Rava (Risk and Vulnerability Assessment for the Western Cape)

Disaster Mitigation for Sustainable Livelihoods Programme (DiMP)
University of Cape Town

Executive Summary

Institutional context

In April 2002, the Provincial Tender Board approved Phase I of a Risk and Vulnerability Assessment Model for the Western Cape Province, to be undertaken jointly by the Universities of the Free State and Cape Town. Phase I of the RAVA Project represents the first step in a comprehensive risk assessment of likely disaster threats. It focuses on identifying natural and other hazards relevant to the Western Cape as well as the most appropriate institutional sources for reliable hazard information.

This report addresses the interim reporting requirement to:

- complete an audit of hazard/disaster risk information sources and organisations relevant to the Western Cape, including the nature of information storage formats, and
- prepare a draft report indicating all identified natural and human-induced disasters.

The UCT component reported here primarily reflects natural and other threats, and excludes information on droughts and floods. These two phenomena were analysed by the University of the Free State.

Methodology

To collect and consolidate relevant data/information on relevant natural and human-induced hazards in the Western Cape, three data gathering strategies were adopted:

- Participatory consultation with key stakeholders took place through three distinct processes:
  - Individual consultation with representatives from 32 municipalities
  - Consultative workshop with key stake-holders with 45 representatives of local and provincial government, members of the private sector and scientists based in technical and research institutions.
  - Individual and group consultation with over 60 scientific and technical specialists.

- Historical review of disaster occurrence and significant events, through:
  - Review of 'Declared Disasters' in accordance with the Fund Raising Act of 1978
  - Newspaper review of disasters/ and 28 significant events (1990-present)
  - Review of seven declared disasters/ and over 191 significant events recorded by Provincial Disaster Management, Government officials, private officials, scientific research organisations and NGO'S.

- Scientific characterisation of selected natural and human-induced hazards.

The scientific characterisation of priority natural and human-induced hazards included the following:

- <u>Brief technical reports characterizing specific hazards</u>, including areas most at risk, vulnerability conditions that would increase the likelihood of loss, and likely hazard impacts on future sustainable development/disaster management outcomes

- An audit and evaluation of relevant data/available information relevant to the Western Cape and related to their specific hazard type/cluster

- An assessment/proposal describing steps needed to accurately scientifically characterise the scale and scope for the specific hazard under discussion, including time and cost implications, as well as requirements for GIS processing.

Findings

Feed-back from municipalities indicated that around 78% of the priority hazards were either fires, transport accidents, floods or storms. However, six of the disasters classified under the Fund Raising Act of 1978 were weather related (the Joe Slovo fire of 26 November 2000 was worsened by gale force winds). Six of the seven events were located in the Cape Town Metropole, with five of the events occurring in disadvantaged communities. Across all processes, fires and hydrometeorological conditions (including storms and floods), as well as transport accidents feature as prominent priorities.

Consultation participants recommended that, due to resource constraints, priority should be given to characterising hazards in relation to populated areas as well as essential/critical services and environmentally/economically valuable assets/areas.

Findings: Focus on Natural Hazards

The Western Cape is exposed to a wide range of natural hazard processes that have potential to cause harm. Moreover, as human settlements continue to expand rapidly in ecologically fragile areas, including coastal regions, the probability of loss is expected to increase further. In addition, the growth of underserved and highly vulnerable informal settlements is already reflected in significant seasonal losses triggered by fire events, strong winds and heavy rainfall.

Hydrometeorological hazards are processes or phenomena of atmospheric, hydrological or oceanographic nature, which may result in the loss of life, illness or injury and property damage. The Western Cape's 1 332 km coastline, combined with its diverse climate, topography and ecology, places it at risk of a wide range of threats generated by weather, hydrological and oceanic conditions.

A significant number of previous disasters and 'significant events' have been associated with weather conditions. These include the Cape Flats floods (1994 and 2001), the Apollo and Treasure oil spill events (1994 and 2000), the Mannenberg wind storms (1999 and 2002), South Peninsula Fires (2000) and Joe Slovo informal settlement fire (2000).

There are many diverse data sources that are useful and relevant for characterising hydrometeorological hazards. Unfortunately, they have not been streamlined, standardised or made consistent for generating spatially-relevant hazard information across the Western Cape.

Geological hazards are natural earth processes or phenomena, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Although the Western Cape is not noted for its geological instability, strong seismic events in the 1960s along with repeated localised rockfalls and landslides affecting roads and other infrastructure underline the importance of this hazard cluster.

Biological threats typically refer to processes of organic origin or those conveyed by biological vectors. These include exposure to pathogenic micro-organisms, toxins and bioactive substances which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

In the Western Cape, the two most significant biological hazards concern veldfires and communicable diseases, particularly those with epidemic potential.

Focus on Human-induced Hazards

The Western Cape faces a wide range of human-induced hazards, ranging from sophisticated facilities for nuclear energy and hydrocarbon processing, to high rates of soil, water and vegetation degradation. The highly diversified nature of the province's economy, combined with its extensive port facilities and natural resource base, have resulted in areas of concentrated industrial activity, particularly in the province's ports. This is particularly the case for the Cape Town Metropole as well as locations such as Saldanha Bay. It is further reflected in extensive dependence on long-haul road, rail and sea transport capabilities to move potentially hazardous materials over long distances.

A clear challenge in auditing information concerning technological hazards relates to the wide diversity of stakeholders and interest groups. This is characterized by the involvement of a vast number of private sector players, and is similarly reflected in corporate concerns with respect to confidentiality of risk-related information. The field is also reflected in a wide range of legal instruments at different stages of implementation and with different enforcement mechanisms.

Focus on strategic services and communities at risk

In accordance with best international practice, particular attention should be given to protecting critical and strategic infrastructure. This includes electricity transmission lines that have to traverse a wide variety of landscapes and ecosystems, which are often far from any inhabited areas.

There are many communities in the Western Cape who remain highly vulnerable to a wide range of natural and other hazards. As strategic considerations are made to determine hazard assessment priorities for the Western Cape, particular attention should be focused on those communities who live in conditions of chronic endangerment and disaster vulnerability.

Recommendations

Recommendations related to the setting of research priorities

Recognising constraints with respect to time and financial resources available to this research initiative, decisions are required concerning the following five 'focus areas' are proposed.

These decision focus areas address:

- Priority hazard types
- Strategic priorities
- Scientifically robust outputs

- Effective participatory consultation
- Effective GIS outputs

With respect to priority hazard types, the following are recommended:

- As a result of the diversity of data-sets relevant to key hazard types, and lack of coverage of the Western Cape for any one hazard type, resources should be assigned to **streamlining information for (maximum) 1–3 hazard types**.

- Consideration should be given to prioritise selected streamlining of those **weather threats that can result in the most damaging impacts.**

- Consideration should also be given to streamlining **veld-fire information** for the Province.

- **The project deliverables should be revisited**, given the constraints regarding the completion of all activities foreseen (specifically the transfer of relevant and appropriate data to an integrated GIS database, mapping and printing of hazardous areas in the Western Cape and the development of a conceptual disaster decision support management tool (DSMT) to assist the Provincial Government of the Western Cape, Disaster Management in disaster management planning).

With respect to strategic priorities, the following are recommended:

- **Careful consideration should be given to deciding what deliverables are priority for the Province** (eg allocation of resources to obtain accurate hazard information for priority hazards such as veld fires and selected weather threats … or generation of generic maps with limited and/or inaccurate data).

- As it is expensive to focus time/resources on all areas of the Western Cape, priority should be given to **populated areas, strategic infrastructure/services, economically vulnerable communities and areas containing economic and environmental assets**.

- Consideration should be given to convening a consultation with key stakeholders to discuss options/constraints with respect to information-sharing.

With respect to effective participatory consultation, the following are recommended:

- A focused **consultation with key stakeholders** is convened prior to finalising mapped outputs of selected hazard types.

- **Capacity-building and support needs** of hazard information users should be assessed to guide further training activities.

With respect to the generation of scientifically robust outputs, the following are recommended:

- **The Technical Advisory Committee** established after the 3–4 October consultative workshop should continue to guide the technical outputs of the assessment.

- The methods and outputs generated by specific subject specialists should **be reviewed and verified by members of the Technical Advisory Committee** to ensure their reliability, accuracy and robustness prior to transfer into GIS.

Recommendations with respect to the GIS component of the project

<u>The following are recommended:</u>

- With respect to **hardcopy paper maps –** it is suggested that one-two sets of maps are produced (size A0) and that an additional set is included in the project report.

- The dissemination of **raster images** via e-mail or CDs **is not recommended**

- The **distribution of ArcExplorer through the Africon project should be leveraged**. It is suggested that, in the short term, RAVA data be distributed to users as ArcExplorer projects on CDs.

- The availability of **Internet GIS resources** (ie user bandwidth, GIS Internet software licenses and Web server infrastructure) from the PGWC should be assessed. If these will be available to the RAVA project in the near future, **it would be cost-effective to seriously consider this as a preferred alternative.**

- It is suggested that the **mobile device solution** is provided to users with the specific need to be able to view GIS data on mobile devices.

Acknowledgements

The Disaster Mitigation for Sustainable Livelihoods Programme (DiMP) would like to express its appreciation to a number of key people and organisations who generously gave their time and support in the course of the RAVA Hazard Assessment.

We are grateful to all those who set aside time from their busy work schedules to compile specialist reports, respond to the audit forms and to provide background information relevant to the RAVA Hazard Assessment.

In this context, we specifically would like to thank specialists who contributed their time and effort in compiling reports, namely Roy van Ballegooyen, Dirk van Bladderen, Greg Forstyh, Dr Gerhard Graham, Tom Hemsted, Bruce Hewitson, Aidan Keyes, Dr Andrzej Kijko, Dr Lindley Perryman, Professor Retief, Leigh Stubbs, Andre Theron and Carl Wainman.

We would also like to thank all of those who responded to the audit forms, namely Barry Alers, Grant Benn, Glynnis Carolissen, Trevor Fester, Frans Fik, Herman Fouché, CM Gouws, Dr Gerhard Graham, Joan Hartman, Tom Hemsted, Stephen Henkin, Richard Matzapoulos, Denver Mentor, Keith Moir, Frans Mouski, Garry Paterson, Grant Ravenscroft, Dr Cleeve Robertson, Bernadette Sheldon, Chris Snyman, Andrew Turner, Johan van den Berg and Mike Wallace.

Also those who responded to the significant events forms, namely Arrive Alive,
Jacobus Davids, P.A.M de Vos, Trevor Fester, Greg Forsyth, Elsa Green, Stephen Henkin, Cielie Karow, Johan Minnie, GM Moelich, Frans Mouski, Lavenia Nicholson, Danie Russouw, Lincoln Stander, J Swart, Roy Veldtmann and S.A Visser.

Finally we would like to thank all of those who provided background information relevant to the assessment namely Dr Emma Archer, Professor Geoff Brundrit, Mike Creswell, Kay Dabourn, Douglas Drysdale, Alfonso Fernandez, Trevor Fester, Stephen Henkin, Professor Tim Hoffman, Mervyn Knickelbein, Professor Kratz, Proffesor Mike Meadows, Dr Hassan Mohammed, Anton Moulden, Kerry Murphy, Craig Northmore, Terence Parker, Grant Ravenscroft, Ted Rowen, Bernadette Sheldon, Mike Smart, Mike Wallace and Hein Vosloo.

Finally, our appreciation is expressed to Schalk Carstens and his team in Provicial Disaster Management for their ongoing support to this initiative.

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PART V Presentation of Findings: Focus on Human-Induced Hazards

List of acronyms and abbreviations

amax	Maximum Credible Acceleration
ASCII	American Standard Code for Information Interchange
BCLME	Benguela Current Large Marine Ecosystem
BMP	Best Management Practice
CMC	Cape Metropolitan Council
CNC	Cape Nature Conservation
CPD	Chapmans Peak Drive
CSAG	Climate Systems Analysis Group
CSIR	Council for Scientific and Industrial Research
DEAT	Department of Environmental Affairs and Tourism
DiMP	Disaster Mitigation for Sustainable Livelihoods Programme, University of Cape Town
DiMTEC	Disaster Management Training and Education Programme, University of the Free State
DMISA	Disaster Management Institute of Southern Africa
DMS	Disaster Management System for the Western Cape
DSMT	Decision Support Management Tool
DWAF	Department of Water Affairs and Forestry
FDI	Fire Danger Index
FLODSIM	Flood Damage Simulation Model for Irrigation Areas
FPAs	Fire Protection Associations
g	Gravity
GEMC3	Global Emergency Monitoring Command and Control Centre system
GIMS	Geographic Information Management Systems
GIS	Geographic Information System
GOOS	Global Ocean Observing System
GPS	Global Positioning Satellite
hazmat	Hazardous Material
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
IFAW	International Federation for Animal Welfare
IMT	Institute of Maritime Technology
IPCC	International Panel on Climate Change
ISCW	Institute for Soil, Climate and Water
MAFD	Mean Annual Flood Damage
MCM	Marine and Coastal Management, DEAT
MHI	Major Hazardous Installation
Ml	Local Magnitude
mmax	Maximum Regional Magnitude
MRC	Medical Research Council
MTO	Mountain to Ocean Forestry Pty Ltd
NGOs	Non-governmental Organisations
NNR	National Nuclear Regulator
NPA	National Ports Authority of South Africa
NSRI	National Sea Rescue Institute
PAFTECH	Provincial Advisory Forum Technical
PAWC	Provincial Administration: Western Cape

PDA	Personal Digital Assistant
PGA	Peak Ground Acceleration
PLAAS	Programme for Land and Agrarian Studies
PSC	Provincial Steering Committee for Rava
PSHA	Probabilistic Seismic Hazard Assessment
Rava	Risk and Vulnerability Assessment for the Western Cape
Ropes	Regional Ocean Modelling and Prediction System
SADC	Southern African Development Community
Sadco	Southern Africa Data Centre for Oceanography
Safcol	South African Forestry Company Ltd
SA-ISIS	South African Integrated Spatial Information System
Samsa	South African Maritime Safety Authority
SANDF	South African National Defence Force
SANRAIL	South African National Road Agency Limited
SAPS	South African Police Service
SAWS	South African Weather Service
SRK	Steffen, Robertson and Kirsten Consulting
TAG	Technical Advice Group for Rava
TB	Tuberculosis
TEWA	Tangible Economic Damage Flood Water Damage Assessment
UCT	University of Cape Town
UFS	University of the Free State
WAP	Wireless Application Protocol

Part I Background and Focus for the Report

1.1 Introduction

In April 2002, the Provincial Tender Board approved Phase I of a Risk and Vulnerability Assessment Model for the Western Cape Province to be undertaken jointly by the Universities of the Free State and Cape Town. For the location of the Western Cape in relation to South Africa, refer to figure 1.1.1

Figure 1.1.1
Map of the Western Cape in relation to South Africa

Administrative Districts of the Western Cape

This initiative aims to achieve the following activities by March 2003:

- Completion of an audit of existing information and data on likely natural, technological and compound hazards in the Western Cape
- Identification of all potential disaster hazards for the Western Cape
- Transfer of relevant and appropriate data to an integrated GIS database
- Mapping and printing of hazardous areas in the Western Cape
- Development of a conceptual disaster support management tool to assist the Provincial Government Western Cape, Disaster Management in disaster management planning
- Consultation with other disaster management stake-holders and user-groups who may use the information and the DSMT
- Reporting on activities in Phase I
- Completion of a project proposal for Phase II and III to fully complete the research and project for the Western Cape

The project, now known as *RAVA* (Risk and Vulnerability Assessment), is consistent with requirements underlined in South Africa's forthcoming *Disaster Management Act*. This legislation places clear emphasis on disaster mitigation and prevention, as well as efforts that improve the identification of high-risk areas and communities.

Phase I of the RAVA Project represents the first step in a comprehensive risk assessment of likely disaster threats. It focuses on identifying natural and other hazards relevant to the Western Cape as well as the most appropriate institutional sources for reliable hazard information.

This report addresses the interim reporting requirement to:

- complete an audit of hazard/disaster risk information sources and organisations relevant to the Western Cape, including the nature of information storage formats, and
- prepare a draft report indicating all identified natural and human-made disasters

1.2 Structure of this report

This interim report will begin by reflecting the conceptual framework used to guide the research undertaking and the methodology applied for collecting and consolidating disaster and hazard related information. It will present consolidated findings from the assessment and interpret these, with recommendations for the remaining months of Phase I RAVA.

Specifically, the report is organised as follows:

Part II	Presentation of the hazard assessment methodology used
Part III	Presentation of findings: Insights from consultative processes along with historical review of disasters and 'significant events'
Part IV	Presentation of findings: focus on natural hazards
Part V	Presentation of findings: focus on human-induced hazards

Part VI	Presentation of findings: focus on strategic services and vulnerable communities
Part VII	Conclusions and Recommendations

1.3 Institutional arrangements and constraints

For the purpose of this interim report, tasks were divided between the Universities of the Free State and Cape Town. Research undertaken by UCT took place between end July–November 2002.

The UCT component reported here primarily reflects natural and other threats, and excludes information on droughts and floods. These two phenomena were analysed by the University of the Free State.

While the report below is a comprehensive first step towards collecting and compiling information on disaster occurrence and hazard patterns, it has been constrained by several key factors:

1) While considerable hazard-related information exists in many government departments, research institutions and private companies, **this is not streamlined**.

2) There is **not one hazard type for which consistent and uniform information exists for the entire Province**. As an example, this constraint has required the research team to seek-out, identify and contact as many as five to ten different institutions for a single natural hazard, increasing the complexity of the research task.

3) For technological hazards such as 'hazardous materials', the task has been further compounded by the **diversity of private sector partners involved**, as well as the **multitude of government and professional** regulatory mechanisms that exist for this hazard category.

4) In this regard, the research team's ability to audit existing information related to critical services has been **constrained by current national security concerns**. Such discomfort about disclosing critical information to outside organisations is to be fully expected, given recent bomb explosions and the possibility of further attacks to essential infrastructure/critical services.

5) Given the emergent nature of this field in South Africa, many of the government, private sector and research institutions approached had a **low level of awareness about the relevance of their work to disaster risk reduction**. Many datasets highly relevant to this study are maintained for reasons other than hazard evaluation. This resulted in the research team spending extensive time explaining the scope of the research project, and creatively exploring links between potentially relevant databases and this initiative (eg the Medical Research Council's database on road-accident victims to potentially dangerous road crash sites).

6) **As no priorities or parameters for the hazard assessment were provided**, the scope of the assessment was extremely wide. The internationally accepted definition of a 'hazard' is *a potentially damaging physical event, phenomenon and/or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.* [1] Without more specific parameters, **the range of potential natural and other hazards is almost endless.** Therefore, in-depth analysis of a more limited and specific range of hazards was not possible given the time available.

7) **Full engagement of the UCT research team only became possible in late July**, after the implementing agreement between the Universities was signed. This imposed extreme time-constraints for the research, and allowed for only 3½ months to complete the audit before the report submission date of 8 November.

[1] ISDR (2002) *Living with Risk: a global review of disaster reduction initiatives*, p. 339

Part II Hazard Assessment Methodology

2.1 Introduction to this section

The Western Cape is exposed to a wide range of potential natural and other hazards. Despite this, there has been little systematic collection and consolidation of information either on hazard occurrence or disaster events.
Part II describes the research methods used to collect and consolidate information, including consultative processes involving more than seventy practitioners and subject specialists, an audit of disaster and 'significant' events (1990–present) and technical reviews for selected hazard clusters.

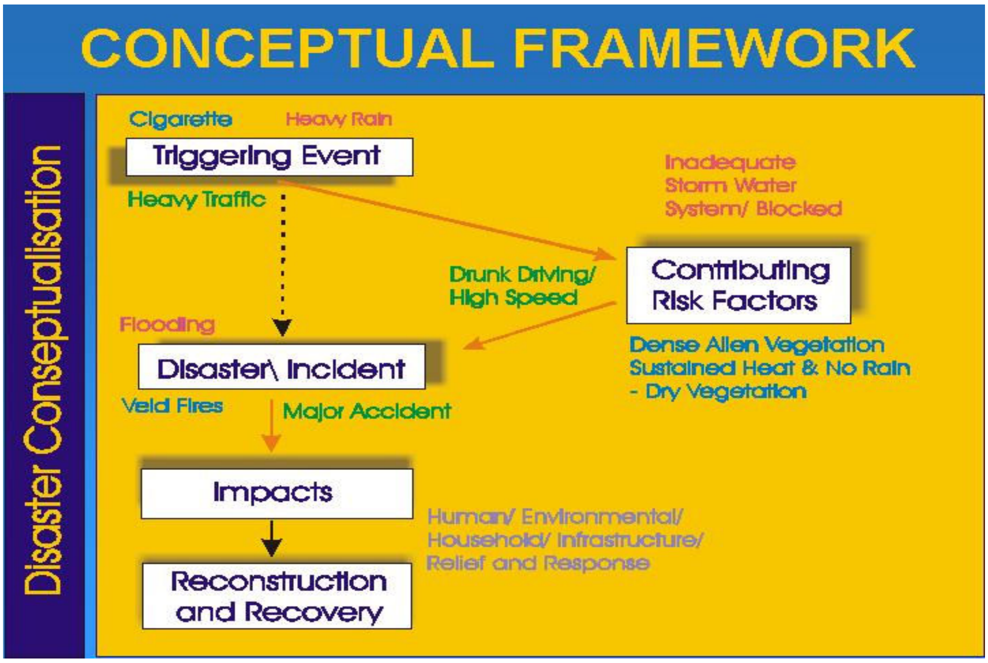
This section addresses the following areas:

- Conceptual framework guiding the research process
- Assessment methods used in this study, specifically:
    - participatory consultation
    - historic review of disaster occurrence
    - scientific/technical review of selected natural and human-induced hazards
- The information and data consolidating process

2.2 Conceptual framework used in this study

To guide the overall representation of hazards, vulnerabilities and disasters, the research process was informed by the conceptual framework represented in Figure 2.2.1.

Figure 2.2.1
Disaster Risk Conceptual Framework



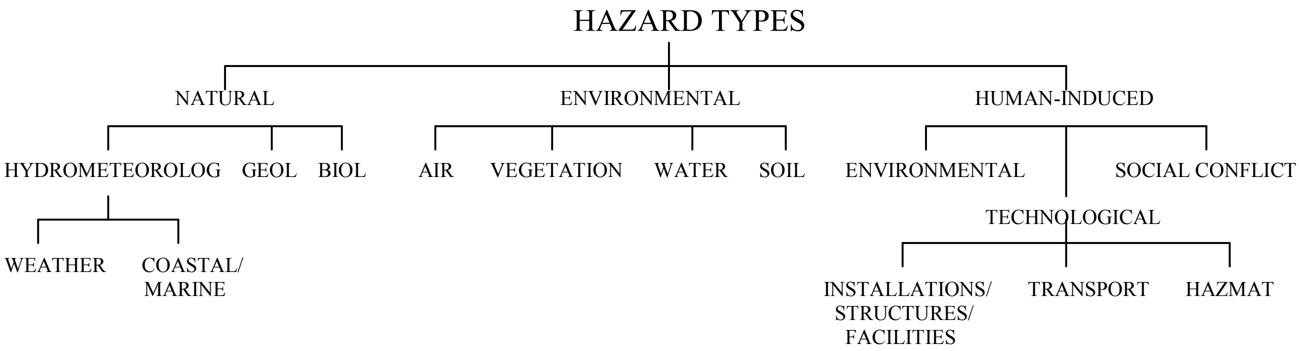
This approach views disaster events as the outcome of interaction between hazards (‘triggering events’) and conditions of vulnerability (‘contributing risk factors’). A disaster occurs when a community, structure, ecosystem, or service is unable to resist, withstand, manage or recover from the impact of a ‘hazard event/process’ without external assistance.

In this conceptualisation, the term ‘hazard’ is not viewed as synonymous with ‘disaster’. Hazards are viewed as natural/other phenomena both *with potential to cause harm*, but often with considerable *potential to bring benefits.* Such an approach views phenomena like seasonal floods and fynbos fires as ecologically necessary for the natural environment. However, it also recognizes that the continuing expansion of developed areas into natural habitats increases the probability of damaging hazard impacts, as well as human, economic, infrastructural and other losses.

The conceptual framework adopted here gives priority not only to identifying natural and human-induced hazards for the Western Cape. It also emphasizes the importance of key vulnerability factors and intervening conditions that increase the probability of human, economic, infrastructural and environmental losses for specific hazard clusters. In this regard, it acknowledges that hazards differ with respect to their origin (natural or human-induced) and effects. Hazards may be further differentiated by their area extent, speed of onset (ie slow-onset or sudden onset), frequency/probability, magnitude and duration).

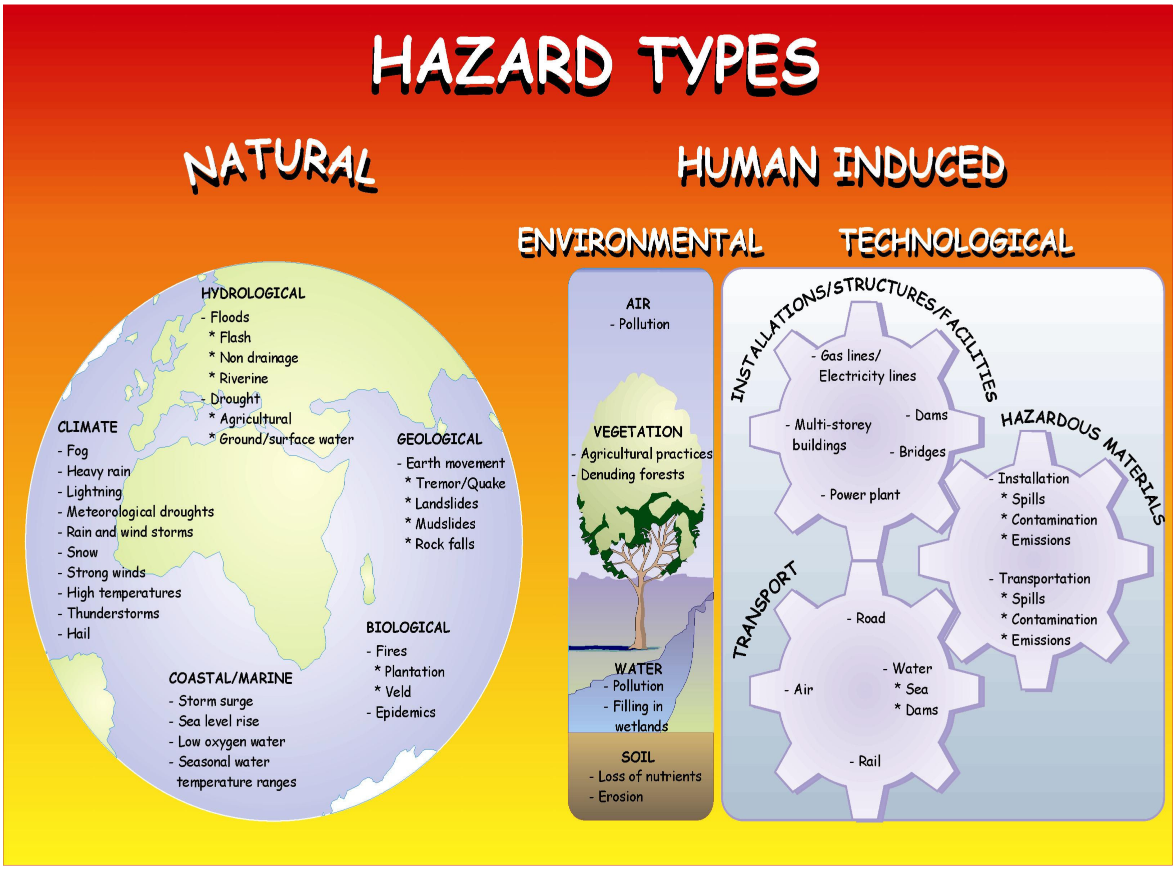
In this context, the study classified hazards according to widely accepted international criteria, as reflected below in figure 2.2.2 and figure 2.2.3.

Figure 2.2.2
Organogram of Hazard Types



* An important human-induced hazard cluster refers to *Social Violence.* This incorporates sub-categories of *weapons, perpetrators and methods.* While this is indeed a critical hazard cluster, it represents a highly specialized hazard type that requires focused research beyond the scope of this study.

Figure 2.2.3
Graphical representation of Hazard Types



Compound hazards refer to destructive or damaging events/processes involving two or more sub-categories of the hazard types listed above. For instance, 'smog' results from (fog + air pollution) (inversion + sunlight + pollution).[2] Many significant disaster events in the Western Cape occur as the result of compound hazard processes (eg estuarine flooding following a severe frontal storm could reflect the interaction between heavy rainfall inland and storm surge conditions, exacerbated by coastal erosion).

For the purposes of this first report, the research process set aside a review of complicated compound hazard processes to focus specifically on:

- Identifying the **primary natural and human-induced hazard processes** relevant to the Western Cape, and areas/communities most at risk from such endangering events
- Describing the **conditions that increase the probability of harmful impacts** from hazard events/processes
- Identifying **relevant datasets and information gathering processes** that already exist for these hazard processes

[2] Hewitt, K., (1997) *Regions of Risk: A geographical introduction to disasters,* Addison Wesley Longman Limited, pp. 55–58

- Outlining **steps necessary to characterize the probabilities / magnitudes of hazard occurrence** across the Western Cape for inclusion in a consolidated GIS

For the purposes of this study, the following working definitions are used:

Table 2.2.4
Disaster definitions

Term	**Definition**
Disaster	A serious disruption of the functioning of a community or society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community/society to cope by using its own resources.
Significant hazard event	An event of significant magnitude that either results in human, environmental, infrastructural or other losses, or requires outside assistance to avert serious losses.
Hazard (also shock, threat)	A potentially damaging physical event, phenomenon and/or human activity which may cause the loss of life, illness or injury, property damage, social and economic disruption or environmental degradation.
Hydrometeorological hazards	Natural processes or phenomena of atmospheric, hydrological or oceanographic nature, which may result in the loss of life, illness or injury, property damage, social and economic disruption or environmental degradation.
Geological hazards	Natural earth processes or phenomena that may result in the loss of life or injury, property damage, social and economic disruption or environmental degradation.
Biological hazards	Processes of organic origin or those conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances that may result in the loss of life or injury, property damage, social and economic disruption or environmental degradation.
Human-induced hazards	Hazards that are induced by human processes, including environmental degradation, technological hazards and social violence.
Technological hazards	Danger originating from technological or industrial accidents, dangerous procedures, infrastructure failures or certain human activities that may result in the loss of life or injury, property damage, social and economic disruption or environmental degradation.
Hazard analysis	Identification, studies and monitoring of any hazard to determine its potential, origin, characteristics and behaviour.
Vulnerability	A set of conditions and processes resulting from physical, social, economic and environmental factors, which may increase the susceptibility of a community to the impact of hazards.
Disaster risk	The probability of harmful consequences or expected loss resulting from interactions between natural or human-induced hazards and vulnerable/capable conditions.
Environmental degradation	Processes induced by human behaviour and activities (sometimes combined with natural hazards), that damage the natural resource base or adversely alter natural processes or ecosystems.

2.3 Hazard assessment methods used in this study

There are different methods for identifying natural and other hazards. These typically combine *deductive* and *inductive* strategies to characterize hazard occurrence, by:

- Reviewing the history of hazard impacts and their consequences
- Developing 'hazard scenarios' using appropriate science to determine and then map the extent of an area likely to be affected by a scenario event (eg 1:100 year flood)[3]

Disaster and hazard historical records provide information to deduce levels of risk based on past experiences. In addition, they help identify the qualitative aspects involved in assessing vulnerability to specific hazards. Moreover, they help 'overcome the inherent problem that human memory tends to be significantly shorter than the return period of most hazard phenomena'.[3]

'Hazard scenario mapping' complements this by integrating layers of scientific information into a Geographic Information System to reflect the likely spatial distribution of hazard occurrences of different magnitudes.

Historic review of disaster and hazard event records, together with scientific assessments of hazard occurrence probabilities, are viewed as the most objective approaches for characterising key hazards. However, the findings they generate may not necessarily 'match' individual perceptions of disaster risk. To be effective, they ideally should be complemented by processes that ensure *participatory consultation with key stakeholders* on what constitutes stakeholder perceptions about priority hazards.

