b>22 010</b>	<b>100</b>	<b>21 750</b>	<b>100</b>	<b>83 205</b>	<b>100</b>
<b>B</b>	<b>Currently in education and training</b>								
1	Pre-school	833		587		427		1 847	
2	School	16 176		8 772		5 239		30 187	
3	FET College	133		72		195		400	
4	University	76		120		301		497	
5	Adult education and other	60		71		51		182	

Source: StatsSa 2001, in Thomas (2005)

### Box 6.1 Health Standards in George

- Key health facilities in the area include a regional hospital (George), two private hospitals (Geneva Clinic and George Medi-Clinic) and several clinics (Rosemoor, Parkdene, Lawaakamp, Thembaletu, Pacaltsdorp, Conville, George Central and Blanco). There are also about 80 soup kitchens and other social projects related to HIV/AIDS, teenage pregnancy as well as children's homes for orphans and street children. The two most critical social issues have been identified as HIV/AIDS and tuberculosis (TB). The infection rate for HIV/AIDS is 13 per cent in George and about 27 per cent in areas such as Thembaletu and Lawaakamp. Existing demands for social facilities are not met, largely as a result of funding constraints.
- As the largest and relatively well developed urban centre in the Southern Cape health standards of the settled George population are not significantly influenced or shaped by rural or subsistence lifestyles and dietary shortcomings. If we add the fact that George's health-care services (including the existence of a provincial hospital) are relatively well developed and accessible to all population groups, health issues do not rank as high-priority areas in the discussion of economic-development options and strategies.
- The first point made above does not deny the fact that apartheid also had its impact on the provision of health services and that the effects are in many ways still visible all around.

## Annex 2

### Box 6.1 continued...

- Being on one of South Africa's long-distance transport routes and having a relatively large migrant-transit population, the HIV-infection rate in George may be higher than the average for the Western Cape, and could well be on a path to further increase, unless the problems are attended to in a vigorous way.
- Part of George's well developed predominantly private health services have evolved because of the influx of high-income (white) (pre-) retirees into the area and the ability of that segment of the population to afford top-class facilities. George also plays an important role as regional (Southern Cape) health-service centre. These facilities are, however, not necessarily available to low-income households who need basic services.
- Health services at outlying places in the George Municipality are far less developed, in particular in rural settlements, and will, thus, need special attention in the future.
- George's health-services sector is in many ways a regional facility, with the capacity strained by much more than just local demand.

**Source: Thomas (2005: 37)**

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**Annex 3:**  
**Aerial Photograph of Thembaletu**

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## Annex 4

### Loss Estimates for 2006 and 2007 Extreme Weather Events over George

Table 6.9 Total Reported Direct Economic Losses by all Stakeholders in the Southern Cape for the August 2006 Floods

By Organisation/ Administration	No. of recorded Impacts*	Losses [ZAR]	Losses [%]
<b>National Government Dept.</b>			
** Transnet	0	0.00	0.00%
DWAF	31	2,870,000.00	0.56%
SanParks	5	1,800,000.00	0.35%
SANRAL	1	87,734,298.03	17.21%
<b>Subtotal</b>	<b>37</b>	<b>92,404,298.03</b>	<b>18.13%</b>
<b>Provincial Government Dept.</b>			
Housing		28,885,685.00	5.67%
Agriculture	2424	109,873,289.74	21.55%
Cape Nature	5	3,400,000.00	0.67%
Education	15	1,919,000.00	0.38%
Provincial Roads	312	90,840,000.00	17.82%
** Public Works	31	12,960,000.00	2.54%
** Social Development	n/a	0.00	0.00%
<b>Subtotal</b>	<b>2787</b>	<b>247,877,974.74</b>	<b>48.63%</b>
<b>District and Local Municipalities</b>			
Bitou	6	877,172.00	0.17%
Breede River/Winelands	19	1,426,499.28	0.28%
** Eden District	4	5,768,393.00	1.13%
George	26	16,691,512.00	3.27%
Hessequa	8	19,000,000.00	3.73%
** Kananaland	n/a	0.00	0.00%
Knysna	81	32,998,370.00	6.47%
Mossel Bay	101	15,458,324.70	3.03%
Oudtshoorn	12	6,974,000.00	1.37%
Prince Albert	5	382,000.00	0.07%
Swellendam	8	4,170,000.00	0.82%
** Theewaterskloof	n/a	0.00	0.00%
<b>Subtotal</b>	<b>270</b>	<b>103,746,270.98</b>	<b>20.35%</b>
<b>Other Sector</b>			
** Eskom	n/a	0.00	0.00%
Spoornet	8	47,246,640.00	9.27%
Telkom	73	670,060.65	0.13%
<b>Subtotal</b>	<b>81</b>	<b>47,916,700.65</b>	<b>9.40%</b>
<b>Private Sector</b>			
South African Insurance Agency	1369	17,818,253.16	3.50%
<b>Subtotal</b>	<b>1369</b>	<b>17,818,253.16</b>	<b>3.50%</b>
<b>Total</b>	<b>4544</b>	<b>509,763,497.56</b>	<b>100.00%</b>

\* An 'impact' for the purposes of this study refers to a 'discrete measurable negative outcome that is directly associated with the August 2006 extreme weather events. A negative impact may be human (ie injury, illness or death), infrastructural, agricultural or environmental and may also be estimated economically'

\*\* Data were requested but not received

Source DiMP (2007)

## Annex 4

**Table 6.10 Preliminary Damage Assessment of the November 2007 Floods\***

NATIONAL DEPARTMENTS		TOTAL LOSSES
Department of Water Affairs and Forestry		R 6 500 000.00
Department of Environmental Affairs and Tourism		R 500 000.00
SanParks		R10 640 000.00
<b>TOTAL</b>		<b>R17 640 000.00</b>
PROVINCIAL DEPARTMENTS		TOTAL LOSSES
Department of Transport and Public Works (Cape Nature)		R8 192 705.00
Department of Transport and Public Works (Roads)		R157 446 000.00
Department of Agriculture		R185 000 000.00
Department of Social Development		R1 387 000.00
Department of Health		R250 000.00
Department of Local Government and Housing		R104 879 000.12
<b>SUB TOTAL</b>		<b>R457 154 705.12</b>
MUNICIPALITIES		
Theewaterskloof Local Municipality		R10 798 440.00
Swellendam Local Municipality		R8 488 387.00
Breedersvlei Winelands		R58 048.00
Eden District Municipality		R43 706 500.00
Hessequa Local Municipality		R15 508 100.00
Mosselbay Local Municipality		R36 280 000.00
George Local Municipality		R46 000 000.00
Bitou Local Municipality		R34 800 000.00
Oudshoorn Local Municipality		R2 144 500.00
Kannaland Local Municipality		R8 814 000.00
Knysna Local Municipality		R66 968 000.12
<b>SUB TOTAL</b>		<b>R271 563 975.12</b>
<b>GRAND TOTAL</b>		<b>R746 358 680.24</b>

\*These figures are preliminary and still need to be verified. No preliminary assessments were received from SANRAL, Telkom and Eskom. The assessment also excluded private losses.  
Source: Office of the Premier (2007)

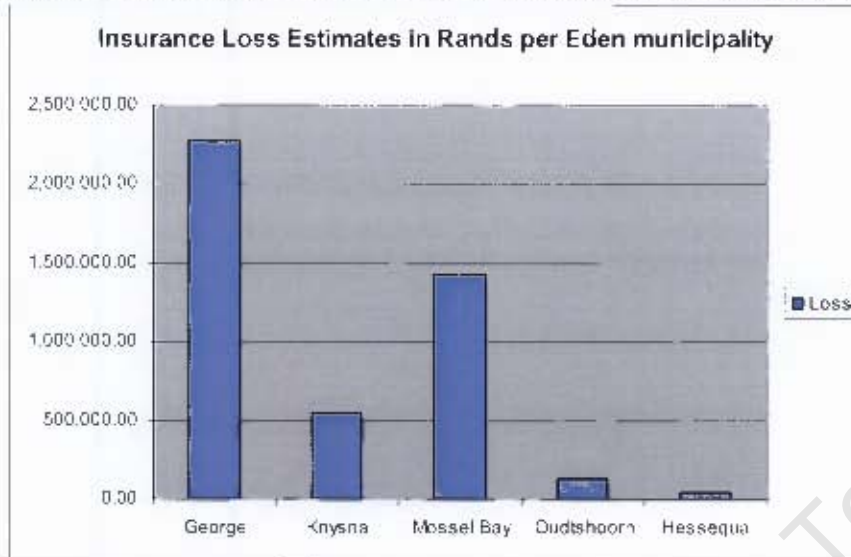
**Table 6.11 George Municipal Budget for Civil and Technical Services for 2006/2007**

Municipality	Civil and Technical Service [2006/2007]			Economic Losses for August 2006		
	Planned Expenditure Budget	Maintenance & Repair Budget	Maintenance & Repair as % of Planned Expenditure	Total {ZAR}	As a % Planned Expenditure	As a % Maintenance & Repair
George	327,647,000.00	R 44,061,000	13.45%	16,691,512.00	5.1%	37.9%

Source: DIMP, 2007

## Annex 4

Figure 6.6 Insurance Loss Estimates for August 2006 damages per Eden Municipality



Source: DiMP (2007)

Table 6.12: Total Recorded Direct Economic Losses for George for August 2006 Floods

Sector	Losses from George
George Municipality	R 16 691 512.00
DWAF	R 90 000.00
SANRAL	R 47 600 000.00
DLGH	R 14 568 485.00
Provincial Education	R 165 000.00
South African Insurance Agency	R 2 271 136.32
<b>Total</b>	<b>R 81 386 133.32</b>

Source: DiMP (2007)

## Annex 5

### Early Warnings Issued by SAWS between 19 to 25 November to Overberg and Eden District Disaster Managers

Date and Time	Warning Message
19/11/2007 11:21	*7 ADVISORY: Heavy falls of rain >50mm possible in places in the Overberg District & S-ern parts of Breede River valley on Wednesday (21st).
20/11/2007 09:33	*7 Warning 1: Very rough seas with waves exceeding 5m developing between Cape Point and Plettenberg Bay tomorrow Wednesday afternoon persisting Thursday.
20/11/2007 09:41	*7 Warning 2: Heavy falls of rain expected in Overberg, Eden District and Breede River valley from tomorrow Wed (21st) afternoon thru Thursday, may result etc....
20/11/2007 09:43	*7 Warning 2: Heavy falls of rain etc..... may result in flash flooding in places.
20/11/2007 09:45	*7 Warning 3: Very cold, wet, windy conditions set in tomorrow Wednesday persisting Thursday over interior of W-Cape Province and W-high ground of N-Cape Province.
20/11/2007 10:28	*7020 WARNING UPDATE: Very rough seas with waves exceeding 5m to develop between Cape Columbine and Plettenberg Bay tomorrow Wednesday afternoon persisting through Thursday.
20/11/2007 16:11	*7 UPDATE: Heavy falls of rain are expected in the Overberg & Breede River Valley tonight (Tuesday.) spreading to the Eden area tomorrow Wednesday through Thursday which may result in flash flooding in places.
21/11/2007 13:06	*7 WARNING 1 AMD: Heavy falls (above 50mm) of rain in Overberg and Eden district west of Mossel Bay today (Wednesday) and tomorrow (Thursday).
21/11/2007 13:12	*7 Very rough seas with waves greater than 5m expected between C Point and Plett Bay today (Wed) and tomorrow (Thu).
21/11/2007 17:30	Phone call to Gerhard Otto and Schalk Carstens advising them that heavy falls might move into entire Eden from tonight and DM practitioners should be on standby
22/11/2007 04:27	*7 WARNING UPDATE: Heavy falls >50mm have spread to Eden district. Further heavy falls expected in Overberg AND Eden Districts today (Thursday).
22/11/2007 11:42	*7 WARNING UPDATE: Heavy falls of rain >50mm persist in Eden district and eastern parts of Overberg today (Thursday) and tomorrow (Friday).
22/11/2007 15:03	*7 Warning Update - Rain trend 08:00-14:00 show heavy rainfall has spread to Southern Karoo affecting N1 between Touws River and Prince Albert, likely to persist into tomorrow Fri
22/11/2007 16:08	Please note that Johan Stander will act standby during tonight Thursday night and will be available for consult or call out at 084 264 4765

## Annex 5

23/11/2007 08:56	Rainfall actuals provided
23/11/2007 09:14	*7 Warning update: Further heavy falls of rain >80mm are expected in places east of Mossel Bay & eastern parts of Little Karoo today Friday, abating by midday tom Sat.
23/11/2007 14:48	Rainfall actuals provided
25/11/2007 09:39	*7 ADVISORY, Scattered thundershowers with isolated significant falls of rain (20 to 30mm) likely tomorrow (Mon) morning in the District
25/11/2007 09:46	*7 ADVISORY Correction, Scattered Thundershowers & isolated significant falls of rain (20-30mm) tomorrow (Mon) morning in the EDEN District

Source: Johan Stander, SAWS

University of Cape Town

## Annex 6

### Hazardscape Adjustment Scoring Key

Category	Points									
<b>Purposive Adjustments</b>	5 per adjustment					2.5 per incomplete adjustment				
<b>Responsive Adjustments</b>	2 per adjustment									
<b>Implementing Human Agency</b>	By household members only using their own tools = 10		By household members only using outside tools = 7		By household members & outside assistance or requiring the consent of outsiders (e.g. municipality, ward councillor, neighbours) = 4			By outside agents only = 1		
<b>Effectiveness</b>	Very effective (100%) = 10		Effective (75-99%) = 7		Relatively effective (50-74%) = 4		Only helps a little by slightly lessening severity of impact (1-49%) = 1		Doesn't help at all (0%) = 0	
<b>Cost of Adjustments</b>	R0 = 1	R1 – R99 = 2	R100 – R199 = 3	R200 – R500 = 4	R501 – R1000 = 5	R1001 – R2000 = 6	R2001 – R4000 = 7	R4001 – R6000 = 8	R6001 – R8000 = 9	R8000 + = 10
<b>Innovative Ideas yet to be Implemented</b>	5 per idea									
<b>Maximum Total</b>	<b>495</b>									

## Annex 7

### Household Questionnaire for 50 Structured Interviews in November – December 2007

#### A. Physical Characteristics

1. Physical Address/GPS point/camp name:

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2. Is the road: a) tar b) gravel c) sand /earthen

3. Dwelling type: a) RDP b) Informal c) Caravan/tent

4. Description of dwelling:

a) Building materials: i) wood ii) corrugated iron iii) cardboard iv) plastic v) mud brick vi) thatch vii) stone viii) cement brick ix) clay brick x) tile roof xi) slate roof xii) steel xiii) other

b) State of dwelling: i) excellent ii) average iii) poor

c) Garden: i) Yes ii) No

5. Is the property serviced with water & sanitation?

a) Yes b) No

6. Topographical landscape: Dwelling situated on:

a) Valley b) Side of slope: i) gentle ii) steep

c) top of slope hill

7. Geology/geomorphology :

a) i) Consolidated soil/rock ii) Unconsolidated soil/rock

b) Soil type:

i) Sandy soil ii) Clay soil iii) Gravel iv) Solid rock

c) Vegetation:

i) completely vegetated (grass & other plant species) ii) partially vegetated iii) no vegetation

iv) plenty of trees v) minimal trees vi) no trees

vii) indigenous vegetation viii) alien vegetation ix) vegetation type unknown

d) Proximity to river:

i) Yes - proximate estimate in metres: \_\_\_\_\_

ii) No

e) Proximity to wetland:

i) Yes -proximate estimate in metres: \_\_\_\_\_

ii) No

f) High water table/underground spring:

i) Yes

ii) No

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Annex 7

**B. Livelihoods Analysis**

1. Gender of household head? a.) Male b.) Female

2. Age of household head? a.) Male b.) Female

3. Ethnicity of household members?

- a) African
- b) Coloured
- c) White
- d) Indian
- e) Foreign African
- f) Asian
- g) Other

H

4. How many people live in the house?

U

- a) 1
- b) 2
- c) 3
- d) 4
- e) 5
- f) 6
- g) 7
- h) 8
- i) 9
- j) 10
- k) more than 10

M

5. Age of household members?

A

N

- a) \_\_\_\_\_
- b) \_\_\_\_\_
- c) \_\_\_\_\_
- d) \_\_\_\_\_
- e) \_\_\_\_\_
- f) \_\_\_\_\_
- g) \_\_\_\_\_
- h) \_\_\_\_\_
- i) \_\_\_\_\_
- j) \_\_\_\_\_
- k) \_\_\_\_\_

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6. Highest education level of each household member?

