WEST COAST DISTRICT MUNICIPALITY

DISASTER RISK ASSESSMENT UPDATE

2012

Prepared by:

Dr Elretha Louw

Environmental and Advisory Services

Aurecon

1 Century City Drive

Waterford Precinct

Century City

7442

Prepared for:

Mr. Nabeel Rylands

Sub-directorate: Risk Reduction Planning

Disaster Management and Fire Brigade Services

Western Cape Government

Private Bag X3

Sanlamhof

7530

TABLE OF CONTENTS

TERMINOLOGY

The following terminology[i] is utilised in this document:

TERM	DEFINITION
Aircraft Incident	An aircraft incident is an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which a person is fatally or seriously injured, the aircraft sustains damage or structural failure or the aircraft is missing or is completely inaccessible[ii].
Animal diseases	An animal disease is the impairment of the normal state of an animal that interrupts or modifies its vital functions, affecting a disproportionately large number of animals[iii]. Some diseases infect and are spread by animals only and other diseases, known as zoonosis, can be transferred from animals to humans and result in impairment of human life and/or death. Section 2.1.3.1 in this report discusses the hazards associated with both forms of animal diseases that are hazardous to humans and animals and considers the following animal diseases that are prominent in the WCDM: Rabies, African Horse Sickness (AHS), Porcine reproductive and respiratory syndrome and more recent global diseases that could impact the West Coast District such as Avian influenza.
Capacity	The combination of all strengths, attributes and resources available within a community, society or organisation that can be used to achieve agreed goals.
Contingency Planning	A management process that analyses specific potential events or emerging situations that may threaten society or the environment. Contingency planning establishes arrangements to enable timely, effective and appropriate responses to such events and situations.
Critical Infrastructure Disruption	Critical infrastructure is a term used by governments to describe assets that are essential for the functioning of a society and economy. These assets include electricity generation, telecommunication systems, financial services, and agriculture and public health establishments.
Dam failure	A dam is a barrier across flowing water that obstructs, directs or slows down water, often creating a reservoir, lake or impoundment. The term 'dam' here includes any catchment or barrier dam and any other form of impoundment used for the storage of unpolluted water or water containing waste. General dam failure can be attributed to foundation failure (leakage and piping), concrete or mortar deterioration, flow erosion and timber deterioration.
Development planning	An integrated, multi-sectoral process through which governmental institutions streamline social, economic and spatial growth.
Disaster	A disaster means a progressive or sudden, widespread or localised, natural or human-caused occurrence. It is a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.
Disaster Risk	The potential disaster losses, in lives, health, status, livelihoods, assets and services, which could occur to a particular community or society over a specified future time period.
Disaster Management	Disaster management means a continuous and integrated multi-sectoral, multi-disciplinary process of planning and implementation of measures to prevent or reduce the risk of disasters; mitigate the severity or consequences of disasters; emergency preparedness; a rapid and effective response to disasters; and post-disaster recovery and rehabilitation. It is the systematic process of using administrative directives, organisations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster. This term is an extension of the more general term 'Risk Management' to address the specific issue of disaster risks. Disaster Management aims to avoid, lessen or transfer the adverse effects of hazards through activities and measures for prevention, mitigation and preparedness.
Disaster Risk Reduction	The conceptual framework of elements considered with the possibilities to minimise vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development.
Disaster Risk Reduction Plan	A document prepared by an authority, sector, organisation or enterprise that sets out goals and specific objectives for reducing disaster risks together with related actions to accomplish these objectives.
Drought	A drought is a shortage of precipitation over an extended period and it entails deficient rainfall