Therefore, to collect and consolidate relevant data/information on relevant natural and human-induced hazards in the Western Cape, three data gathering strategies were adopted:

- Participatory consultation with key stakeholders
- Historic review of disaster occurrence and 'significant events'
- Scientific characterisation of selected natural and human-induced hazards

2.3.1 Participatory consultation

Extensive attention was given to a broad-based consultation with a wide range of government, private sector and scientific stakeholders. During the course of the study more than 156 people were contacted and consulted, as reflected in Table 2.3.1.1. This not only ensured the inclusion of a wide range of opinions and perspectives, it also achieved immediate 'process' outcomes in areas such as capacity-building, shared ownership of the initiative and project 'fine-tuning' in response to practical suggestions from both information providers as well as likely users.

[3] Granger, K., (2000) *An Information Infrastructure for Disaster Management in Pacific Island Countries,* The Australian Journal of Emergency Management, 15:1, pp. 20–32

Table 2.3.1.1
List of people contacted and consulted

Type	Government			Private Sector	Universities	Research Institutions
	Local	**Provincial**	**National**			
Natural						
Hydrometeorological						
General						
Coastal/Marine					1	2
Climate						2
Hydrological		5	1	2		
Geological						
Earthquake						2
Rockfalls/Landslides						
Biological						
Fires	3	4		6	1	3
Epidemics	1	4				
Human-Induced						
Environmental						
Air Pollution	1	2				
Vegetation						
Soil Degradation		2		3	3	1
Technological						
Installations/Structures/ Facilities		1		9	6	1
Transport		3	5	3		3
Hazardous Materials	6	4		12		2
Total						
	11	25	6	35	11	16

Participatory consultation took place through three distinct processes:

- Individual consultation with representatives from municipalities
- Consultative workshop with key stakeholders
- Individual and group consultation with scientific and technical specialists

Individual consultation with representatives from Western Cape municipalities
Following the PAFTECH meeting of 26 July, 2002 at Lambert's Bay, a questionnaire was circulated to all 32 municipalities, as reflected in figure 2.3.1.2, requesting local opinions concerning priority natural and other hazards (refer Annex C–1). Information was also sought on existing research reports about natural and other threats.

Figure 2.3.1.2
Map of all municipal districts in the Western Cape

Municipal Districts of the Western Cape

In addition, disaster management representatives from municipalities were also consulted for information on 'significant disaster events' since 1990, as well as data on 'level 3 hazardous materials spills' recorded since 1990 (refer Annex C–3). This information was sought locally, as there is at present no mechanism that effectively consolidates municipal information on such events at provincial level.

Consultative workshop 3–4 October 2002, Cape Town Lodge
On 3–4 October, a consultative workshop was held at the Cape Town Lodge to present current information on selected natural and other threats, and to guide the research process. (Refer to Consultative Report and CD's) Attended by 45 scientists and researchers, representatives of local and provincial government, as well as specialists

from the private sector, the forum provided a useful opportunity for multi-disciplinary engagement on priority hazards, along with suggestions on mapped outputs and technical collaboration.

Individual and group consultation with scientific and technical specialists
The Western Cape has a wealth of scientific and technical expertise relevant to hazards and disasters. Both prior to and following the Consultative Meeting, a wide range of specialists were consulted on the scale and frequency of different hazard processes. Moreover, as one of the recommendations at the Consultative Meeting was the establishment of a Technical Advisory Committee to guide the project, this group convened on Monday, 14 October to clarify scientific deliverables for the research (refer Annex D).

2.3.2 Historic review of disaster occurrence and 'significant events'

As historic review constitutes a key component of a comprehensive audit of natural hazards, and given the absence of consolidated reports on 'significant hazard events' this was undertaken using the following methods:

- Review of 'Declared Disasters' in accordance with the Fund Raising Act of 1978
- Newspaper review of disasters/'significant events' (1990–present)
- Review of disaster/'significant events' recorded by Provincial Disaster Management
- Requests for information on 'significant events' from municipalities and subject specialists

Review of 'Declared Disasters' in accordance with the Fund Raising Act of 1978
Disaster declarations for the Western Cape gazetted from 1990–2002 were reviewed, resulting in the identification of seven distinct events.

Newspaper review of disasters/'significant events' (1990–present)
Articles from the Cape Argus than span over more than 10 years were reviewed to determine disasters or 'significant events'. This resulted in the identification of 28 events as reflected in Table 3.3.2.1, Part 3.3.

Requests for information on 'significant events' from municipalities and subject specialists
More than 80 technical and scientific specialists, as well as representatives from municipalities and selected nongovernmental organisations were consulted (refer Annex B) for information on disasters and 'significant events' relevant to their field since 1990. This resulted in the identification of 219 events as reflected in Table 3.3.2.1, Part 3.3.

2.3.3 Scientific review of natural and other hazards

It is recognized international best practice to incorporate specialist opinion on the likely impact of known hazard processes into assessments that inform disaster reduction decision-making. In this context, the opinions of more than 60 technical specialists were sought in connection with a wide range of natural and human-induced hazards relevant to the Western Cape. In addition to reporting back on disasters and significant events specific to their respective fields, they were also approached to provide:

- **Brief technical reports** characterising specific hazards, including areas most at risk, vulnerability conditions that would increase the likelihood of loss, and likely hazard impacts on future sustainable development/disaster management outcomes (refer Annex D).
- An **audit and evaluation of relevant data/available information** relevant to the Western Cape and related to their specific hazard type/cluster.
- **An assessment/proposal describing steps needed** to accurately scientifically characterise the scale and scope for the specific hazard under discussion, including time and cost implications, as well as requirements for GIS processing.

2.4 The information and data consolidating process

Responses from the newspaper review as well as questionnaires distributed to municipalities and technical specialists were consolidated into tables and graphs in Parts III and IV. Specialist reports on natural and human-induced threats were consolidated into their respective sections. Specialist assessments auditing existing data sets and hazard-related information were consolidated in summary tables in sections 3.5 and 4.5. Similarly, the cost and time implications involved in characterising specific hazards for mapping purposes are also summarised in sections 3.5 and 4.5.

Part III Presentation of Findings: Insights from consultative processes along with historical review of disasters and 'significant events'

3.1 Introduction

Findings through consultation as well as a historical review of disasters and 'significant events' provided extremely useful insights on practitioner priorities with respect to disaster risk, as well as the frequency and severity of hazard impacts across the province. This section consolidates findings from these processes:

Part 3.2 focuses on the feedback provided from questionnaires distributed to municipalities

Part 3.3 presents findings from historical reviews of officially 'declared disasters'. It also presents information on 'significant events' derived from newspaper records and opinions of both subject specialists as well as municipal representatives

3.2 Feedback from consultative processes

Two consultative processes were undertaken to identify those hazards considered to be of greatest concern. These included the distribution of questionnaires to municipal managers following the PAFTECH meeting in Lambert's Bay (26 July, 2002) and the consultation convened at the Cape Town Lodge from 3–4 October.

3.2.1 Feedback from municipalities

Hazard assessment questionnaires (Annex C.1) were distributed to 32 Western Cape municipalities. Of these, 22 were completed and returned to DiMP/UCT. The seven hazard types considered most important are reflected in Table 3.2.1.1.

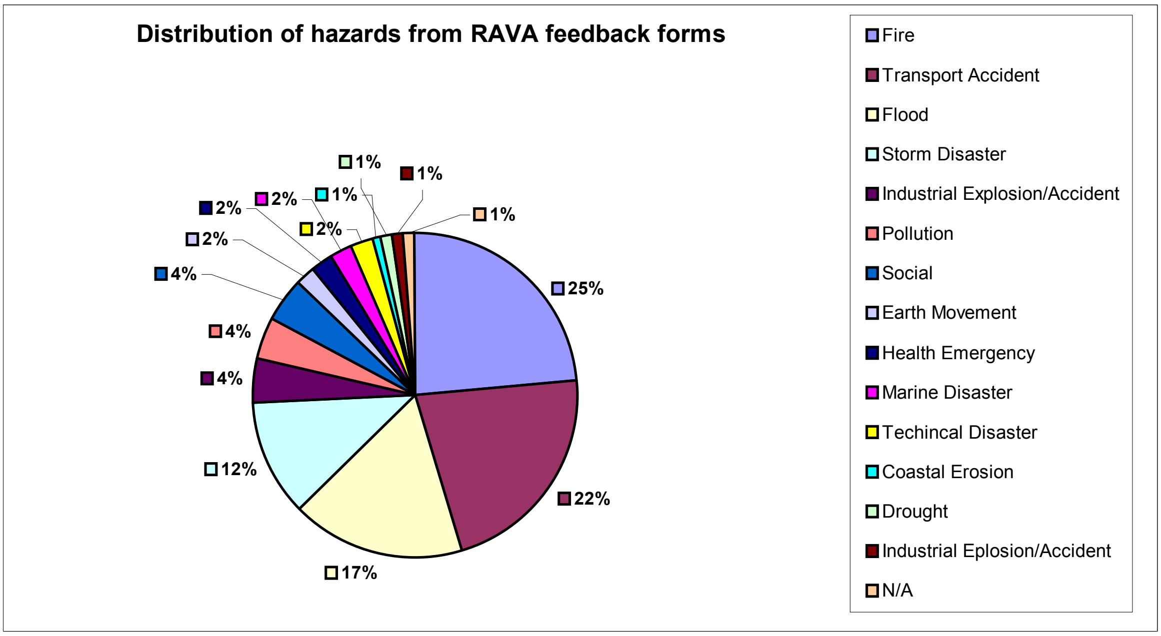
Table 3.2.1.1
Municipality feedback on priority hazards in the Western Cape:

Hazard type	Number of responses	% all responses*
Fires	22	25
Transport accidents	19	22
Floods	16	17
Storms	11	12
Industrial explosion/accident	4	4
Pollution	4	4
Social emergency	4	4
Total		88

* does not total 100% , as table includes the seven hazards most frequently mentioned

Figure 3.2.1.2

Distribution of hazard priorities reported from municipalities



Feedback from municipalities indicated that around 78% of the priority hazards were either fires, transport accidents, floods or storms.

3.2.2 Consultative meeting

To take advantage of this local expertise, a consultative workshop was convened on 3–4 October, which brought together 45 representatives of local and provincial government, members of the private sector and scientists based in technical and research institutions. The scientific presentations on subjects as diverse as climate change and nuclear energy underlined the diversity of risks in the Western Cape, as well as the expertise available to address them.

The consultative process indicated a clear need for greater interaction between those involved in development planning and disaster management at local and provincial levels, and their scientific colleagues involved in researching hazard-related fields. The compelling nature of the input provided by subject specialists resulted in the conclusion that all hazard types presented at the meeting should be viewed as priority areas. However, participants recommended that, due to resource constraints, priority should be given to hazards in populated areas as well as essential/critical services and environmentally/economically valuable assets/areas.

The presentations also underlined the need for specialist input to interpret the range of data provided from different sources for governmental planning purposes. A detailed workshop report and CD containing all presentations was provided to all those who attended.

3.3 Findings from historical reviews, newspaper reviews and opinions of subject specialists/practitioners

3.3.1 Historical review of declared disasters

Official government documents generated from national, provincial and local levels were reviewed to identify formally gazetted disaster declarations from 1990–present. This resulted in seven events being identified, which are summarised below in Table 3.3.1.1.

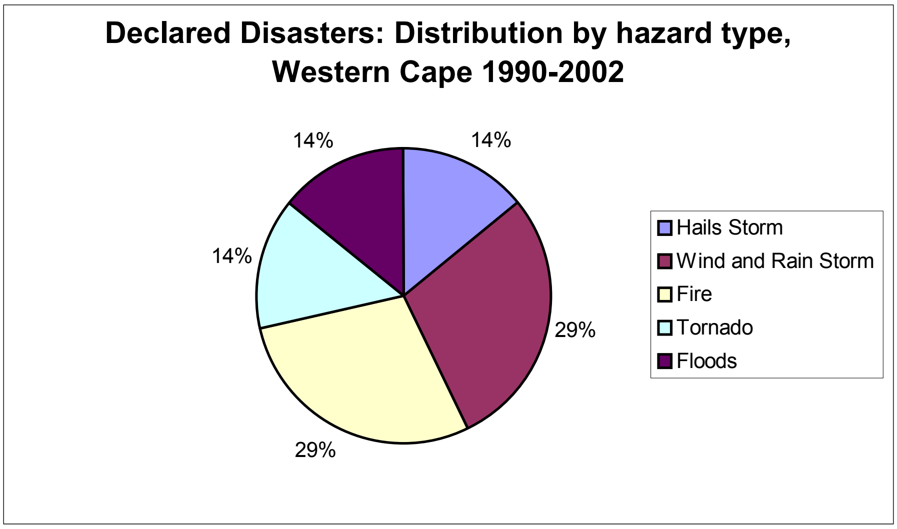
Table 3.3.1.1
Declared Disasters: 1990–2002, Western Cape Province

Hazard type	**Type**	**Date of Disaster**	**Area(s) Affected**	Date Declared
Hydro meteorological	Hail Storm	19 April 1994	Oudtshoorn	3 May 1994
Hydro meteorological	Storm	26–28 April 1994	Magisterial District of Wynberg	29 June 1994
Hydro meteorological	Storm	26–28 April 1994	Magisterial District of Cape Town	29 June 1994
	Informal Fire	20–21 January 1996	Marconi Beam and Khayelitsha	
Hydro meteorological	'Tornado'	29 August 1999	Manenberg, Guguletu, KTC, Lusaka, Tambo Village, Tambo Square and Surrey Estate	1 September 1999
	Informal Fire	26 November 2000	Joe Slovo	8 December 2000
Hydro meteorological	Floods	16 July 2001	Browns Farm, Phola Park, KTC, Monwood, Oscar Mpetha, Marcus Catrey Rasta Village, New Arest, Tambo Square, Schaapskraal, Millers Park, Kosovo, Phillippi, Sweet Home, Cross Roads and certain areas of Athlone	27 August 2001

Note:
There have been 7 disasters declared under the Fund Raising Act (1978) for the Western Cape for the period of 1990–present of which 71% are of hydro meteorological origin.

Five of these are of hydrometeorological origin. However, six of the disasters classified under the Fund Raising Act of 1978 were **weather related** (the Joe Slovo fire of 26 November 2000 was worsened by gale-force winds). Six of the seven events were located in the **Cape Town Metropole**, with five of the disasters occurring in **disadvantaged communities**. The distribution of these events by type is shown in Figure 3.3.1.2.

Figure 3.3.1.2
Declared disasters in the Western Cape – distribution by type



3.3.2 Newspaper review and feedback from subject specialists and practitioners

The limited number of officially declared events restricts the scope of analysis, as it reflects relatively rare events with large-scale human and economic impact. Therefore, to complement this, a review of newspaper articles for the period 1990–2002 was undertaken. This was further complemented with input from subject specialists and practitioners who were asked to reflect on 'significant events' from 1990–2002 relevant to their area or field of expertise.

Unfortunately, only 8/30 representatives from municipalities responded to this request. Clearly their input is not fully representative of all municipalities within the Western Cape. Moreover, only one subject specialist reported on 'significant events' related to his field of expertise.

The term 'significant event' is described below:

A significant event is defined in reference to the external support that is required in times of a crisis. 'External support' could refer to Red Cross or Salvation Army, a fire tender assisting from another municipal district etc. A significant event is not declared as a disaster.

In this context, 'significant events' were presented as relative occurrences, thus reflecting the size of a municipality along with its capacity to deal with an incident rather than externally applied criteria with respect to loss. In this way, 'significant events' were expected to vary from municipality to municipality. For instance, it was expected that an event might be 'significant' for a smaller municipality with less resources and manpower but 'not significant' for one with the capability to deal with the event.

A total of 219 'significant events' were reported by resource people contacted and gathered from newspaper articles. These are reflected in Table 3.3.2.1 and Figure 3.3.2.2.

Table 3.3.2.1
'Significant events' – number of events reported by each source

Source	Fire	Flood	Spill	Transport* Accidents	Marine Hazard	Structure Failure	Storm	Snow	Emission	Total
Municipal Managers/ Government Officials	26	22	12	80	6	2	4	1	1	**154**
Private Organisation	0	3	0	0	0	0	0	0	0	**3**
Scientific/ Research Organisation	15	0	0	0	0	0	0	0	0	**15**
NGO	16	2	1	0	0	0	0	0	0	**19**
Newspaper	19	2	2	2			1		2	**28**
Total	**76**	**29**	**15**	**82**	**6**	**2**	**5**	**1**	**3**	**219**
Percentage	**34.7**	**13.2**	**6.8**	**37.4**	**2.7**	**0.9**	**2.3**	**0.46**	**1.4**	**99.9**

Note:

- 200 shacks destroyed is considered significant
- 10 000 hectares destroyed in a veld fire is considered significant
- 4 cars/fatalities involved in road accidents is considered significant
- 63/82 events were reported from Spoornet (76.8%)

Figure 3.3.2.2
Graph showing distribution of reported 'significant events'

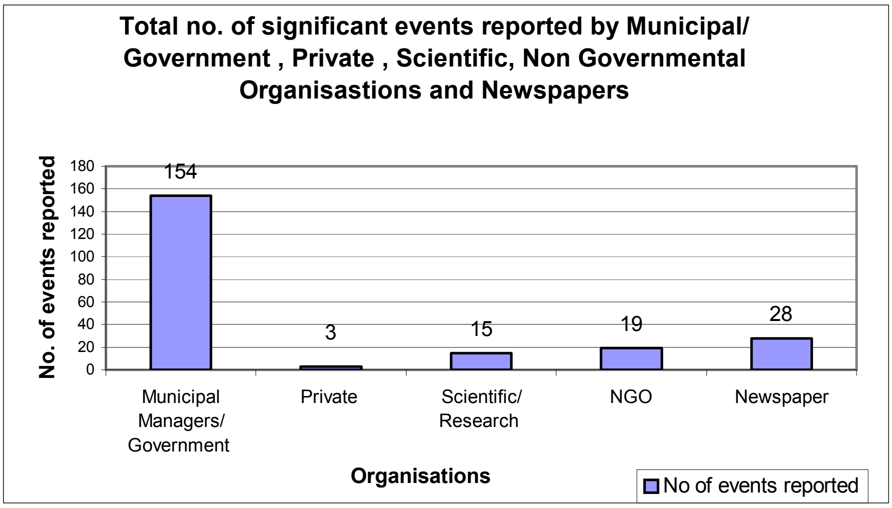
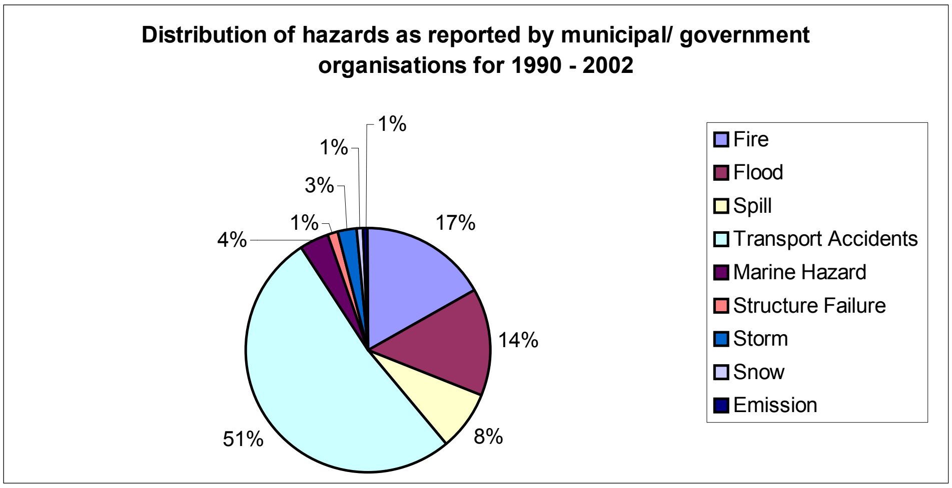


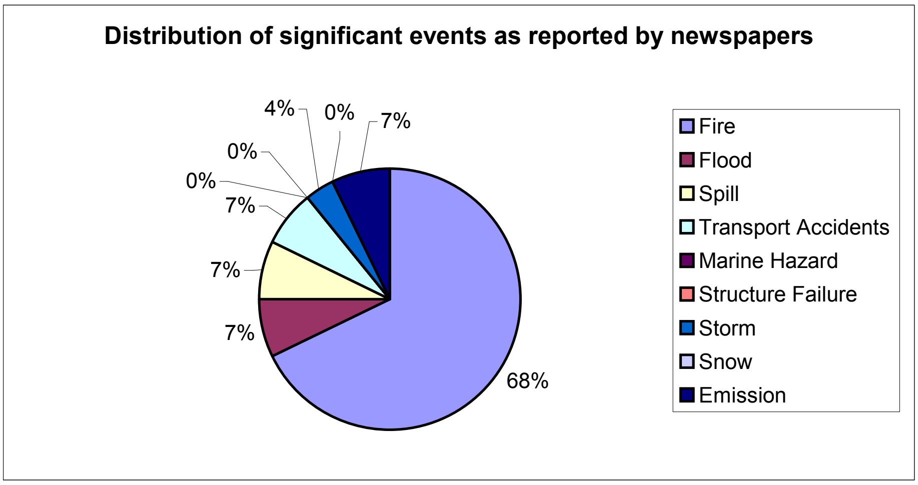
Figure 3.3.2.3
Distribution of 'significant events' as reported by municipal/government organisations



These findings illustrate the influence of work responsibilities and current job descriptions on what is perceived as ‘significant’. For instance, 51% of all responses from representatives from government/Spoornet gave priority to transport accidents. When the Spoornet reports are removed, ‘significant events’ were given priority in this order. Fires (28.6%), floods (24.2%), transport accidents (20.9%), spills (13.2%). This more closely approximates the feedback provided by the questionnaires distributed to municipalities.

The priority on fire was also illustrated by the newspaper reports (68%) compared to 7% each for floods, spills, transport accidents and emissions (refer Figure 3.3.2.4). Interestingly, 89% of all newspaper reports identified gave priority to informal settlement fires, compared to11% for veld fires.

Figure 3.3.2.4
Distribution of ‘significant events’ as reported by the Cape Argus (1990–2002)



3.3.2 Conclusion

The findings presented from the declared disasters, newspaper review, and insights from subject specialists and practitioners illustrate several points: Firstly, it is clear that the majority of 'declared disasters' are triggered or worsened by weather conditions. However, they tend to have a greater impact on people, infrastructure and economic activities than on the natural environment (eg 2000 South Peninsula Fires and Treasure oil spill). In this context, the most powerful impact is noted in economically disadvantaged and under-served communities.

'Significant events', however, clearly reflect the field of expertise of many of those consulted. With respect to disaster management activities, many practitioners respond to fires as the major priority for their work, and they are also responsible for managing hazardous materials spills. When other municipal services lack capacity, disaster management practitioners step in to manage/coordinate an emergency response, for instance transport accidents.

Reports indicating awareness of environmentally 'significant events' were almost non-existent. Recognising the increasing patterns in disaster risk as human settlements push back into ecologically fragile areas (ie urban fringe conditions, coastal/marine developments), these risk categories are likely to become more significant in the future.

Across all processes, fires and hydrometeorological conditions (including storms and floods), as well as transport accidents feature as prominent priorities.

Part IV Presentation of Findings: Focus on Natural Hazards

4.1 Introduction

The Western Cape is exposed to a wide range of natural hazard processes that have potential to cause harm. Moreover, as human settlements continue to expand rapidly in ecologically fragile areas, including coastal regions, the probability of loss is expected to increase further. In addition, the growth of underserved and highly vulnerable informal settlements is already reflected in significant seasonal losses triggered by fire events, strong winds and heavy rainfall.

This section provides information on natural threats in the following sub-parts:

Part 4.2	provides an overview of natural threats in the Western Cape
Part 4.3	focuses specifically on hydrometeorological threats, including weather-related hazards, riverine floods and marine/coastal threats
Part 4.4	addresses issues around geological hazards, specifically seismicity, land slides and rock falls
Part 4.5	focuses on biological hazards, notably veldfires and communicable diseases such as tuberculosis
Part 4.6	summarises research costs for completing reliable assessments for selected natural hazard types/clusters

4.2 Overview of natural hazards in the Western Cape

The profile of declared disasters in the Western Cape underlines the Province's marked exposure to a wide range of natural threats, in which 6/7 disasters since 1990 were triggered or made worse by weather conditions.

In this context, the Province faces a variety of sudden onset hazards, including seismic hazards with the potential for localised earth instabilities. The Western Cape's long coastline is exposed to frontal weather conditions, as well as the consequences of periodic oil spills and coastal erosion.

Moreover, its diverse vegetation exposes it to periodic 'natural fires' that are essential for regeneration of fynbos. However, the combination of expanding human settlements and alien plants in the natural ecosystems, have been increasing the severity of these fire events.

Lastly, while the Western Cape has not historically experienced significant epidemic outbreaks, it has one of the highest tuberculosis infection rates worldwide.

This diversity of these threats is explored in the sections below.

4.3 Hydrometeorological threats

Hydrometeorological hazards are processes or phenomena of atmospheric, hydrological or oceanographic nature, which may result in the loss of life, illness, injury or damage to property. The Western Cape's 1 332 km coastline, combined with its diverse climate, topography and ecology, puts it at risk of a wide range of threats generated by weather, hydrological and oceanographical conditions.

A significant number of past disasters and ‘significant events’ have been associated with weather conditions. These include the Cape Flats floods (1994 and 2001), the Apollo and Treasure oil spill events (1994 and 2000), the Mannenberg wind storms (1999 and 2002), South Peninsula Fires (2000) and Joe Slovo informal settlement fire (2000).

There are many diverse data sources that are useful and relevant for characterising hydrometeorological hazards. Unfortunately, they have not been streamlined, standardised or made consistent for generating spatially-relevant hazard information across the Western Cape.

This section addresses weather-related hazards (Bruce Hewitson, CSAG/UCT), riverine floods (Dirk van Bladeren, SRK) and marine/coastal threats (Roy van Ballegooyen (CSIR), Andre Theron (CSIR) and Carl Wainman (IMT).

Weather-related hazards: extreme weather events

Bruce Hewitson
Climate Systems Analysis Group, UCT

<u>Introducing weather hazards</u>

Hazards resulting from weather-related events span a broad spectrum of impacts, from floods and rain, through to heat waves, lightning, and wind, to mortality among the ill, outbreaks of disease, and cumulative effects on energy demand. Most natural hazards have some component of weather contributing to the nature of the event, and the weather is often the final component that causes an event become a natural ‘disaster’. For example, light rain, in itself not an extreme event, if persistent over many days may lead to soil saturation and consequent flooding in regions with a high water table.

As such a comprehensive list of weather hazards is problematic. For the most part the hazards can be considered under the categories of Temperature, Rainfall, and Wind. However, under even cursory examination it is apparent that there are multiple facets even to these categories, such as:

- Heavy rainfall events
- Extreme high winds
- Storm surge
- Lightning
- Hail
- Extended dry/wet periods
- Heat waves
- Pollution episodes
- Unseasonable (hence unprepared for) weather
- Long-term trends moving the climate system out of infrastructural norms.

Any one of these, or others not noted here, while of varying frequency and recurrence interval, may precipitate or form the principle component of a serious natural hazard. Furthermore, in the context of a changing climate system, and the Western Cape Climate <u>is</u> changing, the very nature of these events may change.

Initial analysis of the rainfall record for the last 50 years, for example, indicates that the average number of rainy days per month is lower, but that the intensity of rain events has increased. The duration of dry spells in spring has also increased. Furthermore there is an increase in the maximum rainfall, which means more runoff into storm water drains and rivers and an increased likelihood of flooding (see Figure 4.3.1). Rainfall also has an impact on groundwater levels, infiltration, erosion, pollution and water storage. In addition to rainfall, wind speed patterns have also undergone changes, with an overall increase in wind speed along coastal margins.

International consensus states that under future climates more extreme events are likely and that further action is necessary to reduce uncertainty.

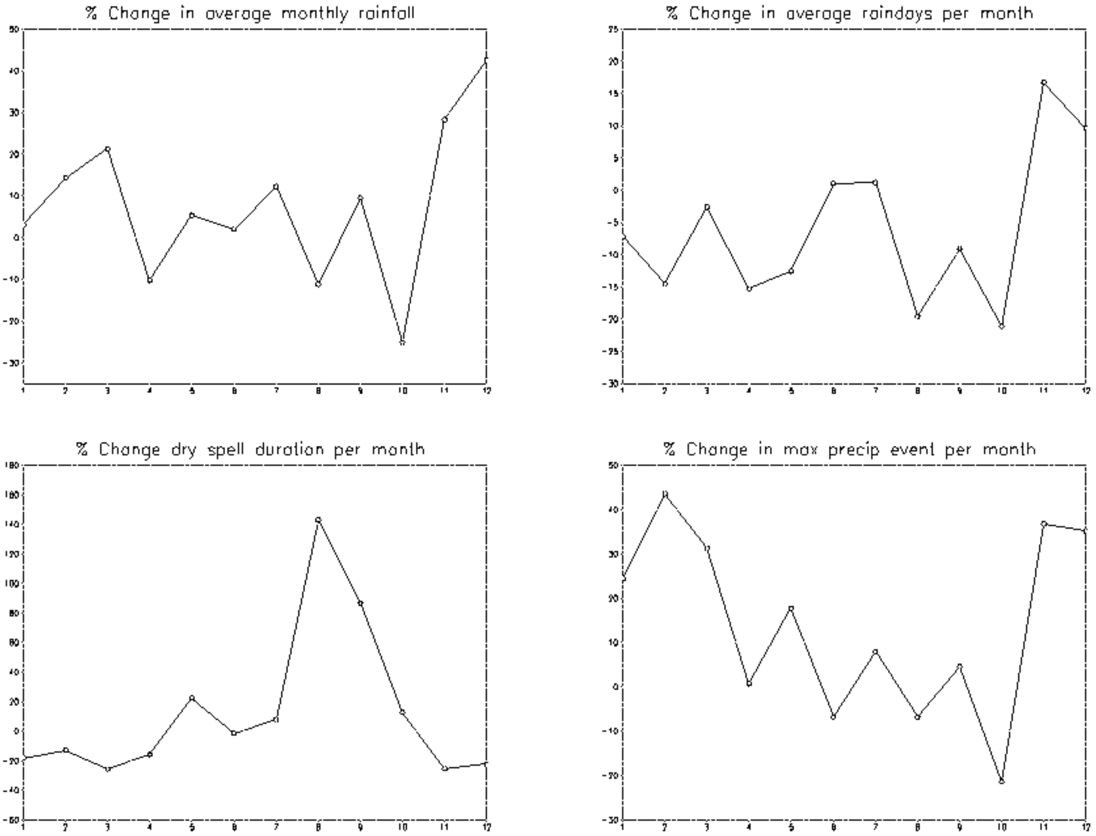
In the Western Cape and particularly in Cape Town, major precipitation events are likely to intensify in wind and rainfall possibly resulting in greater erosion and increased frequency of flooding. Dry spells are likely to increase in duration placing more demands on irrigation, while winters may become 'shorter' with an increase in summer convective rain. This will have an impact on agriculture and water delivery.

In general, the communities most vulnerable are those with poor infrastructure. Nonetheless it must be noted that in many cases weather-related hazards such as lightning, hail storms, flooding or coastal storm surge are serious regardless of community.

The very nature and breadth of weather hazards, that they are components of many other natural disasters, coupled with short societal memory[4], all emphasise the urgent need for comprehensive understanding of past and present variability, trend, and frequency of relevant weather events. Only with such knowledge can policy development, and appropriate infrastructural planning, be made.

[4] For example, the flood plain around Laingsburg, subsequent to the major disaster in the 1980s, is once again built with residential housing.