- a) \_\_\_\_\_
- b) \_\_\_\_\_
- c) \_\_\_\_\_
- d) \_\_\_\_\_
- e) \_\_\_\_\_
- f) \_\_\_\_\_
- g) \_\_\_\_\_
- h) \_\_\_\_\_
- i) \_\_\_\_\_
- j) \_\_\_\_\_
- k) \_\_\_\_\_

7. What special or specific skills does each household member have?

- a) \_\_\_\_\_
- b) \_\_\_\_\_
- c) \_\_\_\_\_
- d) \_\_\_\_\_
- e) \_\_\_\_\_
- f) \_\_\_\_\_
- g) \_\_\_\_\_
- h) \_\_\_\_\_
- i) \_\_\_\_\_
- j) \_\_\_\_\_
- k) \_\_\_\_\_

8. Are there any illiterate household members?

- a) Yes. How many? \_\_\_\_\_

## Annex 7

b) No

9. How long are you living in the settlement?

- a) 1 year    b) 2 – 4 yrs    c) 5 – 7 yrs    d) 8 – 10 yrs    e) 11 – 13 yrs    f) 14 – 16 yrs  
g) 17 – 19 yrs    h) 20 – 22 yrs    i) 23 – 25 yrs    j) 26 – 28 yrs    k) 29 – 31 yrs    l) 32 – 34 yrs  
m) 35 – 37 yrs    n) 38 – 40 yrs    o) 41 – 43 yrs    p) 44 – 46 yrs    q) 47 – 49 yrs    r) 50 +

10. How long are you living in this dwelling?

- a) 1 year    b) 2 – 4 yrs    c) 5 – 7 yrs    d) 8 – 10 yrs    e) 11 – 13 yrs    f) 14 – 16 yrs  
g) 17 – 19 yrs    h) 20 – 22 yrs    i) 23 – 25 yrs    j) 26 – 28 yrs    k) 29 – 31 yrs    l) 32 – 34 yrs  
m) 35 – 37 yrs    n) 38 – 40 yrs    o) 41 – 43 yrs    p) 44 – 46 yrs    q) 47 – 49 yrs    r) 50 +

11. Did you have a choice in deciding on this site location?

- a) Yes. What was this choice? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
b) No. Why not? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

12. Where were you originally from?

- a) Originally from George    b) Eastern Cape    c) Northern Cape    d) Free State  
e) KZN    f) Gauteng    g) Mpumalanga    h) Limpopo Province    i) Surrounding rural town/farmland    j) Neighbouring country (specify: \_\_\_\_\_)

13. Why did you migrate to George?

- \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

14. Are there any disabled or mentally ill household members?

- a) Yes. How many? \_\_\_\_\_  
b) No

15. Do any household members suffer of the following illness or disease? Indicate how many.

- a) HIV/AIDS \_\_\_\_\_  
b) STDs \_\_\_\_\_  
c) T.B \_\_\_\_\_  
d) Asthma \_\_\_\_\_  
e) Diabetes \_\_\_\_\_  
f) High blood pressure \_\_\_\_\_  
g) Arthritis \_\_\_\_\_  
h) Other? Specify \_\_\_\_\_  
\_\_\_\_\_

16. Do you or your household members have access to any specific information which you can use to make your house and household safer against floods?

- a) No  
b) Yes. Specify: i) Information on building safer houses. In what form is this information communicated? (e.g. book, pamphlet etc.) \_\_\_\_\_  
ii) Information on safer behavioural practices. In what form is this information communicated? \_\_\_\_\_  
iii) Early warning systems to flood events. In what form is this information communicated? \_\_\_\_\_

## Annex 7

c) If yes above, how do you utilise this information?

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17. Do the household members have a heavy drinking problem? Yes [ ] No [ ]

18. How many household members are working?

a.) 1    b) 2    c) 3    d) 4    e) 5    f) 6    g) 7    h) 8    i) 9    j) 10    k) more than 10

19. Type of employment of each working household member?

a) \_\_\_\_\_

b) \_\_\_\_\_

c) \_\_\_\_\_

d) \_\_\_\_\_

e) \_\_\_\_\_

f) \_\_\_\_\_

g) \_\_\_\_\_

h) \_\_\_\_\_

i) \_\_\_\_\_

j) \_\_\_\_\_

k) \_\_\_\_\_

20. Type or period of wage/salary income of each working household member? Amount earned?

Note: Fill in the amount earned under the appropriate category

Household Member	(i) Hourly Wage	(ii) Daily Wage	(iii) Weekly Wage	(iv) Fortnightly Wage	(v) Monthly Salary	Total H/hold income
A						
B						
C						
D						
E						
F						
G						
H						
I						
J						
K						
<b>Total (Rands)</b>						

21. How much does the household spend a month (groceries, clothes, school fees, travelling etc.)?

a) R 0    b) R 1 – R 50    c) R 51 – R 100    d) R 101 – R 150    e) R 151 – R 200    f) R 201 – R 250    g) R 251 – R 300    h) R 301 – R 350    i) R 351 – R 400    j) R 401 – R 450  
 j) R 451 – R 500    k) R 500 – R 750    l) R 751 – R 1000    m) R 1001 – R 1250    n) R 1251 – R 1500    o) R 1501 – R 1750    p) R 1751 – R 2000    q) R 2001 – R 2250    r) R 2251 – R 2750    s) R 2751 – R 3000    t) R 3001 – R 3250    u) R 3251 – R 3500    v) R 3500+

22. Do any household members pay tax?

a) Yes. How many? \_\_\_\_\_

## Annex 7

b) No. Why not? \_\_\_\_\_

23. Do any household members hold a bank account?

a) Yes. How many? \_\_\_\_\_

b) No. Where do you keep your money/savings? \_\_\_\_\_

24. How much money on average does this household save a month?

a) R 0 b) R 1 – R 50 c) R 51 – R 100 d) R 101 – R 150 e) R 151 – R 200 f) R 201 –

R 250 g) R 251 – R 300 g) R 301 – R 350 h) R 351 – R 400 i) R 401 – R 450

F j) R 451 – R 500 k) R 500 – R 750 l) R 751 – R 1000 m) R 1001 – R 1250 n) R 1251 –

I R 1 500 o) R 15001 – R 1750 p) R 1751 – R 2000 q) R 2001 – R 2250 r) R 2251 –

R 2750 s) R 2751 – R 3000 t) R 3001 – R 3250 u) R 3251 – R 3500 v) R 35001+

N 25. Are there any household members or family members who work away from home/George  
and send money back home?

A a) Yes. How many? \_\_\_\_\_

How much do they remit? \_\_\_\_\_

N b) No.

26. Which of the following assets does the household possess:

C a) Vehicle –specify type and quantity: (car [ ], bakkie [ ], microbus [ ], truck [ ],  
motorcycle [ ]).

I Is the vehicle used for: i) travelling to work ii) to generate income (e.g. delivery etc.)

A iii) no income generation activity

What is the value of the vehicle/s? \_\_\_\_\_

L b) Computer. How many? \_\_\_\_\_

Is the computer used for: i) income generation/work ii) study iii) no specific use

Value of computer/s: \_\_\_\_\_

c) Sewing machine. How many? \_\_\_\_\_

Is it used for i) income generation ii) training iii) personal use

27. Is this property:

C a) Owned by the household head. Value of the property: \_\_\_\_\_

A b) Rented. Cost of monthly rent: \_\_\_\_\_

c) Squatted

P 28. Does the household have access to micro-lending sources?

I a) Yes. Explain: \_\_\_\_\_

b) No.

T 29. Does the household receive income from:

A a) Pension. Amount: \_\_\_\_\_

b) Child grant. Amount: \_\_\_\_\_

c) Disability grant. Amount: \_\_\_\_\_

d) Work place injury fund. Amount: \_\_\_\_\_

L e) Other. Specify: \_\_\_\_\_ Amount: \_\_\_\_\_

30. Does the household have any insurance?

a) House

b) Vehicle

c) Medical aid

d) Life

## Annex 7

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31. Does any household members belong to any of the following:

- a) Burial society. How many? \_\_\_\_\_
- b) Financial support network? Explain: \_\_\_\_\_
- c) Business co-operation? Explain: \_\_\_\_\_
- d) Family support group? Explain: \_\_\_\_\_
- e) Neighbourhood watch? Explain: \_\_\_\_\_
- f) Community discussion forums? Explain: \_\_\_\_\_
- g) Religious organisations? Explain: \_\_\_\_\_

32. Which community based organisations are of direct importance to the household?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

33. Which NGOs are of direct importance to the household?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

34. Which local government departments/ services are most important to the household?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

35. What is the value of the dwelling? \_\_\_\_\_

36. How close are you from the clinic? \_\_\_\_\_

37. How often do you go to the clinic? \_\_\_\_\_

38. How many children go to school? \_\_\_\_\_

39. How close is the school (primary & secondary) from the house? Primary: \_\_\_\_\_  
Secondary: \_\_\_\_\_

40. Does the household have electricity supply? A) yes      B) No  
If yes,    i) formal      ii) illegal

### Communication

41 Does the household have a telephone/ cell phone? A) Yes    b) No

42. Does the household have a radio? A) Yes    b) No

43. Does the household have a television? A) Yes    b) No

44. Does the household have easy access to the internet? A) Yes    b) No

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**C. RESILIENCE: FLOOD RISK ADJUSTMENTS/PREPARATION**

**1. Hazard Adjustment**

1.a) What measures have you taken to protect the dwelling against rain leakage?

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.b) How effective are these measures?

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.c) What did it cost you to implement these measures?

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.d) Did you require any permission from the following before you could implement the above measures:

i) Municipality    yes [ ] (any specific department? \_\_\_\_\_)  
How did you gain their permission? \_\_\_\_\_

no [ ]

ii) Ward councillor    yes [ ]    How did you gain his/her permission? \_\_\_\_\_

no [ ]

iii) Community leader    yes [ ]    How did you gain his/her permission? \_\_\_\_\_

no [ ]

iv) Neighbours    yes [ ]    How did you gain their permission? \_\_\_\_\_

no [ ]

.e) Did you implement the above measure/s on:

Your own [ ]    What knowledge/skills and resources were necessary to implement the measure? \_\_\_\_\_

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---

OR

Require outside assistance [ ]    Who did you ask and why? \_\_\_\_\_

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## Annex 7

2.a) What measures have you taken to protect the dwelling against seepage?

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b) How effective are these measures?

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c) What did it cost you to implement these measures?

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d) Did you require any permission from the following before you could implement the above measures:

i) Municipality    yes [ ] (any specific department? \_\_\_\_\_)

How did you gain their permission? \_\_\_\_\_

no [ ]

ii) Ward councillor    yes [ ]    How did you gain his/her permission? \_\_\_\_\_

no [ ]

iii) Community leader    yes [ ]    How did you gain his/her permission? \_\_\_\_\_

no [ ]

iv) Neighbours    yes [ ]    How did you gain their permission? \_\_\_\_\_

no [ ]

e) Did you implement the above measure/s on:

Your own [ ] What knowledge/skills and resources were necessary to implement the measure? \_\_\_\_\_

---

---

OR

Require outside assistance [ ] Who did you ask and why? \_\_\_\_\_

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3.a) What measures have you taken to protect the dwelling against ponding?

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## Annex 7

b) How effective are these measures?

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c) What did it cost you to implement these measures?

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d) Did you require any permission from the following before you could implement the above measures:

i) Municipality    yes [ ] (any specific department? \_\_\_\_\_ )  
How did you gain their permission? \_\_\_\_\_

no [ ]

ii) Ward councillor    yes [ ]    How did you gain his/her permission? \_\_\_\_\_

no [ ]

iii) Community leader    yes [ ]    How did you gain his/her permission? \_\_\_\_\_

no [ ]

iv) Neighbours    yes [ ]    How did you gain their permission? \_\_\_\_\_

no [ ]

e) Did you implement the above measure/s on:

Your own [ ] What knowledge/skills and resources were necessary to implement the measure? \_\_\_\_\_

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OR

Require outside assistance [ ] Who did you ask and why? \_\_\_\_\_

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4.a) What measures have you taken to protect the dwelling against stormwater run off?

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b) How effective are these measures?

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## Annex 7

.c) What did it cost you to implement these measures?

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.d) Did you require any permission from the following before you could implement the above measures:

i) Municipality    yes [  ] (any specific department? \_\_\_\_\_)

How did you gain their permission? \_\_\_\_\_

no [  ]

ii) Ward councillor    yes [  ]    How did you gain his/her permission? \_\_\_\_\_

no [  ]

iii) Community leader    yes [  ]    How did you gain his/her permission? \_\_\_\_\_

no [  ]

iv) Neighbours    yes [  ]    How did you gain their permission? \_\_\_\_\_

no [  ]

.e) Did you implement the above measure/s on:

Your own [  ]    What knowledge/skills and resources were necessary to implement the measure? \_\_\_\_\_

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OR

Require outside assistance [  ]    Who did you ask and why? \_\_\_\_\_

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5.a) What measures have you taken to protect the dwelling against road/overland run off?

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b) How effective are these measures?

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c) What did it cost you to implement these measures?

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## Annex 7

.d) Did you require any permission from the following before you could implement the above measures:

i) Municipality yes [ ] (any specific department? \_\_\_\_\_)

How did you gain their permission? \_\_\_\_\_

no [ ]

ii) Ward councillor yes [ ] How did you gain his/her permission? \_\_\_\_\_

no [ ]

iii) Community leader yes [ ] How did you gain his/her permission? \_\_\_\_\_

no [ ]

iv) Neighbours yes [ ] How did you gain their permission? \_\_\_\_\_

no [ ]

.e) Did you implement the above measure/s on:

Your own [ ] What knowledge/skills and resources were necessary to implement the measure? \_\_\_\_\_

\_\_\_\_\_

OR

Require outside assistance [ ] Who did you ask and why? \_\_\_\_\_

\_\_\_\_\_

6.a) What measures have you taken to protect the dwelling against flooding from riverine?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

.b) How effective are these measures?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

.c) What did it cost you to implement these measures?

\_\_\_\_\_

\_\_\_\_\_

.d) Did you require any permission from the following before you could implement the above measures:

i) Municipality yes [ ] (any specific department? \_\_\_\_\_)

How did you gain their permission? \_\_\_\_\_

no [ ]

ii) Ward councillor yes [ ] How did you gain his/her permission? \_\_\_\_\_

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no [ ]

iii) Community leader yes [ ] How did you gain his/her permission? \_\_\_\_\_

no [ ]

iv) Neighbours yes [ ] How did you gain their permission? \_\_\_\_\_

no [ ]

.e) Did you implement the above measure/s on:

Your own [ ] What knowledge/skills and resources were necessary to implement the measure? \_\_\_\_\_

OR

Require outside assistance [ ] Who did you ask and why? \_\_\_\_\_

7.a) What measures have you taken to protect the dwelling against flooding from wetland?

.b) How effective are these measures?

.c) What did it cost you to implement these measures?

