Severe Weather Compound Disaster: August 2006 cut-off lows and their consequences in the Southern Cape, South Africa

Co-financed by
the Provincial Disaster Management Centre and
Department of Transport and Public Works

Compiled by
Disaster Mitigation for Sustainable Livelihoods Programme, University of Cape Town
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Executive Summary

In August 2006, two cut-off low weather systems severely affected the Southern Cape, resulting in widespread damage and hardship. The impacts sustained in these events reflect the fifth experience of severe weather losses within the Western Cape since 2003 and which cumulatively total close to a billion rands in direct economic damage.

While deaths and displacement associated with severe storms thankfully remain limited in the Western Cape, the direct economic losses from the 2006 events exceeded R 509 million, more than double those sustained in 2003.

This report consolidates the findings of research undertaken following the 'cut-off low events' of August 2006, as commissioned jointly by the National Disaster Management Centre, and the Departments of Local Government and Housing, as well as Public Works and Transport of the Western Cape Provincial Government.

Overview of the rainfall events and impacts

The two 'cut-off low' events occurred at the beginning of August 2006 and three weeks later. The first event resulted in daily rainfall exceeding 200 mm in George, Tsitsikamma, Humansdorp and Port Elizabeth. On 20 August 2006 a second cold front was reported to the west of South Africa. This low-pressure system was considerably smaller and less intense than the first event and was centred further inland, resulting in its heaviest rainfall of 34.5 mm and 80.4 mm being recorded Barrydale and Oudtshoorn respectively.

The combined effect of these two cut-off low systems was further amplified by the heavy rainfall levels recorded during July that led to saturated soil conditions and rising dam levels. Together, these factors triggered significant run-off- associated losses and riverine flood damage exceeding R 509 million in municipalities extending from the Overberg and Cape Winelands to the Eden and Central Karoo District Municipalities. The severity of the damage was reflected in the Eden District Municipality being classified as a local disaster on 15 September, 2006.

The August 2006 cut-off lows triggered serious impacts and losses across much of the Western Cape of South Africa in the area represented in Figure 1. Administratively, this comprised the Cape Winelands, Overberg, Eden and Central Karoo District Municipalities.

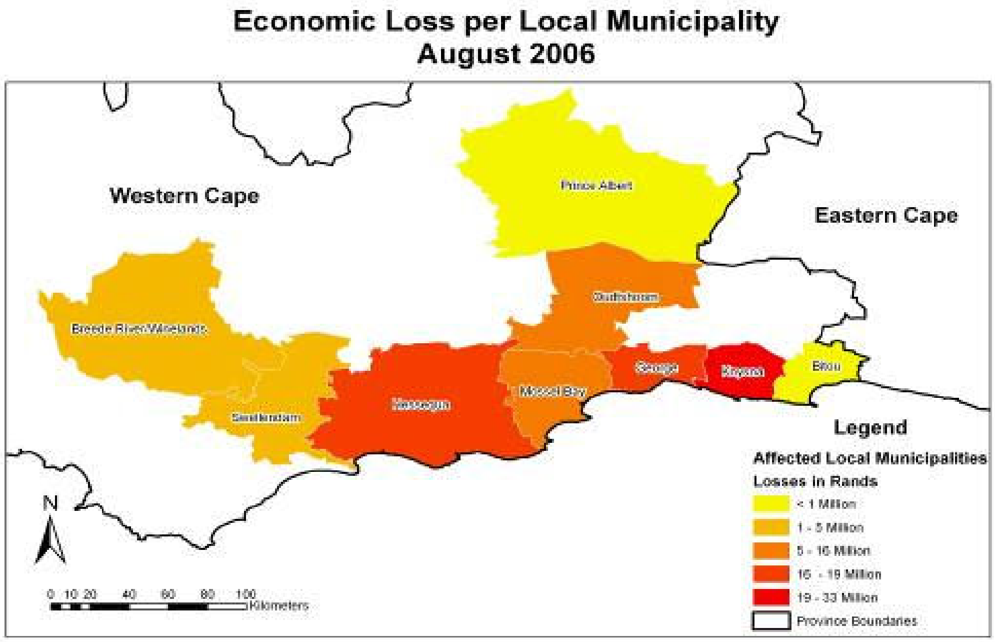

Figure 1: Geographic areas affected by the August cut-off lows, Western Cape

While the two cut-off lows affected a wide area of the Western Cape, the impacts were most severe in the Southern Cape and Central Karoo – areas that are heavily dependent on tourism and agriculture – and that have repeatedly sustained severe storm impacts since the1980s. In total, direct economic losses exceeding R 509 million were recorded, with the humanitarian impact reflected in the need to evacuate more than 1 500 people in ten settlements from within the Eden District Municipality.

The cut-off lows of August 2006 represented the third severe storm system to trigger sizeable losses in the Southern Cape since 2003. The 'Montagu Flood' of 2003 and December 2004 flood event resulted in combined direct losses of R 272 million and the temporary displacement of more than 1 000 people from their homes. More important, this accelerating loss trajectory graphically illustrates the Southern Cape's marked lack of adaptive capacity to withstand extreme weather – in a province that has been identified as highly exposed to the effects of rising climate variability (Midgely et al. 2005)[1]

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[1] Midgely, G., Chapman, R., Hewitson, B., Johnston, P., De Wit, M., Ziervogel, G., Mukhebir, P., Van Niekerk, L., Tadross, M., Van Wilgen, B., Kgope, B., Morant, P., Theron, A., Scholes, R. and Forsyth, G. (2005) *A Status Quo, Vulnerability and Adaptation Assessment of the Physical and Socio-Economic Effects of Climate Change in the Western Cape,* South African National Biodiversity Institute, Kirstenbosch Research Centre, CSIR Report No. ENV-S-C 2005-073 Environmentek, Stellenbosch

Terms of reference for the research

This research was co-financed by three national and provincial government departments – the National Disaster Management Centre as well as the Provincial Departments of Public Works and Transport and Local Government and Housing. In this context, UCT/DiMP was commissioned to:

- Describe and analyse the weather conditions that triggered the flooding.
- Review the catchment, river-flow, land-use and run-off characteristics that may have exacerbated the event.
- Provide a history of past flood or related extreme weather events.
- Describe existing organisational arrangements related to disaster management, including risk reduction and IDPs, emergency preparedness, response and recovery.
- Describe and chronicle the events from the initial SAWS weather warning to 25 August.
- Describe measures taken to anticipate and manage the event, including search and rescue, emergency relief, logistics, security and communication.
- Describe impacts on people, such as evacuations and homelessness and livelihoods, infrastructure damaged and destroyed, disruptions to telecommunications, electricity, road and other lifeline services, damage and destruction to agriculture, and environmental impacts.
- Report on relief impacts in costs and supplies.
- Indicate areas that show increased sensitivity to extreme weather, indicating links to future more extreme climate events, and their implications for disaster management, climate risk management and sustainable development planning.
- Provide maps, graphs, tables and photographs to illustrate the points above.

Summary of main conclusions

Eden is a 'provincial pressure point'.

The Eden District is a major provincial growth node, with tourism, agriculture and related industries its primary sources of economic growth and employment. Recent rapid population growth and urban expansion have provided welcome development opportunities in the region. However, simultaneously, they have also generated significant internal pressures on the capacities of both the natural environment and existing municipal services to manage the consequences of such rapid growth.

These internal pressures are further exacerbated by the south coast's almost annual exposures to extreme weather - reflected in costly losses to poor households in run-off and flood-exposed areas as well as agriculture, transport and other essential infrastructure. It is this convergence of dynamic and demanding external and internal forces that profile the district municipality as a 'provincial pressure point'.

In this context, the documented impacts from repeated extreme weather events in Eden suggest an unsustainable development trajectory for the district. This is indicated by the costly economic losses associated with extreme weather, which have greatly exceeded local capacity to resist and recover without external assistance.

Rising disaster losses have been significantly driven by rapid urban growth and expansion.

Many of the losses attributed to the extreme weather are driven by rapid urban growth that has seriously undermined the protective capacities of the natural environment. This is measurably evidenced by the upward trend in weather and run-off-associated infrastructure losses since 2003, suggesting that the 'triple bottom-line' for sustainable regional growth and development may already be compromised.

It is further reflected dramatically by the measurable increase in hard surfaces in municipalities such as George, whose urban area increased by approximately 75 km^2, or an average of 3.94 km^2 annually from 1985 to 2004. The severe run-off risk generated by such rapidly hardening catchments now exceeds both the technical and infrastructural capacity of existing services and infrastructure to manage the consequences of heavy rain events – let alone the increased frequency of severe storms anticipated with climate change conditions.

Similarly, the district's rapid urban expansion and population growth have not been matched by strategic investments in the redesign or maintenance of critical infrastructure. This is especially indicated by losses to roads and storm water systems, as well as sewage treatment and water supply plants – many of which are repeat-impacts associated with previous weather events.

Disaster and climate risk management are prerequisites for sustainable integrated development for the Eden District.

Disaster and climate risk management are critical prerequisites for sustainable growth in the Eden District Municipality due to its repeated exposure to both extreme weather and endangering wild-fires. In addition, this recurring pattern illustrates how poorly managed development risks have become 'transformed and transferred' onto essential services such as disaster management, emergency services and those responsible for critical provincial and municipal infrastructure.

In this context, there are pressing needs to integrate risk management considerations into the region's spatial and integrated development planning, with accompanying financial and human resource allocations.

The social impact assessment identified two distinct vulnerable groups who were affected by the extreme weather event.

The first group comprised those living in more affluent residential areas who found themselves in run-off and flood-exposed locations. This contrasted with the second group that, while also exposed to run-off and flood conditions, resided in poor and marginalised settlements. This second group was further differentiated into those who resided in low-income formal housing and those who lived in informal dwellings.

Field research indicated that development conditions significantly drove vulnerability outcomes in extreme weather-exposed communities. Moreover, the impacts generated by local flood and rain damage further undermined the social development of the affected communities. In this context, the limited nature of the relief interventions, while providing emergency assistance, is unlikely to have yielded lasting benefits to poorer households and settlements.

The Disaster Management Act's call to reduce the vulnerability of disaster-prone areas, communities and households should be made a priority

The Disaster Management Act (Act 57 of 2002) makes explicit the need to reduce the vulnerability of disaster-prone areas, communities and households. In poorer settlements, this could best be undertaken through comprehensive community risk assessments to identify those most at risk, followed by participative community-based disaster risk management planning. Such processes would also assist in identifying the most vulnerable for response activities in the event of future extreme weather events. They would also strengthen participative governance relations between at-risk communities and local authorities.

Formal low-income homes sustained significant losses due to lack of 'weather-proofing' and 'run-off-proofing'

Many of the most at-risk, low-income settlements affected in the severe weather events were sited below road level and thus exposed to endangering run-off due to limited storm water capacity. In addition, poor construction standards increased exposure to heavy rain, run-off and subsidence.

This lack of structural robustness of low-income homes to extreme weather events represents an unaffordable pressure on already resource-constrained households. Housing developments for all economic groups, but especially for lower income categories, should actively incorporate design criteria to avert risks driven by severe weather and surface run-off.

Currently, there are no provisions or specifications for 'weather-proofing' or 'flood-proofing' low-income homes in areas exposed to heavy rain and run-off conditions. However, in areas exposed to recurrent heavy rain events, 'weather-proofing' is an important consideration to protect assets as well as the health of household members.

An unambiguous provincial protocol for social vulnerability assessment of extreme weather-affected households is urgently needed

In this event, the determination that there was 'no need for social relief' was not informed by a systematic or rigorous household needs assessment. Moreover, the independent social impact assessment undertaken by UCT/DiMP confirmed that there were indeed many households who experienced significant hardship as a result of the extreme weather, as well as the destruction of uninsured property and compromised employment opportunities.

While such hardship might not have appeared obvious from a rapid 'drive-by' assessment, detailed household assessments proved otherwise. Moreover, it is incongruous that poor households did not require social relief, when municipal and provincial departments sought emergency funding assistance from the National Treasury and wealthier residents and businesses sought insured assistance to cope with and recover from the extreme weather and its associated risks.

Post-disaster reconstruction is an opportunity to restore critical infrastructure beyond replacement standards to risk-averse levels.

The technical demands and administrative complexity of emergency reconstruction were apparent following the August events. Given the tight implementation time-frames imposed, it is to the credit of the technical staff concerned that repairs were completed on time.

However, current reconstruction funding instruments do not easily enable risk-averse rehabilitation due to tight annual financial reporting cycles. While not applying to all disaster-affected structures, post-event funding mechanisms should selectively allow strategic reconstruction to risk-averse levels.

Research findings also suggest an inverse relationship between per capita investment in municipal repair/maintenance and flood/run-off related losses in heavy rainfall events. This highlights the protective value of investing in maintenance and repair and motivates for increased municipal and provincial expenditure in infrastructural maintenance. It also calls for further cost-benefit research to determine minimum per capita budgetary maintenance/repair allocations and/or investments in protective upgrading to risk-averse levels.

It should be noted that steps were taken to address the certain issues raised in the report before its finalisation. However, the events were accurate at the time of the flooding and the reconstruction process.

Despite costly recurrent impacts it is still impossible to generate a spatial agricultural loss profile for the Southern Cape.

Agricultural risk management within the province is significantly limited by the absence of geo-referenced loss data. Agriculture repeatedly sustains the highest losses associated with weather extremes. However, unlike Provincial Roads, where it is now possible to identify repeatedly exposed infrastructure through GIS, a spatial agricultural loss profile for the Southern Cape is not possible.

As recommended repeatedly since 2003, this limitation could be overcome if farmers sustaining losses could record specific Surveyor General Numbers on their impact forms. In this context, the Provincial Department of Agriculture is urged to incorporate S.G. numbers on its disaster loss reporting forms.

Post-disaster impact reporting and documentation processes require urgent streamlining.

Loss estimation research following disaster events is a powerful research method for answering questions such as ‘what failed?’, ‘where did it fail?’ and ‘why did it fail?’. It complements more traditional inductive risk assessment processes by pointing out specific susceptibilities of key services, and characterising these with respect to external exposure to heavy rain and run-off.

However, the onerous reporting demands carried by technical personnel in this event also diverted their energies from actual on-site supervision of implementation to administration and reporting. This underlines the urgent need to streamline the impact reporting process, so that a uniform approach is adopted that serves multiple outcomes, such as mobilising of funds, and post-event risk analysis.

In this context, it is important that 'impact assessment, recovery and reconstruction guidelines' are developed consultatively and accompanied by an orientation process for key provincial and municipal stake-holders to streamline the reporting and post-event reconstruction processes.

Recommendations for Provincial and National Departments

Introduction

Provincial recommendations are organised by sector or department, and cross-referenced to the appropriate section in the report in the right-hand margin.

Ref.	Prov. Dept	Recommendation	Cross-ref
6.2.2	Roads	The repeat failure of provincial roads in Eden should be averted through urgent investments in upgrading and risk-proofing of vulnerable sectors critical to the regional economy, along with upward adjustments in repair/maintenance budgets.	5.4.1
6.2.3	Housing	Formally built low-income homes should: • not be sited in flood or run-off exposed locations without robust storm-water capacity and foundations, • be constructed to meet minimum design criteria for extreme weather events, including severe storms, heavy rains and strong winds.	5.4.1
6.2.4	Education	Within the Cape Winelands Municipality specifically, attention should be given to assessing and improving the rain and wind resistance of roofs in school buildings, especially primary schools.	5.4.1
6.2.5	Social Dev.	An unambiguous provincial protocol for social vulnerability assessment of extreme weather-affected households should be developed and applied after each extreme weather event.	4.1.3
6.2.6	Agriculture	All agricultural losses should be accompanied by a Surveyor General Number (S.G. No.). The Provincial Department of Agriculture is urged to incorporate S.G. numbers on its disaster loss reporting forms.	5.4.2
6.2.7	PDMC	In cooperation with the NDMC and key role-players, the PDMC should: • engage with National and Provincial Treasury to explore financial provisions for restoring critical infrastructure beyond replacement standards to risk-averse levels, • engage with the SA Institute of Engineers to establish a mechanism for mobilising skilled engineers after extreme weather processes and other disasters for post-event assessment and reconstruction, • engage risk-prone municipalities and relevant provincial departments on practical strategies for reducing climate risk impacts on vulnerable infrastructure, • establish standard impact reporting procedures for those	 4.3.7 4.3.7 4.3.7 5.4.2

		municipalities and government departments that do not yet use a uniform system, • prepare simple technical, administrative and financial guidelines that streamline impact reporting formats and the management of emergency reconstruction. This includes ensuring that all municipal and provincial (especially infrastructural) losses are geo-referenced (with a GPS), ensure that a dedicated person is appointed to take responsibility for impact tracking in each municipality as well as ensuring that data are never submitted without a detailed report of each impact.	4.3.7 5.4.2
6.2	DWAF	Areas/infrastructure adjacent to and downstream from rivers where gauging stations have repeatedly failed should be identified and mapped as 'flood-risk exposed' for planning purposes.	5.4.1

Recommendations for District and Local Municipalities

Introduction

Municipal recommendations are organised by sector or department, and cross-referenced to the appropriate section in the report in the right-hand margin.

Ref.	Thematic Area	Recommendation	Cross-ref
6.3.1	Development Planning	Future urban expansion in the Eden District should actively incorporate landscape sensitivity considerations into spatial development and integrated development planning processes. Integrated climate adaptation and disaster risk research should be undertaken to determine the relationship between urban development and hydro-geological risks in the district – especially in areas where there is now evidence of recurrent impacts. Areas/infrastructure adjacent to and downstream from rivers where gauging stations have repeatedly failed should be identified and mapped as 'flood-risk exposed' for planning purposes. Risk management, including 'strategic rethinking' to better risk-proof critical infrastructure' should be integrated into all local planning and regulatory processes, specifically to: • tighten land-use regulations to avoid further 'unravelling' of protective 'environmental services', • incorporate risk assessment for flood, run-off, slope failure and subsidence into all future environmental impact assessments within the district.	2.3.5 2.3.5 5.4.1 4.2.6 4.2.6

		and, particularly for weather-exposed infrastructure, to: • investigate existing design criteria for critical infrastructure – especially roads and storm water to determine their relevance and robustness for extreme rainfall events, • 'rethink' investment, environmental, engineering and human resource strategies for risk-averse infrastructure, • develop decision models that evaluate the relative strengths of proactive investment in upgrading and maintaining critical road and other infrastructure to offset future losses from expected extreme weather, • investigate available climate risk insurance options as potential risk transfer mechanisms to ease financial pressure on weather-exposed municipalities. Integrated development planning should be an opportunity to reduce, not increase the exposure of poor households to endangering surface run-off, rain and subsidence damage.	3.6.2
6.3.2	Urban Planning	Climate and disaster risk management should be integrated into urban planning and budgeting processes. This includes: • incorporating technically robust disaster risk assessments in the planning phase of all major developments in weather exposed locations, • upgrading of critical bridge, road and storm water infrastructure to risk-averse levels. Sewage treatment plants sited near to rivers at risk of flash flooding should be identified and flood-proofed.	5.4.1 4.2.6 5.4.1
6.3.3	Civil and Techncial Services	Municipal maintenance and repair should be prioritised and funded as 'front-line climate and disaster risk management services' for municipalities exposed to extreme weather. Priority should be applied to reducing and managing endangering run-off, and harvesting run-off to strengthen adaptive capacity during drought. This includes: • protecting remaining 'natural flood attenuation' capacity wherever possible to minimise excess run-off, • investing more vigorously in robust storm water, bridge and road infrastructure to avoid repeat failures, • investigating/rigorously applying municipal incentives/deterrents to reduce agricultural, commercial and residential run-off, investigating/ rigorously applying incentives/deterrents	5.4.1 5.4.1

		to encourage rainwater and run-off harvesting that minimise the impact of future droughts.	
6.3.4	Disaster Management	**With specific respect to disaster and climate risk assessment:** Integrated climate adaptation and disaster risk research should be undertaken to determine the relationship between urban development and hydro-geological risks in the district – especially in areas where there is now evidence of recurrent impacts. Areas/infrastructure adjacent to and downstream from rivers where gauging stations have repeatedly failed should be identified and mapped as 'flood-risk exposed' for planning purposes. Suburbs and settlements that required emergency assistance due to the extreme weather, flooding and surface run-off should be identified and mapped as 'risk-prone' for risk management planning. **With specific respect to risk reduction planning:** The Disaster Management Advisory Forum should urgently identify a skilled and committed multi-stakeholder task team that focuses on strategies for mitigating extreme weather-associated risks. Spatial loss and impact information from extreme weather events should be incorporated into integrated planning processes – to highlight at-risk sites and settlements. Existing disaster management capacity should be urgently increased to manage the wide-ranging demands of post-event recovery as well as risk reduction planning and preparedness/response. The reduction of the vulnerability of disaster-prone communities and households' should be enabled through comprehensive community risk assessments followed by participative community-based disaster risk management planning. Creative, locally relevant, robust and sustainable risk reduction measures should be identified and communicated among residents of at-risk settlements. **With specific respect to preparedness and response:**	2.3.5 5.4.1 5.4.1 4.2.6 2.3.5 4.2.6 3.6.2 3.6.2 4.1.3

		Contingency planning for at-risk communities and settlements should be undertaken consultatively well in advance of a weather alert. Formalised systems should be established for communicating and confirming understanding of warning information among government and nongovernmental role-players. Warning information as well as response and relief updates should be communicated in multiple, context-specific and language-appropriate forms. Early warnings should be communicated understandably to households and settlements known to be exposed to extreme weather, surface run-off and flood risk. Institutional arrangements with respect to the JOCs and mini-JOCS should be formalised and agreed on by critical stake-holders. An effective and inclusive contingency plan should be in place for response and relief that ensures timely and equitable assistance to settlements that are high-risk. A mobile JOC should be considered for the Eden District Municipality, with necessary communication tools, for example, a specially adapted bus) **With specific respect to post-disaster reporting:** An initial assessment of affected infrastructure should be taken directly after a weather event. This should be revisited a month later. Only infrastructure for which the municipality is directly responsible should be recorded and all other infrastructure should be referred to sectors/or departments responsible for the specific infrastructure. All municipal impacts should be recorded, even if funding is not needed. This enables the early identification of extreme weather "hot spots" for improved risk management. There should be uniformity across all municipalities and sectors for calculating and presenting damage costs. These should be accurate and not presented as estimates.	4.1.3 4.1.3 3.6.2 4.1.3 3.6.2 4.1.3 5.4.2 5.4.2 5.4.2 5.4.1

Recommendations for South African Weather Services

Introduction

Recommendations for SAWS are reflected in the left-hand column with explanations given in right-hand column in the table below.

Recommendation	Explanation
Extreme weather warnings should differentiate between anticipated levels of risk.	Warnings should ideally be differentiated, stating different levels of anticipated extreme weather risk. If, for example, key responders had known a "level-three" warning had been issued, they would have taken urgent precautionary actions.
Extreme weather warnings should, where possible, provide expected values for rainfall and wind speed.	None of the warnings issued mentioned any potential values of rainfall or wind speed, only of possible wave heights. If possible forecast values were included along with a severity rating system, more action would probably be taken by key responders in all sectors.
Extreme weather warnings should be issued at least a day in advance.	Virtually all the warnings were issued the morning that the weather event occurred, whilst most of the advisories were issued a day in advance. The advisories were more useful than the warnings since they gave end-users time for preparedness action.
Weather warnings should include descriptions of likely localised impacts.	Very few of the warnings included a description of the possible impacts of the weather event they describe, such as possibility of flooding, wind damage etc.
Weather warnings should be communicated directly by telephone to key officials. .	For events above a certain level of risk it may be more effective to telephone and speak directly to key provincial officials and municipal managers of the areas likely to be affected. While the SMS system is a very effective and rapid means of communication, phone calls are less easily disregarded and provide opportunity for questions of clarification.

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The Disaster Mitigation for Sustainable Livelihoods Programme would like to formally acknowledge the many individuals who contributed time, insights and information in the course of this review. In this context, DiMP appreciates that many of those who provided information faced multiple demands during the research process – including post-event relief and reconstruction, as well as other reporting responsibilities. While it is not possible to list all those who gave their time, information and insights in the course of this review, we would particularly like to acknowledge the following individuals.

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Acronyms

ACSA	Airports Company South Africa
ACVV	Afrikaanse Christelike Vroue Vereniging
AMSL	Above Mean Sea Level
CBO	Community Based Organisation
CSIR	The Council of Scientific and Industrial Research
DCS	Department of Community Safety
DEAT	Department of Environmental Affairs and Tourism
DiMP	Disaster Mitigation for Sustainable Livelihoods Programme
DLGH	Department of Local Government and Housing
DMC	Disaster Management Centre
DPLG	Department of Provincial and Local Government
DWAF	Department of Water Affairs and Forestry
EIA	Environmental Impact Assessment
EMS	Emergency Medical Services
GIS	Geographic Information Systems
GPS	Global Positioning System
ICDM	Inter-ministerial committee on disaster management
IDP	Integrated Development Plan
JOC	Joint Operations Centre
KZN	KwaZulu Natal
MFMA	Municipal Finance Management Act
MIG	Municipal Infrastructural Grant
MTEF	Medium Term Expenditure Framework
MTO	Mondi Timber Cape
NA	Not Applicable
NDMC	National Disaster Management Centre
NEMA	National Environmental Management Act
NGO	Non Governmental Organisation
NSRI	National Sea Rescue Institute
PDMC	Provincial Disaster Management Centre
PPMU	Provincial Project Management Unit
RDP	Reconstruction and Development Programme
SA	South Africa
SADF	South African Defence Force

SAIA	South African Insurance Association
SAPS	South African Police Service
SANDF	South African National Defence Force
SANZAF	South African Standard Time
SAST	South African Standard Time
SAWS	South African Weather Service
SMS	Short Messaging Service
SPCA	Society for the Prevention of Cruelty to Animals
TB	Tuberculosis
TINs	Triangulated Irregular Networks
UCT	University of Cape Town
WGS	World Geodetic System
WSAR	Wilderness Search and Rescue

Abbreviations

Km	kilometre
m	metre
mm	millimetres
Mtn	Mountains
Plett	Plettenburg Bay

Definitions

Aeolian:	Pertaining to the wind. Used for landforms generated by the wind, or sediments transported by the wind. home.mira.net/~gnb/caving/papers/kg-svckt.html
Aerial photographs	Aerial photography is the taking of photographs from above with a camera mounted on an aircraft, balloon, rocket, kite or similar vehicle. en.wikipedia.org/wiki/Aerial_photographs
ArcGIS:	A family of software products that form a complete GIS (Geographic Information System). www.maps-gps-info.com/maps-gps-glossary.html
Cadastral Map	A legal map for recording title to a property. The map indicates legal boundaries and the ownership of the property. www.ncbuy.com/credit/glossary.html
Catchments	The land area drained by a river and its tributaries. www.wsroc.com.au/report/report/acron.htm
Cut-off low system	A 'cut-off low' is a 'closed low in the upper air, supported by a low-pressure system on the surface' (SAWS report). In other words, it is atmospheric circulation that becomes separated from the main flow/system, and often results in heavy rainfall, gale force winds and other severe weather.
Dendritic	In hydrologic terms, the form of the drainage pattern of a stream and it's tributaries when it follows a treelike shape, with the main trunk, branches, and twigs corresponding to the main stream, tributaries, and subtributaries, respectively, of the stream. weather.gov/glossary/glossary.php
Ellipsoid	A smooth mathematical surface that can be used to approximate the shape of the earth. It is an ellipse, with axes approximate to the dimensions of the earth, rotated around the polar axis. www.geography.wisc.edu/sco/references/glossary.html
Extratropical	In meteorology, the area north of the Tropic of Cancer and the

	area south of the Tropic of Capricorn. In other words, the area outside the tropics. weather.ncbuy.com/glossary.html
GemsC3 incident management system	Disaster Information Management System.
Geodetic	Referring to the determination of the size and shape of the Earth and the precise location of points on its surface. mbmgquake.mtech.edu/seismic_glossary.html
Geology	The science and study of the Earth, its composition, structure, physical properties, history, and the processes that shape it. It is one of the Earth sciences. en.wikipedia.org/wiki/Geology
Geomorphology	The form or shape of the earth or landscape. buttecreekwatershed.org/ecr/new/glossary.htm
Geopotential Height	Height above sea-level measured in terms of atmospheric pressure rather than absolute height. www.scotland.gov.uk/cru/kd01/lightgreen/ccsnow_11.htm
Georeference	Determine the geographical location of an image. www.asf.alaska.edu/reference_documents/datacenters_references/glossary.html
Groundwater recharge	The natural process of infiltration and percolation of rainwater from land areas or streams through permeable soils into water-holding rocks that provide underground storage (i.e. aquifers). www.sonomamarinrcds.org/district-ssc/resources/glossary/gloss-fghi.html
Gully	Deep ditch cut by running water (especially after a prolonged downpour). wordnet.princeton.edu/perl/webwn
Gumplastiek	Black plastic sheeting, often used for roofing to prevent leaking.
Lithified	Turned into rock. Sediments, over time with heat and pressure, become rocks. www.kenaiwetlands.net/glossary.htm
Meteorological	Meteorology is the scientific study of the atmosphere that focuses on weather processes and forecasting. Meteorological phenomena are observable weather events which illuminate and

	are explained by the science of meteorology. en.wikipedia.org/wiki/Meteorological
Orographic Rainfall	Precipitation that results when moist air is lifted over a topographic barrier such as a mountain range. www.geographic.org/glossary.html
Orthophotographs	An orthophotograph has the spectral qualities of a photograph but the spatial attributes of a map. Orthophotographs therefore may look simply like an aerial photograph but directions, dimensions and plan positions can be all scaled from them, which makes them far more useful. http://www-staff.lboro.ac.uk/~cvjhc/Orthos.htm
Perennial	A stream that would normally be expected to flow throughout the year. www.msnucleus.org/membership/html/jh/earth/dictionary/water/definitions.htm
PetroSA	The national oil company of the Republic of South Africa.
Ridging High Pressure	An elongated area of relatively high atmospheric pressure, almost always associated with and most clearly identified as an area of maximum anticyclonic curvature of wind flow. http://nsidc.org/arcticmet/glossary/ridge.html
Schist	Metamorphic crystalline rock which can be split along approximately parallel lines. www.wisconline.com/wisconsin/geoprovinces/glossary.html
Slate	Slate is a fine-grained, homogeneous, sedimentary rock composed of clay or volcanic ash which has been metamorphosed (foliated) in layers (bedded deposits). en.wikipedia.org/wiki/Slate
Slip	A fault. A smooth joint or crack where the strata have moved on each other. www.netl.doe.gov/coal/Coal%20Primer/glossary.html
Slope Subsidence	Movement of the land on which property is situated. A structure built on a hillside may slide down the hill due to earth movement caused by heavy rains. www.nv-insurance.com/GlossaryS.htm
Stratigraphy	A branch of geology concerned with form, arrangement, geographic distribution, chronological succession, classification,

	correlation and mutual relationships of rock strata, especially sedimentary. gemini.oscs.montana.edu/~geol102/spring2004/Field%20Trip%20Stuff/Webpages/Glossary.htm
Topographic maps	Land maps that display elevation along with natural and man-made features. www.crwc.org/programs/watershedmgmt/scnonpoint/glossary.html
Triangulated Irregular Networks (TINs):	A data structure that produces a continuous surface from point data. Often used to create a digital terrain model. Shows slope characteristics using GIS. hds.essex.ac.uk/g2gp/gis/sect101.asp
Washout	The channel or break produced by erosion of relatively soft soil by water. wordnet.princeton.edu/perl/webwn
Water Scour	Removal of soil or fill material by the flow of floodwaters. The term is frequently used to describe storm-induced, localized conical erosion around pilings and other foundation supports where the obstruction of flow increases turbulence. www.csc.noaa.gov/rvat/glossary.html

Part I: Background, Conceptual Framework and Methodology

Introduction and Context

In August 2006, two cut-off low weather systems severely affected the Southern Cape, resulting in widespread damage and hardship. The impacts sustained in these events reflect the fifth experience of severe weather losses within the Western Cape since 2003 and which cumulatively total close to a billion rands in direct economic damage.

While deaths and displacement associated with severe storms thankfully remain limited in the Western Cape, the direct economic losses from the 2006 events exceeded R 509 million, more than double those sustained in 2003.

This report consolidates the findings of research undertaken following the cut-off low events of August 2006, as commissioned jointly by the National Disaster Management Centre, and the Departments of Local Government and Housing as well as Public Works and Transport of the Western Cape Provincial Government.

Section 1.1 gives a brief overview of the endangering weather system, its impacts and the general profile of the areas officially classified as disaster-affected.

Section 1.2 introduces the conceptual framework for the study and key terms.

Section 1.3 clarifies the geographic scope for the research.

Section 1.4 describes the overall research approach and methods used.

Section 1.5 states ethical considerations that are reflected in the report.

Section 1.6 outlines the study's limitations.

Section 1.7 presents the overall structure of the report.

1.1 A brief overview

1.1.1 The extreme weather system and its consequences

On 30 July 2006 a large cold front was first identified approaching the west of South Africa over the South East Atlantic Ocean, making landfall a day later and generating significant rainfall across much of the Western Cape. By 1 August 2006, the cold front had developed into a 'cut-off low system',[2] and intensified, resulting in rainfall over the

[2] A 'cut-off low' is a 'closed low in the upper air, supported by a low-pressure system on the surface' (SAWS report). In other words, it is atmospheric circulation that becomes separated from the main flow/system, and often results in heavy rainfall, gale force winds and other severe

Garden Route region. George and Knysna were both particularly affected, receiving 230.1 mm and 169 mm rainfall respectively.

The heaviest rainfall associated with this system fell on 2 August 2006, when the system was most intense and as it moved slightly eastward to the Eastern Cape south coast. Very high rainfall was experienced in this region with 105.6 mm, 129.6 mm and 300.0 mm recorded at Tsitsikamma, Humansdorp and Port Elizabeth respectively.

On 20 August 2006 a second cold front was reported to the west of South Africa. Although this low-pressure system was considerably smaller and less intense than the first event, the system was cut-off from the main westerly flow before it had even made landfall. By early morning on 21 August 2006 the small system had made landfall over the Western Cape south coast. This second event was centred further inland than the first, and on 21 August 2006 the heaviest rainfall was recorded Barrydale and Oudtshoorn, with 34.5 mm and 80.4 mm respectively. Relatively little rainfall was recorded over the Western Cape south coast, whilst no rainfall occurred in the Eastern Cape.

The combined effect of these two cut-off low systems was further amplified by the heavy rainfall levels recorded during July that led to saturated soil conditions and rising dam levels. Together, these factors triggered significant run-off- associated losses and riverine flood damage exceeding R 509 million in municipalities extending from the Overberg and Cape Winelands to the Eden and Central Karoo District Municipalities. The severity of the damage was reflected in the Eden District Municipality being classified as a local disaster on 15 September 2006.[3]

1.1.2 General overview of areas that reported significant disaster impacts, as well as those specifically classified as experiencing a 'state of disaster'

The August 2006 cut-off lows triggered serious impacts and losses across much of the Western Cape of South Africa in the area represented in Figure 1.1.2.1. Administratively, this comprised the Cape Winelands, Overberg, Eden and Central Karoo District Municipalities[4].

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weather.

Part I written by Ailsa Holloway, DiMP, UCT

[3] Published in Provincial Gazette, 13 October 2006

[4] Economic losses were initially reported for Theewaterskloof and Kannaland local municipalities. Unfortunately, these amounts were not confirmed by the two municipalities concerned – and regrettably, could not be included in the report.

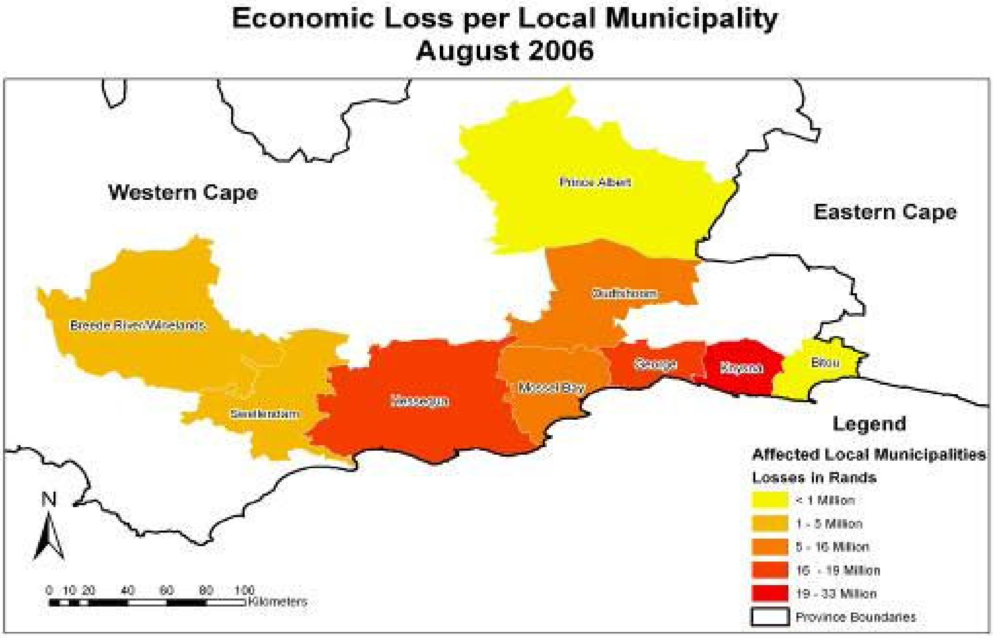

Figure 1.1.2.1: Geographic areas affected by the August cut-off lows, Western Cape

While the two cut-off lows affected a wide area of the Western Cape, the impacts were most severe in the Southern Cape and Central Karoo – areas that are heavily dependent on tourism and agriculture – and that have repeatedly sustained severe storm impacts since the1980s.

1.1.4 The August 2006 cut-off lows and their relevance to sustainable development within the Southern Cape

The Eden District is predominately rural, with the major commercial centres of Plettenberg Bay, Oudtshoorn, George and Mossel Bay historically dominating the area's settlement pattern. However, there is clear evidence of significant recent population growth in this region, with statistics compiled by the Department of Water Affairs and Forestry indicating that between 1996 and 2007, the district's population increased by 35% from 381 041 to 512 573. Census statistics from 1996-2001 also underline significant upward urban growth, with the urban population increasing 39.1% (71 588 to 99 555) compared to 19% in rural areas. In this context, the towns of George and Mossel Bay specifically showed significant population growth, with their respective populations increasing by 25.7% and 11.96%.

With rising exposure of towns, infrastructure, services and agriculture to extreme weather, it is unsurprising that the cut-off low systems in August 2006 resulted in such widespread and devastating loss. In total, direct economic losses exceeding R 509 million were recorded, with the humanitarian impact reflected in the need to evacuate more than 1 500 people in ten settlements from within the Eden District Municipality.

The meteorological profile for August 2006 was characterised by particularly severe falls early in the month – with a maximum of 327.8 mm rain recorded for the Western Cape in

George from 31 July - 4 August 2006 (and 230.1 mm alone recorded on 1 August 2006). The adverse conditions generated by the first cut-off low were further amplified three weeks later when a second extreme weather event resulted in 111.7 mm rain over George from 21 – 24 August 2006.

Significant impacts were sustained at provincial, municipal and household level. Of the provincial losses sustained, the Departments of Agriculture and Public Works and Transport recorded impacts respectively totalling R109.9 million and R 90.8 million. Municipalities most severely affected included Knysna, George, Hessequa and Mossel Bay, whose combined economic losses exceeded R 84.55 million.

The August 2006 cut-off lows represented the third severe storm system to trigger sizeable losses in the Southern Cape since 2003. The 'Montagu Flood' of 2003 and December 2004 flood event resulted in combined direct losses of R 272 million and the temporary displacement of several thousand people from their homes. More important, this accelerating loss trajectory graphically illustrates the Southern Cape's marked lack of adaptive capacity to withstand extreme weather – in a province that has been identified as highly exposed to the effects of rising climate variability (Midgely et al. 2005)[5] .

This is evidenced by the repeated and increasingly costly failures of critical infrastructure, limited engagement between government and residents of high-risk settlements and constrained public-private participation – especially between government role-players and the tourism industry.

1.1.4 Institutional arrangements for the research and terms of reference

This research was co-financed by three national and provincial government departments – the National Disaster Management Centre, as well as the Provincial Departments of Public Works and Transport, and Local Government and Housing. In this context, UCT/DiMP was commissioned to:

- Describe and analyse the weather conditions that triggered the flooding.
- Review the catchment, river-flow, land-use and run-off characteristics that may have exacerbated the event.
- Provide a history of past flood or related extreme weather events.
- Describe existing organisational arrangements related to disaster management, including risk reduction and IDPs, emergency preparedness, response and recovery.
- Describe and chronicle the events from the initial SAWS weather warning to 25 August 2006.
- Describe measures taken to anticipate and manage the event, including search and rescue, emergency relief, logistics, security and communication.

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[5] Midgely, G., Chapman, R., Hewitson, B., Johnston, P., De Wit, M., Ziervogel, G., Mukhebir, P., Van Niekerk, L., Tadross, M., Van Wilgen, B., Kgope, B., Morant, P., Theron, A., Scholes, R. and Forsyth, G. (2005) *A Status Quo, Vulnerability and Adaptation Assessment of the Physical and Socio-Economic Effects of Climate Change in the Western Cape,* South African National Biodiversity Institute, Kirstenbosch Research Centre, CSIR Report No. ENV-S-C 2005-073 Environmentek, Stellenbosch

- Describe impacts on people, such as evacuations, homelessness and livelihoods, infrastructure damaged and destroyed, disruptions to telecommunications, electricity, road and other lifeline services, damage and destruction to agriculture, and environmental impacts.
- Report on relief impacts in costs and supplies.
- Indicate areas that show increased sensitivity to extreme weather, indicating links to future more extreme climate events, and their implications for disaster management, climate risk management and sustainable development planning.
- Provide maps, graphs, tables and photographs to illustrate the points above.

1.2 Conceptual Framework for this Study

In the past, severe weather events such as the August 2006 cut-off lows would have been understood as a 'natural disaster', or 'Act of God'. However, international best practice now views disasters as interplay between natural or other threats and conditions of socio-economic, environmental or infrastructural vulnerability.
A disaster only occurs when a vulnerable household, community, city, province, business, ecosystem or physical structure is subjected to a hazard or shock which it cannot withstand, or from which it cannot recover without external assistance.
Normally, a hazard is viewed as an external phenomenon with potential to cause harm, while vulnerability refers to the internal characteristics of the household, community or area exposed to the hazard that increase the likelihood of loss. In this context, it is no longer correct to state that a storm 'caused' a flood, but rather to state that the storm 'triggered' the resulting flood.

In this conceptualisation, any specific level of disaster risk faced by a household, community or area is shaped by both hazard and vulnerability conditions, and can be broadly understood as the probability of losses which a household, community or municipality cannot resist or recover from without external assistance.

With respect to the August cut-off low disaster, the originating hazard refers to the weather systems (both singly and together), characterised by heavy rain, strong coastal winds and cold temperatures.

The specific secondary hazards considered in this report are:
- endangering surface run-off (both overland and riverine),
- slope failure (including debris flows, mudslides and landslides).

With respect to this research report, vulnerability is viewed as those characteristics likely to increase the probability of loss with respect to river systems, agriculture, physical infrastructure and critical services, as well as human well-being and health status.

In this context, the location of many of the most severely affected human settlements in low-lying areas or on coastal dune sands increased their exposure to the heavy rain and subsequent run-off. Similarly, aged and structurally inadequate storm water infrastructure was unable to respond adequately to the heavy run-off conditions – resulting in 'knock-on' structural failures to road, housing and other infrastructure.

The research presented below seeks to identify those risk conditions that increased the likelihood of loss, as well as the household/community responses and institutional mechanisms that reduced the severity of the weather event.

1.3 Geographic Focus for the Study

The research scope changed during the course of the study due to the occurrence of a second cut-off low within three weeks of the first system. While, meteorologically, this was a significantly weaker system, the cumulative effect of two cut-off lows following July 2006's heavy rain compounded impacts within the Southern Cape and extended losses into the Overberg and Cape Winelands Districts.

In addition, many other impacts were observed elsewhere in South Africa, especially in the Eastern Cape due to the intensity of the first weather system. However, areas outside the Western Cape were excluded from the research.

Figure 1.1.2.1 represents the overall area assessed with respect to the scale of the extreme weather system, the extent of hydrological impacts (i.e. riverine flooding), and the range of reported agricultural and infrastructural impacts.

1. 4 Methods Used

The scope of the research required a skilled trilingual team (English, isiXhosa, Afrikaans) with experience in post disaster impact assessment, capacity to work across the biophysical and social vulnerability disciplines and who had knowledge of the policy frameworks that guide disaster risk management in South Africa.

1.4.1 Composition of the research team and field research component

The research team comprised ten people. These included four team members qualified in environmental and geographical science, but with advanced specialisations in geology, disaster risk and atmospheric science. Other members contributed with their skills in social development, disaster loss estimation, advanced GIS and knowledge of institutional arrangements associated with disaster risk management in South Africa.

Altogether, 91 person-days were spent in the field, primarily in the municipalities within the Eden District Municipality. This included the dispatch of a five-person assessment team to George by 7 August 2006, less than a week after the first weather system had triggered impacts in the Southern Cape. Two team members then travelled to the Central Karoo to meet with affected residents and other stake-holders.

From 8 -17 November 2006, a field researcher returned to the Southern Cape to conduct in-depth recovery assessments in low-income areas and informal settlements within each of the five municipalities.

The context for field research was significantly informed by two stake-holder consultations facilitated by the Provincial Disaster Management Centre, the first in Swellendam on 10 August 2006, and the second in George on the following day. It was enabled by the Disaster Debriefing session attended by 90 people in George on 22 February 2006, also facilitated by the Provincial Disaster Management Centre.

1.4.2 Data collection

1.4.2.1 Secondary data sources

A wide range of secondary data sources were drawn on in the course of the research. These included:

- the South African Weather Services for precipitation, wind and temperature data,
- the Council of Geoscience,
- the Department of Water Affairs and Forestry for information on flood peaks and gauging station failure,
- the Provincial Department of Local Government and Housing for housing impacts,
- the Local and District Municipalities in the affected areas,
- the South African Insurance Association for recorded private sector losses, and
- local and provincial newspapers.

1.4.2.2 Semi-structured interviews with key informants outside disaster-affected areas

Semi-structured interviews took place either directly or telephonically with a wide range of governmental role-players outside the affected areas. These included representatives of provincial departments, including: Local Government and Housing, Roads, Education, Agriculture, Health and the Provincial Treasury. Detailed interviews took place with representatives of the Provincial Disaster Management Centre of the Western Cape as well as those involved in administering the Municipal Infrastructure Grant. Interviews also took place with representatives of the Department of Water Affairs and the CSIR as well as the South African Weather Service. Extensive telephonic and electronic consultation took place with engineers involved in reconstruction and repair of damaged infrastructure.

1.4.2.3 Primary data collection methods in affected areas

A range of data collection methods were used to collect primary information in the affected areas. These included:

- field assessments in affected municipal and agricultural areas,
- direct observation of environmental impacts and recording of mass movements and landslides,
- semi-structured interviews and focus group discussions in affected areas – particularly in low-income and informal settlements,
- application of participatory impact and risk assessment methods, and
- semi-structured interviews with governmental and other key role-players.

Immediately following the first event, and in the second field visit in November, informal and low-income settlements were visited in the Eden District Municipality. In these areas, semi-structured interviews were undertaken with residents affected by the August cut-off lows.

Detailed field research methods are described in Parts 2 and Part 3 of this report.

1.4.2.4 Primary data collection of disaster impacts

An extensive process was undertaken to collect, compile and geo-reference all recorded direct infrastructural impacts – across four district and eleven local municipalities affected in the August events as well as provincial and national departments that sustained losses. Private sector losses were also determined through the intervention and advocacy of the South African Insurance Association (SAIA). This effort in documenting and geo-referencing impacts was particularly time-consuming, and greatly facilitated by the efforts of provincial and municipal engineers as well as technical services personnel overseeing the reconstruction funded by the Municipal Infrastructure Grant.

1.5 Ethical Considerations

In order to ensure confidentiality of information provided by a wide range of resource people and institutions, individuals consulted in the course of this study will not be referred to by name, but rather by official designation or as representatives of specific organisations.

UCT/DiMP also acknowledges that the research team conducted most of its field research in the immediate aftermath of the extreme weather when local residents and government officials in the affected areas were under severe duress – especially those where skilled human capacity was significantly constrained. In this context, the team has, wherever possible, balanced the need for a fair reflection of the disaster's impact with a realistic appreciation of the many other urgent priorities that needed to be addressed at that time.

1.6 Limitations of Research

Although every attempt has been made to capture the events surrounding the August 2006 cut-off lows correctly, it was impossible to consult with all those affected. Similarly, given that the events affected four district municipalities across a wide range of sectors, it was not possible to document the event in depth in a specific geographic area or sector.

A critical limitation in this report is the absence of detailed indirect and secondary losses associated with the August cut-off lows. It is clear from interviews in the affected areas that the local tourist industry has sustained significant impacts. Unfortunately, a more extensive study on these medium long-term impacts was not possible given time and budgetary constraints.

Lastly, one of the major constraints to the implementation of the research was the consistently uneven management of incident recording/tracking documentation, along with lack of streamlined processes for recording impacts/loss.

This was particularly concerning with respect to the lack of systematic loss information by the Provincial Disaster Management Centre, which was unable to provide verified impact information to substantiate the amounts estimated in the original Cabinet submission. In the absence of clear and streamlined recording systems, both with respect to incident management, as well as with respect to tracking loss, all members of the research team spent considerable effort attempting to ‘recreate’ the incident. This is illustrated clearly by the delayed submission of official losses sustained by the Eden District Municipality which was only received by UCT/DiMP in May 2007, nine months after the 2006 weather events.

Such constraints especially applied to reproducing the institutional links that either enabled or limited an effective response. This may have resulted in unintended misinterpretation of the information collected.

1.7 Structure of this Report

This report is structured in the following way:

Part I has introduced the *background, conceptual framework and methods* used in this research.

Part II provides an overview of the *‘biophysical’ aspects of the disaster event*, specifically the meteorology, flood hydrology and land-use characteristics that contributed to its severity.

Part III examines *patterns of social vulnerability* and impacts in specific at-risk settlements and communities.

Part IV addresses the *institutional arrangements* related to the August events, specifically institutional capacities for risk reduction, emergency management and recovery and rehabilitation.

Part V focuses on the *direct economic impacts* of the event by ‘counting the costs’.

Part VI focuses on *conclusions and recommendations*.

Accompanying appendices provide examples of *data collecting instruments* and summary tables, as well as a list of people contacted.

Part II: The August 2006 Cut-off Lows: Extreme Weather,[6] Georisks and Land-use[7]

The scale, distribution and severity of the disaster losses were shaped partly by the powerful character of the weather system. Across the Western Cape, impacts also reflected the significant role of sudden riverine flooding and land-use patterns. Part II examines the 'biophysical' characteristics of the August 2006 cut-off lows, and is divided into three main parts

Section 2.1 presents an overview of climatic history for the areas that were disaster-declared and its relationship to recorded rainfall in the 2006 cut-off lows.

Section 2.2 describes the characteristics of the August 2006 cut-off lows (including precipitation, wind and temperature outcomes) and areas that were directly affected. It also outlines the steps taken to disseminate early warning information by the South African Weather Service.

Section 2.3 describes the geomorphology, geology and land-use that exacerbated the impact of the extreme weather events

2.1 Historical Climatology

2.1.1 Introduction

The Cape south coast is one of the richest year-round rainfall areas in South Africa. Most rain falls in the winter months. However, as one moves towards the east, summer rainfall becomes more significant. Rainfall is brought about by extra-tropical cyclones (frontal low-pressure systems) that move eastward from the South East Atlantic Ocean. Along the Cape south coast humid sea-winds from the warm Agulhas Current feed these systems with extra moisture.

The entire Cape south coast, particularly the Garden Route, is a major tourist destination and attracts thousands of visitors annually. The region is home to a diverse range of flora, with a unique mixture of Cape Fynbos, endemic temperate forests and wetlands.

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[6] This section written by Fiona Tummon, Department of Environmental and Geographical Science, UCT.

[7] This section written by Xavier Middleton

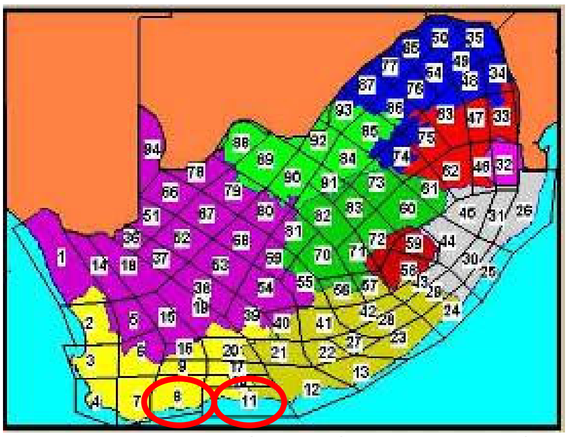


Figure 2.1.1.1: Map dividing South Africa into 94 rainfall regions.
The red circles highlight the two regions discussed

The two cut-off low events which occurred on the 31 July - 4 August 2006 and 21 - 24 August 2006 were centred over the Western and Eastern Cape south coast. By considering Region 8 and Region 11 in Figure 2.1.1.1 it was possible to capture most of the area affected by these two systems. Region 8 includes the worst hit area surrounding George, whilst Region 11 includes the area surrounding Humansdorp, which was also severely impacted. Average monthly precipitation was considered for an 85-year period from 1921 through 2006.