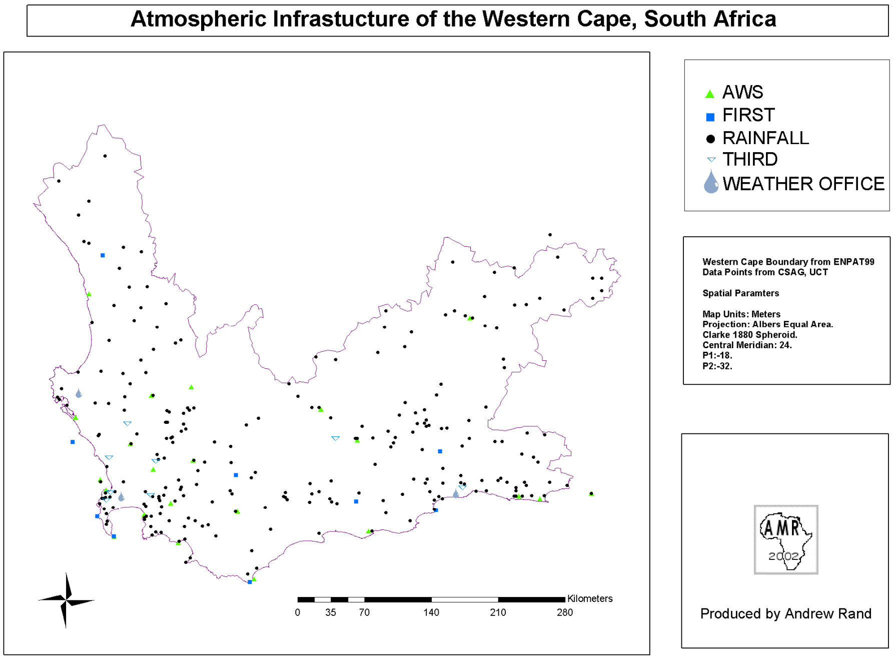
Figure 4.3.1
Percentage Change



Critique of current data

Current data is problematic, hosted by multiple institutions, in a range of formats and resolutions, and in many cases lacking any significant quality control (refer to Table 4.3.2). While in principle there has been adequate to good data collection over the recent decades, the lack of access to the data and the disparate nature of format and quality preclude immediate assessment of the regional characteristics of many of the attributes of the weather system.

Table 4.3.2
Atmospheric Infrastructure of the Western Cape



In addition, there are notable gaps in the data in terms of spatial representativeness, variables of interest, and adequate duration of record. These problems mitigate against the rapid development of comprehensive summary statistics. This in itself is not an unusual situation, and one faced by many regional authorities in other nations. It can be adequately addressed through a concerted data assimilation exercise, coupled with appropriate measures to ensure continued data collection in the medium to long term.

Proposed approach for coarse provincial hazard assessment

The principle requirement for weather-related hazard assessment is to compile comprehensive baseline climatology of the relevant variables, spatial references, and the derivative statistics of consequence. Thus the data base would include the baseline time series, means, and variability indices for the basic variable, and also a suite of derivative attributes such as trend, histograms and shape, wet spell and dry spell durations, seasonal attributes and variation in seasonal boundaries, 90th percentile values, recurrence intervals, etc. In addition, an important component will be to assess the change in these attributes, and consider possible future climate change implications in this regard. For example, whether the 2002 Mannenburg wind event[5] may be considered a weather situation that is likely to occur more often in the future.

The above analysis requires collation of the disparate data, conversion to a common format, quality control, and analysis to derive relevant attributes. The analysis will utilize standard statistical tools to assess the spatial and temporal attributes, plus more advanced techniques to generalize the time-dependant spatial characteristics to a continuous spatial field. In

[5] This event was widely reported as a tornado. However, the dynamics suggest otherwise (which is not to say the event was not of serious consequence) and requires further research to understand and assess whether this is a phenomena new to the western Cape or not.

particular it will be important to assess the combinatory effect of weather events, such as storm surge coupled with high winds and heavy rain.

The final product, spatially and temporally referenced, can then be made available[6] in an appropriate format, such as a GIS database to show areas at risk. The time frame and costs involved are reflected in Table 4.3.3.

The activities as described above can be undertaken by the Climate System Analysis Group at the University of Cape Town. Relevant partners would be those supplying data (see Tables 4.3.3 and 4.3.4). Due to the problematic nature of the data sets, significant time will be required to undertake the data processing and quality control prior to the analysis. This is a process that may be subject to unanticipated delays, especially the acquisition phase where one is dependent on institutions holding the data to make it available. Given suitable resources, acquisition may possibly be completed by the end of the 1st quarter of 2003, with the data processing and quality control likely to be complete by mid-year. At this point, comprehensive summary statistics and analysis may be undertaken relatively rapidly.

In summary, the task is manageable within a reasonable time frame given suitable human resources. It must be recognized, however, that the final product is limited to the information content of the recorded data, and as such there will be natural gaps. The most notable of these are likely to be located in regions of steep topography, or for variables not well recorded (such as fog).

[6] It is important to note that some data sets have certain intellectual property constraints, necessitating that the final data product will not likely be made available in the public domain, and retain distribution limitations.

Table 4.3.3
Data sources available for assessing weather-related hazards

Source	Duration of Record	Temporal Resolution	Spatial Resolution	Format	Variables
SAWS – Rainfall stations	varied	daily	stations – 248	excel spreadsheet	rainfall
SAWS – AWS		hourly	stations – 22		air temp, wind speed and direction, humidity, air pressure, rainfall, sunshine
SAWS – First order station		three per day	stations – 9		same as AWS plus cloud cover, visibility (fog), radiation and upper air obs
SAWS – Weather office		hourly	stations – 3		same as first order station plus radiation and upper air obs
SAWS – Third order		daily	stations – 8		rainfall and temp
IMT	1920 – 1970s	monthly average	coastal only	gis database	SAWS blue book data – potential overlap with above
Seawatch buoy (False Bay)	Oct-02	hourly	1 buoy in operation		wind speed and direction, air pressure, air temperature, current speed and direction, turbidity, salinity, temp, dissolved oxygen and fluorescence
Roman rock weather station	Jun-02	hourly	station – 1		air temperature, relative humidity, wind speed and direction, pressure
Elands Bay			pending		same as seawatch buoy plus swell height, direction, period
CSIR			2 buoys		significant wave heights and period
ARC-ISCW	2 – 20 years	hourly; records updated weekly/ monthly	stations – 163		rainfall, air temperature, wind speed and direction, relative humidity, solar radiation, evaporation max and min
Koeberg Power Station					awaiting details…
CSAG station data set	1900 – 2000	daily	up to 1500 stations dependent on time/place	binary	tmin, tmax, precipitation
Low resolution gridded reanalysis data	1979 – present	6 hourly	250 km	binary	surface temps, air temps, wind speed, humidity, sea level pressure charts, upper air winds

Table 4.3.4
Estimated costs and time-frame for consolidating weather hazard-related data

Source	**Cost – data**	**Cost – processing**	**Cost – analysis**	*both costed in person hours*
SAWS – Rainfall stations	free	100	400	
SAWS – AWS				
SAWS – First order station				
SAWS – Weather office				
SAWS – Third order				
IMT	Negotiable	100	250	
Seawatch buoy (False Bay)	free	20	20	
Roman rock weather station	free	20	20	
Elands Bay		n/a	n/a	
CSIR		50	100	
ARC-ISCW	Negotiable	100	400	
Koeberg Power Station		pending	pending	
CSAG station data set	Negotiable	20	400	
Low resolution gridded reanalysis data	free	10	100	
TOTAL person hours		420	1690	**2110**

TOTAL ZAR (Rate R150 per hour)				**316,500.00**

Final deliverable: spatially referenced summary statistics of extreme weather events for the Western Cape

Final data products remain intellectual property of UCT

Riverine Flooding in the Western Cape Province

Dirk van Bladeren
SRK Consulting

Characteristics of riverine floods

A flood is generally defined as an event that results in water occurring in areas that normally do not have water. The extent and intensity of this occurrence determine the impact of the flood. Flooding may therefore range from events that result in flooded roads due to inadequate storm water drainage or poor drainage, such as the annual flooding that is experienced in the Cape Flats, to events such as that of January 1981 in Laingsburg. Floods therefore range from being an inconvenience to total devastation.

The intensity of floods in South Africa is measured in cubic metres per second (m3/s) and the risk of a flood is defined as the probability of occurrence in a year in % or return period (years). Thus a 50-year flood has a 2% (1/50x100) probability of occurring in any year. The probability of a 50-year flood occurring at least once in a 50-year design life is 66%. The planning for floods is therefore very dependant on the risks that are considered acceptable and impacts that the realization of that risk would have. The provision of drainage for roads for small catchments and urban roads is based on return periods of between 1:2 years to 1:10 years. For major roads and larger catchments, designs are based on events from 1:10 years to 1:100 years.

Conditions that constitute a hazard for a flood event are flood depth and velocity of the flow. Shallow depths of inundation and low velocities may result in material damage and inconvenience, but are not a personal threat. Higher inundation combined with higher flow velocities will not only result in material damage but also pose a threat to personal safety. The hazard of an area is described as factor that is the product of flow depth and velocity.

Flooding in the Western Cape is characterised by the following**:**

- High flow velocities and flow depths. (Mountain areas and the Karoo rivers).
- Slower flowing rivers that are well established such as the Berg, Breede and Olifants rivers.
- Debris loads that can destroy communication routes.
- Small variance in annual floods in the higher rainfall regions (Berg-, Olifants-, Breede- and the rivers around the Cape metro) and higher variance in the more arid areas (Gourits catchment and some coastal rivers).
- Land degradation and veld fires may result in floods and land slides. The flooding from these areas may be more severe and faster.

Areas and communities at risk are:

- **Informal settlements** in low laying and poorly drained areas. The land in these areas was usually vacant and the close proximity to water is a further incentive to settle.
- **Industrial areas** developed in low laying and poorly drained areas. This is due to the lower land prices and inundation and flooding of these areas result in significant economic damage and in some instances environmental and health hazards.
- **Agricultural areas** adjacent to water courses and infrastructure located in the water course.
- **All developments** (residential, commercial etc) that is located within the levels of certain floods.
- **Communications** (roads, railways, telecoms etc) can be disrupted in a severe event and this disruption can be wide spread.

Floods impact upon all sectors of society. As development increases the impacts of floods will also increase as more pressure is placed on the available land to be developed for residential, commercial, industrial etc purposes.

Flood Information

Information regarding floods is held by:

- The Department of Water Affairs and Forestry (DWAF). DWAF manages and controls numerous flow gauging points that extend over the whole province. The gauging points record flow depths and time. These records are continuous and the flow depths are converted to flow intensities by using calibration curves. DWAF have also published a report on the 1981 floods and have several notes on other floods.
- Local authorities. Township development plans that indicate flood lines and developments. Some local authorities have undertaken hazard assessments investigations. Damage reports are also compiled for extreme or frequent floods.
- Universities. Studies of certain catchments for research.
- Department of Agriculture. Damage reports and rainfall data.

- CSIR. Studies on certain catchments.
- Consultants. Flood lines and studies.
- Media reports. Social impacts and damage reports. These reports should however be confirmed.

The data and information held by all these institutions are however not that readily accessible, consistent and always relevant. The exception is DWAF who have also compiled a database on flood events. The database only consists of readily available data at this stage and is continually being updated.

In order to determine if the information is accurate and relevant, analysis of the data would need to be undertaken as part of the study for a specific area.

Approach to coarse provincial hazard assessment

Data and information are the most crucial aspects for the hazard assessment on a provincial basis. The data required depends on the level of the assessment. It is proposed that the provincial assessment first be conducted on the larger catchments and water courses that cross several local authorities. Local authorities that have the capacity and resources to conduct hazard assessments should be responsible for their local watercourses and those that are not able to do this should be assisted. The proposed deliverables of the first coarse assessment are:

- Maps (could be GIS based) that indicate areas at risk. These would be cadastral maps showing developments and infrastructure. From these maps priority areas can be identified.
- Maps showing flood risks for several flood events on the identified rivers.
- Maps showing flood hazards for the various flood events.
- Tabulated flood levels and hazards at areas of specific interest.
- Standardized methodology to provide these deliverables. This is to ensure that all studies are consistent and not biased.

The methodology would consist of:

- Obtaining all previous studies for the river under investigation.
- Obtaining all available topographical information. The resolution and accuracy of the data needs to be checked for relevance. The reference systems also need to be confirmed.
- Supplementing the topographical information with additional aerial and terrestrial surveys.
- Obtaining all land-use and planning and development plans.
- Obtaining all the amiable flow data (DWAF) for analyses.
- Applying analytical methods to obtain the various flood magnitudes in terms of peak flow and in some circumstances volume. The methods that could be used are statistical analysis of recorded floods, empirical methods and deterministic methods. It is crucial that the analysis be conducted on a total catchment basis to ensure consistency.
- Transferring all the special information to a common system (GIS).
- Hydraulically modeling the estimated flood flows in the selected watercourses using the topographical information. The models can be stationary or dynamic models. As a first hit stationary models should suffice.
- Transferring the estimated flood lines to the GIS. This could be done using programming or digitizing hard copies.
- Using the outputs from the hydraulic modeling to determine the hazards.
- Reporting. The report should outline the methods and assumptions, shortcomings and recommendation for other rivers and more detailed studies. All the spatial data needs to be stored on a GIS system and other data gathered and generated on a GIS compatible database.

Parties that need to be involved are:

- The Provincial Disaster Management Department
- Local authorities impacted upon by the water course (river)
- Land surveyor/s
- GIS specialist
- Hydrological and hydraulic specialists
- Department of Transport
- Department of Water Affairs and Forestry
- Department of Agriculture and Land Affairs
- Environmental and social scientists

The study should be managed by the hydrological and hydraulic specialist who will report to a steering committee drawn from the parties involved. The province would chair this steering committee.

The Breede River valley is recommended as a pilot study area. The valley is well developed from Ceres to Swellendam and has been subjected to frequent flooding in the past. Flow data is amiable along the whole course of the river and the results from the hydrological and hydraulic study could be verified and confirmed with data available. The study could then also be used as a benchmark for other rivers that will follow.

The cost elements are (indicative estimate only):*

- Data collection (R25 000)
- Data interrogation (R45 000)
- Survey includes cadastral (R150 000 to R450 000 is dependant on what is available)
- Hydrological study (R50 000)
- Hydraulic modeling (R130 000)
- Transfer of data and results to GIS and data base (R 220 000)
- Reporting (R80 000)
- Project management (R 30 000)

* In addition, travel and accommodation are estimated at R25 000.

The study area identified should be completed within six months.

The study for the initial area should be limited to the main river. The results will be very dependent on the resolution and accuracy of the topographical data, which are reflected in the budget allocation for survey.

Marine Hazards in the Western Cape

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Introduction

Marine hazards may be caused by natural events or anthropogenic activities but typically are a combination of both.

The marine environment around southern Africa, and particularly that of the Western Cape, is subject to many extremes. Natural marine hazards in the Western Cape are therefore numerous but not all are expected to be of significance. However, the higher level of anthropogenic activity, particularly in and surrounding the Cape Peninsula and other coastal cities, is expected to significantly increase the level of impact associated with the various marine hazards.

Marine hazards are generally well known and taken into consideration in the environmental design of shipping and marines structures. Financial constraints, however, result in a level of residual risk remaining after most environmental factors have been taken into account in the environmental design of shipping and marine structures. This residual risk is then typically pooled and managed by implementing appropriate mitigation or disaster response measures.

The full extent of risk of loss of life and financial loss is not always fully appreciated. For example particularly local authorities often poorly appreciate the long-term financial losses due to coastal erosion. The purpose of this hazard assessment is to identify and highlight all, but particularly these lesser-appreciated, relevant marine hazards.

Hazard Inventory

If a hazard is defined as an event or process (natural or anthropogenic) that results in a potentially deleterious impact on a desirable *status quo*, then the following marine hazards of the Western Cape are listed in the Table Below.

Table 4.3.5
Coastal and Marine Hazard typology

Hazard Type	Cause	Consequence	Locality	Mitigation	Existing Expertise and Information
Natural Hazards					
Storm Damage: High winds, waves, currents and water levels associated with typically winter storms. Damage is particularly severe when the storm co-incides with high spring tides.	High winds, waves, and currents.	**Shipping loss**, loss of life, pollution and associated risks.	All along the coast but particularly in the vicinity of ports and coastal cities.	Appropriate environmental design, seaworthiness of shipping and trained crews, rapid response of salvors/NSRI/emergency services, better environmental information and forecasts.	SAMSA, DEAT, NPA, salvors, NSRI, offshore industries (MOSSGAS), CSIR, UCT, wreck database.
	High winds, waves, and currents.	**Damage to infrastructure** (breakwaters, pipelines, etc), health risks but mainly financial loss.	All along the coast but particularly in the vicinity of ports and coastal cities.	Appropriate environmental design, better environmental information and forecasts.	DEAT, NPA, CMC, local authorities, CSIR, UCT, engineering consultants.
	High waves, currents and water levels, particularly when co-incident with spring high tides.	**Coastal erosion**. Mainly financial loss.	Anywhere where there is significant infrastructural development along the shoreline.	Appropriate planning (knowledge of and adherence to set-back lines), better environmental information and forecasts.	CSIR, IMT, UCT, engineering consultants, CMC, industry.
	High waves and water levels, particularly when co-incident with spring high tides.	**Potential flooding in estuaries**, river back-up. Mainly financial loss.	SW and Southern Cape Coasts.	Appropriate planning, better environmental information and forecasts.	CSIR, local authorities, DEAT.
Localised hazards: Unexpectedly strong currents, adverse wind and wave conditions (eg freak waves) occurring at specific localities.	Unexpectedly strong currents, adverse wind and wave conditions (eg freak waves) occurring at specific localities and resulting in unexpected impacts.	**Shipping loss, infrastructural damage, loss of life**	All along the coast but mainly in the vicinity of ports and small harbours.	Appropriate planning, better environmental design, better environmental information and forecasts, rapid response of NSRI/salvors.	NPA, NSRI, salvors, CSIR, UCT.
Toxic algal blooms	Seasonal blooms, mainly late summer.	Shellfish poisoning, threat to mariculture, threat to community livelihood,	Mainly West Coast.	Appropriate response planning, better environmental information	DEAT (MCM), CSIR, UCT.

Hazard Type	Cause	Consequence	Locality	Mitigation	Existing Expertise and Information
		shellfish resource depletion.		and forecasting of events.	
Low oxygen water	Associated with episodic blooms, mainly late summer.	Threat to mariculture, threat to community livelihood, shellfish resource depletion.	West Coast only.	Appropriate response planning, better environmental information, forecasting of events.	DEAT (MCM), CSIR, UCT.
Long-term Hazards					
Climate change: Sea Level Rise and increased Storminess	Long-term rise in sea level and change in storminess along our coasts.	Increased exposure to extreme events (which themselves might increase in frequency or intensity), increased saltwater intrusion and raised groundwater tables, greater tidal influence, increased flooding (frequency and extent), increased coastal erosion.	Greater Cape Town, Melkbos-strand to Gordon's Bay, the south Cape coast, Mossel Bay to Nature's Valley, Saldanha Bay (Langebaan).	Development of vulnerability atlas/GIS where sites are assessed according to scale of potential impacts, coastal zone managers/ engineers/ planners need to remain informed on the probable future impacts of global weather changes.	UCT, SAWS, CSIR.

Storm Damage

Description of Hazard

The hazard in this case is the combination of extreme winds, wave, currents and sea levels associated with storm events. Any one of these processes (winds, waves, etc) may result in loss of life and serious impacts on coastal infrastructure, shipping and the coastal environment, however it is typically a combination of these factors that lead to the most serious impacts.

For example, high wave conditions may lead to incidents such as the loss of cargo from shipping and may also result in significant loss of life, while a combination of high waves, strong winds and adverse current conditions can lead to major financial loss such as the grounding of the Bos 400. Should a storm occur during spring high tides, the additional increase in water level associated with the spring tides results in significantly increased damage to coastal infrastructure. Under these circumstances wave damage and coastal erosion is significantly increased.

Storm damage is typically seasonal, the greatest damage occurring during winter storms. In particular, strong NW conditions result in dangerous conditions for shipping in Table Bay and also result in significant damage to coastal infrastructure. This is caused by combined high waves and increased water levels due to wind and wave set-up. The damage is not only restricted to winter storms. Conditions such as a strong 'black southeaster' can lead to substantial wave damage along the False Bay coastline caused by a similar combined exposure to high waves and increased water levels due to wave and wind set-up by the southeasterly winds.

Typical consequences of these storm conditions are:

- The loss of cargo from ships with the potential for associated navigational hazards (eg containers floating just below water level)
- Damage to shipping and rigs both external to and inside ports
- The sinking of ships, ship collisions and groundings and associated potential loss of life
- Wave damage to coastal infrastructure such as harbour breakwaters, constructions, pipelines, commercial and private property, etc
- Coastal erosion

Associated with all of the above is the consequential risk of pollution. In the case of shipping there is usually an oil spill risk (if only the bunker fuel) and at times a risk of toxic spills. In the case of pipelines there is an associated risk of bacterial pollutions and thus human health risks. In all cases the pollution events have short to long-term financial consequences, particularly for local authorities. Furthermore the adverse conditions in themselves pose significant danger for any rescue attempts should they be required.

Except for shipping accidents where there may be loss of life, the risks are largely financial. Typically there is adequate warning for areas at risk to be evacuated. In the case of shipping and pollution events, the loss is largely borne by the ship owners and ship insurers. However, in the case of damage to coastal infrastructure the loss is borne by commerce, private owners and, to a large extent, by local authorities.

In many cases the loss is related to inappropriate development and/or environmental design. With careful planning, infrastructural development could have been undertaken to minimise the financial losses. The development of a regional database on appropriate set-back lines and adherence to these set-back lines can play a major role in minimising potential losses. Similarly, more rigorous consideration of environmental factors in the design and construction of coastal infrastructure will limit the potential for deleterious impacts such as accelerated coastal erosion due to inappropriate developments.

Existing Information

The hazards associated with storm damage are typically associated with shipping and/or coastal infrastructure. The hazards and risks associated with shipping are managed by the South African Maritime Safety Association (SAMSA) that has regulatory powers. The other major role player for shipping is the National Ports Authority (NPA) that has many procedures in place to limit the adverse consequences of storms. The South African Weather Services (SAWS) provide weather forecasts while the CSIR provides real-time systems to help ensure the safety of maritime operations and shipping. The South African Data Centre for Oceanography (SADCO), together with the Climate Division of the SAWS store much of the data required to characterise and predict storms and their consequences in the marine environment.

In terms of coastal erosion, the CSIR has undertaken many studies related to set-back lines (eg CSIR 1990, 2000a), however no integrated overview exists of set-back lines for the Cape Town Unicity or other outlying coastal towns and cities in the Western Cape. The approach taken by the Ethekwini Municipality, whereby an integrated GIS database of set-back lines has been developed for the whole coastline under their jurisdiction, is recommended (CSIR 2000b, 2002).

Approach to coarse provincial hazard assessment

The natural hazards associated with storms can be mapped in terms of vulnerability of marine activities to storm conditions and the vulnerability of the coastline to coastal erosion. The vulnerability in terms of shipping accidents is best provided by a marine risk assessment based on shipping volumes, types of cargoes and the safety procedures in place. However, a comprehensive marine risk assessment is expensive and would be inappropriate for a coarse provincial hazard assessment. A simplified approach to identifying risk hazards, risk sources and regions most at risk is indicated, a process best undertaken by the CSIR in conjunction with other consultants, SAMSA and the National Ports Authority.

The expertise to map the vulnerability of the coastline to coastal erosion exists within the CSIR, while information suitable for coastal erosion vulnerability also exists at UCT as well as in 'State of the Coast Environment' report undertaken by the CSIR for the Environmental Management Department of the CMC Administration (City of Cape Town, 2001). Such a mapping of coastal erosion vulnerability would best be undertaken by the CSIR, in conjunctions with other relevant role players. The CSIR has already undertaken a mapping of set-back lines for the Ethekwini Municipality for the whole coastline under their jurisdiction (CSIR 2000b, 2002).

<u>Localised hazards</u>

Description of Hazard

The hazard in this case is the development of specific and localised conditions in the marine environment that may pose a hazard to shipping and users of the coastal zone. Examples of such risks are:

- freak waves that at times wash fishermen off the rocky coastline along the eastern shoreline of False Bay
- Long period swell conditions in Table Bay that can cause severe rolling of ships and cargo loss that may pose a navigational hazard

- Long wave energy in Saldanha Bay that can lead to mooring problems and potential pollution

Most of these conditions are not unexpected and the risk posed can be minimised by adequate knowledge of the combination of environmental conditions that lead to the risk event.

Existing Information

Being localised hazards, most information is obtainable from the local community and or the relevant port authorities. The CSIR has been instrumental in characterising the hazards associated with long waves in Saldanha Bay and together with the UCT Oceanography Department is the best starting place for investigating such hazards.

Approach to coarse provincial hazard assessment

The best means of undertaking a coarse provincial hazard assessment into these localised hazards would be to undertake a literature search, combined with obtaining anecdotal evidence and description of such hazards. This would require a modest effort.

Toxic algal blooms/low oxygen water

Description of Hazard

Although in some parts of the world the severity and frequency of red tides is reported to be increasing because of coastal pollution from nutrient-rich sewage, industrial wastes and fertilizer runoff, events in southern African waters are an entirely natural phenomenon, unrelated to pollution. A combination of factors are conducive to the development of red tides, such as strong upwelling followed by calm conditions. Associated with red tides may be low oxygen water events exacerbated by factors such as seasonal low-oxygen bottom waters, warmed surface waters, light onshore winds and relatively calm conditions.

Red tides occur every year along the Cape west and south coasts, usually in late summer and autumn. During spring and early summer, south-easterly winds result in upwelling of cool deep, nutrient-rich waters that may contain large quantities of dinoflagellate cysts, the resting stages of these organisms which spend the winter in the seafloor sediment. Once upwelling becomes less intense and the sea becomes warmer and calmer, the cysts germinate and the dinoflagellates already present in the water begin growing and dividing, resulting in a ‘bloom’. Their numbers are concentrated by winds and currents, as well as the dinoflagellates' own ability to swim. Before long the ‘bloom’ becomes so dense that it discolours the water, resulting in a ‘red tide’ that may be various shades of red, yellow, brown, green or purple, depending on the pigments characteristic of each dinoflagellate species.

These red tides can lead to low oxygen conditions, which in turn can have a large impact on marine resources in the region. As ‘red tide’ or phytoplankton blooms sink and decay, bacterial decomposition depletes the oxygen supply in the water, resulting in low-oxygen waters near the seabed. The consequences of these low oxygen conditions are the mortality of fish, lobster and, in severe cases, of intertidal organisms.

The major consequences of red tides and low oxygen conditions include:

- mortality of sea life due to physical damage such as suffocation by gill clogging/irritation
- mortality of sea life due to oxygen depletion in the water column
- mortality of sea life due to direct poisoning

- illness or death due to indirect poisoning by consuming filter-feeding shellfish. Four types of indirect poisoning affect humans, namely Paralytic Shellfish Poisoning (PSP), Diarrhetic Shellfish Poisoning (DSP), Neurotoxic Shellfish Poisoning (NSP) and Amnesic Shellfish Poisoning (ASP) that has not yet been recorded off the South African coast, but the responsible organism is thought to occur in our waters

Existing Information

Existing information of the occurrence of red tides around southern Africa is obtainable from Dr Grant Pitcher of MCM, DEAT. The occurrence and severity of these events are contained in a number of publications. Information on red tides can be obtained on the MCM Website at http://www.environment.gov.za/mcm/info/redtide.htm. The red tide status of the marine environment can be obtained from the Marine and Coastal Management Redtide Hotline at (021) 402 3368.

The formation of these so-called harmful algal blooms and the associated low oxygen water conditions are the subject of a concerted research effort (Benguela Large Marine Ecosystems) by scientists from South Africa, Namibia and Angola, the intention being to provide some sort of 'early warning system' to alert resource managers to the onset of these adverse marine conditions.

Approach to coarse provincial hazard assessment

Information on typical locations of red tides and frequency of occurrence are available from Dr Grant Pitcher of MCM. It should be adequate to simply collate and abstract these data into a coarse provincial hazard assessment.

Given the uncertainty and scope in the work required, as well as a clear knowledge of the level of information readily available, the best approach to deal with the following hazards would be to hold a workshop of experts in the field. This would be necessary before getting a clear idea of the costs involved.

The hazards to be assessed are:

- Storm damage (Shipping losses/damage to infrastructure)
- Localised hazards
- Toxic algal blooms/low oxygen water
- Oil Pollution
- Toxic cargo spills/radioactivity
- Ballast water exchange
- Marine discharges
- Climate change

Suggested participants would be:

Salim Malik (SAMSA) – storm damage
Ian Hunter (SAWS) – storm damage
Andre Theron (CSIR) – Infrastructure damage/coastal erosion/climate change
Marius Rossouw (CSIR) – storm damage/shipping
Geoff Brundrit (UCT) – Localised Hazards/Climate change
Dr Lynn Jackson – Oil pollution/Ballast Water issues/Toxic Spills
Saras Mundree (CSIR) – Ballast Water issues
Susan Taljaard (CSIR) – Marine discharges/Ballast water issues
Dr Grant Pitcher (MCM) – Red Tides/ low oxygen waters
Dr Pedro Monteiro (CSIR) – Low oxygen waters
Roy van Ballegooyen (CSIR) – Overview/facilitator.

A suggested agenda for a 2 day workshop would be

1. *Day 1:*

   Topic(s)

   - – Storm Damage (Shipping losses/damage to infrastructure)
   - – Coastal erosion
   - – Localised hazards
   - – Climate change

   Participants

   Salim Malik (SAMSA) – storm damage/shipping
   Ian Hunter (SAWS) – storm damage/shipping
   Marius Rossouw (CSIR) – storm damage/shipping
   Hans Moes (CSIR) – storm damage/shipping
   Geoff Brundrit (UCT) – Localised Hazards/Climate change
   Andre Theron (CSIR) – Infrastructure damage/coastal erosion/climate Change
   Roy van Ballegooyen (CSIR) – Overview/facilitator
   GIS Specialist

2. *Day 2: Morning*

   Topics(s):

   Oil Pollution
   Ballast Water
   Toxic Spills

   Participants

   Dr Lynn Jackson – Oil pollution/Ballast Water issues/Toxic Spills
   Salim Malik (SAMSA) – storm damage/shipping
   Saras Mundree (CSIR) – Ballast Water issues
   Susan Taljaard (CSIR) – Marine discharges/Ballast water issues
   Roy van Ballegooyen (CSIR) – Overview/facilitator.
   GIS Specialist

   Day 2: Afternoon

   Topics(s):

   Marine Discharges
   Red Tides/ low oxygen waters

   Participants

   Dr Lynn Jackson – Oil pollution/Ballast Water issues/Toxic Spills
   Susan Taljaard (CSIR) – Marine discharges/Ballast water issues
   Dr Grant Pitcher (MCM) – Red Tides/ low oxygen waters
   Dr Pedro Monteiro (CSIR) – Low oxygen waters

<u>Estimated costs</u>:

Day 1:	8 participants @ R 3000/day	R 24 000
	Fixed cost of venue, catering	R 3 000
	1 Flight and S&T	R 3 500
	Total	R 30 500
Day 2:	8 participants @ R 3000/day	R 24 000
	Fixed cost of venue, catering	R 3 000
	1 Flight and S&T	R 3 500
	<u>Total</u>	<u>R 30 500</u>

Added to the above should be costs of write-up if done by consultants. Assume a cost of approximately R 3000/day.

Specific Studies

In addition to the above, I believe that specific attention needs to be paid to:

Oil spill issues and coastal erosion and flooding issues. Without a clear scope we cannot cost the oil spill issues, however we recommend the following for a coarse provincial hazard assessment in the domain of coastal erosion and flooding in estuaries due to storms.

Desktop coarse vulnerability assessment of coastline to coastal erosion, including comment on sea level rise (R 60 000 to R100 000 depending on agreed scope).

Desktop coarse vulnerability assessment of flooding in estuaries due to storms (R 40 000 if required).

Also recommended for a later stage would be a more comprehensive coastal erosion vulnerability assessment for the Western Cape, which would include a more comprehensive coverage, and one or two specific site visits (cost approx R 250 000).

Ultimately a comprehensive study of set-backs lines could be undertaken at a cost of R 250 000 to R 300 000 for the Western Province. This would preclude the necessity for the comprehensive coastal erosion vulnerability assessment for the Western Cape, as it would be incorporated in such a study.