.d) Did you require any permission from the following before you could implement the above measures:

i) Municipality yes [ ] (any specific department? \_\_\_\_\_)

How did you gain their permission? \_\_\_\_\_

no [ ]

ii) Ward councillor yes [ ] How did you gain his/her permission? \_\_\_\_\_

no [ ]

iii) Community leader yes [ ] How did you gain his/her permission? \_\_\_\_\_

no [ ]

iv) Neighbours yes [ ] How did you gain their permission? \_\_\_\_\_

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no [ ]

.e) Did you implement the above measure/s on:

Your own [ ] What knowledge/skills and resources were necessary to implement the measure? \_\_\_\_\_

OR

Require outside assistance [ ] Who did you ask and why? \_\_\_\_\_

### 2. Vulnerability Adjustment

R  
E  
D  
U  
C  
E  
  
E  
X  
P  
O  
S  
U  
R  
E

1. What did the municipality do to reduce your exposure to flood impacts?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

2. Did NGOs or business do anything to reduce your exposure to flood impacts?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

3. Did your community do anything to reduce your exposure to flood impacts?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

P  
R  
O  
T  
E  
C  
T  
I  
O  
N

4. Are you aware of any legislation which enforces the government to protect you against flood or any other risks?

\_\_\_\_\_  
\_\_\_\_\_

5. Are there any legislation or community rules that stipulate how you should behave/live so as to not endanger your neighbours to flood or any other risk?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

O  
F  
A  
T

6. Are there special measures in place that ensures the protection of children, women, the elderly and the disabled?

a) Measures by your household: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

b) Measures by your community: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

c) Measures by the municipality: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

R  
I  
S  
K

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D  
I  
S  
A  
S  
T  
E  
R  
R  
E  
S  
P  
O  
N  
S  
E

7. Does your household have mechanisms in place that prepares it for future flood events?

a) Yes [ ] Explain: \_\_\_\_\_

b) No [ ] Why not? \_\_\_\_\_

8. Does your community have mechanisms in place that prepares it for future flood events?

a) Yes [ ] Explain: \_\_\_\_\_

b) No [ ] Why not? \_\_\_\_\_

9. Has the municipality any mechanisms in place to prepare the community for future flood events?

a) Yes [ ] Explain: \_\_\_\_\_

b) No [ ] Why not? \_\_\_\_\_

10. Does your household have any plans in place to respond to a flood?

a) Yes [ ] Explain: \_\_\_\_\_

b) No [ ] Why not? \_\_\_\_\_

11. Does your community have any plans in place to respond to a flood?

a) Yes [ ] Explain: \_\_\_\_\_

b) No [ ] Why not? \_\_\_\_\_

12. Does the municipality have any plans in place to respond to a flood?

a) Yes [ ] Explain: \_\_\_\_\_

b) No [ ] Why not? \_\_\_\_\_

13. How would your household cope with a flood event?

\_\_\_\_\_  
\_\_\_\_\_

## Annex 7

14. How would your community cope with a flood event?

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## Annex 8

### Vulnerability Indicators Selected for Household Questionnaires in Thembaletu

Capital	Indicator
Physical	1. Road type 2. Dwelling type 3. Dwelling building materials 4. Current state of dwelling 5. Dwelling has a garden 6. Property serviced with water & sanitation 7. Dwelling has legal electricity supply 8. Distance from the clinic 9. Distance from the school <b>Communications</b> 10. Household has telephone/cell phone 11. Household has television 12. Household has radio 13. Household has easy access to internet
Natural	14. Type of topography dwelling situated on 15. Type of soil/rock dwelling built on 16. Type of surrounding vegetation 17. Proximity to river/stormwater channel 18. Proximity to wetland 19. High water table/ underground spring
Human Capital	20. Gender of household head 21. Age of household head 22. Ethnicity of household members 23. Number of household members 24. Age of household members 25. Highest education level of each household member 26. Number of children currently at school 27. Special or specific skills of each household member 28. Number of illiterate household members 29. Number of years living in the settlement 30. Number of years living in current dwelling 31. Personal choice of site location 32. Place of origin 33. Reason for migration 34. Number of disabled or mentally ill household members 35. Major illnesses or disease by any household members (e.g. HIV/AIDS, STDs, T.B, Asthma, Diabetes, High blood pressure, Arthritis) 36. Frequency of going to clinic 37. Household members have any access to information on flood-proofing dwelling 38. Household members with heavy drinking problem
Social Capital	39. Burial society membership 40. Financial support network

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	<ul style="list-style-type: none"> <li>41. Business co-operation</li> <li>42. Family support group</li> <li>43. Neighbourhood watch</li> <li>44. Community discussion forum</li> <li>45. Religious affiliation</li> <li>46. CBOs of direct importance to household</li> <li>47. NGOs of direct importance to household</li> <li>48. LM departments of direct importance to household</li> </ul>
Financial Capital	<ul style="list-style-type: none"> <li>49. Number of household members working</li> <li>50. Type of employment of each household member</li> <li>51. Type or period of wage/salary income of each working household member</li> <li>52. Household monthly expenses</li> <li>53. Household members paying tax</li> <li>54. Household members with bank account</li> <li>55. Household or family members working outside of George and remitting money</li> <li><b>Household assets</b></li> <li>56. Vehicle</li> <li>57. Computer</li> <li>58. Sewing machine</li> <li>59. Property owned/rented or squatted</li> <li>60. Value of house (if owned)</li> <li>61. Access to micro-lending sources</li> <li>62. Income from social grants</li> <li>63. Household insurance</li> </ul>

## Annex 9

### Rationale in the Selection of Flood Vulnerability Indicators

The significance of the following flood vulnerability indicators for determining the physical exposure, the livelihoods analysis and flood vulnerability adjustments was informed by the methods in 7.5. The flood vulnerability indicators were clustered according to those pertaining to physical exposure and those pertaining to livelihoods analysis.

#### 1. Physical Exposure to Floods

The physical exposure can be considered as the physical and natural capital of the household. The following 12 indicators were considered under physical exposure:

- Type of road;
- Condition of dwelling;
- Whether dwelling has a foundation;
- Water and sanitation on property;
- Whether property has a garden;
- Whether vegetation exist in and around property
- Location of dwelling;
- Proximity of dwelling to river/stream/stormwater channel;
- Stormwater outlet close to property
- Proximity of dwelling to wetlands;
- High water table;
- Underground spring present on property

##### 1.1 *Type of Road*

It was considered whether the road was comprised of tar, paving, gravel, sand or earthen or whether no road existed altogether. The material composition of the road is important where flood risk is considered. It is widely understood that impermeable surfaces such as tarred roads increase run-off because of a lack of surface retention and in this way increases flood risk. However, for this scoring

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system the hard surfaces received the lowest score whereas surfaces such as gravel, sand, earthen as well as no roads received a higher score. This is because from a social perspective, where proper hard surfaced roads exist, it was still possible to commute in and out of the area. However, roads comprising of gravel, sand or earthen or if there is no road at all, makes it difficult to commute. This becomes a major concern for evacuation during floods as well as for emergency vehicles needing to access flood victims. This observation is also made in Pyle (2006). A case in example includes a personal experience by the researcher (box 1).

### **Box 1 Researcher's field notes of Personal Rescue Operation**

#### **Monday 26 November 2007 (heavy rains on this day)**

My car got caught in the mud in Thembaletu on this Monday morning. The problem lies with the gravel roads. There are no pavements and no proper stormwater drainage, but only informal channels about 30 cm deep dug along the side of the road by the municipality. What is produced with the onset of heavy rain is a stream of water flowing in these channels causing deep thick mud.

My car was caught in this mud about 10:00 AM. Three locals braving the heavy rain were walking down the street towards me. I asked them to assist in getting my car out of the mud. However, their efforts only worsened the situation.

I then called the police who could not assist me but provided the number of two towing service companies. I called company 1, who said that it will cost R 750 for the service. I then contacted company 2 who said that they do not rescue cars stuck in mud because it doesn't pay for them (i.e. it is not good business). Company 2 then gave me a contact of a 3<sup>rd</sup> company, who was not available at the time of calling them. I then went back to company 1, who further told me that I have to pay them R 750 before they even do the job. This was impossible for I did not have this amount of cash on me. Besides, who carries so much money on them anyways?

At 10:45 AM I was forced to call the police again. A different operator answered the call to who I explained the whole situation and the fact that I am not from the town and that I have nobody to assist me. After speaking for about 5 minutes and being transferred to another operator and having to negotiate my situation, eventually it was agreed that they would dispatch a police van to assess and assist my situation. It was probably also the fact that I told them that I am a researcher from the University of Cape Town studying the flood situation which heralded a more positive response.

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### Box 1 continued...

The police van with 2 police officers arrived at 11:25AM –a 40 minute response time. The police officers took approximately 10 minutes to scope out the situation and attempted various approaches before finally towing my vehicle in a reverse position. Furthermore the officers arrived without any tow rope and luckily I happened to have one.

At 11:35 AM my car was rescued from the mud. I was therefore stuck for 1 hour 20 minutes in the mud, because of the poor road conditions. I was soaking wet for this entire period and suffered near hyperthermia. With cold blue finger tips I could barely grip the steering wheel as I attempt to drive back to my accommodation about 20 minutes from Thembalethu. I required an immediate warm shower to allow my blood to flow properly again.

These are the living conditions of the people of Thembalethu. The police and the two tow service companies pointed out that cars get caught in the mud frequently in Thembalethu during heavy rains. How many of them are able to spend R 750 on a towing service? Who among them can use the prestige of a university's name to herald faster responses? How many of them can afford to lose 1 hour 30 minutes of their working day on rescuing a vehicle caught in mud? How many of them have a cosy shelter and warm shower to go to at the end of such an ordeal?

### *1.2 Condition of dwelling*

Here the overall state of the dwelling was considered based on observations. It was therefore determined whether the dwelling was in an excellent, average or poor state. It was also considered whether the dwelling underwent any extensions, renovations or upgrading. The state of the dwelling is important as it will determine the integrity of the dwelling to the flood hazardscape.

### *1.3 Dwelling has foundation*

Whether the dwelling had a concrete foundation or not was factored into the assessment. It is common to find informal dwellings without foundations. However many RDP dwellings also exclude foundations or existing foundations were poorly built and deteriorated over the years. Factoring in the existence of a foundation is important as this will influence the extent to which upwelling water from the high water table is able to penetrate and seep into the dwelling.

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### *1.4 Water and sanitation on property*

Water and sanitation is not only important for flood risk but are basic needs relevant for a healthy lifestyle. It was noted in Benjamin (2005) that residents in informal settlements do not use communal toilets because of the unhygienic state of these but instead defecate in the open. Furthermore it was found that the use of communal taps often located next to unhygienic communal toilets often accumulate stagnant water around them. Children particularly are exposed to such stagnant water. Thus where flood risk is concerned such practices may cause polluted water from faeces and other waste to rise closer to dwellings and increasing health related risks. Without water and sanitation on the property or inside the dwelling, residents are forced to make use of communal taps and toilets or the outdoors during the flooding period. In this way, they are also exposed to health risks by being exposed to the wet conditions.

### *1.5 Garden on property*

It was found that gardens and lawns are a physical adjustment against the flood hazardscape. Consideration was therefore given to whether the property had a garden or not.

### *1.6 Vegetation in and around property*

It was found that general vegetation in around the property acted as a physical adjustment against the flood hazardscape. Consideration was therefore given to whether complete, partial or no vegetation existed in and around the property.

### *1.7 Location of dwelling*

One of the causal reasons for dwellings being exposed to certain types of the flood hazardscape is because of a location on steep slopes or in valleys of tributary streams. Consideration was therefore given to whether dwellings are located in a valley, steep slope, gentle slope, on top of the slope or on a flat surface.

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### *1.8 Proximity to river/stream/stormwater channel*

The proximity of dwellings to either a tributary stream or stormwater channel is one of the reasons for dwellings being exposed to flood risk. It was therefore estimated how far the dwelling was in meters from such sources. The closer the distance the greater the vulnerability and the further the distance the lower the vulnerability becomes.

### *1.9 Stormwater outlet close to property*

It was found that dwellings were exposed to flooding from stormwater channels because of stormwater outlets directly exiting opposite the property or dwelling. Consideration was therefore given to whether dwellings were close to a stormwater outlet.

### *1.10 Proximity to wetlands*

It was found that the proximity of dwellings to a wetland was one of the reasons for being exposed to flood risk. It was therefore considered whether the dwelling was close (in meters) to a wetland or not. The closer the distance the greater the vulnerability and the further the distance the lower the vulnerability becomes.

### *1.11 High water table*

A high water table was another causal reason for dwellings being exposed to seepage. It was therefore considered whether the dwelling was located on an area with a high water table.

### *1.12 Underground spring*

The presence of an underground spring on a property was another reason for dwellings being exposed to seepage from upwelling water. It was therefore considered whether the dwelling had an underground spring that upwelled water on the property.

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### 2. Household Flood-Specific Livelihoods Analysis

The livelihoods analysis were categorised according to physical, human, financial and social capital. Physical capital included the following indicators:

- House ownership;
- Household assets;
- Electricity supply;
- Possession of cell phone;
- Possession of television;
- Possession of radio;
- Access to internet

Human capital included the following indicators:

- Age of household head;
- Ethnicity of household head;
- Household members within vulnerable age group;
- Highest educational achievement within household;
- Illiterate household members;
- Percentage of household members with useful skills;
- Percentage of household members employed;
- Recently or currently unemployed household members;
- Number of years living in the settlement;
- Number of years living in the dwelling;
- Choice of site location;
- Place of origin;
- Reason for migration;
- Disable/ mentally ill household members;
- Major illnesses/ diseases;
- Household members that are heavy drinkers;
- Access to flood safety information

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Financial capital included the following indicators:

- Per capita monthly household income;
- Per capita monthly household expenditure;
- Remittances;
- Average monthly household savings;
- Percentage household members with bank accounts;
- Access to micro-lending sources;
- Insurance coverage

Social capital included the following indicators:

- Social capital/ security;
- Political affiliation

### *2.1 Physical capital*

#### 2.1.1 House ownership

House ownership is a valuable fixed asset that ensures some form of financial security. For example, it is common practice for owners of RDP houses to sell or rent out their house, while living in informal dwellings, as a poverty adjustment strategy. A respondent explained that:

“There is an informal property market – some people don’t live here, but live for example in P.E [Port Elizabeth] or anywhere in the Eastern Cape then they would go back home in December. They would then be short of money and therefore are compelled in selling their property.” [Also see box 2]

It was therefore necessary to establish whether the dwelling was owned or rented. If the dwelling was owned vulnerability would be reduced, whereas if the dwelling was rented vulnerability increased because of a lack of a fixed asset. An owner of a dwelling may also undertake renovations and upgrading of the dwelling at any desired time. A tenant cannot do the same without the authority of the owner of the rented property. Thus an owner could flood-proof a dwelling as a mitigation strategy or immediately repair a flood damaged dwelling if the resources were available. On the contrary, it could be argued that a house owner may be more vulnerable if a flood damages or completely destroys his/her

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house compared to a house that is partially or completely destroyed where the occupants are only tenants and not owners. In such a case an owner would incur greater loss than a tenant who simply may move into another rented property. The former interpretation however was adopted for this indicator where house ownership was viewed as desirable.

### 2.1.2 Household assets

For the same reason of financial security as (2.1.1) above it was considered whether the household owned any assets that could assist in the generation of household income. It was therefore considered whether a household owned or rented a vehicle, owned a computer or was building up a computer, or owned a sewing machine. It should however be pointed out that, in many cases, although households did own one or more of the aforementioned assets, they did not necessarily use it for the purpose of income generation. This particular indicator was therefore not that significant despite the fact that it reflected additional opportunities for households to generate income.

### 2.1.3 Electricity supply

It has been well documented by DiMP researchers that there is a clear relationship between fire risk and a lack of formal electricity supply. The relevance to flood risk was partially explained in Benjamin (2005). Here it was noted that because of informal electricity usage, illegal electricity connections by informal dwellings from RDP dwellings or municipal infrastructure result in dangerous connections of live wires. These are poorly insulated and either run in mid-air or along the ground in what is termed as “a spaghetti” of connections. Those that run along the ground often run through pools of water caused by ponding. It was found that the copper of the wire was exposed in the pools of water. Children playing football in the vicinity would unintentionally disconnect the wires by tripping over it and then would reconnect it themselves. This exposed them to the risk of electrocution.