	relative to the statistical multi-year average for a region[iv]. Drought is not merely low rainfall, but a relative concept based on the expected, or average, rainfall of an area, whether desert of tropical, for any given time of year[v].
Early Warning Systems	The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss by reducing or mitigating disaster risk. It incorporates a system of data collection and analysis that monitors people's well-being (including security), in order to provide timely notice when an emergency threatens, and thus to elicit an appropriate response. An Early Warning System is the integration of four main elements: Risk Knowledge; Monitoring and Predicting; Disseminating Information; and Response. Failure of any part of the system will imply failure of the whole system.
Fire	Veld Fire: Fire that occurs in the open countryside beyond the urban limit or homestead boundary in fynbos, natural veld, plantations, crops or invasive vegetation outside a built-up area. Wildfires, occurring mainly during the "dry" season in the Western Cape, can be started both by people and by acts of nature. They may be associated with slash and burn or bush clearing activities, which in times of drought and high wind can be difficult to manage and can lead to runaway fires. In 50% of the cases it is not known how the fires start and the negligence of people often plays a role. Vegetation fires, mostly caused by humans, can be predicted and in many cases prevented through the application of appropriate policies. Structural Fire: This is when fire involves the structural components of various residential buildings ranging from single-family detached homes and townhouses to apartments and tower blocks, or various commercial buildings ranging from offices to shopping malls. A structural fire in an informal settlement involves temporary dwellings[vi].
Floods	A flood is defined as the temporary inundation of normally dry land areas resulting from the overflowing of the natural or artificial confines of a river or other body of water, including groundwater[vii].
Harmful Algal Blooms (HABs)	Harmful algal blooms (HABs) are caused by dense concentrations of phytoplankton. Phytoplankton can grow explosively, creating something called a "bloom". When conditions at the surface become unfavourable for the phytoplankton, the blooms sink and decay, the decomposition depletes the oxygen supply in the water. All harmful algal blooms were once referred to as "red-tides" because of the discolouration caused by algae suspended in the water. The term red tide is misleading as the discolouration of the water may be brown, orange, purple or yellow, as well as red. In some cases, the water may not be discoloured at all[viii]. The discolouration varies with the species of phytoplankton, its pigments, size and concentration, the time of day and the angle of the sun[ix].
Hazard	A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydro meteorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its location, intensity, frequency and probability.
HAZMAT: Oil spill at sea	A shipping incident is an occurrence associated with the operation of a ship that could affect the safety of operation[x]. An oil spill is a release of a liquid petroleum hydrocarbon into the environment, especially marine areas, due to human activity, and is a form of pollution. The term is usually applied to marine oil spills where oil is released into ocean or coastal waters but oil spills may also occur on land[xi]. Oil spills may be due to releases of crude oil from tankers, offshore platforms, drilling rigs and wells, as well as spills of refined petroleum products (such as gasoline, diesel) and their by-products, heavier fuels used by large ships such as bunker fuel, or the spill of any oily refuse or waste oil[xii].
HAZMAT: Road and Rail	Spillage of hazardous materials on roads and/or rail that can result in death or injury due to contact with toxic substances, resulting explosions and/or fires. Where spillage occurs in environmental sensitive areas, it can result in death of fauna and flora and can cause severe contamination of resources, such as groundwater and surface water[xiii].
Heat Wave	A heat wave is a prolonged period of excessively hot weather, which may be accompanied by high humidity. Specifically SAWS defines a heat wave:'when for 3 days the maximum temperature is 5 degrees higher than the mean maximum for the hottest month'[xiv].
Human Disease	A human disease is the impairment of the normal state of a human being that interrupts or modifies its vital functions, affecting a disproportionately large number of people[xv]. Diseases affect humans in different ways, and they arise from different causes. While some diseases are caused by pathogenic organisms, such as bacteria, others seem to arise spontaneously, such as heart disease or cancer. Diseases caused by pathogenic organisms are often transmissible from one person to another, while