Please note that all of the above costs are indicative and not firm quotes due to:
- in some cases, the lack of knowledge of the scope of work required, and
- the lack of knowledge of rates of specialist (could be higher or in some cases non-existent).

4.4 Geological threats

Geological hazards are natural earth processes or phenomena, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Although the Western Cape is not noted for its geological instability, strong seismic events in the 1960s along with repeated localised rockfalls and landslides, affecting roads and other infrastructure, underline the importance of this hazard cluster. This section addresses seismic hazards (E. Hattingh, G. Graham, A. Kijko and M.S. Bejaichund Council for Geoscience) and rockfalls/landslides (Tom Hemstead. Zietsman Lloyd & Hemstead Inc)

Current status of seismic hazard assessment for the Western Cape

E. Hattingh, G. Graham, A. Kijko and M.S. Bejaichund

<u>Introduction</u>

The Council for Geoscience was approached by DiMP to participate in a consultation process (as part of Phase I of RAVA) on the different natural (and other) hazards facing the Western Cape Province. This document is a brief exposé of the data and results currently available for a seismic hazard assessment of the Western Cape. It also reflects very briefly on the current knowledge regarding the methodology of seismic hazard assessment.

Seismic hazard and risk are closely related, with risk being a product of the vulnerability and the hazard (ie financial exposure). The only work done so far on seismic risk was a study for a re-insurance company. The details of the analyses can unfortunately not be addressed in this report.

The Western Cape can be considered as one of the regions displaying the highest level of seismic activity of tectonic origin in South Africa (Figure 4.4.1). Owing to the destructive earthquake of 29 September 1969, the Tulbagh-Ceres area is of prime interest when performing a seismic hazard assessment for an area in the Western Cape.

Seismotectonic Setting

The seismicity of the region generally ties in well with the existing understanding that regional maximum compressive stress directions are oriented E-W in the Western Cape Province, as well as along most of the southern Cape Fold Belt (Figure 4.4.1). In the southwestern Cape, WNW-ESE orientated fractures seem to be the most active structures. Within the syntaxis south of the Worcester Fault (Figure 4.4.1), seismogenic NE-SW striking faults coincide with important deep aquifer fracture systems, as they are clearly associated with hot springs.

Seismicity

According to Theron (1974), earth tremors have been recorded in the Western Cape as early as 1620. A complete seismological catalogue was compiled by Fernández and Guzmán (1979a), covering all events recorded in southern Africa for the time period 1620–1970.

A large portion of the western Cape events in the Fernández and Guzmán catalogue resulted from the seismicity recorded in the Tulbagh area, especially in the time directly following the large Tulbagh-Ceres earthquake on 29 September 1969. This earthquake, having a local magnitude (*M*L) of 6.3, was the most destructive earthquake in South African history and was followed by a long sequence of aftershocks, the most severe of which, on 14 April 1970, had an *M*L of 5.7. A comprehensive report regarding the 1969 earthquake by van Wyk and Kent (1974) covers aspects such as the geology of the Ceres-Tulbagh area; the seismic history of the southwestern Cape; macroseismic observations in the seismic active areas of the 1969 earthquake; hydrological phenomena associated with the earthquake; aftershock focal mechanism; geophysical implications of the whole earthquake sequence during 1969–1971 and some elements of seismic hazard assessment and earthquake-resistant building recommendations.

According to the SABS number 0160-1989 code of Practice (1994), for the general procedures and loadings to be adopted in the design of buildings South Africa is characterised by low seismicity. Most of the Western Cape falls into seismic hazard zone I, a zone with low natural seismic activity. The document lists the peak ground accelerations for Cape Town as 0.1g. This corresponds to a ground movement known as peak ground acceleration (PGA). It should be noted that g (gravity) corresponds to 9.8 m/s2.

The worst damage resulting from the Tulbagh earthquake of 29 September 1969 occurred in the northern part of the Tulbagh Valley which is situated close to the earthquake epicentre (Keyser, 1974). Severe damage occurred to buildings in the towns of Tulbagh, Wolsley, Ceres and Prince Alfred Hamlet. Damage also occurred in the villages of Saron, Gouda and Hermon as well as in the towns of Worcester and Porterville. Slight damage was caused in towns as far away as Stellenbosch. Nine deaths resulted from the earthquake and the damage to buildings was estimated at US $24 000 000 (Lander, 1970).

A maximum seismic intensity (Modified Mercalli, MM, Scale) of VIII was observed during the earthquake in the Tulbagh region. This corresponds to peak ground acceleration (PGA), of greater than 0.13 g but less than 0.26 g, according to the 3 intensity PGA relation of Trifunac and Brady (1975). The lower and upper limit of PGA were obtained by substituting for the intensity in the intensity PGA relation with VII½ and VIII½, respectively. Using the PGA-magnitude-hypocentral distance relationship (Kijko and Graham 1998, 1999) the PGA at Tulbagh was calculated to be 0.22 g. This was obtained using the assumption that the epicentral distance between Tulbagh (33.28□S, 19.14□E) and the earthquake was 25 km, with the focus of the earthquake being at a depth of 10 km.

<u>Assessment of Seismic Hazard</u>

Various hazard assessments for the southern Africa region, of which the Tulbagh area forms part, have been performed (eg Fernández and Guzmán, 1979b, Fernández and du Plessis, 1992, 1993). Fernández (1996) did a hazard assessment for southern Africa with specific application to the Tulbagh area. Due to the lack of a complete earthquake catalogue for the time period 1900–1993, the use of the distribution of extreme annual peak ground accelerations was necessary for the study of the Tulbagh area. The Gumbel Type III distribution was elected, so that the value of the maximum credible acceleration (*amax*) at the selected site could be obtained.

An attempt to apply a probabilistic seismic hazard assessment (PSHA) to the Tulbagh area using a technique developed by Kijko and Graham (1998, 1999) was made by Kijko, Retief and Graham (2002). The procedure is parametric and consists essentially of two steps. The first step is applicable to the area in the vicinity of the site for which the knowledge of the seismic hazard is required and comprises of the estimation of *area*-specific parameters. The second step is applicable to a specified *site*, and consists of an assessment of the distribution of the *site*-specific parameters. In each step the parameters are estimated by the maximum likelihood procedure, therefore by applying the Bayesian formalism any additional geological or geophysical information (as well as all kinds of uncertainties) can easily be incorporated. Consequently, the procedure is capable of giving a realistic assessment of seismic hazard in areas of both low and high seismicity, including cases where the seismic catalogues are incomplete.

The procedure allows the assessment of seismic hazard in terms of PGA, peak ground velocity and peak ground displacement, as well as an assessment of the whole spectrum of ground motion.

Estimation of the Seismic Hazard Parameters

It is convenient to describe the occurrence of earthquakes in a region in terms of the area-specific parameters *b, ?, and mmax*. The parameter *b*, typically close to 1, describes the relative number of small and large events in a given time interval (Gibowicz and Kijko, 1994). The parameter *?*, represents the number of earthquakes occurring per unit time (eg number of events of a certain magnitude per year), within a specified area. It is also important to have a measure of the largest possible earthquake that can occur in a given area. The parameter that represents this is the maximum regional magnitude, *mmax*. This value is often constrained by the size of the fault, the past seismicity, etc.

At present there is no generally accepted method for estimating the value of the maximum regional magnitude *m*max. The available methods for evaluating *m*max fall into two main categories: deterministic and probabilistic.

The deterministic procedure most often applied is based on the empirical relationships between the magnitude and various tectonic and fault parameters. The relationships are variously developed for different seismic areas and different types of faults. In most cases, unfortunately, the value of the parameter *m*max determined by means of any deterministic procedure is very uncertain.

The value of *m*max can also be estimated probabilistically, that is purely on the basis of the seismological history of the area, viz by utilizing seismic event catalogues and appropriate statistical estimation procedures.

For assessment of hazard at a site, the site-specific ground motion parameter, maximum peak ground acceleration, *amax*, should also be evaluated.

An example of a Seismic Hazard Assessment in the Western Cape

As an example of the application of the technique described above, the information contained in *the Earthquake Database of the Council for Geoscience* was used in the evaluation of the seismic hazard for Tulbagh (Kijko, A., Retief, S.J.P. and Graham, G., 2002). Figure 4.4.2 shows the seismological stations throughout South Africa where the instrumental data was collected. The procedure was applied using all seismic events that occurred within a radius of 300 km from Tulbagh.

Since the catalogue of earthquake recordings is incomplete (due to the limited history of observed earthquakes), the catalogue is divided into an incomplete part (historic) and a complete part (instrumental). All event magnitudes contained in these subcatalogues are in the local Richter, *M*L, scale. According to Fernández and Guzmán (1979a), the magnitudes of the historical earthquakes were obtained either from the various sources indicated in their article, or by conversion of the maximum MM intensity to magnitude.

The incomplete part of the catalogue spans the period 1801/1/1-1970/12/31, containing 25 of the largest seismic events that occurred in the Tulbagh region during this period. It was assumed that for all of these events the standard deviation in magnitude determination was 0.3. Events prior to 1801/1/1 were not used in the calculations, since it was decided to use only the most reliable information in the hazard assessment.

For the area surrounding Tulbagh, the maximum expected magnitude was calculated as 39 . 0 60 . 6 ˆ max □□*m* , the Gutenberg-Richter parameter 13 . 0 75 . 0 ˆ □□*b* , and the mean area-characteristic seismic activity rate 67 . 1 56 . 3 ˆ □□*?* events (with *M*L □2.50) per year. Calculations revealed that the main contribution to the determination of the *b*-value comes from the incomplete part of the catalogue (80.4%), with smaller influence from the two subdivisions of the complete part of the catalogue (15.9% and 3.7% respectively). The main contribution to the determination of the activity rate, *?*, is also from the incomplete part of the catalogue (71.4%) while the other two subdivisions of the catalogue contribute to a lesser extent (25.8% and 2.9% respectively).

Assuming the occurrence of a very strong seismic event, of the order of magnitude 6.6 (mmax) in the vicinity of Tulbagh, a maximum credible horizontal PGA of 0.30 g was determined. The vertical-to-horizontal ground acceleration ratio can conservatively be taken as 0.6 (Ambraseys, 1995). This would imply a vertical PGA of □0.18 g. This value is clearly much higher than that prescribed by SABS 016-1989.

Figure 4.4.3 shows the contoured peak ground acceleration values (in units of gravity) with a 10% probability of being exceeded at least once in 50 years. Cooler colours typically represent the lower PGA values whereas the warmer colours represent the higher values. The seismic hazard was calculated, in the form of a matrix, for points of an equally spaced grid of 0.025o in both latitude and longitude.The map as such is a reflection of the seismic hazard, and could be used as a tool in assessing the long-term earthquake hazard, as an overview. In conjunction with additional geological information, this could aid in seismic hazard mitigation.

Conclusion

A more detailed hazard map, based on similar lines to the map produced in Figure 4.4.3,can be produced for the Western Cape. However, it is important to note that the hazard map shown in Figure 4.4.3 is biased. The seismic data is collected at sites of hard rock, and it is assumed that these results hold across the province. Site-effects have not been taken into account. Site-effect is a term used to describe the change in PGA value due to the sub-surface geology at a site of interest. This change is linked to an amplification of seismic wave amplitudes due to soil condition. In general, the softer the soil type (or the more unconsolidated) at a site, the more the ground motion will be amplified, and the higher the ground motion PGA will be. The hazard map produced in this report is based on the assumption that the subsurface geology of the entire area is rock. This is not always the case.

It is proposed that, for the seismic assessment hazard in the Western Cape Area, three hazard maps should be produced. The maps will be produced based on three categories namely: Hard Rock, Stiff Soil and Soft Soil. This will provide a more accurate evaluation for PGA based on soil types. Also, a zoned geological map indicating the sub-surface geology for the area will be provided. Therefore, depending on the area for which an expected PGA is required, the soil type for the area must first be determined from the zoned geological map and thereafter its location on the relevant hazard map must be referred to. A user manual on how to use and interpret these maps will be compiled as part of the seismic hazard assessment.

Figure 4.4.1.
Map of the Western Cape, showing the epicentres of earthquakes

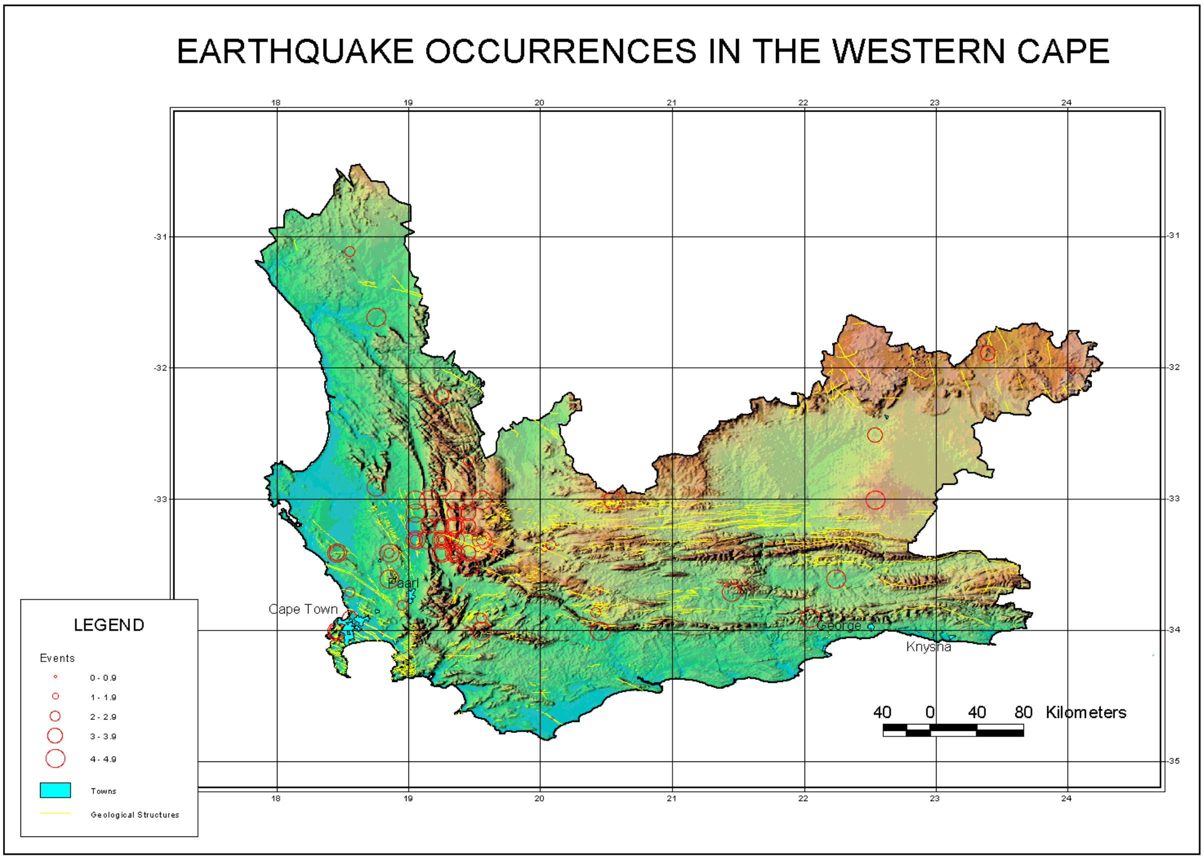


Figure 4.4.2.
Seismological stations in South Africa

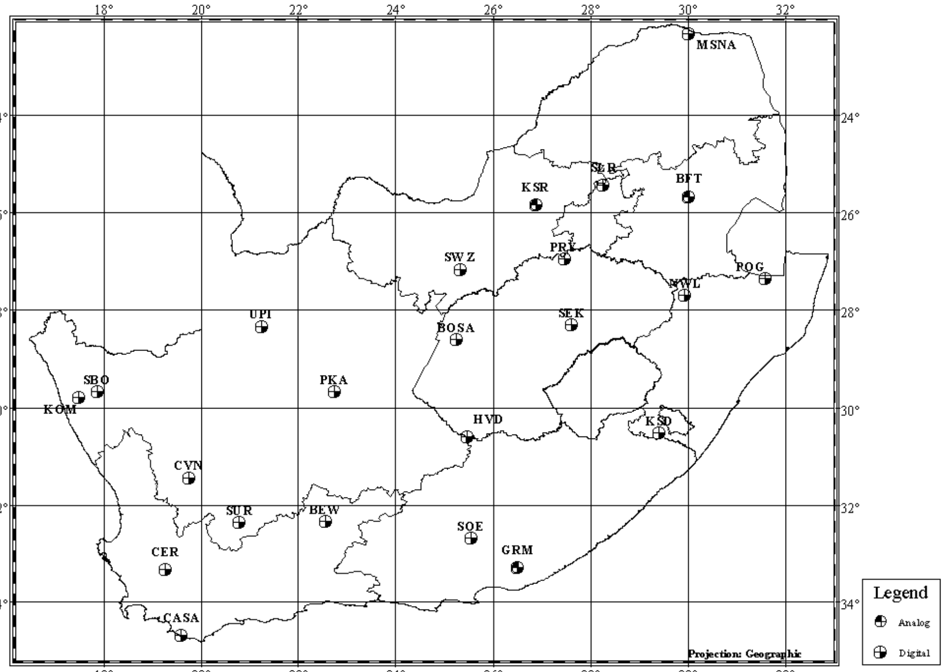
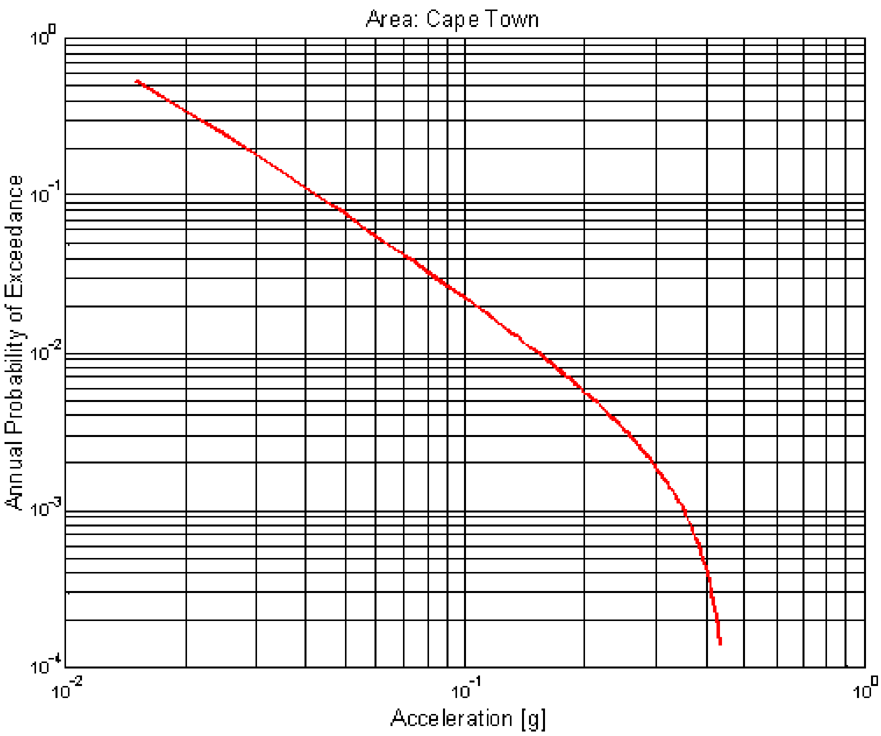


Figure 4.4.3.
Graph showing the contoured peak ground acceleration values with a 10%



probability of exceedence in 50 years in the Western Cape.

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Rockfalls in the Western Cape

Summary by DiMP Research Team – background by Tom Hemsted (Zietsman Lloyd & Hemsted Inc)

Rockfalls refer to a free fall of rock from steep slopes or rock-faces. Rockfall hazards occur in many areas and on many passes in the Western Cape, the most well know being Chapman's Peak, Du Toits Kloof Pass, Bain's Kloof Pass and the Outeniqua Pass. The steep slopes and potentially loose debris increase the risk of a rockfall on these passes. The impact of a rockfall initiated by a seismic event is however probably one of the highest rockfall hazards.

Damage from rockfalls in road passes is usually limited to the pass itself, with structural damage to the pass. In cases where the pass may be closed as a result of a rockfall the potential for economic losses are high, particularly in cases where they are transport or tourist routes. Deaths related to rockfalls occur, but their probability is less frequent than structural damage to the pass.

One of the best documented rockfall passes is Chapman's Peak Drive. Tom Hemstead, who is currently conducting a Hazard Assessment on the pass, said the following: '*Chapman's Peak Drive is the main commuter route connecting Hout Bay to Noordhoek and the Southern Peninsula. The pass has been subjected to numerous rockfalls and debris flow incidences since it opened on 6 May 1922. These events have resulted in an unknown number of serious injuries and deaths during this period. The records available from the Provincial Roads department record 5 fatalities since 1987. The pass was closed in Jan 2000, after a rockfall fatality on 29 Dec 1999. Work has now started on the repair and restoration of CPD, which is to be re-opened as a toll road.*

With the proposed opening of the road, a hazard assessment is being carried out on the probability of rockfalls, and under which weather conditions the hazard from rockfalls on CPD reach a stage where the risk to the user exceeds the acceptable limit and must be closed. This assessment is also being used to establish where additional rockfall protection measures are to be positioned for greatest user benefit. The possibility of a substantial rockfall event triggered by a seismic activity cannot be ruled out, but a probability has not be investigated.' (Tom Hemstead).

Besides passes, residential areas are also subject to rockfalls, when positioned beneath a steep scree slope with loose material. Data indicating residential areas at risk has not been as extensively assessed. However, once these areas are defined the existing Digital Terrain Models and geological mapping tools could be applied to assess the risk. The Engineering consulting firm Zietsman Lloyd & Hemstead Inc Entabeni Cnession is directly involved in modeling rockfalls on Chapman's Peak Drive and with their model other passes and residential areas could be assessed. Regrettably no costs were available for the modeling of rockfalls in the Western Cape.

4.5 Biological hazards

Biological threats typically refer to processes of organic origin or those conveyed by biological vectors. These include exposure to pathogenic micro-organisms, toxins and bioactive substances which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

In the Western Cape, the two most significant biological hazards concern veldfires and communicable diseases, particularly those with epidemic potential.

This section addresses veldfires (Greg Forsyth, CSIR) and communicable diseases with a specific focus on tuberculosis (Aidan Keyes, Department of Health: Information Management Western Cape).

The occurrence of veldfires in the Western Cape Province

Greg Forsyth
CSIR – Stellenbosch

Introduction

The Western Cape Province, with the exception of the dry regions of southern Namaqualand in the north and the Central Karoo district, is prone to the regular occurrence of veldfires. Often these veldfires cover large areas and can be very destructive (see Table 4.5.1).

Table 4.5.1
Large veldfires (>10 000 hectares) that have occurred in fynbos – based on data from Bands (1977), Brown *et al.* (1991), Thompson (1992) and unpublished records of Western Cape Nature Conservation (Table 2.2 in Kruger *et al*., 2000).

Locality	Date of ignition	Duration (days)	Area (hectares)
Hottentots-Holland Mountains	14 December 1942	18	11 200
Hottentots Holland Mountains	20 January 1958	16	17 130
Cederberg*	1959	–	18 150
Du Toit's Kloof Mountains*	16 February 1971	17	18 000
Krakadouwpoort, Cederberg*	7 December 1972	4	27 000
Kouga Mountains	May 1975	10	18 700
Sneeuberg, Cederberg	12 December 1975	6	13 500
Heksberg, Kouebokkeveld	31 January 1976	10	30 000
Cederberg	1979	–	10 740
Nuweberg, Grabouw	21 January 1984	–	29 300
Cederberg*	November 1985	–	17 160
Southern Cederberg*	27 December 1988	–	57 752
Waterval, Tulbagh	27 December 1988	–	12 770
Hex River Mountains	27 December 1988	–	13 932
Kogelberg-Kleinmond	27 December 1988	–	16 362
Sonderend Mountains	27 December 1992	±10	16 839

Locality	Date of ignition	Duration (days)	Area (hectares)
Grootwinterhoek	March 1995	–	16 300
Bain's Kloof	15 February 1998	4	10 508
Zachariashoek-Wemmershoek	February 1999	4	13 838
Brandvlei Dam to Du Toit's Kloof and Franschhoek	25 February 1999	17	±30 000
Franschhoek, Groenland Mountains and Grabouw	24 March 1999	17	±70 000
Sonderend Mountains	29 November 1999	11	11 470
Bot River to Koeëlbay	29 November 1999	6	12 898
Central Langeberg* (multiple ignition, 3 main fires)	10 and 13 December 1999	13	±43 800

* Veldfires ignited by natural causes: lightning fires or falling rocks

A number of conditions need to be in place for the occurrence of veldfires. These include suitable weather, sufficient fuel and a source of ignition. All these conditions occur to some extent at certain times of the year in the Western Cape. However these vary from place to place, giving rise to different veldfire regimes (ie the frequency and seasonality of veldfires) in different parts of the province.

The manner in which a veldfire burns is determined by the characteristics of the climate, fuel in the form of vegetation and the terrain. Climate influences fire behaviour through air temperature, humidity and wind speed and this in turn affects the moisture content of both living vegetation and dead plant material. High air temperatures, low humidity and high wind speed dry the vegetation, increasing veldfire risk and the difficulty of extinguishing a veldfire once it has started.

Climate

The Western Cape Province south of the interior plateau (Karoo) has a Mediterranean climate with hot, relatively dry and windy summers and cool and wet winters. The winter rainfall regime is most pronounced in the west and becomes bi-modal with spring and autumn peaks further east beyond Swellendam and onward to Plettenberg Bay.

The summer climate is characterised by the dominance of mid-ocean high-pressure cells (anticyclones) over the southern Atlantic and Indian oceans and is the source associated with hot, dry and windy conditions and is highest from December to March.

In winter the high-pressure cells move northwards, allowing the passage of westerly cold fronts to bring rain to the Western Cape. These fronts are often followed by periods of cool, calm and clear days resulting in low fire hazard conditions. Most of the rain falls between May to September with rainfall along the mountain ranges (> 3000 mm) being substantially higher than at the coast.

These cold fronts are often preceded by off-shore flows of warm dry air from the interior plateau, known as berg winds. Sharp increases in temperatures and decreases in humidity accompany these berg winds which are often strong. Thus, periods of high fire hazard can occur in winter as well as summer. The areas around George, Knysna and Plettenberg Bay are especially vulnerable.

Weather conducive to veldfires

Weather conditions characteristic of veldfires are persistent windy conditions combined with high temperatures (above 30°C) and low mean relative humidity. These conditions cause vegetation to dry out and if ignition should occur the veldfires will spread rapidly and often uncontrollably. Van Wilgen (1981) found that the average wind speed in the case of wildfires that burnt less than 5 000 hectares was 38,9 km per hour, the mean minimum and maximum temperatures were 15,7°C and 30,9°C respectively, and the relative humidity was a minimum of 32,9% and a mean of 48,3%. In the case of large veldfires (>5 000 hectares burnt) wind speeds averaged 46,7 km per hour, minimum and maximum temperatures were 16,2°C and 37,0°C, minimum relative humidity was 17,8% and the mean was 37,2%.

Fuel (Vegetation)

Veldfires require fuel in the form of vegetation that can burn. The evergreen sclerophyllous shrublands of the Western Cape are extremely fire prone. The most common and distinctive veld type within this vegetation is fynbos that typically occurs in mountainous terrain on sandstone-derived soils. Tall proteoid shrubs are dominant together with shorter, small-leaved ericoid shrubs, reed-like restios and herbaceous plants. Renosterveld is another distinctive veld type forming dense shrublands on relatively nutrient-rich soils, derived from shale. Renosterveld is richer in grasses and herbaceous plants than the fynbos but much of its original extent has been replaced by agricultural.

Veldfire is an integral part of the region's ecology and fynbos and renosterveld vegetation will burn readily at most times of the year (Van Wilgen and Van Hensbergen, 1992). However, evergreen forest communities rarely burn, as they are restricted to areas protected from fire such as mountain kloofs and scree slopes.

Live vegetation usually contains substantial amounts of moisture while dead plant material contains very little. Vegetation having a high moisture content will slow the burning process, since heat from the fire must first drive off this moisture. Dead plant material accumulates steadily in fynbos as its post-fire age increases. Fynbos plants also contain oils and resins and together with the accumulated dead material makes fynbos fire-prone. The size and arrangement of the dead fuel is important in determining how quickly the moisture content can respond to changes in climatic conditions. Thus finer dead material can dry in a matter of hours while drought has a cumulative effect on the dryness of heavier dead fuels.

An extreme fuel hazard is a situation where the vegetation is tall (2–3 m), dense and continuous from top to bottom, has large amounts of leaves and twigs and other fuel particles with a maximum thickness of less than 2 mm. The proportion of dead material is 30 – 50% or more and there is a large quantity of dead elevated fine fuel (McCarthy *et* al, 1999). This is not uncommon in fynbos stands with a post fire age of 12 to 15 years.

In dry, hot and windy weather conditions, fynbos will burn when it is only four years old, even though the ecologically desirable minimum interval may be at least eight years (Van Wilgen and Van Hensbergen, 1992).

During the last 100 years alien plants, particularly woody shrubs and trees, have also invaded many fynbos areas, (Richardson *et al*, 1992). These species were primarily introduced for plantation forestry, windbreaks and drift sand reclamation. About 1,6 million hectares of primary catchment G (Berg River to Agulhas) and 0,7 million hectares of catchment H (Breede River) have been invaded to some extent (Versfeld *et al,* 1998). The invading alien plants grows faster than fynbos and rapidly create higher fuel loads (see Table 4.5.2). They originate from fire prone environments and are therefore highly adapted to fire. These characteristics promote more intense fires than if the veld were not invaded.

Table 4.5.2

Fuel loads and fire intensities in different types of vegetation
(Table 1 in Chapman and Forsyth, 2001).

Vegetation Type	**Fuel Loads Gm^{-2}**	**Fire Intensity KWm^{-1}**	**Reference**
Savanna / grassland	100–1000	10 000	Stocks et al 1997
Fynbos	1000–3000 Max 7000	20 000–30 000	Van Wilgen et al 1995 Stocks et al 1997
Acacia Cyclops (Rooikrans)	9000	20 000–60 000	Van Wilgen and Holmes 1986
Pine plantations	18 000–40 000	No data	See Van Wilgen and Scholes 1997
Eucalypt plantations	42 000	No data	SeeVan Wilgen and Scholes 1997
Australian eucalypt	> 21 000	60 000 Max 100 000	Luke and McArthur 1978 Cheney 1983
North American boreal forest	1500–5000	60 000–100 000	Stocks et al 1997

Thus the hotter, drier and windier the weather (extreme fire danger), coupled with large volumes of dry vegetation, the more likely a large veldfire.

Fire Weather Zones

On the basis of the effects of weather variables on fuel moisture, Van Wilgen (1984) Identifies five distinct fire climate zones for the Western Cape. These zones are:

- Western coastal zone: veldfires are most likely to occur under extreme conditions of high temperature, low relative humidity and high winds in summer
- Western Cape inland zone north of Langeberg including Hex River and Breede River valleys: high mean potential for fire in summer
- South-western coastal zone: veldfires most likely under extreme conditions in summer and occasionally in winter under berg wind conditions
- Eastern inland zone: potential peak in summer
- South-eastern coastal zone: veldfires likely under occasional suitable conditions in either summer or winter; winter berg winds are important

Topography

Topography also has an influence on how a veldfire behaves with steep slopes increasing the rate at which the fire spreads and kloofs acting as chimneys. Slope dramatically increases the speed at which a fire can move. Each 10% increase in slope doubles the speed of a veldfire (Luke and McArthur, 1978). A fire will travel four times as fast up a 20% slope and can rapidly ascend cliff-faces if sufficient vegetation is growing on them. Conversely, that rates of spread are much slower when a fire is burns downhill.

Ignition

Lightning is the main natural source of ignition of vegetation in the Western Cape but sparks from rolling quartzite rocks also cause veldfires (Kruger and Bigalke, 1984). If lightning occurs in winter the resultant veldfires may burn only small areas before being extinguished by rain, whereas 'dry' electrical storms in late summer and autumn often result in major veldfires (Kruger, 2000).