2.1.2 Historic climatology - Region 8 (Focus on George)

This region lies to the west of the south coast area and thus rainfall is predominantly centred in winter. Average annual rainfall is relatively high compared to most other regions in South Africa and heavy downpours can occur year round.

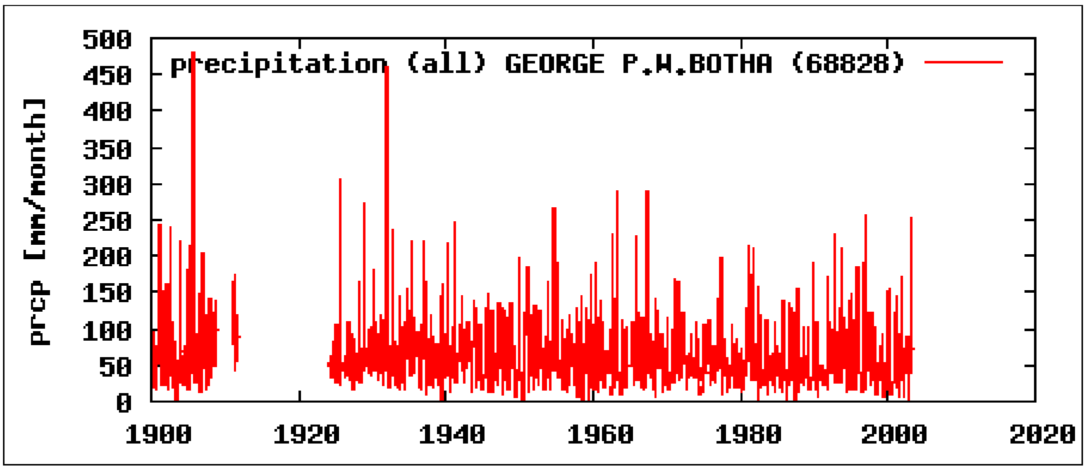


Figure 2.1.2.1: Available precipitation readings from 1900-2006 for P.W. Botha Airport, George

Although August is not the highest rainfall month in George, it is one of the four highest months. Rainfall above 240 mm falls within the 97.5%, therefore the 230.1 mm of rain that fell on the

1 August 2006 was very close to these limits. *It is important to note that nearly four times the monthly average fell in one day*, falling almost within the 97.5% percentile.

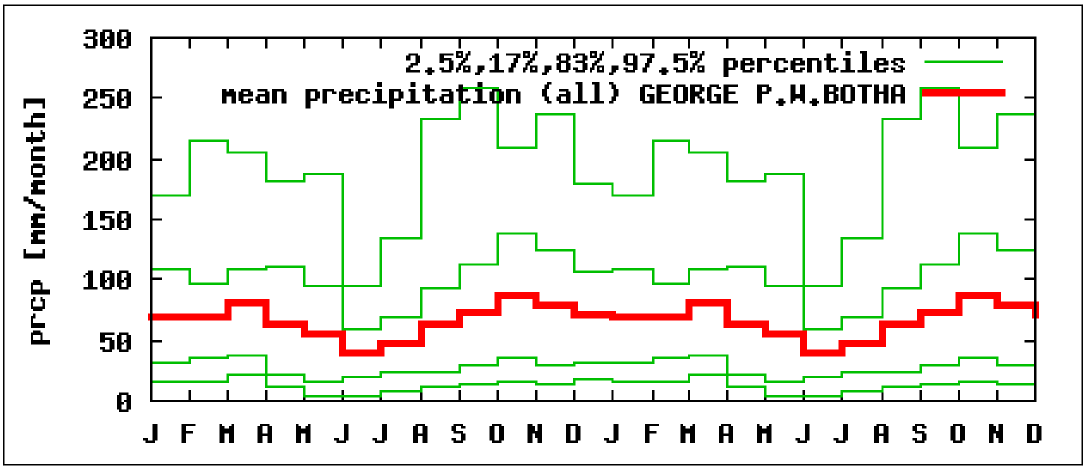


Figure 2.1.2.2: Two annual cycles of George precipitation. The red line indicates the annual cycle whilst the green lines indicate the 2.5%, 17%, 83% and 97.5% percentiles

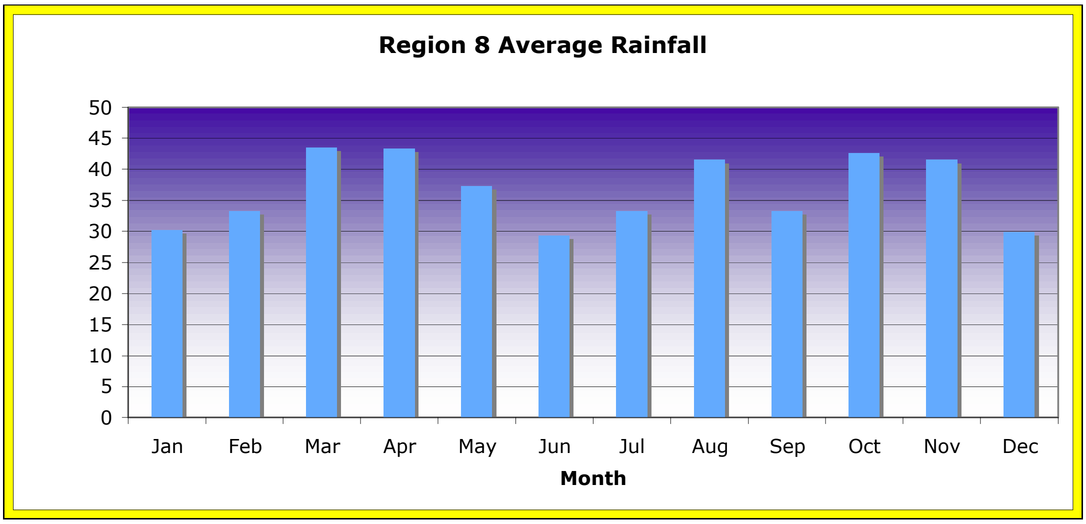


Figure 2.1.2.3: Average annual cycle for Region 8 (averages from 1921-2006)

The annual cycle for Region 8 is very similar to that of George (as seen in Figure 2.1.2.3 above). The cycle is bimodal with high rainfall occurring twice a year, in March-April and August-November. The average August rainfall for Region 8 is 41.5 mm, slightly lower than that for George itself. George is surrounded by the relatively high Outeniqua Mountains, which cause orographic rainfall (rainfall that occurs as a result of moist air being forced upwards). Nevertheless, the rainfall that occurred during the first event alone, a total of 327.8 mm for the 5-day period, was well above both the regional and George's own monthly averages. In fact, these were the highest rainfall recordings on record for George.

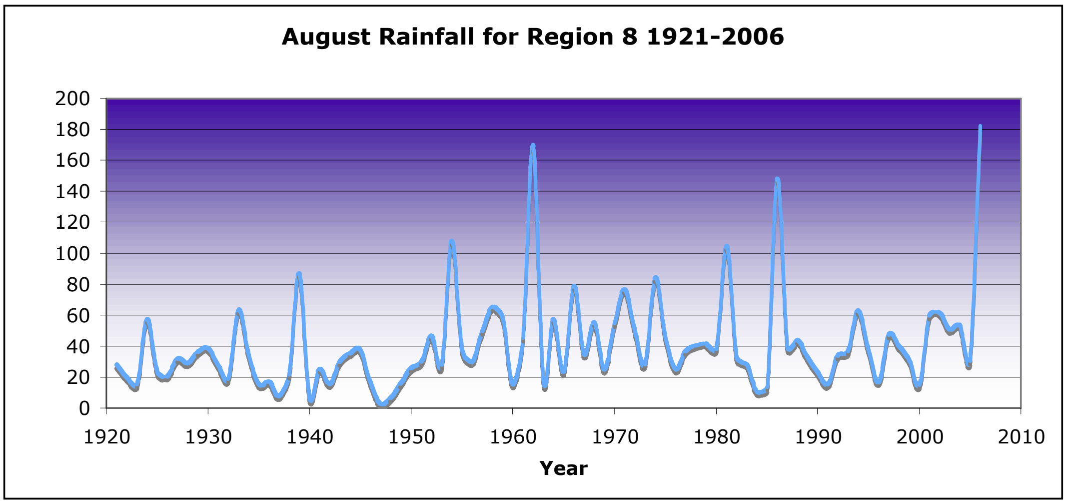


Figure 2.1.2.4: August rainfall for Region 8 from 1921-2006

A number of other intense rainfall events have occurred over Region 8. In 1962 and 1986 events occurred which were almost as severe as those that occurred in August 2006, with rainfall greater than 140 mm. Other precipitation peaks over 100 mm occurred in 1954 and 1981. August 2006, however, appears to have the highest recorded monthly total from 1921-2006, thus confirming the status of the two systems as extreme precipitation events.

2.1.3 Historic climatology: Region 11 (Focus on Humansdorp)

This region lies more to the east than Region 8 and thus receives more summer rainfall, although heavy rainfall still occurs in winter. Similarly to Region 8, Region 11 also has high annual average rainfall compared to most of the rest of South Africa.

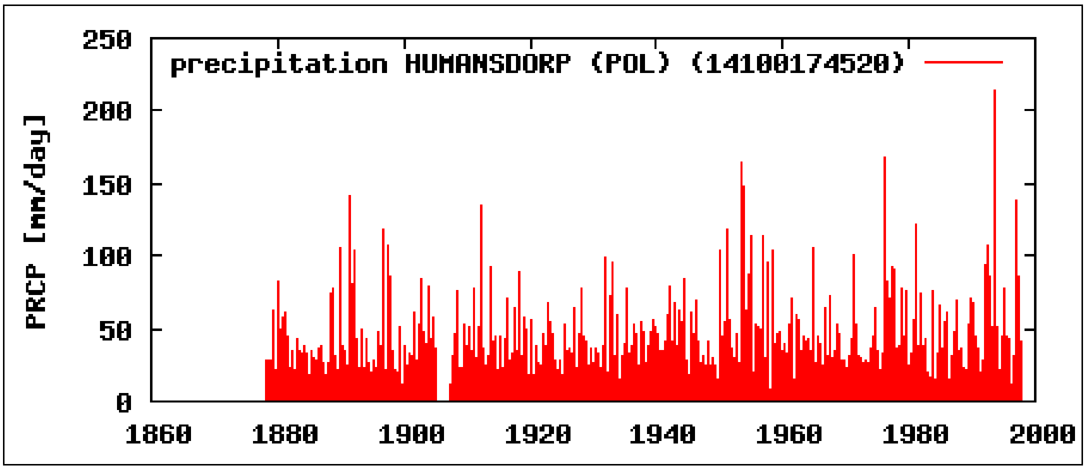


Figure 2.1.3.1: Available precipitation readings from 1880-2006 from Humansdorp Police Station

As August is one of the peak rainfall months, high rainfall is expected during this month. However, the rainfall that occurred during August 2006 was particularly intense, with

465mm falling within that month alone. This was mostly the result of the excessively heavy rainfall that occurred on 2 August 2006 when 302 mm of rain fell. This value lies well above any recorded value from 1880 through 2000. It is also almost ten times the 97.5% percentile daily rainfall rate and would certainly classify as an extreme rainfall event.

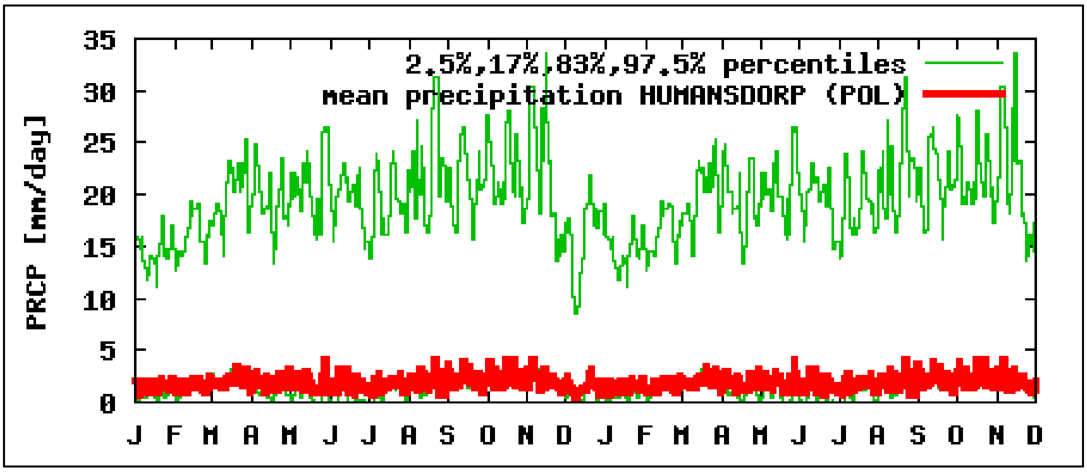


Figure 2.1.3.2: Two annual cycles of Humansdorp precipitation. The red line indicates the annual cycle whilst the green lines indicate the 2.5%, 17%, 83% and 97.5% percentiles

Humansdorp has a similar rainfall cycle to George with a bimodal annual cycle. Peak rainfall occurs in both March and August-November. Rainfall is on average higher than in George and Region 8. During the first event (31 July- 4 August 2006) more rainfall fell over Humansdorp than over any other recorded station, *with 357 mm* falling within this 5-day period alone.

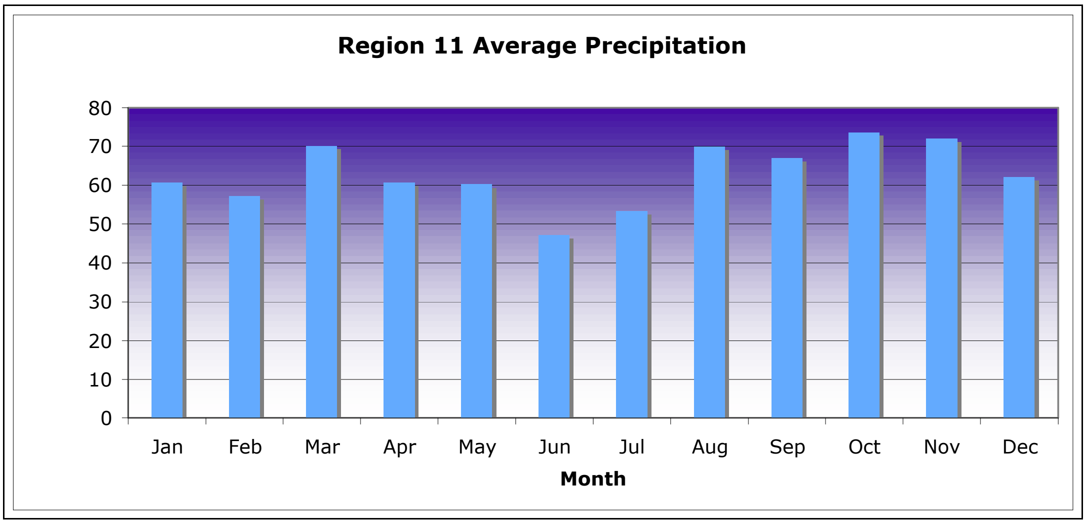


Figure 2.1.3.3: Average annual cycle for Region 11 (averages from 1921-2006)

The average August rainfall for Region 11 is 69.8 mm, somewhat higher than the August average for both Region 8 and Humansdorp itself. The 465 mm total rainfall that fell over Humansdorp in August 2006 was over seven times greater than the regional average, again confirming the extreme status of the two events which occurred during this month.

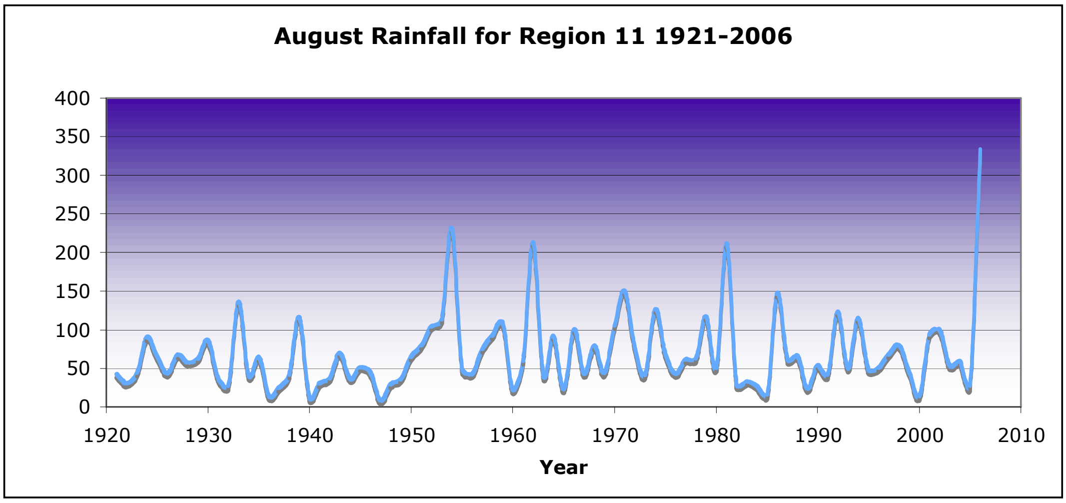


Figure 2.1.3.4: August rainfall for region 11 from 1921-2006

Intense precipitation events, with rainfall over 200 mm, have occurred over Region 11 in the past during August 1954, 1962 and 1981. A large number of peaks over 100 mm have also occurred. August 2006, however, appears to have the highest recorded monthly total from 1921-2006, thus again confirming the status of the two systems as extreme precipitation events.

2.2 Meteorological Report and Weather Warnings[8]

2.2.1 Introduction

Two cut-off low systems hit the Cape South coast in August 2006 causing flooding and extensive damage throughout the region. This report is aimed to provide an overview of the large-scale meteorological conditions during both events.

The following are definitions for a cut-off low:

"A closed low in the upper atmosphere, supported by a low pressure system on the surface." *(SAWS report).*

[8] The assistance of Keith Moir, Gail and Glenda Swart of the South African Weather Service is gratefully
acknowledged for the synoptic charts, rainfall data and severe weather warnings.

“A cold low, originating within the Westerlies that becomes displaced equator-ward out of the westerly current, process evident at very high levels in the atmosphere.” *(http://amsglossary.allenpress.com/glossary/search?id=cutting-off-process1)*

“An upper level low pressure system that has been separated, or ‘cut-off’, from the normal west to east wind flow. Warm air moves southward around the northern tip of a trough, eventually pinching off the area of low pressure. Such lows can stay in place for several days, drifting slowly eastward with its associated cloudiness and precipitation.” *(http://www.intellicast.com/IcastPage/LoadPage.asp)*

Cut-off lows are often associated with heavy rainfall, strong winds, low temperatures and snowfalls and they can be particularly damaging because of their slow movement. On average, 2-6 cut-off low systems occur each winter season over South Africa’s winter rainfall region. The two systems discussed here were by no means extraordinary. However, because the area affected had already received extensive rainfall in the previous month, the region was severely impacted.

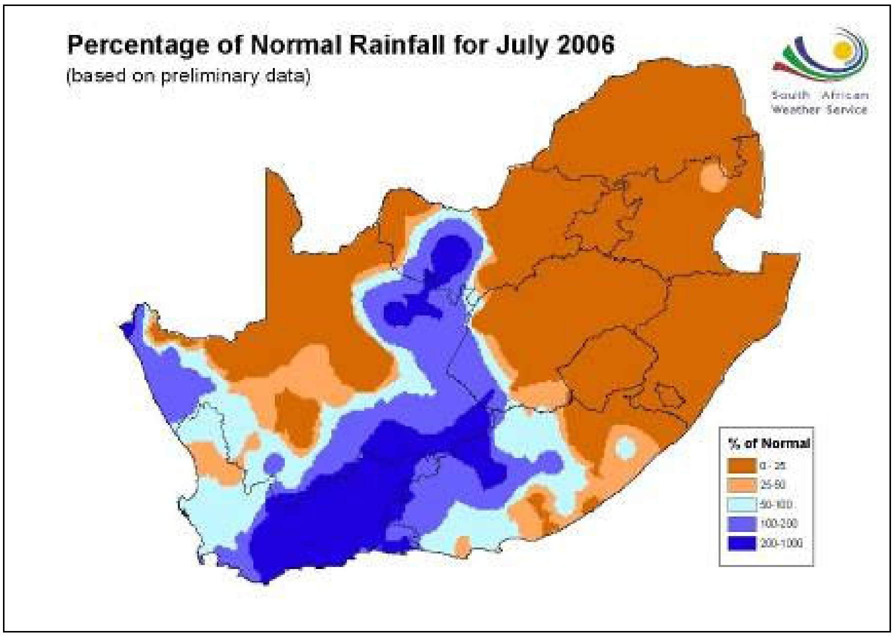


Figure 2.2.1.1: Percentage of normal rainfall for July 2006 based on preliminary data obtained by SAWS. (Courtesy SAWS)

2.2.2. Event One: 31July -3 August 2006

Day One: 31 July 2006 - landfall

On the 30 July 2006 a large cold front was clearly visible to the west of South Africa over the South East Atlantic Ocean. By early morning on the 31 July 2006 this system had made landfall and the majority of the Western Cape, including the Little Karoo and South coast, were experiencing significant rainfall. Rainfall between 20-40 mm was recorded for many stations in these regions; with George receiving the highest rainfall of all, 45.5mm falling on the 31 July 2006. Below-zero temperatures were also recorded over much of the Western and Northern Cape high ground.

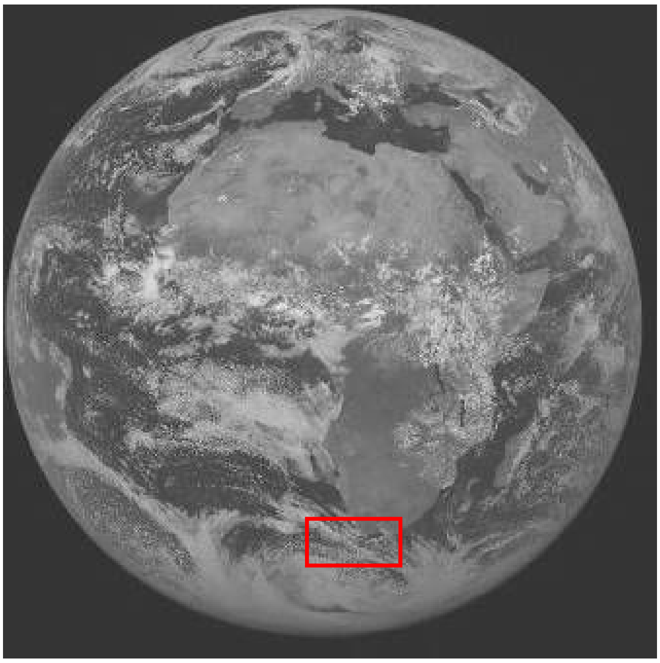


Figure 2.2.2.1: Eumetsat image for 30 July 2006.

The red block highlights the large cold front system that made landfall early on the morning of July 31st. A large low-pressure trough over the interior contributed to intensifying the frontal system by bringing moist tropical air into the region. Simultaneously, a high-pressure system to the south of the country contributed moisture by transporting moist air from the warm Agulhas current northwards.

Day Two: 1 August 2006 - heavy rains in George

By 1 August 2006, the cold front had developed into a cut-off low system and intensified. Rainfall was concentrated over the Garden Route region and George was again particularly affected, receiving 230.1 mm whilst Knysna received 169 mm. Other stations in the region received between 30-50 mm (see Table 2.2.2.1 below). Cold temperatures persisted over the Northern and Western Cape high ground and some snow fell over these areas, particularly on the Swartberg Mountains.

Table 2.2.2.1 Daily rainfall observations for the first cut-off low. Blocks coloured in dark blue indicate stations that recorded rainfall over 300mm, whilst blocks coloured light blue indicate stations that recorded rainfall over 100mm for the 4-day period 31July – 3 August 2006

		DAY					
		31 Jul	1 Aug	2 Aug	3 Aug	4 Aug	Total
STATION	Swellendam	52	27	2.5	0.5	0	82
	Cape St Blaize	45	90.8	17.4	4.2	0.3	157.7
	George	45.5	230.1	47.3	4.3	0.6	327.8
	Knysna	40.8	169	86.6	4.8	0.8	302
	Plettenberg Bay	34.2	38.8	49.8	6.4	14.8	144
	Tsitsikamma	30	8.2	105.6	34.8	26.4	205
	Humansdorp	2	7	302	46	0	357

	Robertson	35.5	8.5	6.5	0.7	0	51.2
	Montagu	18.5	40	0	0	0	58.5
	Barrydale	25	36	20.5	0	0	81.5
	Oudsthoorn	21.6	37.2	4.6	0.8	0	64.2
	Uniondale	3	18	70	10	0	101
	Kareedouw	17.5	3.2	269	50	2	341.7
	Uitenhage	0.2	5	74	11	5.8	96
	Port Elizabeth	0.2	8.6	128	64.4	3	204.2
	Ladismith	43	35	7	2	0	87
	Grahamstown	0	13.8	77	42.6	8.6	142
	East London	0	0.9	56.6	19.4	0.1	77
	Bisho	0	1.2	102	26.4	2	131.6
	Graaf Reinet	3.4	37	62.2	0	0	102.6
	Umtata	0	12.4	48.1	0.4	0	60.9
	Cape Hermes	0	7.4	70	11.6	0	89
	Mtunzini	0	40.8	0	0	0	40.8
	Cape St Lucia	0	94.8	0.2	0	0	95

Very rough seas, with swells greater than 5 m, were experienced all along the Cape south coast up to Port Alfred. Winds associated with cold fronts and cut-off low systems often result in high seas, so the conditions experienced along the coast during this event were not unusual.

Day Three: 2 August 2006 - heaviest recorded rainfall

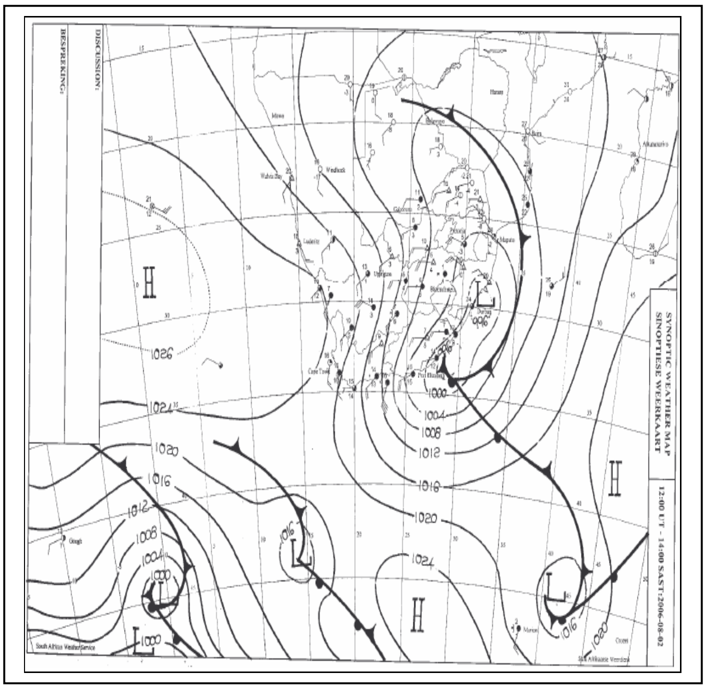


Figure 2.2.2.2: Synoptic chart for August 2 2006.

By the 2 August 2006 the low-pressure had intensified further, with the central pressure dropping to 996 hPa. In the upper atmosphere, at the 500 hPa geo-potential height level, the intensity of the system was more clearly evident. At this level the system was centred over Kwazulu-Natal, though at the surface the low had not moved as far eastwards and was situated over the Port Elizabeth region. A ridging high pressure had begun to develop over the South East Atlantic Ocean, which eventually moved the slow-moving cut-off low offshore

The heaviest rainfall fell on the 2 August 2006 when the system was most intense. The cut-off low had moved slightly further eastward and was now situated over the Eastern Cape south coast. Very high rainfall was experienced in this region with 105.6 mm, 129.6 mm and 300.0 mm being recorded at Tsitsikamma, Humansdorp and Port Elizabeth respectively. Rainfall over the interior was less intense. However, for these semi-arid regions rainfall was still considerable, for example, rainfall of 62.2 mm was recorded at Graaf Reinet.

Although rainfall was not as heavy on the 2 August 2006 as on the 1 August 2006, flooding was reported in many places in the region, particularly in George and Wilderness. Much of the Garden Route region had received considerable rainfall in the month prior to this event and thus many of the dams and water reservoirs in the region were already nearly at capacity. The sustained and excessive nature of the rainfall during this event pushed these facilities beyond their limits

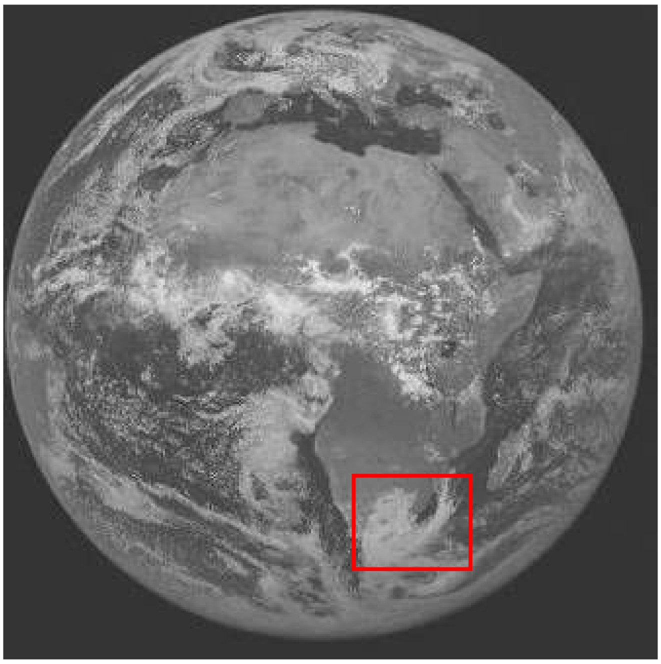


Figure 2.2.2.3: Eumetsat image.

The red block highlights the large extent of the cut-off low system.

On 2 August 2006, very cold temperatures were experienced by most of the country. Minimum temperatures remained below or near zero and maximum temperatures did not exceed 15ºC in many places. Associated with the very cold temperatures, snow continued to fall over the Western Cape high ground as well as over the Eastern Cape, south east Free State, Lesotho and Kwazulu-Natal Drakensberg. Strong winds were also experienced in many places and rough seas continued between Cape Agulhas and Port Alfred, with swells still over 5 m. These winds were the result of the intensity of the cut-off low system, which can clearly be seen in this image.

Day Four: 3 August 2006 – rainfall abates

By the 3 August 2006 the upper level flow started returning to normal. However, very cold temperatures continued to be recorded over the Eastern Cape interior, resulting in snow falling on the Lesotho and Southern Drakensberg mountains. The coastal region also experienced gale-force winds resulting in very rough seas between Plettenberg and Richard’s Bay.

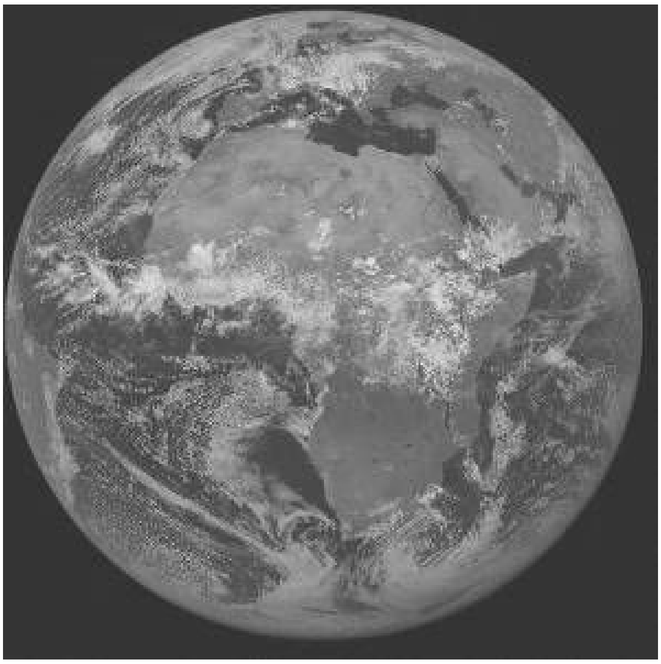


Figure 2.2.2.4: Eumetsat image for 4 August 2006.

By the 3 August 2006 the upper level flow started returning to normal. Skies began to clear over the Western Cape south coast and the interior as rainfall abated. Rainfall continued, however, over the Eastern Cape south coast and adjacent interior, but was less intense. Port Elizabeth recorded the highest rainfall of 60.8 mm, with Grahamstown a close second with 42.6 mm. These readings were nevertheless considerably less than the previous days' rainfall as only the tail end of the large cut-off low system was overland.

Day Five: 4 August 2006 – skies clear but windy conditions

By 4 August 2006 skies had cleared over most of the country as the South Atlantic high pressure moved further eastwards. Rain continued to fall over parts of the Eastern Cape during the morning. However, by afternoon rainfall had stopped in almost all regions. Temperatures over the interior were still low, and snowfalls also occurred over the Eastern Cape high grounds and Lesotho during the morning.

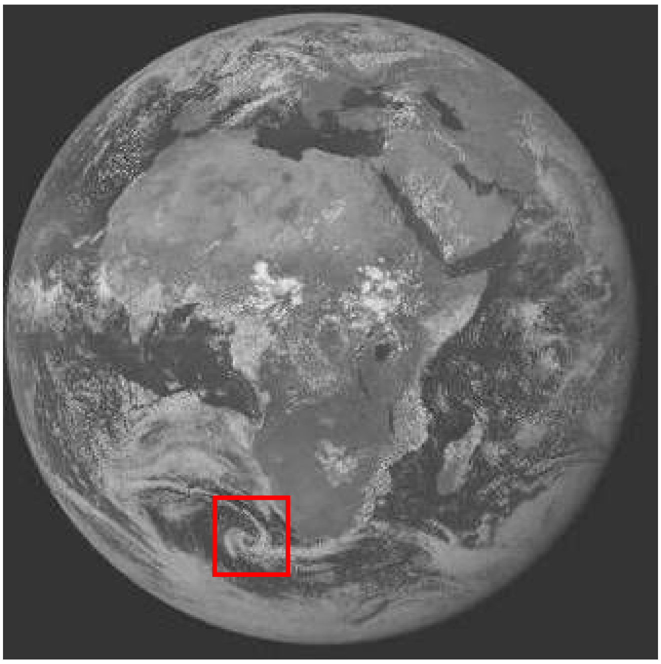
Very windy conditions occurred only along the coast, where rough seas with swells greater than 5 m occurred between Port Alfred and Richards Bay.

Day Six: 5 August 2006 – skies clear and no rain

By the 5 August 2006 the cut-off low system had moved further south and joined the main westerly flow. Cold conditions were still experienced over most of the north east interior of the country, but skies were clear and no rainfall occurred.

2.2.3 Event Two: 21 August - 24 August 2006

On the 20 August 2006 a second cold front was visible to the west of South Africa. This low-pressure system was considerably smaller and less intense than the first event as described above. Surprisingly, the system was cut-off from the main westerly flow before it had even made landfall.



The red block highlights the cut-off low. By early morning on the 21 August 2006, the small system had made landfall over the Western Cape South coast. A second, even smaller, low-pressure had formed to the north-east of South Africa as well. Similarly to the first event, both of these systems were fed by moist tropical air from a large low-pressure trough that had developed over the continent.

Figure 2.2.2.5: Eumetsat image for 20 August 2006.

Day One: 21 August 2006 – landfall

This second event was centred further inland than the first and on August 21st heaviest rainfall was recorded Barrydale and Oudtshoorn, with 34.5 mm and 80.4 mm respectively. Relatively little rainfall was recorded over the Western Cape south coast, whilst no rainfall occurred in the Eastern Cape.

Temperatures over the Northern Cape western high ground and Western Cape interior were very low; however, no snowfalls were recorded.

Table 2.2.2.2 Daily rainfall observations for the first cut-off low. Blocks coloured light blue indicate stations that recorded rainfall over 100mm for the 3-day period 21-24 August 2006

	DAY:				
	21-Aug	22-Aug	23-Aug	24-Aug	Total
Swellendam	9	15	80	20	124
Cape St Blaize	0	12.6	0.5	22.3	35.4
George	0.2	71.5	4	36	111.7
Knysna	0	29	2.6	16.8	48.4
Plettenberg Bay	0	19	0.6	6.8	26.4
Tsitsikamma	0	4	4.4	16.6	25
Humansdorp	0	25.5	3	43	71.5
Robertson	7.5	11.5	59	31	109
Montagu	3	13	28	10.5	54.5
Barrydale	34.5	5	31	0	70.5
Oudsthoorn	80.4	8.8	1	14.4	104.6

Uniondale	0	0	0	0	0
Kareedouw	0	4.3	0	8.2	12.5
Uitenhage	0	0.8	2.8	12	15.6
Port Elizabeth	0	0	0.4	5	5.4
Ladismith	2	20	3.5	12.5	38
Grahamstown	0	3.2	4.8	39.2	47.2
East London	0	0	0.1	23.6	23.7
Bisho	0	0	0.4	23.8	24.2
Graaf Reinet	1.4	3.2	4.8	1.2	10.6
Umtata	0	0	1.2	3	4.2
Cape Hermes	0	0	0	0	0
Mtunzini	0	0	0	11	11
Cape St Lucia	0	17.2	3.6	10	30.8

Day Two: 22 August 2006 - significant rainfall over South coast

Significant rainfall occurred mostly over the Eastern and Western Cape South coast, particularly at George, which recorded the highest rainfall for August 22nd, of 71.5mm. Rainfall over the interior was relatively light, with most stations receiving below 15mm. Temperatures remained low over the Western and Northern Cape interiors.

Day Three: 23 August 2006 – heaviest rainfall

Heaviest rainfall occurred on the 23 August 2006. The small cut-off low system that was situated over the Northern and Western Cape border had moved further inland resulting in relatively heavy rainfall in the Montagu and Swellendam regions. Montagu, Robertson and Swellendam recorded 28 mm, 59 mm and 80 mm respectively.

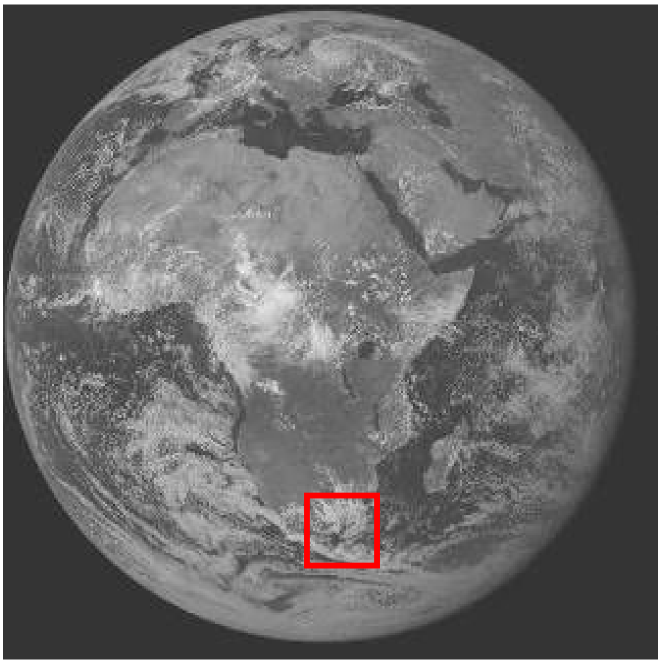


Figure 2.2.2.6: Eumetsat image for 24 August 2006.

The red block highlights the cut-off low. By the 22 August 2006 the two small low pressure systems had moved eastward, over the Eastern Cape south coast and the Northern and Western Cape west coast border. Upper level atmospheric circulation patterns mirrored the surface conditions. By 23 August 2006, the second, slightly larger low-pressure had also moved further eastward and was now centred over the northern Kwazulu-Natal coast. By the 24 August 2006 a ridging high, which had been developing over the South East Atlantic, moved in and pushed the small, inland low pressure quite considerably more eastward over the Eastern Cape South coast

The cut-off low was still situated further inland than the first event and thus rainfall was highest in these regions. Grahamstown recorded the highest rainfall of all the interior stations with a total of 39.2 mm for the 24 August 2006.

Rainfall had abated over most of the Western and Northern Cape; however, the coastal region from George eastward still received significant rainfall. George and Humansdorp received the highest coastal rainfall for the 24 August 2006, with 36 mm and 43 mm respectively. Temperatures over the interior remained low.

By 25 August 2006, skies had cleared over the entire country as the South Atlantic ridging high moved eastwards over South Africa. Little rainfall was recorded except for light rainfall during the morning at a number of Eastern Cape stations. The cut-off low system had moved eastward, offshore and joined up with the main westerly flow.

The first cut-off low had already caused extensive damage to the Western Cape south coast and parts of the Eastern Cape south coast. The cumulative impact that the second event had on these regions caused further significant damage, despite this event not being as intense as the first.

2.2.4 Severe Weather Warnings: Information Dissemination

The South African Weather Service (SAWS) is responsible for producing forecasts and issuing severe weather warnings to the public as well as to the government. Forecasters determine the probability of an occurrence of an event and assess the possible impacts of such an event. Rain and snowfall, very cold temperatures, strong winds and large ocean swells are potentially the most damaging and these features are usually focused on.

Once a forecast has been produced, warnings are issued if the likelihood of a severe weather event is significant. Warnings are issued by the SAWS head office in Pretoria as well as by the local Weather Office, in the case of the two events discussed, the Cape Town Weather Office.

The SAWS warning system has been described in some detail by Carter (2004). SAWS is responsible for distributing forecasts to national media and government departments as well as to various local government departments and media offices. Their warnings are also posted on their website and telephonic forecast. Short Message Service's (SMS's) are also sent to numerous national and local government departments.

In the case of the two events discussed the Cape Town Weather Office released warnings to three Cape Town based daily newspapers, the Cape Times, Cape Argus and Die Burger. Warnings were also posted on the SAWS website and their telephonic forecast.

2.2.4.1 Cut-off low - Event One: 31 July – 4 August 2006

An initial advisory was sent out on the 28 July 2006 for a cold front that was to hit the country on the 30 July 2006. The advisory indicated that: "Very cold and wet conditions over the western high ground of the Western and Northern Cape Sunday overnight" were to be expected (Sunday being the 30 July 2006). This forecast was correct, as a large cold front did move over the region causing significant rainfall.

This advisory was upgraded to a warning, very similar to the initial advisory, which was then sent out on the 29 July 2006. Two subsidiary advisories for “Snow expected on the mountains of the Western Cape on Monday, with heavy falls of rain likely Monday night along the Cape South coast and adjacent interior” (Monday being the 31July 2006) as well as for “very cold, wet and windy conditions with snow on the mountains expected to spread to the Eastern Cape on Tuesday, reaching the southern and eastern Free State, Lesotho and Drakensberg” were sent out on the 29 July 2006.

By Tuesday the 1 August 2006 the system had already hit much of the Western, Northern and Eastern Capes and a number of warnings were given for very cold, wet and windy conditions, snowfalls over the Swartberg mountains, Eastern Cape high ground and Lesotho as well as for very rough seas with wave heights in excess of 5 m between Cape Agulhas and Port Alfred. In particular, one of these warnings stated that “heavy falls of rain are expected in places along the Cape south coast and adjacent interior”.

Advisories were simultaneously given for heavy rainfall over the Eastern Cape, Lesotho and southern Kwazulu-Natal on Wednesday, for gale force winds very cold and windy conditions over the entire country as well as Lesotho and very rough seas between Plettenberg and Richard’s Bay on Wednesday, 2 August 2006 and Thursday, 3 August 2006 respectively.

On 2 August 2006 warnings were given for very cold conditions over most of the country, snowfalls over the high ground of the Western and Eastern Cape, Lesotho and the Drakensberg, gale force winds and very rough seas between Plettenberg Bay and East London as well as for heavy falls of rain along the Garden Route, eastern parts of the little Karoo and along the south east coast and adjacent interior between Plettenberg Bay and Port Alfred.

Again, these warnings were accompanied by a number of advisories which stated that very cold conditions were to persist over the south eastern high grounds, further heavy rainfalls were to be expected over the Eastern Cape and gale force winds and rough seas were expected between Plettenberg Bay and Richard’s Bay on Thursday, 3 August 2006.

By 3 August 2006 the cut-off low system had moved eastwards and the Western Cape was feeling some relief as the rainfall abated and the temperatures began to rise again. However, much of the country was still experiencing very cold conditions and again, a large number of warnings were given, this time more particularly for the eastern and northern parts of the country.

Warnings very similar to the advisories issued on the 2 August 2006 were issued. These included warnings for continued snowfall over the Eastern Cape, Lesotho and Free State high grounds, very cold conditions over the eastern half of the country, gale force winds and rough seas between Cape St. Francis and Richard’s Bay as well as for heavy rainfalls along the coast and adjacent interior of the Eastern Cape.

By the 4 August 2006 the system had largely moved offshore, but the eastern half of South Africa and Lesotho were still experiencing the influences of the tail end of the large cut-off low system. Warnings were still given for cold conditions over the eastern section of the country, morning snowfalls over the Eastern Cape, Lesotho and Kwazulu-

Natal western high ground and gale force winds and rough seas from Port Alfred to Richard's Bay. A further warning was given for the Western Cape indicating that "due to current levels of rivers and dams, further showers may lead to localised flash flooding in places along the Cape southern coasts.

2.2.4.2 Cut-off low - Event Two: 21 August – 24 August 2006

Warnings regarding heavy rainfall were sent out on the 18 August 2006, 3 days before a second cut-off low system hit the Cape south coast. The warning indicated that "heavy falls of rain are expected to set in over the Overberg Sunday (20 August 2006) overnight spreading to the South coast and adjacent interior Monday" (21 August 2006). This warning was, however, amended by a contradictory advisory issued the following day which stated that "No heavy falls to be expected. Accumulative rainfall of 25 mm to 30 mm likely for South coast/Overberg during Tuesday" (22 August 2006).

These warnings were followed up by two further warnings, issued the following day, regarding widespread rainfall over the Cape South coast over the 23 August and 24 August 2006. Of particular importance, perhaps, was the warning issued at 8 am on Wednesday, 23 August 2006, which stated that the "persistent widespread rain (40 mm in 24 hours) through Wednesday and Thursday, on the Western Cape South coast and adjacent interior will maintain localised flooding condition".

As the cut-off low tracked eastward and offshore, the rainfall began to subside. A warning was nevertheless sent out on the morning of the 24 August 2006 indicating that "rainfall abating in the western areas of the South coast. Further falls of 15–20 mm still possible George and eastwards". Since this area had experienced extensive rainfall and flooding over the preceding three weeks this warning was quite appropriate. Even small amounts of rainfall such as 15-20 mm can trigger local flooding after weeks of sustained rain.

Just as in the first event, the weather that was experienced during the second cut-off low was very similar to what was forecast and warned. The South African Weather Service appeared to have forecast the cut-off low systems and their possible impacts remarkably well. The difficulties experienced reflect apparent 'disconnects' between the warnings and advisories issued and their interpretation and subsequent responses by local officials and other end-users. This could possibly be attributed to end-users not fully understanding or ignoring the warnings, and thus taking inadequate preparatory actions.

However, in both these events, SAWS is to be particularly commended for issuing its warnings and advisories in easily understandable and accessible language.

2.2.5 Recommendations:

Extreme weather warnings should differentiate between anticipated levels of risk.

As mentioned in Carter (2004), warnings should ideally be differentiated, stating different levels of anticipated extreme weather risk. If, for example, key responders (i.e. 'end-users' of warning information) knew a "level-three" warning had been issued, they would know to take urgent precautionary actions.

In relation to these and previous weather events, key responders have commented that they receive “so many warnings” that they tend to discard them. This is illustrated by the fact that very similar warnings to those given for this event were also given earlier during July.[9]

While the weather conditions experienced in mid-July were not nearly as severe as those that occurred from the 31 July 2006 to the 3 August 2006, the warnings were almost identical. This underlines the urgency for an extreme weather ‘severity code’ or scale to differentiate between different levels of risk.

Extreme weather warnings should – where possible – provide expected values for rainfall and wind-speed.

None of the warnings issued mentioned any potential values of rainfall or wind speed, only of possible wave heights. This perhaps is related to the previous point, but if end-users were informed that more than “50mm of rainfall” is expected, or that wind speeds may exceed 60km/hr they might be more likely to take preparedness measures. If possible, forecast values (which are available to the weather service) were included along with a severity rating system, more action would probably be taken by key responders in all sectors.

Extreme weather warnings should be issued at least a day in advance.

Virtually all the warnings were issued the morning that the weather event was to occur, whilst most of the advisories warned against events that were to occur the following day. The advisories are potentially more useful than the warnings since they are given at least a day in advance, thus allowing the end-user some time to take action.

Weather warnings should include descriptions of likely localised impacts.

Very few of the warnings include a description of the possible impacts of the weather event they describe (e.g. possibility of flooding, wind damage etc). Only the warning issued on 4 August 2006 included a warning against possible localised flash flooding, although severe flooding *had already occurred* in many areas throughout the Cape South coast region.

Weather warnings should be communicated directly by telephone to key officials.

For events above a certain level of risk it may be more effective to telephone and *speak directly* to key provincial officials and municipal managers of the areas likely to be affected. The SMS system currently used is a very effective and quick means of communication, however, phone calls are not as easy to ignore and provide an opportunity for the recipient to ask questions directly.

[9] On the 14 July 2006 warnings were issued for “very cold and wet conditions to be expected on the western high ground of the Western and Northern Cape” as well as for “heavy falls of rain expected this morning over the southern coastal areas of Western Cape, between Gordon’s Bay and Stilbaai, as well as the Overberg region”.

2.3 Geomorphology, Geology and Land-use[10]

The two cut-off low systems described above were associated with extensive flooding, slope failures and infrastructural damage in the Eden District, underlining the significant vulnerability of the district's populated areas to heavy rainfall hazards. However, they also raise important questions about the role that rapid urban growth itself has played in driving endangering flood risks by increasing local vulnerability (or 'susceptibility') to extreme weather events. [11]

In this context, the concept of landscape sensitivity' is helpful for understanding how changes in the district's landscape might have both exacerbated and increased local flood risks. For
instance, changes within the landscape (for instance the building of a road or a new development) promote localised slope instability and erosion, by altering the natural balance of the landscape. A change in one component of the landscape can alter another.

Similarly, changes in erosion rates or even sedimentation rates can alter natural drainage systems, which in turn have a knock-on effect on other spheres of the natural environment (i.e. changes in channel size, changes in surface run-off, and changes in ecology).

Significant changes or increases in surface run-off (through paving or hardening of surfaces) can also affect groundwater recharge (which in turn affects the water table). Scale is also a key factor in effecting changes across a landscape. For instance, although one road or paved surface may only affect the slope instability of one hill, a road network may generate changes that affect a regional landscape.

This section examines the underlying geological characteristics of the Eden District Municipality - including the Bitou, George, Hessequa, Kannaland, Knysna, Mossel Bay and Oudtshoorn Municipalities – focusing on those geological features that increase and

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[10] References to support this section were drawn from:
Barnett, W., Armstrong, R.A. and de Wit, M.J (1997) Stratigraphy of the upper Neoproterozoic Kango and lower Palaeozoic Table Mountain Groups of the Cape Fold Belt revisited. *S..Afr.J.Geol.*, 100: 237 –250.
Brunsden, D. and Thornes, J.B. (1979) Landscape sensitivity and change. Transactions, Institute of British Geographers 4(4): 463-484.
Dingle, R.V., Seisser, W.G. and Newton, A.R. (1983) The Mesozoic and Teritary Geology of Southern Africa, A.A. Balkema, Rotterdam.
Hattingh, J. (1996) The macro-geomorphology of the Eastern Cape, *In:* Lewis, C.A. (Ed). The Geomorphology of the Eastern Cape, South Africa, Grocott & Sherry Publishers, Grahamstown
Maud, R.R (1996) The macro-geomorphology of the Eastern Cape, *In:* Lewis, C.A. (Ed). The Geomorphology of the Eastern Cape, South Africa, Grocott & Sherry Publishers, Grahamstown
Toerien, D.K. (1979) Geology of the Oudtshoorn area: explanation of sheet 3322. Geological Survey Government Printer, Pretoria.

differentiate *exposure* of the towns, suburbs and settlements across the Eden District to heavy rainfall and its consequences for surface run-off and slope subsidence.

Then, focusing specifically on the George and Mossel Bay Municipalities, it describes the extent of urban spread is since the 1930s and associated shifts in land-use, as important co-risk (or 'vulnerability') factors for intensifying run-off and slope instability in these areas.

The section continues by examining the risk interactions between these underlying conditions and extreme weather – with a specific focus on the suburbs/settlements of Thembalethu and Wilderness Heights (George) and Glentana (Mossel Bay), all of which experienced significant but differentiated impacts following the August 2006 cut-off lows. This is partly due to their particular underlying geophysical characteristics which increase exposure to heavy rainfalls and run-off and related consequences. However, it also significantly reflects the specific 'internal' vulnerability characteristics that also contributed to the risk for each of the respective human settlements, including:

- their location and exposure (to riverine and wetland flooding and slope subsidence),
- the robustness of formal and informal infrastructure and associated services, and
- most importantly, the residents' capabilities themselves to anticipate, resist and recover from recurrent extreme weather systems.

Section 2.3 is divided into five parts:

Section 2.3.1 describes the assessment research methods used.

Section 2.3.2 outlines the geophysical characteristics of the Eden District Municipality and associated municipalities that increase exposure to run-off and slope failure following heavy rain events.