	some other diseases can be transmitted from parents to their children by inheritance.
Impact	The terms Primary Impact and Secondary Impact are used to describe the different causes and scales of potential impacts from a hazard event: Primary Impacts are also called direct impacts. Secondary impacts are often referred to as indirect or induced impacts. This does not imply that secondary impacts are of secondary importance, in many cases the effects on biodiversity and the environment from secondary impacts are much more significant than those of primary impacts.
Integrated Development Plan (IDP)	This term is used in relation to a municipality and means a plan envisaged in section 25 of the Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000).
Local Municipality (LM)	This is a municipality that shares municipal executive and legislative authority in its area with a district municipality within whose area it falls, and which is described in section 155 (1) of the Constitution as a category B municipality.
Mitigation	The lessening or limitation of the adverse impacts of hazards and related disasters.
Nuclear Event	The Koeberg Nuclear Power Station (KNPS) is situated 27 kilometres North of Cape Town. The two nuclear reactors at the station supply 8% of South Africa's electricity needs. The reactor type used at Koeberg is a Pressurised Water Reactor (PWR) with the station generating electricity since 1984. At the Koeberg facility an unexpected nuclear accident will be the radiological release or radioactive contamination into the environment[xvi]. This leakage will be an unintended event, resulting from operating errors, equipment failures or other mishaps, the consequences or potential consequences of which are negligible from the point of view of protection or safety[xvii].
Preparedness	The knowledge and capacities developed by governments, professional response and recovery organisations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions. These activities and measures include the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations.
Prevention	The outright avoidance of adverse impacts of hazards and related disasters.
Recovery	The restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors.
Residual Risk	The risk that remains in unmanaged form, even when effective disaster risk reduction measures are in place, and for which emergency response and recovery capacities must be maintained.
Resilience	The capacity of a system, community or society potentially exposed to hazards to adapt by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organising itself to increase this capacity for learning from past disasters for better future protection and to improve disaster risk reduction measures.
Response	Response is the provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected. These measures can be of immediate, short-term or protracted duration.
Risk	The combination of the probability of an event and its negative consequences.
Risk Assessment	A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environments on which they depend.
Risk Management	The systematic approach and practice of managing uncertainty to minimise potential harm and loss.
Road Accident	Road accidents are accidents which occurred or originated on a way or street open to public traffic; which resulted in one or more persons being killed or injured and in which at least one moving vehicle was involved.
Sand dune migration	Sand dune systems can provide an important natural coastal flood defence and are also of great importance from nature conservation, recreation and tourism perspectives. Sand dune migration occurs when a whole dune advances without change in shape and size by the wind, especially if there is no vegetation to keep the sand in place. Natural factors, such as strong south-easterly and north-westerly winds during summer and winter respectively, and the sediment characteristics of sand along the coastline (generally fine-grained), coupled with inappropriate development within the coastal dune cordon, has caused migrating coastal dunes to become a hazard along parts of the coastline backed by low relief topography[xviii].
Seismic Hazards	A seismic hazard is the potential for dangerous, earthquake-related natural phenomena such as ground shaking, fault rupture or soil liquefaction. The phenomena could then result in adverse

	consequences to society like destruction of buildings or loss of life.
Severe Storms	Wind is air in motion. The speed and direction of wind is determined by atmospheric pressure and weather systems in a particular area. See the Beaufort Scale in section 2.1.1.3.
Shoreline Erosion (coastal erosion)	Coastal erosion can be described as the removal of beach or dune sediment, or the weathering of rocks by wave action and currents, tidal currents or drainage[xix]. Shoreline erosion occurs on both exposed and sheltered coasts, primarily through the action of currents and waves but sea level (tidal) change can also play a role. Where there is a bend in the coastline, quite often a build-up of eroded material occurs forming a long narrow bank (a spit). Armoured beaches and submerged offshore sandbanks may also protect parts of a coastline from erosion. Over the years, as the shoals gradually shift, the erosion may be redirected to attack different parts of the shore[xx].
Storm Surge	A storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. Storm surge should not be confused with storm tide, which is defined as the water level rise due to the combination of storm surge and the astronomical tide. Storm surge is a complex phenomenon as it is sensitive to changes in storm intensity, forward speed, the angle at which it approaches the coast and size. Other factors which can impact storm surge are the width and slope of the continental shelf i.e. a shallow slope will potentially produce a greater storm surge than a steep shelf[xxi].
Vulnerability	The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. Conditions of vulnerability and susceptibility to the impact of hazards are determined by physical, social, economic and environmental factors or processes.