Human action, either through arson or accident, is the main cause of contemporary veldfires, and with increasing population levels, the relative importance of humans as a source of ignition will continue to increase (Bond and Van Wilgen, 1996).

Land use change

Development in natural areas is an accelerating trend in many areas of the Western Cape. Residential properties on the urban fringe are often sought after for their aesthetic value, especially if they are in close proximity to picturesque landscapes and natural vegetation. People like to live in 'green' areas, screened out from others. Therefore it is inevitable that periodic veldfires will pose an occasional risk along the urban fringe.

Irregular boundaries formed by features such as gullies, ravines and ridges form 'fingers' of vegetation that penetrate the urban environment and can provide a 'conduit' for veldfires to travel into the urban environment. These areas are most commonly a part of the natural drainage system that is unsuitable for building, and a dangerous amount of fire-prone vegetation can therefore be found very close to development. Veldfires can very quickly spread from adjacent vegetation to nearby properties and buildings.

In addition, informal settlements are also often found on the urban fringe where vacant undeveloped land can be occupied. The risk of a veldfire spreading from the edges into such a settlement is much higher than it would be for a less densely developed suburb. The risk is increased by the proximity of the structures in an informal settlement, the highly flammable building material used and the lack of fire fighting infrastructure.

Reflections on the availability of veldfire related data in the Western Cape

There is no comprehensive and up-to-date GIS coverage of veld age (age since the last fire) for the Western Cape.

Where fire records do exist their extent is determined by the jurisdiction of the authority or institution involved (see Table 4.5.1). In general these are small areas with the exception of areas controlled by the Western Cape Nature Conservation Board.

In some cases, such as the Western Cape Nature Conservation Board, MTO Forestry (SAFCOL), and the Cape Peninsula National Park, good recent veldfire records exist and these are in GIS format. However, for most local municipalities fire records will in all probability be descriptive and patchy rather than accurate spatial records.

The most valuable fire records would be spatial records reflecting the last time any particular area of veld had burnt. For the purpose of establishing fire hazard it is not worthwhile trying to obtain records further back than the last time any particular area burnt. The older a fire prone vegetation type, the higher the veldfire hazard under suitable climatic conditions.

Unfortunately detailed veld age records mostly do not exist in the Western Cape. This is a problem currently being addressed by the Department of Water Affairs and Forestry in their implementation of the National Veld and Forest Fire Act (No. 101 of 1998),

However, we have a fair knowledge of where different vegetation types occur in the province and their fuel properties. We also know how veldfires behave under certain climatic conditions. By using this information we can derive the veldfire hazard at different times of the year for any particular location in the province. Where veld age data is available such information can be further refined.

Table 4.5.3
A rough estimate of the veldfire records available in the Western Cape

Area	**Source**	**Quantity (Coverage)**	**Quality**	**Format**	**Constraints**
Western Cape	Western Cape Nature Conservation Board (WCNCB)	Largest amount of veldfire data in province but some missing data	Good	Paper prior to 19?????? GIS and Access database from 19?	Only available for areas under the control of WCNCB
Cape Peninsula	Cape Peninsula National Park (CPNP)	Good coverage for CPNP, including data from the City of Cape Town and the former Cape Regional Services Council	Good	Paper prior to 19? And GIS since 19?	Only available for the CPNP.
Western Cape	Local municipalities	Unknown but assume that most keep some form of records	Variable?	More than likely paper records	If available it is likely to be non spatial and of limited value.
West Coast	West Coast National Park	?	?	?	?
Koeberg Nature Reserve	Eskom	?	?	?	?
Private Land (Farms)	If at all from district municipalities	?	?	?	?
Commercial plantations	MTO Forestry	Complete for their land holdings	Good	Paper prior to 19? and GIS since ?	Records from a very limited area

Conclusion

The occurrence of veldfires in the Western Cape is inevitable. These fires contribute to the vigorous condition of fynbos vegetation, provided that it does not occur too frequently at any particular locality. Through an understanding of fire weather, the fuel properties of the vegetation and fire behaviour, veldfire hazards can be identified and managed.

Proposal for Coarse Provincial Hazard Assessment

The objective of this proposal is to compile an initial veldfire hazard assessment of the Western Cape at a local municipality scale. This proposal is valid for thirty days starting from 7th November 2002.

Applicable expertise
The CSIR has substantial experience in veldfire research in South Africa. Some recently compiled technical reports illustrates this experience. Our project team consists of Greg Forsyth, Dr Brian van Wilgen and Dr Fred Kruger.

Approach

Our approach will be to develop an uncomplicated initial veldfire hazard assessment at local municipality scale. Descriptive ranks (rare, unlikely, possible, likely and almost certain) of the likelihood of a veldfire occurring within any local municipality will be assigned to each.

To derive the above rankings it will firstly be necessary to identify fuel and climate hazards and then to rank the likelihood of that fuel burning. We will derive this using existing climatic, vegetation and cover information as well as our understanding of the vegetation fuel properties and fire behaviour. We will also take into account any similar studies previously done in the Western Cape.

The resulting information will be incorporated into the GIS database on risk and vulnerability currently being compiled by DiMP for PAWC.

A possible second phase of the project would include the consequences of a veldfire to major community assets. Major community assets (environmental, economic and social) would be identified and the likely damage to them, should a veldfire occur, ranked using a descriptive scale of insignificant, minor, moderate, major and catastrophic.

The values of likelihood of occurrence and vulnerability will then be combined in a matrix to provide a list of identified assets ranked by the risk veldfire poses to each asset.

Tasks

1. Identify and rank the veldfire hazard (based on climate conditions and vegetation type) occurring within each local municipality in the Western Cape.
2. Compile a GIS coverage of the resultant information at a local municipality scale.

Possible phase 2:

3. Identify major community assets and rank the damage that is likely should a veldfire occur.
4. Compile a matrix showing identified assets ranked by the risk veldfire poses to each asset.
5. Determine veldfire risk priorities, options and strategies.

Deliverable

The Veldfire Hazard Assessment will be presented as a short written report to be delivered by 28th February 2002. This report will include a supporting GIS coverage in ArcView format. Three copies of the report will be made available as well as an electronic version formatted in MS Word 2000 and cut to CD.

Time frame

This project is envisaged to start by 1st December 2002 and end on 28th February 2002. This will depend on the signing of a contact by 30th November 2002.

Reporting

The project leader, Greg Forsyth, will report to Dr Ailsa Holloway of DiMP, University of Cape Town

Project budget

The project has a fixed price of **R 50 000.00 excluding VAT.** This includes professional fees and running costs for transport, materials and incidental expenses necessary for completion of the project. **Note that a possible phase 2 it not included in this budget.**

A break down of expenditure is given in the table below:

Tasks	Human Resources (R)	Running Costs (R)	Total Costs (R)
Task 1: Veldfire risk analysis	**30 000**	**6 500**	
Task 2: Create GIS coverage	**6 000**	**1 000**	
Task 3: Compile short report	**6 000**	**500**	
Total (excluding VAT)	**42 000**	**8 000**	**50 000**

Payment schedule

Invoices will be submitted as follows:

- 100% on delivery of the final report

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The Occurrence of Communicable Diseases in the Western Cape Province: focus on tuberculosis

Summary by DiMP Research Team – background by Aidan Keyes (Department of Health: Information Management Western Cape).

Communicable diseases refer to illnesses caused by microorganisms transmitted from an infected person or animal to another person or animal. In the Western Cape, tuberculosis (TB) is the most significant communicable disease, with more than 99% of reported communicable diseases in the Cape Town Metro related to TB. This is illustrated in Table 4.5.4 which profile reported communicable diseases for the Western Cape Administrative districts in 2001.

Table 4.5.4
Reported communicable diseases for the Western Cape Administrative Districts

Diseases	Boland / Overberg	Cape Metropole	South Cape / Karoo	West Coast / Winelands	Total	% of all cases
Acute flaccid paralysis	0	5	0	0	5	0.02
Acute rheumatic fever	0	3	0	2	5	0.02
Cholera	0	1	0	0	1	0.00
Congenital syphilis	9	15	3	1	28	0.10
Crimean-congo fever	0	1	0	0	1	0.00
Haemophilus influenza B	0	7	0	0	7	0.03
Legionnellosis	0	1	0	0	1	0.00
Leprosy	0	1	0	0	1	0.00
Malaria	3	40	6	6	55	0.20
Measles	0	30	0	3	33	0.12
Meningococcal infection	18	78	3	14	113	0.42
Poisoning, food	0	3	4	0	7	0.03
Poisoning, agric	12	8	3	4	27	0.10
Poisoning, pesticide	15	2	9	3	29	0.11
Positive tuberculin test	0	50	0	13	63	0.23
Rheumatic heart disease	0	1	1	0	2	0.01
Shigellosis	0	1	28	0	29	0.11
TB (All forms)	5250	11197	5481	4491	26419	97.69
Typhoid fever	1	5	0	1	7	0.03
Typhus fever (epidemic)	0	1	0	0	1	0.00
Viral hepatitis A	20	96	11	15	142	0.53
Viral hepatitis B	4	13	12	10	39	0.14
Viral hepatitis non-A, B	0	0	1	0	1	0.00
Viral hepatitis unspecified	0	14	0	0	14	0.05
Whooping cough	2	11	0	1	14	0.05
					27044	

While other provinces in South Africa regularly report high incident rates for epidemic communicable diseases such as cholera, the most significant infectious disease in the Western Cape is tuberculosis. TB is an ubiquitous infectious disease endemic to the Western Cape, and as such has been declared a ‘Health Emergency’. While the TB Epidemic does not conform neatly to the strict definition of a disaster, its potential impact to cause loss over the long term is extremely high. The Western Cape has one of the highest incidence rates for tuberculosis globally.

The TB epidemic in the Western Cape has increased during the past decade, especially in relation to rising levels of HIV/Aids infection. However, the severity of this trend is unequally distributed across the province. Figure 2 illustrates the increasing incidence of TB per 100 000 people for the Boland/Overberg District Municipality from 1995–2002. While this increase may reflect improved detection and reporting, the statistics reflect an increase of almost 20% in TB incidence between 1996–2001.

Communities are at greatest risk when experiencing high levels of poverty, overcrowding, HIV infection and poor access to basic health services. This is reflected in Table 4.5.5 which compares TB rates per 100 000 people for the Boland/Overberg, Cape Metropole, South Cape/Karoo and WestCoast/ Winelands Administrative

Table 4.5.5

TB rates/100 000 pop, Boland/ Overberg, Cape Metropole, South Cape/Karoo and WestCoast/ Winelands Administrative Districts of the Western Cape, 2001

Administrative District	**No. Cases TB**	**Rate per 100 000 pop.**
Boland/ Overvberg	5632	1162
Cape Metropole	18311	663
South Cape/Karoo	5405	1128
West Coast/Winelands	8454	1114

Table 3 illustrates the effect of uneven access to health services between the Cape Metropole and outlying administrative districts. The Cape Town Metropole's tuberculosis incidence rate is 663/100 000 compared to 1 162/100 000 for the Boland for example, or 75% lower.

While the TB epidemic is closely managed through constant monitoring and TB Control Programmes, TB trends are significantly influenced by the increasing impact of HIV/AIDS infections. Statistics indicate that more than **70%** of HIV positive people die from TB (TB is the major manifestation of AIDS in HIV positive patients).

Data on communicable diseases are consolidated by the Health Information Management Department of the Western Cape. TB in particular is monitored through the 'TB Register' that is updated weekly through new notifications and quarterly for notified cases. The 'TB register' is organized both in files and in electronic forms, with a section specifically involved in data monitoring and analysis. Other communicable diseases can similarly be sourced from the unit's databases.

The following is a list of resource people involved in communicable disease monitoring:

NAME	DEPARTMENT	PHONE NUMBER	E-MAIL
Mr. E. Reynolds	Provincial Administration Western Cape	(021) 483 4661	Ereynold@pawc.wcape.go.za
Mr. S. Titus	Provincial Administration Western Cape	(021) 483 3737 / 5707	Stitus@pawc.wcap.gov.za
Mr. A.B. Keyes	Provincial Administration Western Cape	(021) 483 5431 / 2270	Akeyes@pawc.wcape.go.za

4.6 Summary tables: Information audit and Hazard Assessment Costs

HAZARD ASSESSMENT TYPE	**AUDIT OUTLINE**	**TOTAL**
Weather Related Hazards	Cost data Cost processing Cost analysis	Negotiable 63 000 253 500
Sub-Total		**316 500**
Riverine Flooding	Data collection, transfer & examination	290 000

	Hydrological study & modelling Report & project management Travel and accommodation	630 000 110 000 25 000
Sub-Total		**1055 000**
Marine Hazards	2 day Consultative meetings Coarse vulnerability assessment of: ▪ Estuary flooding ▪ Coastline to coastal erosion Comprehensive coast erosion vulnerability assessment	67 000 40 000 100 000 250 000
Sub-Total		**457 000**
Seismic Hazards	Data preparation Map creation Report compilation	31 240 9 300 34 725
Sub-Total		**75 265**
Rockfalls	No data	
Veldfires	Veldfire risk analysis Create GIS coverage Compile short report	36 500 7 000 6 500
Sub-Total		**50 000**
Communicable Diseases	No Data	
GRAND TOTAL		**1953,765.00**

Note: Total's excluding VAT

4.7 Conclusion

The extensive review presented in this section of the report illustrates how extensively the Western Cape is exposed to a wide range of potential hydrometeorological, geological, and biological hazards. Moreover, increasing population growth, combined with increasing probabilities of extreme weather conditions is likely to further increase the probability and severity of natural hazards triggered by climate conditions.

While the reports given here demonstrate the wealth of scientific expertise available to interpret patterns and trends in natural hazards, it is unfortunately not being fully engaged in strengthening disaster risk management capabilities.

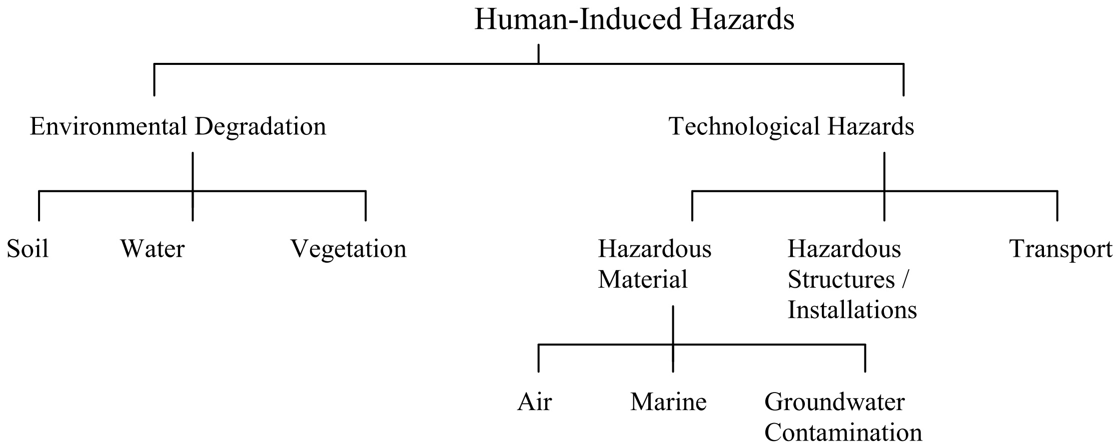
Similarly, while there is a vast array of disparate data-sets related to natural hazard patterns and trends, these are fragmented, of varying levels of quality, and do not provide a uniform portrait of hazard potential for the province.

Despite impressive levels of research undertaken to date, there is no major natural hazard category in the Western Cape that contains uniform robust and verified data that ‘covers’ the Province and can be easily incorporated into a GIS. There are, however, committed specialists of an international level who have skills to interpret the available data from different sources, and who, within 3–6 months, could provide robust data for incorporation into a GIS.

Part V Presentation of Findings: Focus on Human-Induced Hazards

5.1 Introduction

Human-induced hazards arise as a result of human processes. They can be further classified into technological hazards or ‘environmental degradation’ as shown below. For the purposes of this study, ‘environmental degradation’ is viewed as having three components (soil, water and vegetation), while ‘technological hazards’ are categorized into ‘hazardous materials’, ‘hazardous structures or installations’, and ‘transport’.



This section is divided into the following sub-parts:

Part 5.2 provides an **overview of human-induced hazards** in the Western Cape
Part 5.3 focuses specifically on **technological hazards** of concern, including hazardous materials, hazardous installations and transport hazards
Part 5.4 addresses issues around **environmental degradation** in the Western Cape
Part 5.5 **concludes** the section

5.2 Overview of technological threats and environmental degradation processes in the Western Cape

The Western Cape faces a wide range of human-induced hazards, ranging from sophisticated facilities for nuclear energy and hydrocarbon processing, to high rates of soil, water and vegetation degradation. The highly diversified nature of the province’s economy, combined with its extensive port facilities and natural resource base, have resulted in areas of concentrated industrial activity, particularly in the ports. This is particularly the case for the Cape Town Metropole as well as locations such as Saldanha Bay. It is further reflected in extensive dependence on long-haul road, rail and sea transport capabilities to move potentially hazardous materials over long distances.

A clear challenge in auditing information concerning technological hazards relates to the wide diversity of stakeholders and interest groups involved. This is characterised by the involvement of a vast number of private sector players, and is similarly reflected in corporate concerns with respect to confidentiality of risk-related information. This is further reflected in a wide range of legal instruments at different stages of implementation and with different enforcement mechanisms.

5.3 Technological hazards

Technological hazards are those that may cause danger originating from technological or industrial accidents, dangerous procedures, infrastructure failures or certain human activities.

This report will focus specifically on hazardous materials, hazardous installations as well as transportation-associated hazards.

5.3.1 Hazardous materials

A hazardous material is any chemical, compound or mixture of compounds that is physically harmful (eg flammable or combustible liquid compound) and/or harmful to one's health (eg agents that can damage the lungs, skin, eyes or mucous membranes).[7]

The field of hazardous-materials management is vast. With respect to 'off-site' hazardous materials, this report focuses on endangering air emissions and marine oil/toxic spills, as well as groundwater contamination.

Air emissions

Summary by DiMP Research Team – background by Grant Ravenscroft (Scientific Services)

Introduction

The high levels of industrial activity concentrated in the Cape Town Metropole underline the need for careful monitoring of potentially harmful atmospheric pollutants. A pollutant is a chemical element that finds its way into the atmosphere because of structures, vehicles and human activity. This can be the result of man-made static structures and vehicles, as well as fires. These pollutants have a great impact on the long-term human health, and most usually comprise:

- Sulphur Dioxide SO_2
- Particulate Matter
- Carbon Monoxide CO
- Nitrogen Dioxide NO_2
- Ozone O_3
- Benzene C_4H_8
- 1, 3-Butadiene C_4H_6
- Lead Pb

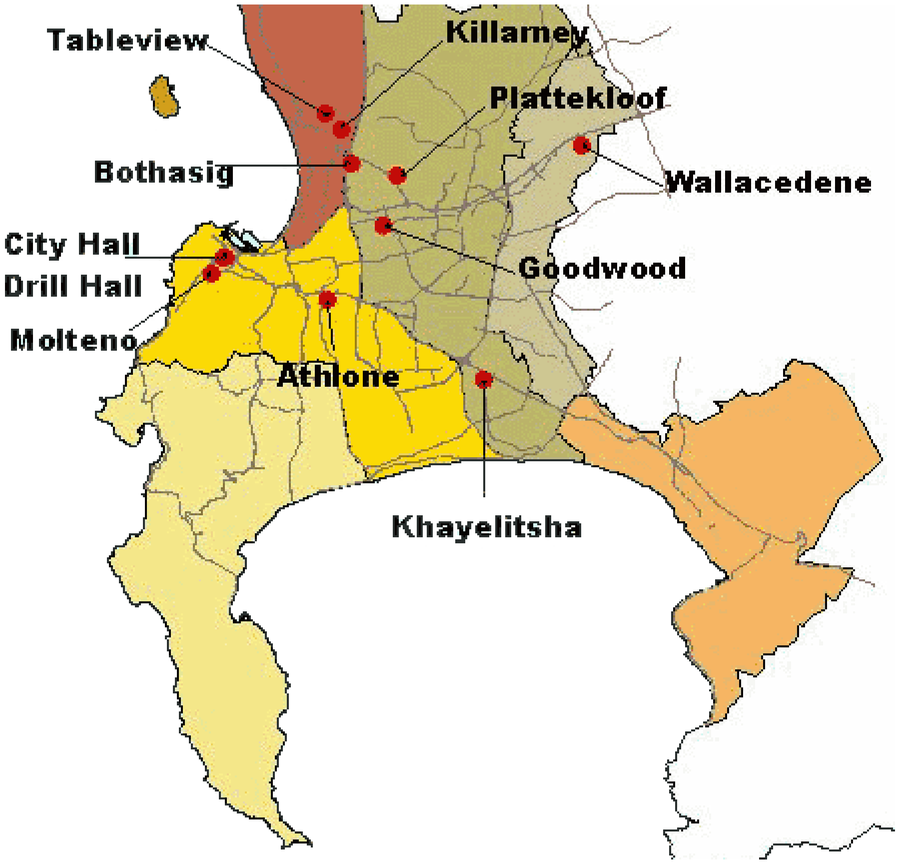
Each of these pollutants has an impact on the health of the community when the level of pollution is high over a long period of time, except in the case of fire where there is an immediate impact. Table 5.3.1.5 summarises the principal pollutants.

Currently there are ten monitoring stations in the City of Cape Town. These are shown in figure 5.4.3.1. Unfortunately they do not cover the entire Metropole, nor are other monitoring stations sited elsewhere in the Province. The guidelines used for monitoring air quality are

[7] http://www.orcbs.msu.edu/chemical/sop/hazchemdef.html

the same as those used in the United Kingdom. The concentration of the pollutant is measured in micrograms per cubic metre. Values are recorded for every day of the year. Each pollutant has levels of severity, ranging from low to very high. Each level is associated with increasing values in pollution. These values are available to the public on the internet.

Figure 5.3.1.1
Map of the Monitoring Stations in the City of Cape Town[8]



Areas at risk

In the Western Cape there is a high incidence of PM-10 (particulate matter with particle diameter of 10 μm) episodes. An episode occurs when the concentration of a pollutant in the air exceeds a given standard, which is 50μg/m^3. The episodes are categorized in terms of severity. This ranges from a moderate episode, which occurs at levels between 51μg/m^3 and 75 μg/m^3, and a very high episode, which occurs at levels greater than 100μg/m^3. It is noted that very high episodes occur most frequently in the informal settlement of Khayelitsha (See Figure 5.3.1.2). It is interesting to note that the informal settlement Wallacedene has a high number of episodes, yet is significantly smaller than Khayelitsha. The pollution levels in Khayelitsha influences the levels of PM-10 in Wallacedene under southerly wind conditions. The pollution is carried many kilometers under these conditions and is often re-circulated the next day. The high episodes in the informal settlements may be caused by the use of wood, paraffin and gas for cooking and heating.

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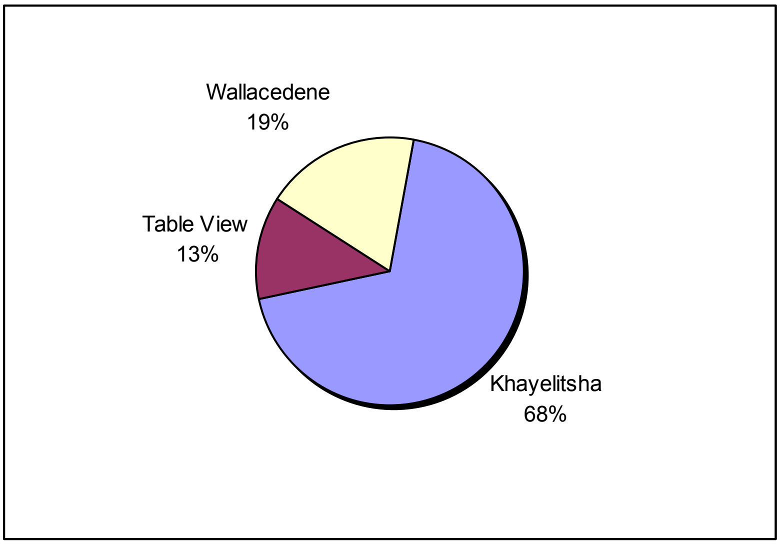
8 http://www.orcbs.msu.edu/chemical/sop/hazchemdef.html

Figure 5.3.1.2
68% of episodes recording levels higher than 100 $\mu g/m^3$ occurred in Khayelitsha between 2001 and 2002



Issues concerning data use for hazard mapping

The challenge in mapping the various air emissions to illustrate the most hazardous areas is to map an intrinsically dynamic value in a static manner. Then what level should be mapped? The effect of emissions is largely a long-term one and largely with respect to health impacts.

Various questions can be asked. Is pollution seasonal? Are the levels of PM-10 particularly high in winter because of wood and coal being used to heat homes? Table 5.3.1.3 and figure 5.3.1.4 seem to suggest a possible relationship between pollution and seasonality. Are the levels of sulphur dioxide particularly high in industrial areas?

Table 5.3.1.3
Recorded Values for PM-10 above threshold value of 100 $\mu g/m^3$ in Khayelitsha between 2001 and 2002

Date	**Pollutant**	**Threshold Value ($\mu g/m^3$)**	**Recorded Value ($\mu g/m^3$)**
20-Jun-01	PM10	100	109
23-Jun-01	PM10	100	104
7-Jul-01	PM10	100	111
14-Jul-01	PM10	100	143
20-May-02	PM10	100	101
4-Jun-02	PM10	100	118
18-Jul-02	PM10	100	114
20-Jul-02	PM10	100	139
21-Jul-02	PM10	100	107
11-Aug-02	PM10	100	114
21-Sep-02	PM10	100	130

Figure 5.3.1.4
Graph illustrating recorded values against time for PM-10 in Khayelitsha (Threshold Value of 100 μg/m^3)

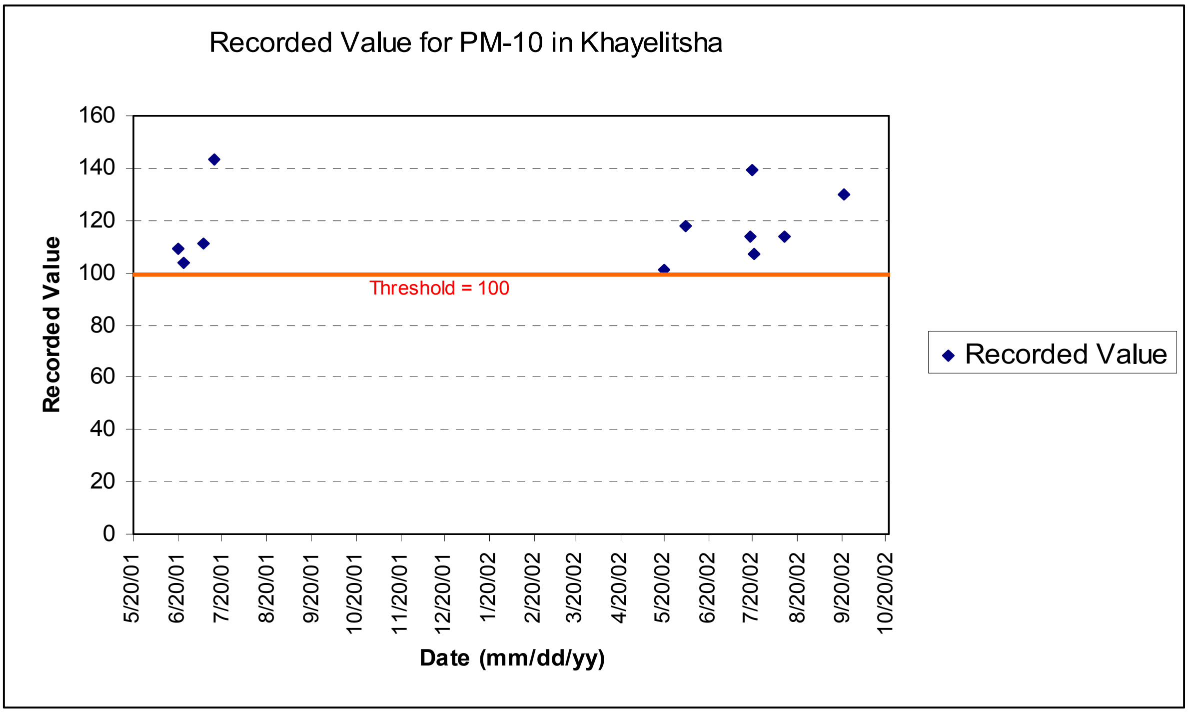


Table 5.3.1.5
Summary of principal pollutants and their consequences

Pollutant	**Characteristics & Sources**	**Threshold Value**	**Effect on Health**	**Effect on Environment**
Sulphur Dioxide (SO_2)	• Can occur in ambient air or can combine with water to form acid rain • Where there is burning of fossil fuels • Power stations and industry	266 $\mu g/m^3$	• Asthma • Chronic lung disease	• Damage to vegetation and soil
Particulate Matter PM-2.5 PM-10	• Vary in composition, size and source • Range in diameter from 2.5 μm (PM-2.5) to 10 μm (PM-10)	50 $\mu g/m^3$	• Particles are small enough to penetrate deep into the lung tissue • Lung problems • Particulate Matter can be comprised of carcinogenic matter which is carried into the lungs	
Carbon Monoxide (CO)	• Resulting from any combustion process • Primarily motor vehicles	11.6 mg/m^3	• Hampers transport of oxygen in the blood stream • Decrease oxygen supply to the heart	
Nitrogen Dioxide (NO_2)	• Road traffic, power stations, heating facilities, industrial processes	28 $\mu g/m^3$	• Irritate lungs • Lower resistance to respiratory infections • Aggravate heart and lung disease	

Pollutant	**Characteristics & Sources**	**Threshold Value**	**Effect on Health**	**Effect on Environment**
Ozone (O_3)	• Produced by a reaction between nitrogen dioxide, hydrocarbons and sunlight • Higher occurrence in rural areas • Prevalent in summer time	100 μg/m^3	• Impact on lungs	
Benzene (C_4H_8)	• Forms part of petrol • Combustion of petrol	16.25 μg/m^3	• Cancer • Nervous system disorders • Liver and kidney damage • Reproductive disorders • Birth defects	
1,3 – Butadiene (C_4H_6)	• Combustion of diesel engines • Used in industrial processes	2.25 μg/m^3	• Cancer • Nervous system disorders • Liver and kidney damage • Reproductive disorders • Birth defects	
Lead (Pb)	• Combustion of fossil fuels • Metal processing industries • Waste incineration	0.25 μg/m^3	• Harmful to children • Has been linked to impaired mental function, visual-motor performance, memory, attention span and neurological damage	

References

1. http://www.orcbs.msu.edu/chemical/sop/hazchemdef.html
2. http://www.capetown.gov.za/airqual
3. http://www.airquality.co.uk/archive/index.php
4. http://www.epa.gov/air/aqtrnd97/brochure/pm10.html
5. http://www.ecan.govt.nz/Air/home-heating.html
6. http://www.ecan.govt.nz/Air/Winter-Report/more-pm10.html

Oil pollution and toxic cargo spills/radioactivity:

Roy van Ballegooyen[*1], Andre Theron[*1] and Carl Wainman[*2]
[*1]CSIR Environmentek– Stellenbosch
[*2]Institute for Maritime Technology

Description of Hazard

The hazard here is the release of hydrocarbons into the marine environment. This may be intentional (tank cleaning, etc) but typically is an accidental discharge. These discharges may be catastrophic due to shipping accidents or may be more modest and associated with bunkering accidents and cargo handling in ports. Substantial risk is also posed by smaller vessels should they not comply with oil pollution regulations.

Although the probability of occurrence is typically low, the consequences of an oil spill can be catastrophic. Consequently considerable resources have been expended in oil spill contingency and response planning. Response measures exist in each of the ports as well as at sensitive industrial locations (Koeberg). Furthermore, a significant response capability exists in DEAT (Department of Environmental Affairs and Tourism).

Existing Information

The responsibility for oil spill contingency and response planning rests with DEAT, the person responsible being Dr Lynn Jackson.