Section 2.3.3 describes urban growth and land-use changes for George and Mossel Bay that have hardened catchments and subsequently increased run-off potential following heavy rains.

Section 2.3.4 describes the specific risk interactions between the underpinning geophysical features of Thembalethu, Wilderness Heights and Glentana and the extreme weather conditions experienced in August 2006. It focuses on the 'realised risks' (the risk outcomes or impacts) for the residents of the three settlements and the main causal factors which 'drove' these impacts.

Section 2.3.5 concludes with recommendations.

2.3.1 Methodology

2.3.1.1 Overview

A wide range of field research, analytic methods and data management obstacles were undertaken or addressed in the course of this assessment[12]. These are reflected in the sub-sections below:

2.3.1.2 Field research

Fieldwork was conducted over a two week period (7 – 19 August 2006), immediately after the first flooding event (31 July - 3 August 2006). Handheld GPS (Global Positioning Systems) units were used to add the necessary spatial dimension to the data, for importation into a GIS.

Field research (through field observations and photographs) primarily aimed at documenting the landscape's response to the August 2006 cut-off lows. It focused on identifying and documenting:

- the geophysical and infrastructural risk outcomes (or impacts) in specific localities (ie slope failure, endangering run-off, land subsidence),
- the contributing environmental and infrastructural risk factors that increased local vulnerability (susceptibility) to the heavy rainfall and its associated consequences.

2.3.1.3 Data consolidation and analysis

A range of complementary geophysical and spatial analytic methods were used. For determining the general *geological and geomorphological exposure* of the area to extreme rainfall events, the methods used were compilation of maps and TINs (Triangulated Irregular Networks to show slope characteristics) using GIS[13]; analysis of the area's underlying geology through the generation of a simplified stratigraphy, investigation of the area's geomorphology through the use of orthophotographs and aerial photographs, and analysis of land-use changes and patterns.

- Compilation of maps and TINs
  Maps and TINs were compiled using a desktop GIS application (i.e. ArcGIS 8.3). Datasets were generated from field data (GPS data, field notes, pictures) and digital datasets (aerial photographs, orthophotographs and shape files). The GIS data were based on the current series of 1:50 000 topographical maps, available from the Department of Land Affairs. Additional GIS data were obtained from the GIS

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[12] However, a more detailed and comprehensive analysis was not possible, given the size of the Eden District Municipality (21 748 km^{2}), the time constraints for field research, as well as the intensive nature of data preparation.

[13] TINs are composed of a continuous network of triangles at randomly located terrain points, which can be used to represent 3D surfaces. The size of the triangles varies (based on the characteristics of the landscape). Small triangles can model highly variable terrain, as opposed to larger triangles, that are specifically suited for flat to smoothly sloping surfaces. In this regard, TINs are invaluable in the modelling of slopes, aspect and with the necessary GIS add-ons, even runoff,

Research Facility at the University of Cape Town. For this study, TINs were generated from available topographical data, in particular using 20 m interval contour lines (Figure 2.3.1.3.1).

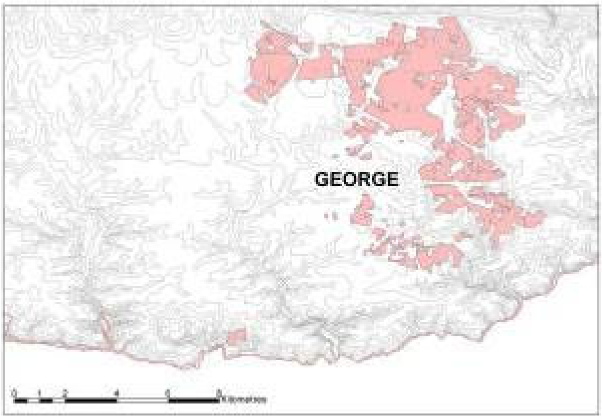

Figure 2.3.1.3.1: Shows the same contours as observable from a topographical map

Figure 2.3.1.3.2: Shows the TIN derived from the same set of Contours

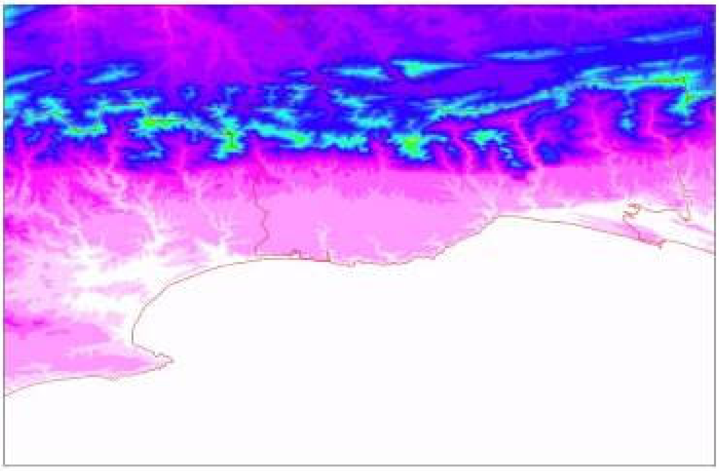

Figure 2.3.1.3.3: At a larger scale, this TIN of the Southern Cape shows elevations derived from a larger sample of contour lines.

These three images (Figure 2.3.1.3.1 to 2.3.1.3.3) are examples of TINs, and were derived from contour lines (as found on a topographical map). The difference between them depends on the resolution of the contour data. For instance, 20 m interval contours give a more accurate TIN than contours with 50 m intervals. However, on a regional scale (‘zoom out’ view), it is more appropriate to use larger intervals.

- Analysis of the area’s geology

This was based on the 1:250 000 geological map[14].and accompanying explanation booklet obtained from the Council of Geoscience. At present, apart from a 1:50 000 geological map of the Mossel Bay area, detailed geological mapping of the Eden District (on a 1:50 000 or lower scale) is still ongoing. Additional geological data for this report were based on field notes, complementary research papers and books.

A simplified geological succession or stratigraphy of the area (including ages) is summarised in Table 2.3.1.3.1. In accordance with geological convention, the oldest part of the succession is given at the bottom of the table and the youngest at the top.

Table 2.3.1.3.1 Simplified stratigraphy of the Eden District (A detailed stratigraphy is beyond the scope of this report). Modified after Toerien (1979) and Maud (1996)

Geological Era/Period		**Millions of years**	**Geological Group, Formation, etc.**		**Dominant lithology (rock or sediment type)**
Cenozoic	Tertiary to Recent (Holocene)	65 – 0			Alluvium, sand dunes, soils, aeolianites, beach deposits, limestones, silcrete
Mesozoic	Cretaceous	144 – 65	Enon Formation	Uitenhage Group	Pebble-conglomerates (near Knysna)
	Jurassic	208 – 144			
	Triassic	245 – 208			
Palaeozoic	Permian	286 – 245	Ecca Group Dwyka Group	Karoo Group	Shales Tillite (diamictite)
	Carboniferous	360 – 286			
	Devonian	408 – 360	Witteberg Group Bokkeveld Group Table Mountain Group	Cape Supergroup	Quartzites, shale, sandstones
	Silurian	438 – 408			
	Ordovician	505 – 438			
	Cambrian	590 –505	Cape Granite Suite (particularly the Maalgaten granites near George)		Granite
Late (neo) Proterozoic		900 – 570	Kango and Kaaimans inliers	Kango and Kaaimans Groups	

[14] Geological or geologic maps are usually superimposed onto topographical maps, and designed to show subsurface geological features, such as geologic units (i.e. particular rock formations), geological structures (faults, folding, strike and dip symbols) and various additional information as indicated by the map key.

- Investigation of the area's geomorphology
  In order to investigate and document the topography of the landscape and the general geomorphology of the area, orthophotographs and aerial photographs were used. These images were used in conjunction with computer-generated TINs.

- Analysis of land-use changes and patterns
  For examining the extent of *urban expansion and land-use changes and patterns*, aerial photos, orthophotographs and topographical data were analysed and mapped using digital copies.

The data were obtained from the Department of Land Affairs: Chief Directorate of Surveys and Mapping. The immediate aim was to determine the extent and nature of land-use and land-cover changes in the Eden District, over a specific time interval. The oldest viable aerial photography series was taken in 1939 (Job 140), with the most recent orthophotographs dating from 2004.

Photographs from a specific year and job number were manually merged using an image processing package (Photoshop CS) to form an image composite (Figure 2.3.1.3.4). The image composites were imported into a GIS application. The specific land-use features were digitized and added to the GIS for further consideration.

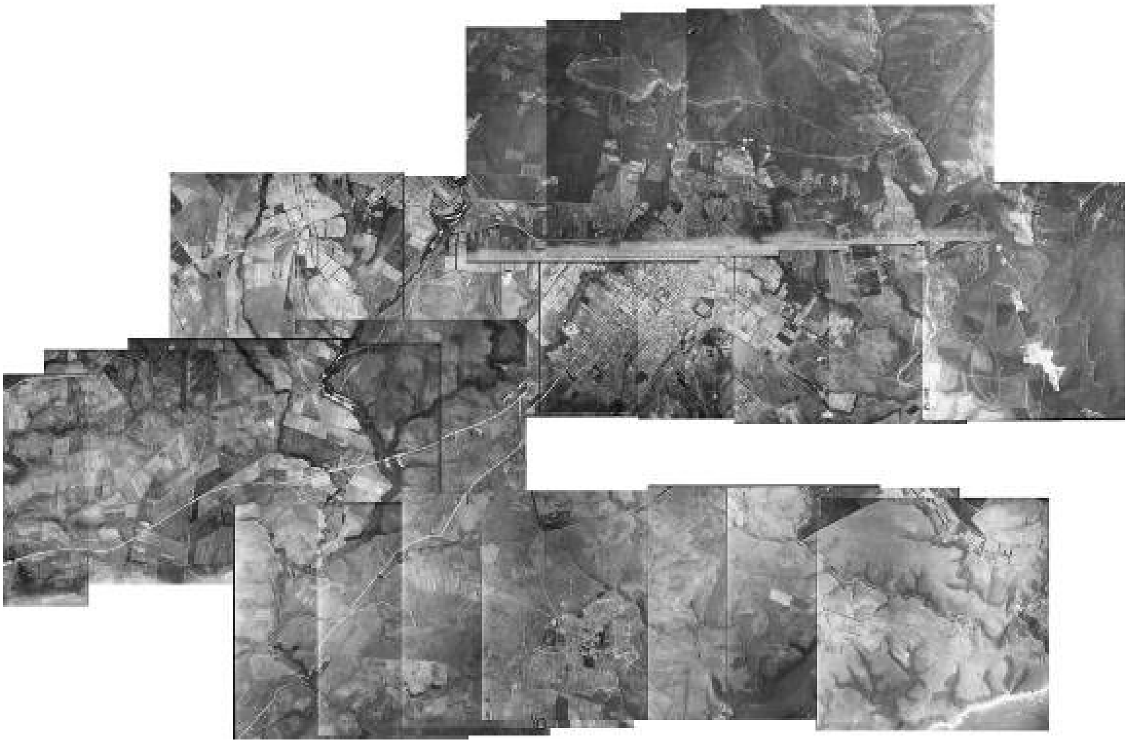

Figure 2.3.1.3.4: Example of an aerial photography image composite of the George and Pacaltsdorp area (derived from photography series 1939 Job 140)

Land-use patterns were divided into the following categories: urban, cultivated lands (agricultural), and natural vegetation.

2.3.1.4 Challenges associated with the data

The Hartebeesthoek 94 datum[15] (a variation on the World Geodetic System 1984 ellipsoid or WGS 84), is commonly used as the official coordinate system for South Africa. The projections of the digital datasets (shape files) obtained from the Department of Land Affairs were not in WGS 84. The digital datasets had to be converted to WGS 84.

Digital or scanned copies of archival and pre-1970 aerial photographs (non-ortho-corrected) were generally of poor quality. The images were in some cases overexposed (particularly coastal areas), whereas others were low resolution scans. The quality of a number of the images made it difficult to discern landscape features or to conduct a high-resolution study of land-use changes (over time). However the digital images allowed for significant manipulation in an image processing application (Photoshop CS) or a desktop GIS.

Individual digital images had to be registered and geo-referenced for use within the GIS application. Projection conversion of the digital datasets and image registration were very time consuming.

The geology of the Eden District had to be based on the available 1:250 000 geological map. More detailed 1:50 000 geological maps for the area are still being drafted by the Council of Geoscience (with the exception of a completed 1:50 000 geological map for the Mossel Bay area).

2.3.2 Geophysical profile for George and Mossel Bay Municipalities

Within the Eden District Municipality, the Hessequa, Mossel Bay, George, Knysna and Bitou Municipalities are located on the vast coastal platform between the Indian Ocean and the mountain ranges of the Cape Fold Belt. The Kannaland and Oudtshoorn Municipalities are located within the Cape Fold Belt.

The Outeniqua Mountain range forms the most northern border to the Mossel Bay and George Local Municipalities. Directly south of the mountain range is a flat, seaward-sloping, plateau (indicative of coastal erosion over million of years). As shown in Figure 2.3.2.1 the topography varies considerably from the steep escarpment slopes north of George, to the rolling hills and river valleys on the coastal platform. Near the coast, the terrain is rocky, with steep coastal cliffs.

The Maalgate and Skaapkop Rivers are also shown in Figure 2.3.2.1. They are classified as incised rivers and form a dendritic (or ‘tree-like’) pattern on the weathered[16] granite bedrock. Incised rivers are rivers that are fixed in position, with stable channels, which allow very little lateral movement. Moreover, the slopes on the shoulders of incised river valleys are characteristically steep.

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[15] World Geodetic System 1984 (WGS 84) is the reference ellipsoid for the Hartebeesthoek 94 datum.

[16] Weathering is the chemical alteration and mechanical breakdown of rocks, soils and minerals at or near the Earth’s surface. It occurs ‘in-situ’, unlike erosion.

In areas exposed to heavy rainfall, incised rivers may experience intense and endangering peak flows. However, if the steep river slopes are stabilised by protective vegetation, (Figure 2.3.2.1), the risk of slope failure is reduced.

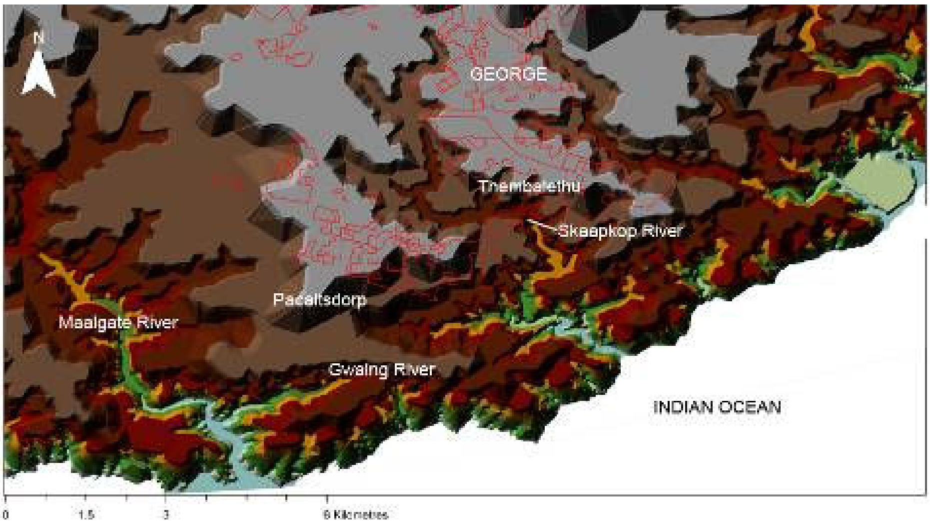

Figure 2.3.2.1: A TIN generated digital elevation map (hill-shade) showing the topography for George

Figure 2.3.2.2 provides a simplified geological map of the George-Mossel Bay area. The difference in landforms between the two municipalities is a result of their underlying geology. For instance; the steep coastal cliffs near Glentana and Wilderness are predominately composed of the slates and schists of the Kaaimans Group[17], whereas the gently sloping plateau between Mossel Bay and George is underlain by the granites from the Maalgaten Granites.

[17] Slates and schists are both metamorphic rocks. In terms of the rock cycle, shales are formed from mud, however if shales are altered further they become slates. In general there is a hardening of the rock with metamorphism, therefore slates are generally harder than shales (and mud) and more importantly more resistant to erosion. Schists are slates that havebeen metamorphosed even further, hence are even more durable.

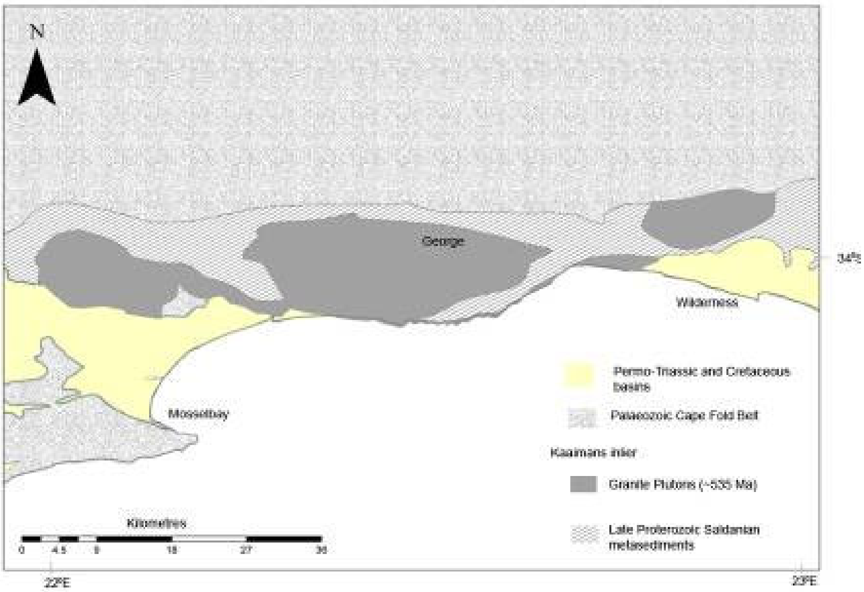

Figure 2.3.2.2: Simplified geological map of the area near Mossel Bay,George and Wilderness

Granites are generally easily weathered and eroded, allowing for the creation of deeply incised river valleys in coastal areas. Figure 2.3.2.3 illustrates how slope stability of incised rivers is naturally maintained through thick vegetation cover.


Figure 2.3.2.3: An example of an incised river or incised river valley (the photo was taken overlooking the Map of Africa, near Wilderness)

2.3.3 Land-use changes in the George and Mossel Bay Local Municipalities

2.3.3.1 Population change 1996-2001

Statistics compiled by the Department of Water Affairs and Forestry indicate that between 1996 and 2007, the population of the Eden District increased by 35% from 381

041 to 512 573 (Table 2.3.3.1.1. Census statistics indicate that from 1996-2001 however, the total urban population increased by 39.1% (71 588 to 99 555) compared to a 19% increase in the rural population. The towns of George and Mossel Bay showed significant urban growth with an increase of 25.7% and 11.96% respectively. This sharp increase in the urban population is significant, considering the rapid total urban expansion of some of the major towns in the area.

Table 2.3.3.1.1 Population figures for Eden District

Name	Total Population Change		Urban		Rural	
	1996*	2007**	1996*	2001*	1996*	2001*
Kannaland	21 105	26 890	1 889	3 218	2 981	2 850
Hessequa	38 395	49 574	6 505	8 796	3 255	3 712
Mossel Bay	59 542	80 999	13 074	17 727	2 349	2 334
George	107 723	154 828	23 232	32 681	2 488	2 844
Oudtshoorn	78 846	93 917	12 977	14 896	2 757	3 229
Bitou	18 354	34 859	3 905	7 478	1 180	1 285
Knysna	42 975	55 057	10 006	13 221	1 506	1 513
Eden DM		16 449				
Eden	381 041	512 573	71 588	99 555	16 516	19 758

**Source: Census 2001, SA Statistics* ***Source http://www.dwaf.gov.za (2007)*

2.3.3.2 Current land-use

While land-use in the Eden District is predominately agricultural (Figure 2.3.3.2.1), significant areas, particularly within the mountain ranges of the Cape Fold Belt, are state-owned and conservation areas. The urbanisation of the area is also apparent, due to the gradual shift from agricultural land-use to commercial and residential, with previously agricultural land being made available (rezoned) for urban developments.

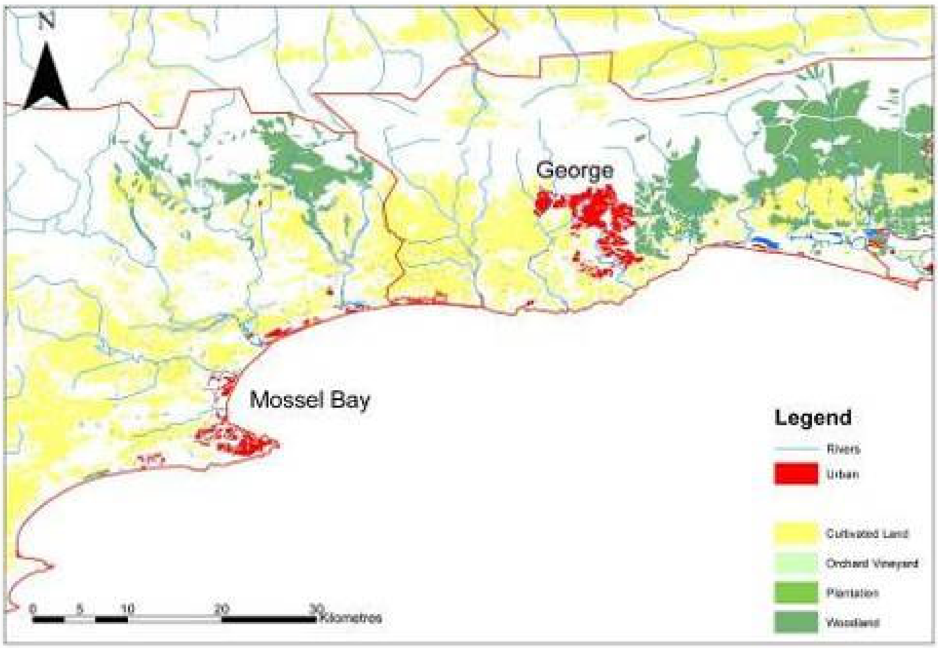

Figure 2.3.3.2.1: A preliminary land-use map for George and Mossel Bay (2004 data)

2.3.3.3 Urban expansion and land-use changes in George and Mossel Bay, 1937-2004

The time-series land-use analysis revealed significant urban expansion, within the area, specifically with respect to the rapid expansion of George and Pacaltsdorp[18]. In particular, urban development within the George area nearly trebled over a 47 year period. This is consistent with documented population growth of 26% from 1996-2001.

It is also directly related to increasing extreme weather exposures, given the location of newer developments, especially those towards the south and along the steep slopes of the Skaapkop River (Figure 2.3.3.3.1).

[18] The yellow areas indicate the degree of urban development in 1957, the lightly shaded orange show further expansion up to 1985 and the dark orange areas reflect additional urban growth from 1986-2004

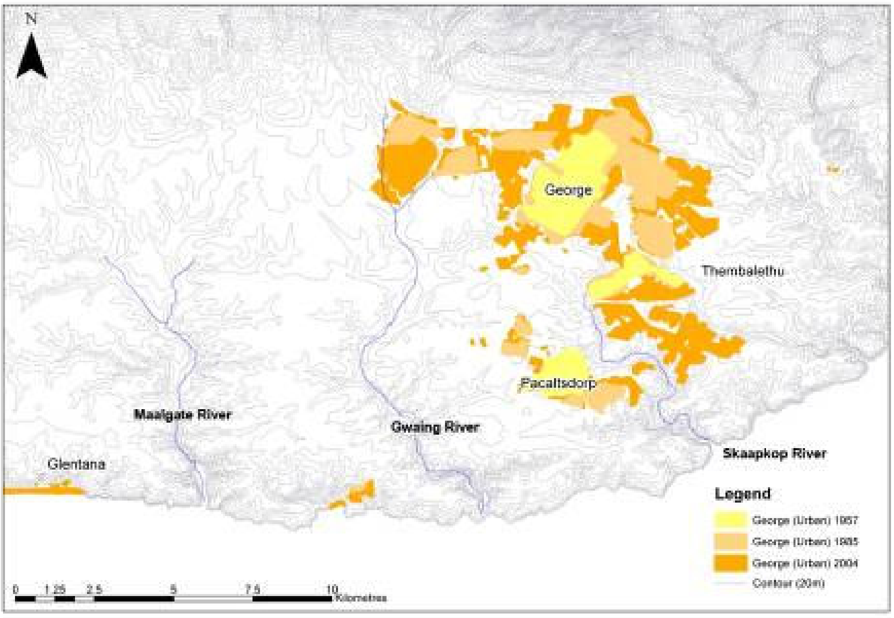

Figure 2.3.3.3.1 The urban expansion of George and Pacaltsdorp
(town centres from 1957, 1985 and 2004)

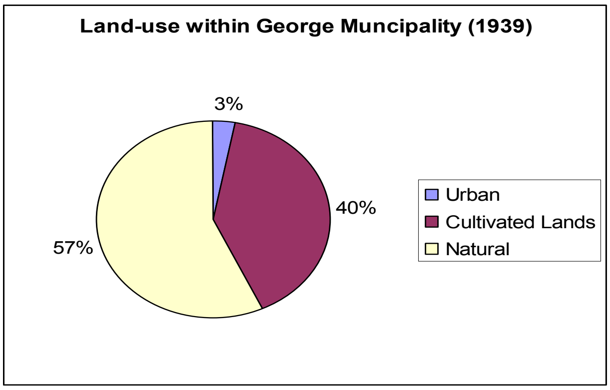

Figure 2.3.3.3.2 Change in land-use within the George Municipality 1939

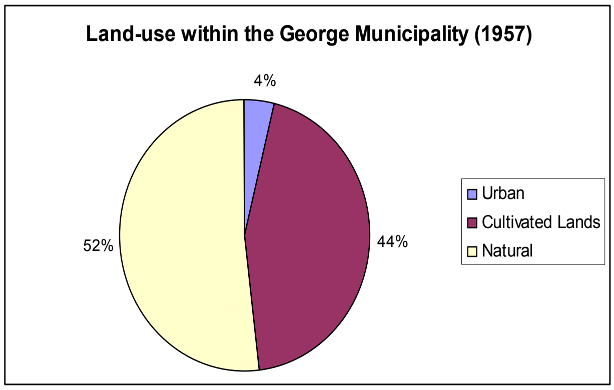

Figure 2.3.3.3.3 Change in land-use within the George Municipality 1957

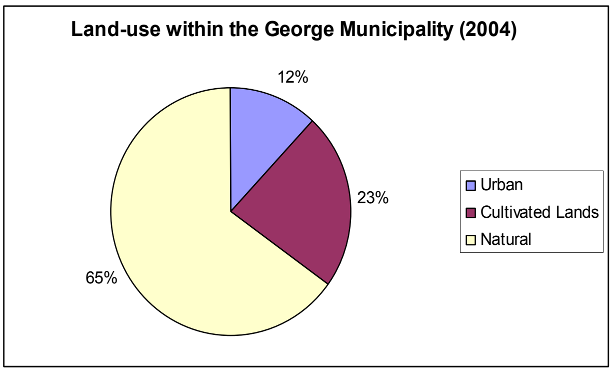

Figure 2.3.3.3.4 Change in land-use within the George Municipality 2004

The most significant observable change represented in the pie graphs above is the marked reduction in land for cultivation, declining from 40% to 23% of available area over the past 50 years. This signifies a gradual transformation of farmland to support urban development requirements.

The pace of urban growth however, has dramatically accelerated since the 1980s. Table 2.3.3.3.1 compares the extent of urban development in 1957, 1985 and 2004 (respectively the yellow, light orange and dark orange shading in figure 2.3.3.3.1). It also gives an annual average rate of urban spatial expansion in km^2 for each period. It shows that between 1957 and 1985, the overall urban area of George doubled from 7.39 km^2 to 15 km^2. Yet, from 1985 to 2004, the municipal urban area increased by 600% from 15 km^2 - 90 km^2. This represents an average annual municipal increase of 3.9 km^2 between 1985-2004 – or fifteen times higher than the 0.3 km^2 urban growth rate for each year during the previous period.

Table 2.3.3.3.1 Rate of Change in Urban Areas within George Local Municipality 1957-2004

Year	Urban Area (ha and km^2)		Increase in Urban Area (ha)	Average Annual Increase (km^2)
1957	738.72	7.39		
1985	1 467.00	14.67	728.28	0.26
2004	8 955.43	89.55	7 488.43	3.94

The 20% population growth recorded for Mossel Bay between 1996 and 2001 is similarly paralleled spatially by the urban.

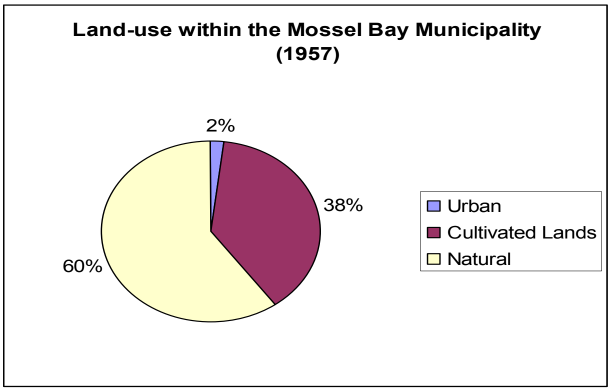

Figure 2.3.3.3.5: Change in land-use within the Mossel Bay Municipality 1957

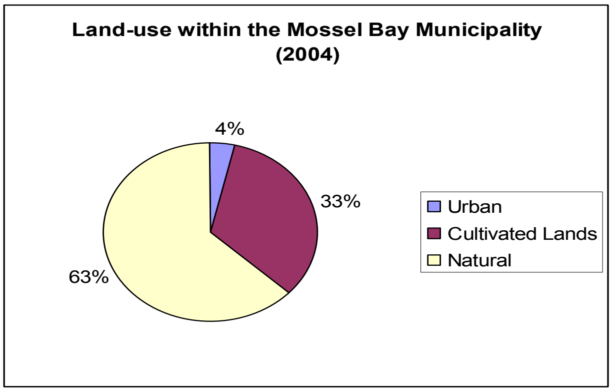

Figure 2.3.3.3.6: Change in land-use within the Mossel Bay Municipality 2004

Figures 2.3.3.3.5 and 2.3.3.3.6 also illustrate the gradual shift in the land-use in the Mossel Bay Municipality. Analysis of aerial photographs shows a slightly lower rate of urban growth, from 177.34 hectares (1957) to 3 327.56 hectares (2004). This represents an increase in urban areas in just under 50 years of 31.51 km^2 or an annual increase of 0.67 km^2.

2.3.4 Storm, run-off, subsidence - risks and outcomes: Thembalethu, Wilderness, Glentana

The risk context: While underlying geophysical characteristics of the district contribute to its general exposure to heavy rain events, many human settlements within Eden are characterised by important internal features that also drive their vulnerability to extreme weather. This section examines three severely affected settlements in terms of their exposure (specifically their locations and surrounding environmental conditions), along with their respective capacities to resist or withstand the heavy rains.

For each settlement, this is examined in the following way, with the general exposure and resistance factors being highlighted in yellow and field evidence for a specific settlement shown below the double line in tan.

General exposure factors

Urban Flood	Exposure	Capacities to	Resist Flooding	
Location	Environmental Surroundings	Degree of protection from natural environment	Degree to which infrastructure is flood- or run-off proofed	Degree to which infrastructure is adequately maintained
Underlying geology, geomorphology and geophysical attributes	Proximity to wetlands, watercourses and floodpaths Proximity to fire-affected slopes Hardened catchment conditions through urban growth	Degree to which indigenous land cover remains or has been removed – especially on slopes Degree to which wetlands have been protected or degraded Degree to which catchments are infested by alien vegetation	Adequacy of siting of housing, drainage and road infrastructure. Adequacy of design and construction to flood/run-off proof standards	(In)adequacy of regular maintenance. (In)adequacy of pre-rainfall preparedness measures

General resistance factors

Levels of relative exposure and resistance: site-specific evidence from field research and loss estimation

2.3.4.1 Thembalethu

Thembalethu is a suburb in the George Local Municipality, situated approximately 12 km from the CBD of the city of George. It is composed of a mix of low-income housing and informal dwellings with an estimated population of 18 000.

Exposure factors - location and surroundings

Thembalethu's rapid growth, and a general lack of flat-lying land, has led to many informal and formal dwellings being built on the moderately sloping western shoulder of the Skaapkop River (Figure 2.3.4.1.1). This location on steep slopes, combined with inadequate stormwater drainage contributed greatly to the settlement's flood-related damage.

Factors that reduced local capacity to resist the heavy rain and resulting run-off

Inadequate or non-existent drainage systems are the major contributors to flood damage in this area (Figure 2.3.4.1.1).

Figure 2.3.4.1.1: Spatial distribution of infrastructural impacts at Thembalethu, near George

Figure 2.3.4.1.2 The lack of adequate drainage systems compounded the flood risk at Thembalethu

Table 2.3.4.1.1 examines Thembalethu's vulnerability to localised flooding in relation to its exposure and capacities to resist heavy rain events.

Table 2.3.4.1.1 Critical risk factors that increased Thembalethu's vulnerability to flooding

Urban flood exposure		Local Capacity to resist flooding		
Location	Environmental surroundings	Degree of protection from natural environment	Degree to which infrastructure is flood- or run-off proof	Degree to which infrastructure is adequately maintained/winterised
Underlying geology, geomorphology and geophysical attributes	Proximity to wetlands, watercourses and floodpaths Proximity to fire-affected slopes Hardened catchment conditions through urban growth	Degree to which indigenous land cover remains or has been removed – especially on slopes Degree to which wetlands have been protected or degraded Degree to which catchments are infested by alien vegetation	Adequacy of siting of housing, drainage and road infrastructure. Adequacy of design and construction to flood/run-off proof standards	(In)adequacy of regular maintenance. (In)adequacy of pre-rainfall preparedness measures
Location in a wetland	Sited on the slopes of the Skaapkop River – results in slope-induced seepage	Significant degradation of the wetland - resulted in overland flow, surface run-off, pooling and damming	Lack of adequate drainage for surface run-off and overland flow	

In this settlement, infrastructural damage was increased by inadequate drainage to:

- manage significant overland flow or surface runoff,
- minimise pooling and damming, or significant slope-induced seepage.

2.3.4.2 Wilderness, George Local Municipality

Wilderness is a coastal town[19], situated in the foothills of the Outeniqua Mountains. The town lies 15km east of George, between the drowned river valley (ria) of the Kaaimans River in the west, and the mouth of the Touws River to the east. The town is connected to George through the Kaaimans River Pass (on the N2 highway).

Figure 2.3.4.2.1: Landslide (mass movement) distributions at Wilderness, Western Cape

<u>Exposure factors - location and surroundings</u>

The mass movement events above Wilderness were significantly affected by the area's geology – in particular the structural geology of the Kaaimans Group (for instance, the seaward dipping beds) and more importantly the new developments which are generally new housing developments on the slopes of hills.

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[19] Coastal towns, like Wilderness are popular holiday destination. The scenic nature of the Garden Route has contributed to the demand for land and an increase in the number of residential and recreational coastal developments around the town.

These events were typically ‘flows’ instead of falls, in other words highly water-saturated debris,
definitely due to the heavy rain, "slipping" on the seaward dipping Kaaimans Group beds, primarily assisted by gravity.

Damage at Wilderness was extensive. New housing developments and infrastructure on the slopes of the Wilderness hills are increasingly vulnerable to mass movement or slope failure (Figure 2.3.4.2.2). The risk of slope failure is further compounded by the following:

- Steep slopes
- Significant surface runoff
- Extensively weathered bedrock (Figure 2.3.4.2.3)
- Natural bedding planes (steeply dipping towards the sea)
- Recent developments on the hillside slopes

Figures 2.3.4.2.2: Exposed section showing a soil profile.

Figures 2.3.4.2.3: Water saturated mud and weathered bedrock in a mudflow (across a road) [20]

[20] Bedrock is consolidated rock (typically beds), which is generally covered (overlain) by broken-up (unconsolidated) and/or weathered rocks and soil.

Figure 2.3.4.2.4 Figure 2.3.4.2.5

Figures 2.3.4.2.4 & 2.3.4.2.5: Examples of bedrock-assisted landslides and near Wilderness

The soil profiles shown in Figures 2.3.4.2.4 and 2.3.4.2.5 illustrate the ‘brittleness’ of the underlying bedrock (in this case the Kaaimans Group). The weathered layer of this bedrock (the orange rock in the picture) remains brittle for a depth exceeding 1.5 m – with clear engineering implications for developments in the area (especially in the hills north of Wilderness) as well as in promoting mass movement.

<u>Factors that reduced capacity to resist and withstand the heavy rain and associated run-off</u>

Figure 2.3.4.2.6: Significant damage to a road due to slope failure (mass movement) underneath the road

Figure 2.3.4.2.7: Significant damage to a house, due to slope failure (mass movement) underneath the road

In the case of Wilderness, slope failure was increased by the following factors (Table 2.3.4.1.2)

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Table 2.3.4.1.2: Factors that reduced capacity to resist and withstand the heavy rain and associated run-off.

Slope failure exposure		Local Capacity to resist slope failure		
Location	Environmental surroundings	Degree of protection from natural environment	Degree to which infrastructure is flood- or run-off proof	Degree to which infrastructure is adequately maintained/winterised
Underlying geology, geomorphology and geophysical attributes	Proximity to natural watercourses and floodpaths Hardened surfaces due to urban growth	Degree to which indigenous land cover remains or has been removed – especially on slopes Degree of landscape sensitivity through urban development	Adequacy of siting of housing, drainage and road infrastructure. Adequacy of design and construction to flood/run-off proof standards	(In)adequacy of regular maintenance. (In)adequacy of pre-rainfall preparedness measures
Road infrastructure located on steep slopes characterised by extensively weathered bedrock	Increased surface run-off	Slope instability and failure	Inadequate drainage systems (pipes and gullies) for surface run-off	

The damage at Wilderness can be attributed to:

- Surface runoff (primarily due to natural drainage patterns, but exacerbated by the systematic increase in hardened surfaces,
- Slope instability and failure (mass movement), due to an increase in landscape sensitivity (through urban developments),
- Inadequate stormwater drainage systems (pipes, gullies),
- Rampant development (housing and infrastructure) within an already vulnerable area.

2.3.4.3 Glentana, Mossel Bay Local Municipality

The tiny coastal town of Glentana is situated along in Mossel Bay, approximately 20 -30 kilometres from the city centres of George and Mossel Bay. The town is bordered by the mouth of the Groot-Brak River to the west (7km) and the rocky headlands near Ghwano Bay, at the mouth of the Maalgate River and Harold's Bay to the east (Figure 2.3.4.3.1).

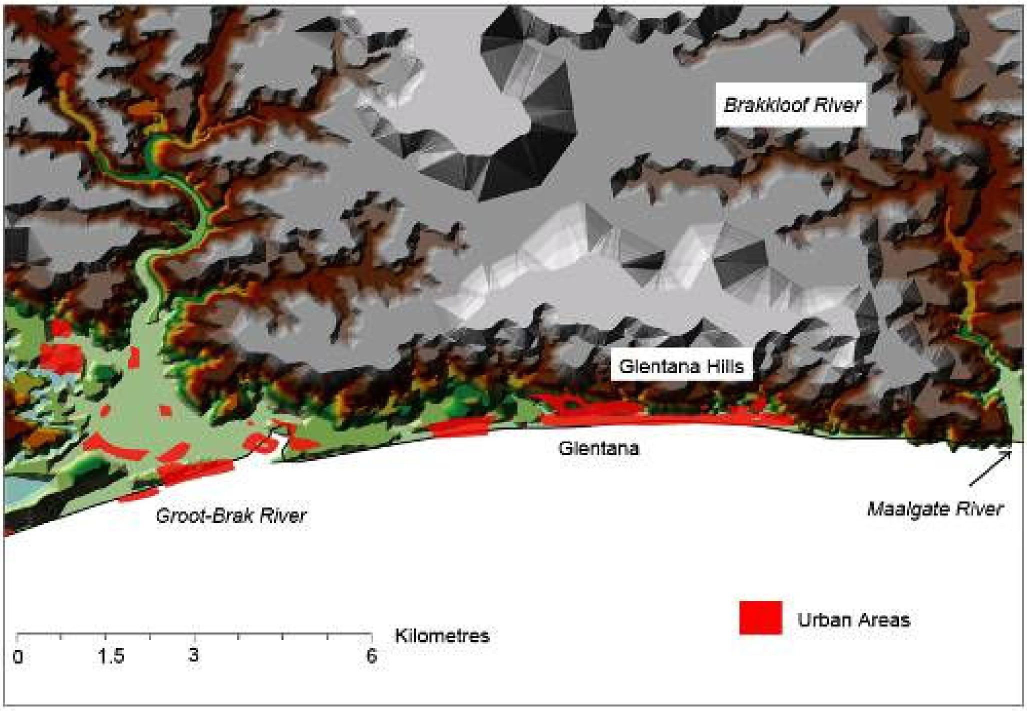

Figure 2.3.4.3.1: A TIN generated digital elevation map (hill-shade) showing the topography of Glentana and environs.

Exposure - Location and surroundings

The vast majority of residences (predominately holiday homes) are located along the coastline and on the vegetated coastal dunes. There are also a number of houses built along the lower-reaches of the concave-sloped hills. Similar to Wilderness, the Kaaimans Group bedrock is weathered and as it dips steeply towards the sea, it is highly prone to localised mass movement events (Figure 2.3.4.3.2).

Flood-related damage at Glentana was very extensive, including slip damage (primarily "washouts" due to erosion) to private property (houses, parking bays) and municipal infrastructure (municipal roads, storm water drainage pipes[21]).

[21] The storm water drainage system, in particular was unable to cope, resulting in the formation of gullies along and through roads.

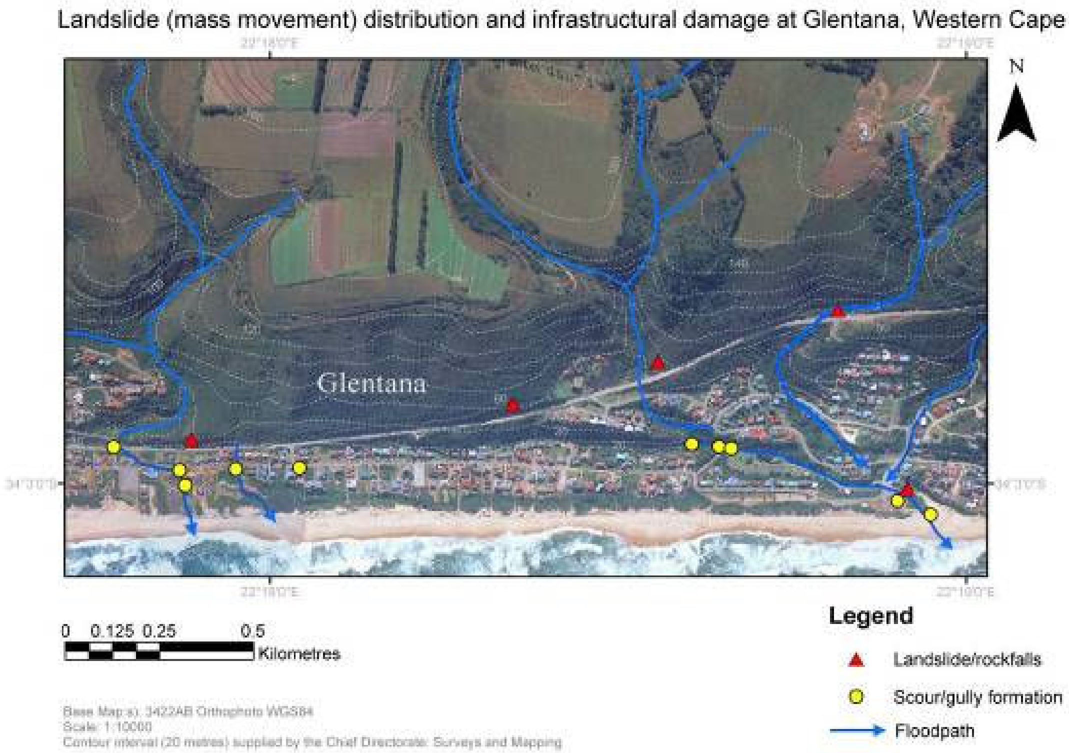

Figure 2.3.4.3.2: Landslide (mass movement) distribution and infrastructural damage at Glentana, Western Cape. A number of non-perennial streams are highlighted and represent proposed floodways of the surface run-off

The houses in Glentana are also exposed to potentially damaging run-off, due to their location near to non-perennial streams that drain off the coastal hills into the ocean. These streams pass through Glentana, with coastal developments (houses, roads etc.) crosscutting the natural floodpaths or floodways. This results in a number of houses standing directly within the floodway or floodpath of the streams (Figure 2.3.4.3.4).

Figure 2.3.4.3.3: Infrastructure (road) build in the floodway of one of the non-perennial streams

Figure 2.3.4.3.4: Infrastructure (housing) build in the floodway of one of the non-perennial streams

Factors that reduced capacity to resist and withstand the heavy rain and associated run-off

The majority of houses and paved roads on the vegetated coastal dunes are built on an unstable foundation of unconsolidated dune sand. Unconsolidated dune sand, as opposed to lithified or consolidated sand dunes is prone to erosion, through riverine or wind/aeolian processes. In addition, the houses, paved roads and parking lots provide hard, impermeable surfaces that result in an increase in surface run-off, particularly during and following heavy rainfall. High surface run-off is known to promote erosion in erosion-prone areas.

Figure 2.3.4.3.5: Storm water run-off

Storm water run-off created a 6 metre wide channel on the coastal dune, by eroding the underlying unconsolidated dune sands. The house on the right was stabilised onto the sand-dune using poles, while the house on the left suffered extensive slip damage

Figure 2.3.4.3.6: The storm water drainage system was unable to cope with the surface run-off


Figure 2.3.4.3.7


Figure 2.3.4.3.8

Figure 2.3.4.3.8 & 2.3.4.3.9: Examples of extensive flood damage to roads, due to preferential erosion of the dune sands.


Figure 2.3.4.3.9: A 4 metre wide gully formed along the side of a road

In the case of Glentana, environmental flood-risk was increased by the following factors indicated in Table 2.3.4.3.1.

Table 2.3.4.3.1: Factors that reduced capacity to resist and withstand the heavy rain and associated run-off

Urban flood exposure		Local Capacity to resist floods		
Location	Environmental surroundings	Degree of protection from natural environment	Degree to which infrastructure is flood- or run-off proof	Degree to which infrastructure is adequately maintained
Underlying geology, geomorphology and geophysical attributes	Proximity to wetlands, watercourses and floodpaths Proximity to fire-	Degree to which indigenous land cover remains or has been removed – especially on slopes	Adequacy of siting of housing, drainage and road infrastructure. Adequacy of design	(In)adequacy of regular maintenance. (In)adequacy of pre-rainfall

	affected slopes Hardened catchment conditions through urban growth	Degree to which wetlands have been protected or degraded Degree to which catchments are infested by alien vegetation Degree of landscape sensitivity through urban development	and construction to flood/run-off proof standards	preparedness measures
Houses located on vegetated coastal dunes	Houses and roads and car parks: located in the path of non-perennial streams (floodpaths) increase hard, impermeable surfaces – results in increased surface runoff.		Houses and paved roads on vegetated coastal dunes - built on unstable foundations of unconsolidated dune sand. Houses, roads, stormwater not constructed to withstand heavy rain and run-off	

The extensive damage at Glentana can be attributed to:

- Surface runoff (along natural drainage patterns and man-made hardened surfaces),
- The natural erodibility of the unconsolidated coastal sands,
- Inadequate and poorly implemented stormwater drainage systems (pipes, gullies)
- The construction of infrastructure and housing within an already flood-vulnerable area.

2.3.5 Conclusions and recommendations

2.3.5.1 Conclusions

The Eden district is considered a growth node, with tourism, agriculture and related industries remaining the primary sources of economic growth and employment in the region. It is therefore certain that developments in the area will continue.

However, the impacts from the August 2006 heavy rainfall events highlight specific areas, in which the landscape's sensitivity to change has been influenced strongly by human activity, in particularly urban expansion. There are a number of areas where the environment is unable to sustain large and small developments, without triggering a response – which increases its extreme weather-associated risks. This is particularly apparent in Glentana and Wilderness where there are growing risks of erosion or slope instability.

In this context, the following key factors were identified in this preliminary assessment as contributing to flood-damage, in the Eden District:
- non-risk-averse and uninformed town planning, in particular residential developments and infrastructure situated within flood-vulnerable areas,
- excessive surface run-off (the effect of a systematic increase in hardened surfaces should be considered),
- inadequate or failing storm water drainage systems.

2.3.5.2 Recommendations

Future urban expansion in the Eden District should actively incorporate landscape sensitivity considerations into spatial development and integrated development planning processes.

Effective land-use planning should ideally enable the sustainable development of areas for human habitation. However, documented impacts from repeated extreme weather events in the Eden District suggest that the area generally is following an unsustainable trajectory. This is evidenced by the costly economic losses associated with extreme weather, which have exceeded local capacity to resist and recover without external assistance.

The district's complex risk profile - climatically, environmentally, agriculturally, infrastructurally and socially - further highlights the general sensitivity of its respective landscapes to developments at both macro scales (i.e. overall catchment hardening) and micro scales (i.e. inadequate storm water capacity for surface run-off volumes).

In this context, specific action is also urged for development planning and environmental impact assessment processes within the district to include the *cumulative effects* of several spatially related developments on the environment rather than limiting their focus to the effects of one specific project or case.

Integrated climate adaptation and disaster risk research should be undertaken to determine the relationship between urban development and hydro-geological risks in the district – especially in areas where there is now evidence of recurrent impacts.

Recognising the Southern Cape's exposure to repeat cut-off low phenomena, and its limited capacity to manage current climate variability, it is urged that applied climate adaptation and disaster risk research better inform risk-averse planning in the district.

This should examine the impact of existing urban development on the frequency and severity of hydro-geological risks. Similarly, it should focus on the capacity of existing developments to cope with extreme weather and adapt to changing climate conditions and suggest measures that would increase their resistance as well as adaptive capacity. The intent of the research should be to practically inform planning and investment in this provincial 'pressure point' so that sustainable growth is possible despite heightened exposure to extreme weather.

Part III: Social Impact Assessment[22]

3.1 Introduction, Identification, Methodology

3.1.1 Introduction

This social impact assessment captures the experiences of those affected by the August 2006 cut-off lows, with a specific focus on residents of informal settlements and low-cost housing. It also examines the complex processes that increased the vulnerability of specific economic groups to extreme weather and its impacts.

Section 3.1.1 outlines the criteria used for identifying communities/households as 'disaster-affected'.

Section 3.1.2 gives an overview of qualitative and quantitative methods used.

Section 3.1.3 presents the limitations of the research.

Section 3.1.4 highlights the ethical considerations of the research.

Section 3.1.5 presents the structure of the remainder of Part III.

3.1.2 Criteria for Site Selection

The Eden District comprises eight local municipalities across a wide geographic area extending from its coastal margins to arid inland areas. This constrained a fully inclusive assessment of all eight municipalities and resulted in only two municipalities being prioritised for field research.

The process of prioritising municipalities was assisted by a Provincial stake-holder consultation ('Provincial Debriefing') on the first severe weather event, which took place in George on the 11 August 2006 and was attended by municipal managers (or their representatives) as well as affected Provincial and National Departments.

Following this Provincial Debriefing, the following municipalities were prioritised for field investigation.

- George Municipality
- Mossel Bay Municipality
- Oudtshoorn Municipality
- Knysna Municipality
- Bitou Municipality.

Within each of the above municipalities, settlements were selected based on the recommendations from local government departments, municipal managers and NGOs. A team of researchers visited these municipalities to observe the impacts of the first event. Following this initial scoping exercise, the team decided to focus on George and Mossel Bay, due to the impacts experienced by residents of informal and formal low-cost areas in these areas.

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[22] Ameen Benjamin, DiMP, UCT

3.1.3 Description of Data Collection Methods and Instruments

A range of qualitative and quantitative methods were used to assess the impact of the cut-off low on the vulnerable and marginalised communities as well as the impacts on severely affected wealthier communities. Field information was collected by three researchers in the five identified municipalities on the following dates: August 8 – 24 August 2006. Subsequent field information was collected by one researcher in the George and Mossel Bay Municipalities between the 8 - 17 November 2006.

3.1.3.1 Qualitative Methods

Qualitative data were collected from both primary and secondary sources, using a range of data collection methods. The informants included key institutional role players such as municipal line departments, civil society and ward councillors as well as community leaders and community residents.

<u>Primary qualitative research methods</u>

The following participatory research methods were used for data collection:
- Interviews with representatives of key local institutions
- Interviews and focused group discussions with community leaders and residents
- Participatory risk assessment methods with community representatives: hazard impact mapping and transect walks
- Site Observations
- Photographs

Interviews with representatives of key local institutions and organisations
Institutional interviews were conducted with municipal managers, key local district and municipal departments, clinic staff, active NGOs and CBOs, and ward councillors.

District departments included the Department of Social Services for Eden and Eden Disaster Management. At municipal level this included George (Disaster Management/Fire Services, Department of Local Economic and Development, Department of Housing, Department of Technical Services and a Community Clinic in Thembalethu), Mossel Bay (Fire Services/Disaster Management, Department of Housing, Department of Technical Services, Department of Waste Management, Department of Electricity and the Department of Parks and Recreation) and Oudtshoorn (Municipal Manager, Department of Housing and Department of Technical Services)

In addition, different groups and individuals were interviewed:
In the George Municipality, these included; the Outeniqua Business and Professional Women's Club, a Youth Group, several ward councillors in the settlement of Thembalethu, a High School principal and SANZAF (the South African National Zakaah Fund).