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A lack of electricity supply also has further implications for flood risk where early warning is concerned. This is explained by the following response by a Thembaletu respondent:

"The problem here is the electricity. Because we have no electricity you can't buy meats because you can't refrigerate the meat. We are therefore forced to buy packed foods and tin foods. So for example we would buy meat and fish/tuna/sardines in tins. We would then have to consume it all when once it is opened because there is nowhere to store it. It is not also healthy to only eat tin foods.

A further problem with the electricity is that for example if we want to watch sports then we have to go to the tavern. And if you go to the tavern, you can't just sit there and watch T.V. You have to buy a beer. That is the only place to watch T.V. We therefore can't stay in touch with the world because we can't watch the news, sports etc. because we can't have T.Vs or radios. It therefore becomes difficult to know what the weather would be the next day and we therefore don't know when it is going to rain. We could use batteries to run the T.V or the radio but it becomes difficult to charge this every time. [Another respondent mentioned that they have to carry their battery to town -7km away each time they have to charge it]

We had informal electricity connections, but the municipality came and said we can't do that because it will create problems. The problem is that this is *All Brick* [A private brick-making company] land and therefore the municipality can't provide us with electricity. The other problem is that in informal settlements people just build anywhere and on top of each other so it makes it difficult to have any electricity points. Because people build on top of each other there are no roads to your house. For example in 2002 I bought my car and I had to ask my neighbours to keep an open space for me to drive my car through. I then had to make my own road with concrete and gravel. However, because I wasn't equipped or skilled for that, I didn't design the road properly so the concrete washed away with the rains. I think it is only George where we have no electricity. In Oudtshoorn there is an informal settlement that has electricity."

For the above reasons electricity supply was selected as an indicator. It was therefore determined whether a household had legal or illegal electricity supply or no electricity supply.

### 2.1.4 Possession of cell phone/telephone

Informal households do not have landline phone connections and only some RDP households do. The major form of communication in low-cost settlements is via cell phones. The possession of cell phones (or telephone) by household members was considered as an indicator because it would determine the ability of a household to communicate with emergency services or any other assistance (family, neighbour, friends) during flooding as the case in box 1.

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### 2.1.5 Possession of television

This indicator was selected as it determines the ability of a household to receive early warnings through watching the weather forecast on television as explained by a respondent in (2.1.3) above.

### 2.1.6 Possession of radio

This indicator was selected for the same reason as (2.1.5) above. Radio ownership is more widespread among residents of low-cost settlements than television ownership for economical reasons.

### 2.1.7 Easy access to internet

This indicator was selected for the same reason as (2.1.5) and (2.1.6) above with regards to accessing weather forecasts. Access to the internet would enable households to access flood safety and preparedness information.

## *2.2 Human capital*

### 2.2.1 Age of household head

The age of the household head was considered as an indicator because it is understood that the more physically and economically active age group [21 to 64 years] of household heads were better able to undertake physical adjustments to their dwellings. Household heads within this age category were economically active and through the ability of being financially secure were better able to recover from flood impacts. Child headed households however were considered the most vulnerable. This is followed by households headed by the elderly.

### 2.2.2 Ethnicity of household head

Despite South Africa being a democratic country, issues of ethnicity or race still play a role in local politics. Thembaletu for example is a predominantly African settlement and so the political leadership was African. As African residents were given preference over Coloureds or foreigners in matters related to local governance, the voices of minority race groups were reportedly silenced. Their

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hardships were therefore seldom taken up and advocated for in local political meetings.

### 2.2.3 Household members within vulnerable age group

Children under 5 years of age are usually considered as a vulnerable age group especially with regards to health risk because of their poorly developed immune systems. They are also not able to fend for themselves and are fully dependent on their parents. This makes them particularly vulnerable when it comes to evacuations from rising flood waters. Elderly people above 65 years of age were considered vulnerable because they may be physically and economically dependent on others. Children below 5 years and adults above 65 years were considered as the vulnerable age group where flood risk is concerned. This is also consistent with the DR literature.

### 2.2.4 Highest educational achievement of household members

Educational level becomes important for employment purposes or further study opportunities. For example, individuals with a minimum grade 10 to 12 leaving certificate may be entitled to enter technical colleges or institutions to acquire specific skills. A grade 12 or tertiary education qualification may entitle one to more enabling forms of employment than those below this level.

Besides employment and study opportunities, the higher the level of education would also determine the ability of household members to resourcefully explore various opportunities. This could include the ability to tap into social networks or utilise basic resources to physically adjust their dwelling. Such household members would be able to interpret weather warnings or flood safety information pamphlets if they were provided with these much better than those more poorly educated.

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### 2.2.5 Illiterate household members

This may ensure the opposite effect of (2.2.4) above (i.e. the opposite of the opportunities created through higher education levels).

### 2.2.6 Percentage of household members with useful skills

The possession of useful technical skills associated with the building trade by anyone or more household members increased the ability of such households to physically adjust their dwellings. Other skills such as communication, political and business skills were also considered as this enabled such household members to exploit opportunities to the advantage of the household.

### 2.2.7 Percentage of household members employed

This determines whether the household would have a larger or smaller per capita income. The larger the per capita income the greater the household's access to financial resources would be. This potentially increases the choices for flood protection of a household as well as more rapid recovery from flood impacts.

### 2.2.8 Recently or currently unemployed household members

Those who are between the ages of 21 – 64 years and do not work were considered as unemployed. Unemployed household members generate the opposite effect of (2.2.7) above. A respondent for example explained that, because of his unemployment, he could not yet implement his innovative ideas of flood-proofing his informal dwelling. The following response further illustrates the significance of this indicator for increasing vulnerability:

"The problem is we don't have long jobs. We only work for a year or half a year or two years, so we don't have enough money to get proper things like concrete and plastic to make the ground proper" (informal dweller respondent during November-December 2007 interviews).

### 2.2.9 Number of years living in the settlement

Benjamin (2005) found that new arrivals into an informal settlement tend to be less aware of flood risk or flood prone areas and therefore settle in these areas. Older residents however have more local knowledge and tend to avoid such

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locations. New arrivals also had fewer choices of site location since “prime sites” were already occupied and for this reason were forced into at-risk locations. The same trend was generally observed in Themba lethu. The time period which households reside in the settlement was therefore considered as an indicator.

### 2.2.10 Number of years living in the dwelling

In many instances residents may have lived in the settlement for many years but only recently moved into their current dwelling. This was usually the case with new RDP house owners who only in recent years received their low-cost formal house. These new home owners lived in another location in the settlement in an informal dwelling while waiting to receive their house. In this way new home owners were less aware of the flood related risks of their specific site location than more established home owners. New home owners also had less time to flood-proof their dwelling than more established home owners. The case of a Themba lethu respondent in box 2 illustrates the significance of this indicator.

**Box 2 Excerpts of an Interview with an Informal Dweller in Ward 12, Themba lethu  
-2 December 2007**

“I was first living with my cousin who arrived in 1992 and lives in another part of Themba lethu. However the situation was becoming very difficult living with him because of his wife. When we would go out at night and arrive home after 8PM the door would be locked. This is because my cousin would be drunk and asleep while the wife wouldn't open the door. I would then have to walk up and down the settlement the entire night with friends or sleep in the tavern. I then came to this area where I bought a house from another person who went back to the Eastern Cape. I paid R 400 for the house. The house which I bought was about 15 metres away from this current site, but at that previous site (15 metres away) sewerage water –toilet water would surface and surround my house. There was always a horrible smell around there. One couldn't even walk around without gumboots or safety shoes. I then moved to this current location.

People say that we should stay at Asazani [which is in Themba lethu but at the end of the settlement] which is about 40 to 50 minutes walk from here. However, from this current site it takes one 40 to 50 minutes to walk to town therefore it is much quicker to get to town from here than from Asazani which will take you about 80 to 100 minutes to get to town.

I stayed for 2 months on the site that was 15 metres from the present site. I then scoped out the current site and observed what happens to the rainwater at the current site. Observing the way the water drains the current location I knew that I had to build on the highest site within the present location. However, when I moved on the present site I wasn't aware of the soil conditions. I didn't know about the underground springs which are present here. The springs are under the floor of my house.

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### 2.2.11 Choice of site location

In (2.2.9) above it was pointed out that because of a lack of choice of site location households were forced into flood-prone areas. Box 2 also illustrates that with a choice of site location one is better able to analyse the safety of the location. For this reason this was considered as an indicator to determine vulnerability.

### 2.2.12 Place of origin

Some residents were originally from George (8% of sample interviews), while some (8% of sample interviews) were from neighbouring towns in the province. However, the majority (82% of sample interviews) originated from other provinces of which the Eastern Cape is the largest (80% of sample interviews). Only a few were from other African countries. The place of origin determined whether they had access to social networks or a political voice. It was found that people from the same place of origin tend to form social organisations to assist each other. For example, it was found that an elderly man originally from Oudtshoorn had life-long friends move down from Oudtshoorn to live with him following the death of his wife. People from the Eastern Cape formed a burial society and micro-lending organisation to assist those from the Eastern Cape. Immigrants from Somalia formed a social network where they assist each other. As an example, during an interview with a Somali respondent (a spaza shop<sup>1</sup> owner), another Somali who had a problem of the immediate repayment of money to a creditor entered. He came to the respondent to seek advice and assistance.

However foreigners, often Somalis, were particularly vulnerable. The recent xenophobic crisis in South Africa, during May-June 2008, illustrated the vulnerability of foreigners in the country. Somalis usually are businessmen and in low-cost settlements open spaza shops where their prices would be so competitive that they are perceived to undercut the prices of local traders, driving

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<sup>1</sup> These are shops in low-cost or informal settlements that sell only basic necessities.

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local businessmen out of business. This was one of the main drivers to the recent xenophobic crisis. The Somali respondent explained that their spaza shop was robbed on two occasions. He further explained that they have no passports or any I.D (identification document) except for refugee papers that were valid for only 2 years. They therefore could not buy a vehicle or obtain a drivers licence. He was therefore driving a rental car without any drivers licence. Other Somalis who do have drivers licence were able to obtain one because they had acquired immigration status or they had a passport.

### 2.2.13 Reason for migration

The reason for migration determined whether households were forced out of their place of origin to seek employment or whether they made an informed choice such as migrating to access better study opportunities. The latter reason made a household less vulnerable than the former because the latter indicated a level of individual agency whereas the former was the consequence of external conditions.

### 2.2.14 Mentally ill or disabled household members

The presence of such household members generated the same problem as discussed in (2.2.3) above, particularly the need for constant care from others. Here for example, a mother explained that her mentally disabled daughter required her constant attention and for this reason she could not work despite her good reference.

### 2.2.15 Major illness/ disease

Household members that suffer of major illnesses or disease were viewed as increasing the vulnerability of the household. For example, a respondent (in 2.2.8 above) lost his job because of his illness. This had implications on his ability to flood-proof his house. Another example included a female AIDS patient who also headed her household. Her dwelling was located 5 meters from a wetland and suffered serious damage during the third event because of its proximity to the

## Annex 9

wetland. During the interview this particular respondent was drunk. She stated that she usually gets drunk to psychologically cope with her disease. This has a negative influence on her ability to undertake risk reduction strategies (see 2.2.16 below).

### 2.2.16 Household members who heavily consumed alcohol

The SIA in DiMP (2007) found that alcohol abuse compromised responsible behaviour and contributed to the lack of innovation to undertake physical adjustments to the dwelling. Irresponsible behaviour also leads to negative social and economic outcomes that may increase vulnerability (see box 3).

#### **Box 3 Excerpts of an Interview with a female RDP dweller –27 November 2007**

Yes, my husband has a heavy drinking problem, especially on weekends. He would come home drunk and then cause violence with me by beating me. This affects the children, especially my 8 year old daughter who becomes emotionally affected and then has to spend the night at my mother's house. This also affects the schooling of my daughter in a way because she doesn't want to work.

I was once so stressed that I had to go to a mental hospital for 2 weeks, luckily I have medical aid to cover for the expenses. During this period my children stayed at my mother's house. My husband said that he will change. However, this weekend I called the police who arrived and only spoke to my husband warning him.

His behaviour affects my work. He beat me over the weekend where he had hit me in the face, that's why I called the police. I therefore couldn't go to work on Monday and today because of the scars in my face around my mouth. I will now have to lie to my supervisor. By missing work now means I will miss some of my leave days.

### 2.2.17 Access to flood safety information

In Cape Town informal dwellers are provided with pamphlets containing flood safety information as part of the city's winter preparedness campaign. Residents who receive and are able to interpret the information to some extent take heed of it according to their capacity to do so. The existence of any similar information in Thembaletu would therefore create some form of awareness around flood safety options.

## Annex 9

### *2.3 Financial capital*

#### 2.3.1 Per capita monthly household income

As discussed in 2.2.7 for economic resilience the more the household members that contribute to the household income the greater the financial security of the household.

#### 2.3.2 Per capita monthly household expenditure

The larger the monthly household expenditure was the less the savings that were available and the less the monthly household expenditure was the greater the savings that were available. This determined the availability of household funds for risk reduction and disaster recovery strategies.

#### 2.3.3 Remittances

If there were household members working outside of George who remit money back to the household this increased the household income. This may contribute to the economic resilience of the household. On the contrary if the household had to remit money away to relatives for example, in the Eastern Cape, then this decreased the household income.

#### 2.3.4 Average monthly household savings

Like 2.3.2 above, the greater the household savings were the greater the availability of funds for reduction and recovery strategies.

#### 2.3.5 Percentage household members with bank accounts

It is common practice for informal dwellers in general to keep their savings in their dwellings so as to avoid bank service charges. This has seen many informal dwellers loose their savings in the event of informal settlement fires. Likewise floodwaters may also damage money. The use of bank accounts for saving money eliminates this risk.

## Annex 9

### 2.3.6 Access to micro-lending sources

The ability to access micro-lending sources enables households to acquire money during difficult times such as recovering from flood losses. In this way access to micro-lending sources increases resilience.

### 2.3.7 Insurance coverage

Household insurance coverage would increase the resilience of households where flood damages to property and or personal possessions are concerned. Insurance coverage also refers to human life and health. Funeral coverage and medical aid schemes for example are therefore considered.

## *2.4 Social capital*

### 2.4.1 Social capital/security

It was considered whether a household belonged to certain social networks or had access to municipal services. This would increase the resilience of a household before (for preparedness), during (for response) and after (for recovery) floods.

### 2.4.2 Political affiliation

Access to political figures or parties would ensure that the household has a political voice to present their concerns and problems. A household would also be better informed of existing local (including flood risk) projects and programmes.

## **3 Flood Vulnerability Adjustments**

The following were considered as adjustments to household vulnerability for flood risk:

- Whether there was any awareness of legislation that requires the protection of individuals against disaster risks;
- Whether there were any community rules or regulations that ensured a safer settlement;

## Annex 9

- Whether there were special measures taken at municipal, community and household levels to protect the most vulnerable (including children, women and the elderly);
- Whether the household had any flood preparedness plans;
- Whether the household had a flood response plan.

### *3.1 Awareness of legislation relevant to disaster risk reduction, recovery and response*

Awareness of relevant legislation relating to disaster risk reduction, recovery and response by individual households implied that such a household would be better able to insist that the municipality ensure their civil rights. In this way their vulnerability might be reduced.

### *3.2 Existence of community rules and regulations for a safer settlement*

Existence of community rules and regulations for ensuring a safer settlement would make it easier to incorporate rules that control behaviours that increase the flood risk exposure of the broader community. This means that existing systems could be utilised for reducing the vulnerability of the most vulnerable to flood risk.

### *3.3 Special measures at the household, community and municipal levels to protect the most vulnerable*

Children, women, the elderly, disabled and minority groups are usually considered the most vulnerable groups during emergencies/disasters. If special measures (irrespective whether they apply to flood risk or not) to protect these groups already exist, this would make it easier to implement or include flood risk protection measures that are sensitive to the needs of the most vulnerable. The Disaster Management Act, for example specifically profiles the need to prioritise vulnerable households.

## **Annex 9**

### *3.4 Household preparedness plan*

The existence of a formal or informal household flood preparedness plan would decrease the household's vulnerability to flood risk because such a household would be better prepared to deal with a flood event.