A set of contingency plans exist for the regions in South Africa and are updated as resources allow. A coastal sensitivity atlas has been published by the Department of Transport (Jackson and Lipschitz, 1984). This sensitivity atlas could to be updated, enhanced and made more user-friendly using the latest GIS technology and numerical modelling capabilities for contingency planning.

A general assessment of the vulnerability of coastal resources to shipping (oil, toxic wastes, garbage, etc) has been undertaken and a draft paper to motivate the proclamation of particularly sensitive marine areas and associated marine protected areas has been submitted to DEAT and SAMSSA by Sue Lane and Associates, funded by the International Federation for Animal Welfare (IFAW).

Statistics on oil spills have been collated by Dr Lynn Jackson for South Africa's ports as well as the coastal and offshore regions.

Approach to coarse provincial hazard assessment

Sufficient information should be in existence for a coarse provincial hazard assessment. The coverage is somewhat patchy but should be adequate. This information needs to be collated and reformatted for input into a GIS system. This could be done in consultation with DEAT and SAMSA by a number of consultants/institutions (eg CSIR, Sue Lane and Associates and Crowther Campbell who all have experience in this field). The CSIR is well versed in risk assessments, oil spill modelling and are presently developing a national oil spill contingency plan for a West African state, while Sue Lane and Associates have undertaken general assessment of the vulnerability of coastal resources to shipping.

Toxic Cargo Spills/radioactivity

Description of Hazard

Typically heightened precautionary measures are associated with the transport of hazardous cargo, nevertheless incidents of toxic spills do occur, the most recent being from the Jolly Rabino in 2002. Also included in this category are toxic spills on land that reach the marine environment via stormwater run-off or natural drainage.

Existing Information
It is uncertain to what extent statistics exist on toxic spill in the offshore and coastal environments. Such information, as exists, would be obtainable from Dr Lynn Jackson of DEAT.

Approach to coarse provincial hazard assessment

As with oil spills, modes of transport and transport routes that pose the potential source of pollutants need to be mapped, together with particularly sensitive and vulnerable marine areas. These mappings together with the transport and the fate of toxic materials in the marine environment, will allow for the assessment of associated risks. Best suited to this task would be DEAT and SAMSA assisted where necessary by the CSIR and other consultants working in this field.

Groundwater pollution

Summarised by DiMP Research Team – background by Kerry Murphy (Council of Industrial and Scientific Research (CSIR)) and Mike Smart (Department of Water Affairs and Forestry (DWAF))

Groundwater is an important resource in the Western Cape. It is stored in aquifers below the ground and so is susceptible to hazardous contaminants that may filter into the ground should there be a spill. A large, important aquifer underlies most of the Cape Flats region of the Western Cape. This aquifer is used mainly for agricultural purposes, although it is used as domestic and industrial water supply in Atlantis. It is also used extensively for garden irrigation by homeowners. This aquifer is particularly vulnerable to a spill of hazardous material as it is overlain by highly permeable sandy soils and has a high water table. Similar primary/intergranular aquifers occur in the Sandveld along the west coast including important aquifers at Saldanha Bay and Lamberts Bay.

The bulk of the Western Cape is underlain by fractured rock aquifers. The hazard will depend on the extent of fracturing of the rock, depth to water table, extent of weathering and rock composition. The clay rich shale and granitic rock are generally less susceptible due to the clayey nature and generally low transmissivity. The fractured Table Mountain Group Aquifer (Cape Fold Belt), on the other hand, can be highly transmissive. Spills can travel large distances in a relativley small timeframe along open fractures. The natural water quality is excellent and therefore needs special protection. Towns and agriculture are becoming increasingly dependent on groundwater and springs (groundwater discharge) in the aquifer.

Other regions of the Western Cape use groundwater mostly for domestic and agricultural purposes. Examples of such areas are those in the vicinity of the Beaufort West and Leeu Gamka. These boreholes are drilled into Karoo fractured rock aquifers. Because of the existence of major transport routes over the aquifers, and the type of goods transported, these areas would be at greater risk. Should there be a transportation accident, the extent of pollution risk would depend on the type and quantity of material that has been spilled and the protection afforded by the overlying soils and geology.

Profiles of hazardous materials and the impact they would have on the environment have been done, but these are for specific locations. No single broad study has been Sconducted for the entire Western Cape. To date, there has also been no consolidation of existing work conducted.

5.3.2 Hazardous installations

Summarised by DiMP Research Team – Background by Ted Rowen (Ted Rowen and Associates Consultants)

Introduction

There are a wide variety of industries within the boundaries of the Western Cape. Many of these use chemicals and other substances that are potentially dangerous to the surrounding communities as well as the environment. Incidents resulting from a hazardous substance spillage or igniting can have lethal consequences.

The Major Hazard Installations (MHI) Regulations promulgated under the Occupational Health and Safety Act came into being in 1993 and have been recently revised. These regulations apply to those industries that have a certain quantity of hazardous chemical substances on their premises that present a risk to the employees and the surrounding community, or have the potential for a major disaster. The regulations require such industries to conduct a risk assessment of the premises, which would be known as a major hazard installation (MHI). The purpose of the risk assessment is to consider various incidents that may occur at the MHI, as well as the possible frequency and magnitude of these incidents. Once this is completed, the aim is to put into place steps to remove the potential cause, reduce it or control it. This risk assessment is to be conducted by an Approved Inspection Authority.

There are, however, shortcomings in the regulations:

- No specific quantity is given for how much of a specific hazardous chemical substance is allowed on the premises of an installation to require its definition as an MHI.
- The guidelines for what ‘potential to cause a major accident’ are undefined, and fail to adequately specify criteria for ‘an occurrence of catastrophic proportions’.
- There are as yet no permanently appointed Approved Inspection Authorities.

Implications for auditing information on Major Hazardous Installations

In the absence of clear criteria and procedures for defining what constitutes an MHI, no systematic procedure exists within local authorities for recording MHIs that could then be mapped. Systems for recording and monitoring MHIs can only be effectuated once these procedures are clarified and understood jointly between the industries concerned and authorities responsible for monitoring/enforcing the legislation.

[The following proposal was suggested by an experienced hazardous installations assessment specialist:

1. Take urgent steps to regularise the criteria for the assessment of major hazardous installations in relation to what the limiting quantities of hazardous materials are and the definition of a catastrophic event. This should be done together as a collaboration between the local councils and the Department of Labour.
2. Regularise with the Department of Labour the appointment of an authorised inspection authority.
3. Determine how installations will be selected for assessment. It should be decided whether this would be the responsibility of the section 16(2) appointee, as defined by the Occupational Health and Safety Act, to determine whether or not the installation falls into this category.
4. Local authorities must determine the extent to which they want the major hazardous installations to comply. It should be decided whether all installations should do an environmental assessment. An installation near the docks would have to have a more extensive environmental assessment than one factory in a rural area inland.
5. Include in all planning the provision of the Occupational Health and Safety Act. Especially those relating to hazardous substances, major hazardous installations and hazardous chemical regulations.

   It is essential that the regulations be clarified as soon as possible. There are many unnecessary assessments being conducted by consultants who are not authorised to do so.

   In order to achieve a clear set of regulations, all levels of government up to the provincial level have to be involved. There also has to be collaboration with the Departments of Health and Labour. The councils should then present the national government with recommendations. There is a need for specialist advice to provide information to make the recommendations. As local authorities need to interface closely with industry, their effort can be strengthened by resource people with experience in industry.
   There are currently no permanent inspectors of MHIs. Permanent Approved Inspection Authorities have yet to be appointed.

   Currently all planning is being based on immediate needs, with little long term planning. There is a need to have a trend prediction of the industries coming into the Western Cape to strengthen industrial risk management.]

Koeberg[9]
Dr. Lindley Perryman Eskom
Marc Maree Koeberg, Eskom

Introduction
Koeberg Nuclear Power Station is located approximately 30km north of Cape Town on the Atlantic Coast. The station comprises of two three-loop Pressurized Water Reactor (PWR) systems designed to produce 2785 MW (thermal). Each system or unit is designed to give a net output of 921.5 Mwe. The station was build by a French Consortium. Koeberg is very similar to a number of the PWR stations in France. Commercial operation of the first unit (Unit 2) commenced in November 1985. Koeberg supplies a significant portion of the electricity in the Western Cape. The power station has excellent safety and technical performances (Unit 1 holds the record for the longest running unit in Eskom – 454 days of non-stop operation.

Description of Hazard
In the event of a severe nuclear accident at Koeberg Nuclear Power Station the plant may pose a radiological risk to persons residing in potentially affected areas located within a 16 km radius from the power station. The potentially effected areas are specific areas exposed to a radiological plume pathway depending on the meteorology, plume dynamics and operational plant characteristics.

Existing information
Various documents addresses Eskom's recommendations. These include:

- The Blaauwberg Spatial Development Plan is the framework that describes spatial development for the area surrounding the Koeberg Nuclear Power Station.
- The Environmental Policy of the City of Cape Town addresses sources of energy. The Management Plan for the Blaauwberg Conservation Area addresses conservation in the vicinity of Koeberg Nuclear Power Station.

Future implications
Spatial development around Koeberg Nuclear Power Station are documented in the Blaauwberg Spatial Development Plan as has been previously stated. Future implications and requirements from the National Nuclear Regulator have been addressed in this document.

Caltex Refinery
Summarised by DiMP Research Team - Background by Terence Parker (Caltex)

The Caltex Refinery is situated in the suburb of Milnerton in Cape Town, next to the N7 highway. It was built in the mid 1960's, then far from any residential area. The main products of the refinery are leaded and unleaded petrol, diesel, illuminating kerosene, jet fuel, fuel oil, bitumen, liquefied petroleum gas (LPG) and industrial fuel gas. Trucks distribute petrol and diesel to various filling stations, the jet fuel to Cape Town International Airport and the LPG is distributed to be used in small gas bottles or in larger quantities in industry.

Caltex conducted a risk assessment in compliance with the Occupational Health and Safety Act (1993) Major Hazard Installation Regulations (MHIR 1998). The risks were identified using United Kingdom standards. The study identified risk at a given point (individual risk) and public

[9] Koeberg is not regulated by the Major Hazardous Installation Act, but by the National Nuclear Regulator

safety looking at the worst-case scenario (societal risk). The assessment looked at 3 000 different scenarios.

The highest risk was found to be related to the loading of LPG which is located at the Eastern boundary of the site. The worst-case scenario would be a truck driving away while loading. The LPG would be released in large enough quantities to cause an explosion, should there be an ignition source. This risk has been mitigated by putting into place various safety precautions. Among these are automatic shut-off valves on the pumps that are activated should the driver pull away during loading.

Another major risk is hydrogen sulphide (H_2S). At certain stages in the refining process H_2S is in gaseous form, which is lethal. The gaseous H_2S is converted to liquid sulphur and then to solidified sulphur. The solid sulphur is then stored in a closed silo. There are strict controls in place for the handling of H_2S gas such as analysers linked to alarms in the process areas. The Caltex Refinery works closely with City of Cape Town Scientific Services to monitor air pollution in the area, thus closely monitoring the levels of H_2S among other air pollutants.

Overall it was found that the risk was largely contained within the boundaries of the refinery. An emergency response plan was also submitted to relevant authorities together with the risk assessment for compliance with the Major Hazardous Installations Regulation.

5.3.3 Transportation-related hazards
Summarised by DiMP Research Team

Introduction

Western Cape municipalities' concerns regarding transportation of hazardous materials were reflected in the RAVA forms (refer Annex C-1) in which they stated their hazard priorities. 22% of the responses identified transport as the greatest hazard in the Western Cape, 52.6% of these regarded the transportation of hazardous material to be a priority (refer Table 5.3.3.1).

Table 5.3.3.1
Transportation hazard priorities as identified by municipalities

Hazard Sub-type	**Frequency**
Hazmat in Transit	10
Type Not Specified	4
Bus/Train/Minibus	3
Airplane/Helicopter	1
Ship (Oil Spill)	1
Total	**19**

Road

Road accident information is currently being consolidated by the Provincial Department of Transportation. This information is being examined to identify hazardous road locations. The individuals within the department who were contacted were extremely constrained for time. This proved to be a challenge when gathering information about road accidents.

Information was also sought from representatives of the petroleum industry. In this context, individual companies take responsibility for managing the safe transportation of hydrocarbon products. However, consolidated data-bases with respect to routes across all petroleum companies do not exist. Relevant contact people include:

Name	Organisation
1. Frans Fik	Provincial Department of Transport
2. Chris Snyman	Provincial Department of Transport
3. Douglas Drysdale	Caltex
4. Mervyn Knickelbein	Engen

<u>Air</u>

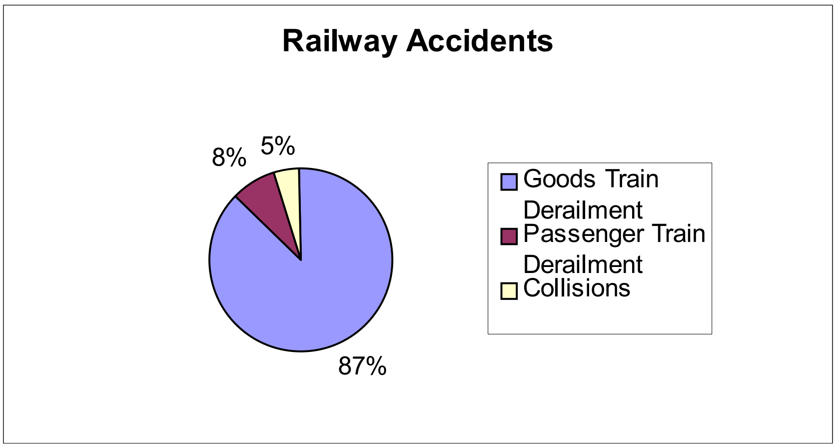
The South African Civil Aviation Authority (CAA) collates information regarding aircraft accidents within South Africa, and hence the Western Cape. This is collated electronically, but contains elements of confidential information. An event is considered significant if any structural damage occurs to the aircraft. The following person was contacted within the CAA:

Name	Organisation
Daleen Gouws	South African Civil Aviation Authority

<u>Rail</u>
Background by Trevor Fester (Spoornet)

There have been a total of 63 significant rail accidents from 1995 to August 2002. Of these, 87% were the derailment of goods trains. This could pose a problem depending on the type of goods being transported. Spoornet does not currently map railway accidents on GIS.

Figure 5.3.3.2
Significant Railway Accidents in the Western Cape



In this context, Spoornet identified the following areas of concern:

- Train collisions and derailments are considered noteworthy, as these events can contribute significantly to injuries, loss of life and can cause major environmental damage. This is especially true if the cargo being transported is considered hazardous.
- Level crossing accidents occur between trains and road vehicles, where the road crosses the railway line. This could be disastrous should a collision occur where dangerous goods are being transported, resulting in spillage.
- Rail accidents could be weather related. These occur when railway lines are subject to washaways due to heavy rains/flooding.
- Interference with vulnerable and strategic railway infrastructure, such as bridges, tunnels, signals, etc, is also cause for alarm.
- The increasing expansion of informal settlements in areas adjacent to railway lines is also of concern. Statistics indicate that the rate of interference with rail traffic, especially in these areas, is rapidly increasing. Given the fact that Spoornet transports large tonnages of petro-chemical products through some of these areas, a significant rail accident would have a serious impact should it occur.

5.4 Land Degradation

Summarised by DiMP Research Team

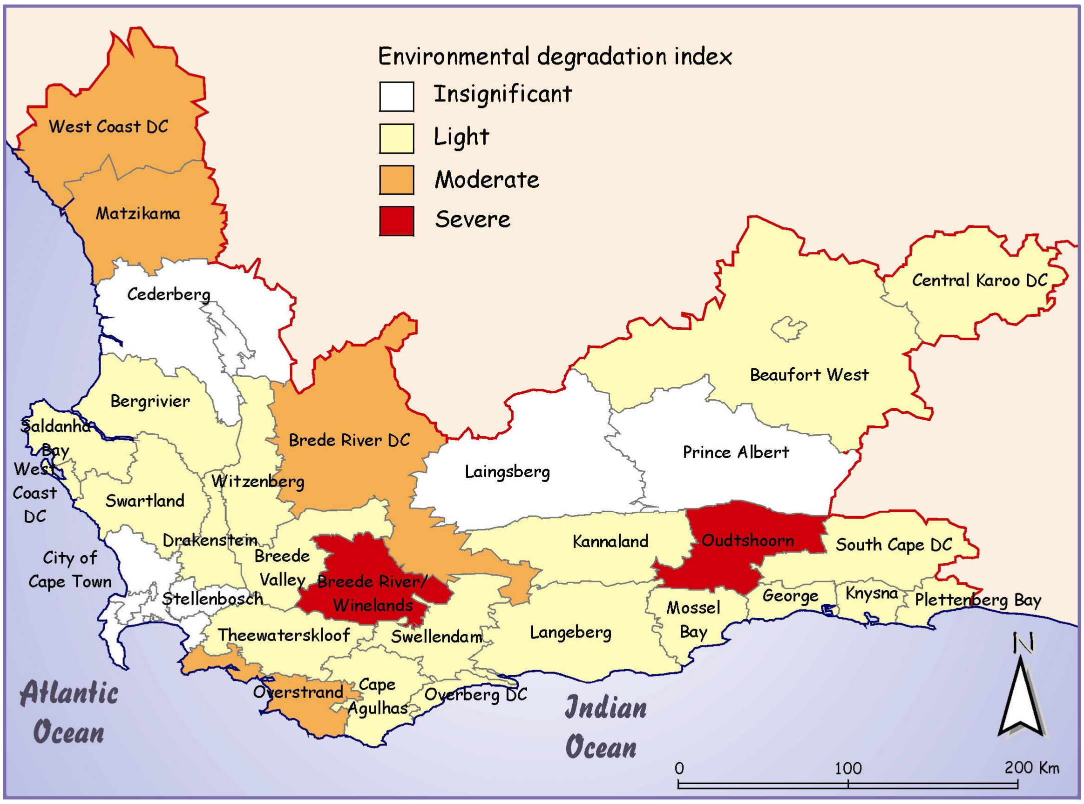
Land Degradation and Hazards

Land degradation is defined as 'the substantial decrease in either or both of an area's biological productivity or usefulness due to human interference' (Johnson and Lewis 1995, cited in Meadows 1998). Land degradation in the Western Cape occurs in many forms, such as clearance of natural vegetation, invasion of alien organisms, soil erosion through wind or water, physical or chemical degeneration of soil, loss of wetlands and riverine ecosystems or a decline in surface and groundwater quantity and quality (Meadows 1998).

Generally, land degradation is characterised by poor land management and is affected by both climatic and human influences. The extent of degradation is determined by environmental characteristics such as water, soil or vegetation (Hoffman and Ashwell 2001). Degradation is exacerbated through conditions of drought since poorly managed land is unable to recover as quickly as well-managed land.

Soil and veld degradation indices, measuring severity and rate of degradation, determined the status of land degradation in the Western Cape (Hoffman and Ashwell 2001). A combined degradation index, summing both the soil and veld indices established municipal areas most at risk (see map below):

Figure 5.4.1
Combined Degradation Index Map



Municipal Districts of the Western Cape showing Environmental Degradation

According to Hoffman and Ashwell (2001), the Western Cape has the second lowest provincial soil degradation index, only moderately significant in commercial grazing areas of the Little Karoo and Vanrhynsdorp. Soil degradation is commonly sheet erosion. Severe veld degradation has occurred in areas of Hermanus, Montagu, Oudtshoorn and Calitzdorp, with changing plant composition forming the most common problem.

Municipal districts of Oudtshoorn and the Breede River/Winelands contain severe combined environmental degradation while Hermanus, the Breede River DC, Matzikama and West Coast DC municipal districts contain moderate combined environmental degradation (Hoffman and Ashwell 2001). Priority districts for commercial farming in the Western Cape are:

- Calitzdorp
- Montagu
- Oudtshoorn
- Vanrhynsdorp

Implications of land degradation in areas most at risk include threats to food security through the reduction of crop yields, increased financial costs, competition and conflict regarding land and resources, social disruption, unemployment, poverty and an escalation in urbanisation (Hoffman and Ashwell 2001, Meadows 1998). Land degradation also increases flood potential by reducing soil absorption capacity and increasing run-off.

Information regarding land degradation is held by:

- National Department of Agriculture
- National Botanical Institute
- Environmental Monitoring Group
- Department of Environmental Affairs and Tourism (DEAT)
- Programme for Land and Agrarian Studies (PLAAS)
- Department of Water Affairs and Forestry (DWAF), specifically the Working for Water Programme

References:

Hoffman, T and Ashwell, A. 2001. *Nature Divided: Land degradation in South Africa*. University of Cape Town Press, Cape Town.

Meadows, M. The nature, extent and significance of land degradation in the Mediterranean-climate region of South Africa. *Petermanns Geographische Mitteilungen,* 142, 1998/ 5+6.

5.5 Conclusions

This section has focused on a wide range of human-induced hazards, some which are of a sudden onset character (oil spills) and others that might be defined as 'creeping' or 'slow-onset hazards' (eg environmental degradation and groundwater pollution).

Some of these phenomena have been extensively researched (e.g. land degradation) while others lack clear criteria for defining what constitutes a hazard to be recorded (eg MHIs).

In other instances, work is still to be done to identify and map 'hazardous' road locations, although basic accident data exist.

With respect to groupings such as the petroleum industry, on- and off-site hazards are managed within the organisational contexts of the different companies involved. This has significant implications for accessing, collecting and consolidating information on different facilities and transportation routes, and providing safeguards that such information will not be misused either commercially, or with respect to security.

Finally, there are few data-sets that provide adequate and uniform coverage of the Western Cape. Existing data-seta are skewed in favour of the Cape Metropole (e.g. air emissions) or with respect to selected studies at specific sites (e.g ground water pollution). Extending this coverage uniformly across just populated areas of the Western Cape would constitute a major undertaking. In this context, any 'roll-out' of extended hazard monitoring should be undertaken strategically, and draw extensively on local technical expertise, as well as inclusive stake-holder consultation.

Part VI Findings: Focus on Strategic Services and Vulnerable Communities

6.1 Introduction

International best practice with respect to disaster risk management increasingly gives attention to the protection of strategic and critical infrastructure. It also focuses on the disaster risk reduction needs of highly vulnerable communities, particularly those in isolated rural areas and periurban informal settlements.

Part 6 focuses on these two areas as priorities for hazard identification and assessment.

Part 6.1 addresses the protection of Eskom's transmission infrastructure in the Western Cape.

Part 6.2 focuses on the needs of informal settlements in the Western Cape.

6.2 Essential services and infrastructure

Introduction

This report discusses certain aspects of risk and vulnerability assessment that are applicable to Eskom's power transmission network with regard to natural hazards. Substations are not specifically discussed here, as it is felt that the transmission lines are more exposed to natural hazards. Substations are more robust as their locations are generally selected very carefully considering all forms of natural hazards. Also, it is easier to protect substations from the effects of natural hazards due to their relative small size. Lines, on the other hand, have to traverse a wide variety of landscapes and ecosystems, which are often far from any inhabited areas.

This report looks at some methods used by Eskom Transmission to mitigate the effects of natural hazards on transmission lines and more particularly **fire hazards**.

Eskom Transmission Network
Leigh Stubbs Eskom

Risks to Eskom Transmission lines due to natural hazards

Transmission lines (>132kV) form the backbone of electricity delivery from Generation power stations to electricity consumers. In most cases, the large cities of South Africa are fed directly from the Transmission network. Hence the Transmission network forms a critical part of a city's lifeline and it is important to understand the risks that it is exposed to and where the network is most vulnerable. This is, however, very sensitive information, as there are persons could use this information on vulnerability in a negative manner and seriously increase the overall risk.

Transmission lines traverse the whole country and are exposed to many risks. The following are the major risks:

- Large veld and forest **fires**. When fires get close to power lines, there can be breakdown of electrical insulation, which results in electrical short circuits and consequent voltage depressions. The lines trip and often interruptions of power supply results.
- **Lightning Storms**. When lightning strikes the power lines directly, the lines also fault and trip. This is caused by the excess voltage (due to the lightning) which the lines are exposed to.
- **Bird Streamers**. Transmission towers form a very convenient roosting place for many species of large birds. Often the streamers (droppings) that these birds release are long enough to cause an insulation failure thus resulting in line trips.
- **Wind storms**. Very strong winds can cause transmission line conductors to sway. There are occasions when this leads to electrical clearances becoming too small and flash-overs occur.
- **Thick Marine Fog.** Marine fog can be very conductive due to the high salt content. This can also be a cause of insulation failure and hence electrical flash-overs.
- **Severe Floods.** Floods that result in severe soil erosion can cause the line towers (pylons) to fall over, thus rendering the line inoperable.

In most instances the impact of sporadic line trips that result from these types of hazards is limited in magnitude and extent. However, there are places where the transmission network is more vulnerable to some of these major hazards. For example, a large fire that burns under two adjacent lines which are the only ones that feed a major customer or city, can cause a total loss of supply to that customer. Similarly, if a severe flood crossed the same two lines, a total loss of supply could occur.

For the sake of this report, fire will be considered a little more closely as a means to demonstrate how Eskom Transmission manages its risk. It will also be pointed out how a GIS based risk database could help with such risk management.

Fire Risk Management Principles for Eskom Transmission

A simple process is followed in order to develop a fire risk management plan. (A similar process is followed for each type of risk) The following steps are generally followed and each will be explained in terms of what sources of information are used:

- Identify all high risk areas
- Prioritise in terms of impact or vulnerability
- Define measures to be taken
- Manage the implementation of measures

Identify all high risk areas

For fire risk management purposes, high risk areas are those areas where a fire (controlled or not) which burns close to or under a transmission line can cause the line to trip. The following factors contribute towards this risk:

- **Fuel load**

  This is the quantity of combustible plant material within the line servitude (measured in tonnes per hectare). Several factors, such as vegetation type and age, play a role, but it remains difficult to quantify all vegetation types. Some methods to gauge this, using aerial photography, have been tried with some success. However, the best method still seems to be an 'on the ground' assessment using certain measurement techniques.

- **Land use**

  Different forms of land use also come with associated fire risks. These would include the following:

  Agriculture: Certain crops are highly combustible and are certain to cause the lines to trip. However, most farmers' livelihoods are based on their crops and hence they have some measures to prevent the spread of unwanted fires. Other farmers, such as cane farmers, use fire as part of their harvesting process. This is highly risky and special arrangements are made with these farmers to accommodate this process. Forestry also has a huge fire risk, but also have substantial plans to mitigate this risk.

  Informal settlements: These are a significant source of fires. Their location and socio-economic activities (burning wood for cooking and heating) make them extremely risky. Informal settlements are highly dynamic and grow very quickly, so up to date information is always needed.

  Roads and railway lines: Motorists and passengers often discard burning cigarette butts onto and next to roads. Roadside 'braais' which are often left burning can also be a source of fire.

  Land slope: Slope or gradient of the land plays a significant part in the spread of runaway fires. Road verges, railway verges, hills and mountains are all considered.

  Dry River beds: Riverbeds are often infested with alien vegetation and reeds. The vegetation is also dense and hence poses a significant fire risk.

  These factors can largely be determined using existing map information which is already plotted on Eskom Transmissions GIS system. However, ground patrols are still necessary to determine actual risks on a span by span basis. This is hugely laborious.

- **Climate and weather**

  Weather plays a significant role in the characteristics of fire behaviour. Various models for determining the Fire Danger Index (FDI) are being considered and most use the weather data, such as relative humidity, temperature, wind speed, and recent precipitation history. Days where the FDI is very high are particularly risky. FDI can also vary depending on micro-climatic conditions, hence a need to monitor sensitive spots more closely.

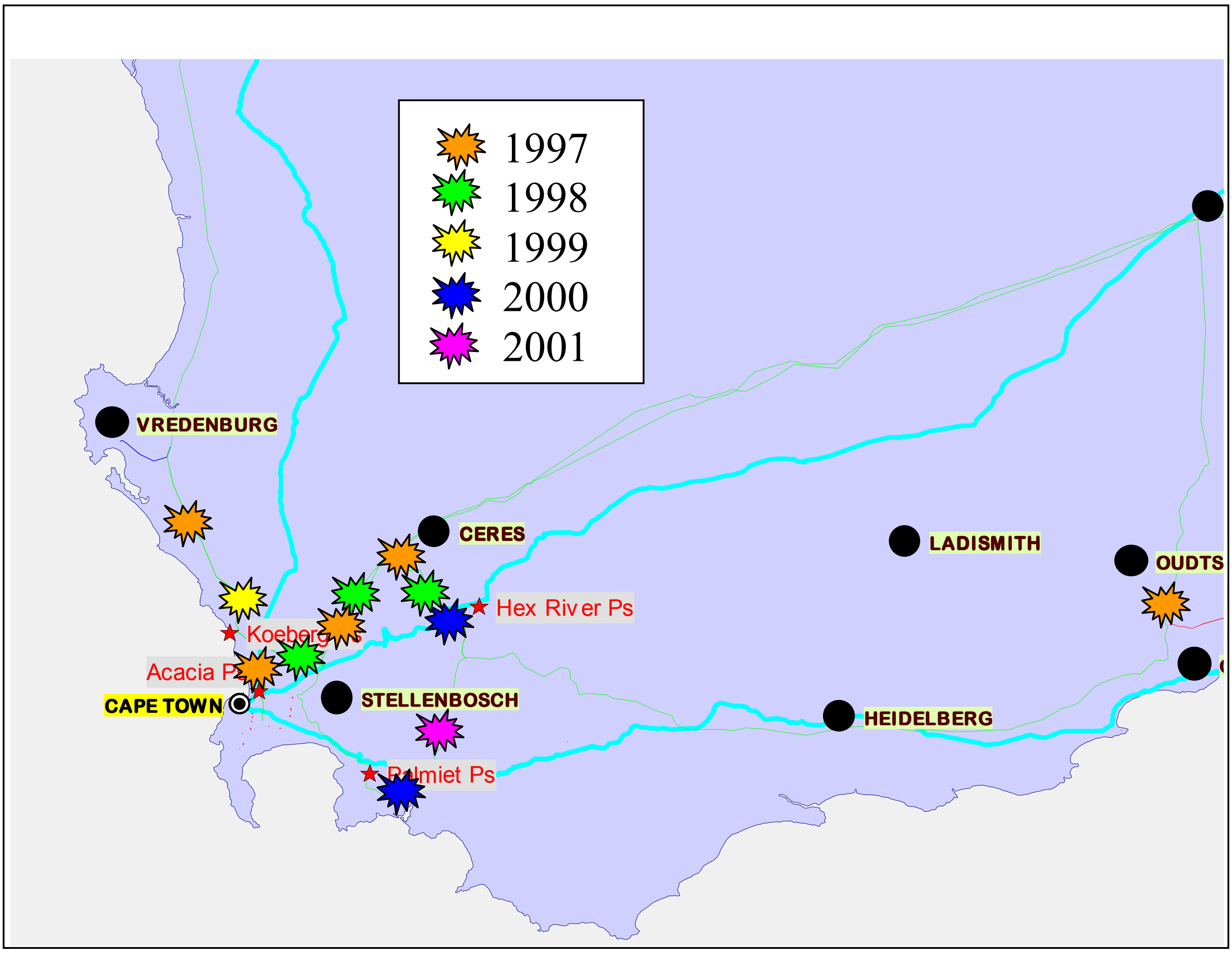
At this point, information would have been gathered at a fairly high level and not necessarily by means of 'ground' patrols. The next step is to determine the higher priority of areas in terms of impact and vulnerability.

Priorities in terms of impact or vulnerability

The next step in this process is to look at the recent history (say five years) of line faults due to fire. This information is captured in another data-base (not the GIS system) called TIPPS.