In Oudtshoorn, a religious leader doing community development work was also interviewed.

Interviews and focus group discussions with community leaders and residents
Focus group discussions were held with community leaders of the relevant informal settlements. These yielded valuable information through a participatory exercise

discussed later. Following the discussions with the community leaders, semi-structured interviews were conducted with affected residents.

In November 2006, 43 structured interviews were conducted in Thembalethu, Wilderness Heights, Touwsraten and Power Town in both the formal and informal dwellings.

Participatory risk assessment methods with community representatives
Participatory risk assessment methods were used in the focus group discussions with community leaders. These included the drawing of a hazard map by community leaders representing their perceptions of areas most seriously affected.

Figure 3.1.3.1.1: Drawing a hazard Map

Following the generation of hazard maps, transect walks through the respected settlements were conducted with either the ward councillor or community leader. These provided insight into the reality of the settlement dwellers along with the impacts of the extreme weather and associated flooding.

Site observations
Site observations by car were also conducted with municipal staff and ward councillors preceding interviews with community leaders and residents. The purpose was to obtain a broader understanding of the geographical features of the entire settlement or urban area, and where most impacts were experienced. Time constraints prevented a more comprehensive site assessment by foot.

Visual impact recording with photographs
Photographs recording the impacts of the flooding on individual dwellings and infrastructure such as roads, storm water drains and bridges were taken during site observations, transect walks and household interviews with community residents.

<u>Secondary qualitative data sources</u>

Secondary sources for collecting qualitative data on the impacts of the August flooding included local newspapers as well as Internet articles or reports. Where socio-economic and development status of the municipalities were concerned, the respective municipal IDP plans were looked at.

3.1.3.2 Quantitative data sources

Quantitative data sources for assessing the social extent of the extreme event included:

- Disaster Management debriefing reports
- Clinic health records
- Household socio-economic loss information from structured interviews

Disaster Management incident and debriefing reports
Disaster Management incident and debriefing reports indicated the extent of social impacts by reporting the numbers of people who received shelter and assistance in each low-income settlement.

Clinic health data
Monthly reports for the Thembalethu clinic were collected for July, August and September of 2005 and 2006 respectively. This was followed up with an interview with the head nurse of the clinic.

Household socio-economic loss information from structured interviews
Structured household interviews conducted in Thembalethu, Wilderness Heights, Touwsraten and Power Town yielded valuable and differentiated socio-economic loss information relevant to the recovery of affected households.

3.1.3.3 Spatial data sources

Cadastral and topographical maps
Cadastral and topographical maps were provided by the various departments of the different municipalities. In some instances, departmental impact data were recorded spatially on municipal or provincial maps.

Spatial impact data recorded by handheld GPS
Handheld GPS (Global Positioning System) devices were used to record the exact geographical location of households interviewed.

3.1.4 Assessment limitations

This assessment was undertaken in the context of a post disaster event, and as such, represented a ‘broad-brush’ overview of impacts in selected communities, rather than an in-depth social science investigation.

Furthermore, it proved very difficult to interview representatives of municipal departments while they were responding to the consequences of the extreme weather.

Difficulties were also encountered in conducting household interviews. These included:
- Limited number of interviews undertaken due to the need to work through and with the ward councillors or the community leaders in most areas.
- Unwillingness of many households to be interviewed.
- Absence of critical household members during the team’s field visits, due to work commitments – thus excluding those households from the assessment.

Finally, the research tended to have a heavy focus on the first event (ie in early August) as opposed to the second event, three weeks later. Most of the fieldwork was conducted immediately after the first event and the onset of the second event coincided with the end of fieldwork.

While fieldwork conducted three months later aimed at further understanding the social impacts of the second event, this did not eventuate. The later field research indicated that community residents were unable to separate the two events and viewed the first event as the most destructive. Community residents tended to only speak about the first event and hardly seemed unable to recall the second event – possibly viewing both extreme weather events as a single experience of winter hardship.

3.1.5 Ethical considerations

Many informants shared emotional experiences. As a result, in the interest of confidentiality, no real names of the informants appear in this report.

3.1.6 Structure of remainder of Part III

Section 3.2 focuses on the municipalities of George and Mossel Bay with reference to specific affected settlements in each of those municipalities.

Section 3.3 synthesises the findings from the municipal and settlement-specific case studies in order to understand underlying risk factors for weather-related impacts and hardship.

Section 3.4 reviews the early warning and preparedness experience of households affected by the extreme weather events as well as their experience of response and recovery

Section 3.5 concludes the report with recommendations to reduce extreme weather-related risks in poor households and settlements.

3.2 Social Impacts Experienced in George and Mossel Bay

3.2.1 Introduction

This section provides an overview of the social impacts of the extreme weather event in the municipalities of George and Mossel Bay. It specifically describes the groups and areas most seriously affected, which field research indicates, fell into two broad categories:

- Those living in more affluent residential areas who found themselves in locations exposed ('vulnerable') to severe weather, subsidence and flooding.
- Those living in poor and marginalised communities, specifically those living in:
  - low-income formal housing (also known as RDP or Reconstruction and Development Programme housing),
  - informal dwellings in locations exposed ('vulnerable') to severe weather, subsidence and flooding.

3.2.2 General weather-related social impacts in the George Municipality

3.2.2.1 Overview of losses in low-income areas

The George Municipality comprises 20 wards and has under its jurisdiction the towns of George (population 118 178), Wilderness (population 2711) and Herolds Bay (population 454)[23]. George is the largest town in both the municipality and in the Eden District.

Within George, Wilderness and Herolds Bay are generally upper-income residential areas. Poorer settlements and residential areas include Ballotsview, Blanco, Borcherds, Bossiesgieft, Conville, Golden Valley, Kleinkrantz, Maraiskamp, New Dawn Park, Pacaltsdorp, Palana Valley, Syferfontein, Thembalethu, Touwsraten and Wilderness Heights.

With respect to structural impacts experienced in the poorer areas, a recurrent observation by the Department of Local Government and Housing in George noted that subsidised houses built lower than road level incurred excessive damage, as storm water from higher areas flowed down and through them. The Department further stated that there are some houses in Thembalethu (in Power Town 1 034 houses) and New Dawn Park Phase 1 that are so much lower than the roads, that it would prove cheaper to rebuild those houses.

Specific impacts reported by the Municipality's Department of Technical Services, Department of Local Government and Housing (DLGH) for George, as well as the report by Disaster Management for George Municipality are summarised below in Table 3.2.2.1.1

Table 3.2.2.1.1 Reported infrastructural and associated impacts in informal and low-income housing areas within George

Area	No. impacts reported	Description
Ballotsview	1	Front door and roof of house damaged by the rain
Blanco	1 1	Wall of the house collapsed and a hole was blasted in the wall by flowing water from run-off. Part of Boshoff Street reported washed away.[24]
Borcherds	3	Subsidence of floors in houses.
Bossiesgieft	3	Houses damaged 'beyond repair'. Total cost R 6 000 x 3 or R 18 000
Conville	2	Road and bridge over Molen River were washed away (Figures 3.2.2.2.1 to 3.2.2.2.3)
Herolds Bay	1 2 3 1 1	Part of Skimmelkrantz entrance road to the town was washed away, resulting in the closure of the one lane. At Exits 1 and 2 from Herolds Bay in Rooidraai Street the paving subsided but the street was still accessible. At the caravan park, three camping sites washed out to sea. The pump station required 30 m³ of gravel to replace eroded material. Large section of the beach was washed away, and the

[23] Population information derived from the George Municipality's Draft Revised IDP 2006/2007.
[24] Disaster Management Report

	1	remaining beach was littered with driftwood.. Part of Gwayang road was washed away, leaving two houses isolated.
Maraiskamp	110	Houses flooded because of overflowing storm water. All houses were situated on an underground water spring[25]
New Dawn Park	215 55 4 1 1	Diverse problems experienced by low-income houses, including water overflowing because of lack of stone walls on the edge of valleys and river channels; absence of storm water channels, and roads and houses located below or along a steep gradient slope. Subsoil water flooded low-lying houses largely due to no pavement to stop water from entering dwellings from the road. Bungalow houses flooded because of seepage of subsoil water. Sinkhole collapsed on the erf as a result of excessive subsoil water causing house to be flooded. Floor of the house subsided and the wall burst because of storm water gushing inside.
Ou Stottingsterrein	37	This land is occupied by 37 families living in impoverished conditions that were further worsened by the storm. DLGH estimates the total damage for the 37 families at R 222 000, estimated at R 6 000 a unit.
Protea Park	1	Water was running down the walls of the house, possibly from a leaking roof.
Thembalethu	15 80 49 20	All the informal dwelling residents were flooded, or affected by floods, but only a few reports were received by DLGH. The following are some of the significant reports received by DLGH. “Bungalow” (wooden houses) damaged. The average cost of damage - R 32 899, totalling R 493 485. At Erf 8270, houses situated on an underground spring incurred damage totalling R 480 000. At 24th Street, houses situated on an underground spring experienced interior flooding. At France informal settlement camp, structures in a very wet area suffered damage amounting to R 60 000. Behind Thembalethu High School in the ravine and on top of the slope there were problems of run-off. The damage to dwellings amounted to R 180 000. All brick houses experienced similar problems. The cost of damage to dwellings amounted to R 60 000. There were 48 other incidents reported from Thembalethu with a wide range of problems, summarised in Table 3.2.2.1.1.
Touwsranten	72	Informal dwellings made even more fragile after exposure to the extreme weather. The damage amounted to R 432 000, estimated at R 6 000 per unit
Wilderness Heights	80	This settlement is located on Erf 329 (property of the Western Cape Provincial Govt) and accommodates 80 families who have resided in informal dwellings here for 15 years. DLGH reports that the area floods every time it rains, but the people refuse to relocate. Total damage estimated at R 4 080 000 or R 46 000 per unit

[25] In Maraiskamp, to solve this problem temporarily, the Housing Department built concrete slabs around the walls of the houses. The Department also constructed concrete channels and secured these with retaining walls.

3.2.2.2 Deaths and evacuations associated with the extreme weather and flooding

The primarily structural impacts summarised above indicate the significant vulnerability of poor households to extreme weather and run-off – further highlighted by direct and indirect impacts of the heavy rain and flooding on human life and safety. For instance, Disaster Management reported that the road and bridge over the Molen River collapsed, resulting in three deaths. The body of one of the deceased could not be found. The collapse of this bridge proved a major obstacle for commuting to work and school, as is evident in Figures 3.2.2.2.1 and 3.2.2.2.2.

Moreover, Table 3.2.2.2.1 below indicates that approximately 1 500 residents required evacuation across ten settlements in response to the extreme weather event.

Table 3.2.2.2.1 Summary of settlements evacuated in George and Mossel Bay Municipalities following the August 1 cut-off low event

Municipality	Settlement	Adults evac.	Children evac.	Infants evac.	Total evac	Blankets Dist.	Mattresses Dist.
George	Blanco	78	24	6	108	80	2
	Conville	135	46	7	188	50	30
	Kleinkrantz	100	25		125	70	
	Pacaltsdorp	135	35	6	176	80	30
	Palana Vly	138	38	5	181		
	Syferfontein		35		35		
	Thembalethu	96	19	4	119		
	Touwsrantein	120	44	12	176	120	
	Wilderness Hts	104	53	9	166	118	10
Total George		906	319	49	1274	518	72
Mossel Bay	Power Town				320		

Figure 3.2.2.2.1: Bridge washed away over Molen River

Figure 3.2.2.2.2 Children trying to cross the Molen River where the bridge collapsed

Figure 3.2.2.2.3 Adults struggling to cross the Molen River where the bridge collapsed

3.2.3 Social impact of extreme weather and localised flooding in Thembalethu

This section focuses more specifically on the social impacts of the extreme weather event in Thembalethu.

Section 3.2.3.1 provides an overview of the settlement profile, including its geographic location, access to essential services, settlement infrastructure and access to social and community services

Section 3.2.3.2 gives insights on the most vulnerable and their losses – from household interviews, focusing on who was most affected and why (through comparisons of impacts borne by informal dwelling and RDP residents.

Section 3.2.3.3 outlines health impacts associated with the extreme weather and local flooding

Section 3.2.3.4 reflects on the impact of the extreme weather event on employment

Section 3.2.3.5 concludes by examining the consequences for economic recovery following the extreme weather event

3.2.3.1 Settlement profile

<u>Location and population</u>

Thembalethu comprises 5 wards with an approximate population of 18 000. There are about 8 000 RDP houses and over 2 000 informal dwellings in the settlement[26]. The settlement is located on a geographically inappropriate landscape for human settlements (Figure 3.2.3.1.2). The settlement is on hilly landscape and has rivers on either side. The result is that there are dwellings (both RDP and informal) situated on slopes of hills and in the valleys of the two rivers and their tributaries. The land consequently has a high water table and in some areas, there are underground springs.

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[26] Information from personal communication with Ward 12 councillor and informal dwelling information from DLGH report.

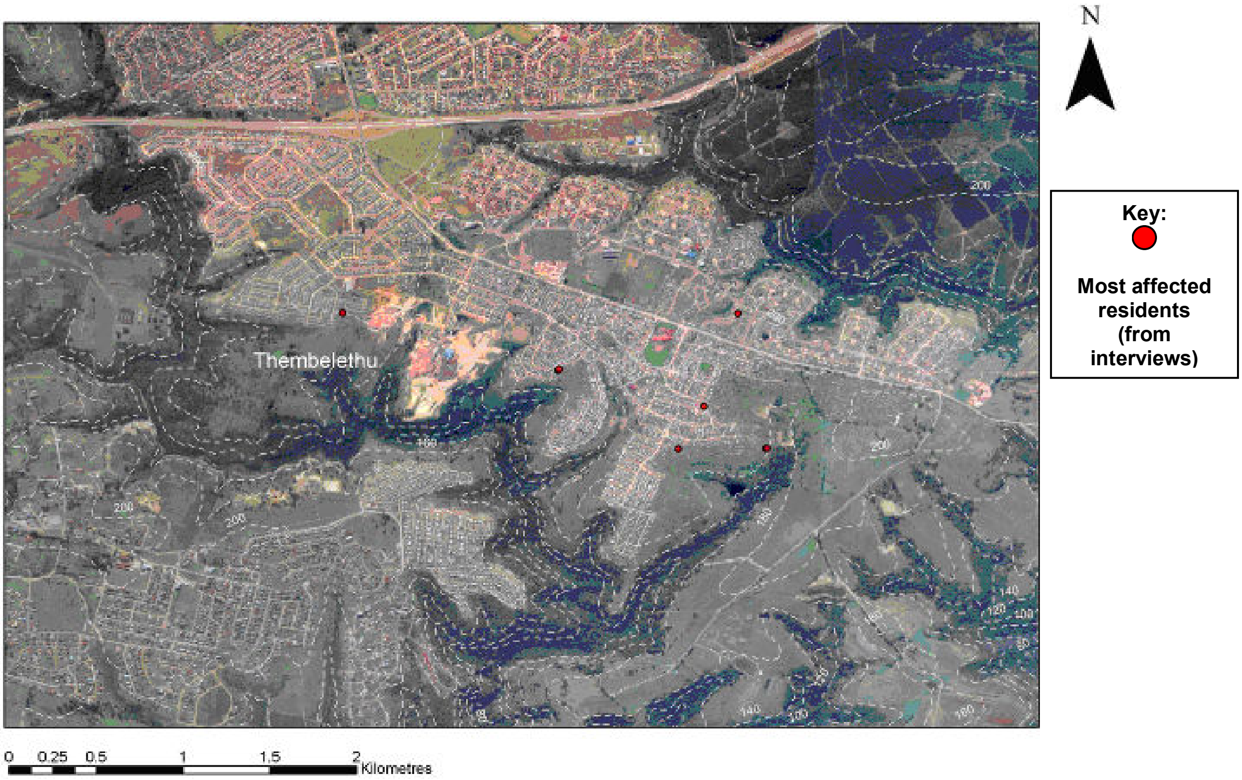

Figure 3.2.3.1.1 Aerial Photograph of Thembalethu. Red dots indicate residents most affected


Figure 3.2.3.1.2: Informal and RDP housing on a dipping slope


Figure 3.2.3.1.3: Low cost housing and informal dwelling on a slope

Access to essential services

Most of the informal areas are under-serviced, especially in terms of water and sanitation. There are high people to toilet and tap ratios. For example, one communal tap is shared by 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 have to stand in long queues for water collection, especially on weekends. Refuse removal happens once a week. On collection, black refuse bags are handed to the people for the forthcoming week. However, there are weeks where refuse is not removed. The result is dumping of household refuse in the surrounding environment (see Figure 3.2.3.1.4). 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 dwelling residents.


Figure 3.2.3.1.4: Dumping of household refuse


Figure 3.2.3.1.5: Sloping tarred road eroded by run-off


Figure 3.2.3.1.6: Storm water outlet onto road

<u>Settlement infrastructure</u>

The RDP houses, as mentioned earlier, are built in a challenging landscape. There is a juxtaposition of houses being built on elevated hill tops, and others on the slopes and in the valleys. Because of this, infrastructure is ill-sited in an uncoordinated and haphazard manner. Roads are located above housing developments. Only a very few of these roads are tarred. Given the topography, run-off tends to erode these tarred roads relatively quickly (see Figure 3.2.3.1.5). Storm water drainage systems also seem to be unplanned, as outlets of some of these storm water channels are directly onto the roads (see Figure 3.2.3.1.6), or directly exit towards RDP houses (Figure 3.2.3.1.7). Besides blaming the landscape, much of this uncoordinated siting of infrastructure is a result of poor integrated development planning.

Figure 3.2.3.1.7: Storm water outlet running directly towards RDP house

Access to social and community services

Other development constraints in the settlement include the absence of any community hall, library and playground. There is only one clinic that services 18 000 people, causing long waiting periods. This is situated on the outskirts of the settlement, making it virtually impossible for the most vulnerable (the elderly and children) to attend if they live in the centre of the settlement, particularly because of the lack of personal and public transport.

There are also no real community development projects and Development Forums are virtually non-existent. The community is still waiting to establish a ward committee but respondents indicated that the Municipality does not support this.

3.2.3.3 Insights on the most vulnerable and their losses – from household interviews

This section provides exploratory insights into the risk profile of informal dwelling and RDP housing residents and seeks to explain reasons for hardships and impacts associated with the extreme weather events of August 2006.

Specific questions were asked and the responses compared between the two groups. These were:

- Who was most affected by the extreme weather and associated flooding and subsidence?
- Why were these households specifically affected?
- Was there any evidence of local risk reduction measures?
- What were the mechanisms of the loss process? How were households directly affected?
- How were homes repaired or reconstructed?

Profile of households interviewed

In-depth interviews were conducted with residents from one informal dwelling in each ward were interviewed (five households) within Thembalethu along with residents residing in six RDP homes to determine differences and similarities in their experience of the extreme weather events.

These interviews indicated an average monthly household income for informal residents at R1 055, with most households who work receiving wages either on a weekly or fortnightly basis for unskilled to semi-skilled labour intensive employment. Those who receive regular monthly incomes are pensioners and those dependent on child grants. The average monthly household expenditure reported was R 876.

Some residents have been living in their informal dwelling for over a decade while others are new arrivals. The earliest arrival to the settlement from the households interviewed was in 1993 and the latest arrival in 2003. The origin of these dwellers was not exclusively the Eastern Cape; there are some residents from Cape Town. The major reason for migration to George was employment. The main reason for most residents' site location was because that particular piece of land was available.

Based on interviews from the six RDP houses from different wards across the settlement, on average, five occupants lived in each RDP house.

The average monthly household income for RDP residents interviewed was R 2 005. Similar to the experience of the informal residents, employed residents of RDP houses, received weekly or fortnightly wages for unskilled to semi-skilled labour intensive work. Again the only monthly income earners were pensioners and those dependent on child grants. The average monthly household expenditure for these households was R 1 245.

Most of the RDP residents interviewed had been living in the settlement for some time with the latest arrival being in 1999 and the earliest pre-dating the 1994 elections. Most were originally from the Eastern Cape, who had moved to George for employment. Some residents had waited for as long as ten years after applying for the house before they actually received it whereas some only waited for two years. While the majority of the residents applied to the municipality for housing, some acquired their house by buying it from previous owners reportedly for about R 3 000.

<u>Who was most affected by the extreme weather and associated flooding and subsidence?</u>

Informal dwellings affected in Thembalethu	**RDP homes affected in Thembalethu**
All residents of informal dwellings were affected because their homes were located in poorly drained areas.	Residents of RDP dwellings also claimed to be affected by the flooding. The determining factors seem to be poor location and a lack of integrated planning as well as the poor structural integrity of dwellings.
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 (see Figure 3.2.3.2.1).	The most seriously affected were those residing in houses located lower than the street level (Figures 3.2.3.2.2). This constituted about 60 % of all RDP dwellings

In addition to the damage described above, a further 49 structural impacts were reported to dwellings in the settlement. These are shown below in Table 3.2.3.2.1

Table 3.2.3.2.1 Damage to dwellings in Thembalethu

Problem Reported	**Number of incidents**
Roof broken and cracks in wall	1
Roofing sheets broken and door swollen	1
Water seeping from under floor	1
Big cracks in house	1
Floor subsiding	1
Water leaking through roof	1
House is about to collapse	2
House is falling apart	1
House is damaged	11
Water seeping through foundation	12
Cracked walls as a result of foundation subsiding	1
Big hole in the house	1
Roof destroyed/damaged	2
Water damaged door	3
Wall of house washed away by water	3
Foundation subsiding due to water underground	5
Foundation raised due to water	1
'Bungalow' house in danger because of excessive water flow	1

Figure 3.2.3.2.1: A seriously affected informal dwelling, located in a poorly drained area with high water table

Figure 3.2.3.2.2: A house below street level

The worst affected were women-headed households. Interviews and field observations suggested that older women ($\geq$50 years) with young children or grandchildren who were most affected of this group. These households reported a low income base and therefore have to settle for 'second best' in terms of building material as well as site location. The following experience of one such household illustrates this.

Thandiswa[27], aged 54, and her two sons aged 11 and 16 years, were being accommodated in a shelter for battered women, managed and financed by the Outeniqua Business and Professional Women's Club. The shelter is some distance from Thembalethu located in a previous 'coloured' suburb within George. The reason Thandiswa and her two sons required emergency accommodation was because her informal dwelling collapsed during the heavy rains – as it was constructed of old rotten wood. She was unable to afford proper building material at the time and so out of desperation had to settle for inferior material. The dwelling was also packed with rubbish (plastic and paper) which Thandiswa collected in order to recycle for some form of income. She also used this rubbish for insulation in her house. The heavy rains and strong winds caused the plastic roofing to collapse and also destabilised her walls. Run-off water also contributed to the destruction of her house. Besides recycling waste, Thandiswa depends on her 16 year old for income - he works on weekends, and occasionally after school, pushing trolleys at the Shoprite supermarket.

Why were they most affected?

Residents of informal dwellings	**Residents of RDP houses**
For the most seriously affected, the root cause was poverty (the average monthly income was only R 1 055). As a result, they are obliged to live in the vulnerable locations described earlier, and to construct dwellings of inferior building materials. Many informal dwelling residents lacked the capacity to incorporate any preparedness or coping strategies.	The root cause of their vulnerability was poor urban planning and development oversight. There is poor regulation/enforcement of building standards and poor communication between municipal and district departments. There were instances where houses are built lower than streets, situated on a high water table, often with underground springs, with no or very few drains, which are often blocked. In some instances dwellings were built directly under the storm water drainage outlets. All housing projects are outsourced with little control over the activities of the private contractors. Contractors therefore used the cheapest possible building materials, and construct in a sloppy manner contributing 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 'coped' with the risk by using buckets to catch leaking water from roofs, scooping the water out or trying to keep the doors closed. Some made holes in the walls of their homes to drain water out (Figure 3.2.3.2.3). This practice

[27] Not her real name

	made them more vulnerable, especially when heavy rains returned before the hole was repaired which was the case with the second event.

Was there any evidence of local risk reduction measures?

Residents of informal dwellings	Residents of RDP houses
Informal dwelling residents who were less seriously affected, displayed capacity for reducing the risk by: - digging channels to facilitate drainage, - using plastic sheets and stabilising their roofs. - laying a concrete slab for the floor.	Some people used what they call 'mestick', a type of putty, which they placed around the nails and screws of the roofs. Others placed plastic in the gaps of the roofs. Some also filled the cracks of walls before and after rains, while some painted their walls with a protective coating. Others elevated the foundation of their dwellings.

Figure 3.2.3.2.3: A hole made in an RDP dwelling to drain out water

What were the mechanisms of the loss process? How were households directly affected?

Residents of informal dwellings	Residents of RDP houses
All informal dwellings were affected by flooding through: - Seepage of ground water and run-off water (Figure 3.2.3.2.5) and rain water leaking through poorly constructed roofs (Figure 3.2.3.2.4) - Run-off water also entered through the doors of dwellings, and rainwater in some cases managed to enter through the walls of the dwellings. In some isolated cases, strong winds also contributed to sustaining damage.	RDP dwellings were affected by flooding through: – Run-off from the road entering into dwellings through the doors. In cases where dwellings had to contend with storm water outlets, storm water run-off gushed through the walls of these dwellings. – The high water table meant that water entered houses through the sides of the walls and also through the poor foundations. The poor quality of construction, accompanied by the inferior quality building materials, meant that rain water also entered through the cracked walls (Figure 3.2.3.2.9) and poorly

	sealed roofs (Figure 3.2.3.2.10).

Figure 3.2.3.2.4: Informal dwelling with poor roofing and construction

Figure 3.2.3.2.5: Seepage from groundwater and run-off

Figure 3.2.3.2.6: Poor roof construction

Figure 3.2.3.2.7: Water entering RDP dwelling through wall

Figure 3.2.3.2.8: Run-off from street entering RDP through front door

Figure 3.2.3.2.9: Light entering RDP dwelling through cracked wall

Figure 3.2.3.2.10: Debilitated roof of RDP dwelling sagging from rainwater

<u>How were homes repaired or reconstructed?</u>

Residents of informal dwellings	**Residents of RDP houses**
Most informal dwelling residents had to reconstruct or replace either a small or large part of the dwelling. In very few instances informal dwellings were completely reconstructed. Where parts of dwellings were replaced or reconstructed, the costs amounted to R 560. In the very rare case where a dwelling was replaced, the cost was valued at R 5 000 (however in this case the replaced dwelling was not constructed from wood and corrugated iron but from *nutech board*, made from cement fibre).	RDP dwellings affected sustained serious infrastructural damage. The residents of RDP dwellings were not familiar with market values of building materials and were unable to estimate the cost to their damage. From the DLGH reports (Table 3.2.2.1.1), household interviews and observations the types of physical damage included: - Walls washed away resulting in those houses about to collapse (Figure 3.2.3.2.11) - Cracks in walls (Figure 3.2.3.2.12) - Damp and mouldy walls inside dwellings resulting in the peeling off of paint and doors swollen (Figure 3.2.3.2.14) - Foundations subsiding/raised (Figure 3.2.3.2.15) - Roofs broken

The same damage to personal belongings were encountered by the most seriously affected of both informal and RDP homes. These personal belongings included furniture (beds, cupboards, couches) as wells as clothing and bedding. Most households found it difficult to estimate the costs of these losses, but where estimates were given losses to personal belongings ranged from R 2 000 to R 4 000.

Figure 3.2.3.2.11: Part of the wall of a RDP house washed away by storm water run-off

Figures 3.2.3.2.12

Figures 3.2.3.2.12

Figures 3.2.3.2.12 and 3.2.3.2.13: Cracked walls to RDP dwelling due to heavy rains

Figure 3.2.3.2.14: Damp and mouldy wall inside RDP dwelling

Figure 3.2.3.2.15: Subsided foundation because of high water table

3.2.3.3 Health impacts associated with the extreme weather and local flooding

As children under 5 years are considered the most vulnerable to health impacts as a result of poor environmental conditions, clinic data for children under 5 years were obtained from the Thembalethu Community Clinic. The data were analysed in order to observe whether there was any noticeable rise in reported cases of ill-health, especially lower respiratory infections and diarrhoea. Data were obtained for statistics the month before the event, during the event and immediately after the event. Thus data for the months of July, August and September 2006 compared with the same months for 2005, when less rain was experienced. The data for the months of July, August and September 2005 and 2006 are presented in Table 3.2.3.3.1 and Table 3.2.3.3.2 respectively.

The clinic data do not show a great difference to the impacts to the health of children under 5 years as a result of the August 2006 events. However, curative cases for this age category were not nearly as high in August 2006 (261 cases) than the month prior (364 cases) and after it (295 cases). Furthermore, the number of curative cases for the same month the previous year was far higher (430) and in fact the cases reported for all three months in 2005 were higher than the corresponding months in 2006.

However, the elevated number of diarrhoea cases in children under 5 years suggests a relationship between poor environmental conditions following the 2006 severe weather events and paediatric ill health. This is mainly because diarrhoea is a common illness associated with stagnant and possibly contaminated water, because of wet and damp conditions due to heavy rains.

Thus, reported diarrhoea cases in August 2006 were more than double (16 cases) those of the previous month (7 cases); in contrast the corresponding month in 2005 recorded no such cases. Furthermore, in September 2006 the cases increased even further to 23. This was because the stagnant water in the settlement had been present for a month in the settlement and as warmer spring temperatures increased the risk of infections.

For lower respiratory infections no significant increase after the August 2006 events were noticed as the reported cases in July 2006 was higher (6 cases) than that in both August 2006 (2 cases) and September 2006 (2 cases). Furthermore, in August 2005 the reported cases (6 cases) were also higher than that in August 2006.

Table 3.2.3.3.1 Thembalethu Clinic data for children under 5 years for 2005

Month	Curative case for under 5 years	Diarrhoea	Lower respiratory Infections
July	391	2	1
August	430	0	6
September	393	0	0

Table 3.2.3.3.2 Thembalethu Clinic data for children under 5 years for 2006

Month	Curative case for under 5 years	Diarrhoea	Lower respiratory Infections
July	364	7	6
August	261	16	2

September	295	23	2

The clinic data are inconsistent with information gathered from household interviews where most of those interviewed from informal and RDP homes reported that one or more household members suffered from ill health due to the wet and damp conditions. This discrepancy is in-part explained by:

- Many residents received medical assistance when they were sheltered in the schools or community halls outside the settlement, when clinic personnel visited flood victims there. These consultations were not captured in the clinic records[28].
- The clinic is located in an area that is inaccessible to most Thembalethu residents especially those most vulnerable. As a result, those who are in most need of the service are unable to access it.

Illnesses as a result of the flooding were not unique to children under 5 years but also affected older children, as well as adults. The types of illnesses reported by both informal and RDP residents included:

- respiratory infections such as asthma attacks, pneumonia and whooping coughs;
- T.B conditions worsening
- colds and sinus problems;
- arthritis conditions worsening
- skin rashes because the water remaining in the houses contained bacteria and micro-organisms;
- physical injuries because of people falling in the slippery conditions.
- high blood pressure because of stressful conditions.

Of the informal dwelling households that experienced ill health by one or more of its household members, most obtained medical assistance from either the clinic or the hospital, with some relying on home-made remedies. Furthermore, around half of the households consulted reported children under 5 years suffering from illness.

In contrast, all of the RDP dwelling households who experienced ill health by one or more of its household members sought medical assistance. Households consulted the clinic, a private doctor, and the hospital directly. One family reported a child under five years who had been ill.

3.2.3.4 Impact on employment - work missed

The heavy rains affected the ability of over half of Thembalethu's working population to attend work. Reasons for not being able to attend work were because people had to 'patch' up their dwellings (both informal and formal) and in some cases people feared for their safety in travelling in the heavy rains.

Residents of informal dwellings	Residents of RDP houses
Only a small percentage of those who normally worked actually missed out on work as a result of the flooding. Those who missed out on work did so for up to 3 days. All those who missed out on work earn a fortnightly income and lost around a-third of	Of those households interviewed, 42.86 % of those who work actually missed out on work as a result of the flooding. People stayed out of work for between 2 - 3 days. Of those who missed out on work, most earned a weekly wage and lost over half their

[28] Information from consultation with Sister Vimbi, a senior nurse at Thembalethu Clinic.

their normal earnings.	regular weekly earnings.

3.3.3.5 Household incomes negatively impacted

All the above impacts had a negative impact on household income for both informal and formal dwellers. Furthermore, some small scale farmers in Thembalethu lost livestock valued at R 39 500. Although not all the interviewees were able to estimate the cost of their losses, it is possible to estimate the economic impact on the affected households.

Table 3.3.3.5.1 Financial impacts for informal and RDP housing residents

Household Impact	Average estimated h'hold loss (Rand) Informal dwelling residents	Average estimated h'hold loss (Rand) RDP housing residents
Damage to physical structure of dwellings: a) partial destruction b) complete destruction	 560 5 000	 - -
Damage to personal belongings	2 500	2 500
Medical costs due to health impacts	0	110
Work missed	90	180
Total estimated household losses range:	**3 150 - 7 590**	**2 790**

Although these are approximations only, and exclude the costly estimates for repairs to RDP homes, actual losses would most certainly prove to be more expensive. This is in-part because many of the residents who provided estimates undervalued their actual losses. The figures also however indicate that the residents would suffer the impacts of these losses for some time. This is because for both informal and RDP residents, the estimated losses far exceed their average monthly income.

3.2.4 Social impact of extreme weather and localised flooding in Touwsranten

3.2.4.1 Settlement profile

<u>Geographic location and road access</u>

The settlement of Touwsranten is about 7 kilometres from Wilderness, and is divided in two parts by vacant state forest land. As such the settlement has two entrances. The housing at the first entrance comprises low-income municipal housing in very poor dilapidated state with some backyard informal dwellings.

<u>Access to essential services</u>

Housing at the second entrance comprises 72 informal and low-cost formal RDP housing units. The geographical location of the second entrance is in a very vulnerable physical area. The land on which both formal and informal houses are built is on a dipping slope because of the valley (Figure 3.2.4.1.1). The informal dwellings are divided in a clear racial pattern with 'Coloureds' amalgamated in one pocket and 'Africans' in another. This has implications for access to basic services as the informal dwelling residents are provided with only two toilets and one communal tap. As such, these limited basic services are more accessible to the 'African' population. Some informal dwelling residents pay R 70 a month to RDP housing residents to use their water supply.

The informal dwellings have no electricity connections (legal or illegal) and some RDP houses also have no electricity connection. Refuse is collected every Thursday and residents are provided with 50 black bags every three months. However, there are some occasions where they are not handed out. There is a community hall in the settlement but this is located at the first entrance, giving those residents priority access to it.

Other development constraints include the fact there are no recreational facilities especially for children. Furthermore, children have to travel to school by foot to the nearest town approximately 3 km away as there are no schools in the settlement. The nearest health facilities include private doctors in the nearest town. However the nearest public health facilities are located in George, about 28 km away.

Profile of households interviewed

Based on the sample of five informal household interviews, there was an average of four occupants per informal dwelling, with the gender of the household head primarily male.

Only around a third of the informal households interviewed reported being employed, with an average monthly household income of R 1 712. Of those who work, nearly half reported receiving a weekly wage, and the average monthly household expenditure was estimated at R 1 378.

The majority of the informal dwelling residents are new residents with most having arrived in 2000 with the latest arrival in 2004. All of these residents are originally from the surrounding areas who moved because of either being evacuated from farms or because they were living with parents or siblings and needed to live on their own. The reasons for choosing their housing site varied - from the site being the only open space available, to those who bought or were given the piece of land to stay on.

Based on the sample interviews of five RDP households, there was an average of three occupants per house. Males constituted 100 % of the RDP household heads and the average age of household heads was reported to be 56 years.

Only around a-third of interviewed RDP housing residents were employed, with the average monthly household income reported at R 1 904 and average monthly household expenditure of R 1 262. Of those who work, over 80% reported receiving a weekly wage, and 83.33% receive a weekly income with 16.67% of the population receiving a fortnightly income.

Most of those living in RDP dwellings had lived in the settlement for a number of years, with the earliest arrival in 1993 and the latest arrival in 2001. Most of these residents were also from surrounding farms where they were evacuated or forced to leave because of the farms closing down. The majority of these residents moved into their formal low-cost houses around 2001, but some moved in as early as the post-1994 elections.

Figure 3.2.4.1.1 Touwsranten houses
built on a dipping slope

3.2.4.2 Insights on the most vulnerable and their losses – from household interviews

Who was most affected?

Both informal dwellings and RDP houses were affected. According to the DLGH report, all informal dwelling residents were affected. This is because all informal dwellings are located at the bottom of the slope closer to the valley (Figure 3.2.4.2.1). Among RDP dwellings the most worst affected were those situated on the lower side of the street (i.e. the dipping side) where most of the run-off is received.

Figure 3.2.4.2.1: Informal dwellings located
on the bottom of the sloping landscape

Why were they most affected?

Residents of informal dwellings	Residents of RDP houses
The location of the informal dwellings at the bottom of a hilly landscape, they are exposed to nearly all the run-off water.	The reasons for weather and flood-associated impacts are primarily associated with poor siting, construction & maintenance of critical infrastruct.

29 The 'dop' system was an approach for remunerating farm workers which the white farmers use to undertake during the apartheid years. Here, farm workers were paid a meagre wage but as consolation were provided with cheap wine. The rationale behind this was that farm workers would become addicted to alcohol and would therefore be satisfied with being remunerated with

Previously the roads were earthen, but recently were gravelled and accompanying 'slote' (channels) were created which contributes to increased run-off down the slope. Dwellings do not have any concrete foundation and are constructed of poor materials (wood, corrugated iron and plastic) with poor structural integrity. The poor quality dwellings are the consequence of abject poverty of the residents. The majority were unemployed or earned very low wages. There are high alcohol consumption rates as the result of the previous 'dop' system[29] during the apartheid years. This contributes to a perception of hopelessness and influences their approach to life – many of these residents lack the initiative for any risk reduction or preparedness strategies.	Because of poor siting on a sloping terrain, the RDP dwellings were situated lower than the road and therefore received run-off from the road and water coming down the slope. Poor construction practices also undermined the structural integrity of these dwellings to withstand extreme weather. Many of these dwellings had an earthen interior rather than a concrete foundation. The poor maintenance of drains resulted in blocked drains, contributing to increased run-off. In some instances there were also external compounding factors such as the construction of a dwelling on the side higher than the road. This had implications for those dwellings built on the side lower than the road because the contractors blocked the drainage with sand and rubble. As a result, the dwellings lower than the road received further excess run-off.

Was there any evidence of risk reduction measures?

Residents of informal dwellings	**Residents of RDP houses**
The residents therefore simply 'cope' with the risk. Two such coping strategies involve the digging of channels to facilitate drainage of run-off water, and the placement of corrugated iron on the sides of the dwelling to catch rainwater that would otherwise seep into the dwelling. But even this practice is confined to only a few individual dwellings. There are some isolated practices of risk reduction and preparedness initiatives. This includes the digging of channels around the house long before the rainy season, planting of a garden in front of the house to assist in absorbing the excess water and paving in front of the house to assist in drainage (see Figures 3.2.4.2.2 and 3.2.4.2.3).	Those affected residents whose homes were sited lower than the road had to cope with their risk by digging channels around their homes to facilitate run-off and to cement the cracks in their walls. Some of these residents had paving in front of their houses which assisted in allowing the run-off to flow away from their house but which were diverted to the homes behind them. Another form of risk-proofing involved sealing the screw holes in the roof.

cheap wine instead of high wages.

Figure 3.2.4.2.2: Garden in front of informal dwelling with channels dug around the dwelling

Figure 3.2.4.2.3: Paving in front of informal dwelling

<u>What were the mechanisms of the loss process? How were households directly affected?</u>

Residents of informal dwellings	Residents of RDP houses
As a result of being located right at the bottom of the slope and constructed in an unstable manner from poor materials, informal dwellings were affected by the extreme weather in the following manner. The run-off water from higher up came down the slope and entered into dwellings through the doors and under the walls. Rain water leaked through the roofs and ground water seeped in from underneath because of no concrete foundations. A nearby drain also overflowed and this excess water entered the surrounding dwellings.	Run-off from the road flowed into the dwelling by entering through the front door and from under the walls, because of dwellings had no concrete foundations.

<u>What were the impacts? How were homes repaired?</u>

Residents of informal dwellings	Residents of RDP houses
The damage to the physical structure of informal dwellings was seen in only a few cases where wall damage was sustained. These needed replacement which required the purchase of new material. In most cases the informal dwellings were inundated with water for some time but with little structural damage.	The most severe case of structural damage included cracks sustained in the walls, and the paint on the walls peeling off. In most cases dwellings were inundated with water for some time which resulted in dampness to the walls and swelling of the floor which led to floor tiles becoming loose.

Informal dwelling residents incurred damage to personal household belongings, including clothes becoming mouldy and having to be discarded, cupboards swelling and rotting and foodstuff being spoilt. RDP housing residents sustained damage to furniture, especially chipboard cupboards that were swollen from the dampness.

3.2.4.3 Health impacts associated with the extreme weather and local flooding

In the absence of a community clinic, clinic health data could not be obtained to monitor whether there was an increase in ill health following the August extreme weather events. Instead, health information was obtained from household interviews.

Only some of the informal households reported ill health as a consequence of the wet, damp conditions. Generally, they reported attending a clinic in George, where they paid no medical costs but transport costs. Those who went to private doctors had to spend about R 100 on consultation fees.

RDP housing residents who suffered ill health as a consequence of the wet, damp conditions reported colds and flu. Some sick people went to the clinic in George for assistance, while others bought medication at the pharmacist.

3.2.4.4 Impact on employment - work missed

Residents of informal dwellings	Residents of RDP houses
Most employed informal dwelling residents missed work. The period for missing work ranged from two days to one month. The fact that some people could not get to work because of the road being cut off meant that they had to stay absent for as long as a month. Others missed work because conditions were too dangerous and because they had to stabilise their dwellings. This resulted in losses to household income ranging from R 250 to R 400.	Most of the employed RDP housing residents missed work. The period for missing work ranged from two days to one week. The reasons for staying out of work included conditions being too dangerous and the road being cut off. This resulted in losses to household income ranging from R 390 to R 1 000.

3.2.4.5 Household incomes negatively impacted

Table 3.2.4.5.1 Financial impacts for informal dwelling and RDP housing residents

Impact	Av. Est. household loss (Rands) Informal dwellings	Av. Est. h'hold loss (Rands) RDP homes
Damage to physical structure of dwellings:	N/A	N/A
Damage to personal belongings	460	350
Medical costs due to health impacts	10 – 100	10 – 100
Work missed	250 – R 400	390 – 1000
Total estimated household losses range:	**720 - 960**	**750 - 1 450**

Although these are approximations only, and exclude the costly estimates for repairs to RDP homes, actual losses would most certainly prove to be more expensive. The figures also however indicate that the residents would suffer the impacts of these losses for some time. This is because for both informal and RDP residents, the estimated losses far exceed their average monthly income.

3.2.5 Social impact of extreme weather and localised flooding in Wilderness Heights

3.2.5.1 Settlement profile

Geographic location

This is an informal settlement at high altitude, about 2 km from Wilderness, on the property Erf 329. The settlement slopes towards a valley with a stream. The settlement is surrounded by wooded vegetation (Figure 3.2.5.1.1). The settlement has been established for over 15 years and has always suffered from floods. DLGH estimates there are 80 families and 80 informal dwellings, whereas the community leader estimates there are 85 families, and 85 informal dwellings. The settlement is separated by bush.

Access to essential services

Approximately 25 dwellings serviced by one communal tap are located on the side closest to the main road. The side further along the gravel road has about 55 – 60 dwellings serviced by five communal taps. Each household has its own bucket toilet or pit latrine (this lasts up to 18 months only). The population comprises only ‘coloured’ people all of whom were ex-farm workers.

There is a school opposite the settlement but it no longer operates, and its facilities are used as a community hall and a church. The nearest public health facilities are in George, some 17 km away.

Figure 3.2.5.1.1: Aerial photograph of Wilderness Heights. Red dots represent most affected residences, based on interviews.

<u>Pofile of households interviewed</u>

Based on 10 household interviews there is an average of five occupants per dwelling. Household interviews indicated just under a 50% employment rate, with most working as artisans (builders, carpenters, painters etc.), gardeners, domestic workers and shop assistants. The average monthly household income was reportedly R 4 686 with a wide disparity among individual households ranging from R 1 100 to R 12 200. Similarly, the average monthly household expenditure for informal dwelling residents was reported to be R 2 085 with disparities among individual households ranging from R 830 to R 6 800.

The majority of these residents had lived in this location from 5-15 years (DLGH report). Most of the residents were originally from the surrounding areas; they moved because they were evacuated from farms or because they were living with parents or siblings and needed to live on their own. There are also some residents originally from George and Oudtshoorn. The reasons for choosing their site location varied from the site being the 'only open space' to those who bought or were given the piece of land to stay on. Furthermore, some settled because they noticed other buildings and dwellings. Because the majority of these residents are ex-farmers the population has a high alcohol consumption rate as a consequence of the 'dop system'

3.2.5.2 Insights on the most vulnerable and their losses – from household interviews

Who was most affected?

The DLGH report stated that all the dwellings were affected, but from the household interviews not all, but about 90 % of the dwellings, were affected by the extreme weather. Figure 3.2.5.1.1 indicates those most affected by the flooding. Most affected dwellings were located on the side of the street and in the areas dipping towards the stream (the densely vegetated areas). These affected dwellings were equally distributed between male- and female-headed households.

Why were they most affected?

The location of the dwellings is in an area of high drainage where run-off from the road is flowing towards the stream, where a number of dwellings are located.

The dwellings are constructed from inferior materials and most of them have no solid foundation. Moreover, the high alcohol abuse among the residents has a negative influence - most do not even cope with the risk and the few that do try to cope with the risk, undertake such practices as carving holes in the dwelling to facilitate water to escape from inside.

Was there any evidence of risk reduction?

Some residents dug channels to divert the run-off, but this only affected their neighbours negatively. Older, more responsible, residents undertook precautionary measures some years earlier. However, the efficacy of these measures is not as robust now - for example, some years earlier, an older resident had placed zinc around the bottom of his house to prevent water from entering. Unfortunately, these zinc plates are now rusted and not effective.

Another example involved residents sloping the ground around the house in such a way that the water should ideally drain away from the house, however this did not prove to be effective in this event.

The most robust risk reduction measure observed was a dwelling built on stilts and logs.

What were the mechanisms of the loss process? How were households directly affected?

The water from the road flowed down towards the stream and affected the dwellings in its path.

- The water entered dwellings through the holes in the ground and then seeped into the houses.
- Water also entered through the doors of some dwellings and rain water leaked through the roofs of most dwellings.

What were the infrastructural and property losses?

Damage to the physical structure of dwellings was evident in only a few cases where dwellings incurred damage to walls, roof and floor/carpets. This damage amounted to at least R 1 020. In most cases, the dwellings were inundated with water creating an unpleasant living environment of wet or damp conditions.

However, there were a number of personal household belongings that were damaged in all those households affected. These personal belongings included furniture such as couches, cupboards, benches and mattresses; electrical appliances such as televisions and disco speakers; fabrics such as curtains as well as carpets; as well as personal items such as clothes and blankets. Many households also had to discard foods which were spoiled. Often these included food items which were suppose to last for the entire month. Damage was estimated at R 1 800 per household.

3.2.5.3 Health impacts associated with the extreme weather and local flooding

In the absence of a community clinic close by, health information had to be sourced from the household interviews. Less than 20% of those interviewed reported some deteriorating health conditions, including bronchitis, asthma, cold, flu, whooping cough and TB. In all of the cases of ill health, medical assistance was sought from a private doctor, with costs ranging from R 90 to R 240.

3.2.5.4 Impact on employment: work missed:

Households interviewed reported that 50% of those employed missed work during the August events ranging from two days to three weeks. The explanations given for missed work included conditions ‘being too dangerous’, the roads being flooded and having to stabilise dwellings.

3.2.5.5 Household incomes negatively impacted

The impacts on the earnings of these households ranged from losses between R 130 to R 750 off the normal income. All the above impacts had a negative impact on household income. Although not all the interviewees were able to estimate the cost of their losses, it was possible to estimate an average economic loss.

Table 3.2.5.5.1 Financial impacts for residents

Impact	**Average estimated household loss (Rand)**
Damage to physical structure of dwellings:	1 020
Damage to personal belongings	800 – 1 800
Medical costs due to health impacts	90 – 240
Work missed	130 – 750
Total estimated household losses range:	**R 2 040 - R 3 810**

3.2.6 General weather-related social impacts in the Mossel Bay Municipality

3.2.6.1 Overview of losses in low-income areas

The Mossel Bay Municipality covers an area of 2007 km² with a total population of 71 488, including 20 059 households.

Towns and settlements within its municipal boundaries include: Boggoms Bay, Brandwag, Buisplaas, Dana Bay, Glentana, Great Brak River, Friemersheim, Hartenbos, Herbertsdale, Little Brak River, Mossel Bay, Outeniqua Beach, Power Town, Reebok, Tegniet, Vleesbaai.

Approximately 30.38 % of the population is employed with males comprising 60.37 % of the employed and females comprising 39.63 % of those employed. (Source: Mossel Bay Municipality Integrated Development Plan 2004/2005, June 2004.)

With respect to losses associated with the August 2006 extreme weather events and associated flooding as well as numerous mudslides, the Director of Community Services for the Mossel Bay Municipality reported the following damage to personal property as notified to their offices.

Location/suburb	Type of loss	Description of loss
Great Brak River	Household property Business damage Obstructed storm water and associated losses	69 incidents of damage to household property 1 x severe structural damage to home, to the extent it would 'collapse' 3 accounts of damage to business assets Damaged stock valued at R 9 218.95 (1 incident)
Asla Park	Household infrastructural and property losses	3 homes affected by water entering dwellings through the doors and the roofs
Great Brak River, Glentana Bay, Mossel Bay and Midbrank	Municipal infrastructure	Damage to streets, pavements and storm water systems
Many sports and recreation facilities		The manager of Environment and Horticulture, Sport and Recreation explained that previously, storm water systems were designed to explicitly drain onto sports and recreation facilities. Previous town planning systems permitted this because, in the past, sports and recreation facilities were not viewed as important as they are today

With respect to direct social impacts, the Waste Management Department (which is also responsible for Environmental Health concerns) reported that 320 people from Power Town were evacuated from their homes during the flooding. In addition, at the Disaster Debriefing in George, it was reported that Mossel Bay Municipality experienced one death.

Across the Mossel Bay Municipal area, negative impacts were equally encountered by both wealthy (especially Glentana Bay) and poorer settlements and towns. In this context, the physical environment, along with socio-economic variables and poor planning and regulation were determining factors in the vulnerability of the population. This will be explored in more detail in the cases of Glentana Bay and Power Town.

3.2.7 Social impact of extreme weather and localised flooding in Glentana Bay

3.2.7.1 Settlement profile

Glentana Bay situated 30 km from Mossel Bay and 20 km from George. It has 4 km of sandy pristine beach. As such, it acts as a magnet for holiday and retirement homes. Most of the residents are pensioners, and as the majority of the houses belong to holiday home owners, these are not occupied for most of the year.

3.2.7.3 Insights on the most vulnerable and their losses

<u>Who was most affected?</u>

Nearly every house in Glentana Bay was damaged. The most severe damage occurred to the houses closest to the beach front which were built on sand dunes. However, as the houses owned by holiday home owners were generally insured, the losses could be absorbed – through risk transfer mechanisms to short-term insurers. Residents who were pensioners however, even though insured, sustained the most serious economic impacts.

<u>Why were they most affected?</u>

All of the houses in Glentana Bay are built on sand dunes. As a result, all of the houses are built on unstable foundations (Figure 3.2.7.2.1 and Figure 3.2.7.2.2). This is clearly evident when one looks at the roads/parking bays and the small layer of tarmac over metres of thick sand (Figure 3.2.7.2.3 and Figure 3.2.7.2.4). Furthermore, some houses are constructed in an old river course which was reclaimed with this extreme event.

Most of the residents are retired people who bought their houses when they were younger as a retirement investment. These residents had difficulties in managing the impacts of the flooding as they are all elderly. They were not able to remove the boulders and other rubble from their homes.

The underlying factor for the vulnerability of the residents and home owners of Glentana Bay is associated with poor town planning regulations in relation to the physical environment. No building of any sort ought to exist in this fragile ecosystem. Although the municipality claims that these property developments occurred prior to the National Environmental Management Act (NEMA) of 1998, which instituted the compulsory obligation of undertaking Environmental Impact Assessments (EIA) before any development commences, active property development with respect to holiday and retirement homes is continuing in the area[30].

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[30] This almost contradictory position by the local authority was illustrated at the Disaster Debriefing in George - when the municipality representative was questioned as to why the

Figure 3.2.7.2.1 Figure 3.2.7.2.2

Damaged houses built on an unstable foundation of thick beach sand (sand dunes) in the path of an old river channel.

Figure 3.2.7.2.3 Figure 3.2.7.2.4

Damaged road and parking area built on an unstable foundation of thick beach sand (sand dunes) in the path of an old river channel

<u>What were the mechanisms for the loss process? How were households directly affected?</u>

Because the houses are built on unstable foundations of sand dunes, they collapsed because of foundations becoming weakened. This occurred in two ways:

- Through a dormant river reclaiming its path because of large volumes of run-off. This resulted in the river carving away the sides of the sand dunes, and destabilising the foundations on which those houses were built causing them to collapse (Figure 3.2.7.2.6).
- Through storm water run-off exceeding the capacity of the storm water channels to contain it. The majority of the storm water systems have outlets to the sea but which pass by the houses. As a consequence, torrents of storm water run-off washed past those dwellings, taking with it the sand over which it flowed. This caused the sand beneath the foundations to wash away, and the houses to become unstable and

municipality allowed people to build in Glentana, despite the obvious risks, he responded that "if people want to build there and are willing to pay huge amounts of money to us then we won't stop them from doing so".

collapse. Figure 3.2.7.2.6 and Figure 3.2.7.2.7.