### *3.5 Household response plan*

Similar to 3.4 above, a formal or informal household response plan would decrease the vulnerability of the household to a flood event. This is because such a household would not be caught by surprise resulting in panic and confusion during an event.

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## Annex 10

### Household Vulnerability Adjustments for Household Questionnaires in Themba lethu

Classification of Adjustment	Specific Adjustments
Reduce Exposure	<ol style="list-style-type: none"><li>1. Efforts by the LM to reduce household exposure to flood impacts</li><li>2. Efforts by NGOs, CBOs or business to reduce household exposure to flood impacts</li><li>3. Efforts by community to reduce household exposure to flood impacts</li></ol> <p><b>Note:</b> Measures by household to reduce exposure falls under household physical adjustments</p>
Social Protection and Resistance	<ol style="list-style-type: none"><li>4. Awareness of any legislation that enforces government to protect household against floods or any other risks</li><li>5. Existence of by-laws or community rules to control behaviour of individuals so as not to endanger ones neighbours to floods or any other risks</li><li>6. Existence of measures at household, community or municipal level that ensures protection of children, women, the elderly and the disabled</li></ol>
Disaster Preparedness & Response	<ol style="list-style-type: none"><li>7. Existence of household/ community/ municipal flood preparedness plan</li><li>8. Existence of household/ community/ municipal flood response plan</li><li>9. How the household/ community copes with a flood</li></ol>



## Annex 12

### Score Key for Physical Capital Indicators

Indicator	Points (total points = 70)							
	-10	-7	-3	-2	-1	0	5	10
<b>House ownership</b>						RDP house Owned	Informal house Owned	Rented
<b>Household assets*</b>	Vehicle (owned)		Vehicle (rented)	Computer	Incomplete computer			None
<b>Electricity supply</b>						Legal	Illegal	None
<b>Possession of cell phone**</b>				Yes				No
<b>Possession of T.V</b>	Yes						Yes, but broken	No
<b>Possession of radio</b>	Yes						Yes, but broken	No
<b>Access to internet</b>	Yes							No

\*Each asset to be subtracted (according to its weight) from the total 10

\*\*Each cell phone within household to be scored and subtracted from the total 10

## Annex 13

### Score Key for Human Capital Indicators

Indicator	Points (total = 170 points)	
<b>Household head age</b>	21 to 64 years = 0 points 65 years & above = 7 points	20 years & below = 10 points
<b>Household head ethnicity</b>	White = 0 points African = 2 points	Coloured = 6 points Foreign African = 10 points
<b>Vulnerable age group members</b> (Note: score for every individual in this category)	6 to 64 years = 0 points	5 yrs & below; above 65 yrs = 10 points
<b>Highest educational achievement</b>	PhD = - 10 points Masters degree = - 8 points Honours degree = - 6 points Graduate degree = - 3 points Diploma Certificate = - 1 point Grade 12 = 0 points Grade 11 = 1 point Grade 10 = 2 point	Grade 9 = 3 points Grade 8 = 4 points Grade 7 = 5 points Grade 6 = 6 points Grade 5 to 7 = 7 points Grade 4 to 8 = 8 points Grade 1 to 3 = 9 points No schooling = 10 points
<b>Illiterate members</b>	None = 0 points 1 = 5 points	2 or more = 10 points
<b>% useful skills</b>	100% = 0 points 76-99% = 2 points 51-75% = 4 points	26-50% = 6 points 1-25% = 8 points 0% = 10 points
<b>% employed</b>	100% = 0 points 91-99% = 1 point 81-90% = 2 points 71-80% = 3 points 61-70% = 4 points 51-60% = 5 points	41-50% = 6 points 31-40% = 7 points 21-30% = 8 points 1-20% = 9 points 0% = 10 points
<b>Recently/ currently unemployed (21-64 years)</b>	0 = 0 points	10 points for each unemployed person
<b>Years in settlement</b>	29 years & above = 0 points	11-13 years = 6 points
<b>Years in dwelling</b>	26-28 years = 1 point 23-25 years = 2 points 20-22 years = 3 points 17-19 years = 4 points 14-16 years = 5 points	8-10 years = 7 points 5-7 years = 8 points 2-4 years = 9 points 1 year or less = 10 points
<b>Choice of site location</b>	Yes = 0 points Partial choice = 5 points	No = 10 points
<b>Origin</b>	George = 0 points Western Cape towns = 2 points Eastern Cape = 2 points	Other Province = 5 points Foreign African country = 10 points
<b>Reason for migration</b> (If originally from George then this category should be excluded from the total score [N/A])	Study = 1 point Visit or stay with family/friend = 4 points	Relocation of company = 7 points Seek employment = 10 points
<b>Disabled/ mentally ill</b>	No = 0 points	10 points for each disabled/ mentally ill person
<b>Major illness/disease</b>	None = 0 points Arthritis = 5 points Diabetes; High/low blood pressure; involuntarily loss of consciousness = 6 points	T.B = 7 points HIV/AIDS = 10 points
<b>Heavy drinkers</b>	No = 0 points	Yes = 10 points
<b>Flood safety information</b>	Yes = 0 points Own insight = 5 points	No = 10 points

## Annex 14

### Score Key for Financial Capital Indicators

Indicator	Points (total = 70 points)	
<b>Per Capita Monthly Household Income*</b>	Above R1000 = 0 points	R451 – R500 = 6 points
	R701 – R1000 = 1 point	R401 – R450 = 7 points
<b>Per Capita Monthly Household Expenditure*</b>	R651 – R700 = 2 points	R351 – R400 = 8 points
	R601 – R650 = 3 points	R301 – R350 = 9 points
	R551 – R600 = 4 points	R0 – R300 = 10 points
	R501 – R550 = 5 points	
<b>Remittances</b>	Remittances to household = -10 points	None = 0 points Remittances Away = 10 points
<b>Average Monthly Household Savings</b>	R1501 and above = 0 points	R151 – R200 = 6 points
	R401 – R1500 = 1 point	R101 – R150 = 7 points
	R351 – R400 = 2 points	R51 – R100 = 8 points
	R301 – R350 = 3 points	R1 – R50 = 9 points
	R251 – R300 = 4 points	R0 = 10 points
	R201 – R250 = 5 points	
<b>Percentage Household Members with Bank Accounts</b>	100% = 0 points	41 – 50% = 6 points
	91 – 99% = 1 point	31 – 40% = 7 points
	81 – 90% = 2 points	21 – 30% = 8 points
	71 – 80% = 3 points	1 – 20% = 9 points
	61 – 70% = 4 points	0% = 10 points
	51 – 60% = 5 points	
<b>Access to Micro-lending Sources</b>	Yes = 0 points	No = 10 points
<b>Insurance Coverage</b>	House coverage = -10 points	Funeral plan for 51 to 100% of household members = -4 points
	Vehicle insurance = -7 points	Funeral plan for 1 to 50% of household members = -2 points
	Disability cover = -7 points	None = 10 points
	Medical aid = -6 points	
	UIF (Unemployment Insurance Fund) = -5 points	
	Pension coverage = -5 points	

\*R10/day per person is used as the poverty line (approximately US\$ 1.2/day per person). This is because international organizations often speak of the amount of poor people living below US\$ 1/day.

## Annex 15

### Score Key for Social Capital Indicators

<b>Indicator</b>	<b>Criteria</b>	<b>Points</b>
<b>Social Capital/Security</b> (Score for each network the household belongs to or has access to)	For each municipal department services received	-2
	Each NGO	-2
	Each CBO	-2
	Religious organisation	-2
	Attends community discussion	-2
	Neighbourhood watch	-2
	Family support group	-2
	Business cooperation	-2
	Financial support network	-2
	None	10
<b>Political Affiliation</b>	Ward councillor	-10
	Ward committee member/ community leader	-10
	Active member of a political party	-6
	Priest	-3
	Former ward committee member	-1
	None	10

## Annex 16

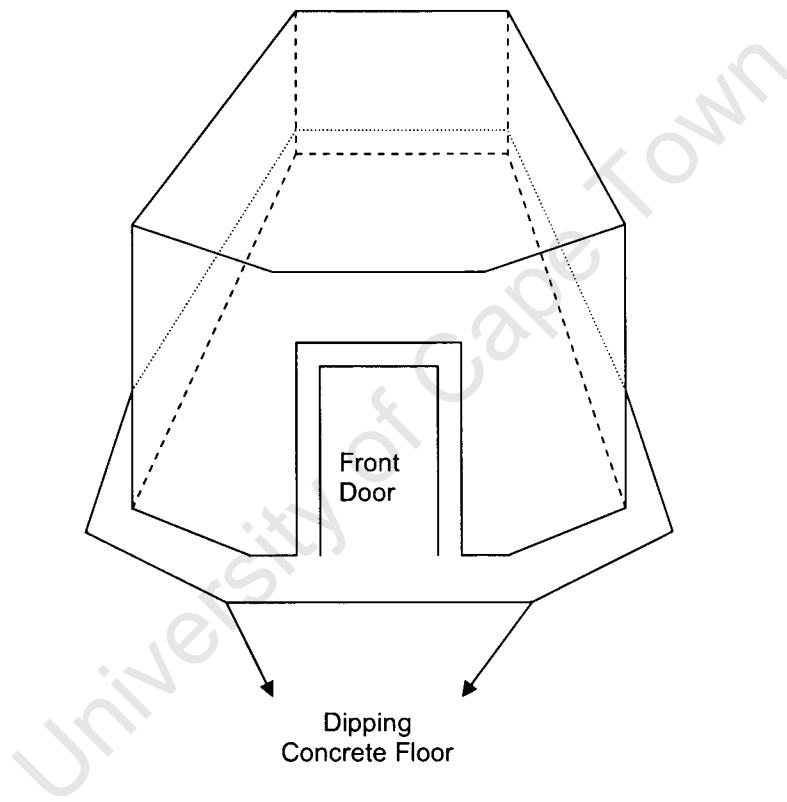
### Score Key for Flood Vulnerability Adjustments

<b>Awareness of Legislation</b>	<b>Community Rules/ Regulations</b>	<b>Special Measures to Protect Most Vulnerable</b>	<b>Preparedness Plan</b>	<b>Response Plan</b>
Awareness of exact legislation (e.g. Disaster Management Act, Environmental Law, Social Protection etc) = 10 points	Detailed, accurate & appropriate identification of such rules & regulations = 10 points	Measures at household level = 10 points each; measures at community level = 7 points each; measures at municipal level = 4 points each	Proper plans = 10 plans  Proper plans involve such plans that were systematically thought of, drawn up and communicated among the household members	Proper plans = 10 plans  Proper plans involve such plans that were systematically thought of, drawn up and communicated among the household members
Abstract knowledge of some general law = 6 points	Identification of relevant but general rules & regulations = 7 points	Detailed, accurate & appropriate identification of such rules & regulations = 10 points		
Acknowledgement of awareness of some legislation but without identifying any example = 2 points	Identification of general rules & regulations but not relevant to the topic = 4 points	Identification of relevant but general rules & regulations = 7 points each	Ad hoc plans = 5 plans  Ad hoc plans involves such plans that were "thumb-sucked" and not systematically thought of, drawn up and is not well understood or recognised by all members	Ad hoc plans = 5 plans  Ad hoc plans involves such plans that were "thumb-sucked" and not systematically thought of, drawn up and is not well understood or recognised by all members
No awareness = 0 points	No rules & regulations = 0 points	Identification of general rules & regulations but not relevant to the topic = 4 points each		
		No rules & regulations = 0 points	No plan = 0 points	No plan = 0 points

## Annex 17

### Illustration of the Dipping Concrete Floor

**Figure 8.4 Illustration of the Dipping Concrete Floor built around some RDP houses by the Municipality following the August 2006 events**



## Annex 18

### Figures 8.5 and 8.6

Figure 8.5 a (left) and b (right) Examples of dwellings with newly installed concrete dipping floor following the August 2006 events



Figure 8.6 Example of the effectiveness of the concrete dipping floor in preventing ponding water from seeping into dwellings



## Annex 19

### Figures 8.7, 8.8 and 8.9

Figure 8.7 Illustration of an Informal Dwelling that is partially built on stilts because of its location on a steep slope –the south facing part of the dwelling still would experience seepage because of being built at ground level

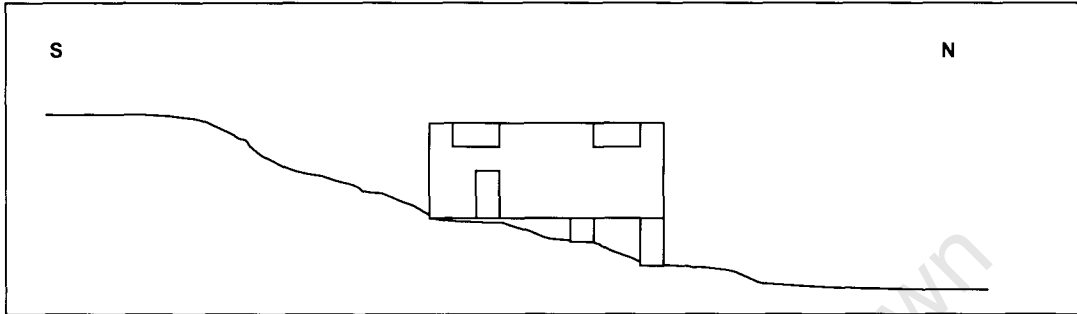


Figure 8.9 Informal dwelling with a metal frame mounted to the bottom of the door to collect rainwater leaking from roof (note some dwellings have the frame mounted on the top of the door)

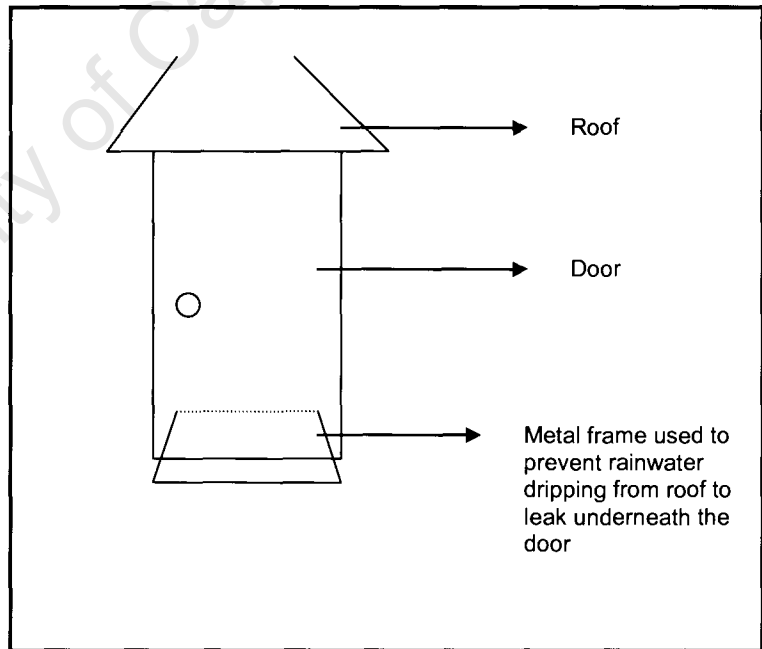
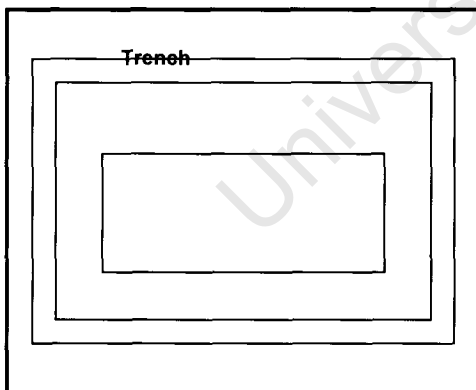


Figure 8.8 Informal dwelling with a trench dug around it to protect against seepage



## Annex 20

### Figures 8.10, 8.11 and 8.12

**Figure 8.10** An Informal Dwelling that has Excavated a chunk of earth around the dwelling In an attempt to prevent seepage and ponding