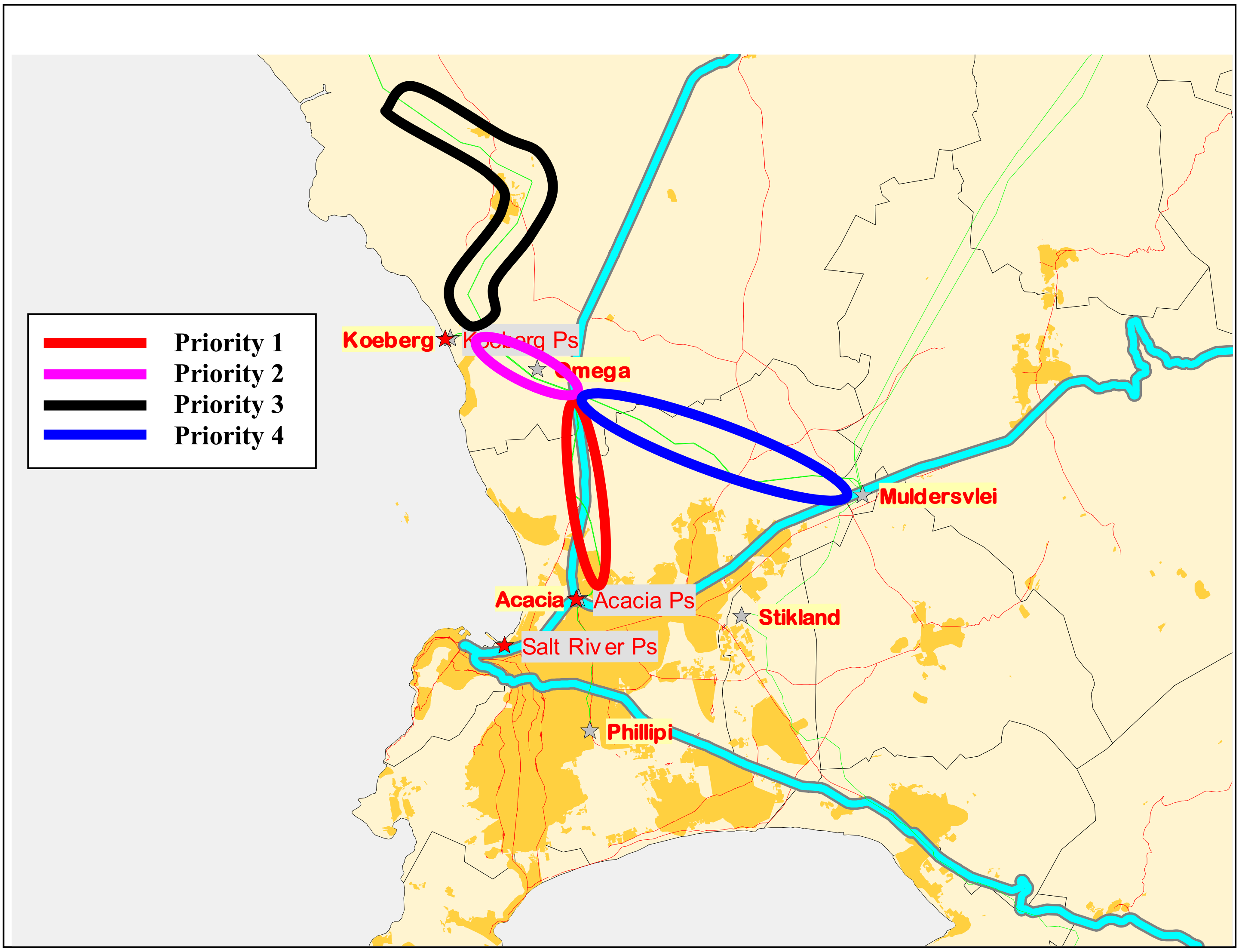
Reports can be drawn to determine where faults occurred due to fire and at what times of the year, on what line etc. These faults can then be plotted on the GIS map for the whole region. Figure 6.2.1 shows what such a plot could look like.

Figure 6.2.1
History of line faults due to fire



In figure 6.2.1 the encircled region represents the area of highest fire risk caused by faults. It is prudent to focus on this region as shown by figure. 6.2.2. Focusing on a smaller area allows one to prioritise the servitude areas within that area with respect to vulnerability and impact. The highest priority could be represented by priority 1 and ascending numbers representing lower priorities. Priorities would be determined in terms of probable impact on customers as well as considerations where the whole network is at risk, such as when Koeberg is forced to shut down. Such a prioritisation could be mapped as shown in figure 6.2.2.

Figure 6.2.2
Prioritisation of servitude corridors (example)



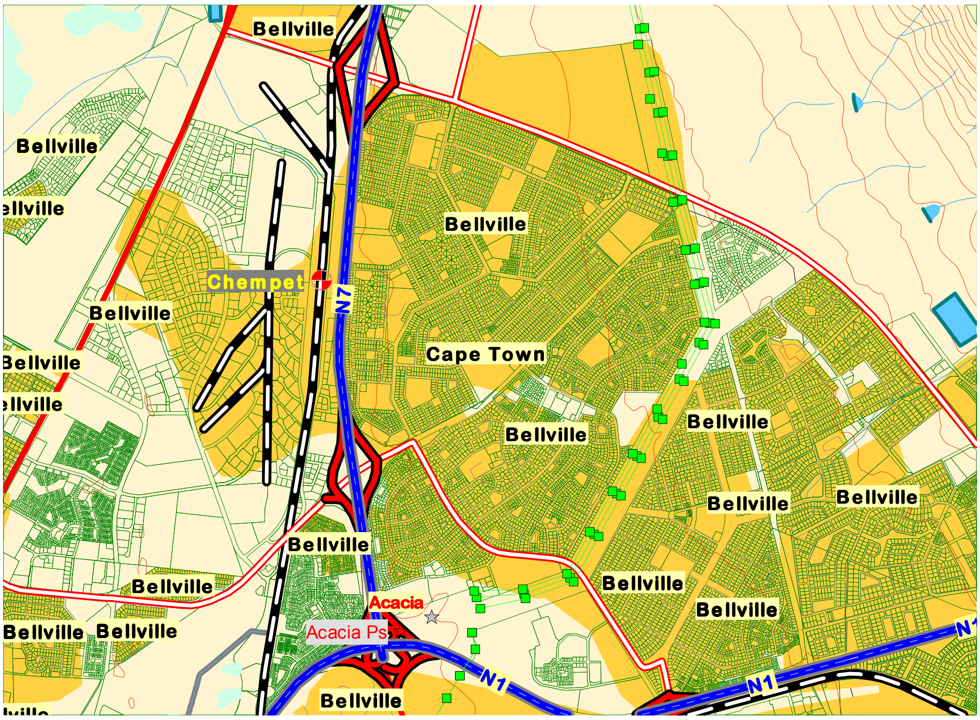
Defined Measures

Once the servitude corridors have been prioritised, one can then look more closely at the areas in question in order to define the preventive measures. The first pass would be to do a detailed aerial survey along the route of the lines within the high priority corridors. This would typically be done just before the fire season. All factors contributing to risk would be noted for each span of line. Hotspots would then be identified and more detailed ground inspections would be used to enhance the quality of information. This information is not presently captured on the GIS system.

For each type of risk, action plans are developed on a span by span basis. This would include various activities like cutting fire breaks to isolate sources of fire from the line servitude, and clearing alien vegetation from within the servitude. In some cases the bush would be cleared wider than the registered servitude.

On high FDI days during the fire season staff members are posted at strategic look-out points to watch for fires and then to respond where there are fires by calling the relevant fire-fighting services as well as dispatching staff to the scene of the fire. In some cases it is possible to switch the line out while a fire burns underneath it so as to prevent faulting and consequent voltage dips. This is done in conjunction with the control centre.

Figure 6.2.3
GIS map indicating Eskom Powerline

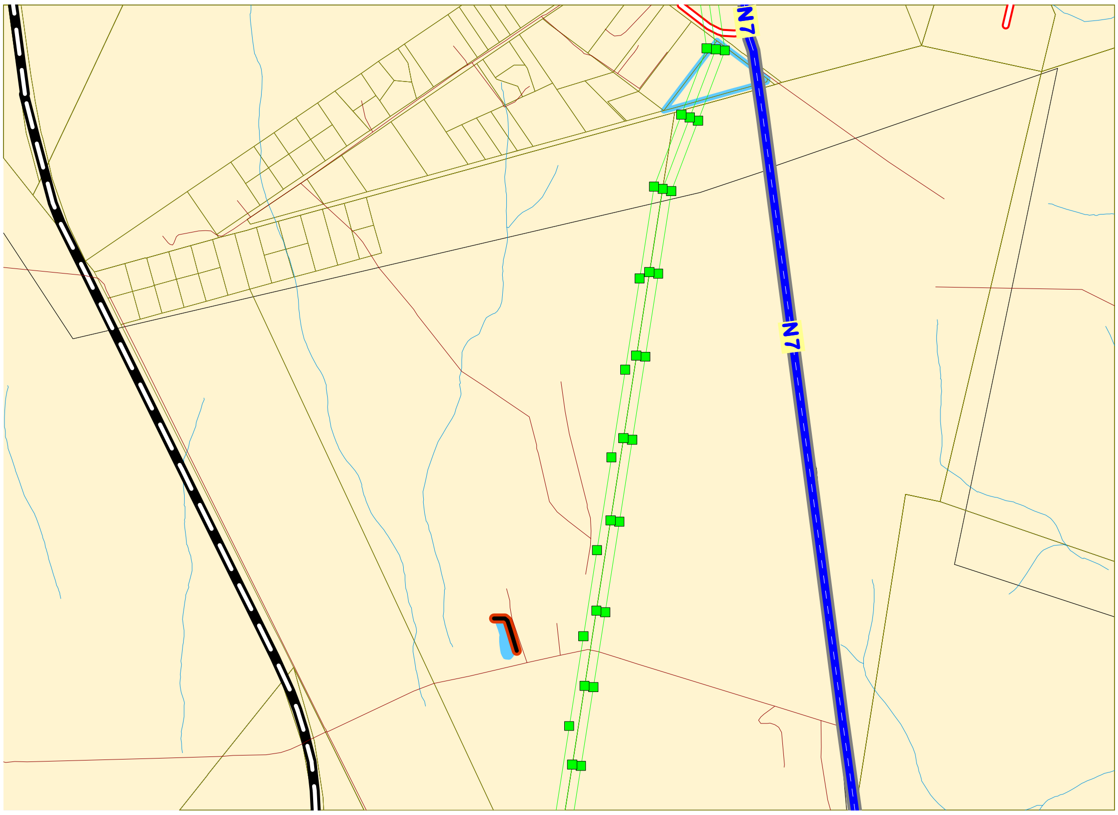


The following photograph shows a brick factory on one side and an informal settlement on the other side of a very important line corridor containing three adjacent transmission lines (figure 6.2.4). Both of these are sources of fire. Note the fact that all alien vegetation has been cleared from within the servitude as well as 50m on either side. Even if a fire does burn under the lines, the probability of a fault is significantly reduced.

The GIS map that follows shows the angle of the photograph (figure 6.2.5). Note that the GIS map presently contains no information about the informal settlement or the brick factory. It is thus very important to augment the GIS information with aerial photographs. A geocorrected aerial photograph, which can be overlaid with the GIS information, would be the most ideal planning tool.

Figure 6.2.4
Photograph showing potential sources of fire

Figure 6.2.5
GIS map showing angle of photograph

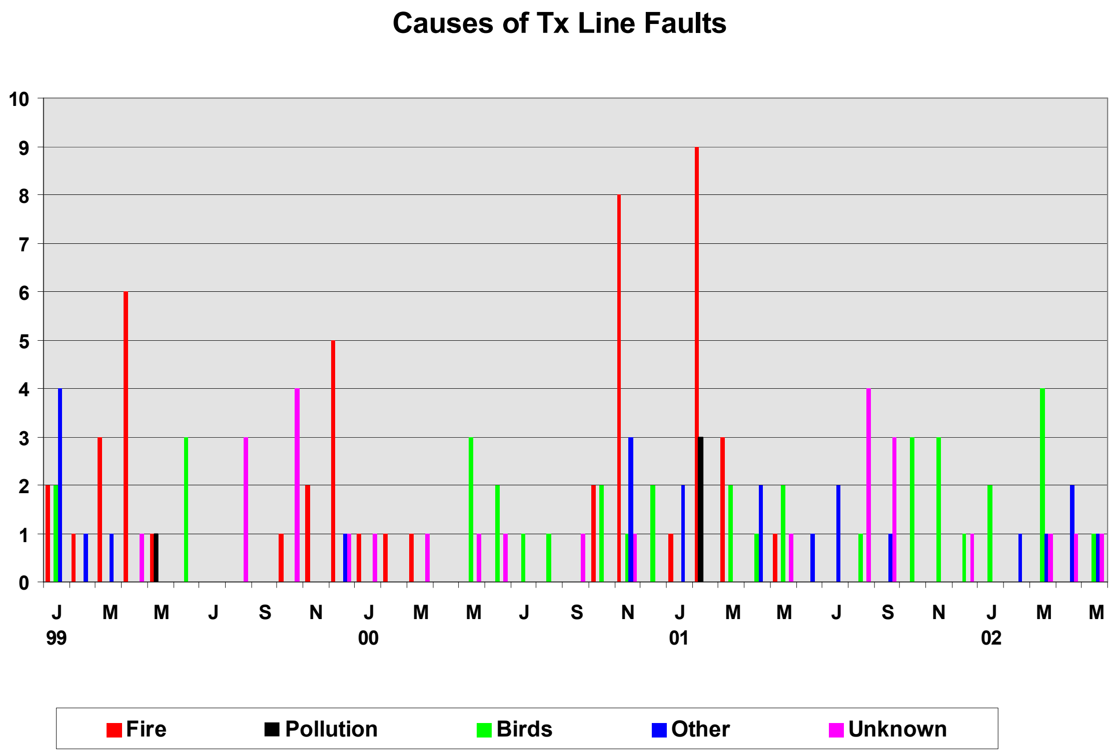


Conclusions

It is hoped that this report has outlined the importance and usefulness of using GIS type database systems to plan for potential disasters. Eskom Transmission uses such a system to implement some of its fire mitigation plans with great success. Through the planning process outlined here Eskom Transmission in the Western Province was able to reduce its faults caused by fire from **23** in the 2000/2001 fire season to **ZERO** in the 2001/2002 fire season.

Figure 6.2.6

Causes of Line Faults



What would have made this process quicker and less expensive would have been to have recent aerial photographs which could be directly overlaid with the GIS information. From this it would have been possible to define scopes of work for bush-clearing contractors in a very short time. Instead it took many man-hours of ground patrols and costly aerial patrols to do this.

Another very useful type of GIS data would be a fire scar map showing the recent history of veld fires. This would enable Eskom to focus on areas where there have been no fires for quite some time. This would have to be done in conjunction with a vegetation-type map.

6.3.1 Vulnerable communities: Informal settlements in the Western Cape

Helen Macgregor
DiMP/UCT

Introduction

Just as strategic specific critical/lifeline services require strategic 'risk-proofing', there are many communities in the Western Cape who remain highly vulnerable to a wide range of natural and other hazards. As strategic considerations are made to determine hazard assessment priorities for the Western Cape, particular attention should be given to those communities who live in conditions of chronic endangerment and disaster vulnerability.

Overview of informal settlements in the Western Cape

Informal settlements are largely the product of unplanned urban development, which has resulted in illegal settlements positioned largely on City Council land. Informal settlements have emerged rapidly since the abolishment of Apartheid and the associated Pass Act, Group Areas Act and Illegal Squatting Act, all of which had controlled influx into the urban areas. The subsequent growth of informal settlements has occurred rather haphazardly, being characterised by a the lack of development planning and policies. As a result many informal settlements have been established in areas defined as hazardous, such as on vleis/marshlands, underneath electricity power lines or near sewage culverts.

As a result informal settlements are prone to a range of hazards, namely fire, flooding and infectious diseases. In the following sections fire, flooding and infectious diseases will be explored, providing reference to (where possible) risk areas in the Western Cape and a critique on the existing data. Whilst each of these are explored independently it is important to note that they are interrelated. In the case of infectious diseases it is often the case that they arise as a secondary impact to a disaster incident such as a flood or fire. In this case the hazard becomes an indicator of the risk and vulnerability of the community.

Fire risk in informal settlements

Informal settlements prone to fires are generically characterised by dwellings built from untreated wood and thermoplastics, positioned in close proximity, where there is a high use of paraffin for cooking and candles for lighting[10] and where there are low levels of fire risk awareness and socio-political instability. The assumption that all informal settlements are prone to fire is however inappropriate. Fire risk in an informal settlement vary according to structural and non-structural risks.

Structural risk factors refer to the materials that the structure is built from, its proximity to similar buildings, access to water and access by fire tenders. Non structural risks refer to community dynamics that determine the socio-political stability of the community, awareness of cooking with paraffin and knowing who to call at the time of a fire. In the following example the interplay of both structural and nonstructural risks increases the risk. In Joe Slovo there is the increasing perception that residents are using the settlement to establish themselves close to Epping Industria. As a result many residents may own a more formal dwelling elsewhere in the City. The

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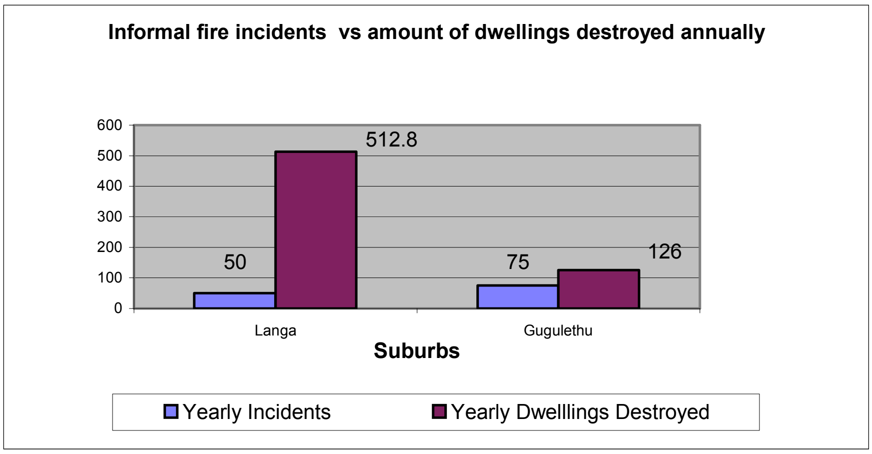
[10] Refer to Part IV for a breakdown of fire triggers in Joe Slovo

expense of building with metals as opposed to untreated wood and thermoplastics becomes a serious consideration, with the subsequent increase in the use of flammable materials. In this case land tenure choices affect the structural risk.

Whilst informal settlements are prone to fire, the incidence rate expressed as a feature of the number of incidents in relation to the population demographics produces a clearer understanding of the degree of fire risk for a settlement. In the following graph Langa is compared with Guguletu, in terms of the incidence rate per 1000 dwellings destroyed (figure 6.3.1).

Figure 6.3.1
Informal fire incidents in Langa compared with Guguletu



In determining the fire risk of an informal settlement the frequency of fire events (number of incidents), the severity (number of dwellings affected) and incidence rate (rate of dwellings destroyed/1000) therefore all need to be assessed. In the case of Langa and Guguletu, the number of fire incidents are fairly constant, whilst when analysed in relation to the number of dwellings destroyed per event 5.4 times higher. In the case of Gulguletu the average fire affects 1.68 households whilst a fire in Langa will affect as many as 10.26. In the case of Langa fire risk is therefore proportionally higher than in Guguletu. Assessing risk therefore requires that the frequency, severity and incidence rate all be assessed.

<u>Health Risks in informal settlements</u>
Background by Dr Hassan Mohamed, City of Cape Town Health Directorate

The greatest contributing health risk factors in informal settlements are lack of access to water and sanitation. In most informal settlements sanitation involves the use of the bucket toilet system, which is shared between three to four households and removed once a week. In the event of the bucket overflowing, the risk for Shigella dysentery increases. In 1999 the outbreak of Shigella dysentry in Crossroads informal settlement (Cape Town) resulted in the death of three children and 100 people being affected. Cases of cholera for the Western Cape are almost non existant with only one reported incident from 1990–2002. Cases of diarrhoea and contagious diseases, such as skin rashes are however more prevalent, but are largely secondary effects of being displaced.

In cases of fire or flooding where the community is displaced, the risk of diarrhoea and infectious disease increases. Diarrhoea may occur as a result of poor storage, cooking of food or from the breakdown of toilets. Such diseases are in this case a secondary effect of disasters. In general however it is most common for such diseases to occur in poor areas where there is limited access to water and sanitation.

Flood risk in informal settlements background by Dirk van Bladeren, SRK

Flooding of informal settlements is caused by poor or no drainage of the settlement due to its location in or next to a vlei/marsh. A vlei/marsh is generally characterised by a shallow water table. In certain cases on the Cape Flats the water table can be as high as half a meter beneath the surface. As a consequence of both the high water table and poor drainage flooding occurs annually on the Cape Flats. One of the largest local floods in recent years was the 26–28 June 1994 flood disaster (declared under the Fund Raising Act 1978), which affected the greater Cape Town area, a large proportion of which were informal settlements.

The underlying contributing risk factors are the informal nature of the settlement that is not guided by development codes, which would prevent development in these at-risk areas. Whilst flooding of this nature does not result in direct loss of human life it is often the disruption of people's livelihoods and the probability of infectious diseases that is the most hazardous.

Critique of existing data

The most extensive data available are from the MANDISA (Mapping, Monitoring and Analyses of Disaster Incidents in South Africa) database that has correlated over 12500 incidents from 1990–1999 for the Cape Town Metropole. These incidents both reflect declared disasters as well as large to small scale incidents, i.e. single dwelling fires. The incidents are sourced from the SA Red Cross, Fire Services, Local Disaster Management, Newspapers, Department of Social Development

The database has the ability to correlate from 12 different data sources, namely Fire Services, Social Services, Red Cross, Disaster Management, Airforce, Cape Nature Conservation, Cape Peninsula National Parks, Department of Social Development, Fire control center/stations, local disaster management, National Disaster Management, National Sea Rescue Institute, Navy, Newspapers, Provincial Disaster Management, Red Cross Children Hospital, SANCOB, SAPS, SA Red Cross and Ukuvuka Santam/ Cape Argus Operation Fire Stop.

The strength of the database lies in its ability to run an analysis over time, and to provide comparisons of trends across and within areas. Furthermore, the ability to link with other datasets provides the opportunity for an in depth analysis. However the extent of the analysis is largely determined by the available data in the database. In many cases there is an uneven accuracy and completeness of information provided by different sources. Similarly there are often totally incompatible incident reporting formats that can result in conflicting information for the same events.

A further constraint is that the MANDISA database only covers the Cape Metropolitan Council. The challenge in mapping informal settlement hazards for the Western Cape lies in the shortage of available data, both in terms of baseline data and comparative data. In many instances informal settlements have not been accurately mapped and as a result their location and extent is unknown. Furthermore the dynamic nature of these settlements is such that they can develop and change within weeks, even days. The issue of available data therefore needs to be considered in light of the changing nature of informal settlements.

Provincial hazard assessment

1. The production of a GIS map for informal settlement risk would require the baseline mapping of all informal settlements. As the majority of established informal settlements have been in effect since 1994, aerial photographs will be able to provide the baseline data.

2. The second process would require the identification of settlements most well known to be at risk. This would be done through a consultation with municipalities and social services that would provide social and economic data, i.e. poverty/health/ crime data to provide indicators of levels of resilience to natural and other hazards.

3. The third process would require the capturing and consolidation of information around the risk profile of those settlements identified as at risk.

The project would take approximately two–three years and cost approximately R250 000/year.

Recognising the highly dynamic character especially of newly forming informal settlements, mechanisms to ensure continuous updating of information would need to be established.

Part VII Conclusions and Recommendations

7.1 Introduction

The final part of this report summarises the study's main findings and makes practical recommendations on how to proceed with respect to the remaining months of the project.

It is organised in the following way:

Part 7.2 focuses on various options for generating GIS outputs from the project, taking into account future needs for updating information, and for disseminating this to a wide range of users

Part 7.3 summarises the scientific and process conclusions derived from the study

Part 7.4 provides recommendations on the possible way forward in connection with the project

7.2 Dissemination of RAVA spatial information

Eben van Heerden, AFRIGIS

7.2.1 Introduction

Various users on the RAVA project will have an interest to scrutinize the hazard map information that will be produced in Phase 1. These users include municipal planners, municipal disaster managers, provincial managers, industry experts, RAVA steering-committee members and project team representatives.

The logistical and financial challenges to disseminate a provincial spread hazard information dataset on intricate classification of potential hazards are huge. It is therefore pertinent to consider the alternative methods of distributing this information to the role-players on the project. This section explores the possible alternatives and provides suggestions.

7.2.2 Options for disseminating spatial information

There is a range of alternatives for disseminating hazard information in spatial formats. These include:

- Hardcopy maps
- E-mailed / CD Raster Images
- ArcExplorer CDs
- Internet Mapping
- Mobile Device Maps

<u>Hardcopy Maps</u>

The plotting of hardcopy A0 paper colour maps was the initial suggested method of distributing the spatial information for RAVA.

The ***requirements*** for this alternative would include plotting facilities at the consultants working on the project for initial production, as well as at the province for the plotting of further copies.

The ***pros*** of this alternative would include the presentation of tangible deliverables to project funders, the representation of spatial information in RAVA project reports as well as wall maps. Furthermore, users of the information will not be required to extract, manipulate or produce any outputs to be able to view the information. Also, no computer infrastructure or expertise will be required.

The ***cons*** include the fact that any changes to the data will leave the plotted maps redundant. The logistical challenges and costs to distribute these hardcopy maps throughout the province are significant. The quality of the paper maps will deteriorate with time as the paper tears, colours fade and the maps are exposed to dust and dirt. The viewing of the information will further be limited to the location of the physical maps. The reproduction of maps will also have a cost and time implication to either the project or the provincial budget as duplicate sets are required. The potential to end up with outdated information is high.

It is therefore recommended that there is a limited need for hardcopy maps. It is suggested that one set of maps is produced (size A0) and that an additional set is included in the project report.

E-mailed / CD Raster Images

GIS systems have the functionality to export spatial data as raster images in common formats that include jpeg, bitmap etc. These images can then be viewed by using several commercially available applications like Microsoft Paint, Microsoft Imaging, Corel, Internet Explorer etc.

The ***requirements*** to distribute raster images would include e-mail connectivity as well as computer hardware (with CD drive, sufficient hard disc space) and basic image viewing software resources on the user side. The users would further need to have basic computer skills to open and view the images.

The ***pros*** of this option are that the information can be disseminated electronically via e-mail or CDs. This reduces costs to produce and distribute the information. The time required to produce the raster images is less than for the plotting of maps. The images can further be viewed with commonly used commercial applications. Very little user skill is required to view the maps in this format.

The ***cons*** include the fact that changes in the data will require the reproduction of the raster images and the need to re-distribute these images via e-mail or CDs. This option also requires computer infrastructure and sufficient hard disc space to save and view the maps. Users will not be able to manipulate or query the maps seeing that the images effectively represent static data. The potential for outdated information is rather high.

It is concluded that for raster maps, the time, logistics and effort required to distribute these images would be similar to the dissemination of ArcExplorer data. ArcExplorer data would however provide the user with much more functionality though. **The dissemination of raster images via e-mail or CDs is not a preferred solution**.

ArcExplorer CDs

ArcExplorer is a freeware GIS data viewer. This software offers basic GIS functions and is used to display and query spatial data. ArcExplorer can be used to disseminate GIS vector data by distributing the ArcExplorer software setup files and the GIS data on CDs. Users can then use the CD to install ArcExplorer on their machines and view the data.

The ***requirements*** for this solution include computer hardware (CD drive, sufficient hard disc space, Windows '95 / NT / 2000) and ArcExplorer software (this is freeware without any cost implication to users). The users will further require training on ArcExplorer functionality.

The ***pros*** of this alternative include the fact that vector data are disseminated, which provides users with added functionality (eg planners can do spatial overlay and in this way start asking intelligent area specific questions). This solution has a low cost implication as ArcExplorer is free and only the cost of the CDs would apply. This alternative has a faster turnaround time to disseminate information in comparison to hardcopy map production.

The ***cons*** include the need for resources to operate the ArcExplorer software as well as basic user skills and training requirements. The distribution of CDs with ArcExplorer and data would be required. Furthermore, the users will need to have computer hardware that is able to run the ArcExplorer software. The potential to end up with outdated information is rather high. The possibility exists that some of the data might have restricted distribution rights, which poses an obvious problem.

As the Africon project will be enabling users with ArcExplorer functionality anyway, it is recommended that the option be explored to distribute RAVA data as ArcExplorer projects to the users in the short term. This should be done by distributing CDs.

Internet Mapping

The distribution of GIS data via the Intranet / Extranet / Internet has been used very effectively where a widely distributed user group needs to access GIS information. This solution allows any user (that has been assigned login rights) with Internet connectivity to log onto a website and browse GIS information in the same way as browsing any other website.

The ***requirements*** for this alternative include a workstation with Internet connectivity, login rights (username and password) and basic Internet user knowledge. Limited training will be required on the website specific functionality.

Several ***pros*** exist for this option. Wide user coverage is achieved with this solution. The cost to disseminate the information is the lowest of all the alternatives, as only the data on the web server needs to be updated. This therefore eliminates the logistical challenges of the other alternatives. The turnaround time to make updated information available to users is the lowest of all the alternatives. The potential to end up with outdated information is very low. The user is familiar with the Internet look and feel, which will help bridge the initial hurdle of using new technology. It is not expected that GIS data publishing fees will be required. Users will have the ability to view maps specific to their requirements as functionality will include the ability to toggle map layers on / off.

Cons include the initial capital outlay to get the site up and running. These costs include an Internet GIS software license and GIS web server PC, although these resources might be available from the client at present or in the near future. Also, basic user computer skills and the need for training on the Internet mapping solution will be required. Acceptable bandwidth connectivity will be required for users to browse the on-line maps. This might present challenges in some of the regions.

It is concluded that the available resources (ie user bandwidth, GIS Internet software licenses and Web server infrastructure) will have to be assessed before implementing this option. If these will be available to the RAVA project in the near future **it will be cost-effective to seriously consider this as a preferred alternative**. If the resources however will only be available in the medium to long term, then the ArcExplorer CD option will provide a good interim solution to the project.

Mobile Device Maps

In the information age information is provided as, when and where required. The distribution of GIS data via mobile devices has therefore become a reality. Mobile devices with GIS viewer software are currently used very effectively where a widely distributed and mobile user group needs to access GIS information. This solution allows users to browse GIS information in the field.

This alternative ***requires*** a mobile device (palm pilot, palm PC, notebook) and GIS mobile viewer software. Users will have to have access to a PC to install and transfer software and data to the handheld device.

The **pros** of this alternative include the low cost and short time required to produce and distribute the information. It is an obvious advantage that GIS information will be available to users at any location. Furthermore, this alternative will deliver vector data, which provides users with added functionality (eg planners can do spatial overlay and in this way start asking intelligent area specific questions). This alternative has a faster turnaround time to disseminate information in comparison to hardcopy map production.

The alternative has the following cons: Basic user computer skills will be required and the users will have to be trained to use the mobile GIS viewer. It is obvious that a handheld device will be required as well as mobile GIS viewer software. The potential to end up with outdated information is also high.

It is concluded that this will never be the only option to view the spatial information. At least one of the options of hardcopy maps, raster images, ArcExplorer data or on-line mapping will always also be available to users. It is suggested that this solution be provided to users with the specific need to be able to view GIS data on mobile devices.

7.3 Conclusions drawn from the assessment of hazards and disasters in the Western Cape

Phase I of the RAVA Project foresaw the following activities to be completed by 31 March 2003. These are:

a) Completion of an audit of existing information and data on likely natural, technological and compound hazards in the Western Cape
b) Identification of all disaster hazards for the Western Cape
c) Transfer of relevant and appropriate data to an integrated GIS database
d) Mapping and printing of hazardous areas in the Western Cape

e) Development of a conceptual disaster decision support management tool (DSMT) to assist the Provincial Government of the Western Cape and Disaster Management in disaster management planning
f) Consultation with other disaster management stakeholders and user groups who may use the information and the DSMT
g) Reporting back on activities in Phase I

Conclusions drawn from reviewing existing information with respect to hazards and disasters in points a) and b) is reflected below:

Conclusions derived from findings

7.3.1 Findings from consultative processes, reviews of declared disasters and newspaper articles

Findings indicate that:

- Seven officially declared disasters were reported from 1990–2002, of which 6/7 were weather-related, 5/7 affected economically disadvantaged communities and 6/7 were located in the Cape Metropole.

- Fires, floods, transport accidents and spills were viewed as the hazards of greatest concern by municipal representatives consulted.