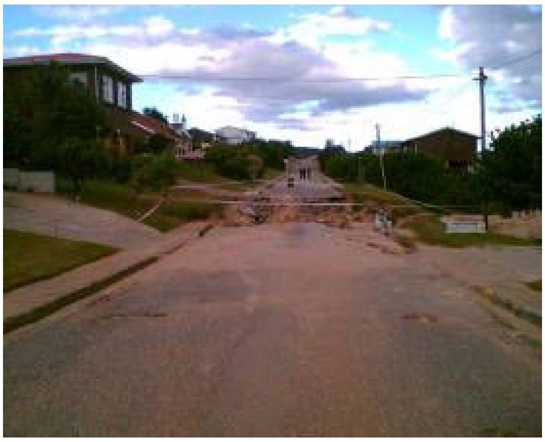

Figure 3.2.7.2.5: Road collapsed because storm water drain burst

Figure 3.2.7.2.6: House collapsed because of storm water run-off destabilising its foundation

Figure 3.2.7.2.7: Houses destabilised and partially collapsed because of storm water run-off

Figure 3.2.7.2.8: Road damaged because of storm water overflowing

<u>What were the impacts?</u>

As a consequence of the extreme weather events, insurance premiums on houses in the region rose. Retired people who are dependent on pensions were particularly negatively affected by this as the higher insurance premiums are proving very expensive. Furthermore, it was reported that the insurance companies are also unwilling to pay for the damage incurred from the flooding. Some residents also lost their vehicles that were parked in roads which collapsed. Many houses were also isolated because of no street access as the roads were completely damaged.

The residents received a lot of publicity from different visitors - ranging from tourists, journalists, insurance assessors to researchers. Many retired residents expressed fatigue with all the publicity generated from the impacts of the extreme weather events.

3.2.8 Social impact of extreme weather and localised flooding in Power Town

3.2.8.3 Settlement profile

Geographic location and demographic composition

Power Town is an informal settlement at Kleinbrak River, 5 km from Mossel Bay and 5 km from Great Brak River. The settlement is bordered by the N2 to the north, the Klein Brak River to the west, a water sewerage plant and wetland to the east and the sea further to the south. There are about 428 people[31] or 142 families[32] –'Coloureds', 'African' and 'White' – living in the settlement. The settlement surprisingly has 11 community leaders. The 142 dwellings all constitute wood structures with zinc roof tops. On the opposite side of the informal settlement, bordering the bank of the river, there are six formal municipal houses and one tent/caravan dwelling. The settlement is called Power Town because of the old power station there. The reason for closing down the old power station was because it was situated below the flood line and was therefore viewed as being at-risk.

Access to essential services

The settlement has five communal taps, 17 pit latrines and six bucket toilets. The toilet ratio is therefore one toilet to 18 people. Only some toilets are in a good condition - as a result some people use the bush. Toilets are cleaned on Tuesdays and Fridays. The settlement has three skips and waste usually gets collected on a Tuesday and Friday; however, at times, two weeks pass without any refuse removal[33].

As part of the MEC of Local Government and Housing's priority, the residents of Power Town will be relocated to a safer area after much resistance on the part of residents to relocate. This relocation was however agreed upon with the MEC after several visits since August 2006 (immediately after the first extreme event) by the MEC to the settlement. The residents can now expect the building of 150 low cost houses.

[31] Source: Power Town community leader.
[32] Source: Department of Housing, Mossel Bay Municipality.
[33] Source: Power Town community leader.
Author's note: It is useful to note that just prior to the researcher's first visit to the settlement, the solid waste was removed. The community leaders viewed this as suspicious because this occurred on a Thursday, not a refuse collection day, and was 2 weeks after refuse was last collected. Their suspicion was further aroused when they learnt that prior to the field visit the researcher had met with the manager of the Waste Management Department who was informed about the intended visit to Power Town. The residents of Power Town claim that there is a lack of communication between the municipality and the community.

Figure 3.2.8.1.1: Community map of Power Town

Figure 3.2.8.1.2: Aerial map of Power Town.
Note: This map is several years old. The informal dwellings to the left of the road no longer exist.

Profile of households interviewed

Based on the six interviews conducted with residents of informal homes (which included occupants of a tent/caravan), on average there are three occupants per informal dwelling. This is consistent with the estimated population of 428 and the estimation of 142 informal dwellings. More than ¾ of the households were male-headed.

The average monthly household income of informal dwelling residents interviewed was estimated to be R1 846, with R1 470 as their average monthly expenditure. Nearly half the population were reported to be is employed, with the majority receiving their wages weekly.
Those who received monthly incomes were pensioners and those dependent on child grants.

Some residents had been living in their informal dwelling for over a decade while others are new arrivals. The earliest arrival to the settlement from the sample population was in 1995 and the latest arrival in 2004. Most of these residents were originally from the surrounding farms where they were evicted. The reason for most residents' site location is because that piece of land was available. In the case of the tent/caravan dwelling, they received their piece of land because of the husband working for the municipality.

Based on the six household interviews conducted with residents of municipal houses, on average there are five occupants per dwelling.

The average monthly household income for the municipal housing residents interviewed was R 3 446, with the average monthly expenditure for these households estimated at R 1 156. The majority of those employed reported earning a weekly income.

These residents have been staying in these houses for a number of years, the longest being over 30 years and the most recent being 10 years. All of these residents used to live on farms. The reason for moving here for all these residents was because they had to be closer to the towns where they work for the municipality. All of them received these houses because of the males work for, or used to work for the municipality, hence they are described as Municipal houses.

3.2.8.4 Insights on the most vulnerable and their losses

Who was most affected?

All of the residents of Power Town, both the informal dwelling residents and those living in the municipal houses, were affected by the flooding. Even dwellings that were built on stilts were affected as the water level was very high. As a result 320 of the 428 residents (74.77 % of the population) were evacuated.

Why were they most affected?

A combination of socio-economic and environmental factors were the underlying reasons for these residents being so badly affected. For the informal dwelling residents the fact that they earn minimum wages with poor job security and have low literacy levels, are the reasons these residents live in this vulnerable location with inferior housing.

For both the informal dwelling residents and the municipal housing dwellers, the surrounding physical environment and geomorphologic processes contributed to their risk. The following environmental factors played a role.

- These houses are all within the 1 in 50 year flood line of the Klein Brak river. Here the municipal houses are even more at risk as they are only about 50 metres from the river (Figure 3.2.8.2.1).
- The water sewerage plant and the wetland behind the informal dwellings further placed these residents at risk. The water table here is extremely high (Figures 3.2.8.2.2 to 3.2.8.2.4).
- The Klein Brak River's mouth was closed because of sandbanks having formed there. This therefore disrupted the onset of the riverine flooding, as the river no longer had its normal flow. The reason the sandbanks formed at the mouth were a combination of increased farm dams further upstream combined with the dry weather in summer, causing reduced run-off and as a result the river had less energy to deposit the sediments and beach sand.
- Finally the informal settlement has poor drainage which results in ponding (Figure 3.2.8.2.5).

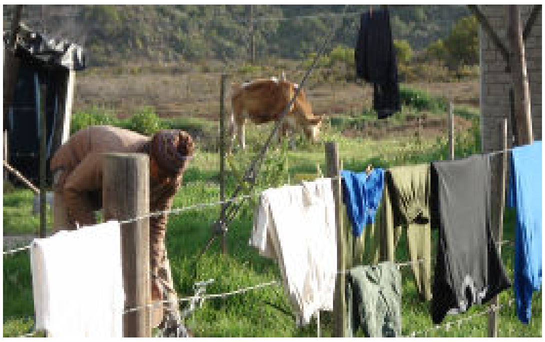

Figure 3.2.8.2.1: Proximity of municipal house to the river in the background

Figure 3.2.8.2.2: The wetland bordering the informal dwellings

Figure 3.2.8.2.3: Proximity of the wetland to informal dwellings

Figure 3.2.8.2.4: Evidence of high water table

Figure 3.2.8.2.5: Ponding around the informal dwellings

What were the mechanisms of the loss process? How were households directly affected?

Residents of informal dwellings	Residents of municipal homes
The majority of the informal dwellings were affected by the flooding by water seeping in from underneath because of the high water table, and by rainwater leaking through the roofs. Those dwellings bordering the wetland and the small stream (about 5 m away) were affected by water flowing into their dwellings through doors	All municipal houses were affected because of the Klein Brak river bursting its banks and its water entered into these dwellings through their back and front doors.

What were the impacts?

Residents of informal dwellings	Residents of municipal homes
The damage to the physical structure of informal dwellings ranged from the entire dwelling being destroyed and having to be replaced, to those that only needed either the roof or walls replaced. There were also dwellings that only suffered from the damp and mouldy floor and walls. Where estimates were given, this damage ranged between R 230 to R 570 worth of losses. The damage to the physical structure of informal dwellings included walls becoming mouldy and the paint peeling off. The costs for repainting were estimated at R 500. Informal dwelling residents incurred losses to the following household belongings: furniture, beds and mattresses, carpets, electrical	Municipal housing residents incurred losses to the following household belongings: furniture, electrical appliances (such as freezer, fridge and

appliances (such as T.V, video machine, and fridge), bicycles, clothes and food. These losses range from R 1 100 to R 7 800.	CD player), carpets, clothes, towels, linen and blankets. Where estimates were given, these losses amounted to R 2 000.


Figure 3.2.8.2.6: Informal dwelling completely destroyed


Figure 3.2.8.2.7: Residents collecting material to reconstruct their dwellings

3.2.8.3 Health impacts associated with the extreme weather and local flooding

In the absence of a nearby clinic, household interviews had to be relied on for health information. Among the informal dwelling residents interviewed, more than half reported an increased experience of ill health as a consequence of the wet and damp conditions. The type of illness experienced included aggravated asthma conditions, bronchitis, cold and flu. In 90 % of all these cases, medical assistance was required but the majority of sought assistance of private doctors. As this meant travelling to Hartenbos or Mossel Bay, they incurred transport costs as well as consultation fees, totalling between R 340 and R 400 each.

Among the municipal housing dwellers, few residents interviewed reported experiencing ill health as a consequence of the wet and damp conditions (although some reported worsening symptoms of T.B. and arthritis, lung infections, whooping cough and colds). In all cases, medical assistance was required, reflected in the majority seeking private medical assistance or consulting a pharmacist. The costs associated with these consultations ranged from R 100 to R 450.

3.2.8.4 Impacts on employment: work missed

Among the informal dwelling residents, of those who were employed, a majority missed work during the extreme weather events for 1 - 2 weeks. The reasons included the conditions were too dangerous, that they were relocated and they had to rebuild or fix their dwellings. This affected household income; loss of income amounted to a shortfall of R 300 - R 600 compared to their usual earnings.

Among the municipal housing dwellers, of those who were employed, nearly all were unable to work during the extreme weather events for 3 - 7 days. Reasons included the conditions were too dangerous, roads were closed and that they were evacuated from homes. Losses to household earnings amounted to R 530.

3.2.8.5 Household incomes negatively impacted

All the above impacts had a negative impact on household income for both informal and formal dwellers. These estimates are shown below

Table 3.2.8.5.1 Financial impacts for informal dwelling and municipal housing residents

Impact	**Average estimated household loss (informal dwellings)**	**Average estimated household loss (Municipal housing)**
Damage to physical structure of dwellings:	230 – 570	500
Damage to personal belongings	1 100 – 7 800	2 000
Medical costs due to health impacts	340 – 400	100 – 450
Work missed	300 – 600	530
Total estimated household losses range from:	**a) 1 970** **b) 9 370**	**a) 3 130** **b) 3 480**

These indicative figures illustrate the challenges to household recovery following an extreme weather event for both groups, given that the monthly income for informal and municipal housing residents respectively was estimated at R 1 900 and R 3 500.

3.3 Development at Risk or Developmental Risk?

There are two distinct population categories affected by the August extreme events - each experiencing the flooding in different ways. The first category refers to the wealthier residents who were affected and the second category refers to residents of the poorer settlements that were also affected. Within the poorer settlements there is a further subdivision of housing types that were seriously affected.

This section examines how the hazards and the vulnerability factors differ for the different categories of affected people. It focuses on contribution that developmental issues such as increased urbanisation, governance and socio-economic factors make towards driving the risks of flooding in the Southern Cape. In turn, these risks place further constraints on the socio-economic development of the groups most exposed to severe weather and its associated impacts.

3.3.1 Understanding the hazard

Flooding in settlements in the August extreme events does not only refer to *riverine flooding* but also includes *run-off generated flooding, high water table flooding and heavy rain flooding*.

- Riverine flooding involves rivers and estuaries flooding its surrounding areas.
- Run-off generated flooding involves overland run-off and stormwater run-off.
- High water table flooding involves wetland flooding, ponding of water and seepage into dwellings.
- Heavy rain flooding involves rain water leaking through roofs and walls of dwellings.

Table 3.3.1.1 Urban flood hazard in the Southern Cape: types and consequences

Settlement/suburbs at-risk	Urban flood hazard type	'Chain of causation' for household losses
Wealthier residential areas	riverine flooding run-off generated flooding	'Dormant' or non-periennial rivers claimed their floodways. Water courses and storm water systems exceeded capacity - resulting in flood waters washing away the foundations of houses
Low-income housing	riverine flooding, run-off generated flooding, high water table flooding heavy rain flooding	Flood waters from the rivers entered houses, storm water run-off flowed through doors and rain water leaked through roofs and cracked walls.
Informal dwellings	run-off generated flooding, high water table flooding heavy rain flooding	Run-off water flowed into and damaged houses, ground water seeped through floors areas, and rain water leaking through roofs of dwellings.

3.3.2 Understanding the vulnerability factors

In all suburbs and settlements that were significantly affected, both internal and external vulnerability factors prevailed, underpinned by important socioeconomic considerations.

3.3.2.4 Residents of wealthier residential areas (ie Glentana)

Underpinning socioeconomic factors	Retired pensioners most seriously affected (ie limited earnings, livelihood diversification and risk transfer mechanisms)
External vulnerability drivers	Residence in unsafe locations in-part due to limited planning and enforcement of environmental legislation.
Internal vulnerability drivers	Residents' choices to reside in a scenic but high-risk location

3.3.2.5 Residents of low-income formal housing areas

Underpinning socioeconomic factors	
External vulnerability drivers	Poor siting and lack of integrated planning generated unsafe residential locations – often because of poor communication between municipal and district departments. Poor maintenance of critical infrastructure Weak regulation of building standards. Outsourcing of all housing increases difficulties in controlling building standards.

	New housing developments, now impact on existing houses.
Internal vulnerability drivers	Lack of awareness among residents on both how to risk-proof homes and how to practice safer coping strategies than those currently practised.

3.3.2.6 Residents of informal dwellings

Underpinning socioeconomic factors	Poverty, poor job security, low education levels and limited individual responsibility It is because of poverty that people find themselves in vulnerable locations in unsafe dwellings
External vulnerability drivers	Limited service provision and inclusion in local governance processes
Internal vulnerability drivers	Low education levels and negative social behaviour together contribute to minimum risk reduction practices and coping strategies

For the poorer households, economic recovery from this event will take from between two months to two years. This further increases the vulnerability of these residents to future extreme weather events and undermines social development potential both at household and municipal levels.

3.4 Early Warning, Preparedness, Response and Recovery[34]

At the Provincial Debriefing in George on the 11 August 2006, the Eden Disaster Management stated that a Flood Committee established in February 2006 was planning for an event like this, but that planning was clearly not enough. 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 to all relevant departments via SMS. Eden Disaster Management kept everyone (i.e. all the municipalities) updated with weather reports.

None of these warnings for the first event were communicated to communities. This is evident in the municipalities of George, Mossel Bay and Oudtshoorn. Some residents who had access to radio and T.V. and who could interpret the weather forecasts, received their 'early warning' through weather forecasts on the news. However, some residents from Power Town and Wilderness Heights claimed that they only received early warnings for the second event by the police and fire services.

In Thembalethu, only Thandiswa's family received assistance with reconstruction of their dwelling from the municipality. Furthermore, Thandiswa's family also received second hand clothes from wealthier residents in George. In the low-cost housing area, only after the flooding, did the municipality install more storm water drains and channels (Figures 3.4.2 and Figure 3.4.3) but these were poorly built. There was no evidence of any

[34] Detailed information on response and recovery is given in Part IV

assistance for recovery to the residents of Touwsranten and Wilderness Heights. In Power Town the residents there expect to be relocated and provided with 150 low-cost houses in the near future.

Figure 3.4.1: Reconstructed dwelling after being completely destroyed (above)

Figure 3.4.2: Newly installed storm water culvert and channel, although incomplete

Figure 3.4.3: Newly installed storm water drain

3.5 Conclusions and Recommendations

In this social impact assessment we find that there are two distinct vulnerable populations that were affected by the extreme weather event. The first vulnerable population group involves those living in more affluent residential areas who find themselves in vulnerable locations. The second group of vulnerable populations involve those living in poor and marginalised communities. Within the second vulnerable group of poor and marginalised communities we find two subcategories. The first subcategory refers to low income formal housing and the second subcategory refers to the informal dwellings in vulnerable locations.

The social risk tends to be developmentally driven.

- Increased urbanisation influences the risk, both in terms of the hazard itself as well as the vulnerability conditions of the populations affected.

- Issues around governance and socio-economic factors generate vulnerable conditions.
- Poor planning and lack of implementation for preparedness and early warning systems further exacerbated the extent of social impacts. In turn the impacts generated by the flooding risk now retard the social development of the populations affected even further. The efficacy of the recovery process does not in any way assist in the process as the measures implemented seem unsustainable and inconsistent and do involved minimal community consultation.

3.5.1 Conclusions

This social impact assessment identifies two distinct vulnerable groups who were affected by the extreme weather event. The first group comprised those living in more affluent residential areas who found themselves in run-off and flood-exposed locations. This contrasted with the second group that, while also exposed to run-off and flood conditions, resided in poor and marginalised settlements. This second group is further differentiated into those who resided in low income formal housing and those who lived in informal dwellings.

Field research indicates that development conditions significantly drove vulnerability outcomes in extreme weather-exposed communities. These included a combination of factors, including:

- The consequences of rapid urban growth, both with respect to the hazard itself as well as the vulnerability conditions of the groups most affected.
- Uneven local governance and constrained socio-economic conditions.
- Inadequate contingency planning and communication of early warning, which exacerbated the extent of social impacts.

Moreover, the impacts generated by local flood and rain damage have further undermined the social development of the populations affected. In this context, the short-term nature of the relief interventions is unlikely to yield lasting benefits to poorer households and settlements.

3.5.2 Recommendations

The Disaster Management Act's call to reduce 'the vulnerability of disaster-prone areas, communities and households' should be made a priority

The Disaster Management Act (Act 57 of 2002) makes explicit the need to reduce the vulnerability of disaster-prone areas, communities and households. In poorer settlements, this could best be undertaken through comprehensive community risk assessments to identify those most at risk, followed by participative community-based disaster risk management planning. Such processes would also assist in identifying the most vulnerable for response activities in the event of future extreme weather events. They would also strengthen participative governance relations between at-risk communities and local authorities.

Integrated development planning should be an opportunity to reduce, not increase the exposure of poor households to endangering surface run-off, rain and subsidence damage.

Many residents of low income formal neighbourhoods sustained damage to their homes and property due to high volumes of surface run-off due to the location of their homes below road level. Risk averse integrated development planning provides a mechanism for reducing these risks by more safely siting low-income homes and the installation of robust storm water systems (refer also to recommendation on housing).

Creative, locally relevant, robust and sustainable risk reduction measures should be identified and communicated among residents of at-risk settlements.

Globally, and in the Western Cape, there is growing awareness of the need to strengthen the local risk-management capabilities at suburb or settlement level. These measures can significantly complement those of local authorities – and are locally relevant and affordable. They include efforts to reduce accumulations of solid waste that obstruct storm water channels, as well as simple strategies to 'flood' or 'run-off' proof individual households. Local participatory research that identifies such measures should be undertaken, and practical self-sustaining risk reduction measures communicated to at-risk households.

Early warnings should be communicated understandably to households and settlements known to be exposed to extreme weather, surface run-off and flood risk.

Warning communication should go beyond local officials and include residents of suburbs and settlements known to be exposed to extreme weather, surface run-off and flood risks. The specific mechanisms for warning communication should be consultatively agreed on in advance with residents in these areas, and ensure that subsequent messages are communicated accessibly and timeously to all households exposed.

An effective and inclusive contingency plan should be in place for response and relief that ensures timely and equitable assistance to settlements that are high-risk

Similarly, contingency planning should include consultations with residents of suburbs and settlements known to be exposed to extreme weather, surface run-off and flood risks, as well as non-governmental service providers who may be called upon to respond in the event of extreme weather. Contingency plans should ensure adequate coverage of known at-risk areas so that timely and equitable assistance can be provided.

An unambiguous provincial protocol for social vulnerability assessment of extreme weather-affected households should be developed and applied after each event

The determination that there was 'no need for social relief' was not informed by a systematic or rigorous household needs assessment. Moreover, the independent social impact assessment undertaken by UCT/DiMP confirmed that there were indeed many households who experienced significant hardship as a result of the extreme weather, as well as the destruction of uninsured property and compromised employment opportunities.

While such hardship might not have appeared obvious from a rapid ‘drive-by’ assessment, detailed household assessments proved otherwise. Moreover, it is incongruous that poor households did not require social relief when municipal and provincial departments sought emergency funding assistance from the National Treasury and wealthier residents and businesses sought insured assistance to cope with and recover from the extreme weather and its associated risks

Consideration should be given to ‘weather- and runoff-proofing’ homes in low-income developments

Many of the most at-risk low income settlements are sited below road-level and are exposed to endangering run-off due to limited stormwater capacity. In addition, poor construction standards have increased exposure to heavy rain, run-off and subsidence.

Currently, there are no provisions or specifications for ‘weather’- or ‘flood’-proofing ’ low-income homes in areas exposed to heavy rain and run-off conditions. However, in areas exposed to recurrent heavy rain events, ‘weather-proofing’ is an important consideration to protect assets as well as the health of household members.

Part IV: Institutional Response[35], Risk Reduction[1] and Recovery[36]

Introduction

Effective anticipation, response and recovery/reconstruction efforts in areas recurrently exposed to extreme weather depend heavily on the institutional capabilities and structures. The August 2006 cut-off low experience in the Southern Cape underlines the critical need for these arrangements – as described in the National Disaster Management Framework – specifically highlighting the need for:

- Strengthened **transversal and vertical risk management planning for municipal and provincial organs of state** in extreme weather-exposed areas,
- **Greater effort in engaging civil society**, including the private sector, the media and highly at-risk weather exposed households and settlements (i.e. disaster management advisory fora and ward committees),
- Improved alignment of institutional and funding mechanisms so that **infrastructure demands associated with rapid growth accommodate climate risk reduction and post-event recovery** – without compromising maintenance and service delivery.

This chapter is organised into three main sections:
Section 4.1 focuses primarily on the dissemination of early warning and response to the first August event.

Section 4.2 provides a limited reflection on risk reduction efforts related to extreme weather, with particular emphasis on the challenges and constraints facing the sustainable provision of critical municipal and provincial infrastructure in the Eden District Municipality.

Section 4.3 focuses on the recovery and reconstruction processes, including an overview of the funding mechanisms employed for post-event reconstruction and the critical role played by the MIG engineers within the Dept Local Government and Housing.

Unfortunately, efforts to complete a more comprehensive section on the risk reduction efforts undertaken within the Eden District were unsuccessful, despite interventions and requests channelled through the Provincial Disaster Management Centre. As a result, this important thematic area is addressed minimally, and focuses on challenges in the provision of risk-averse municipal and provincial infrastructure. This reflects the focused inputs from experienced municipal engineers, many with invaluable insights drawn from repeated responses to extreme weather events.

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[35] Ailsa Holloway, DiMP, UCT

[36] Leigh Sonn, DiMP, UCT

4.1 Dissemination of early warning, emergency response and relief

4.1.1 Dissemination of early warning

The ‘early warning system’ in place heavily depended on sending and receipt of SMSs. As profiled repeatedly since the 2003 cut-off low event that affected Montagu, this highly inadequate and limited interpretation of an ‘early warning system’ inevitably resulted in poor risk communication, compromising both institutional preparedness and multi-stakeholder engagement – especially for civil society and for highly weather-exposed marginal communities.

At the Provincial Debriefing in George on the 11 August 2006, Eden Disaster Management confirmed that, although a ‘Flood Committee’ had indeed been established in February 2006, the preparedness planning for extreme weather events had been inadequate for the August 2006 rainfall.

This was again confirmed at the consultative workshop in February 2007 where it was reported that, although SMS warnings were disseminated, stake-holders doubted whether these warnings were distributed timeously (or at all) to those most at-risk, specifically with respect to warnings disseminated to:

4.1.1.1 Government departments

Individuals and departments reported that they were ‘desensitised’ to SMS weather warnings, because they received them ‘too often’, and frequently the weather conditions forecasted did not eventuate.

- It was recognised that there was a lack of capacity/personnel at municipal offices, resulting in a reduced number of messages being received and sent.
- Stakeholders reported that there was no systematic mechanism to confirm receipt of warnings and no personal contact between stakeholders. This undermined accountability for follow-up action across and between spheres.
- Local respondents also indicated that the SMS system was ‘often faulty’ and didn’t ‘work’. Moreover, ‘generic’ SMS messages did not provide sufficiently specific information for different geographic areas

4.1.1.2 Knysna and Oudtshoorn

- These municipalities reported they did not receive any early warnings. Furthermore, the warning in Oudtshoorn reportedly was received ‘the day after’ the rain actually started.
- In the case of Oudtshoorn, even when a warning was received at a local government switchboard, there was uncertainty about ‘what to do’ with it. Other municipalities where warnings were received, also reported ‘not knowing what to do with them’. This was because the SMS warning was not very clear and direct.

4.1.1.3 Civil society

- Businesses were not informed of the event in advance.
- Coincidentally, Eden FM, the local radio station was not operating during the event because it possessed a temporary licence. This meant it could not be a channel for public warning.

Moreover, these observations primarily reflected the opinions of government, business and NGO stake-holders, but **not those of poor underserved marginal communities or even residents in the more affluent, but highly weather- and run-off-exposed areas**.

In this context, complementary field research indicated that these settlements and suburbs generally received no advance warning of the incoming inclement weather. This was particularly evident in the municipalities of George, Mossel Bay and Oudtshoorn. Some residents who had access to radio and T.V. and who were able to interpret the weather forecasts independently received their 'early warning' via weather forecasts on the news. However, some residents from Power Town and Wilderness Heights claimed that they only received early warnings for the second event by the police and fire services – not the first event in early August.

4.1.2 Response and Relief

Response to the 2006 flooding in Eden and its surrounds occurred at a number of levels. There was a multi-sectoral response to the crisis that ensued as a result of the extreme weather. Response mechanisms varied from food aid to search and rescue operations and numerous aspects in between these extremes, all of which are necessary in a crisis situation.
Some of the most significant dimensions of this response are addressed in the following sections:

- A focus on the *multi-agency* character of the response,
- The *coordinating mechanisms* established in the Eden District Municipality to manage the response,
- The *widespread evacuation* of at-risk households across the affected municipalities
- The absence of *social relief* for poor households who were significantly affected by the weather events,
- The respective relationship between – and timing of *atmospheric conditions, weather warnings and associated institutional responses.*

4.1.2.1 Multi-agency response

Considerable assistance was extended from national, provincial and municipal spheres, along with NGO and private sector support including:

- Deployment of **SADF** helicopters to assist in the distribution of food,
- Support by **SAPS** to assist in evacuations and the search for missing persons,

- Assistance by the **Dept of Water Affairs** to monitor storm water, as well as repair burst pipes,
- Involvement by the **Department of Public Works** in road repair, the setting up of roadblocks and traffic diversions where necessary,
- Assistance by **Wilderness Electrical Sub Station** to reconnect electricity to the district,
- The participation by a wide range of **private individuals, businesses and groups** providing helicopters, buses for the transportation purposes, setting up of soup kitchens and supply of food and blankets,
- Assistance by the **SPCA** in the removal and sheltering of animals,
- **Media** acting as a channel of communication between communities and business,
- The **South African Red Cross Society** assisting in the provision of blankets, food parcels and mattresses.

Among government stake-holders, the effectiveness of the response was generally perceived to be good, particularly in the case of emergency services. They were noted to be effective and committed, because of high morale. This is also thought to have been the reason for the low number of deaths and casualties[37].

4.1.2.2 Coordination mechanisms – regional JOC in George

The overall response was coordinated by a regional JOC established in George on Monday, 31 July 2006, with 'mini JOCS' established in Mossel Bay, Conville SAPS and Plettenberg Bay on Tuesday, 1 August 2006.

Respondents reported however, that there was an inherent lack of communication between the regional JOC and the mini JOCs established in municipalities. This was attributed to many of the JOC representatives being shift workers, which made continuity and follow-up difficult. Respondents also commented on the JOC's 'lack of mobility' which constrained its effectiveness as a coordinating node.

Despite the general effectiveness of the emergency response, 'two-way' communication between emergency responders and the affected communities was also reportedly problematic and ad hoc.

There was no evidence that the GemC3 incident management system (disaster management information system) was used to coordinate/streamline action across municipal and provincial role-players in either weather event. In addition, no archived electronic records from the GemC3 system could be retrieved from the Western Cape Disaster Management Centre to reconstruct the management of the two weather events.

[37] Although seven deaths were reported in total – primarily due to drowning, when a vehicle was swept off the Molen River Bridge in George early in the event.

4.1.2.3 Widespread evacuation of flood-exposed households

Across the Eden District Municipality and its respective local municipalities, a significant number of households within informal and other low-income settlements were evacuated. With a specific focus on the George and Mossel Bay Municipalities, the numbers evacuated are summarised below.

Table 4.1.2.3.1 Summary of people evacuated in George and Mossel Bay Municipalities following the August 1 cut-off low event

Municipality	Settlement	Adults evac.	Children evac.	Infants evac.	Total evac	Blankets Dist.	Mattresses Dist.
George	Blanco	78	24	6	108	80	2
	Conville	135	46	7	188	50	30
	Kleinkrantz	100	25		125	70	
	Pacaltsdorp	135	35	6	176	80	30
	Palana Vly	138	38	5	181		
	Syferfontein		35		35		
	Thembalethu	96	19	4	119		
	Touwsrantein	120	44	12	176	120	
	Wilderness Hts	104	53	9	166	118	10
Total George		906	319	49	1274	518	72
Mossel Bay	Power Town				320		

<u>George Municipality</u>

Thembalethu

In Thembalethu, 83 families were sheltered in a primary school, 2 families at the Dutch Reform Church and 2 families were accommodated in the town of George[38]. Blankets, food, clothes and 'gumplastiek' were reportedly handed out to flood victims. Aid was received from Fire Services (clothes and blankets), Nedbank, Correctional Services, ACVV and local churches all provided food. Other private businesses and supermarkets also provided food aid and wealthier residents from greater George brought clothes and blankets to the Fire Services. However, many people, especially those residing in Thembalethu, refused to evacuate. Reasons given for this included fear of theft of their possessions or burglary at their houses.[39] Others refused because they did not like the idea of going to a dry shelter for a day or two and then having to return to their damp, wet homes afterwards.

Touwsranten

In Touwsranten 120 adults, 44 children and 12 infants were evacuated and sheltered between 1 - 3 August 2006. By the 4 August 2006 all the evacuees returned to their dwellings and only 15 people were still receiving food parcels between 5 - 7 August 2006. Residents of Touwsranten claimed that only those from the first entrance where the community hall was located were evacuated and received aid. As a result, those

[38] Information from personal communication with Ward 12 Councillor.

[39] Some residents from formally planned areas also refused to evacuate because they did not want to be temporarily accommodated in the same venue as residents from informal settlements.

most affected who are located in the second entrance, were not evacuated and could not receive access to the aid.

Wilderness Heights

In Wilderness Heights 104 adults, 53 children and 9 infants were evacuated and sheltered in the old school between 1 - 3 August 2006. From 4 – 7 August 2006 there were 39 adults, 25 children and 4 infants still being sheltered in the school. SANZAF (South African National Zakah Fund) was interviewed in the course of the field research. They reported conducting an independent rapid needs assessment and then identifying as priority needs: nappies, children's clothes and blankets. This was followed by an appeal to Cape Town residents through the community radio station, Voice of the Cape (100.4 FM).

<u>Mossel Bay:</u>

In the Mossel Bay Municipality, 320 people were evacuated from Power Town. They had to be relocated to three venues because the first two, the Klein Brak and Reebok community halls, were too small. Some people were also taken to the Great Brak community hall. Donations for flood victims in the Mossel Bay Municipality were received from businesses and supermarkets, smaller businesses, individuals, churches, NGOs and service organisations. NGOs included the S.A Red Cross, ACVV and the Rotary Club.

4.1.2.4 Social relief

As the cluster co-ordinator for social relief, the Provincial Department of Social Services assisted with the identification of affected areas and assisted with the co-ordination and distribution of the food, blankets and accessories in the region. They also referred affected households to local authorities to provide temporary accommodation and requested removal of affected families from the risk areas. However, despite the wide-ranging livelihoods and social impacts identified by the UCT research team (refer Part III), the Department of Social Services located in the Eden District determined that 'there was no need' for social relief during the floods. This was motivated by arguments that:

- all donations received from the public were centralised – and thus coordinated;
- as the public and business communities had already 'contributed sufficiently' to meet the needs of the affected, there was 'no need' for social relief.

The determination that there was 'no need for social relief' was not informed by a systematic or rigorous household needs assessment. Moreover, the independent social impact assessment undertaken by UCT/DiMP (refer Part III) confirmed that there were indeed many households who experienced significant hardship as a result of the extreme weather, as well as the destruction of uninsured property and compromised employment opportunities. [40]

[40] While household hardship might not have appeared obvious from a rapid 'drive-by' assessment, detailed household assessments proved otherwise. Moreover, it is incongruous that poor households did not require social relief when municipal and provincial departments sought emergency funding assistance from the National Treasury - and wealthier residents and businesses sought insured assistance to cope with and recover from the extreme weather and its associated risks.

4.1.2.5 Aligning the movement of the weather system with institutional responses

Cut-off low weather systems generate spatially diffuse and wide-ranging multi-sectoral impacts. Table 4.1.2.5.1 summarises the chronology of the first cut-off low system, with specific respect to the progress across the Western Cape, the warnings and advisories issued – and associated local institutional responses.

Table 4.1.2.5.1 Summary of Chronology of Cut-off Low Event: 29 July - 4 August 2006.
Atmospheric Conditions, Critical Impacts and Institutional Response
Focus on Eden District

Date	General atmospheric conditions and impacts	Specific rainfall, wind, temperature characteristics	Institutional response (SAWS)	Institutional, local response and critical impacts (others)
Friday, 28 July 2006		NA	Initial advisory for a cold front to hit SA 30/07/2006. “Very cold and wet conditions over the western high ground of the Western and Northern Cape Sunday overnight”	Eden Disaster Management issued early warning by SMS to: N2 Roads, Metro Emergency Management Services, Transnet, Department of Health, MTO, NSRI, Petro SA, Red Cross, SAPS, SANDF, Traffic, Municipal Traffic, SPCA, Social Services, ACSA, Department of Agriculture, B-Municipalities, Disaster Management, Councillors, Communities, Cape Nature, DCS, NGO’s, Fire Services, Veterinary Services, and others. (List of +- 60 contacts)
Saturday, 29 July 2006		NA	Advisory upgraded to a warning. Two subsidiary advisories for: “Snow expected on the mountains of the Western Cape on Monday, with heavy falls of rain likely Monday night along the Cape South Coast and adjacent interior” “Very cold, wet and windy conditions with snow on the mountains expected to spread to the Eastern Cape on Tuesday, reaching the southern and eastern Free State, Lesotho and Drakensberg”	SAWS warning forecast dangerous conditions for 31 July 2006. SMS warning sent to Eden District Disaster Management
30 July Sunday	Large cold front visible to the West of South Africa over the South East Atlantic		Warning for: Very cold and wet conditions over the high ground of the Western and Northern Cape overnight. Advisories for: ‘Snow on mountains of the W. Cape Monday” “Heavy falls of rain likely Monday night along the Cape south coast and adjacent interior” “Very cold, wet and windy conditions with snow on the mountains for the Eastern	SAWS issues 2 severe weather warnings to Eden District Disaster Management via SMS

			Cape on Tuesday, reaching the southern and eastern Free State, Lesotho and the Drakensberg Tuesday night”	
Monday, 31 July 2006	Cold front makes landfall early morning Majority of Western Cape experiences significant rainfall	George : highest daily rainfall for 31 July – 45.5 mm Below zero temps over Western and Northern Cape high ground		– Traffic Services receive warning from disaster management via SMS – Fire Services receive warning from disaster management via SMS – NGO’s receive warning from disaster management via SMS – Confirmation of severe weather from various parts of the district – Warning disseminated to local role players – Regional JOC established at DM Centre
Tuesday 1 August 2006	Weather system has already hit much of the Western, Northern and Eastern Cape Cold front develops into cut-off low and intensifies	Rainfall is concentrated over the Garden Route George receives 230.1 mm rain Cold temps persist over North and Western Cape high ground	Warnings given for: “Very cold, wet and windy conditions, snowfalls over the Swartberg Mtns, Eastern Cape high ground and Lesotho” “Very rough seas with wave heights > 5m between Cape Agulhas and Port Alfred” “Heavy falls of rain are expected in places along the Cape South Coast and adjacent interior”	– Knysna local government receive SMS warning of severe weather – Infrastructural Collapse (partial closure of Kaaiman’s Pass, Bridge in Conville etc) – Various Communities recognize the severity of the event and self evacuate. – Emergency Management services receive missing vehicle and persons report – JOCs established – Mossel Bay Fire Services/ DM establish mini JOC – Conville SAPS and George EMS establish mini JOC at Conville SAPS – Plett Municipality establish JOC – WSAR activated – Plett Municipality carries out numerous rescues and vehicle recoveries – Mossel Bay reports heavy rains
Wednes-day, 2 August 2006	Weather system moves eastward now centred	Very high rainfall in Eastern Cape (300 mm recorded in Port Elizabeth)	Advisories for: “Heavy rainfall over the Eastern Cape, Lesotho and southern KZN on Wednesday” “Gale force winds very cold and windy conditions over the entire country and	– Mossel Bay reports more heavy rains – Knysna Local Government reports alarm and impacts as coincidental events. – Plett Municipality reports sporadic infrastructure failures

	over Kwazulu-Natal	Very cold temps across country – minimums near or below zero Snow falls in; W.Cape, E.Cape, SE Free State, Lesotho, Drakensberg. Strong winds reported	Lesotho” “Very rough seas between Plettenberg and Richard’s Bay on Wednesday and Thursday” “Very cold conditions over most of the country” “Snowfalls over the high ground of the Western and Eastern Cape, Lesotho and the Drakensberg” “Gale force winds and very rough seas between Plettenberg Bay and East London” “Heavy falls of rain along the Garden Route, eastern parts of the little Karoo and along the south east coast and adjacent interior between Plettenberg Bay and Port Alfred” Advisories for: “Cold conditions over the south-eastern high grounds” “Further heavy rainfalls were to be expected over the Eastern Cape” “Gale force winds and rough seas were expected between Plettenberg and Richard’s Bay on Thursday (3 August 2006)”	– Plett Municipalitity: R340 Closed, Bitou River in flood, 2 Communities isolated – Mossel Bay Municipality reports loss of one person in Groot Brak – Regional JOC instructs evacuation of danger points, including Powertown and Groot Brak. Assisted by Mossel Bay Municipality and EMS – EMS hold meeting in George – all personal put on standby – Knysna Municipality reports mudslides and flooding of access roads. Civil Contractors called in.
Thursday, 3 August 2006	Upper level low begins returning to normal Rainfall abates	Very cold temps still recorded in Eastern Cape interior, resulting in snow falls on Lesotho and Drakensberg Mts.	Warnings for : “Continued snowfall over the Eastern Cape, Lesotho and Free State high grounds” “Very cold conditions over the eastern half of the country” “Gale force winds and rough seas between Cape St. Francis & Richard’s Bay” “Heavy rainfalls along the coast and adjacent interior of the Eastern Cape”	– Mossel Bay reports water subsidence – NGOs (Knysna) report severe, heavy rains, mud slides and inaccessibility of roads. – Kaaiman’s Pass closed completely by traffic department – Plett Municipality assesses damage – Plett Municipality reports road blocks, flooding of golf courses, closure of district roads, storm damage to informal houses – Plett Municipality opens mass care facilities and initiates relief – Fire Department informed about impacts and

				infrastructural damages
Friday, 4 August 2006	The system largely moves offshore, but the eastern half of South Africa and Lesotho were still experiencing the influences of the tail end of the large cut-off low system.	Clear skies over most of the country Rain falls over parts of the Eastern Cape in the morning, Temps over the interior still low and snowfalls also over the E.Cape and Lesotho high ground during the morning. Very windy conditions along the coast, with swells > 5m between Port Alfred and Richards Bay.	Warnings for: “Cold conditions over the eastern section of the country” “Morning snowfalls over the Eastern Cape, Lesotho and KZN western high ground” “Gale force winds and rough seas from Port Alfred to Richard’s Bay” The Western Cape indicating that “due to current levels of rivers and dams, further showers may lead to localised flash flooding in places along the Cape southern coasts” Advisories for: “Heavy rainfall over the Eastern Cape, Lesotho and southern Kwazulu-Natal on Wednesday” “Gale force winds” “Very cold and windy conditions over the entire country & Lesotho, very rough seas between Plettenberg and Richard’s Bay on Wednesday and Thursday”	– NGOs reported damages to Municipality – Evening: One lane of Kaaiman’s pass was opened and stop/go system was put in place

4.1.3 Recommendations

These emphasise the pressing need for improved disaster management plans. This includes the formalisation of warning dissemination to critical stake-holders, clear definition of staffing, roles and responsibilities of JOCS and local JOCS and the establishment of robust mechanisms that ensure a smooth information flow between critical stakeholders (including government role-players, farmers, private sector, media and disaster-affected settlements).

All district municipalities exposed to extreme weather should establish formalised systems for communicating *and confirming* understanding of warning information among government and non-governmental role-players

This formalised system should also ensure an effective flow of information, between:
- government role-players (within and across spheres),
- JOCS and nongovernmental responders,
- JOCS and the affected communities/settlements.

Warning information as well as response and relief updates should be communicated in multiple, context-specific and language-appropriate forms

Messages need to be conveyed in multiple, context appropriate forms, emphasising the role of local communication channels. In the case of Eden, this specifically underlines the need for community radio stations to have permanent licenses for warning and information dissemination.

Institutional arrangements with respect to the JOCs and mini-JOCS should be formalized and agreed-on by critical stake-holders

It is important that the JOCs have capacity to gather, process and respond to all relevant information, and to have mechanisms to ensure a streamlined continuous information flow between critical role-players (e.g. two-way radios). It also requires the formalisation of protocols to ensure accurate communication between local and regional JOCs

These arrangements depend on the formalisation of a permanent system of JOC membership. This requires that the same people should represent their departments in the JOC at all times so that information is consistent, relevant, maintained and updated

Recognising the significant exposure of Southern Cape to extreme weather and the vast areas involved, a mobile JOC should be considered for the Eden District Municipality, with necessary communication tools (e.g. a specially adapted bus)

Contingency planning for at-risk communities and settlements should be undertaken consultatively well in advance of a weather alert

Contingency planning for at-risk communities and settlements should be *undertaken consultatively with them* long before a weather alert – in the case of the Southern Cape, before the onset of the winter rainfall. Such contingency planning should include procedures for activating response and specific evacuation arrangements.
These actions can also be enabled by greater engagement with local schools on extreme weather, risk and evacuation to increase local awareness and responsibility.

An unambiguous provincial protocol for social vulnerability assessment of extreme weather-affected households should be developed and applied after each event

The determination that there was 'no need for social relief' was not informed by a systematic or rigorous household needs assessment. Moreover, the independent social impact assessment undertaken by UCT/DiMP confirmed that there were indeed many households who experienced significant hardship as a result of the extreme weather, as well as the destruction of uninsured property and compromised employment opportunities.

While such hardship might not have appeared obvious from a rapid 'drive-by' assessment, detailed household assessments proved otherwise. Moreover, it is incongruous that poor households did not require social relief when municipal and provincial departments sought emergency funding assistance from the National Treasury and wealthier residents and businesses sought insured assistance to cope with and recover from the extreme weather and its associated risks.

4.2 Risk reduction constraints

The detailed coverage of existing risk reduction measures exceeds the scope of this report. However, specific attention will be given to institutional and other constraints that 'developmentally' compromise local risk management capacities of government services in the areas exposed to extreme weather. In this context, particular attention is focused on:

- Municipal disaster management
- Municipal planning processes and regulations
- Municipal engineering, roads and storm water capacities
- Low cost housing development, and
- Civil society participation and inclusive governance

4.2.1 Municipal disaster management

4.2.1.1 Disaster Management Advisory Forum

Beginning efforts to establish a Disaster Management Advisory Forum in the Eden District were reported. However, it is unclear to what extent this forum had established an active multi-stakeholder task team that focused on the mitigation of extreme weather-associated risks.

In this context and given the scale as well as the diverse geographic and socioeconomic profile of the areas affected (including the heavy local dependence on tourism) there are pressing needs to mobilise a much wider range of stake-holders for risk reduction planning. The Disaster Management Advisory Forum is an institutional platform for exactly this purpose.

4.2.1.2 Incorporating risk assessment findings for risk reduction planning

The Eden District Municipality has completed a comprehensive risk assessment, underlining many of the geo-risks associated with rapid urban growth. This report could be significantly strengthened with the incorporation of loss and impact information from recent extreme weather events – which clearly signal specific sites and settlements of heightened environmental, infrastructural and social vulnerability in relation to extreme weather. This information needs to be integrated into planning processes within district and municipal spheres.

4.2.1.3 Strengthening human capacity in disaster risk management

Disaster risk management is a critical priority for sustainable growth in the Eden District Municipality, as well as its associated local municipalities due to their repeated exposure to both extreme weather and endangering wild-fires. In this context, there are pressing needs to augment existing disaster management capacity which is severely overstretched, and unable to manage the wide-ranging demands of post-event recovery as well as multi-stakeholder risk reduction planning.

This additional capacity should particularly focus on incorporating social vulnerability, infrastructural and environmental risk reduction considerations into:

- the district's spatial development plans,
- the district's integrated development plans, as well as those for its associated local municipalities

Municipalities would also be more effectively enabled through the focused work of a Disaster Management Advisory Forum, as outlined in the Disaster Management Act and as required in the National Disaster Management Framework.

4.2.2 Municipal planning processes and regulations

Many of the losses attributed to the extreme weather in within the Eden District Municipality and associated local municipalities have been significantly driven by rapid and poorly planned urban growth that has seriously undermined the protective capacities of the natural environment. This is measurably evidenced by the upward trend in weather and run-off-associated infrastructure losses since 2003, suggesting that the 'triple bottom-line' for sustainable regional growth and development may already be compromised.

This was underlined at the debriefing session in February 2007, where many respondents emphasized the importance of the district's Spatial Development Framework to 'manage the improper and unsafe layout' of many settlements.

In addition, the need for tighter regulations that limit the time-frame for actual construction by property developers was also highlighted. This was proposed to avoid the current mismatch between the capacity of the bulk infrastructure provided and the scale (and run-off potential) of the eventual (and often significantly delayed) property development.

In addition, despite their direct relevance to district's sustained future growth, neither climate risk nor disaster risk management is profiled in the district's existing IDP documentation.

4.2.4 Municipal and provincial engineering services: Focus on roads and storm water

Significant losses to road and municipal infrastructure were once again sustained in the Southern Cape, underlining the high risk profile of critical infrastructure in the Eden District Municipality.

4.2.3.1 Provincial and district road networks

The following points outline some of the significant operational constraints in 'weather- and run-off-proofing' critical road, bridge and storm water infrastructure in Eden.

Weather- and run-off-proofing critical infrastructure: roads-at-risk.

- The Eden District Municipality contains **6 900 km** of provincial, main, divisional and minor roads, of which **only 750 km are surfaced (11%)**.

- Many of the surfaced roads are more than 30 years old with technical design features that are **outdated and 'beyond reseal or economic maintenance'**. These poorly surfaced roads are more seriously susceptible to flood damage, and once the surface disintegrates, the damage is magnified.

- The rest are **gravel roads** that are **mostly at or below natural ground level**. These have severely constrained capability to withstand more than 1:5 year flood events. Moreover, road gravel is very thin, resulting in little or no resistance to water scour during heavy rainfall and flood events.

- **Recurring flood events every 1-2 years**, combined with **rapid urban growth** place extraordinary demands on those responsible for protecting the road network, now operating with 'inadequate capacity to continue with both maintenance and flood damage simultaneously'. Moreover, they can no longer ensure a 'properly drained network for a 1:5 or 1:10 year flood event', let alone the 'onslaught of 1:50 or 1:80 flood events' that have affected the Southern Cape since 2003.

- A comparison of infrastructural impacts for cut-off lows in 2003 and 2006 indicates that **48 road sectors within the Eden District experienced repeat impacts**, with repair costs trebling from R 7 million (2003) to R21 million (2006), for total costs exceeding R 28 million.

- These repeat structural failures and their spiralling costs underline the vulnerability of essential road infrastructure in the Eden District to current heavy rainfall events. They also emphasise the urgent need to 'rethink' investment, engineering and human resource strategies for ensuring risk-averse infrastructure in this region – especially infrastructure that is critical to regional economic and social development but is likely to fail due to extreme weather and run-off.

4.2.3.2 Municipalities

Within affected municipalities, there was significant failure of storm water infrastructure – which had serious 'knock-on' consequences for roads and private properties. While Part V describes this in more detail, Table 4.2.3.2.1 shows that total repair and reconstruction costs associated with the two cut-off lows were equivalent to approximately 75% of the 2006/07 maintenance and repair budgets listed below.

Table 4.2.3.2.1 Municipal Budget for the Civil and Technical Services for 2006/2007

Planned Budget 2006/07			**Repair Costs**	
Municipality	Maintenance & Repair Budget (Rands)	Maintenance & Repair as % of Planned Expenditure	Total Repair Costs (Rands)	As a % of Maintenance & Repair
Bitou	15 603 173.00	7.39%	877 172.00	5.6%
George	44 061 000.00	13.45%	16 691 512.00	37.9%
Knysna	9 053 490.00	5.58%	32 998 370.00	364.5%
Mossel Bay	19 970 000.00	37.75%	15 458 324.70	77.4%
Prince Albert	273 320.00		382 000.00	139.8%
	88 960 983.00		**73 381 378.70**	

Most significant are the losses sustained by Knysna (R 33 million), representing nearly **four times** its planned maintenance and repair budget. Similarly, Prince Albert overspent the equivalent of its planned maintenance and repair budget by 140%. Mossel Bay – which proactively allocated R 20 million for municipal maintenance, still spent the equivalent of 77% of its projected maintenance budget on run-off and flood related damage.

4.2.3.3 Critical contributing risk factors for structural failure

Many of the losses sustained have been attributed to **failed or obstructed storm water** drains, reflecting increased surface run-off volumes which are, among other consequences, the outcome of the region's rapid urban and poorly planned growth. Moreover, past **under-investment in maintenance and upgrading** of weather-exposed road and storm water infrastructure has increased the risk of structural failure.

This was further compounded by high levels of '**debris loading**' in storm water channels and water courses – frequently attributed (but not verified) to the Working on Water alien vegetation clearance programme.

In post-event reconstruction, there are several critical constraints that prevent damaged/destroyed infrastructure from being rehabilitated to 'risk averse' levels.

These include **funding specifications that require rapid repairs** within the annual fiscal cycle and aim at achieving **'replacement' not 'risk averse'** standards. Such constraints preclude the incorporation of redesign, resiting, or other technical measures that would increase cost and project implementation times.

Sustainable, 'risk-averse' infrastructure is a critical priority for the Eden District Municipality, and is a prerequisite for continued business confidence and investment. However, these loss patterns – if repeated every 2-3 years – are simply not affordable and undermine prospects for sustained municipal growth and investment.

This is well-illustrated within the Hessequa municipality, where the sewage treatment facility in Heidelberg failed three times (2003, 2004 and 2006), before resources were eventually secured through MIG for its upgrade and 'flood-proofed' resiting.

In this context, there are urgent needs to augment existing public sector technical and engineering skills within these weather-exposed municipalities. Current skilled capacity is severely overstretched – attempting to simultaneously manage routine maintenance as well as minimally repair aged public infrastructure, which cannot withstand repeat heavy rain and run-off events.

4.2.4 Low cost housing development

Significant risk-generating conditions are evident in a number of low-cost (formal) housing developments within the district. These are described in greater detail in Part III of this report.

Moreover, as reported in Part III, there is evidence of inadequate integrated planning – with a number of low income housing developments sited below road-level and thus exposed to endangering run-off due to limited storm water capacity.

In addition, as the construction of low-cost houses is outsourced to private contractors, the quality of the structures is reportedly compromised due to the use of ‘cheap’ building materials. This further increases the exposure of poor families to heavy rain and run-off and their impacts.

4.2.5 Civil society participation considerations

Field research revealed extremely low engagement of residents in poor settlements in municipal concerns, including risk reduction issues. This is particularly concerning given the number of informal settlements located in marginal areas such as wetlands and unstable slopes.