ACRONYMS

Acronym	Explanation
AADQ	Annual Authorized Discharge Quantity
AHS	African Horse Sickness
AI	Avian Influenza
AIDS	Acquired Immune Deficiency Syndrome
AIS	Automatic Identification System
ARS	Automatic Rainfall Sensor
ART	Antiretroviral Treatment
CAA	Civil Aviation Authority
CGS	Council for Geoscience
CMP	Coastal Management Plan
COG	Department of Cooperative Governance
COPD	Chronic Obstructive Pulmonary Disease
COSCPs	Coastal Oil Spill Contingency Plans
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DM	District Municipality
DMC	Disaster Management Centre
DoA	Department of Agriculture
DRA	Disaster Risk Assessment
DWA	Department of Water Affairs
E.g.	Example
Etc.	Etcetera
EMP	Environmental Management Plan
EWS	Early Warning Signal
FPA	Fire Protection Associations
GHGs	Greenhouse gases
HAB	Harmful Algal Blooms
HAZMAT	Hazardous Materials
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HDACC	Health Data Advisory and Co-ordination Committee
HIV	Human Immunodeficiency Virus
IDP	Integrated Development Plan
ICM	Integrated Coastal Management
KNPS	Koeberg Nuclear Power Station
LM	Local Municipality
LPZ	Longer Term Protective Zone
LRIT	Long Range Identification and Tracking
MOU	Memorandum of Understanding

MRCC	Maritime Rescue Coordination Centre
NDMC	National Disaster Management Centre
NDMF	Policy Framework for Disaster Management in South Africa
NGO	Non-Governmental Organisation
NNR	National Nuclear Regulator
NSRI	National Sea Rescue Institute
OIE	World Organisation for Animal Health
PAZ	Precautionary Action Zone: 0 to 5 kilometres.
PDMC	Provincial Disaster Management Centre
Prov	Province
PRRS	Porcine Reproductive And Respiratory Syndrome
PSC	Project Steering Committee
PWR	Pressurised Water Reactor
REM	Radio Equivalent Man
RVF	Rift Valley Fever
SADC	South Africa Development Community
SAMSA	South Africa Maritime Safety Authority
SANCCOB	Southern African Foundation for the Conservation of Coastal Birds
SANDF	South African National Defence Force
SANDMC	South African National Disaster Management Centre
SANDMF	South African National Disaster Management Framework
SANRAL	South African National Roads Agency Limited
SANS	South African National Standard
SAPS	South African Police Service
SAWS	South African Weather Service
SOLAS	Safety Of Life At Sea
SPF	Sun Protection Factor
TB	Tuberculosis
UPZ	Urgent Protection Zone: 5 to 16 kilometres.
USGS	United States Geological Survey
UV	Ultraviolet
VPN	Veterinary Procedural Notices
VTS	Vessel Tracking System
WANO	World Association of Nuclear Operators
WCDM	West Coast District Municipality
WCDMC	West Coast Disaster Management Centre

Executive Summary

The update of the 2006 WCDM Disaster Risk Assessment was completed in the last quarter of 2012 by Aurecon PTY Ltd on behalf of and with the support of the Provincial Disaster Management Centre. This study was undertaken with the aim of providing relevant WCDM disaster risk managers and municipal role-players with a user-friendly working document focusing on pertinent risks in the WCDM that were identified during hazard/vulnerability and capacity assessments.

The methodology for the update of the Disaster Risk Assessment is based on a two-pronged approach: scientific based DRA and community-based DRA. The scientific research methods comprised of desktop research, interviews with relevant district and provincial stakeholders, and compiling GIS maps of the WCDM. Community based research was facilitated in the form of one-day workshops with local role-players in order to rate relevant risks in the municipal area. The data sets collected from these two methods were integrated to consolidate the results and to create a holistic update of the WCDM Disaster Risk Assessment.