- Levels of awareness with respect to the interplay between environmental conditions and disaster risk were lower than expected. However, this is unsurprising given the experience of many practitioners consulted and their current demanding work responsibilities.

- Priority should be given to mapping hazards spatially for populated areas, vulnerable communities, strategic-critical infrastructure, as well as economic and environmental assets.

7.3.2 Findings from scientific reviews of natural hazards

Findings indicated that:

- The Western Cape is exposed to a wide range of potential hydrometeorological, geological, and biological hazards.

- Increasing population growth, combined with increasing probabilities of extreme weather conditions are likely to increase the probability and severity of natural hazards triggered by climate conditions.

- There is a wealth of scientific expertise available to interpret patterns and trends in natural hazards that are not being fully engaged in strengthening disaster risk management capabilities.

- There is a vast array of disparate data-sets related to natural hazard patterns and trends of varying levels of quality.

- There is not one major natural hazard category in the Western Cape that contains uniform robust and verified data that 'covers' the Province and can be easily uploaded into a GIS. **This has significant implications for generating all deliverables foreseen in the initial project document, as it is no longer feasible to expect simple GIS conversion of data for any one hazard type**. **In this context, the foreseen generation of maps by the next reporting date (14 February) is unachievable for those hazards that are the most significant threats in the Western Cape.**

- There are however, committed specialists of an international level who have skill to interpret the available data from different sources, and who, within 3–6 months, could provide robust data for incorporation into a GIS.

- The delivery of a robust 'hazard' characterisation for specific threats will be significantly enhanced if supported by a 'Scientific and Technical Advisory Committee' that can verify the reliability of the methods used and the final product(s) generated.

7.3.3 Findings from reviews of human-induced hazards

<u>Findings indicated that:</u>

- There is a wide range of human-induced hazards, some which are of a sudden onset character (oil spills) and others that might be defined 'creeping' or 'slow-onset hazards' (eg environmental degradation and groundwater pollution).

- Some of these phenomena have been extensively researched (eg land degradation) while others lack clear criteria for defining what constitutes a hazard. (eg MHIs).

- In other instances, work is still to be done to identify and map 'hazardous' road locations, although basic accident data exist.

- With respect to groupings such as the petroleum industry, on- and off-site hazards are managed within the organizational contexts of the different companies involved. This has significant implications for accessing, collecting and consolidating information on different facilities and transportation routes, and for providing safeguards that such information will not be misused either commercially, or with respect to security.

- There are few data-sets that provide adequate and uniform coverage of the Western Cape.

- Existing data-sets are skewed in favour of the Cape Metropole (eg air emissions) or with respect to selected studies at specific sites (eg ground water pollution), and extending this coverage uniformly across just populated areas of the Western Cape would constitute a major undertaking.

- Any ‘roll-out’ of extended hazard monitoring should be undertaken strategically, and draw extensively on local technical expertise, as well as inclusive stakeholder consultation.

7.3.4 Findings with respect to strategic services and vulnerable communities

Findings indicated that:

- Hazard identification and assessment priorities should give attention to protecting both strategic services/infrastructure and communities at risk, particularly those in informal settlements.

- Such areas/communities should be considered for ‘multi-hazard’ assessment processes, given the significant probability of loss from hazards of multiple origins.

7.4 Recommendations

This section is divided into two parts:

Part 7.4.1 focuses on recommendations related to the setting of research priorities in the context of limited time and financial resources.

Part 7.4.2 focuses on recommendations concerning the GIS component of the project.

7.4.1 Recommendations related to the setting of research priorities

Recognizing constraints with respect to time and financial resources available to this research initiative, decisions are required concerning the following five ‘focus areas’:

- Priority hazard types
- Strategic priorities
- Scientifically robust outputs
- Effective participatory consultation
- Effective GIS outputs (addressed in 7.4.2 below)

With respect to priority hazard types, the following are recommended:

- As a result of the diversity of data-sets relevant to key hazard types, and lack of coverage of the Western Cape for any one hazard type, resources should be assigned to **streamlining information for (maximum) 1–3 hazard types**.

- Consideration should be given to prioritise selected streamlining of those **weather threats that can result in the most damaging impacts.**

- Consideration should also be given to streamlining **veld-fire information** for the Province.

- **The project deliverables should be revisited**, given the constraints regarding the completion of all activities foreseen (specifically the transfer of relevant and appropriate data to an integrated GIS database, mapping and printing of hazardous areas in the Western Cape and the development of a conceptual disaster decision support management tool

(DSMT) to assist the Provincial Government of the Western Cape, Disaster Management in disaster management planning).

With respect to strategic priorities, the following are recommended:

- **Careful consideration should be given to deciding what deliverables are priority for the Province** (eg allocation of resources to obtain accurate hazard information for priority hazards such as veld fires and selected weather threats … or generation of generic maps with limited and/or inaccurate data).
- As it is expensive to focus time/resources on all areas of the Western Cape, priority should be given to **populated areas, strategic infrastructure/services, economically vulnerable communities and areas containing economic and environmental assets**.
- Consideration should be given to convening a consultation with key stakeholders to discuss options/constraints with respect to information-sharing.

With respect to effective participatory consultation, the following are recommended:

- A focused **consultation with key stakeholders** is convened prior to finalising mapped outputs of selected hazard types.
- **Capacity-building and support needs** of hazard information users should be assessed to guide further training activities.

With respect to the generation of scientifically robust outputs, the following are recommended:

- **The Technical Advisory Committee** established after the 3–4 October consultative workshop should continue to guide the technical outputs of the assessment.
- The methods and outputs generated by specific subject specialists should **be reviewed and verified by members of the Technical Advisory Committee** to ensure their reliability, accuracy and robustness prior to transfer into GIS.

7.4.1 Recommendations with respect to the GIS component of the project

The following are recommended:

- With respect to **hardcopy paper maps** – it is suggested that one-two sets of maps are produced (size A0) and that an additional set is included in the project report.
- The dissemination of **raster images** via e-mail or CDs **is not recommended**
- The **distribution of ArcExplorer through the Africon project should be leveraged**. It is suggested that, in the short term, RAVA data be distributed to users as ArcExplorer projects on CDs.
- The availability of **Internet GIS resources** (ie user bandwidth, GIS Internet software licenses and Web server infrastructure) from the PGWC should be assessed. If these will be available

to the RAVA project in the near future, **it would be cost-effective to seriously consider this as a preferred alternative.**

- It is suggested that the **mobile device solution** is provided to users with the specific need to be able to view GIS data on mobile devices.

Annex A Definitions used in this study

Definitions

Acceptable risk: The level of loss a society or community considers acceptable given existing social, economic, political, cultural and technical conditions.[12]

Aquifer: A geologic unit capable of containing a usable amount of ground water.[7]

Below 1: 50 year flood line: The 1:50 year flood line is the size of a possible flood that would be expected to occur with a recurrence interval of 50 years. Those living below that line have increased vulnerability to a potential flood.[11]

Biological hazard: Processes of organic origin or those conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. [12]

Cadastral maps: Depicts land ownership information, typically used for purposes of taxation, planning, zoning, assessment and permit granting.[4]

Chemical spill/leak: An industrial accident that involves the release of harmful chemicals during the production, transportation or handling of hazardous chemical substances. This can result in illness, injuries/deaths, as well as impact on physical infrastructure, the natural environment and disruption of services.[11]

Climate change: A statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). [12]

Coastal flood/ storm surge: A tidal surge (often caused by storm force winds) combined with river flooding caused by rainfall inland. A storm surge is a sudden rise of sea, as a result of high winds and low atmospheric pressure. [11]

Commercial fires: Fire incidents in buildings where the occupants are engaged in commerce or trading. Examples are fires that take place in restaurants and cafes, offices, banks, shops, department stores, garages and workshops. [11]

Contributing risk factors: Risk factors that contribute either to the occurrence or intensity of a disaster or incident. If a community is vulnerable to a hazard or trigger then, together with the contributing risk factor, a disaster or incident will occur. The intensity of the disaster depends on the extent of the vulnerability. There can be more than one contributing risk factor.[11]

(Note that this is risk to life and property. Thus an incident that is usually natural can be a contributing risk to a disaster when there is the threat of damage to life and property.)

Dam burst: A flood event in which large volumes of water unintentionally burst from a dam as the result of structural failure or dam collapse. [11]

Dam deluge: A flood event involving large volumes of water that are discharged suddenly downstream due to 'overtopping'. A dam deluge can also result from actions taken to either prevent overtopping or avoid structural damage to the dam, due to build-up of water behind the dam wall. [11]

Dinoflagellate cysts: Dinoflagellates are a group of microscopic, usually between 20 and 150 µm long, generally single-celled organisms, commonly regarded as "algae".[5]

Disaster: A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community/society to cope using its own resources. [12]

Disaster risk: The probability of harmful consequences or expected loss resulting from interactions between natural or human-induced hazards and vulnerable/capable conditions. [11]

Disaster risk reduction (disaster reduction): The systematic development and application of policies, strategies and practices to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) adverse impact of hazards, within the broad context of sustainable development. [12]

Deforestation: The removal of trees from a landscape. This leaves open ground, which is vulnerable to several different hazards. In the case of flooding or heavy rain, the absence of trees prevents water from being absorbed by the soil. Deforestation can also contribute to a fire disaster. After logging there is usually debris left behind. This wood dries out and is very flammable. [11]

Drained wetland: This is an ecosystem that constantly contains surface water. The water can be static or flowing, fresh, brackish or salty. Examples include marshes and swamps. Wetlands are sometimes drained so that houses can be built. However, after heavy rain the wetland will fill again causing flooding in the residential area built on top of it. [11]

Dwellings formal fires: Fires that occur in dwellings that have been formally ‘approved’ or constructed in compliance with municipal building codes and regulations. These include houses, hotels, flats and hostels that are not funded by government. [11]

Early warning: The provision of timely and effective information, through identified institutions, that allow individuals at risk of a disaster, to take action to avoid or reduce their risk and prepare for effective response. [12]

Earth movement: These are hazards that would include rockfalls, landslides, mudslides and earth tremors/earthquakes that are responsible for sudden loss of life and property damage. [11]

Earth tremors: Shaking of the ground. [11]

Earthquake or quake: A sudden break in the upper layers of the earth, sometimes breaking the surface, resulting in the vibration of the ground. This may be strong enough to result in the damage/destruction of infrastructure as well as injury and loss of life. [11]

El niño: The irregularly occurring pattern of abnormal warming of the surface coastal waters off Ecuador, Peru and Chile. This coupled atmosphere-ocean phenomenon is associated with the fluctuation of intertropical surface pressure pattern and circulation in the Indian and Pacific oceans, called the Southern Oscillation. [12]

Emergency management: The organisation, management of resources and responsibilities for dealing with all aspects of emergencies, in particularly preparedness, response and rehabilitation. [12]

Emergency management involves the plans, structures and arrangements which are established to bring together the normal endeavours of government, voluntary and private agencies in a comprehensive and coordinated way to deal with the whole spectrum of emergency needs. This is also known as disaster management. [12]

Environmental degradation: Processes induced by human behaviour and activities (sometimes combined with natural hazards) that damage the natural resource base or adversely alter natural processes or ecosystems. [12]

Environmental hazard: A threat to the public from some aspect of the environment, e.g. earthquakes, landslides, etc. [1]

Environmental impact assessment (EIA): A study undertaken in order to assess the effect on a specified environment as a result of the introduction of a new factor, which may upset the ecological balance. [12]

Environmental risk: Likelihood or probability, of injury, disease, or death resulting from exposure to a potential hazard. [11]

Epidemics: Diseases that are prevalent among a community at a particular time. [11]

Erosion: The removal of solids by the friction force of flowing water or wind. Erosion includes surface and stream erosion. Surface erosion occurs when solids are washed away from the surface of the land and are carried into a water system by rain. Stream erosion refers to erosion within a body of water. The faster the water flows within that body, the more turbulence there is. This leads to a greater capacity to transport solids. [11]

Fire incident/disaster: Fire disasters occur worldwide within both our built and natural environments. They can have widespread impacts, reflected in the destruction of forests, and generation of polluting haze. At smaller scale, fires in informal settlements result in loss of dwellings, household assets, sources of livelihood, as well as injuries and loss of life. [11]

Flash flood: A flood event of short duration with a rapidly rising flood wave and a rapidly rising water level. Flash floods are caused by heavy, usually short precipitation (torrential rain) in an area that is often very small, typically in conjunction with a thunderstorm. [11]

Flood event/disaster: Flood disasters are those in which a significant rise in water level in a stream, lake, reservoir, coastal region or low-lying area results in loss of life or displacement, as well as property/infrastructure damage/crop losses and/or significant disruption of key services. [11]

Flood lines: Line defining the extremity of a flood event.[3]

Fog: Vapour suspended at or near the earth's surface or a cloud resting on the ground. [11]

Fujita index: An intensity scale for tornadoes. The Fujita Scale has six degrees, ranging from wind speeds below hurricane strength (< 116km/h) to over 420km/h. [11]

Fynbos not burned in over 10 years: Fynbos refers to fine-leaved bush, an eco-zone in South Africa's southern Cape area comprising of shrubs and shrubby woodland to three metre high, with patches of hardwood forest. This vegetation type burns periodically, as this is essential for seed dispersal and its regeneration. As human settlements have extended further into the fynbos areas, the natural cycle of burning poses a threat to human inhabitants. [11]

Gas emission/ explosion: An industrial accident that involves a leak or release into the air of hazardous gases, exceeding internationally established safety levels. This can result in illness, injuries/deaths, as well as impact on physical infrastructure, the natural environment and disrupt services. [11]

Geographic information systems (GIS): Computer programmes that combine a relational database with spatial interpretation and outputs in form of maps. A more elaborate definition is that of a system for capturing, storing, checking, integrating, analysing and displaying data about the earth that is spatially referenced. It is normally taken to include a spatially referenced database and appropriate applications software. [12]

Geological hazard: Natural earth processes or phenomena, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. [11]

Ground/surface water drought: The impact of reduced rainfall on the availability of ground or surface water. [11]

Group medical emergency: A sudden threat to human health/survival in a specific group that requires urgent medical intervention/hospitalisation to prevent serious illness or death of group members. [11]

Hazard (also shock, threat): A potentially damaging physical event, phenomenon and/or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. [12]

Hazard analysis: Identification, studies and monitoring of any hazard to determinate its potentiality, origin, characteristics and behaviour. [12]

Hazardous Material: Any chemical, chemical compound or mixture of compounds which is a physical and/or health hazard.[9]

Hail: Precipitation in the form of balls or lumps of ice. [11]

Health hazards: A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes.[2]

Heavy rainstorms: Storms in which large amounts of rain fall in a short period of time (i.e. more than 12.5mm of rain/hr, or >50 mm rain covering 80% of a geographic area in less than 24 hours). [11]

High density alien vegetation: Alien vegetation refers to plants that have been introduced into an area, threatening the survival of naturally occurring habitats (e.g. include acacia, eucalyptus, pine). Alien vegetation in South Africa grows faster and retains less water than the indigenous fynbos. Thus when fire occurs, alien trees burn with a greater intensity than fynbos. Alien vegetation also changes the chemical composition of the soil. This results in an impermeable layer forming in the soil. Thus during flooding, the soil is unable to absorb the water. This results in loss of topsoil as the water runs off. [11]

High temperatures: Temperatures that are higher than a region usually experiences. [11]

High water table: A water table is a more or less horizontal layer in the soil below which all spaces between the soil particles are saturated with water. If a water table is high, then the horizontal layer is close to the ground's surface. If an area has a high water table and flooding occurs, the ground will become saturated with water very quickly. The water will then start to pool above the ground. This can lead to flooding. [11]

Human-induced hazards: Hazards that are induced by human processes, including environmental degradation, technological hazards and social behaviour.[10, 12]

Hydrometeorological hazards: Natural processes or phenomena of atmospheric, hydrological or oceanographic nature,which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. [12]

Inadequate domestic waste disposal: The inadequate disposal of domestic waste, which can, together with an event such as heavy rain and blocked drainage aggravate flooding, provide a breeding ground for disease and lead to a social/health emergency. It can also lead to blocked drains and aggravate flooding. [11]

Inadequate firebreaks: A firebreak is a natural or constructed barrier used to stop or check fires that may occur, or to provide a control line from which to work. An example of a firebreak is a road or a sports playing field. Where such breaks are absent, fire is more likely to spread. [11]

Inadequate storm water drainage or poor drainage: This refers to large drainage systems for rerouting natural run off following rainfall. Blocked, inadequate or no storm water drainage could lead to a flood occurring. This typically occurs in areas that have informal dwellings. It also affects areas with extensively concreted and hard surfaces. [11]

Individual medical emergency: A sudden threat to an individual’s health/survival that requires urgent medical intervention to prevent serious illness or death. [11]

Industrial fires: Fires that occur in buildings where the occupants are engaged in industry, manufacturing or productive labour. These buildings include processing or industrial facilities, furniture, plastics/rubber, textiles, printing, milling, petroleum, food/beverages, paper/packaging, chemical, metal and electronics plants. [11]

Informal dwelling fires: Fires that occur in dwellings that have not been formally ‘approved’ or constructed in compliance with municipal building codes and regulations. Usually, such fires occur in informal settlements, which are densely congested residential areas, often lacking basic amenities and services such as piped water and electricity. An informal dwelling could also be a 'Wendy house' or similar structure in the back yard of an approved building/home that is occupied by people. [11]

Informal settlements: Informal settlements (often referred to as squatter settlements or shanty towns) are dense settlements comprising communities housed in self constructed shelters under conditions of informal or traditional land tenure. They are common features of developing countries and are typically the product of an urgent need for shelter by the urban poor. As such they are characterised by a dense proliferation of small, make-shift shelters built from diverse materials, degradation of the local ecosystem and by severe social problems.[6]

Insect infestations: Occurs when swarms of insects converge in a single place. [11]

Institutional fires: Fire incidents that occur in buildings usually owned or sponsored by the government but also for a similar service that is funded privately. Examples of this include hospitals, educational establishments and government buildings. [11]

La niña: Is the opposite of an El Niño event, during which waters in the west Pacific are warmer than normal and trade winds are stronger. [12]

Landslide: The downslope movement of rock or soil. [11]

Lifeline services: Includes ambulance services, police, fire fighting, electricity and telecommunications services. An example of this is an electricity box or substation. [11]

Lightning: A visible electric discharge between clouds or clouds and the ground. [11]

Low water table: When a water table is low, then the layer of soil saturated with water is far from the ground. A water table can become so low that it is difficult to access ground water. In cases where this occurs for prolonged periods then a hydrological drought can occur. [11]

Mass panic reaction: An event in which a large group or crowd of people panics, resulting in injuries and loss of life. [11]

Meteorological drought: A reduction in rainfall supply, compared with a specified average condition over a specified period. [11]

Mudslide: A form of debris flow with a high water content and relatively fine solid content (up to about the size of gravel). [11]

Natural hazards: Natural processes or phenomena occurring in the biosphere that may constitute a damaging event. [12]

Non-drainage flood: A flood event that results from normal or higher than normal rainfall which would/should generally be drained by adequate stormwater drains. [11]

Nuclear accident/explosion: A release of radiation occurring in civil nuclear facilities, exceeding internationally established safety levels, resulting in illness, injuries/deaths, as well as impacts on physical infrastructure, the natural environment and disrupted services. [11]

Oil spill: An event involving the contamination of water or land by unrefined oil. [11]

Petrol leak/ explosion: A leak or explosion during the production, transportation or handling of petroleum products, resulting in illness, injuries/deaths, as well as impacts on physical infrastructure, the natural environment and disrupted services. [11]

Plantation fires: Fire incidents that occur in commercial forests that are managed by either private companies or parastatal organisations and harvested for profit. In South Africa, these are characterised primarily by non-indigenous or 'alien' tree species. [11]

Public gathering place fires: Fire incidents that occur in churches, halls, cinemas, museums, nightclubs, sports clubs and other places where large numbers of people come together for entertainment and recreation. [11]

Public health emergency: A sudden and specific threat to human health and safety in an identified community or defined population that requires urgent/immediate health and other interventions to prevent widespread injury, illness and/or death. [11]

Rain and wind storms: Storms with both strong winds (i.e. wind speeds from 20.8 metres/second) and heavy rains. [11]

Red tide/Algal bloom: Algal Bloom is the proliferation of algae in water bodies as a result of changes in the water chemistry and temperature. These changes occur as a result of pollution. Algal Bloom poses a danger to marine plant and animal health, as well as human health. [11]

Risk: The probability of harmful consequences, or expected loss (of lives, people injured, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human induced hazards and vulnerable/capable conditions. Conventionally risk is expressed by the equation Risk = Hazards x Vulnerability /Capacity. [12]

Risk assessment/analysis: A process to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability/capacity that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend. [12]

River catchment: This is an area that has been drained by a river. There is an increased vulnerability to riverine floods or flash floods. [11]

River flow rate: Measures the speed at which a river flows. It is measured in cubic metres per second (m^3/s). [11]

Riverine flood: A flood event involving the overflow of a river course as a result of prolonged, copious precipitation over a large area. [11]

Rock fall: A free fall of rock from steep slopes or rock faces. [11]

Scree slopes (Talus Slope): A sloping mass of coarse rock fragments accumulated at the foot of a cliff or slope.[12]

Signigicant hazard event: An event of significant magnitude that either results in human, environmental, infrastructural or other losses, or requires outside assistance to avert serious losses.

Siltation: The deposition of silt by water in a channel or river. [11]

Snow: Frozen vapour falling to the earth in light white flakes. [11]

Social/health emergencies: Events in which people's health and safety are at extreme risk, and are characterised by loss of life, injury or illness. Social or health emergencies can occur as the result of communicable disease outbreaks, inhalation, ingestion or exposure to hazardous substances, or as the result of a mass panic reaction in a group or crowd of people. [11]

Soil erosion/loose soil: Soil erosion is the process by which soil is removed from one place to another through natural mechanisms like water or wind. If a disaster like a flood occurs, the ground will be unable to absorb the excess water. This results in the water running off which in turn can cause landslides or rockfalls. [11]

Southern oscillation index (SOI): This index states the relation in the distribution of atmospheric pressure between the Indian and Pacific Oceans. It is calculated in atmospheric pressure in Tahiti and Darwin (northern Australia). A positive SOI means high atmospheric pressure in Tahiti and low atmospheric pressure in Darwin. A negative SOI correlates with El Niňo phases. [11]

Spill/leak hazardous material: A spill or leak of a hazardous substance that can lead to disasters like a fire. An example of this is where petrol is leaking from a tanker that is transporting it. [11]

Storm event/disaster: Storm disasters are triggered by a violent disturbance of the atmosphere, with strong winds, and often with thunder, rain and/or snow. Storms can include tornadoes (traveling less than 1 km across), and can range up to extra-tropical cyclones which are 2 000 – 3 000 km across. Storm disasters are reflected in loss of life, injuries and property damage, building collapse, flooding and crop losses. [11]

Strong winds storms: Storms with wind speeds greater than 24.4 metres/second. [11]

Structural failure: The failure of the structure of a building could cause a disaster. An example is a chimney that has deteriorated. If a fire is made, the smoke may not be able to leave the house. This could lead to a fire. [11]

Sustained high temperatures: Temperatures that are higher than a region usually experiences over a prolonged period of time. [11]

Technological hazards: Danger originating from technological or industrial accidents, dangerous procedures, infrastructure failures or certain human activities, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. [12]

Thunderstorms: Storms accompanied by heavy gusts of wind and rainfall, and sometimes with hail or tornadoes. [11]

Tornadic storm: A severe thunderstorm that spawns one or more tornadoes (which are violently rotating storms of small diameter that appear as funnel clouds, extending from the base of a larger storm cloud downward, sometimes reaching the ground – at times reaching wind speeds of up to 300 km/hr $^{-1}$). [11]

Vegetation not cleared near homes: Trees, bushes and shrubs within a certain distance of a dwelling. If this vegetation is not cleared, it can be ignited easily and threaten the dwelling. [11]

Veld fires: Fire incidents in South Africa that result in the burning of grass, shrubs and trees in a single event. These can occur in national parks and rural areas as well as within the urban fringe around cities and towns. In other countries veld fires are known as wild fires. [11]

Vulnerability: A set of conditions and processes resulting from physical, social, economic and environmental factors, which may increase the susceptibility of a community to the impact of hazards. [12]

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Annex B List of people contacted

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Air	Amanda Pietersen	Airports Company South Africa	(021) 937 1221	
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Air Emissions	Office of Ravi Pillay	Department of Environmental Affairs, Air Pollution Control	(021) 949 7887	
Air Emissions	Grant Ravenscroft	Scientific Services, City of Cape Town	(021) 684 1012	grant.ravenscroft@capetown.gov.za
Climate	Dr Emma Archer	Climate Systems Analysis Group, UCT	(021) 650 2784	archer@egs.uct.ac.za
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Coastal/Marine Threats	Roy van Ballegooyen	Council for Scientific & Industrial Research	(021) 888 2574	rvballeg@csir.co.za
Coastal/Marine Threats	Professor G B Brundrit	Department of Oceanography, UCT	(021) 650 3277	
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Dams	Brian Davies	Department of Zoology, UCT	(021) 650 3637	
Drought	Riann Noarhs	Department of Agriculture, Western Cape	(021) 808 5194	
Drought	Mr Opperman	AgriSA	(021) 872 1618	
Drought	Dr Dirk Profsky	Department of Agriculture, Western Cape	(021) 808 5190	
Drought	Mr Theo	National Department of Agriculture	(021) 421 2108	theop@nda.agric.za
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Drought	Johan van den Berg	Enviro Vision	(015) 436 5550	
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Environmental Degradation	Freddy Elis	University of Stellenbosch		fe@sun.ac.za
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Telephone Structures	Hugh Sonn	Telkom		

Annex C-1 RAVA Questionnaire submitted to municipalities

RAVA (Risk and Vulnerability Assessment)
Request for Feed-back:

Name:________________________________ Date:___________________________

Position:______________________________ Municipality:_______________________

Contact details: Mailing address____

Tel:___________________Fax:___________________ Email:_________________

The most important hazards/disasters that affect my municipality/area of work are:
(in order of importance)

1.__________________________________ 2.__________________________________

3.__________________________________ 4.__________________________________

5.__________________________________ 6.__________________________________

I know of studies that have been done on the following hazards or disasters in my municipality/area of work:

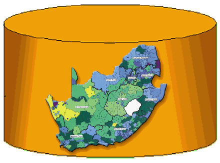
Hazard type	Type of Survey/Research Done and approx dates	Contact Person for More Information

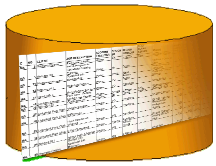
Please phone DiMP at:
Ailsa Holloway/Helen MacGregor/Gillian Fortune at 021 650 4743/2945/4742
Send fax to: 021 689 1217
or email holloway@enviro.uct.ac.za, helenmac@enviro.uct.ac.za, gfortune@enviro.uct.ac.za

Annex C-2 RAVA Audit template

Risk and Vulnerability Assessment (RAVA) for the Western Cape:

Request for GIS information





Please complete the following as accurate as possible:

General Info

Name:______________________________ Date: ______________________________

Position:______________________________ Organisation: ______________________________

Contact details: Tel:_______________ Fax:_______________ Email:_______________

Brief Description of Data/information:

____

____

____

Name of your data/ information

____

Manner in which the data is organized (e.g. lever-arch file/ electronic/ GIS)

____

If electronic, describe format (Word, Excel, Access, other)

____

Time-period of data/information ______________________

Geographical areas covered by the data/information

____

Date captured______________________

Date of next update______________________

Custodian/ Owner of Data: ____________________

Source of Data/information (eg Fire Services): _____________________

If data is on GIS please answer Spatial Data Detail

Geographic Spread (e.g. RSA, entire Western Cape etc.): _________________________

Feature type (Points, Lines, Areas): __________ Feature count (roughly): [ ]

Format (Shp, MidMif, CAD, Raster image, hardcopy etc.): _________________________

Level of Detail (e.g. magisterial dist, suburb, erf, XY coord, etc.) __________________

Accuracy of data (e.g. 10 meter, 1 centimeter, handheld GPS etc.) __________________

Projection: ___________________ Datum (Cape Datum / WGS84): _______________

Size of Dataset (Megabytes): [MB]

Important alphanumeric attributes to note: __________________________________

____

____

Update of Spatial Data

Date captured: _______________ Date of next update: _______________

Frequency of notable change in data (e.g. hourly, daily, annually etc.): ________________

Time period of data (e.g. 2 year monthly rainfall, 10 year seismic events): _____________

RAVA project specific requirements

Is the data confidential? [Yes] [No]

Explain restricted use that applies to the data:_________________________________

____

____

Do you have resources to prepare the data for our use? [Yes] [No]

Explain: ____

Will there be a cost to prepare the data for our use? | Yes | No | Cost estimate: R

Other key contacts w.r.t. this dataset:

Any other comments or suggestions?

Annex C-3 RAVA Significant events form

Risk And Vulnerability Assessment (*RAVA*)
Declared Disasters & Significant Events

Type Eg: Flash Flood, Veld Fire, Earthquake, etc	**Begin Date**	**End Date**	**Area affected**	**Lossess** Infrastructure, Human life, No. of Hectres, etc	**Declared**		**Weather Related**		**Comments**
					Yes	**No**	**Yes**	**No**	

Annex D Terms of Reference for Technical Advisory Committee

Draft
Terms of Reference
Technical Advisory Committee, RAVA

Background

In response to requirements outlined in the forthcoming Disaster Management Act, the Provincial Government of the Western Cape has authorised the Universities of the Free State and Cape Town to assess natural and other hazards in the Western Cape. This is viewed as Phase I of a longer-term project to both assess risk and vulnerability, as well as formulate appropriate disaster prevention and mitigation strategies.

In this regard, the project forsees the following activities to be completed in Phase I

- Completion of an audit of existing information and data on likely natural, technological and compound hazards in the Western Cape.
- Identification of all potential disaster hazards in the Western Cape
- Transfer of relevant and appropriate data into an integrated GIS database.
- Mapping and printing of hazardous areas in the Western Cape.
- Development of a conceptual disaster decision support management tool (DSMT) to assist the Provincial Govt, Western Cape, Disaster Management in planning.
- Consultation with other disaster management stakeholders and user-groups who may use the information and DSMT.
- Reporting on activities in Phase I

In this context, and in response to recommendations made at the RAVA consultation held 3-4 October at the Cape Town Lodge, a *Technical Advisory Committee* is proposed to technically support the hazard assessment process.

Tasks/Responsibilities for RAVA Technical Advisory Committee

The Technical Advisory Committee for Phase I of the RAVA project will carry out the following tasks.

1) Provide specialist input to the audit on existing information and data on likely natural, technological and compound hazards in the Western Cape.
   Specifically, this will involve:
a) Providing specialist advice on historic hazard data/information and future trends with respect to likely impacts.
b) Assessing existing hazard data and information, their appropriateness, relevance, accuracy, strengths and constraints with respect to consolidation into a province-wide hazard map.
c) Generating a brief report on 1a) and 1b) for the hazards falling in their specific area of expertise, including both written and (where appropriate) tabular summaries.

2) Provide a specialist proposal for specifically consolidating/streamlining existing data for incorporation into a province-wide map, including a description of methodology, time-frame, likely partners, costs and constraints.

3) Participate in RAVA Technical Advisory Committee meetings to:
a) advise the Universities of the Free State and Cape Town on steps necessary to ensure the scientific accuracy, robustness and consistency of maps generated.
b) provide a 'peer reference' mechanism that ensures a consistently high standard for the information generated, and identifies/documents limitations of the outputs.

<u>Membership</u>

As recommended following the RAVA Consultation on 3-4 October, 2002, the Technical Advisory Committee will include:

- Those specialists who presented at the Consultation.
- IT GIS partners affiliated with the project to maximise consistency in data for incorporation into GIS
- Representatives of the Universities of the Free State and Cape Town
- A representative of the Project Steering Committee
- Other resource people, as required, to support the process.

Secretariat
DiMP/UCT will serve as Secretariat for the TAC. DiMP will generate all necessary documentation and materials to support the TAC's work, and will include a written record of meeting minutes in its reporting to the Project Steering Committee.