Although Part III describes this in greater detail, there are needs for greater institutional support to encourage social organisation at settlement level (i.e. ward committee). This would both support internal risk reduction efforts as well as provide a structure for more systematic engagement with municipal authorities.

While the primary focus is on residents of poorer settlements, there are also needs for increased engagement and participation of more wealthy residents whose homes are located on dunes within the tidal zone – and who are also particularly exposed to the consequences of extreme weather.

4.2.6 Recommendations

The severe repeat consequences of extreme weather in the Southern Cape illustrate how poorly managed development risks are ‘transformed and transferred’ onto essential services such as disaster management, emergency services and those responsible for critical provincial and municipal infrastructure. Within the Eden District Municipality, inadequately managed urban development is a serious ‘co-driver’ of weather risk and has significantly contributed to the losses sustained.

Disaster and climate risk management should be strategically integrated and funded priorities for the Eden District

Disaster and climate risk management are critical priorities for sustainable growth in the Eden District Municipality, as well as its associated local municipalities due to their repeated exposure to both extreme weather and endangering wild-fires. This is evidenced by the costly impacts and disruptions associated with recurring extreme weather events.

There are pressing needs to integrate risk management considerations into the region's development spatial and integrated development planning, with accompanying financial and human resource allocations. Other specific actions include:

- Activating the District's Disaster Management Advisory Forum to establish a skilled and committed multi-stakeholder task team that focuses on strategies for mitigating extreme weather-associated risks.
- Incorporating spatial loss and impact information from recent extreme weather events into integrated planning processes – to highlight those sites and settlements of heightened environmental, infrastructural and social vulnerability in relation to extreme weather.
- Augmenting existing disaster management capacity, which is severely overstretched, and unable to manage the wide-ranging demands of post-event recovery as well as multi-stakeholder risk reduction planning

Municipalities within the Eden District Municipality should integrate risk management considerations in all local planning and regulatory processes

Many of the losses attributed to the extreme weather within the Eden District Municipality and associated local municipalities have been significantly driven by rapid and poorly planned urban growth that has seriously undermined the protective capacities of the natural environment. This is measurably evidenced by the upward trend in weather and run-off-associated infrastructure losses since 2003, suggesting that the 'triple bottom-line' for sustainable regional growth and development may already be compromised. There are pressing needs to:

- Tighten land-use regulations to avoid further 'unravelling' of these protective 'environmental services'.
- Incorporate risk assessment for flood, run-off, slope failure and subsidence into all future environmental impact assessments within the district.
- Revisit existing design criteria for critical infrastructure – especially roads and storm water to determine their relevance and robustness for extreme rainfall events.

Strategic 'rethinking' should be undertaken transversally and vertically to better 'risk-proof' critical municipal and provincial infrastructure.

Repeat structural failures and their spiralling costs underline the serious vulnerability of essential municipal and provincial infrastructure in the Eden District to current heavy rainfall events. Moreover, as stated previously, these loss patterns, if repeated every 2-3 years, are not affordable and undermine prospects for sustained municipal growth, business confidence and future investment. They also call for:

- An urgent **'rethinking' of investment, environmental, engineering and human resource strategies** for ensuring risk-averse infrastructure – especially that which is critical to regional economic and social development but is likely to fail due to extreme weather and run-off.

- The development of **decision models** that evaluate the relative strengths of proactive investment in upgrading (resiting, redesigning, reconstructing) and maintaining critical road and other infrastructure to offset future losses from expected extreme weather.
- Focused discussions between risk-prone municipalities and provincial departments (Public Works and Transport, Local Government and Housing, especially MIG, and Climate Change/Adaptation representatives) on **practical strategies for reducing climate risk impacts** on vulnerable infrastructure.
- Investigation of available **climate risk insurance options** as potential risk transfer mechanisms to ease financial pressure on weather-exposed municipalities.

Consideration should be given to 'weather- and runoff-proofing' homes in low-income developments

Many of the most at-risk low-income settlements are sited below road-level and are exposed to endangering run-off due to limited storm water capacity. In addition, poor construction standards have increased exposure to heavy rain, run-off and subsidence.

Currently, there are no provisions or specifications for 'weather-proofing' or 'flood-proofing' low-income homes in areas exposed to heavy rain and run-off conditions. However, recognising that the objective of 'social housing' is to address the housing needs of the most socially vulnerable, in areas exposed to recurrent heavy rain events, 'weather-proofing' is an important consideration to protect assets as well as the health of household members.

4.3 Post event reconstruction and recovery

The processes of recovery and reconstruction often focus on the physical rehabilitation of infrastructure and the restoration of disrupted services. However, the effectiveness of recovery and reconstruction is also significantly influenced affected by timely access to adequate funding – especially for critical infrastructure. This can be administratively complicated, as the provision of funding must comply with the often complex requirements imposed by existing financial cycles and established national and provincial funding mechanisms.

This section specifically focuses on the institutional dimensions of the funding and expenditure processes associated with the August 2006 events.[41]

Section 4.3.1 describes the overall process for reconstruction

Section 4.3.2 outlines the process for verifying impacts

Section 4.3.3 describes the steps in mobilising funding for recovery and reconstruction

Section 4.3.4 reviews the allocation, expenditure and implementation processes

Section 4.3.5 provides case-examples from Knysna Local Municipality and Provincial Roads

[41] The research for this section of the report was Information was gathered through key informant interviews, a participatory stakeholder consultation, desk top reviews of government documents and a case study of the Knysna Municipality.

Section 4.3.6 focuses on the constraints, consequences and contradictions experienced through the process.

Section 4.3.7 concludes with recommendations

4.3.1 Overview of the reconstruction and recovery process and time-frame

4.3.1.1 General chronology of the funding process

As detailed in Part V, it was difficult to determine the specific impacts from each of the August 2006 events due to the confounding effect of the second weather event, which occurred approximately three weeks after the first cut-off low and during the impact verification process for the first severe storm.[42]

The tight time-frame for both sourcing and spending funds for recovery and reconstruction is illustrated in Table 4.3.1.1.1. This outlines the complex mix of actions undertaken from the time of the first event in August to the required deadline for spending of emergency funding in June 2007.

Table 4.3.1.1.1 Chronology of institutional actions and measures taken to enable reconstruction following the August 2006 cut-off lows

Phase	Month/Year	Action Taken
Phase I Emergency mgmt Impact verification	August 2006	First severe weather event Post event debriefing meetings in Swellendam and George First Provincial Cabinet submission by PDMC containing impact information Establishment of the Ad hoc flood committee Local municipalities required to submit losses as a result of the first event Second severe weather event Cabinet delegation visited affected areas
Phase II Classification and declaration of local disaster	Sept 2006	PDMC presents impact report to Provincial Cabinet Minister Mufamadi classifies Eden District as a local disaster at the Inter-ministerial Committee on Disaster Management (ICDM)
Phase II Classification and declaration of local disaster	October 2006	PDMC presents impact report to the National Portfolio Committee on Provincial and Local Government NDMC reports impacts to National Treasury First Provincial Cabinet submission by PDMC Declaration of disaster in the Provincial Gazette (6387 – 13 October 2006) Approval of emergency funding
Phase III Funding mobilised	Nov 2006	Third Provincial Cabinet submission by PDMC Ad hoc flood recovery committee meeting: NDMC gives guidelines and expectations on spending of

[42] This was the first time in the last ten years that two extreme weather events resulting in large scale impacts occurred in such a short succession.

		emergency funding
Phase III Funding disbursed	Dec 2006	Funds disbursed to provincial departments
Phase IV National/Provincial expenditure completed	March 2007	National and Provincial departments required to spend all emergency funds received
Phase V Municipal expenditure completed	June 2007	Local municipalities required to spend all emergency funds received

4.3.1.2 Description of processes implemented

Phase I: 1- 31 August 2006 Emergency management and impact verification

The first weather event occurred between the 31 July - 3 August 2006, resulting in extensive damage. A process of collecting impact information was commenced to estimate the costs involved in repair/reconstruction and to assess existing funding capacity within departmental and municipal budgets.

Two meetings were held after the first event to estimate the extent of the damage. These were held in Swellendam (10 August 2006) and George (11 August 2006). The information collected at these meetings was presented to Provincial Cabinet. An ad hoc flood committee was established immediately after the cabinet submission, comprising representatives from the National Department of Water Affairs, Provincial Agriculture, Treasury, Roads and the Municipal Infrastructure Grant programme. These departments were to assist in the verification of losses that had been submitted.

Simultaneously, templates to record the damages were distributed to the affected local municipalities by the PDMC. Although these were supposed to be submitted by the end of August, this was not possible due to the occurrence of the second event. As a result, the process of loss determination required repeating. PDMC presented the results to the Western Cape Provincial Cabinet.

Phase II: September - October 2006 Classification and declaration of a local disaster

On 15 September 2006, Minister of Local and Provincial Government classified the Eden district as a local disaster. This was formally gazetted in the Provincial Gazette on 13 October 2006.

PDMC records indicated that the Minister for Provincial and Local Government would approach the Minister of Finance to explore the possibility of allocating emergency funding from the National Revenue Fund (and not from a contingency fund).

Subsequently it was decided that NDMC make a direct submission to National Treasury, (undertaken in October 2006) resulting in the approval of emergency funding. NDMC presented the expectations and guidelines for spending the emergency funds at an ad hoc flood committee meeting in November.

Phase III: November-December 2006 Funding mobilised and disbursed

Funds were disbursed in December 2006, with stipulated requirements that National and Provincial departments spend the monies by March 2007.

<u>Phases IV and V: January-March 2007 and April-June 2007 Implementation of reconstruction and financial reporting</u>

National and provincial authorities completed expenditure by March 2007. Local municipalities were required to spend the funding by the end of their financial year, June 2007.

When these actions are represented chronologically, it is clear that this process was extremely labour-intensive and both technically and administratively complex with many actions necessary to mobilise recovery funding – juxtaposed against a staggeringly brief period for the actual implementation of reconstruction efforts and financial reporting.

4.3.2. Verification of impacts

After the first event, local municipalities were requested to submit details of the impacts to the PDMC using a specific template which was distributed. They were required to submit the information by the end of August. This was not possible as the second event occurred and resources were diverted to respond accordingly.

Following the second event, it was necessary to repeat the entire process of collection and verification of damage. This resulted in the losses attributed to both events being consolidated as one. Although this impact information requested from the affected departments and municipalities was reportedly returned by email and fax to the PDMC, limited documentation on this could be located by the research team.

While the collection and verification process was underway, it was decided that municipal reconstruction efforts would be implemented through Municipal Infrastructure Grant mechanisms (MIG). This required affected local municipalities to resubmit the reports of damage using the templates in the MIG format. They were then required to submit a further set of impacts in a slightly different form to the research team (altogether, this required at least four different impact reporting/documentation processes)

The verification of the impacts was supported by the ad hoc flood committee. The MIG engineers were also called upon to provide technical support to the affected local municipalities.

4.3.3 Funding

Under optimal conditions, emergency funding mobilisation should take place rapidly following a disaster event. With respect to the general municipal reconstruction process, affected municipalities are normally required to first assess their funding capacity to cover damage costs. If a municipal budget is exceeded, the respective local authority may then seek assistance from the provincial sphere, continuing to national government if need-be.

As can be seen in Figure 4.3.3.1, in October 2006 the Provincial Disaster Management Centre presented an overview of the events and its associated losses to the National Portfolio Committee for Provincial and Local Government and subsequently to the National Treasury.

Coincidentally, this reporting process took place during the same period as the annual Provincial Budget and Expenditure review. This coincidental timing of the two processes provided an administrative opportunity to advocate for and source emergency funding, which was approved at the end of October.

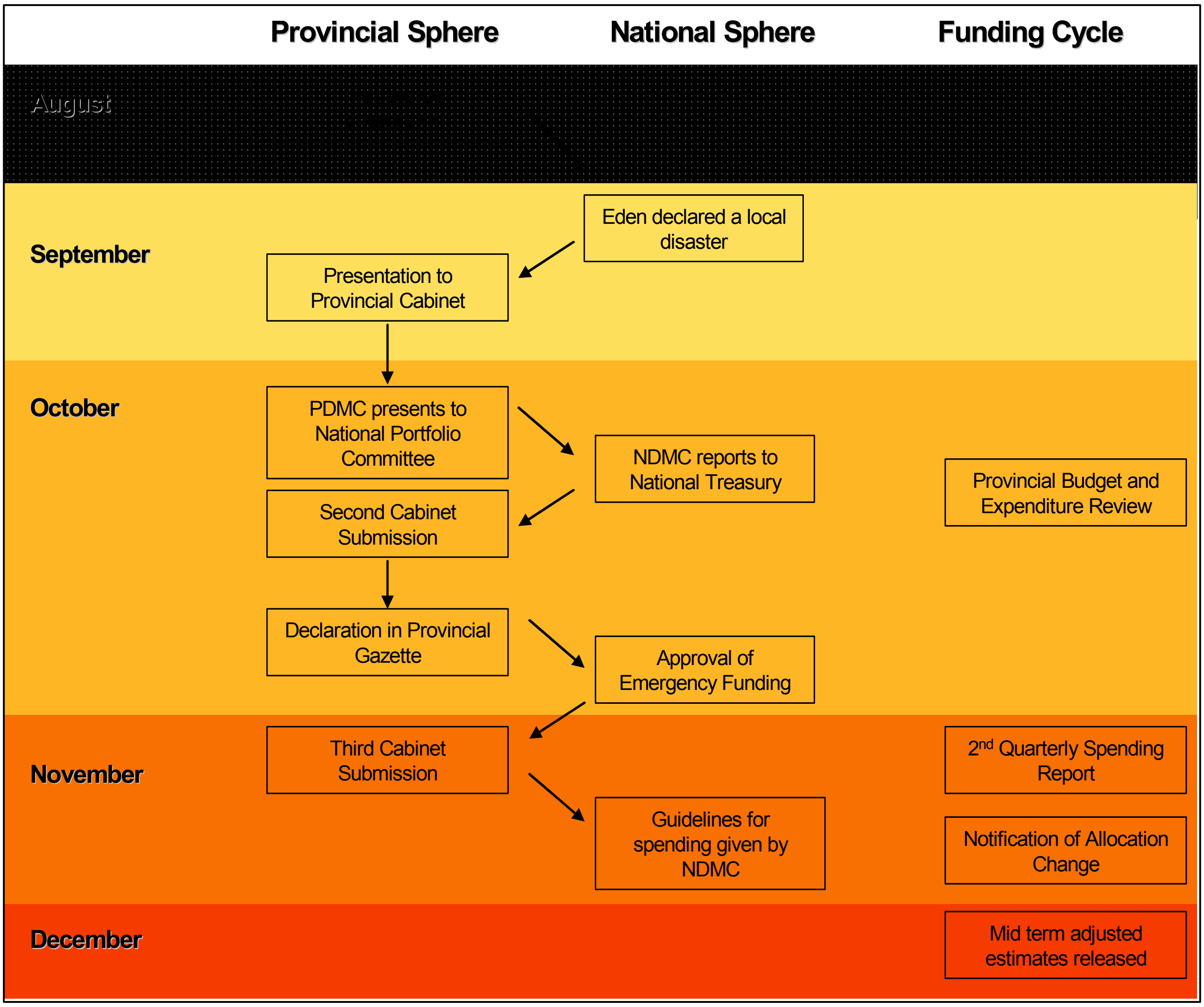

Figure 4.3.3.1: Process of acquiring funding for reconstruction

4.3.4 Allocation, expenditure and implementation

Figure 4.3.4.1 illustrates the complex flow of funding that was allocated for reconstruction.[43]

[43] This was based on information in the adjusted budgets for the provincial as well as national government departments. Interviews were also held with Provincial Treasury and other Provincial Departments.

The shapes in the diagram indicate the following:

- squares indicate National Departments
- circles indicate provincial entities
- octagonal shapes indicate sub-directorates within provincial entities
- parallelograms indicate district and local spheres of government
- solid lines indicate the funding flows
- broken lines indicate the reporting flow. For example, Eden and the local municipalities would report their spending to Provincial Disaster Management

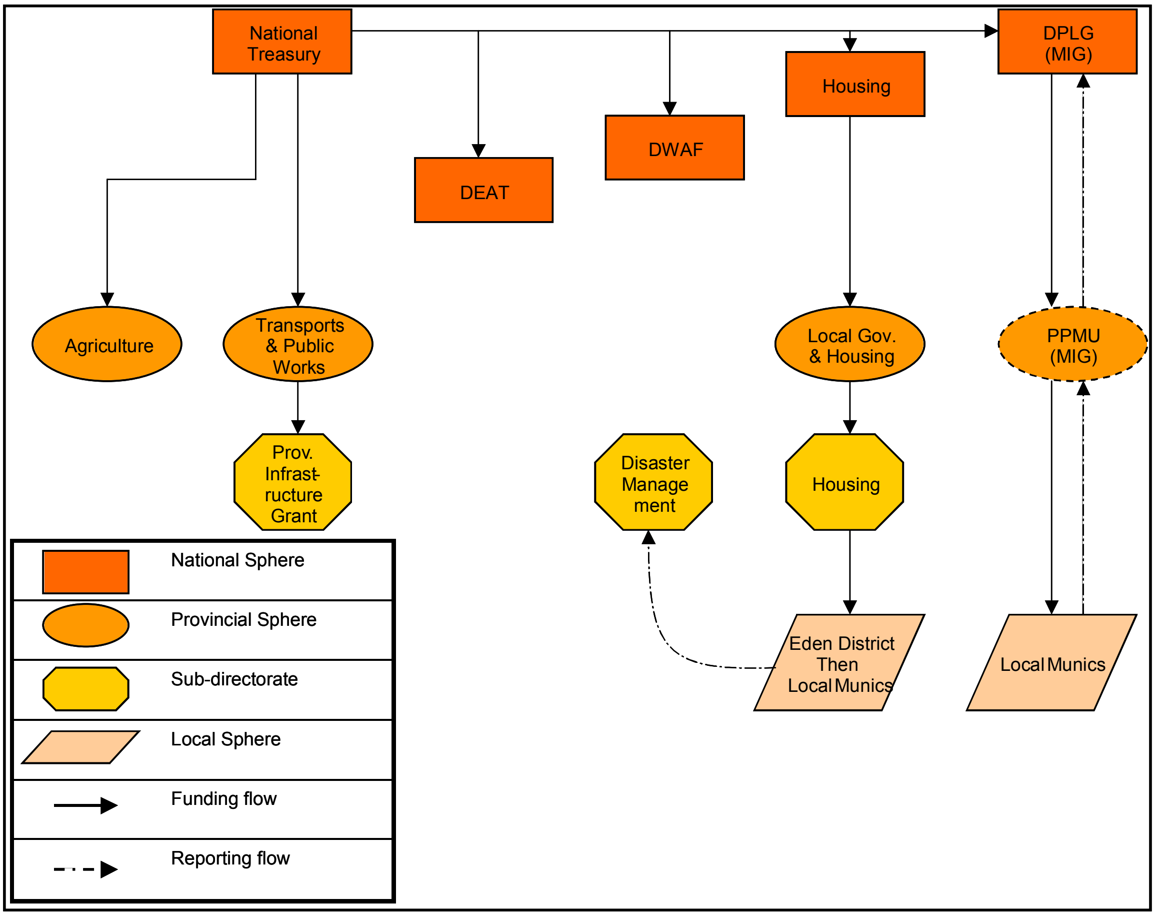

Figure 4.3.4.1: Flow of funds and reporting process

National Treasury provided funding directly to DEAT, DWAF, Dept of Housing and DPLG though the MIG programme. Funding was also provided to Provincial Agriculture and the Dept of Transport and Public Works through Provincial Treasury. The National Department of Housing provided funds to the Provincial Housing Department. This was then transferred to the district and local municipalities. These municipalities then reported directly to the PDMC on their housing expenditure. DPLG provided funding to local municipalities for the reconstruction of municipal infrastructure through the existing MIG process. This meant that the provincial project management unit (PPMU) provided support in terms of technical oversight and monitoring.

It is significant to note that payments for the reconstruction of municipal infrastructure were made as reimbursements on-claim. This required local municipalities to first spend and then submit invoices for reimbursement purposes, specifically obliging municipalities to advance or ‘up-front’ local reconstruction costs with the assumption these would be subsequently reimbursed.

The requirements for spending public finances are outlined clearly in the Public Finance Management Act and the Division of Revenue Act. National and provincial departments were required to spend the funding by March 2007. The Department of Agriculture however, assessed this to be unrealistic, as it deterred risk-averse planning and reconstruction which generally take longer than the three-month deadline allowed.
Local municipalities were required to spend their allocated funding by June 2007[44].

4.3.5 Municipal and provincial case examples: Knysna Municipality and Provincial Roads

Two case-examples compare and contrast the reconstruction experiences of two separate entities within the Eden District, the Knysna Municipality and the Provincial Roads – for which the Eden District is the roads agent. This compares the experience of a municipality which outsourced local repairs to service providers against an organ of state that was directly responsible for implementation.

4.3.5.1 Knysna Municipality

Timing and resource constraints for the research team limited case-specific research to one municipality. In this context, key informants within Knysna were approached to outline their specific experience in the reconstruction process. This was facilitated through telephonic interviews with Knysna’s municipal engineer.

<u>Collection and verification of impacts</u>

Knysna’s technical services department was required to record the weather-associated impacts. Although this should ideally have been completed by skilled engineering staff, the municipality only had three qualified staff members. This resulted in damage being assessed by less experienced technicians, with limited capacity to determine the cause or consequences of the damage sustained.

One innovative strategy implemented by the municipal engineer to ensure that information was as accurate as possible, required the technicians to take extensive photographs of the affected sites. This allowed him to verify the recorded observations, without having to travel extensively across the municipality.

As this initial damage assessment was completed by emergency responders, it was subsequently found that these early assessments under-estimated the severity of the loss. In one such example, where a road near to a school was damaged, the impact was initially assessed as ‘minor’. However, once trees were removed from the damaged site, reconstruction estimates soared to R 3 million.

Discrepancies between the initial assessment and eventual cost estimates were attributed to emergency personnel being both unfamiliar with physical and structural planning processes as well as not fully appreciating the consequences of damage.

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[44] However, in reality, the reconstruction process was completed even sooner as the respective municipal finance departments required documentation earlier to complete the required financial reporting by June 2007.

In total, the technical services department was required to complete five different reports containing the same information but with slightly different formats and presentations. This included two internal reports, one submission to the PDMC, one to MIG and finally to UCT's research team. This placed even more pressure on the overstretched department.

Moreover, after this initial collection process, there was minimal reporting from community members. According to the engineer, the community residents "did not know" that they could report damaged structures, such as street lights. This later damage was only identified during subsequent informal discussions and not included in the impact reports submitted for funding.

<u>Impact reporting for funding mobilisation</u>

The technical services department was obliged to go through several reporting stages or processes.

First reports

The first reports were submitted internally to the Mayoral Committee to determine if the damage could be covered from within the municipality through its operations budget. As a result, approximately R4 million from the municipal budget was diverted to post-disaster repair and reconstruction – specifically prioritised to restore critical infrastructure and to "get services running again". Normal administrative procedures were bypassed because of the urgency of the situation.

For this internal process, each line department submitted loss reports to the technical services division (completed by end of September 2006). Funding was then allocated to each affected municipal department. One element overlooked in this process was the 'actual internal capacity' to cope with the increased workload once funding was approved. As a result, much of the repair work had to be outsourced, due to inadequate implementation capacity within the municipality.

Second reports

The second round of reports was sent to Provincial Disaster Management in a format they had requested.

Third reports

It was then decided that the reconstruction process would be handled through the MIG process. Therefore another submission had to be made in the format used by the MIG. The municipalities were then instructed to report in their own format, as they were responsible for overseeing construction.

Fourth reports

UCT's research team then sent another request for data in a different format.

<u>Expenditure</u>

Provincial government requested that money be spent within three months. This placed administrative pressure on the municipality who was required to outsource reconstruction efforts in accordance with municipal procurement procedures. In addition, it resulted in a sequence of 'knock-on' implications that significantly increased repair costs. These included:

- Increased labour costs for contractors due to the fast-paced month time-frame.

- Increased costs for materials and building supplies due to the urgency of the repairs and increased demand generated by competing high-visibility projects such as the Gautrain and construction of soccer stadia.

In order for the contracted service providers to deliver in the short time frames set by the municipality, they were required to hire more staff. This increased eventual repair and reconstruction costs.

The pressure to deliver quickly also resulted in higher costs for building materials because these were urgently required. Moreover, local repair and reconstruction requirements competed with the development of soccer stadia for 2010, as well as the Gautrain.

As the size and scale of orders for materials required for post-disaster reconstruction were small when compared to high-visibility projects, these could not compete for the attention of suppliers or manufacturers. This resulted in the contractors being obliged to despatch trucks to Gauteng or wherever manufacturers were located to obtain needed materials.

An added local complication was that most of the reconstruction work was intended to be implemented over December and January. As the annual 'tourist season' generally falls over this period in Knysna, little construction was possible over these months – further increasing implementation pressure.

Monthly reporting process

As the Technical Services Department received emergency reconstruction funding through MIG, this required detailed monthly reporting on expenditure. As a result, and to ensure compliance with the Municipal Systems Act, each of the 83 municipal reconstruction projects was assigned a separate four-digit reference number that facilitated expenditure tracking and monitoring. This specifically required that each invoice generated for every reconstruction project had to be referenced, summarized and presented according to the MIG reporting format.

An additional challenge associated with funding post-event reconstruction through the MIG related to difficulties in reallocating funds within projects. Every change in expenditure, no matter how small, required clear, documented motivation.

To minimise the workload associated with these cumbersome administrative processes, the 83 original municipal projects were regrouped into thirteen functional plans.

Administration of Reconstruction Projects

The technical and administrative demands of the reconstruction process demanded significant 'hands-on' involvement of the both the Director of Technical Services, and municipal engineer. They were important intermediaries between 'the two camps' of operational and financial personnel – who had differing understandings about the financial aspects of the reconstruction process. [45]

[45] An important underpinning concern in Knysna relates to attracting and retaining skilled young and emerging mid-career professionals – given the absence of 'middle income' housing and other services.

The administrative demands of emergency reconstruction further underlined significant limitations in financial management capacity within the municipality. It illustrated the limited understanding and skills with respect to implementing the Municipal Finance and Management Act. One example related to the use of the MTEF (i.e. the three-year funding cycle), which the local finance department interpreted as a one-year process. This reportedly negatively affected service delivery as 'everything has to be rushed' in order to be completed approximately three months before the financial year end in order for accounts to be consolidated.

As with other municipal construction projects, the appointment of contractors was not made by technical staff but by a procurement committee.

Recommendations by the Municipality

- Reconstruction should be run as a project, with a project team. This team would include operational and financial personnel, as well as an intermediary possibly a qualified technical person.
- A mechanism should be established so that retired engineers can be engaged as part of the post-event assessment team. This could also be used as a mentoring opportunity.
- A standard template for impact assessment should be developed. This should be simple enough to be used by the field personnel. A suggestion was made of using tick boxes or perhaps using a matrix.

4.3.5.2 Provincial Roads within Eden District

Collection and verification of impacts

In this instance, it was the actual Eden Roads Department that assessed and verified damage. This resulted in a cost-estimate based on the department's local and specialist knowledge of what was 'required to be done, what equipment would be required and how long it would take to effect repairs'. The exercise was substantially informed by experience gained from previous flood damage assessments. However, the initial assessment was not accompanied by quantity surveying to establish exact time-frames or equipment requirements and was a workable 'cost-estimate' only, not a precise costing of repairs.

Impact reporting

After the assessments were complete, reports were compiled indicating the type of damage, estimated equipment and manpower days needed to repair damage, as well as estimated cost for material to be purchased, if required. In this instance, necessary materials such as gravel were obtained from the agent's own sources and were not procured commercially. This limited overall costs to those directly associated with equipment and labour.

The assessment/estimates were then submitted to PGWC, Branch Roads Infrastructure for approval to effect repairs and for additional funding as required.

Administration of reconstruction and repair

Generally, the Eden agent for Provincial Roads 'does not repair flood damage by means of contracts'. Such repairs are directly implemented using their own capacity, or if necessary, with rented equipment from the private sector which operates under their direct supervision. In situations such as the August 2006 extreme weather, which result in extensive damage, the workforce was temporarily increased by appointing contract staff.

However, if the flood damage is so extensive that it exceeds internal capacity, or requires specialised construction knowledge, or where the work volume is excessive, there is also administrative provision for specific repairs to be undertaken by tender.

This work is done under direct instruction and supervision of the branch.
With specific respect to the repair of flood damage associated with August 2006 weather events, work commenced on or about 5 August 2006 and continued up to 30 June 2007. The estimated damage was calculated at approximately R 83 million, excluding structures for which it was not possible to estimate a replacement value (as inputs from specialist structural engineers were required).

Eighteen such structures were "given" to the PGWC, Branch Roads Infrastructure for repair under tender by the branch itself. These repairs had not started by July 2007. Although the Eden District Council was provided with approx R 51 million to repair flood damage, an estimated R 60 million was spent, with the R 9 million being subsidised by district's road maintenance budget.

Unfortunately, up until July 2007, no further funding for flood damage repairs had been provided for the 2007/08 financial year. This has generated a shortfall of R 24.5 million to complete repairs triggered by extreme weather events a year earlier. As a result, no further repair work has taken place, although this could still be financed from the 2007/08 maintenance budget, if authorised by PGWC, Branch Roads Infrastructure.

4.3.6. Constraints, consequences and contradictions

One of the greatest constraints to the reconstruction process was the lack of adequate technical engineering capacity. As already described, this adversely affected the accuracy of the initial collection and verification of damage, especially in affected municipalities. It also created significant demands on the province's overstretched MIG engineers to provide technical support to the entire affected area.

Moreover, lack of skilled engineering and administrative capacity made it difficult to prioritise repairs immediately after the events had happened.

As technical staff was also required to carry heavy administrative and reporting loads, this further diverted engineering capacity from on-site supervision of reconstruction efforts.

A third challenging area was the absence of a systematic approach to impact collection. The multiple recording formats imposed considerable demands on already stretched technical services personnel and resulted in some delays in the submission of data.

The short implementation time-frame for repair and reconstruction clearly constituted a major constraint. This was inevitably determined by the expenditure and reporting requirements of legal frameworks such as the Municipal Finance Management Act.

The consequences of this tight implementation cycle included increased costs due to the urgency of construction.

More important, however, they actively deterred strategic reconstruction to risk-averse levels by requiring rapid 'turn-around' times that did not allow for more detailed flood or subsidence risk assessment or risk management.

Despite these constraints, municipal and provincial technical and engineering staff should be recognised and applauded for rapidly restoring damaged infrastructure under such demanding implementation conditions – and for providing continuity in other routine services simultaneously. With respect to this specific research undertaking, their high standards of reporting are also commended.

4.3.7 Conclusions and recommendations

The technical and administrative complexity of emergency reconstruction is clearly illustrated in this section. Given the tight implementation time-frames imposed, it is to the credit of the technical staff concerned that repairs were completed on-time. However, the administrative processes clearly require streamlining.

The PDMC, in cooperation with the NDMC and key role-players should prepare simple technical, administrative and financial guidelines that streamline impact reporting formats and the management of emergency reconstruction.

The onerous reporting demands carried by technical personnel in this event diverted their energies from actual on-site supervision of implementation to administration and reporting. This underlines the urgent need to streamline the impact reporting process, so that a uniform approach is adopted that serves multiple outcomes (i.e. mobilising of funds, post-event risk analysis).

In this context, it is urged that 'impact assessment, recovery and reconstruction guidelines' are developed consultatively and accompanied by an orientation process for key provincial and municipal stake-holders to streamline the reporting and post-event reconstruction processes.

The PDMC should engage with the Engineering Institute to establish a mechanism for mobilising skilled engineers after extreme weather processes and other disasters for post-event assessment and reconstruction.

Repeated field research has highlighted seriously constrained technical capacity in extreme weather-exposed areas. The August events also illustrate constraints associated with the verification process due to lack of skilled engineering personnel.

This could in-part be addressed by establishing a formal mechanism for 'emergency mobilisation' of skilled engineers following disaster events – to ensure that impacts are accurately assessed and reconstruction plans robustly costed.

Financial provision should be made for restoring critical infrastructure beyond replacement standards to risk-averse levels.

The current reconstruction funding instruments do not easily enable risk-averse reconstruction due to requirements set by tight funding cycles. While not applying to all disaster-affected infrastructure, post-event funding mechanisms should selectively allow strategic reconstruction to risk-averse levels.

Part V: Counting the Costs[46]

Post-disaster (or '*ex post*') investigations of loss patterns provide excellent insights on the internal susceptibility of specific sectors and administrative jurisdictions to extreme weather shocks. They critically guide disaster risk assessments for future events by representing the *realised risks* associated with extreme weather systems as well as the *'progressions of risk'* that drive specific loss processes in infrastructure and agriculture. In addition, they provide quantitative and spatial data that can better inform decision-making on investments in mitigation and preparedness for extreme weather events. This is particularly relevant to future cost-benefit analyses with respect to infrastructure and services that experience repeat and costly losses.

Moreover, ex post research consolidates loss information across sectors and administrative jurisdictions, providing a far more robust understanding of the transboundary or 'knock-on' effects of poorly managed risk. And last, such studies enhance understanding for the management of future climate risks by highlighting those sectors and areas more able to 'cope with' climate variability, as well as those with significantly compromised capacity to resist and recover from extreme weather. This is of direct relevance to climate adaptation in the Western Cape where exposure to an increased frequency of extreme weather processes is anticipated.

This section presents and analyses the direct losses associated with the August 2006 cut-off lows, complementing the findings in Part III, which focus on losses borne by extreme weather-affected households in the Southern Cape. The section, however, sets aside important concerns associated with indirect and secondary losses, as comprehensive research into these outcomes requires a longer time-frame than that afforded for this study.

Part V is organised into the following sections:

Section 5.1 presents the data collection, consolidation and analysis methods applied in the loss estimation process.

Section 5.2 outlines the more significant ethical concerns and constraints faced in the course of the impact assessment.

Section 5.3 provides a detailed description of reported economic losses incurred as a result of the August 2006 extreme weather processes. These are presented in tables, graphs and pie charts, and, where spatial data permit, are mapped.

Section 5.4 provides conclusions and recommendations.

5.1 Methodology

5.1.1 Overview

The August 2006 cut-off low post event analysis represents the fifth extreme weather event that DiMP has reviewed since 2003. Earlier reviews of the 'Montagu Floods' (2003), 'August 2004 Severe Storm' (Cape Town 2004), 'South Coast Floods' (December 2004) and 'April 2005 Cut-off Low' (Bredasdorp, 2005) have underlined

[46] Gillian Fortune, DiMP, UCT. Maps by Thomas Slingsby, Geomatics, UCT

the significant difficulties in consolidating loss information from multiple sources to generate an integrated loss profile.

In each case, the process has been time-consuming and highly labour-intensive, requiring specialist capabilities in quantitative and spatial data collection, management and analysis, as well as excellent interpersonal skills, due to the diversity of individual and institutional role-players involved.

5.1.2 Detailed methodology

5.1.2.1 Identification of key categories of loss and their spatial extent

The effective assessment of losses, generated by wide-area transboundary events, is best preceded by a broad ‘scoping exercise’ to determine the general character of impacts, the areas affected and potential human resources and information sources for more detailed reports. This was undertaken from 3 - 10 August 2006 and focused on:

- Reviewing provincial and local media for initial disaster reports.
- Assessing spatial extent, temperature, rainfall and wind features of the weather system.
- Identifying human resources and other information sources.

Newspaper, Internet and other media sources accessed for initial reports on the disaster are reflected in Figure 5.1.2.1.1. These gave an initial indication of where damages were sustained and the severity of the damage.

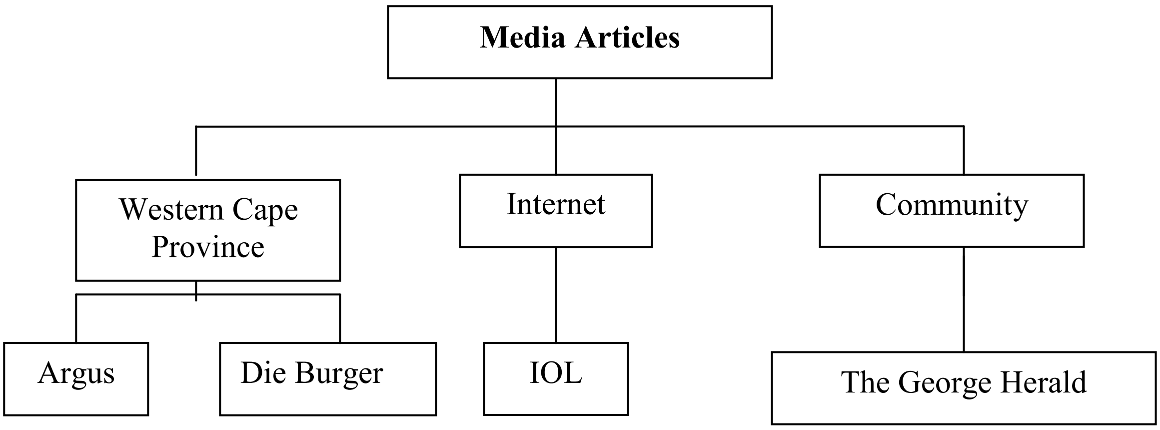

Figure 5.1.2.1.1 News media reviewed for information on disaster impacts

These reports were matched against information on the characteristics of the weather system provided by UCT’s Climate Systems Analysis Group (CSAG) to determine the likely impacts, identify the geographic area exposed to the cut-off low and to inform the subsequent data collection processes.

5.1.2.2 Primary data collection

Primary data collection took place through field research undertaken a week after the first extreme weather event (31 July – 2 August 2006). A team comprising six UCT/DiMP researchers visited the affected municipalities for much of August, to collect quantitative impact data, and to meet with key institutional role-players. They also attended two debriefings on 10-11 August respectively in Swellendam and George. Further information was collected by one researcher in the George and Mossel Bay Municipalities between 8-17 November 2006.

Much of the data gathered directly through field research has informed findings reported in Part II (Geology, land-use and land-change) and Part III on social risk assessment.

5.1.2.3 Collection of secondary data

The collection of secondary data for losses sustained in both August cut-off low events was initiated in December 2006. Table 5.1.2.3.1 lists 25 governmental and private sector institutional sources contacted in the course of the study.

Table 5.1.2.3.1: Key information sources for economic loss data

General loss category	Sources	Contacted	
Municipal infrastructure	**Provincial**	**District**	**Local**
	MIG, Dept Local Govt and Housing	Eden District Municipality	Bitou George Hessequa Kannaland Knysna Mossel Bay Oudtshoorn
		Overberg	Swellendam Theewaterskloof
		Cape Winelands	Breede Valley/Winelands
		Central Karoo	Prince Albert
Provincial dept losses	Roads (Within Public Works & Transport) Dept of Environmental Affairs	Dept of Local Govt & Housing Dept of Agriculture	Dept of Education
National dept losses	SanParks	SanRAL	DWAF
Private sector losses	SAIA		

The apparent delay in collecting economic impact information reflected needs for municipal and provincial role-players to first verify their specific losses in order to justify and source reconstruction funding. It also reflected an understanding of the extreme implementation pressures faced by provincial departments, district and local municipalities – who were obliged to document financial losses simultaneously with technical overseeing wide-ranging reconstruction efforts. These responsibilities were inevitably accompanied by ongoing demands in routine maintenance, overstretching technical personnel in both administrative spheres.

Data collection was similarly constrained by the Provincial Disaster Management Centre's lack of robust impact information across sectors and administrative spheres. In addition, the research team found significant discrepancies in the initial loss estimates consolidated by the PDMC when these were totalled independently by UCT/DiMP in Excel. Unfortunately, the PDMC was also unable to provide hard-copy and/or electronic verification of the initial loss estimates submitted to the Provincial Cabinet and National Disaster Management Centre.

Despite this, the impact assessment process was significantly enabled by the intervention of the Chief Engineer, Municipal Infrastructure Grants and his team within the Department of Local Government and Housing, who helpfully facilitated access to municipal engineers within the affected areas.

Municipal infrastructural losses

MIG engineers supplied UCT/DiMP with contact details of the municipal engineers for information on infrastructural damage. Subsequently, UCT/DiMP contacted the following district and local municipalities for impact data.

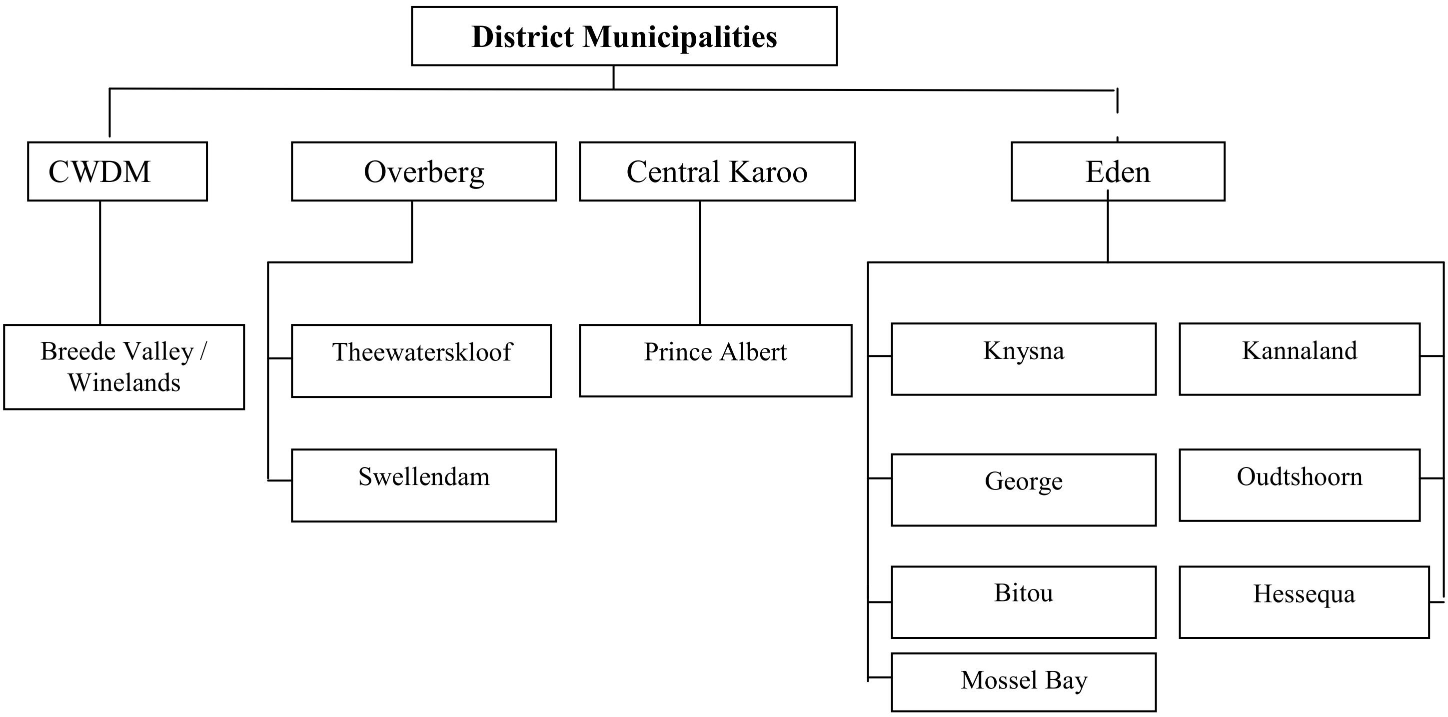

Figure 5.1.2.3.1 District and Local municipalities contacted for infrastructural impact data

Provincial and National departments

The data consolidation team also contacted provincial departments to source loss data for which each department was responsible (see Figure 5.1.2.3.2) A uniform template was then faxed and emailed to contacts within each of the departments (refer Appendices).

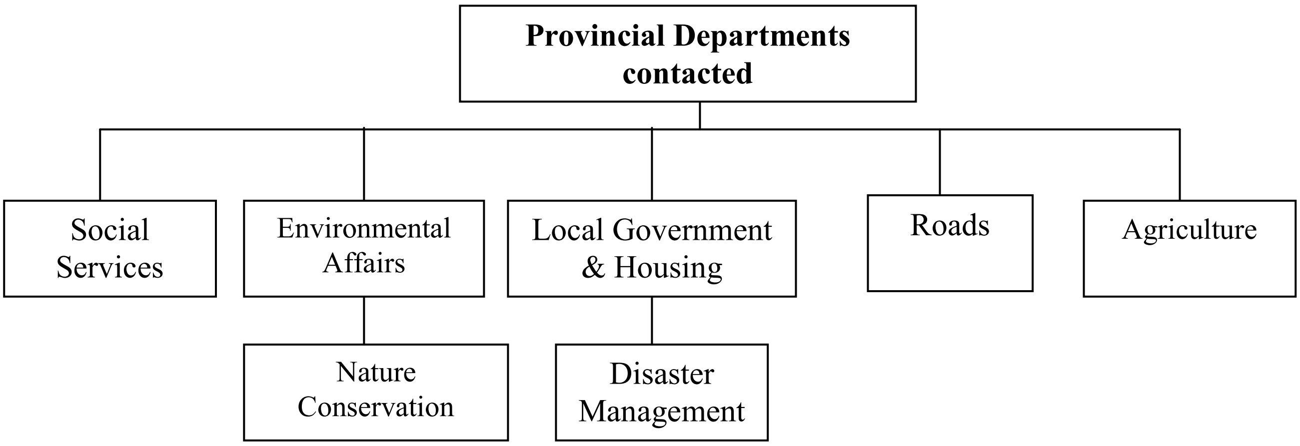

Figure 5.1.2.3.2 Provincial Departments contacted

In the case of both municipal and provincial loss research, follow-up telephonic interviews were conducted with approximately 25 representatives of the municipalities affected, as well as relevant provincial departments and the private sector. These discussions sought information on:

- The nature of impacts experienced (i.e. on people, buildings, roads, agriculture, electricity).
- The scale and geographic distribution of impacts related to a specific sector or area.
- Methods already adopted to collect and represent impact information.
- 'What would be reasonable' for consolidating sector-specific or area-specific information for the purposes of this research.
- 'What would be useful' for the research team to provide back to the municipality or department concerned.

As this process highlighted the absence of any uniformity in recording and consolidating impacts and economic losses, UCT/DiMP reproduced the simple loss reporting forms (refer Appendices) used previously, and distributed these to all government and private sector organisations that reported losses (with the exception of the Provincial Department of Agriculture, Provincial Roads and the National Department of Water Affairs and Forestry who had already systematically consolidated their respective losses.) Spatial coordinates were also requested for each impact recorded by municipalities, provincial and national departments.

<u>Other sources contacted</u>

Information was also sought from relief agencies (such as the South African Red Cross Society) and the South African Insurance Association, who furnished economic loss information from four of its member companies.

5.1.2.4 Data consolidation and analysis

<u>Quantitative data</u>

Impact data were collected from municipalities, government departments and the private sector. These were consolidated into a centralised database and then analysed. Information was streamlined into tables, graphs and charts which are reflected below. Every discrete impact recorded is reflected in tables with the economic loss presented in South African Rand (ZAR)[47].

Spatial data

In addition, wherever possible, impact data were also represented spatially. The information received was entered into a Microsoft Access database and a dbf file created. With the use of ArcView software, impact shapefiles were generated. These shapefiles were used to create the impact map outputs. The following impact information was successfully mapped:
- the damaged or destroyed DWAF gauging stations,
- impacts from George and Oudtshoorn Local Municipalities,
- recurring provincial road impacts for March 2003 and August 2006,
- damage to primary and high schools.

Recurring impacts, their costs and spatial location

One of the distinct themes identified in this assessment focused on '*recurring impacts'*, or instances where infrastructure recorded as failing in the August 2006 events had also failed during one or more previous extreme weather events. The distribution of these recurring impacts, as well as the economic losses associated with them, is documented, comparing impact data respectively for the March 2003 and August 2006 cut-off low events.

The analysis that follows only includes information where data were received from the primary source. This method ensured that all tables, graphs and charts could be robustly linked to data that could be verified and cross-referenced[48]. In those instances where, despite repeated requests for information, documented economic loss information was not provided, data have been excluded from the report.

5.2 Ethical Considerations and Constraints

5.2.1 Ethical considerations

There were a number of confidentiality issues related to data sourced from the private sector and parastatal organisations. This resulted in relatively 'coarse' totals being presented in the findings reported for these agencies.

An important consideration was balancing DiMP's need for data from primary sources against the heavy implementation demands faced by technical staff in the municipal and other government departments contacted. This highlights an urgent need to streamline the data collection methods and data collecting forms for future post impact studies – to minimise the reporting burden on those tasked for field implementation.

5.2.2 Constraints

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[47] For international currency exchange purposes, approximately ZAR 7.00 = USD 1:00 during the course of this study.

[48] The primary source is the institution or the person(s) responsible for the impacted infrastructure.

As there were two weather events in August, differentiating between the first and second event was almost impossible as loss information was consolidated across both.[49] This, by necessity, resulted in the information being consolidated and analysed as one weather event, whose duration was one month.

Although flood and extreme weather damage data were sourced from four insurance companies, only three presented robust economic loss information, resulting in the fourth agency's data being excluded from the study. Moreover, the insurance data provided covered the entire August period. This made it difficult to separate out those losses reported for other random storm events in the same period. Where possible, information on the date, location and damage type associated with a specific insured loss were considered when including the insurance damages in this assessment.

For one municipality, impact data also included infrastructure that was already damaged prior to the August events.

One of the costs for Spoornet included the railway line that stretches from the Eden District to Port Elizabeth. As it was impossible to accurately calculate the cost for the section of the line that was located specifically in the Eden District, the entire cost has been included.

The losses calculated for data received from each primary source did not always match the initial loss estimates provided by the Provincial Disaster Management Centre. As DiMP only incorporated data that could be verified, this resulted in discrepancies between the loss estimates reported here and those initially submitted by the PDMC (refer Table 5.3.1.1 for those entities who were unable to verify their initial loss information, identified by **).

Moreover, detailed loss and spatial data were not always available. This limited the degree to which loss tables and maps could be generated for comparison purposes (the noteworthy exceptions were Provincial Roads and DWAF whose systematically recorded loss data could easily be compared for 2003 and 2006).

5.3 Impact Findings

This study reflects the first occasion in South Africa where multi-sectoral impacts associated with more than one extreme weather event could be compared spatially and with respect to recurring and accumulating expenditure patterns. As the results are very detailed, they are grouped accordingly in the following sections.

Section 5.3.1 provides a general overview of total economic losses recorded.

Sections 5.3.2 and 5.3.3 provide detailed information on losses sustained respectively by national and provincial organs of state.

Section 5.3.4 describes losses incurred by district and local municipalities.

Section 5.3.5 outlines impacts sustained in other organisations and sectors.

Section 5.3.6 completes Part V with concluding observations and recommendations.

[49] A number of international specialists were approached for methodological guidance on consolidating data from 'seasonal loss processes' instead of discrete events. Global disaster loss specialists, including Charlotte Benson and Munich Reinsurance, could offer no methodological guidance on this.

5.3.1 Overview of total recorded economic losses

Table 5.3.1.1 and Figure 5.3.1.1 summarise a total of R 509 763 497.56 in direct reported economic losses associated with the August 2006 disaster event. Of this, R 247.9 million (48.6%) was incurred by Provincial Departments. A further R 103.7 million (20.4%) was recorded as losses by affected district and local municipalities.

Table 5.3.1.1 Total reported economic losses.