**Figure 8.11** An Informal Dwelling that has Inserted corrugated iron sheets to the bottom of the dwelling & securing it with sand in order to prevent seepage



**Figure 8.12** An Example of a best built Informal Dwelling



**Annex 21**

**Levels of Flood Hazardscape Adjustments of  
RDP Dwellings**

University of Cape Town

## Annex 21

HOUSE NUMBER	Rain Leakage Roof				Wall				Door				Seepage				Ponding				Stormwater Run-off				Overland Run-off				Riverine Flooding				Wetland Flooding											
	PURPOSE	AGENCY	EFFECTIVE	COST	PURPOSE	AGENCY	EFFECTIVE	COST	PURPOSE	AGENCY	EFFECTIVE	COST	PURPOSE	AGENCY	EFFECTIVE	COST	PURPOSE	AGENCY	EFFECTIVE	COST	PURPOSE	AGENCY	EFFECTIVE	COST	PURPOSE	AGENCY	EFFECTIVE	COST	PURPOSE	AGENCY	EFFECTIVE	COST												
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4	0	0	2	6	4	1	--	--	--	--	0	0	0	0	0	--	--	--	--	--	--	--	--				
2	0	0	0	0	0	1	0	10	1	5	0	0	0	0	0	0	0	0	0	1	4	4	1	--	--	--	--	0	0	0	0	0	--	--	--	--	--	--	--	--				
3	0	0	0	0	0	1	0	4	10	3	0	0	0	0	0	0	0	0	0	1	4	4	1	--	--	--	--	0	0	0	0	0	--	--	--	--	--	--	--	--				
4	1	0	1	10	10	1	0	1	10	10	0	0	0	0	0	1	0	1	10	7	0	0	0	0	--	--	--	--	0	1	10	10	1	--	--	--	--	--	--	--	--			
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	10	10	--	--	--	--	0	0	0	0	0	--	--	--	--	--	--	--	--			
6	0	0	0	0	0	0	1	10	1	1	0	1	10	1	1	0	0	0	0	0	0	0	0	0	--	--	--	--	0	0	0	0	0	--	--	--	--	--	--	--	--			
7	0	0	0	0	0	0	0	0	0	0	1	10	1	2	1	0	1	10	10	0	1	10	10	1	--	--	--	--	1	0	10	7	1	--	--	--	--	--	--	--	--	--		
8	1	0	1	10	6	1	0	1	10	6	0	0	0	0	0	0	0	0	0	1	10	1	1	--	--	--	--	0	0	0	0	0	--	--	--	--	--	--	--	--	--			
9	0	0	0	0	0	0	1	10	4	1	0	0	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--			
10	1	0	1	10	10	0	1	10	0	1	0	0	0	0	1	0	4	1	2	1	0	10	10	2	--	--	--	--	0	0	0	0	0	--	--	--	--	--	--	--	--	--		
11	0	0	0	0	0	1	0	10	1	2	0	0	0	0	0	1	1	20	2	3	0	1	10	0	1	0	0	0	0	0	0	0	0	--	--	--	--	--	--	--	--	--		
12	0	0	0	0	0	1	0	1	10	4	0	0	0	0	0	1	10	0	1	0	1	10	7	1	0	0	0	0	0	0	0	1	10	4	4	--	--	--	--	--	--	--	--	--
13	0	1	10	4	1	0	2	20	4	2	0	0	0	0	0	0	0	0	0	1	10	4	4	0	0	0	0	0	0	0	0	0	0	--	--	--	--	--	--	--	--	--		
14	1	0	1	10	8	2	0	11	14	8	0	0	0	0	1	0	1	10	8	0	1	1	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
15	0	0	0	0	0	0	1	10	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--	--	--	--	--	--	--	--		
16	1	0	1	10	8	0	0	0	0	0	0	0	0	0	1	0	1	10	8	0	1	10	10	1	0	0	0	0	0	0	0	0	0	--	--	--	--	--	--	--	--	--		
17	0	0	0	0	0	0	0	0	0	0	1	10	0	1	0	0	0	0	0	0	1	10	7	1	--	--	--	--	0	1	10	7	7	--	--	--	--	--	--	--	--	--	--	
18	1	0	1	10	8	0	0	0	0	0	0	0	0	0	0	1	10	0	2	0	0	0	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
19	0	0	0	0	0	0	1	10	1	1	0	0	0	0	0	0	0	0	0	0	1	10	0	1	--	--	--	--	0	0	0	0		--	--	--	--	--	--	--	--	--		
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
21	0	0	0	0	0	0	1	10	4	2	1	0	10	10	5	1	0	1	10	7	1	0	10	10	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
22	1	0	1	7	8	1	0	1	7	6	1	0	1	7	5	3	0	6	30	7	2	0	5	20	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--	--	--	--	0	1	10	10	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
24	0	0	0	0	0	0	0	0	0	0	1	10	4	2	1	0	1	10	6	0	1	10	4	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	20	6	2	1	12	30	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

-- Indicates N/A (not applicable)

## Annex 21

House Number	Adjustments provided by the Municipality			Adjustments provided by the Community			Total Points	Hazardscape Adjustments (%)	Level of Adjustment
	Purposive	Responsive	Effectiveness	Purposive	Responsive	Effectiveness			
1	0	2	4	0	0	0	33	10.46 %	HPAL-A
2	0	0	0	0	0	0	32	10.46 %	HPAL-A
3	0	0	0	0	0	0	33	10.46 %	HPAL-A
4	1/2	0	1	0	0	0	102.5	33.50 %	HPAL-B
5	1	0	7	0	0	0	41	13.40 %	HPAL-A
6	0	0	0	0	0	0	28	9.15 %	HPAL-A
7	0	0	0	0	0	0	87	28.43 %	HPAL-B
8	1	0	10	0	0	0	73	23.86 %	HPAL-A
9	0	0	0	0	0	0	17	14.53 %	HPAL-A
10	0	0	0	0	0	0	73	23.86 %	HPAL-A
11	1	0	7	0	0	0	73	19.78 %	HPAL-A
12	2	0	17	0	0	0	100	27.10 %	HPAL-B
13	2	0	17	0	0	0	94	25.47 %	HPAL-A
14	0	0	0	0	0	0	102	41.98 %	HPAL-B
15	1	0	10	0	0	0	28	7.58 %	HPAL-A
16	1	0	10	0	0	0	86	23.31 %	HPAL-A
17	1	0	4	0	0	0	68	22.22 %	HPAL-A
18	0	0	0	0	0	0	38	15.64 %	HPAL-A
19	0	0	0	0	1	0	29	9.48 %	HPAL-A
20	0	0	0	0	0	0	0	0.00 %	HPAL-A
21	0	0	0	0	0	0	101	41.56 %	HPAL-B
22	0	0	0	0	0	0	156	64.20 %	HPAL-C
23	1	0	10	0	0	0	34	18.89 %	HPAL-A
24	0	0	0	0	0	0	57	23.46 %	HPAL-A
25	0	0	0	0	0	0	98	40.33 %	HPAL-B

½ = incomplete adjustment = 2.5 points (see Annex 3)

## Annex 22

### Average Monthly Household Income and Savings Versus Level of Flood Hazardscape Adjustments for RDP Dwellings

House Number	Monthly Household Income	Estimated Monthly Household Expenses	Flood Hazardscape Adjustment Level	Average Income per Adjustment Level	
				Adjustment Level	Average Income
1	R2 980	R1 160	A	Adjustment Level	Average Income
2	R1 880	R 450	A		
3	R4 530	R2 300	A	A	R3 113
4	R7 000	R3 501	B	B	R3 595
5	R2 820	R2 600	A	C	R3 470
6	R3 500	R1 480	A	D	N/A
7	R4 300	R2 000	B	Average Savings per Adjustment Level	
8	R4 500	R1 700	A		
9	R1 500	R 750	A		
10	R7 000	R5 000	A	Adjustment Level	Average Savings
11	R5 100	R2 250	A		
12	R2 570	R 450	B	A	R1 639
13	R1 500	R1 500	A	B	R2 119
14	R4 000	R2 000	B	C	R1 220
15	R 640	R 200	A	D	N/A
16	R2 400	R 400	A		
17	R3 270	R1 000	A		
18	R2 841	R1 000	A		
19	R1 140	R1 000	A		
20	R2 100	R 490	A		
21	R2 100	R 200	B		
22	R3 470	R2 250	C		
23	R6 800	R2 000	A		
24	R1 540	R1 255	A		
25	R1 600	R 700	B		
<b>Average</b>	R3 243	R1 399			

**Human and Social Capital  
Versus  
Flood Hazardscape Adjustment Levels of RDP Dwellings**

University of Cape Town

**Annex 23**

House No.	Adjustment Level	Highest Education Level	No. of People with useful Skills	Access to Flood Safety Info.	Financial Support Network	Business Cooperation	Community Discussion Forums	Religious Organisation	No. of NB NGOs	No. of NB CBOs	Ward Councillor	Ward Committee Member	Active Member of Political Party	Religious Leader	No. of Important Municipal Departments
1	A	Grade 11	3	No	No	No	No	Yes	2	0	No	No	No	No	4
2	A	Grade 12	4	No	No	No	Yes	Yes	2	0	No	Yes	No	No	2
3	A	Grade 10	4	No	No	No	Yes	N/A	2	1	No	No	No	No	2
4	B	Grade 12	2	No	No	No	Yes	Yes	3	1	Yes	N/A	Yes	No	2
5	A	Grade 12	2	No	No	No	Yes	N/A	0	0	No	No	No	No	7
6	A	Grade 11	1	No	No	Yes	Yes	Yes	0	0	No	No	No	No	0
7	B	Grade 12	2	No	No	No	Yes	Yes	1	0	No	No	Yes	Yes	1
8	A	Tertiary	1	No	No	No	Yes	Yes	0	0	No	No	No	No	3
9	A	Grade 11	1	No	No	No	No	No	0	0	No	No	No	No	2
10	A	Grade 12	2	No	No	No	No	Yes	0	0	No	No	No	No	1
11	A	Tertiary	2	No	Yes	No	Yes	Yes	0	0	No	No	No	No	4
12	B	Grade 12	3	No	No	No	Yes	Yes	0	0	No	No	No	No	1
13	A	Grade 12	2	No	No	No	Yes	Yes	0	0	No	No	No	No	3
14	B	Grade 12	1	No	No	No	Yes	Yes	0	0	No	No	No	No	1
15	A	Grade 6	1	No	Yes	No	Yes	Yes	0	0	No	No	No	No	1
16	A	Grade 12	0	No	Yes	No	No	Yes	0	0	No	No	No	No	1
17	A	Grade 10	3	Yes	No	No	Yes	Yes	0	0	No	No	No	No	1
18	A	Grade 12	2	No	No	No	Yes	Yes	0	1	No	No	No	Yes	7
19	A	Grade 11	1	No	No	Yes	Yes	Yes	0	0	No	No	No	No	1
20	A	Grade 11	2	No	Yes	No	Yes	Yes	0	0	No	No	No	No	1
21	B	Grade 10	1	No	No	Yes	No	Yes	0	0	No	No	No	No	3
22	C	Grade 11	2	No	No	Yes	Yes	Yes	1	0	No	No	No	No	3
23	A	Grade 12	2	No	No	No	No	Yes	0	0	No	No	No	No	3
24	A	Grade 9	1	No	Yes	No	Yes	Yes	0	0	No	No	No	No	3
25	B	Grade 9	1	No	Yes	No	Yes	Yes	1	0	No	No	No	No	1

**Annex 24**

**Levels of Flood Hazardscape Adjustments of  
Informal Dwellings**

University of Cape Town



## Annex 24

House Number	Adjustments provided by the Municipality			Adjustments provided by the Community			Innovative Ideas still to Implement	Total Points	Hazardscape Adjustments (%)	Level of Adjustment
	Purposive	Responsive	Effectiveness	Purposive	Responsive	Effectiveness				
1	1	0	4	0	0	0	0	38	8.80 %	HPAL-A
2	0	1	10	0	0	0	0	107	28.99 %	HPAL-B
3	0	0	0	0	0	0	0	0	0 %	HPAL-A
4	0	1	4	0	0	0	0	93	30.39 %	HPAL-B
5	0	0	0	0	0	0	0	60	19.61 %	HPAL-A
6	0	0	0	0	0	0	0	51	11.81 %	HPAL-A
7	0	0	0	0	1	1	0	118	27.31 %	HPAL-B
8	0	0	0	0	0	0	0	128	29.63 %	HPAL-B
9	0	0	0	0	0	0	0	33	13.58 %	HPAL-A
10	0	0	0	0	1	1	10	122	39.87 %	HPAL-B
11	0	0	0	0	1	1	10	114	37.25 %	HPAL-B
12	0	0	0	0	0	0	0	41	13.40 %	HPAL-A
13	0	0	0	0	0	0	0	282	92.16 %	HPAL-D
14	0	0	0	0	1	4	0	172	39.81 %	HPAL-B
15	0	1	1	0	0	0	0	60	13.89 %	HPAL-A
16	0	0	0	0	1	2	0	75	24.51 %	HPAL-A
17	0	0	0	0	0	0	0	14	4.58 %	HPAL-A
18	0	1	1	0	1	4	5	59	19.28 %	HPAL-A
19	0	0	0	0	0	0	0	122	33.06 %	HPAL-B
20	0	0	0	0	0	0	5	33	13.58 %	HPAL-A
21	0	0	0	0	0	0	0	37	12.09 %	HPAL-A
22	0	0	0	0	0	0	0	41	11.11 %	HPAL-A
23	0	0	0	0	0	0	0	87	23.58 %	HPAL-A
24	0	0	0	0	1	1	0	77	25.16 %	HPAL-A
25	0	0	0	0	0	0	0	55	17.97 %	HPAL-A

## Annex 25

### Average Monthly Household Income and Savings Versus Level of Flood Hazardscape Adjustments for Informal Dwellings

House Number	Monthly Household Income	Estimated Monthly Household Expenses	Flood Hazardscape Adjustment Level	Average Income per Adjustment Level	
				Adjustment Level	Average Income
1	R2 370	R1 000	A	Adjustment Level	Average Income
2	R2 100	R2 000	B		
3	R3 200	R1 000	A	A	R2 200
4	R1 000	R 400	B	B	R2 467
5	R1 800	R1 500	A	C	N/A
6	R2 800	R1 000	A	D	R1 600
7	R 800	R 300	B	Average Savings per Adjustment Level	
8	R1 280	R1 250	B		
9	R4 000	R 400	A		
10	R4 000	R2 750	B	Adjustment Level	Average Savings
11	R3 000	R1 000	B	A	R1 069
12	R1 200	R1 000	A	B	R1 212
13	R1 600	R1 000	D	C	N/A
14	R1 320	R1 000	B	D	R 600
15	R2 880	R 850	A		
16	R1 600	R1 750	A		
17	R1 600	R1 250	A		
18	R4 200	R2 000	A		
19	R6 240	R1 000	B		
20	R6 000	R3 000	A		
21	R3 400	R1 000	A		
22	R1 200	R1 000	A		
23	R 750	R 750	A		
24	R1 200	R 750	A		
25	R1 400	R1 000	A		
<b>Average</b>	R2 430	R 991			