Organisation/Administration	No. Impacts *	Losses (Rands)	Losses (%)
National Government Dept.			
** Transnet	0	0.00	0.00%
Dwaf	31	R 2 870 000.00	0.56%
SanParks	5	R 1 800 000.00	0.35%
SanRAL	1	R 87 734 298.03	17.21%
Subtotal	**37**	**R 92 404 298.03**	**18.13%**
Provincial Government Dept.			
Housing		R 28 885 685.00	5.67%
Agriculture	2 424	R 109 873 289.74	21.55%
Cape Nature	5	R 3 400 000.00	0.67%
Education	15	R 1 919 000.00	0.38%
Provincial Roads	312	R 90 840 000.00	17.82%
** Public Works	31	R 12 960 000.00	2.54%
** Social Development	n/a	0.00	0.00%
Subtotal	**2 787**	**R 247 877 974.74**	**48.63%**
District and Local Municipalites			
Bitou	6	R 877 172.00	0.17%
Breede River/Winelands	19	R 1 426 499.28	0.28%
** Eden District	4	R 5 768 393.00	1.13%
George	26	R 16 691 512.00	3.27%
Hessequa	8	R 19 000 000.00	3.73%
** Kananaland	n/a	0.00	0.00%
Knysna	81	R 32 998 370.00	6.47%
Mossel Bay	101	R 15 458 324.70	3.03%
Oudtshoorn	12	R 6 974 000.00	1.37%
Prince Albert	5	R 382 000.00	0.07%
Swellendam	8	R 4 170 000.00	0.82%
** Theewaterskloof	n/a	0.00	0.00%
Subtotal	**270**	**R 103 746 270.98**	**20.35%**
Other Sector			
** Eskom	n/a	0.00	0.00%
Spoornet	8	R 47 246 640.00	9.27%
Telkom	73	R 670 060.65	0.13%
Subtotal	**81**	**R 47 916 700.65**	**9.40%**
Private Sector			
S.A Insurance Agency	1369	R 17 818 253.16	3.50%
Subtotal	**1369**	**R 17 818 253.16**	**3.50%**
Total	**4544**	**R 509 763 497.56**	**100.00%**

* 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 (i.e. injury, illness or death), infrastructural, agricultural or environmental and may also be estimated economically’
**Data were requested but not received

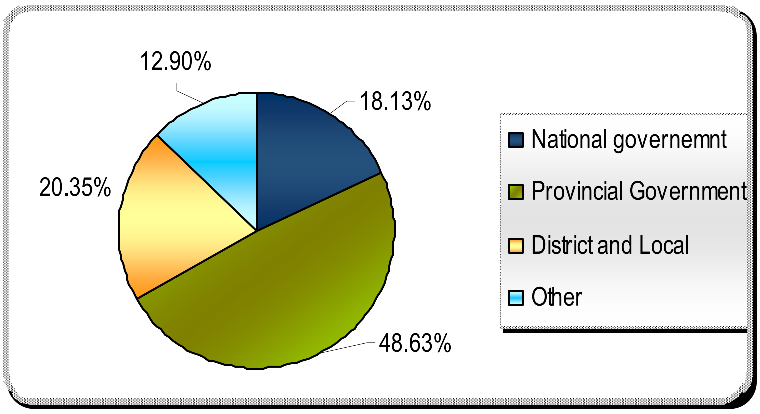
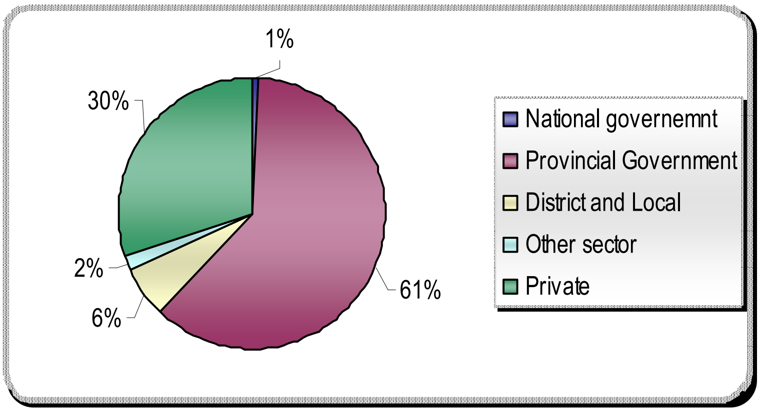


Figure 5.3.1.1: Distribution of total reported economic losses



Provincial government losses exclude the specific number of impacts recorded by Provincial Housing
Figure 5.3.1.2: Distribution of reported impacts (Total 4 537)

Figure 5.3.1.2 illustrates the distribution of the number of recorded impacts, with provincial departments constituting 61% of the total 4 544 recorded impacts. Of these, 2 424 impacts were reported by the Provincial Department of Agriculture.

Extreme weather events compared – March 2003 and August 2006

Impact data collected and consolidated for the cut-off low weather events in March 2003 and August 2006 show an increase of R 297 million (140.3%) in total direct recorded economic losses from 2003 (R 212 422 663) to 2006 (R 510 469 497.56) as illustrated in Figure 5.3.13. The cumulative loss for the two weather events was R 723 million.

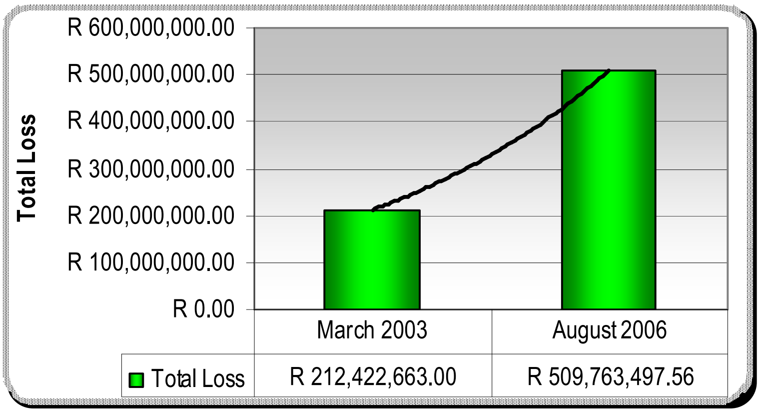


Figure 5.3.1.3:Increase in economic losses for weather events in March 2003 and August 2006

5.3.2 Direct losses sustained by national organs of state

The total reported losses sustained by national organs of state (specifically the Department of Water and Forestry (DWAF), SANRAL and SANParks) were estimated at R92.4 million (refer Table 5.3.2.1 and Figure 5.3.2.1).

Table 5.3.2.1 Economic losses to National Organs of State

National Government	No. of Recorded Impacts	Losses (Rands)	Losses (%)
* Transnet	n/a	0.00	0.00%
DWAF	31	2 870 000.00	3.11%
SanParks	5	1 800 000.00	1.95%
SANRAL	1	87 734 298.03	94.95%
Total	**37**	**92 404 298.03**	**100.00%**

* This request was redirected to a provincial government department

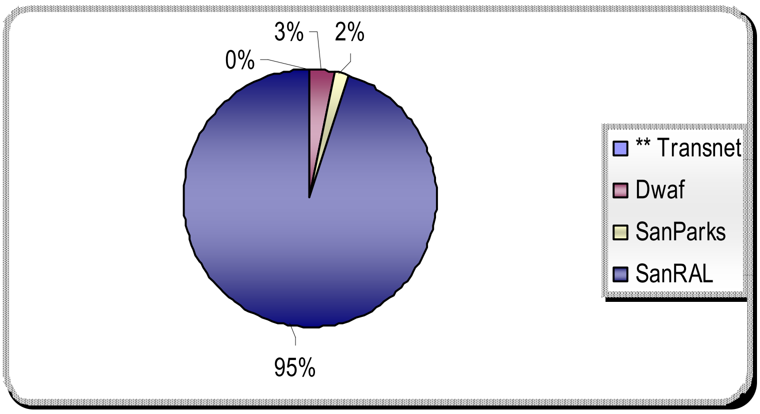


Figure 5.3.2.1: Distribution of economic losses to National Organs of State for August 2006

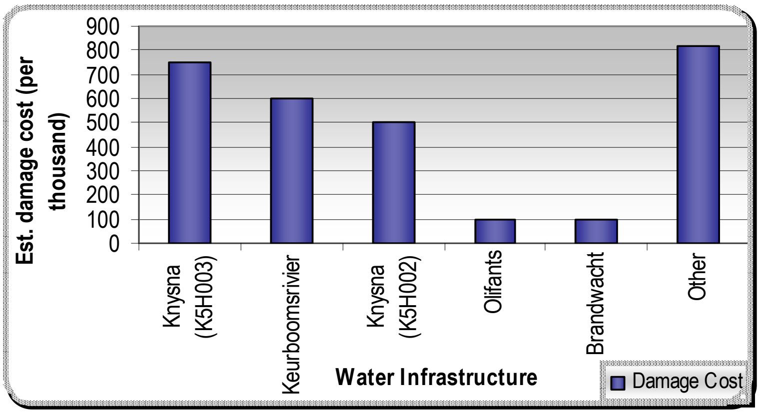
5.3.2.1 South African National Roads Agency Limited (SANRAL)

R 87.7 million (95%) of economic losses recorded by national organs of state were sustained by SANRAL. These losses were incurred on National Route 2 between Mossel Bay and Knysna and were mainly attributed to the severe road damage sustained at Kaaimans Pass.

The damage to the Kaaimans Pass amounted to R 47.6 million (54% of total losses recorded for National Route 2). As Kaaimans Pass links George and Knysna, its temporary closure had significant indirect and secondary impacts in both municipalities, as each depends on income generated from tourism. In this context, tourism-dependent businesses in both municipalities reported being adversely affected by resulting road detours.[50]

5.3.2.2 Department of Water Affairs and Forestry

The Department of Water Affairs and Forestry (DWAF) collated information on the impacts sustained to its infrastructure. Total reported losses were estimated at
R 2.9 million, with the majority of losses being attributed to damaged hydrological gauging stations and other infrastructure.



'Other ':Goukamma, Duiwe, Oukloofdam, Karatara, Kammanasie, Duivenhoks, Diep, Moordkuis, Maalgate, Klein Le Roux, Hartebeeskuil, Grootbrak, Grobbelaars, Witrivier, W Komponentd, Touws, Kaaimans, Joubert, Huis, Duivenhoks W, Touws, Sand, Groot, Rooi, Meul

Figure 5.3.2.2.1: DWAF infrastructure damage

Figure 5.3.2.2.1represents the six gauging stations that individually sustained damage exceeding R 100 000 in the August events. However, of these, only three incurred losses in excess of R 500 000. Two of the more significantly damaged gauging stations were located in Knysna (K5H003 and K5H002), with damage to K5H003, (situated on the Knysna River) resulting in costs that exceeded R 700 000.

It is significant to note that the remaining 25 'other' gauging stations (comprising 83.9% of all gauging stations and hydrological infrastructure in the exposed areas) individually sustained damage lower than R100 000 for a total of R 820 000.

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[50] Detours over the Langekloof Pass also increased costs to transport operators and trucking companies, due to fuel and time delays associated with the extra 400km journey.

Losses compared: March 2003 and August 2006

DWAF-associated losses for the August 2006 events were found to be significantly lower than those incurred in March 2003, declining by R 10 980 000 from R 13 850 000 in 2003 to R 2 870 000 in 2006 (refer Figure 5.3.2.2.2). Of the 31 gauging stations damaged in August 2006, 15 were also damaged in March 2003 (refer Table 5.3.2.2.1), but with three times higher repair expenses. There are many possible explanations for the reduced repair costs, including exposure to a less significant flood peak and/or upgrading of the gauging equipment to more flood-averse standards. This clearly warrants further investigation.

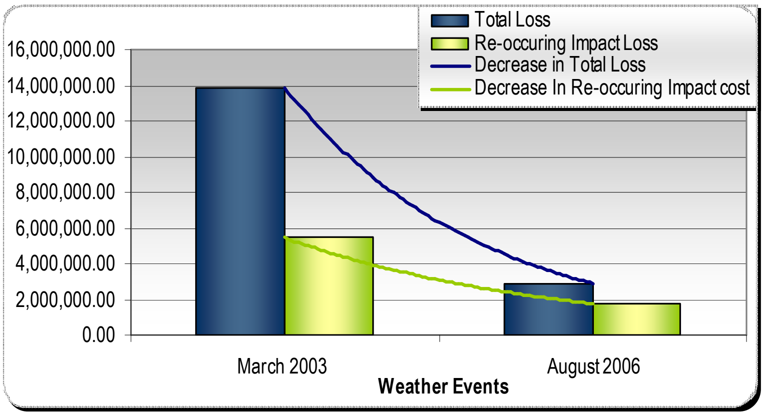

Figure 5.3.2.2.2: Decrease in total and recurring DWAF gauging station losses, March 2003, and August 2006

GAUGING STATIONS DAMAGED OR DESTROYED IN AUGUST 2006

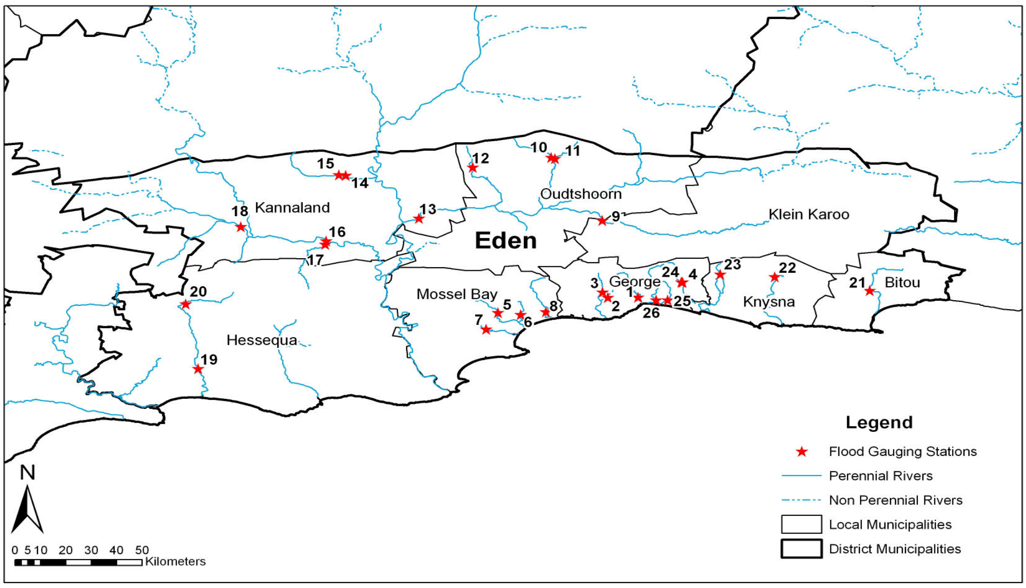

Figure 5.3.2.2.3 Spatial distribution of damaged/destroyed DWAF gauging stations, August 2006

Table 5.3.2.2.1 Reference numbers and names of damaged/destroyed DWAF gauging stations, August 2006, March 2003. Shading represents gauging stations affected in both 2003 and 2006.

Map Ref No.	**Gauging Station No.**	**Gauging Stations Name**	**Location**	**Municipality**	**Damage Cost in August 2003 (Rands)**	**Damage Cost in March 2003 (Rands)**
1	K3H001	Kaaimans	Kaaimans River at Upper Barbierskraal	George	R 20,000.00	
2	K3H007	Rooi	Rooi River at George	George	R 10,000.00	
3	K3H004	Malgas	Malgas River at Blanco	George	R 30,000.00	R 50,000.00
4	K4H003	Maalgate		George	R 30,000.00	R 100,000.00
5	K1H004	Brandwacht	Brandwag River at Brandwacht	Mossel Bay	R 100,000.00	
6	K1H005	Moordkuils	Moordkuil River at Banff	Mossel Bay	R 30,000.00	R 400,000.00
7	K1H017	Hartebeeskuil	Hartenbos River at Hartebeeskuil	Mossel Bay	R 30,000.00	
8	K2H002	GrootBrak	Great Brak River at Wolvedans	Mossel Bay	R 60,000.00	R 50,000.00
9	J3R001	Kammanasie		Klein Karoo	R 50,000.00	
10	J3H014	Grobbelaars	Grobbelaars River at De Kombuys	Oudtshoorn	R30,000.00	R 50,000.00
11	J3H015	Klein le Roux	Little Le Roux River at De Kombuys	Oudtshoorn	R 30,000.00	R 50,000.00
12	J3H020	Meul	Meul River at Vogelfontein	Oudtshoorn	R 10,000.00	
13	J3H011	Olifants	Olifant River at Warmwater	Kannaland	R 100,000.00	
14	J2H005	Joubert	Joubert River at Opzoek	Kannaland	R 20,000.00	
15	J2H007	Huis	Huis River at Zoar	Kannaland	R 20,000.00	R100,000.00
16	J1H019	Groot	Groot River at Buffelsfontein	Kannaland	R 15,000.00	
17	J1H017	Sand	Sand River at Buffelsfontein	Kannaland	R 15,000.00	R 750,000.00
18	J1H018	Touws	Touws River at Okkerskraal	Kannaland	R 20,000.00	R 1,250,000.00
19	H8H001	Duivenhoks	Duiwenhoks River at Dassjesklip	Hessequa	R 50,000.00	R 300,000.00
20	H8H003	Duivenhoks W	Duiwenshoks River at kliphoogte	Hessequa	R 20,000.00	R 2,000,000.00
21	K6H019	Keurboomsrivier	Keurboom River at Newlands	Bitou	R 600,000.00	
22	K5H003	Knysna		Knysna	R 750,000.00	R 70,000.00
23	K4H002	Karatara	Karatara River at Karatara Forst Reserve	Knysna	R 50,000.00	R 80,000.00
24	K4H003	Diep	Diep River at Woodville Forest Reserve	George	R 50,000.00	R 75,000.00
25	K3H011	Duiwe	Duiwe River at Kleinkrantz	George	R 75,000.00	

26	K3H005	Touws	Touws River at Farm 162	George	R 15,000.00	
	*K7H000	Witrivier			R 25,000.00	
	*K5H002	Knysna	Knysna River at Milwood Forest Reserve		R 500 000.00	R 70,000.00
	*K4H100	Goukamma			R 75 000.00	
	*H7H013	W komponent			R 20 000.00	
	*J2R003	Oukloofdam	Cordiers River at Baviaanskloof		R 50 000.00	
		Total			**R 1 760 000.00**	**R 5 445 000.00**

5.3.2.3 SANParks

Losses sustained for the August 2006 event totalled R1.8 million, and included roads, trails and hides, staff accommodation and tourism accommodation,(i.e. caravan parks), rubbish bins, etc. No impacts were recorded for the March 2003 event.

5.3.3 Direct losses incurred by departments of the Provincial Government of the Western Cape

5.3.3.1 Overview of provincial losses

According to impact data compiled, provincial government departments incurred direct losses estimated at R 247 877 974.74, as detailed in Table 5.3.3.1.1. Of all departments, the Provincial Department of Agriculture together with Provincial Roads sustained approximately 80% of the economic losses associated with the August 2006 cut-off lows, totalling more than R 200 million.

The total number of recorded impacts indicated by provincial departments was 2 787. Unfortunately, as the Department of Housing did not consistently document the number of dwellings that were affected, it was necessary to exclude these individual housing impacts from the analysis.

Table 5.3.3.1.1: Economic losses to Provincial Departments for August 2006

Provincial Government	No. of Recorded Impacts	Losses (Rands)	Losses (%)
Housing		28 885 685.00	11.62%
Agriculture	2424	109 873 289.74	44.20%
Cape Nature	5	3 400 000.00	1.37%
Education	15	1 919 000.00	1.06%
Provincial Roads	312	90 840 000.00	36.54%
Public Works	31	12 960 000.00	5.21%
** Social Development	n/a	0.00	0.00%
Total	**2787**	**247, 877 974.74**	**100.00%**

** Date were requested but not received

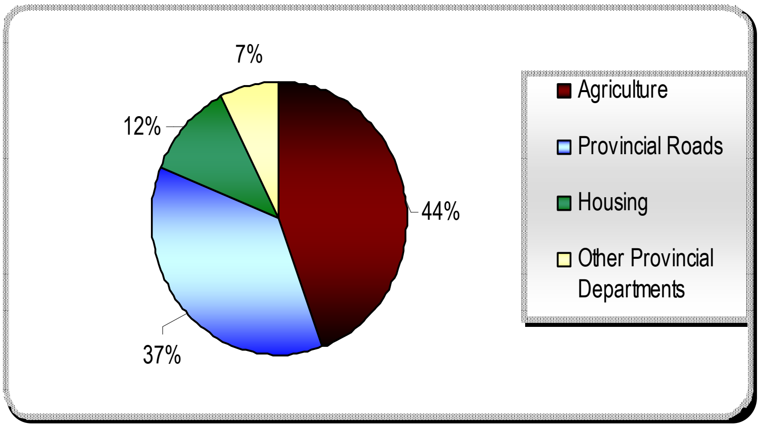

Figure 5.3.3.1.1: Distribution of economic losses to Provincial Government August 2006

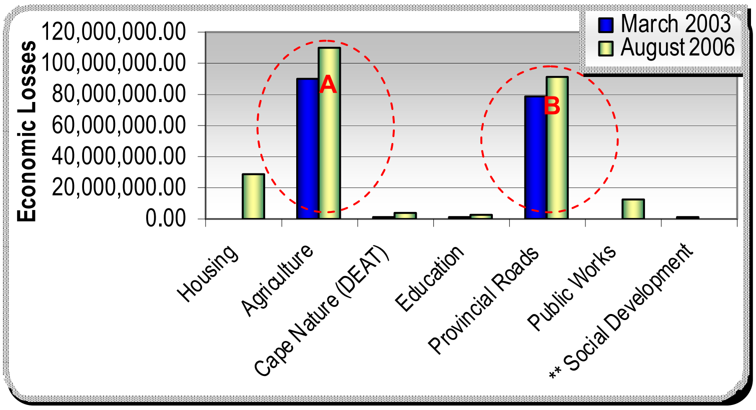

Figure 5.3.3.1.2: Economic loss comparison for: (A) Provincial Agriculture and (B) Provincial Roads, March 2003 and August 2006

<u>Comparing March 2003 and August 2006 events</u>

Figure 5.3.3.1.2 represents the trend in increasing economic losses recorded for provincial departments in August 2006, compared to those recorded in 2003. It shows high cumulative losses sustained by Provincial Agriculture (A)
(R 199 489 425.74) and Provincial Roads (B) (R 169 424 200) over both events. When considered as a monthly average, these represent respective losses equivalent to R 5 million and R 4.2 million per month for the period from March 2003 - July 2006.

5.3.3.2 Department of Agriculture

The Department of Agriculture collected comprehensive damage information from 269 farms that sustained losses associated with the August 2006 weather event. This was entered into an existing electronic database and the information was forwarded to and consolidated by DiMP.

Estimated agricultural impacts estimated at R 109 873 289.74 constituted 44.3% of the total economic loss recorded for provincial departments (refer Table 5.3.3.1.1). Of these, 29.31% were attributed to impacts on irrigation systems and 25% to soil losses, while approximately 12% were explained by damage to road and bridge infrastructure. (refer Table 5.3.3.2.1 and Figure 5.3.3.2.1.)

Table 5.3.3.2.1 Losses classified by type of agricultural damage for August 2006

Type of Damage*	Estimated Loss (Rands)	Estimated Loss (%)
Irrigation system	R 32 205 127.92	29.31%
Soil loss	R 27 635 110.00	25.15%
Road and bridge infrastructure	R 12 954 552.47	11.79%
Crop losses	R 10 480 187.00	9.54%
Livestock	R 7 057 210.00	6.42%
Boundary/camp fence	R 5 212 841.70	4.74%
Rivers	R 4 537 785.00	4.13%
Farm housing and buildings	R 2 732 997.00	2.49%
Natural forest and plantation	R 2 454 200.00	2.23%
Unnamed losses	R 1 426 583.90	1.30%
Grazing land	R 945 291.20	0.86%
Income loss	R 915 514.00	0.83%
Waterways	R 508 950.00	0.46%
Farm equipment	R 347 115.35	0.32%
Electricity supply	R 216 690.00	0.20%
Water supply	R 133 875.00	0.12%
Drainage systems	R 76 259.20	0.07%
Sewage system	R 33 000.00	0.03%
Total	R 109 873, 289.74	100.00%

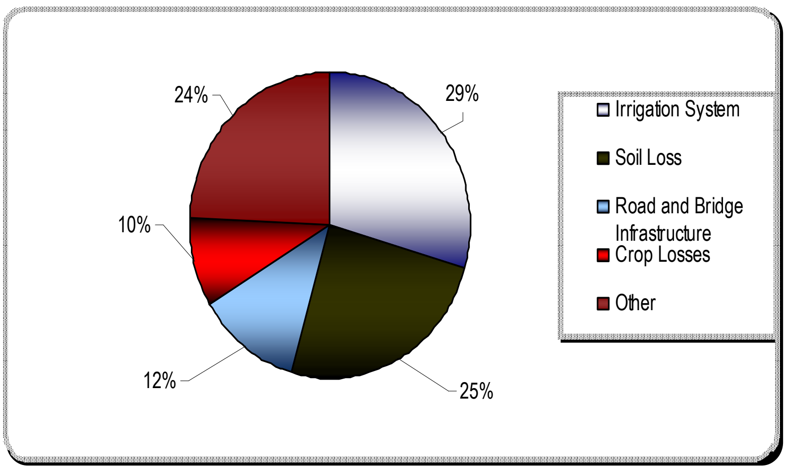

Figure 5.3.3.2.1: Agricultural losses by major damage category for August 2006. Graph showing all loss categories[51]

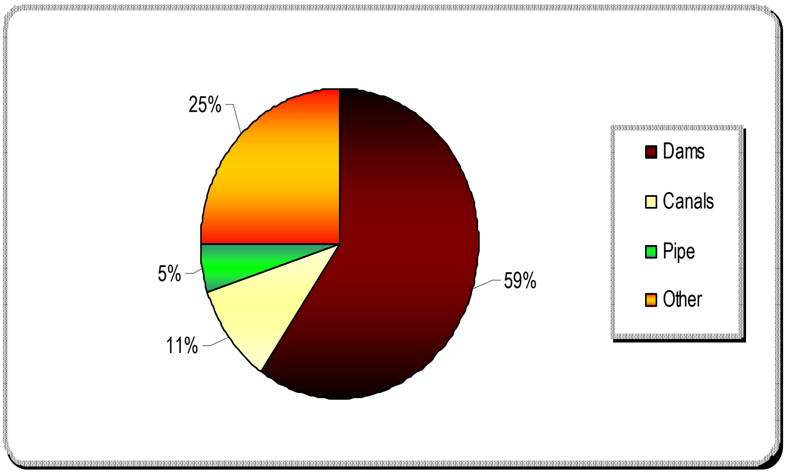

Figure 5.3.3.2.2: Damage to irrigation systems by types.
Other includes Irrigation land, pumps and filters and irrigation systems

Comparative loss data collected for March 2003 indicate that the Department of Agriculture bore losses estimated at R 89 616 136.00 – or R 20 257 153.74 less than in August 2006.

Regrettably, due to the absence of geo-reference information such as Surveyor General Numbers for individual farms, it was not possible to spatially identify those farms affected in earlier extreme weather events.

5.3.3.3 Department of Provincial Roads

Provincial Roads (including major, divisional, minor, and trunk roads) sustained losses estimated at R 90 840 000 or 36.6% of all impacts recorded by provincial departments (refer table 5.3.3.3.1).The trunk roads referred to in graphs and tables were situated in the Eden and the Central Karoo District Municipalities.

Table 5.3.3.3.1: Economic losses for Provincial Roads. All damage costs include a 10% administration cost.

District Municipality	No. of road/ sections of roads	Damage Cost (Rands)	Damage Cost (%)
Cape Winelands	45	R 5 479 980	6.03%
Central Karoo	7	R 3 403 000	3.75%
Eden	230	R 78 527, 020	86.45%

[51] 'Other' includes livestock, boundary/camp fence, rivers, farm housing and buildings, natural forest and plantation, grazing land, income loss, waterways, farm equipment, electricity supply, water supply, drainage systems, sewage systems and unspecified

Overberg	9	R 1 150 000	1.27%
Trunk Roads (Eden & Central Karoo)	21	R 2 280 000	2.51%
Total	**312**	**R 90 840 000.00**	**100.00%**

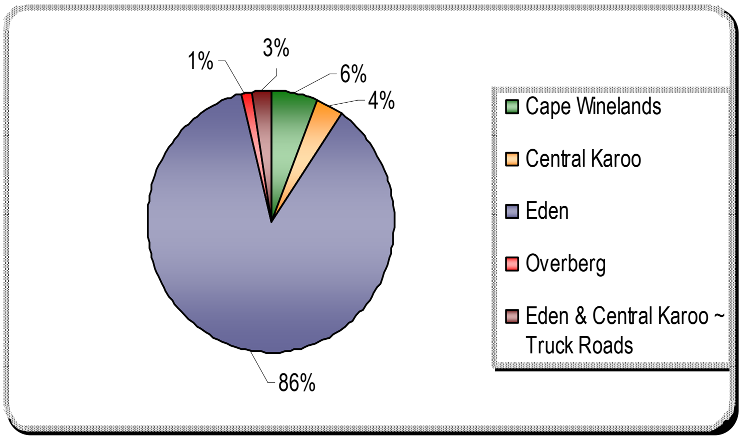

Figure 5.3.3.3.1: Distribution of economic losses for provincial roads

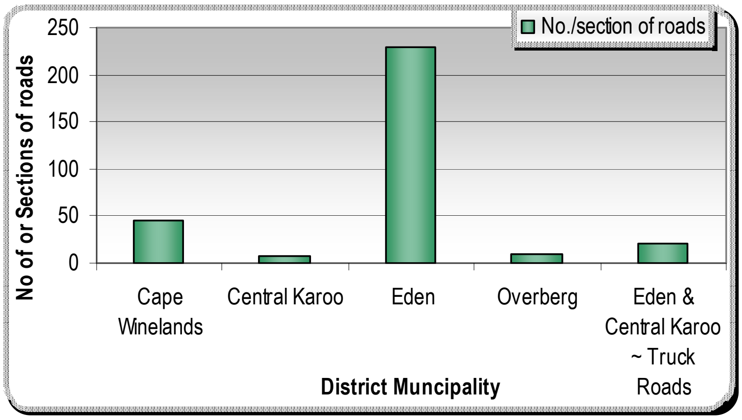

Figure 5.3.3.3.2: Number of Provincial Roads/ Sections of Provincial Roads damaged

Figure 5.3.3.3.2 shows the number of, or sections of, provincial roads damaged in the affected district municipalities. Of the 312 sections of roads that sustained damage, 230 (73.3%) were situated in Eden.

Table 5.3.3.3.2 Recurring provincial roads for March 2003 and August 2006

District Municipality	No. of Roads/ Sectors of Road	2003	2006
Cape Winelands	11	R 2 019 600.00	R 1 016 500.00
Central Karoo	3	R 380 000.00	R 250 000.00

Eden	46	R 6 935 600.00	R 20 780 050.00
Eden & Central Karoo ~ Trunk	2	R 3 000 000.00	R 190 000.00
Overberg	1	R 500 000.00	R 200 000.00
Total	**63**	**R 12 835 200.00**	**R 22 436 550.00**

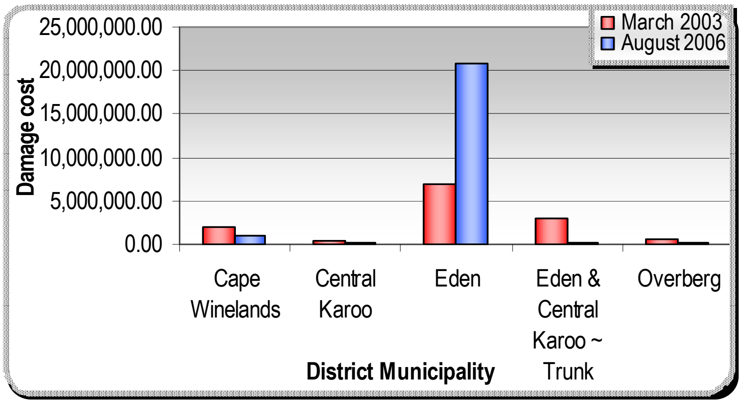

Figure 5.3.3.3.3: Economic impact of recurring provincial road losses for March 2003 and August 2006

Losses compared: March 2003 and August 2006

Loss data provided for March 2003 and August 2006 were analysed to identify those roads and/or sections for which recurrent impacts had been reported in 2003 and 2006. The associated economic losses were then consolidated for each district municipality. Of the 312 provincial roads damaged in August 2006, 63 were also damaged in March 2003.

The comparative losses for these repeat impacts increased by approximately 75% from R 12 835 200 (March 2003) to R 22 436 550 (August 2006), as shown in Table 5.3.3.3.2 and Figure 5.3.3.3.3. While provincial roads losses for Cape Winelands, Central Karoo and Overberg decreased, economic losses recorded for Eden's roads increased by R13 844 450 or almost 200%.

The disproportionate repeat failure rate for provincial roads, especially in Eden, raises the following questions:

- Were the failures a result of inadequate planning or design/ constructions of the roads or storm water systems?
- Were the failures explained by poor or no maintenance plans?
- Was this due to a lack of funding and/or a staffing issue?

Feedback from the acting road agent in Eden indicated that the retrenchment of district staff in the provincial roads department, together with drastic funding reductions, had made it 'impossible for the understaffed department to continue with maintenance and flood damage repair while simultaneously performing good quality control'.

Moreover, rapid growth and rate of development within the district have increased flood and road subsidence risks. These, together with the increased frequency of cut-off low events and associated impacts, have severely limited the ability of the road authority to perform its tasks efficiently.

It was further explained that of the 6 900 km road network in Eden, only 750km are surfaced (most of these are more than 30 years old and beyond repair or economic maintenance). Most remaining gravel roads are reportedly below ground level and very susceptible to flood damage as the road surface has very little or no resistance to water during heavy rainfall events.

Figure 5.3.3.3.4 and 5.3.3.3.5 below show the distribution of road and gauging station failures respectively for the George and Oudtshoorn municipalities. This spatial representation helpfully identifies areas of road that failed, along with their relationship to rivers (i.e. bridges that may have failed or been temporarily inaccessible) and human settlements.

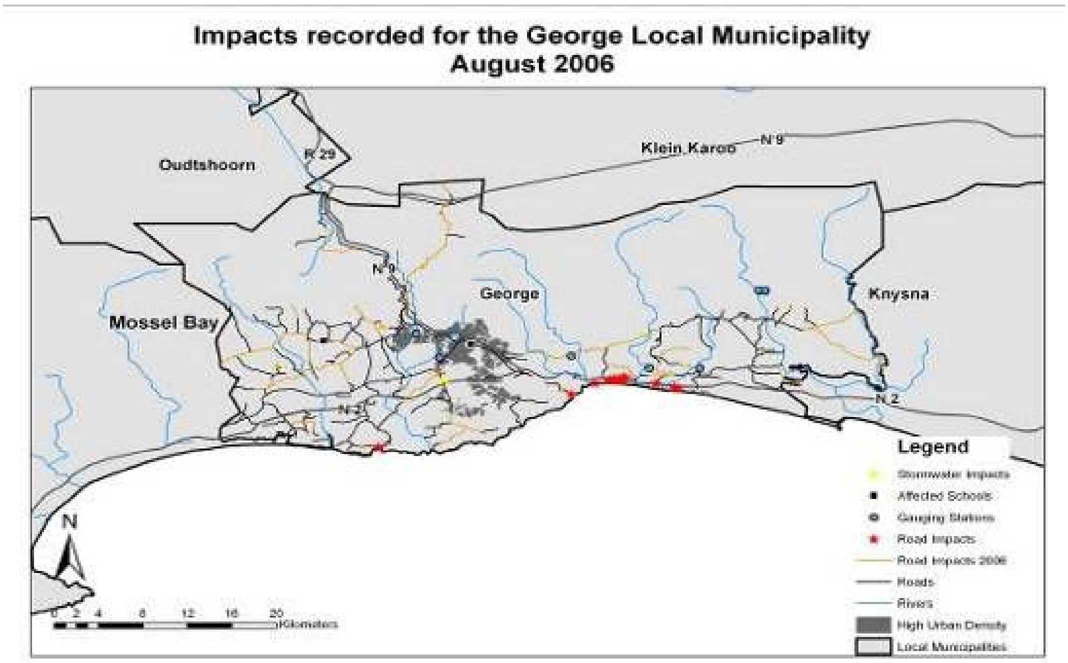

Figure 5.3.3.3.4: Recorded road and river gauge impacts in the George Municipality 2006

Impacts recorded for the Oudtshoorn Local Municipality

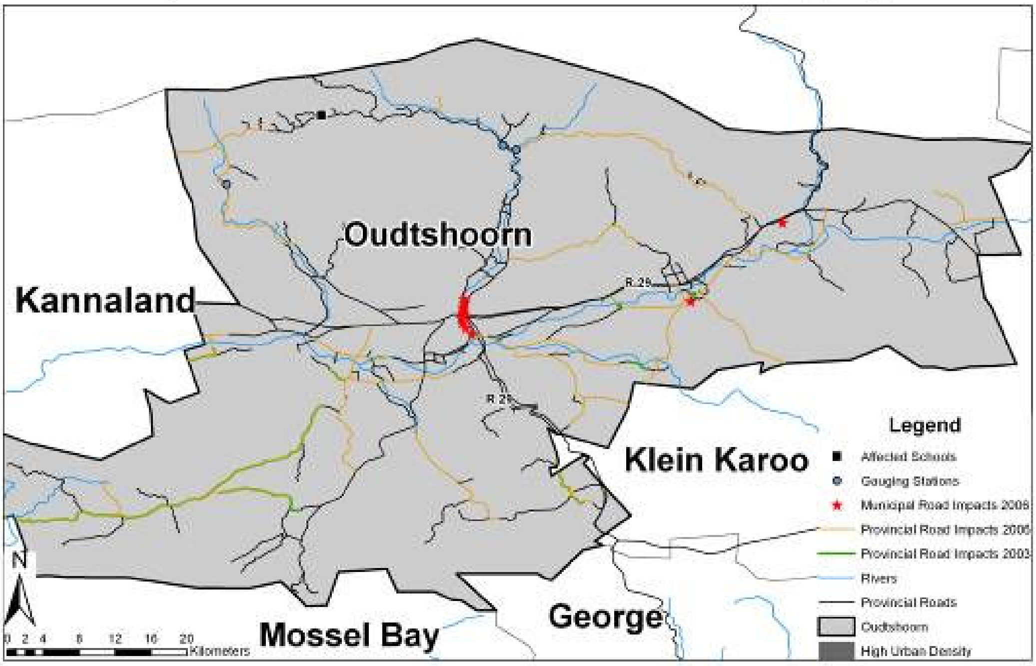

Figure 5.3.3.3.5: Recorded road and river gauge impacts in the Oudtshoorn Municipality 2006

5.3.3.4 Department of Local Government and Housing

The data supplied to DiMP did not specify losses for individual housing units, but consolidated economic loss data for each local municipality. As a result, DiMP was unable to give numbers of houses damaged or destroyed per municipality. While a number of formally engineered homes in the affected areas were damaged or destroyed (refer Part II), most of the housing losses reflected here are for informal and low-income homes.

It was reported that the greatest damage to dwellings within the affected municipalities occurred in George and Mossel Bay totalled R 14 568 485 and
R 12 680 000 respectively, amounting to 50.4% and 44% of all housing losses.

While detailed reasons were not provided for housing failure, inadequate construction and unsuitable siting were given as the two most frequent reasons for damage. This particularly applied to those poorly sited and constructed low-income homes situated lower than natural ground level (i.e. exposed to road and other surface run-off) or in direct flood paths – without adequate storm-water drainage as illustrated in Part III.

Table 5.3.3.4.1 Economic Losses borne by the Provincial Housing Department

Local Municipality	Losses (Rands)	Losses (%)

George	R 14 568 485.00	50.43%
Bitou	R 27 200.00	0.09%
Mossel Bay	R 12 680 000.00	43.90%
Hessequa	R 1 250 000.00	4.33%
Knysna	R 360 000.00	1.25%
Total	**R 28 885 685.00**	**100.00%**

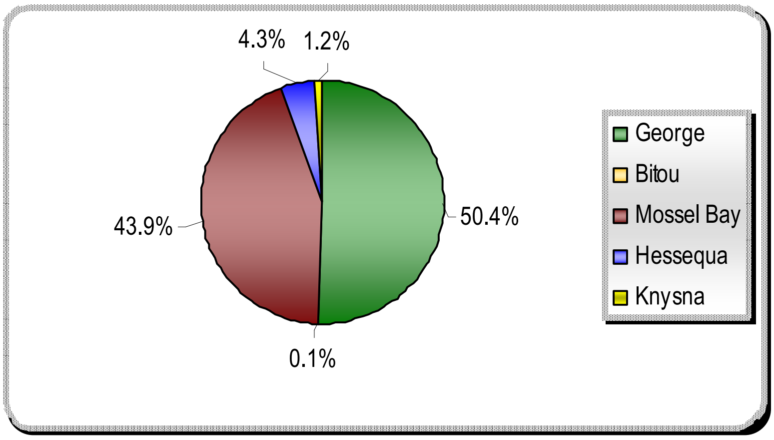

Figure Table 5.3.3.4.1: Distribution of economic losses for Provincial Housing Department

5.3.3.5 Department of Education

The Provincial Department of Education sustained losses estimated at R 2.63 million, attributed to rain and wind. While ten (71%) of the affected facilities were primary schools (refer Figure 5.3.3.5.1), Qhayiya High School, on the outskirts of Hermanus, was the most severely damaged. This school sustained R 1 million or 38% of the total losses for the department. Only one school, Outeniqua High School, was affected a second time since 2003, with damage costs R 25 000 higher in 2006.

In the majority of cases, roof damage was sustained by heavy rain and wind, underlining the need for greater attention to rain- and wind-proofing in areas repeatedly exposed to severe weather within the province. Figure 5.3.3.5.2 shows the spatial distribution of the affected schools, with one-third of these located in the Cape Winelands municipality.

Table 5.3.3.5.1 Reported damage to schools, August 2006 cut-off lows

Ref No.	School Name	Type of School	Municipality	Damage Description	Cost of Damage In August 2006 (Rands)
1	Bella Vista	High	Witzenburg	Damaged boundary wall	R 40 000.00
2	De Waalville	Primary	Hessequa	Roof leaks, ceilings and foundation is exposed	R 100 000.00

3	Geelhoutboom VGK	Primary	George	Repair storm water flow by mobile classroom	R 100 000.00
4	Glen Heatlie AME	Primary	Breede Valley	Floodwater flow through building	R 35 000.00
5	Grootbrakrivier	Primary	Mossel Bay	Repair fence and driveway	R 15 000.00
6	Qhayiya	High	Overstand	Roof leaks, ceilings, storm water drainage system	R 1 000 000.00
7	L.K Zeeman	Primary	Drakenstein	Roof damage	R 29 000.00
8	Lorraine NGK	Primary	Breede Valley	Tree fell on stoep of mobile classroom	R 100 000.00
9	Middlerivier	Primary	Winelands	Water supply cut off by floodwater	R 60 000.00
10	Outeniqua*	High	George	Damaged to school roof	R 65 000.00
11	Overhex NGK	Primary	Breede Valley	Storm water system flow and secure jacks damaged	R 150 000.00
12	Riversonderend	Primary	Theewaterskloof	Damage to school roof	R 100 000.00
13	Simunye	High	Theewaterskloof	Damage to school roof	R 65 000.00
14	Volschenk	Primary	Hessequa	Damage to roof, gutters and sun protection	R 40 000.00
15	Voorbedag	Primary	Oudtshoorn	Damage to roof	R 20 000.00
				Total	**R 1 919 000.00**

* Outeniqua High School also sustained damage in 2003, assessed at R 40 000

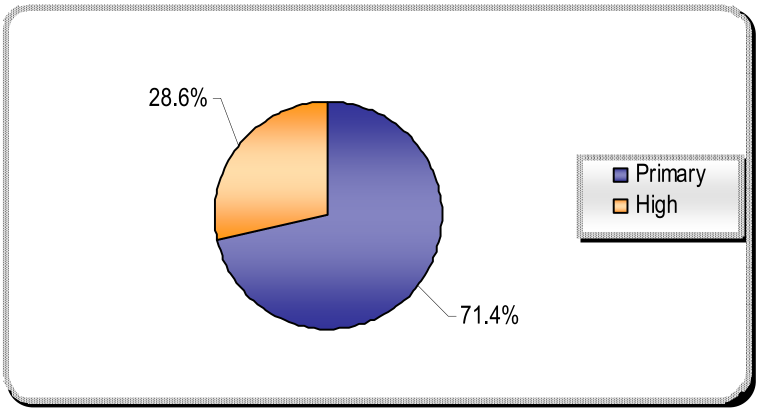

Figure 5.3.3.5.1: Distribution of losses, by school type

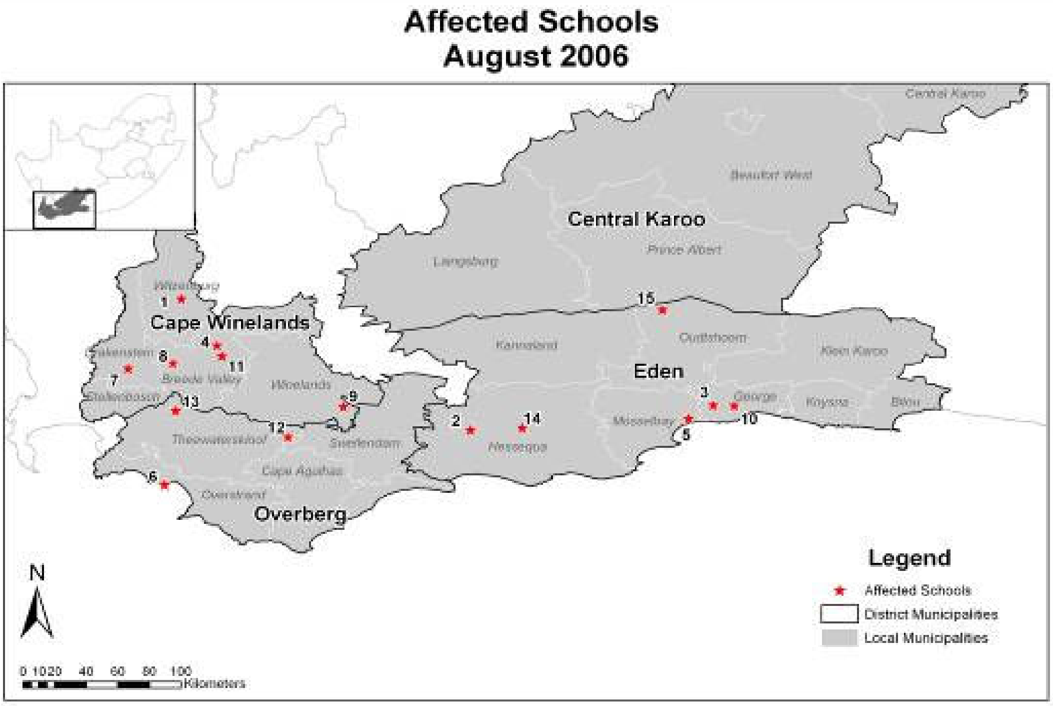

Figure 5.3.3.5.2: Spatial distribution of schools affected by August 2006 cut-off lows

5.3.3.6 Cape Nature Conservation

The Goukamma and De Hoop Nature Reserves operated by Cape Nature Conservation sustained infrastructural damage, totalling R 3.4 million. Each reserve had similarly incurred losses in March 2003. In the earlier event, the Goukamma Nature Reserve's entrance and access route and the De Hoop Nature Reserve's Eastern Sector road were also affected. The combined costs for this were
R 1 130 000, compared with R 1 070 000 in August 2006 (refer Figure 5.3.3.6.1 and Table 5.3.3.6.1).

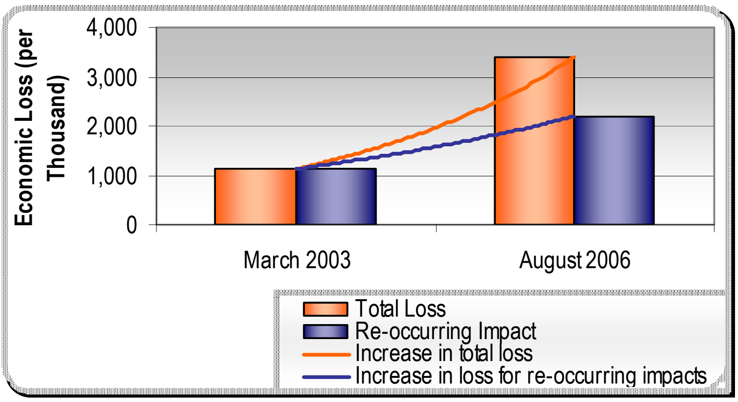

Figure 5.3.3.6.1: Total losses/recurring impacts for
Cape Nature Conservation - March 2003 and August 2006

Table 5.3.3.6.1 Recurring Impacts for Cape Nature Conservation for March 2003 and August 2006

Impacts	March 2003	August 2006
Goukamma Nature Reserve ~ Entrance and Access Route	R 30 000.00	R 2 000 000.00
De Hoop Nature Reserve ~ Eastern sector road	R 1 100 000.00	R 200 000.00
Total	**R 1 130 000.00**	**R 2 200 000.00**

5.3.4 Direct losses sustained by district and local municipalities

5.3.4.1 Overall municipal losses

Data were received from the Eden and Central Karoo District Municipalities, as well as Bitou, George, Hessequa, Knysna, Mossel Bay, Oudtshoorn, Prince Albert, Breede River/Winelands and Swellendam local municipalities.[52]

Total losses reported by these municipalities were estimated at R 103 746 270.98, or 20.3% of the total economic loss for August 2006. Local municipalities within the Eden District suffered damage estimated at R 91 999 378.70, (88.7% of the total municipal infrastructural loss) even though Eden District itself reported impacts estimated at R 5.8 million (refer Table 5.3.4.1.1)[53]

Knysna incurred the highest municipal loss of R 33 million (refer Figure 5.3.4.1.1). This could also be a function of reporting due to the meticulous loss recording methods used within the municipality. These documented specific impacts and associated costs in sanitation, electricity, water supply infrastructure, roads, storm water drainage and other municipal infrastructure.

Table 5.3.4.1.1 Economic losses for each affected local municipality

Local Municipality	Losses (Rands)	Losses (%)
Eden District	R 5 768 393.00	6%
Bitou	R 877 172.00	1%
George	R 16 691 512.00	16%
Hessequa	R 19 000 000.00	18%
** Kannaland	0.00	0%

52 Data were repeatedly requested from the Theewaterskloof and Kannaland local municipalities. Although assurances were given that the data would be provided, information was unfortunately not received by DiMP. The Overberg District Municipality did not submit any data as the municipality was able to absorb its own losses.
53 Damage to formal and non-formal housing was not included in the municipal graphs and tables to avoid duplicating data already collected and provided by the Provincial Housing Department.

Knysna	R 32 998 370.00	32%
Mossel Bay	R 15 458 324.70	15%
Oudtshoorn	R 6 974 000.00	7%
Prince Albert	R 382 000.00	0%
** Theewaterskloof	0.00	0%
Breede River/Winelands	R 1 426 499.28	1%
Swellendam	R 4 170 000.00	4%
Total	**R 103 746 270.98**	**100%**

** Data requested but not received

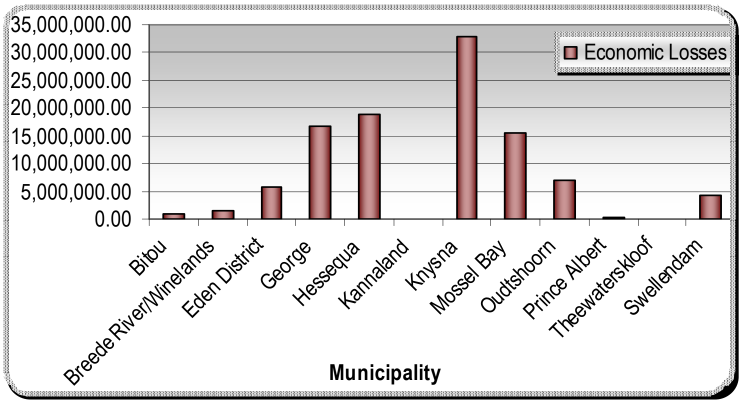

Figure 5.3.4.1.1: Economic losses for each local municipality

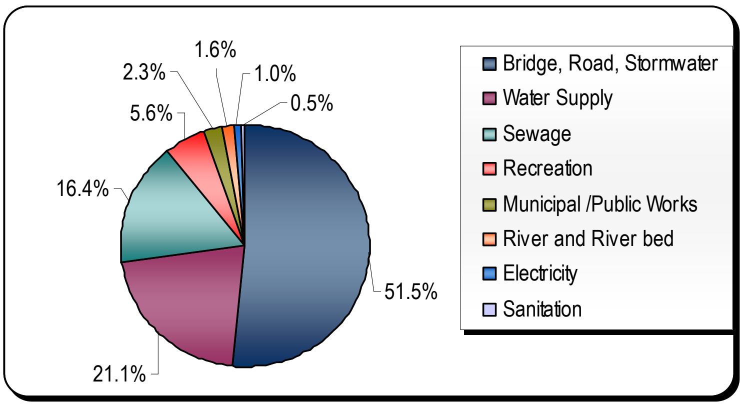

Figure 5.3.4.1.2: Distribution of municipal economic losses, by type of impact

It was not possible to examine each individual impact, as data recorded and forwarded to DiMP had already been clustered and costed by type of infrastructure (refer Figure 5.3.4.1.2).

All the municipalities in the weather-affected area incurred impacts specifically to roads, bridges and storm water drainage systems.[54] According to the data collected, run-off and siltation were the main contributing factors cited for these impacts. 100% of all reported impacts for Bitou, George and Oudtshoorn were attributed to these two factors.

Table 5.3.4.1.2 Impacts type with the highest economic loss (highest four)

District and local Municipalities	Bridge/Road/ Storm water	Water Supply	Sewage	Recreation	Total
Bitou	R 877 172.00				**R 877 172.00**
Breede River /Winelands	R 808 535.74		R 257 963.54		**R 1 066 499.28**
Eden District	R 699 994.00	R 1 700 000.00		R 3 368 399.00	**R 5 768 393.00**
George	R 16 691 512.00				**R 16 691 512.00**
Hessequa	R 4 000 000.00		R 15 000 000.00	R 429 000.00	**R 19 429 000.00**
Knysna	R 9 208 000.00	R 18 863 836.00			**R 28 071 836.00**
Mossel Bay	R 12 480 800.00	R 284 000.00		R 1 966 407.00	**R 14 731 207.00**
Swellendam	R 1 370 000.00	R 1 050 000.00	R 1 750 000.00		**R 4 170 000.00**
Oudtshoorn	R 6 974 000.00				**R6 974 000.00**
Prince Albert	R 350 000.00	R 32 000.00			**R 382 000.00**
Total	**R 53 460 013.74**	**R 21 929 836.00**	**R 1 700 963.54**	**R 5 763 806**	**R 98 161 619.28**

George local municipality sustained the highest economic loss associated with damage to roads, bridges and storm water drainage infrastructure.

With respect to critical infrastructure failure specifically, three sewage plants located within the Hessequa, Swellendam and Breede River/Winelands local municipalities were affected in the August 2006 event. The high costs for the Hessequa facility (R 15 million) were attributed to the upgrading and resiting of the facility to flood-averse standards, while repair costs for the Breede River/Winelands plant were estimated at R 257,963.54.

Both sewage treatment plants were also affected in the March 2003 event with damage costs for Hessequa[55] and Breede River/ Winelands estimated at R322 000 and R 686 400 respectively.

The repeat failure of sewage treatment plants is an area of concern, due to its implications for the health of residents and livestock in the surrounding areas.

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[54] Water supply infrastructure, referred to in table 5.4.12, included water pumps, pump stations, emergency supply tanks and dams, while municipality/public works infrastructure refers to infrastructure owned by the municipality, (i.e. municipal buildings, parks, cemeteries, libraries)

[55] The sewage treatment works in Hessequa is specifically located within Heidelberg and had failed in March 2003, December 2004 as well as August 2006

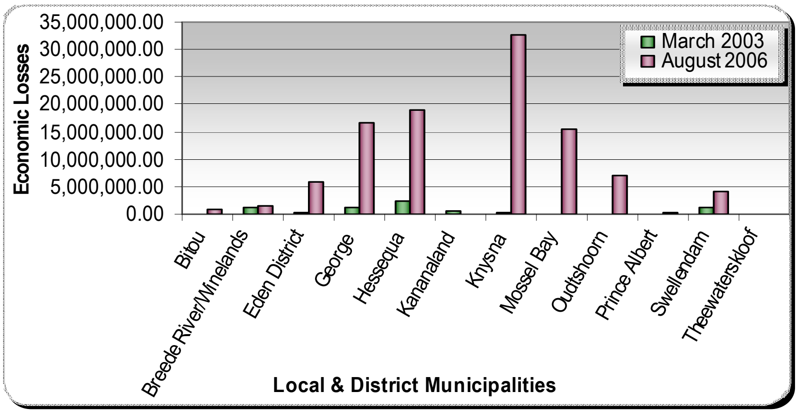

Figure 5.3.4.1.3 Comparison of district and local municipality losses between March 2003 and August 2006

5.3.4.2 Absolute compared with relative (proportionate loss)

As in March 2003 event, one of the difficulties associated with determining disaster impacts is addressing issues of 'absolute' vs. 'proportionate' loss. This is because larger, better-resourced municipalities may sustain higher costs, but have greater capacity to absorb these. This is clearly illustrated when municipal infrastructural losses are related to the planned annual and maintenance and repair budgets for the civil and technical services departments of each municipality. It is further underlined when losses and municipal investments in maintenance/repair are adjusted for population size.

Losses related to annual civil and technical services and repair/maintenance budgets
Although budget information was requested from all the local municipalities in affected areas, only six municipalities responded positively. This information is represented in Table 5.3.4.2.1

Table 5.3.4.2.1 Municipal Budgets for Civil and Technical Services for 2006/2007.

Municipality	Civil and Technical Service (2006/2007)			Economic Losses for August 2006		
	Planned Expenditure Budget (Rands)	Maintenance & Repair Budget (Rands)	Maintenance & Repair as % of Planned Expenditure	Total (Rands)	As a % Planned Expenditure	As a % Maintenance & Repair
Bitou	211 219 119	15 603 173	7.39%	877 172	0.4%	5.6%
George	327 647 000	44 061 000	13.45%	16 691 512	5.1%	37.9%
Knysna	162 191 350	9 053 490	5.58%	32 998 370	20.3%	364.5%
Mossel Bay	52 900 000	19 970 000	37.75%	15 458 324.70	29.2%	77.4%
Oudtshoorn	9 500 000	400 000	4.21%	6 974 000	73.4%	1 743.5%
Prince Albert		273 320		382 000		139.8%
Total	**763 457 469.00**	**89 360 983.00**		**73 381 378.70**		

Table 5.3.4.2.1 shows how proportionate or relative impacts of the August cut-off lows applied to planned annual budgets for Civil and Technical Services as well as repair and

maintenance. This shows total losses comprising R 73 million (or 82%) of the 2006-2007 repair and maintenance budget of R 89 million for the six municipalities concerned.

The relative or proportionate impact of the 'flooding' on municipal budgets disaster became clearer when related to planned repair and maintenance allocations. For instance, Knysna Municipality reported the third largest planned expenditure budget for Civil and Technical Services (R 162 million), but allocated only 5.6% of this (R 9 million) for maintenance and repair. Although economic losses of R 33 million incurred by the municipality constituted only 20.3% of the planned expenditure budget, it was equivalent to 364.5% of the municipality's total maintenance and repair allocation.

In the absence of external financial relief, such costs make reconstruction and recovery almost impossible, as the costs for repairing 'flood-damaged' infrastructure may significantly exceed (in this instance, by 364%) the budgeted allocations for repair and maintenance. Moreover, the opportunity costs associated with post-disaster reconstruction may further compromise efforts to maintain other infrastructure by diverting resources to acute, rather than ongoing needs.

Oudtshoorn's experience was even worse. With only R 400 000 (4.21%) of the planned 2006-2007 expenditure for civil and technical services allocated for maintenance and repair, the municipality sustained direct losses of nearly R 7 million – or 18 times its projected annual maintenance and repair budget.

Population-adjusted calculations of per capita loss and per capita annual allocations for civil/technical services

Table 5.3.4.2.2 and Figure 5.3.4.2.1 represent data from five municipalities, including their estimated population size for 2005. They further relate total economic losses reported by each municipality to population size, generating an estimate of per capita loss for the August 2006 events. The last two columns in Table 5.3.4.2.2 adjust the planned 2006-2007 expenditures for civil and technical services and maintenance and repair for population size.

Table 5.3.4.2.2 Per capita losses for selected municipalities and per capita allocations for civil and technical services and maintenance/repair reported in 2006-2007 budgets

				Planned Per Capita Expenditure 2006-2007	
Municipality	**Popula-tion**	**Economic Loss (Rands)**	**Per Capita Economic Loss (Rands)**	**Overall Civil and Tech Services (Rands)**	**Maintenance & Repair (Rands)**
Bitou	34,859	877 172.00	25.16	6 059.24	447.61
George	154,828	16 691 512.00	107.81	2 116.20	284.58
Knysna	55,057	32 998 370.00	599.35	2 945.88	164.44
Mossel Bay	80,999	15 458 324.70	190.85	653.09	246.55
Oudtshoorn	93,917	6 974 000.00	74.26	101.15	No data
Total	**419,660**	**73 381 378.70**	**174.86**		

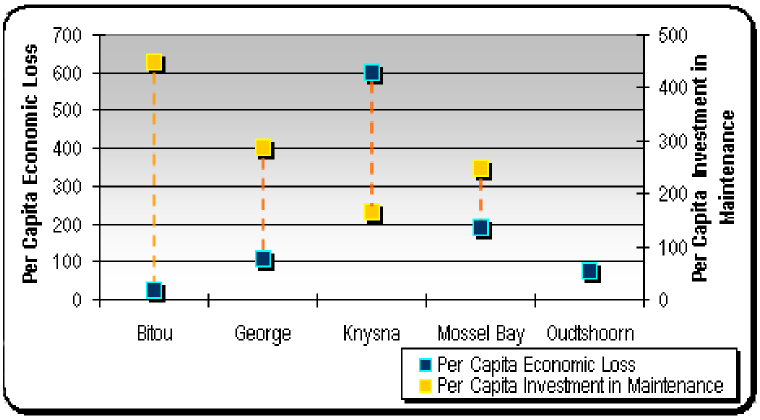

Figure 5.3.4.2.1: Per capita losses in the August 2006 extreme weather events compared with per capita maintenance/repair 2006-2007 budgets for selected southern Cape municipalities

The direct municipal per capita losses associated with the August 2006 cut-off lows ranged from a low R 25.16 in Bitou to R 599.35 for Knysna.

While the scope of this study did not include assessing the protective role of municipal maintenance and repair in averting severe weather-related losses, Figure 5.3.4.2.1 suggests a significant inverse relationship between maintenance/repair allocations and the severity of subsequent disaster loss. This is underlined by Bitou's planned per capita allocation for maintenance (R 447.61) which significantly exceeds those for the other municipalities (especially Knysna – with only R 164.44 allocated per capita).

However, as clearly illustrated in Figure 5.3.4.2.1, given that Bitou sustained the lowest direct losses while other municipalities invested considerably less per capita in maintenance, future cost-benefit investigations are urged on the protective 'risk-averting' role of municipal maintenance and repair in municipalities exposed to severe weather.

5.3.5 Losses borne by other sectors

5.3.5.1 Losses borne by Spoornet, Telkom, Eskom

Due to confidentiality issues, no in-depth analysis is provided for data from Spoornet and Telkom. Spoornet and Telkom reported economic losses of R 47 246 640 and R 670 060 respectively. Data were requested from Eskom but were not received.

5.3.5.2 Losses borne by the private sector

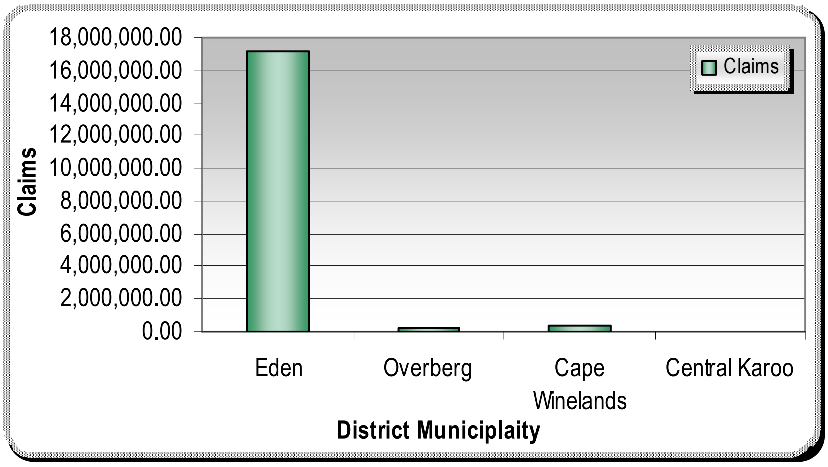

Figure 5.3.5.2.1: Distribution of Insurance claims for August 2006

The total losses reported by the South African Insurance Association (SAIA) were R17.8 million; with the overwhelming majority of claims being generated by policy holders within the Eden District Municipality. Data were included from three separate insurance agencies, but because of confidentiality issues, neither their identities nor the specific spatial locations of the claims may be disclosed.

5.4 Challenges and recommendations

This section summarises key recommendations related to the loss estimation process. It is organised into two parts:

Section 5.4.1 recommends practical measures for provincial and municipal authorities that potentially reduce future losses in weather-exposed areas of the southern Cape.

Section 5.4.2 then recommends measures that would streamline the loss estimation process itself, and reduce demands on personnel actively involved in post-event recovery as well as those collecting and collating relevant loss information.

5.4.1 Recommendations: risk reduction measures for provincial and municipal authorities

5.4.1.1 Riverine flood risk mapping and management

Areas/infrastructure adjacent to and downstream from rivers where gauging stations have repeatedly failed should be incorporated as 'flood-risk exposed' in heavy rainfall events, but…

…the encouraging reduction in costs associated with repeat gauging station failures in heavy rainfall events should be further investigated and documented.

DWAF-associated losses for the August 2006 events were found to be significantly lower than those incurred in March 2003, declining by R 10 980 000 from R 13 850 000 in 2003 to R 2 870 000 in 2006. Although 16 of the 31 gauging stations damaged in August 2006 were also damaged in March 2003, the repair costs were one-third those of the previous event.

On one hand, while the repeat failure of specific gauging stations is a robust indicator of water courses and rivers most likely to flood in extreme weather, on the other hand, the significantly lower repair costs associated with this suggest DWAF's improved management of flood risk. This clearly warrants further investigation, and dissemination to other interested groups.

5.4.1.2 Agriculture

Enhanced support should be provided to farmers in areas exposed to recurrent severe storm events to enable improved riverine flood risk management, reduce 'downstream' consequences and to better utilise heavy rain events to minimise periods of rainfall scarcity.

Farmers in the Western Cape incur the most costly direct losses from repeat extreme weather events. They also are exposed to a wide range of other natural, market-related and veterinary threats. In this context, efforts should be prioritised to strengthen riverine flood risk management, reduce 'downstream' consequences and to better utilise heavy rain events to minimise periods of rainfall scarcity and drought.

5.4.1.3 Roads

The repeat failure of provincial roads in Eden due to extreme weather events should be averted through urgent investments in upgrading and risk-proofing of vulnerable sectors critical to the regional economy along with upward adjustments in repair/maintenance budgets.

The costly failure of provincial roads within Eden underlines an urgent need for upgrading to risk-averse levels of those sectors that are critical to the region's development. Moreover, the Southern Cape's recurrent exposure to extreme weather calls for increased budgetary allocations for repair/maintenance to minimise the risk of future failures.

5.4.1.4 Housing

Formally built low-income homes should not be sited in flood or run-off exposed locations without robust storm-water capacity and foundations, and should be constructed to meet minimum design criteria for extreme weather events, including severe storms, heavy rains and strong winds

The lack of structural robustness of low-income homes to extreme weather events represents an unaffordable pressure on already resource-constrained households. Housing developments for all economic groups – but, especially for lower income categories – should actively incorporate design criteria to avert risks driven by severe weather and surface run-off.

5.4.1.5 Education

Within the Cape Winelands Municipality specifically, attention should be given to assessing and improving the rain and wind resistance of roofs in school building – especially primary schools.

Specifically within the Cape Winelands, a significant number of school roofs (mainly primary schools) were unable to withstand the heavy rains. Recognising the need to ensure the safety of learners and the economic value of teaching equipment and resources concentrated in school buildings, it is urged that the rain and wind resistance of roofs be assessed and improved.

5.4.1.6 Local and District Municipalities

Development in municipalities within the Eden District should urgently incorporate climate and disaster risk management into urban planning and budgeting processes.

The Southern Cape's recurrent exposure to extreme weather events and associated loss profile calls for action to incorporate climate and disaster risk management into municipal planning processes and annual budgetary allocations. Initiatives that should be considered include:

- incorporating technically robust disaster risk assessments in the planning phase of all major developments in weather exposed locations, to better anticipate and mitigate their adverse consequences
- upgrading of critical bridge, road and storm water infrastructure to risk-averse levels

Within municipalities, specific priority should be applied to reducing and managing endangering run-off, and, harvesting run-off to strengthen adaptive capacity during drought.

The dramatic increase in hard surfaces (as in George and Mossel Bay) is of grave concern (i.e. in George, the urban landscape increased by 510% - approximately 75 km^2 - or an average of 3.94 km^2 annually from 1985 to 2004). The severe run-off risk generated by such rapidly hardening catchments now exceeds both the technical and infrastructural capacity of existing services to manage the consequences of heavy rain events – let alone the increased frequency of severe storms anticipated with climate change conditions.

It further underlines the need for municipalities within the Southern Cape to:

- *protect remaining 'natural flood attenuation'* capacity wherever possible (ie wetlands and the vegetated slopes of incised river valleys) to minimise excess run-off,
- invest more vigorously in robust *storm water, bridge and road infrastructure* to avoid repeat failures (including the redesign and resiting of particularly critical infrastructure),

- investigate and rigorously apply municipal incentives and deterrents (ie through local by-laws and regulations) to reduce *agricultural, commercial and residential run-off*, and link this to
- incentives and deterrents (i.e. through local by-laws and regulations) to *encourage rainwater and run-off harvesting* to minimise the impact of future droughts

Sewage treatment plants sited near to rivers at risk of flash flooding should be identified and flood-proofed.

Post-impact research indicates that the second infrastructure 'cluster' that is particularly susceptible to severe rainfall events is sewage treatment plants. To minimise future risks of plant failure, plants sited near to rivers at risk of flash flooding should be identified and flood-proofed.

The protective value of investing in municipal maintenance and repair as a front-line disaster risk management services for extreme weather exposed municipalities should be further investigated and funded.

Research findings suggest an inverse relationship between per capita investment in municipal repair/maintenance and flood/run-off related losses in heavy rainfall events. This highlights the protective value of investing in maintenance and repair and motivates for increased municipal and provincial expenditure in infrastructural maintenance. It also calls for further cost-benefit research to determine minimum per capita budgetary maintenance/repair allocations and/or investments in protective upgrading to risk-averse levels.

Suburbs and settlements that required emergency assistance due to the extreme weather, flooding and surface run-off should be identified and mapped as 'risk-prone' for risk management planning purposes

The process of identifying suburbs and settlements that required emergency assistance is invaluable for ongoing risk identification and risk management planning – as it focuses efforts on those areas that are at-risk and on relevant measures that reduce the likelihood of future losses.

5.4.3 Recommendations: streamlining ex post loss estimation following future extreme weather events

Loss estimation research following disaster events is a powerful research method for answering questions on 'what failed?', 'where did it fail?' and 'why did it fail?'. It complements more traditional inductive risk assessment processes by pointing to specific vulnerabilities of key services, and characterising these with respect to external exposure to heavy rain and run-off as well as their and internal susceptibility.

5.4.2.1 Timing of ex post extreme weather assessments

An initial assessment of affected infrastructure should be taken directly after a weather event and this should be revisited a month later.

This allows the person(s) responsible for tracking impacts to differentiate between impacts affected during each event in a compounded disaster. In the case where only one event occurs, the verification around a month later would enable the collection of information missed in the first phase.

In the context of the August 2006 events, the second event (23 – 26 August 2006) complicated the impact recording process and resulted in most reports not differentiating between the first and second events.

5.4.2.2 Improving uniformity in loss estimation procedures

A dedicated person should be appointed to take responsibility for impact tracking in each municipality and this information communicated to the PDMC. If this is not possible, the task should be outsourced.

In this event, it was extremely difficult to identify the correct person to source data from, seriously delaying the data gathering process.

Standard impact reporting procedures should be established for those municipalities and government departments that do not yet use a uniform system.

This includes the standardisation of hard-copy and electronic formats, and clear designation of a provincial focal point to consolidate these (or out-sourcing arrangements to facilitate this). Following the August 2006 events, the absence of uniform loss-reporting procedures/formats constrained the collection and consolidation of information across sectors and administrative areas (although DiMP has successfully used the same formats since 2003).

Data should never be submitted without a detailed report of each impact.

As a breakdown of economic loss was not always available, this limited the level of detail of the data analysis. It is also impossible to verify impacts recorded without a detailed report of each specific loss.

All municipal and provincial (especially infrastructural) losses should be geo-referenced (with a GPS). If a municipality or department does not have such capacity this should be outsourced or “in-house” capacity strengthened.

As most municipal impacts submitted to DiMP were not geo-referenced, this made spatial identification of recurring impacts impossible.

5.4.2.3 Focus on municipal loss reporting

When recording municipal impacts, only infrastructure which the municipality is responsible for should be recorded, and all other infrastructure should be referred to sectors/or departments responsible for the specific infrastructure.

For instance, a local municipality should not record and submit data for which a provincial department is responsible. In the August 2006 events, particular attention was needed in the consolidation process to avoid duplicating impacts. Many municipalities recorded data that had already been submitted by provincial departments.

All municipal impacts must be recorded, even if funding is not needed. This enables the early identification of extreme weather "hot spots" for improved risk management.

As many municipalities only reported impacts for which they needed funding, not all affected infrastructure/services related to this event were recorded. This limits the early identification of vulnerable services and infrastructure that may come under pressure in the future.

5.4.2.4 Focus on agricultural losses

All agricultural losses should be accompanied by a Surveyor General Number (S.G. No.). The Provincial Department of Agriculture is urged to incorporate S.G. numbers on its disaster loss reporting forms.

Agricultural risk management within the province is significantly limited by the absence of geo-referenced loss data. Agriculture repeatedly sustains the highest losses associated with weather extremes. However, unlike Provincial Roads, where it was possible to identify repeatedly exposed infrastructure through GIS, a spatial agricultural loss profile for the southern Cape could not be completed.

As recommended since 2003, this limitation could be overcome if farmers sustaining losses could record specific Surveyor General Numbers on their impact forms. In this context, it is suggested that S.G. numbers are incorporated on agriculture disaster loss reporting forms.

5.4.2.5 Improving consistency and accuracy in the economic loss calculations

There should be uniformity across all municipalities and sectors for calculating and presenting damage costs. These should be accurate and not presented as estimates.

When economic losses were submitted to the University of Cape Town, it was clear that there were no uniform approaches for calculating and presenting damage costs. Some reports did not state whether administration costs and value added tax (VAT) had been already incorporated into totals.

Part VI Conclusions and recommendations

This section completes the report by summarising main conclusions from the preceding chapters, with a specific focus on the Eden District Municipality and the local municipalities within it. It also consolidates recommendations drawn from field research and secondary data analysis. It is organised as follows:

Section 6.1 summarises main conclusions.

Section 6.2 consolidates recommendations for provincial and national departments.

Section 6.3 consolidates recommendations for district and local municipalities.

Section 6.4 provides recommendations on early warning dissemination by the South African Weather Services.

6.2 Summary of main conclusions

6.1.1 Eden is a 'provincial pressure point'

The Eden District is a major provincial growth node, with tourism, agriculture and related industries its primary sources of economic growth and employment. Recent rapid population growth and urban expansion have provided welcome development opportunities in the region. However, simultaneously, they have also generated significant internal pressures on the capacities of both the natural environment and existing municipal services to manage the consequences of such rapid growth.

These internal pressures are further exacerbated by the south coast's almost annual exposures to extreme weather - reflected in costly losses to poor households in run-off and flood-exposed areas as well as agriculture, transport and other essential infrastructure. It is this convergence of dynamic and demanding external and internal forces that profile the district municipality as a 'provincial pressure point'.

In this context, the documented impacts from repeated extreme weather events in Eden suggest an unsustainable development trajectory for the district. This is indicated by the costly economic losses associated with extreme weather, which have greatly exceeded local capacity to resist and recover without external assistance.

6.1.11 Rising disaster losses have been significantly driven by rapid urban growth and expansion.

Many of the losses attributed to the extreme weather are driven by rapid urban growth that has seriously undermined the protective capacities of the natural environment. This is measurably evidenced by the upward trend in weather and run-off-associated infrastructure losses since 2003, suggesting that the 'triple bottom-line' for sustainable regional growth and development may already be compromised.

It is further reflected dramatically by the measurable increase in hard surfaces in municipalities such as George, whose urban area increased by approximately 75 km^2, or

an average of 3.94 km^2 annually from 1985 to 2004. The severe run-off risk generated by such rapidly hardening catchments now exceeds both the technical and infrastructural capacity of existing services and infrastructure to manage the consequences of heavy rain events – let alone the increased frequency of severe storms anticipated with climate change conditions.
Similarly, the district's rapid urban expansion and population growth have not been matched by strategic investments in the redesign or maintenance of critical infrastructure. This is especially indicated by losses to roads and storm-water systems, as well as sewage treatment and water supply plants – many of which are repeat-impacts associated with previous weather events.

6.1.12 Disaster and climate risk management are prerequisites for sustainable integrated development for the Eden District.

Disaster and climate risk management are critical prerequisites for sustainable growth in the Eden District Municipality due to its repeated exposure to both extreme weather and endangering wild-fires. In addition, this recurring pattern illustrates how poorly managed development risks have become 'transformed and transferred' onto essential services such as disaster management, emergency services and those responsible for critical provincial and municipal infrastructure.

In this context, there are pressing needs to integrate risk management considerations into the region's spatial and integrated development planning, with accompanying financial and human resource allocations.

6.1.13 The social impact assessment identified two distinct vulnerable groups who were affected by the extreme weather event.

The first group comprised those living in more affluent residential areas who found themselves in run-off and flood-exposed locations. This contrasted with the second group that, while also exposed to run-off and flood conditions, resided in poor and marginalised settlements. This second group was further differentiated into those who resided in low-income formal housing and those who lived in informal dwellings.

Field research indicated that development conditions significantly drove vulnerability outcomes in extreme weather-exposed communities. Moreover, the impacts generated by local flood and rain damage further undermined the social development of the affected communities. In this context, the limited nature of the relief interventions, while providing emergency assistance, is unlikely to have yielded lasting benefits to poorer households and settlements.

6.1.14 The Disaster Management Act's call to reduce the vulnerability of disaster-prone areas, communities and households should be made a priority

The Disaster Management Act (Act 57 of 2002) makes explicit the need to reduce the vulnerability of disaster-prone areas, communities and households. In poorer settlements, this could best be undertaken through comprehensive community risk assessments to identify those most at risk, followed by participative community-based disaster risk management planning. Such processes would also assist in identifying the most vulnerable for response activities in the event of future extreme weather events. They would also strengthen participative governance relations between at-risk communities and local authorities.

6.1.15 Formal low-income homes sustained significant losses due to lack of 'weather-proofing' and 'run-off-proofing'

Many of the most at-risk, low-income settlements affected in the severe weather events were sited below road level and thus exposed to endangering run-off due to limited storm water capacity. In addition, poor construction standards increased exposure to heavy rain, run-off and subsidence.

This lack of structural robustness of low-income homes to extreme weather events represents an unaffordable pressure on already resource-constrained households. Housing developments for all economic groups, but especially for lower income categories, should actively incorporate design criteria to avert risks driven by severe weather and surface run-off.

Currently, there are no provisions or specifications for 'weather-proofing' or 'flood-proofing' low-income homes in areas exposed to heavy rain and run-off conditions. However, in areas exposed to recurrent heavy rain events, 'weather-proofing' is an important consideration to protect assets as well as the health of household members.

6.1.16 An unambiguous provincial protocol for social vulnerability assessment of extreme weather-affected households is urgently needed

In this event, the determination that there was 'no need for social relief' was not informed by a systematic or rigorous household needs assessment. Moreover, the independent social impact assessment undertaken by UCT/DiMP confirmed that there were indeed many households who experienced significant hardship as a result of the extreme weather, as well as the destruction of uninsured property and compromised employment opportunities.

While such hardship might not have appeared obvious from a rapid 'drive-by' assessment, detailed household assessments proved otherwise. Moreover, it is incongruous that poor households did not require social relief, when municipal and provincial departments sought emergency funding assistance from the National Treasury and wealthier residents and businesses sought insured assistance to cope with and recover from the extreme weather and its associated risks.

6.1.17 Post-disaster reconstruction is an opportunity to restore critical infrastructure beyond replacement standards to risk-averse levels.

The technical demands and administrative complexity of emergency reconstruction were apparent following the August events. Given the tight implementation time-frames imposed, it is to the credit of the technical staff concerned that repairs were completed on time.

However, current reconstruction funding instruments do not easily enable risk-averse rehabilitation due to tight annual financial reporting cycles. While not applying to all disaster-affected structures, post-event funding mechanisms should selectively allow strategic reconstruction to risk-averse levels.

Research findings also suggest an inverse relationship between per capita investment in municipal repair/maintenance and flood/run-off related losses in heavy rainfall events. This highlights the protective value of investing in maintenance and repair and motivates for increased municipal and provincial expenditure in infrastructural maintenance. It also calls for further cost-benefit research to determine minimum per capita budgetary maintenance/repair allocations and/or investments in protective upgrading to risk-averse levels.

6.1.18 Despite costly recurrent impacts it is still difficult to generate a spatial agricultural loss profile for the Southern Cape.

Agricultural risk management within the province is significantly limited by the absence of geo-referenced loss data. Agriculture repeatedly sustains the highest losses associated with weather extremes. However, unlike Provincial Roads, where it is now possible to identify repeatedly exposed infrastructure through GIS, a spatial agricultural loss profile for the Southern Cape is not possible.

As recommended repeatedly since 2003, this limitation could be overcome if farmers sustaining losses could record specific Surveyor General Numbers on their impact forms. In this context, the Provincial Department of Agriculture is urged to incorporate S.G. numbers on its disaster loss reporting forms.

6.1.19 Post-disaster impact reporting and documentation processes require urgent streamlining.

Loss estimation research following disaster events is a powerful research method for answering questions such as ‘what failed?’, ‘where did it fail?’ and ‘why did it fail?’. It complements more traditional inductive risk assessment processes by pointing out specific susceptibilities of key services, and characterising these with respect to external exposure to heavy rain and run-off.

However, the onerous reporting demands carried by technical personnel in this event also diverted their energies from actual on-site supervision of implementation to administration and reporting. This underlines the urgent need to streamline the impact reporting process, so that a uniform approach is adopted that serves multiple outcomes, such as mobilising of funds, and post-event risk analysis.

In this context, it is important that ‘impact assessment, recovery and reconstruction guidelines’ are developed consultatively and accompanied by an orientation process for key provincial and municipal stake-holders to streamline the reporting and post-event reconstruction processes.

6.2 Recommendations for Provincial and National Departments

6.2.1 Introduction

Provincial recommendations are organised by sector or department, and cross-referenced to the appropriate section in the report in the right-hand margin.

Ref.	Prov. Dept	Recommendation	Cross-ref
6.2.2	Roads	The repeat failure of provincial roads in Eden should be averted through urgent investments in upgrading and risk-proofing of vulnerable sectors critical to the regional economy, along with upward adjustments in repair/maintenance budgets.	5.4.1
6.2.3	Housing	Formally built low-income homes should: • **not be sited in flood or run-off exposed locations** without robust storm-water capacity and foundations, • be constructed to meet **minimum design criteria for extreme weather events,** including severe storms, heavy rains and strong winds.	5.4.1
6.2.4	Education	Within the Cape Winelands Municipality specifically, attention should be given to assessing and improving the rain and wind resistance of roofs in school buildings, especially primary schools.	5.4.1
6.2.5	Social Dev.	An unambiguous provincial protocol for social vulnerability assessment of extreme weather-affected households should be developed and applied after each extreme weather event.	4.1.3
6.2.6	Agriculture	All agricultural losses should be accompanied by a Surveyor General Number (S.G. No.). The Provincial Department of Agriculture is urged to incorporate S.G. numbers on its disaster loss reporting forms.	5.4.2
6.2.7	PDMC	In cooperation with the NDMC/key role-players, the PDMC should:	
		• engage with National and Provincial Treasury to explore financial provisions for restoring critical infrastructure beyond replacement standards to risk-averse levels,	4.3.7
		• engage with the SA Institute of Engineers to establish a mechanism for mobilising skilled engineers after extreme weather processes and other disasters for post-event assessment and reconstruction,	4.3.7
		• engage risk-prone municipalities and relevant provincial departments on practical strategies for reducing climate risk impacts on vulnerable infrastructure,	
		• establish standard impact reporting procedures for those municipalities and government departments that do not yet use a uniform system,	5.4.2
		• prepare simple technical, administrative and financial guidelines that streamline impact reporting formats and the management of emergency reconstruction. This	4.3.7

		includes ensuring that all municipal and provincial (especially infrastructural) losses are geo-referenced (with a GPS), • ensure that a dedicated person is appointed to take responsibility for impact tracking in each municipality as well as ensuring that data are never submitted without a detailed report of each impact.	5.4.2
6.2	DWAF	Areas/infrastructure adjacent to and downstream from rivers where gauging stations have repeatedly failed should be identified and mapped as 'flood-risk exposed' for planning purposes.	5.4.1

6.3 Recommendations for District and Local Municipalities

6.3.1 Introduction

Municipal recommendations are organised by sector or department, and cross-referenced to the appropriate section in the report in the right-hand margin.

Ref.	Thematic Area	Recommendation	Cross-ref
6.3.1	Development Planning	Future urban expansion in the Eden District should actively incorporate landscape sensitivity considerations into spatial development and integrated development planning processes.	2.3.5
		Integrated climate adaptation and disaster risk research should be undertaken to determine the relationship between urban development and hydro-geological risks in the district – especially in areas where there is now evidence of recurrent impacts.	2.3.5
		Areas/infrastructure adjacent to and downstream from rivers where gauging stations have repeatedly failed should be identified and mapped as 'flood-risk exposed' for planning purposes.	5.4.1
		Risk management, including 'strategic rethinking' to better risk-proof critical infrastructure' should be integrated into all local planning and regulatory processes, specifically to: • tighten land-use regulations to avoid further 'unravelling' of protective 'environmental services', • incorporate risk assessment for flood, run-off, slope failure and subsidence into all future environmental impact assessments within the district.	4.2.6

		and, particularly for weather-exposed infrastructure, to: • investigate existing design criteria for critical infrastructure – especially roads and storm water to determine their relevance and robustness for extreme rainfall events, • 'rethink' investment, environmental, engineering and human resource strategies for risk-averse infrastructure, • develop decision models that evaluate the relative strengths of proactive investment in upgrading and maintaining critical road and other infrastructure to offset future losses from expected extreme weather, • investigate available climate risk insurance options as potential risk transfer mechanisms to ease financial pressure on weather-exposed municipalities. Integrated development planning should be an opportunity to reduce, not increase the exposure of poor households to endangering surface run-off, rain and subsidence damage.	4.2.6 3.6.2
6.3.2	Urban Planning	Climate and disaster risk management should be integrated into urban planning and budgeting processes. This includes: • incorporating technically robust disaster risk assessments in the planning phase of all major developments in weather exposed locations, • upgrading of critical bridge, road and storm water infrastructure to risk-averse levels. Sewage treatment plants sited near to rivers at risk of flash flooding should be identified and flood-proofed.	5.4.1 4.2.6 5.4.1
6.3.3	Civil and Techncial Services	Municipal maintenance and repair should be prioritised and funded as 'front-line climate and disaster risk management services' for municipalities exposed to extreme weather. Priority should be applied to reducing and managing endangering run-off, and harvesting run-off to strengthen adaptive capacity during drought. This includes: • protecting remaining 'natural flood attenuation' capacity wherever possible to minimise excess run-off, • investing more vigorously in robust storm water, bridge and road infrastructure to avoid repeat failures, • investigating/rigorously applying municipal	5.4.1 5.4.1

		incentives/deterrents to reduce agricultural, commercial and residential run-off, • investigating/ rigorously applying incentives/deterrents to encourage rainwater and run-off harvesting that minimise the impact of future droughts.	
6.3.4	Disaster Management	**With specific respect to disaster and climate risk assessment:**	
		Integrated climate adaptation and disaster risk research should be undertaken to determine the relationship between urban development and hydro-geological risks in the district – especially in areas where there is now evidence of recurrent impacts.	2.3.5
		Areas/infrastructure adjacent to and downstream from rivers where gauging stations have repeatedly failed should be identified and mapped as 'flood-risk exposed' for planning purposes.	5.4.1
		Suburbs and settlements that required emergency assistance due to the extreme weather, flooding and surface run-off should be identified and mapped as 'risk-prone' for risk management planning.	5.4.1
		With specific respect to risk reduction planning:	
		The Disaster Management Advisory Forum should urgently identify a skilled and committed multi-stakeholder task team that focuses on strategies for mitigating extreme weather-associated risks.	4.2.6
		Spatial loss and impact information from extreme weather events should be incorporated into integrated planning processes – to highlight at-risk sites and settlements.	2.3.5
		Existing disaster management capacity should be urgently increased to manage the wide-ranging demands of post-event recovery as well as risk reduction planning and preparedness/response.	4.2.6
		The reduction of the vulnerability of disaster-prone communities and households' should be enabled through comprehensive community risk assessments followed by participative community-based disaster risk management planning.	3.6.2
		Creative, locally relevant, robust and sustainable risk reduction measures should be identified and	3.6.2

		communicated among residents of at-risk settlements.	
		With specific respect to preparedness and response:	4.1.3
		Contingency planning for at-risk communities and settlements should be undertaken consultatively well in advance of a weather alert.	4.1.3
		Formalised systems should be established for communicating and confirming understanding of warning information among government and nongovernmental role-players.	4.1.3
		Warning information as well as response and relief updates should be communicated in multiple, context-specific and language-appropriate forms.	3.6.2
		Early warnings should be communicated understandably to households and settlements known to be exposed to extreme weather, surface run-off and flood risk.	4.1.3
		Institutional arrangements with respect to the JOCs and mini-JOCS should be formalised and agreed on by critical stake-holders.	3.6.2
		An effective and inclusive contingency plan should be in place for response and relief that ensures timely and equitable assistance to settlements that are high-risk.	4.1.3
		A mobile JOC should be considered for the Eden District Municipality, with necessary communication tools, for example, a specially adapted bus)	
		With specific respect to post-disaster reporting:	5.4.2
		An initial assessment of affected infrastructure should be taken directly after a weather event. This should be revisited a month later.	5.4.2
		Only infrastructure for which the municipality is directly responsible should be recorded and all other infrastructure should be referred to sectors/or departments responsible for the specific infrastructure.	5.4.2
		All municipal impacts should be recorded, even if funding is not needed. This enables the early identification of extreme weather “hot spots” for improved risk management.	5.4.1

		There should be uniformity across all municipalities and sectors for calculating and presenting damage costs. These should be accurate and not presented as estimates.	

6.4 Recommendations for South African Weather Services

6.4.1 Introduction

Recommendations for SAWS are reflected in the left-hand column with explanations given in right-hand column in the table below.

Recommendation	Explanation
Extreme weather warnings should differentiate between anticipated levels of risk.	Warnings should ideally be differentiated, stating different levels of anticipated extreme weather risk. If, for example, key responders had known a "level-three" warning had been issued, they would have taken urgent precautionary actions.
Extreme weather warnings should, where possible, provide expected values for rainfall and wind speed.	None of the warnings issued mentioned any potential values of rainfall or wind speed, only of possible wave heights. If possible forecast values were included along with a severity rating system, more action would probably be taken by key responders in all sectors.
Extreme weather warnings should be issued at least a day in advance.	Virtually all the warnings were issued the morning that the weather event occurred, whilst most of the advisories were issued a day in advance. The advisories were more useful than the warnings since they gave end-users time for preparedness action.
Weather warnings should include descriptions of likely localised impacts.	Very few of the warnings included a description of the possible impacts of the weather event they describe, such as possibility of flooding, wind damage etc.
Weather warnings should be communicated directly by telephone to key officials. .	For events above a certain level of risk it may be more effective to telephone and speak directly to key provincial officials and municipal managers of the areas likely to be affected. While the SMS system is a very effective and rapid means of

	communication, phone calls are less easily disregarded and provide opportunity for questions of clarification.

Appendix A: South Coast Flooding - Flyer

South Coast Flooding: Post Event Impact Analysis

A Research Initiative Supported by
The Ministry of Transport and Public Works, Western Cape,
Disaster Management Centre, South Africa
and
Disaster Management Centre, Western Cape

Implemented by
The Disaster Mitigation for Sustainable Livelihoods Programme (DiMP)
University of Cape Town

Background

On 1 August 2006, record rainfalls triggered major flooding across the Southern Cape Area. There has been widespread social, infrastructural and other impacts of the heavy rains, the costs of which are borne by the local municipalities and its residents. They are also indicative of the severity of future extreme weather events anticipated as a result of climate change.

The Disaster Management Act and the National Disaster Management Framework call for increased disaster research to guide disaster management policy and practice. Moreover, the National Disaster Management Framework calls for post-disaster reviews following significant events and events classified as disasters.

The flood provides an excellent opportunity to consolidate and map loss information (e.g. specific impacts on roads, damage to public infrastructure, health and social impacts). This will provide a key baseline of areas and communities most exposed to future weather extremes. It will also inform future risk mapping and disaster risk management planning.

Assessment

A post event assessment will be conducted by a skilled team of researchers. The aim is to determine the areas and communities most affected by the flooding. Specifically, the following will be investigated:

- The catchment, river flow, land-use and run-off characteristics that may have exacerbated the event.
- The impact to the natural environment.
- Institutional management of the extreme weather event, including preparedness and the effectiveness of warning systems
- The social and livelihoods impacts on those affected by the event.
- Infrastructural impacts such as damaged and destroyed roads.
- Direct losses
- Relief impacts in costs and supplies.

Research Approach

UCT views its disaster-related research as a collaborative process.

Therefore, the Disaster Mitigation for Sustainable Livelihoods Programme will contact the local Municipalities, Provincial Departments and other key resource people or organizations to discuss how best to capture and represent the information.

We particularly welcome suggestions on what kind of information affected municipalities and provincial departments would find most useful.

Research Team Composition

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Dr Ailsa Holloway is the Director of the Disaster Mitigation for Sustainable Livelihoods Programme at UCT. She has worked as the Disaster Preparedness Advisor in southern Africa for IFRC. She has also worked for the UNHCR and WHO in a variety of field settings and headquarters. She holds a doctorate in Public Health from the University of California.

Leigh Sonn
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Leigh Sonn completed a Masters in Applied Science at the University of Cape Town. Her main research focus has been on quantitative loss estimation.

Ameen Benjamin
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Ameen Benjamin has a BSocSci degree having majored in Environmental and Geographical Sciences and Social Anthropology. He also holds an Honours degree in Disaster Risk Science. He has experience working with at-risk communities.

Gillian Fortune
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Gillian Fortune is currently working at DiMP as the Knowledgement Management Coordinator. Her area of expertise is Information Technology, mainly focusing on database administration, data collection and quantitative analysis. She completed her National Diploma at the Cape Town University of Technology in 2001.

Tanya Wichmann
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Tanya Wichmann has a Disaster Risk Science Honours and is currently working as part of the TEAM programme. Her areas of expertise include climatology and bio-geography.

Xola Mlandu
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Xola Mlandu has degrees in Theology (Hons) and Social Sciences (Hons). He has extensive experience in community-based initiatives. He is currently working on the TEAM programme.

Xavier Middleton
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Xavier Middleton holds a Masters degree in Geology from the University of Cape Town. His area of expertise lies in Sedimentology and Marine Geology. His main research focus is on the application of GIS to geo-hazards/risk.

Lyndi Lawson
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Lyndi Lawson is a Disaster Risk Science Honours student. Her thesis will be investigating the factors that drive risk.

Contact Details for DiMP/UCT

If you would have questions about the research, suggestions concerning how best to take it forward, or priorities you would like to see addressed, please do not hesitate to contact the Disaster Mitigation for Sustainable Livelihoods Programme, UCT at:

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Appendix B: Guidelines for completing the Disaster Impact forms (First Round)

Guidelines for completing the Disaster Impact forms

We are hoping to spatially match the impacts of the flood event to a point on a map.

We intend to consolidate all mapped impact.

Please complete the columns the following way.

Column A
Ref no.
Write a number here – i.e. number off 1, 2, 3, 4, ... This is to assist if there are subsequent questions regarding impacts.

Column B
Name of Affected Structures / Areas / Service
Write in the name of the building, service, structure or area that was affected.

Column C
Service Disrupted
This column particularly focuses on services that were disrupted. For instance, if a road were flooded, you would write that the service was disrupted from 24/03/03 10:00 until 25/03/03 06:00.

Columns D to H focus on capturing information that relates ground impacts to particular flood/weather forces. Please tick the boxes that apply.

Columns D_1 to D_3 refer to river-flood impacts – or those impacts that were due *primarily to river flooding*.

River flood affected means structures/services/areas that were flooded.

River flood damaged means structures/services/areas that were flooded by river water and resulted in damage needing repairs.

River flood destroyed means structures/services/areas that were destroyed by river water and required reconstruction.

Columns E_1 to E_3 refer *primarily to direct rain-related impacts* – for instance leaking/damaged roofs.

Rain affected means structures/services/areas that were directly affected by rain.

Rain damaged means structures/services/areas that were damaged by direct rainfall and needed repairs.

Rain destroyed means structures/services/areas that were destroyed directly by rainfall and required reconstruction.

Columns F_1 to F_3 refer to flood impacts *primarily due to significant run-off*, run-off that exceeded existing storm water drainage capacity, or run-off down a slope.

Run-off affected means structures/services/areas that were affected by run-off.

Run-off damaged means structures/services/areas that were damaged directly by run-off, and needed repairs.

Run-off destroyed means structures/services/areas that were destroyed directly by run-off and required reconstruction.

Columns G_1 to G_3 refer *primarily to wind-related impacts* – for instance roofs blowing off.

Wind affected means structures/services/areas that were affected by wind.

Wind damaged means structures/services/areas that were damaged directly by wind, and needed repairs.

Wind destroyed means structures/services/areas that were destroyed directly by wind and required reconstruction.

Columns H_1 to H_3 refer *primarily to debris impacts* – for instance leaves, branches or rubbish being deposited on property.

Debris affected means structures/services/areas that were affected by debris.

Debris damaged means structures/services/areas that were damaged directly by debris, and needed repairs.

Debris destroyed means structures/services/areas that were destroyed directly by debris and required reconstruction.

Column I

Cost
This refers to the estimated costs for restoring a service, conducting repairs or reconstructing infrastructure.

Column J

Comments
Should you want to add any comment, please write the corresponding reference number and the comment you feel is relevant.

Appendix C: Impact Form (Round One)

Name of Organisation/Department: ………………………………… Completed by: ………………………………

(please print) Contact Details: ………………………………

		C. Service Disrupted				D. to H. Nature of Impact															
		From		To		River Flooded			Rain			Run-off			Wind			Siltation			
						D1	D2	D3	E1	E2	E3	F1	F2	F3	G1	G2	G3	H1	H2	H3	I.
A. Ref. No.	B. Name of affected Structure / Area / Service	Date	Time	Date	Time	Affected	Damaged	Destroyed	Affected	Damaged	Destroyed	Affected	Damaged	Destroyed	Affected	Damaged	Destroyed	Affected	Damaged	Destroyed	Cost

TABLE 2: Focus on factors contributing to the risk

		C. Service Disrupted				J. to O. Factors Driving Risk																	
		From		To		Environmen-tal			Infrastructu-ral			Developmen-tal			Socio-Economic			Political Power			In-Migration		
						J1	J2	J3	K1	K2	K3	L1	L2	L3	M1	M2	M3	N1	N2	N3	O1	O2	O3
A. Ref. No.	B. Name of affected Structure / Area / Service	Date	Time	Date	Time	Slope / Valley	Denuded Slope*	Debris	New/under construction	Old	Poorly maintained	Recreation-al Facilities	Schools	Hospital / Clinic / Hall	Unemploy-ment	Casual Workers	Contract Wrokers	None	Some	Strong	Low	Medium	High

*Explain the reason for this e.g. veld fire, deforestation

Appendix D: Letter to Engineers

UNIVERSITY OF CAPE TOWN

Disaster Mitigation for Sustainable Livelihoods Programme
University of Cape Town • Rondebosch • 7701 • South Africa
Telephone +27 (021) 650 2987 • Facsimile +27 (021) 689 1217

18 January, 2006

Dear …………………………

I am writing to request your kind assistance in consolidating disaster loss information from the August 2006 extreme weather events that affected municipalities in the Southern Cape. In response to requirements specified in the National Disaster Management Framework that call for the systematic review of disasters – to strengthen future mitigation capability - the National Disaster Management Centre and Provincial Government of the Western Cape have commissioned the University of Cape Town to conduct a review of the August extreme weather event – and its impacts.

In this context, and following consultations with Mr Du Plessis, Mr Steyn, Mr Wiese and Mr Sayed of the Department of Local Government and Housing, we would like to request your assistance in completing details in relation to specific infrastructural losses sustained as the result of last year's extreme weather. We would particularly welcome your assistance in completing the attached forms detailing the infrastructural impacts. In addition to the actual cost of the damage, we require a precise location, description of the damage and reason for the loss (ie debris accumulation, siltation, etc).

This is the fifth extreme weather event that DiMP has assessed, and, in the case of the Southern Cape, we are endeavouring to geo-reference the roads, bridges, stormwater drainage systems, sewage treatment facilities and other structures that fail repeatedly – along with the reasons for their failure. This is important for profiling priorities for infrastructural risk-proofing – especially in areas expected to face the brunt of increased heavy rainfall events as a result of climate variability.

We would be most grateful if you could kindly complete the attached forms and number the structural impacts, locating them as best you can on a fine scale map and/or aerial photograph. We will consolidate this information across departments and municipalities as part of our deliverable to national and provincial government.

We also plan to have a focused consultation in connection with the impacts generated, which will have a significant focus on infrastructure exposure and resilience in the next two months - and will make available the final report and CD with consolidated mapped information to you when it is completed.

If possible, we would welcome receiving the completed maps and forms by 15 February. The point-person for this project is Gillian Fortune at (021) 650-4742 (email: gillian.fortune@uct.ac.za) or Rifqah Roomaney at rifqah@gmail.com. Please do not hesitate to contact Gillian, Rifqah or me for clarification of any questions you might have.

Thank you so much for your time and help in this. It is most deeply appreciated

Yours sincerely,

Dr Ailsa Holloway
(Director)

CC Hennie Du Plessis

Appendix E: Impact Form (Round Two)

South Coast Flooding August 2006: Impact Assessment

Municipality: ____________________

Impact: ____________________

No	Location (Physical Address)	Town	Spatial Co-ordinates	Description of damage	Cause or contributing factors to Damage	Map reference	Cost of Damage

Appendix F: Contributors List

No.	Name	Organisation	Contact Details	Nature of Assistance *Brief Description*
1	Allisdair Macdonald	Cape Nature Conversation	044 802 5314	Environmental impact damage
2	Andre Roux	Department of agriculture	021 808 5370	Agriculture impact Information
3	Annabelle Marshal	Dept of Transport & Public Works	021-483 2827	GIS data for provincial roads
4	Ashley America	Prince Albert Muncipality	023 541 1039	Municipal impact information
5	Azaad Sayed	Municipal Infrastructure Enhancement	021 483 3214	Contact details and municipal impact information
6	Bartho Burger	Swellendam Municipality	028 514 1100	Municipal impact information
7	Bobby Nelson	George Municipality	044 803 3400	Provided information regarding evacuations, relief and serious losses
8	Boet Vermaak	Oudtshoorn Municipality	044 203 3167	Municipal budget information
9	Callie van den Heever	Department of agriculture	021 808 5369	Agriculture impact Information
10	Clive Mckay	Mossel Bay Municipality	044 606 5036	Relief operation information and insight into early warning issues.Supplied contact details
11	Colin Cyster	Dept of Local Govt and Housing	Fax: 021 483 6617	Provided Housing impact information
12	Dan Joseph	Mossel Bay Municipality	044 606 5151	Provided information about the evacuation process in Power Town
13	Dilores Wevers	Eden District	044 801 4300	Provided information to the role Social Services played in the event
14	Elmien Steyn	Western Cape Disaster Management	021 937 0822	Interview for the recovery section of report
15	Erina de Villiers	Eden District Muncipality	044 803-1314	Municipal impact information
16	Etienne Steyn	Hessequa Municipality	028-713 2418	Municipal impact information
17	Francois De Wet	Dept of Local Govt and Housing	021 483 5616	Interview for the recovery section of report
18	Frans Mouski	DWAF	021 950 7100	Hydro impact information
19	Gavin Juthe	Oudtshoorn	044 203 3014	Provided access to the different departments and gave insight to the unfolding of the event in Oudtshoorn

20	Gehard Otto	Eden District	083 630 2602	Wrote a letter on behalf of DiMP requesting the different departments to assist us with information
21	Hanes Steyn	Mossel Bay Municipality	044 606 5014	Provided information to losses to sports and recreation infrastructure
22	Hans Ottervanger	Eden provincial roads department	044-8031500	Contact details and provincial roads impact details
23	Henk Matthee	Overberg District Municipality	028 425 1157	Impact information
24	Henry Geldenhuys	Bitou Municipality	044 - 501 3260	Municipal impact and budget information
25	Hermia Damons	Oudtshoorn	044 203 3167	Municipal impact
26	Jacqui Pandaram	Western Cape Disaster Management	021 937 0806	Interview for the recovery section of report
27	Jan Steyn	Municipal Infrastructure Enhancement	021 483 3734	Impact information
28	Joe Wiese	Municipal Infrastructure Enhancement	021 483 3152	Impact information
29	Johan Pienaar	Mossel Bay	044 606 5187	
30	Johan van Zyl	Mossel Bay Municipality	044 606 5013	Provided the report from the Director of Community Services documenting the formal reports from residents
31	John Peiser	Roads Infrastructure branch	021-483 2030	Contact details
32	Jone Eksteen	George Municipality	044 801 9187	Assisted with the technical terms of the housing report
33	Lindsay Mooiman	Geoge Municipality	044-801 935	Municipal impact and budget information
34	Lorienne McCartney	Knysna Municipality	044 302 6424	Budget information data
35	Margaret Delo	Western Cape Education Department	021 467 2288	Impact information
36	Marina Murris			Interview for the recovery section of report
37	Mr A. Appels	George Municipality	044 801 9187	Provided the report done by housing which reflected the costs to losses and the areas affected
38	Mr Knoetzen	DWAF	082 808 0442	Hydro impact information
39	Nat Kaschula	Department of Education	nkaschula@pgwc.gov.za	School impacts
40	Neil Perring	Knysna Municipality	044-302 6383	Municipal impact and budget information
41	Nico Liebenberg	Mossel Bay	044 801 5264	Municipal impact information
42	Nicolas Cilliers	Roads Infrastructure branch	021-483 2030	GIS data for provincial roads
43	Norman Angel	Eden Road Authority	044 803 1300	Provincial roads impact information
44	P.Dietzsch	Bitou Municipality	pdietzsch@plett.gov.za	Municipal impact

				information
45	Paul Goedhart		44 874 4098	Impact information
46	Peter Present	Western Cape Education Department	021 467-2024	Impact information
47	Pierre Joubert	Spoornet	083 445 1946	Spoornet impact data
48	Richard Dyanti	George Municipality	044 801 9476	Provided an entry into the other relevant government departments and provided useful insight into the social development of settlements in George.
49	Ricus Fivaz		044 884-1138	Impact information
50	Rodney Nay	Knysna Municipality	044 302 6383	Municipal impact information and interview for the recovery section of report
51	Sister Vimbi	George Municipality	044 880 1181	
52	Tertius Brand	Department of Health	Tbrand@pgwc.gov.za	Flood debrief presentation
53	Tierck Hoekstra	Cape Nature	tierck@capenature.co.za	Environmental impact information
54	Viljoen Bester	Western Cape Treasury	021 483 3545	Interview for the recovery section of report
55	Vincent Gouws	Mossel Bay Municipality	044 801 5268	Municipal impact and budget information
56	Rifilwe Moletsane	Deputy CEO, SAIA	rifilwe@saia.co.za	Insured loss information