**Human and Social Capital  
Versus  
Flood Hazardscape Adjustment Levels of Informal  
Dwellings**

University of Cape Town

## Annex 26

House No.	Adjustment Level	Highest Education Level	No. of People with useful Skills	Access to Flood Safety Info.	Financial Support Network	Business Cooperation	Community Discussion Forums	Religious Organisation	No. of NB NGOs	No. of NB CBOs	Ward Councillor	Ward Committee Member	Active Member of Political Party	Former Ward Committee Member	Religious Leader	No. of Important Municipal Departments
1	A	Grade 10	2	No	No	No	Yes	Yes	1	0	No	No	No	No	No	0
2	B	Grade 9	1	No	No	No	Yes	Yes	0	1	No	No	No	No	No	1
3	A	Grade 10	1	No	No	No	No	Yes	0	0	No	No	No	No	No	0
4	B	Grade 9	1	No	No	No	Yes	Yes	0	0	No	No	No	No	No	0
5	A	Grade 12	1	No	Yes	No	Yes	Yes	0	0	No	No	No	No	No	0
6	A	Grade 12	2	No	No	No	Yes	Yes	0	0	No	No	No	No	No	0
7	B	Grade 9	1	Yes	Yes	No	Yes	Yes	0	0	No	No	No	No	No	0
8	B	Grade 8	1	No	No	No	Yes	Yes	0	0	No	No	No	No	No	0
9	A	Grade 10	1	No	No	No	No	Yes	0	0	No	No	No	No	No	0
10	B	Grade 11	1	No	No	No	Yes	Yes	0	0	No	No	No	No	No	0
11	B	Grade 9	1	No	No	No	Yes	Yes	1	0	No	No	No	No	No	1
12	A	Grade 12	1	No	No	Yes	Yes	No	0	1	No	No	No	No	No	1
13	D	Grade 8	1	No	No	No	Yes	Yes	1	1	No	No	No	Yes	No	2
14	B	Grade 12	1	No	Yes	No	Yes	Yes	0	0	No	No	No	No	No	1
15	A	Grade 10	2	No	No	No	Yes	Yes	1	0	No	No	No	No	No	0
16	A	Grade 11	1	No	Yes	Yes	Yes	Yes	0	0	No	No	No	No	No	0
17	A	Grade 12	1	No	Yes	No	Yes	No	0	0	No	No	No	No	No	1
18	A	Grade 11	3	No	Yes	No	Yes	Yes	0	1	No	No	No	No	No	1
19	B	Grade 12	1	No	No	No	No	Yes	0	0	No	No	No	No	No	0
20	A	Grade 11	3	No	No	No	Yes	Yes	1	0	No	No	No	No	No	0
21	A	Grade 11	2	No	No	No	No	Yes	0	0	No	No	No	No	No	0
22	A	Grade 12	1	No	No	No	No	No	0	0	No	No	No	No	No	1
23	A	Grade 12	2	Yes	No	No	Yes	No	0	0	No	No	No	No	No	1
24	A	Grade 10	2	No	Yes	No	No	No	0	1	No	No	No	No	No	1
25	A	Grade 4	1	No	Yes	No	Yes	Yes	0	0	No	No	No	No	No	1

Annex 27

Figures 8.13 and 8.14

Figure 8.13 Side view illustration of a proposed Box to be built around an informal dwelling and Filled with concrete to prevent Seepage

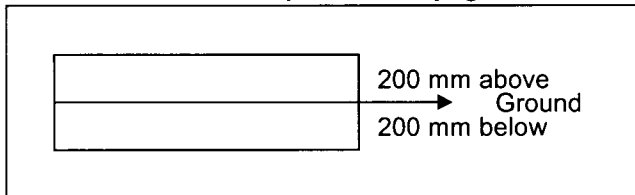
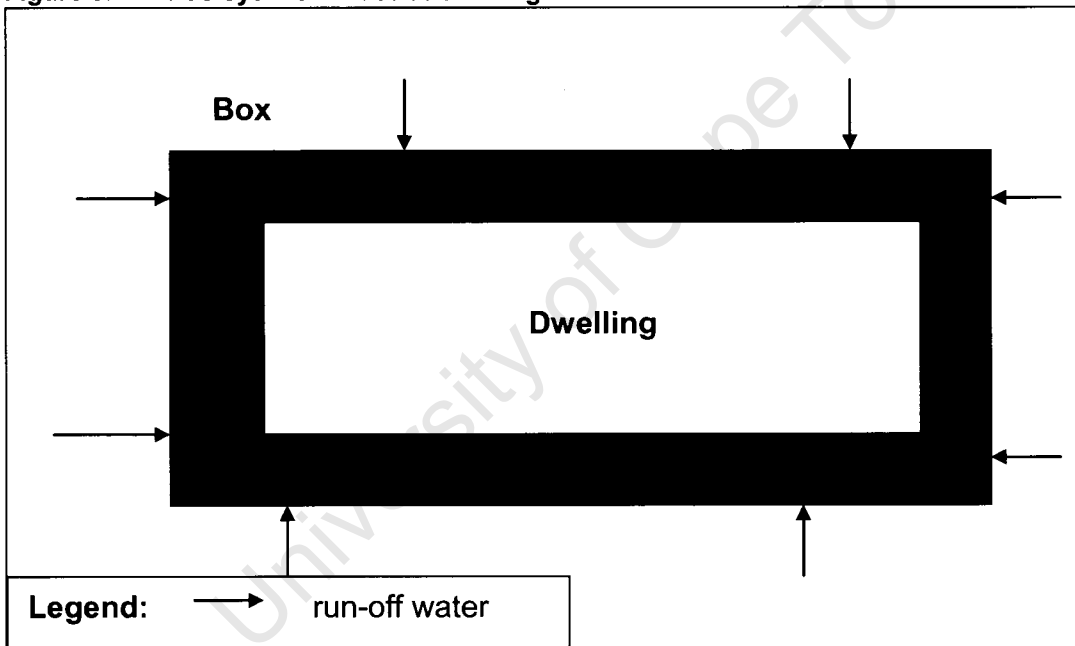


Figure 8.14 Birds eye view illustration of figure 8.13



**Scoring Physical Exposure of RDP Dwelling Households  
in Thembaletu**

University of Cape Town

**Annex 28**

House Number	Physical Exposure Indicators												Sub-total & percent
	Road Type	Dwelling State	Foundation Exists	Water & Sanitation	Garden Exists	Vegetation Cover	Location	Proximity to stream/ stormwater channel	Proximity to stormwater outlet	Proximity to wetland	High water table	Under-ground Spring	
1	7	10	0	0	10	5	0	0	0	0	10	0	42 (35 %)
2	7	10	0	0	10	0	0	0	0	0	10	0	37 (30.83 %)
3	7	10	0	0	0	5	0	0	0	0	10	0	32 (26.67%)
4	7	-5	0	0	10	10	0	0	0	0	0	0	22 (18.33%)
5	7	-5	0	0	10	10	0	0	0	0	0	0	22 (18.33%)
6	7	10	0	0	10	5	0	0	0	0	0	0	32 (26.67%)
7	7	5	0	0	0	0	0	0	0	0	0	0	12 (10%)
8	1	10	0	0	0	0	0	0	0	0	0	0	11 (9.17%)
9	7	5	0	5	10	5	0	0	0	0	0	0	32 (26.67%)
10	7	5	0	0	0	0	2	0	0	0	0	0	14 (11.67%)
11	7	0	0	10	0	5	2	1	0	1	0	0	26 (21.67%)
12	7	5	0	0	10	5	2	1	0	0	0	0	30 (25%)
13	7	5	0	0	10	10	2	1	0	1	0	0	36 (30%)
14	1	0	0	0	10	0	0	0	0	0	10	10	31 (25.83%)
15	7	10	0	10	10	5	6	0	0	0	10	0	58 (48.33%)
16	7	5	0	0	10	5	0	0	0	0	0	0	27 (22.50%)
17	7	10	0	0	10	5	2	0	0	0	10	0	44 (36.67%)
18	7	5	0	0	10	5	6	0	0	0	10	10	53 (44.17%)
19	7	10	0	5	0	5	0	0	0	0	10	0	37 (30.83%)
20	7	5	0	0	10	5	2	0	0	0	10	0	39 (32.50%)
21	7	5	0	0	10	10	0	0	0	0	10	10	52 (43.33%)
22	7	5	0	0	0	5	0	0	0	0	10	0	27 (22.50%)
23	1	-10	0	0	0	0	0	5	0	1	0	0	-3 (-2.50%)
24	1	0	0	0	10	10	0	9	10	1	0	0	41 (34.17%)
25	7	5	0	0	10	2	5	0	0	0	0	0	29 (24.17%)

**Scoring Physical Exposure of Informal Dwelling  
Households in Thembalethu**

University of Cape Town



## Annex 30

### Scoring Vulnerability Pre-Adjustments of RDP Dwelling Households in Thembaletu

Household Number	Physical Exposure	Livelihoods Analysis				Total	Percent	Vulnerability Level
		Physical Capital	Human Capital	Financial Capital	Social Capital			
1	42	23	77	23	0	165	36.67%	B
2	37	13	78	46	-20	154	34.22%	B
3	32	-23	66	30	-2	103	22.89%	A
4	22	-22	81	-2	-42	37	8.22%	A
5	22	-2	62	13	6	101	22.44%	A
6	32	8	35	36	0	111	24.67%	A
7	12	-22	58	20	-21	47	10.44%	A
8	11	-22	71	6	-2	64	14.22%	A
9	32	18	60	41	4	155	34.44%	B
10	14	-22	82	24	0	98	21.78%	B
11	26	-46	49	23	0	52	11.56%	A
12	30	10	101	40	-2	179	39.78%	B
13	36	18	91	47	4	196	43.56%	B
14	31	35	72	13	4	155	34.44%	B
15	58	10	76	44	4	192	42.67%	B
16	27	11	58	37	2	135	30%	B
17	44	16	58	37	4	159	35.33%	B
18	53	-22	80	29	-25	115	25.56%	A
19	37	18	85	46	0	186	41.33%	B
20	39	-24	89	37	0	141	31.33%	B
21	52	13	68	52	0	185	41.11%	B
22	27	-14	99	38	-4	146	32.44%	B
23	-3	-4	116	1	2	112	24.89%	A
24	41	-2	64	30	-4	129	28.67%	B
25	29	-4	84	44	-2	151	33.56%	B

## Annex 31

### Scoring Vulnerability Pre-Adjustments of Informal Dwelling Households in Thembaletu

Household Number	Physical Exposure	Livelihoods Analysis				Total	Percent	Vulnerability Level
		Physical Capital	Human Capital	Financial Capital	Social Capital			
1	76	53	101	22	2	254	56.44%	C
2	85	21	53	8	2	169	37.56%	B
3	98	13	40	8	8	167	37.11%	B
4	73	33	73	36	-6	209	46.44%	B
5	81	31	77	41	2	232	51.56%	C
6	76	31	40	13	6	166	36.89%	B
7	77	53	68	59	2	259	57.56%	C
8	72	35	85	26	6	224	49.78%	B
9	80	49	97	39	8	273	60.67%	C
10	52	45	66	16	6	185	41.11%	B
11	66	48	97	41	4	256	56.89%	C
12	57	45	68	24	0	194	43.11%	B
13	17	33	62	13	-13	112	24.89%	A
14	98	33	67	17	2	217	48.22%	B
15	97	0	84	44	2	227	50.44%	B
16	71	53	65	29	2	220	48.89%	B
17	96	51	65	34	6	252	56%	C
18	71	33	74	21	-2	197	43.78%	B
19	89	29	68	33	8	227	50.44%	B
20	72	19	81	25	4	201	44.67%	B
21	84	33	43	19	8	187	41.56%	B
22	80	65	97	35	8	285	63.33%	C
23	68	33	62	52	6	221	49.11%	B
24	41	38	65	52	2	198	44%	B
25	60	33	57	33	2	185	41.11%	B

## Annex 32

### Scoring Physical Capital of RDP Dwelling Households in Thembaletu

Household Number	Physical Capital Indicators							Sub-total	Percent
	House Ownership	Assets	Electricity Supply	Cell phone	T.V	Radio	Internet		
1	10	10	0	-2	5	-10	10	23	32.86%
2	0	10	0	-2	5	-10	10	13	18.57%
3	0	-11	0	-2	-10	-10	10	-23	-32.86%
4	0	-10	0	-2	-10	-10	10	-22	-31.42%
5	0	10	0	-2	-10	-10	10	-2	-2.86%
6	0	10	10	-2	-10	-10	10	8	11.43%
7	0	-10	0	-2	-10	-10	10	-22	-31.42%
8	0	10	0	-2	-10	-10	-10	-22	-31.42%
9	0	10	0	-2	10	-10	10	18	25.71%
10	0	-10	0	-2	-10	-10	10	-22	-31.42%
11	0	-10	0	-6	-10	-10	-10	-46	-65.71%
12	0	10	0	10	-10	-10	10	10	14.29%
13	0	10	0	-2	-10	10	10	18	25.71%
14	0	0	0	10	5	10	10	35	50%
15	0	10	0	10	-10	-10	10	10	14.29%
16	0	10	0	-4	5	-10	10	11	15.71%
17	0	10	0	-4	10	-10	10	16	22.86%
18	0	-10	0	-2	-10	-10	10	-22	-31.42%
19	0	10	0	-2	-10	10	10	18	25.71%
20	0	-10	0	-4	-10	-10	10	-24	-34.29%
21	10	10	0	-2	5	-10	10	13	18.57%
22	0	-10	0	-4	0	-10	10	-14	-20%
23	0	10	0	-4	-10	-10	10	-4	-5.71%
24	0	10	0	-2	-10	-10	10	-2	-2.86%
25	0	10	0	-4	-10	-10	10	-4	-5.71%

## Annex 33

### Scoring Physical Capital of Informal Dwelling Households in Thembaletu

Household Number	Physical Capital Indicators								
	House Ownership	Assets	Electricity Supply	Cell phone	T.V	Radio	Internet	Sub-total	Percent
1	5	10	10	-2	10	10	10	53	75.71%
2	5	-2	10	-2	10	-10	10	21	30%
3	5	-10	10	-2	10	-10	10	13	18.57%
4	5	10	10	-2	10	-10	10	33	47.14%
5	5	10	10	-4	10	-10	10	31	44.29%
6	5	10	10	-4	10	-10	10	31	44.29%
7	5	10	10	-2	10	10	10	53	75.71%
8	5	0	10	10	10	-10	10	35	50%
9	5	10	10	-6	10	10	10	49	70%
10	5	10	10	10	10	-10	10	45	64.29%
11	5	10	10	-2	5	10	10	48	68.57%
12	5	10	10	10	10	-10	10	45	64.29%
13	5	10	10	-2	10	-10	10	33	47.14%
14	5	10	10	-2	-10	10	10	33	47.14%
15	5	-3	10	-2	-10	-10	10	0	0%
16	5	10	10	-2	10	10	10	53	75.71%
17	5	10	10	-4	10	10	10	51	72.86%
18	5	10	10	-2	10	-10	10	33	47.14%
19	5	10	10	-6	10	-10	10	29	41.43%
20	5	0	10	-6	10	-10	10	19	27.14%
21	5	10	10	-2	10	-10	10	33	47.14%
22	5	10	10	10	10	10	10	65	92.86%
23	5	-10	10	-2	10	10	10	33	47.14%
24	10	10	10	-2	10	-10	10	38	54.29%
25	5	10	10	-2	10	-10	10	33	47.14%

**Scoring Human Capital of RDP Dwelling Households in  
Thembaletu**

University of Cape Town

### Annex 34

Household Number	Human Capital Indicators										
	Household Head Age	Household Head Ethnicity	Vulnerable Age Group	Highest Education Level	Illiterate People	% useful skills	% employed	Unemployed	Years in settlement	Years in dwelling	Choice of site location
1	0	6	0	1	0	4	5	0	7	8	10
2	0	2	0	0	0	4	7	0	6	7	10
3	0	6	0	2	0	2	7	0	8	9	0
4	0	2	10	0	0	6	8	10	3	7	10
5	0	2	10	0	0	6	8	0	4	8	0
6	0	2	0	1	0	0	0	0	8	8	0
7	0	2	0	0	0	6	6	0	4	8	10
8	0	2	10	-6	0	8	8	10	7	7	5
9	0	2	0	1	0	8	6	0	6	7	5
10	0	2	20	0	0	6	7	0	7	8	0
11	0	2	0	-6	0	6	6	20	2	9	0
12	0	2	0	0	0	6	9	20	4	6	0
13	0	2	10	0	0	6	9	10	8	8	10
14	0	2	0	0	0	6	7	20	7	8	0
15	0	6	0	6	10	6	6	10	5	6	5
16	0	2	0	0	0	10	4	0	8	8	10
17	0	2	0	2	0	0	4	10	9	10	0
18	0	2	20	0	0	6	7	10	6	7	0
19	0	2	20	1	0	8	9	10	7	7	5
20	0	2	10	1	10	6	6	0	3	8	5
21	0	10	0	2	0	6	0	0	10	10	5
22	0	2	0	9	0	8	7	20	2	7	0
23	0	2	0	0	0	6	9	30	6	8	5
24	0	2	10	1	0	6	7	0	7	9	0
25	0	2	10	3	0	8	9	10	7	8	5

**Annex 34**

Household Number	Human Capital Indicators						Subtotal	Percent
	Place of Origin	Reason for Migration	Disabled/ Mentally Ill	Major illness/ disease	Heavy drinkers	Flood safety information		
1	2	10	0	9	0	10	77	45.29%
2	2	10	20	0	0	10	78	45.89%
3	2	4	10	6	0	10	66	38.82%
4	2	10	0	3	0	10	81	47.65%
5	2	2	0	9	0	10	62	36.47%
6	2	1	0	3	0	10	35	20.59%
7	2	10	0	0	0	10	58	34.12%
8	0	0	0	0	10	10	71	41.76%
9	2	10	0	3	0	10	60	35.29%
10	2	10	0	0	10	10	82	48.24%
11	0	0	0	0	0	10	49	28.82%
12	2	10	10	12	10	10	101	59.41%
13	2	10	0	6	0	10	91	53.53%
14	2	10	0	0	0	10	72	42.35%
15	2	4	0	0	0	10	76	44.71%
16	2	4	0	0	0	10	58	34.12%
17	2	10	0	9	0	0	58	34.12%
18	2	10	0	0	0	10	80	47.06%
19	2	4	0	0	0	10	85	50%
20	2	10	0	6	10	10	89	52.35%
21	10	10	0	0	0	5	68	40%
22	2	10	10	12	0	10	99	58.24%
23	2	10	10	17	10	0	116	68.24%
24	2	10	0	0	0	10	64	37.65%
25	2	10	0	0	0	10	84	49.41%

**Scoring Human Capital of Informal Dwelling Households  
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Annex 35

Household Number	Human Capital Indicators										
	Household Head Age	Household Head Ethnicity	Vulnerable Age Group	Highest Education Level	Illiterate People	% useful skills	% employed	Unemployed	Years in settlement	Years in dwelling	Choice of site location
1	0	6	20	2	0	8	9	30	8	8	0
2	0	2	0	3	0	0	0	0	8	8	10
3	0	2	0	2	0	0	0	0	7	7	0
4	0	2	0	9	0	6	6	0	9	9	10
5	0	2	10	0	0	6	7	10	10	10	0
6	0	2	0	0	0	0	0	0	7	9	0
7	0	2	10	3	0	6	7	10	9	9	0
8	0	6	10	4	0	8	9	10	8	8	0
9	0	2	0	2	0	8	7	20	8	8	0
10	0	2	0	1	0	6	0	0	7	8	0
11	0	6	30	3	10	8	6	0	6	7	0
12	0	2	0	0	0	6	6	10	5	7	0
13	0	6	0	4	0	0	0	0	7	8	0
14	0	2	10	0	0	6	6	0	8	8	10
15	0	6	0	2	0	6	6	10	8	8	10
16	0	2	0	1	0	6	6	10	9	9	0
17	0	2	0	0	0	6	6	10	9	10	0
18	7	6	0	1	10	4	3	0	8	8	0
19	0	2	10	0	0	8	3	0	9	9	10
20	0	2	20	1	0	6	7	10	6	7	0
21	0	2	0	1	0	4	0	0	7	7	0
22	0	2	10	0	0	8	8	10	8	9	10
23	0	2	0	0	0	0	10	20	7	7	0
24	0	2	0	2	0	4	7	10	9	9	0
25	0	2	0	8	0	0	0	0	7	8	10

**Annex 35**

Household Number	Human Capital Indicators						Subtotal	Percent
	Place of Origin	Reason for Migration	Disabled/ Mentally Ill	Major illness/ disease	Heavy drinkers	Flood safety information		
1	0	0	0	0	0	10	101	59.41%
2	2	10	0	0	0	10	53	31.17%
3	2	10	0	0	0	10	40	23.53%
4	2	10	0	0	0	10	73	42.94%
5	2	10	0	0	0	10	77	45.29%
6	2	10	0	0	0	10	40	23.53%
7	2	10	0	0	0	0	68	40%
8	2	10	0	0	0	10	85	50%
9	2	10	0	0	30	10	97	57.06%
10	5	7	20	0	0	10	66	38.82%
11	0	0	10	6	0	5	97	57.06%
12	2	10	0	0	10	10	68	40%
13	2	5	0	20	0	10	62	36.47%
14	2	5	0	0	0	10	67	39.41%
15	2	10	0	6	0	10	84	49.41%
16	2	10	0	0	0	10	65	38.24%
17	2	10	0	0	0	10	65	38.24%
18	2	5	0	0	10	10	74	43.53%
19	2	5	0	0	0	10	68	40%
20	2	10	0	0	10	10	81	47.65%
21	2	10	0	0	0	10	43	25.29%
22	2	10	0	10	0	10	97	57.06%
23	2	10	0	0	0	5	62	36.47%
24	2	5	0	5	0	10	65	38.24%
25	2	10	0	0	0	10	57	33.53%

## Annex 36

### Scoring Financial Capital of RDP Dwelling Households in Thembaletu

House Number	Financial Capital Indicators							Sub-total	Percent
	Monthly Income	Monthly Expense	Remittance	Monthly Savings	% with Bank Accounts	Micro-lending Sources	Insurance Coverage		
1	4	10	0	4	9	0	-4	23	32.86%
2	9	10	0	8	9	0	10	46	65.71%
3	1	6	0	4	9	0	10	30	42.86%
4	0	1	0	0	6	0	-9	-2	-2.86%
5	7	8	0	0	9	0	-11	13	18.57%
6	0	0	0	6	10	10	10	36	51.43%
7	0	6	0	10	8	0	-4	20	28.57%
8	1	7	10	2	8	0	-22	6	3.53%
9	8	10	10	1	6	10	-4	41	24.12%
10	0	1	10	10	7	0	-4	24	14.12%
11	0	4	10	8	0	10	-9	23	32.86%
12	6	10	0	9	7	10	-2	40	57.14%
13	10	10	10	10	9	0	-2	47	67.14%
14	0	3	0	10	4	0	-4	13	18.57%
15	9	10	0	9	10	10	-4	44	62.86%
16	1	10	10	2	4	0	10	37	52.86%
17	0	9	0	8	0	10	10	37	52.86%
18	4	10	10	4	5	10	-4	29	41.43%
19	10	10	0	9	9	10	-2	46	65.71%
20	9	10	0	1	9	10	-2	37	52.86%
21	1	10	10	1	10	10	10	52	74.29%
22	8	10	0	1	9	0	10	38	54.29%
23	0	9	0	3	9	0	-20	1	1.43%
24	5	7	10	8	4	0	-4	30	42.86%
25	10	10	0	8	10	10	-4	44	62.86%

Annex 37

Scoring Financial Capital of Informal Dwelling Households in Thembaletlu

House Number	Financial Capital Indicators							Sub-total	Percent
	Monthly Income	Monthly Expense	Remittance	Monthly Savings	% with Bank Accounts	Micro-lending Sources	Insurance Coverage		
1	10	10	-10	6	8	0	-2	22	31.43%
2	0	0	10	2	0	0	-4	8	11.43%
3	0	1	10	1	0	0	-4	8	11.43%
4	6	10	10	6	6	0	-2	36	51.43%
5	5	6	0	6	4	10	10	41	58.57%
6	0	6	-10	7	0	0	10	13	18.57%
7	10	10	10	9	10	0	10	59	84.29%
8	10	10	0	0	10	0	-4	26	37.14%
9	1	10	0	1	7	10	10	39	55.71%
10	0	0	10	1	10	0	-5	16	22.86%
11	6	10	0	6	9	0	10	41	58.57%
12	4	6	10	2	6	0	-4	24	34.29%
13	0	1	0	6	10	0	-4	13	18.57%
14	2	5	0	8	6	0	-4	17	24.29%
15	1	5	10	10	8	0	10	44	62.86%
16	1	1	10	2	5	0	10	29	41.43%
17	1	3	10	4	6	0	10	34	48.57%
18	0	6	10	1	8	0	-4	21	30%
19	0	10	10	0	3	0	10	33	47.14%
20	2	9	10	1	7	0	-4	25	35.71%
21	0	9	10	4	0	0	-4	19	27.14%
22	10	10	0	9	10	0	-4	35	50%
23	8	8	0	10	6	10	10	52	74.29%
24	4	8	10	6	4	10	10	52	74.29%
25	0	1	10	2	0	10	10	33	47.14%

## Annex 38

### Scoring Social Capital of RDP Dwelling Households in Thembaletu

Household Number	Social Capital Indicators			
	Social Capital/ Security	Political Affiliation	Subtotal	Percent
1	-10	10	0	0%
2	-12	-8	-20	-100%
3	-12	10	-2	-10%
4	-28	-14	-42	-210%
5	-4	10	6	30%
6	-10	10	0	0%
7	-12	-9	-21	-105%
8	-12	10	-2	-10%
9	-6	10	4	20%
10	-10	10	0	0%
11	-10	10	0	0%
12	-12	10	-2	-10%
13	-6	10	4	20%
14	-6	10	4	20%
15	-6	10	4	20%
16	-8	10	2	10%
17	-6	10	4	20%
18	-22	-3	-25	-125%
19	-10	10	0	0%
20	-10	10	0	0%
21	-10	10	0	0%
22	-14	10	-4	-20%
23	-8	10	2	10%
24	-14	10	-4	-20%
25	-12	10	-2	-10%

## Annex 39

### Scoring Social Capital of Informal Dwelling Households in Thembaletu

Household Number	Social Capital Indicators			
	Social Capital/ Security	Political Affiliation	Subtotal	Percent
1	-8	10	2	10%
2	-8	10	2	10%
3	-2	10	8	40%
4	-16	10	-6	-30%
5	-8	10	2	10%
6	-4	10	6	30%
7	-8	10	2	10%
8	-4	10	6	30%
9	-2	10	8	40%
10	-4	10	6	30%
11	-6	10	4	20%
12	-10	10	0	0%
13	-12	-1	-13	-65%
14	-8	10	2	10%
15	-8	10	2	10%
16	-8	10	2	10%
17	-4	10	6	30%
18	-12	10	-2	-10%
19	-2	10	8	40%
20	-6	10	4	20%
21	-2	10	8	40%
22	-2	10	8	40%
23	-4	10	6	30%
24	-8	10	2	10%
25	-8	10	2	10%

## Annex 40

### Scoring Vulnerability Pre-Adjustments of RDP Dwelling Households in Thembaletu

Household Number	Physical Exposure	Livelihoods Analysis				Total	Percent	Vulnerability Level
		Physical Capital	Human Capital	Financial Capital	Social Capital			
1	42	23	77	23	0	165	36.67%	B
2	37	13	78	46	-20	154	34.22%	B
3	32	-23	66	30	-2	103	22.89%	A
4	22	-22	81	-2	-42	37	8.22%	A
5	22	-2	62	13	6	101	22.44%	A
6	32	8	35	36	0	111	24.67%	A
7	12	-22	58	20	-21	47	10.44%	A
8	11	-22	71	6	-2	64	14.22%	A
9	32	18	60	41	4	155	34.44%	B
10	14	-22	82	24	0	98	21.78%	B
11	26	-46	49	23	0	52	11.56%	A
12	30	10	101	40	-2	179	39.78%	B
13	36	18	91	47	4	196	43.56%	B
14	31	35	72	13	4	155	34.44%	B
15	58	10	76	44	4	192	42.67%	B
16	27	11	58	37	2	135	30%	B
17	44	16	58	37	4	159	35.33%	B
18	53	-22	80	29	-25	115	25.56%	A
19	37	18	85	46	0	186	41.33%	B
20	39	-24	89	37	0	141	31.33%	B
21	52	13	68	52	0	185	41.11%	B
22	27	-14	99	38	-4	146	32.44%	B
23	-3	-4	116	1	2	112	24.89%	A
24	41	-2	64	30	-4	129	28.67%	B
25	29	-4	84	44	-2	151	33.56%	B

## Annex 41

### Scoring Vulnerability Pre-Adjustments of Informal Dwelling Households in Thembaletu

Household Number	Physical Exposure	Livelihoods Analysis				Total	Percent	Vulnerability Level
		Physical Capital	Human Capital	Financial Capital	Social Capital			
1	76	53	101	22	2	254	56.44%	C
2	85	21	53	8	2	169	37.56%	B
3	98	13	40	8	8	167	37.11%	B
4	73	33	73	36	-6	209	46.44%	B
5	81	31	77	41	2	232	51.56%	C
6	76	31	40	13	6	166	36.89%	B
7	77	53	68	59	2	259	57.56%	C
8	72	35	85	26	6	224	49.78%	B
9	80	49	97	39	8	273	60.67%	C
10	52	45	66	16	6	185	41.11%	B
11	66	48	97	41	4	256	56.89%	C
12	57	45	68	24	0	194	43.11%	B
13	17	33	62	13	-13	112	24.89%	A
14	98	33	67	17	2	217	48.22%	B
15	97	0	84	44	2	227	50.44%	B
16	71	53	65	29	2	220	48.89%	B
17	96	51	65	34	6	252	56%	C
18	71	33	74	21	-2	197	43.78%	B
19	89	29	68	33	8	227	50.44%	B
20	72	19	81	25	4	201	44.67%	B
21	84	33	43	19	8	187	41.56%	B
22	80	65	97	35	8	285	63.33%	C
23	68	33	62	52	6	221	49.11%	B
24	41	38	65	52	2	198	44%	B
25	60	33	57	33	2	185	41.11%	B

**Scoring Flood Vulnerability Adjustments of RDP  
Dwelling Households in Thembaletu**

University of Cape Town



**Scoring Household Flood Vulnerability Adjustments of  
Informal Dwelling Households in Thembaletu**

University of Cape Town

## Annex 43

Household Number	Awareness of Legislation	Community Rules & Regulations	Special Measures to Protect Most Vulnerable			Household Preparedness Plan			Household Response Plan			Total	Percentage
			Household	Community	Municipality	Formal	Informal	No Plan	Formal	Informal	No Plan		
1	0	7	40	70	40	0	0	0	0	5	0	162	64.80%
2	2	0	0	0	0	0	0	0	0	5	0	7	2.80%
3	0	0	0	0	0	0	0	0	0	0	0	0	0%
4	0	0	0	0	0	0	5	0	0	5	0	10	4%
5	0	0	0	0	0	0	0	0	0	0	0	0	0%
6	0	4	0	0	0	0	0	0	0	5	0	9	3.60%
7	0	0	0	0	0	0	0	0	0	5	0	5	2%
8	0	0	0	70	0	0	0	0	0	5	0	75	30%
9	0	0	0	0	0	0	0	0	0	0	0	0	0%
10	2	7	0	28	28	0	0	0	0	5	0	70	28%
11	0	4	100	70	0	0	0	0	0	0	0	174	69.60%
12	0	0	0	49	0	0	0	0	0	5	0	54	21.60%
13	2	10	100	70	40	0	0	0	0	5	0	227	90.80%
14	2	7	40	28	0	0	0	0	0	5	0	82	32.80%
15	6	4	0	0	0	0	0	0	0	5	0	15	6%
16	0	4	40	0	16	0	5	0	0	5	0	70	28%
17	0	0	0	0	16	0	0	0	0	0	0	16	6.40%
18	2	0	100	49	0	0	0	0	0	0	0	151	60.40%
19	0	0	0	0	0	0	0	0	0	0	0	0	0%
20	0	0	40	0	0	10	0	0	0	0	0	50	20%
21	0	0	0	0	0	0	0	0	0	0	0	0	0%
22	0	0	0	0	0	0	0	0	0	0	0	0	0%
23	0	4	70	0	0	10	0	0	0	0	0	84	33.60%
24	0	0	0	0	28	0	0	0	0	0	0	28	11.20%
25	0	0	0	0	0	0	5	0	0	0	0	5	2%