The WCDM 2012 DRA update will assist district and local role-players to be able to avoid disaster risks, plan for and reduce disaster risks, and to respond effectively in the case of a disaster to soften the potential impact on people, property and the environment. This update of the 2006 DRA complies with the requirements of the Disaster Management Act, 2002 (Act 57 of 2002).

This document consists of four chapters which are arranged as follows:

Chapter 1 deals with the introduction and provides context and background to the update of the West Coast District Municipality's DRA.

Chapter 2 addresses the 10-point plan provided by the PDMC and covers the risk profile of the WCDM, based on interviews with stakeholders, desktop research and risk assessments which were conducted during workshops in 2012. High risks which were identified within the WCDM include: HAZMAT road spillage; Veld fires; and Harmful Algal Blooms.

Chapter 3 is the conclusion of this document and contains challenges and key findings identified in the WCDM 2012 DRA update.

Chapter 4 contains all the relevant annexures as referred to in the report.

1. INTRODUCTION

1.1. THE WEST COAST DISTRICT MUNICIPALITY

The West Coast District Municipality is a category C municipality which is classified as a medium capacity municipality.

The five local municipalities falling under the West Coast District Municipality are:

- The Swartland Municipality with Malmesbury as administrative centre;
- The Bergrivier Municipality with Piketberg as administrative centre;
- The Matzikama Municipality with Vredendal as administrative centre;
- The Cederberg Municipality with Clanwilliam as administrative centre, and
- The Saldanha Bay Municipality with Vredenburg as administrative centre.

The N7 national road connects all the municipalities in this district except the Saldanha Bay municipality. The key growth sectors in the West Coast District Municipality include agriculture, fishing, manufacturing, mining and tourism.

1.2 BACKGROUND TO THE 2012 DISASTER RISK ASSESSMENTS

The current risk assessment of the West Coast District Municipality is in excess of 6 years and it is crucial to have a current and verified risk assessment to inform all other risk reduction initiatives. The purpose of this document is to update the West Coast District Municipality's disaster risk assessment in accordance with the Western Cape standardised disaster risk assessment methodology that was developed during the 2011/12 financial year.

The 2012 update of the WCDM disaster risk assessment will focus on the gaps as highlighted in the respective disaster risk assessment review documents. General remarks obtained from the 2006 Risk Assessment workshops included that a more detailed risk assessment is required of the Saldanha Harbour area; a community vulnerability assessment needs to be conducted throughout the district; and that the technical nature of the document makes it difficult for the departments and services (users) to understand. These three issues will be addressed in this user-friendly document.

A checklist for the West Coast District Disaster Risk Assessment with ten criteria was developed, by the PDMC, to evaluate each of the disaster risk assessments conducted in the District. As part of the process, a standardised disaster risk assessment methodology was developed so that all risk assessments in the Western Cape Province conforms to a standard and so that the provincial risk profile can be easily updated. The standardised disaster risk assessment methodology consists of two components: Scientific based disaster risk assessment; and Community based disaster risk assessment.

In 2006 West Coast Disaster Risk Management Assessments were evaluated against the standards as laid down in *South Africa's Policy Framework for Disaster Risk Assessment*, with specific reference to *Key Performance Area 2, Disaster Risk Assessment*. This risk assessment methodology entails hazard identification, vulnerability assessment and risk prioritisation for the WCDM. From the National Disaster Management legislation the WCDM had a Disaster Management Risk Assessment (April 2006) and the West Coast Disaster Management Framework (June 2006) composed.

The 2006 DRA indicated what threatening risks exist in the West Coast and a framework was developed to address the risks strategically, based on national and provincial frameworks. The Disaster Management Framework consists of four key performance indicators, namely institutional capacity, risk assessment, risk reduction and response and recovery. The three enablers are information and communication, training, education and awareness, and funding.

This risk assessment, a scientific tool, is applied in the current 2012 report and indicates the total risk for the West Coast District but also specific risks present within each local municipality. See table 1 below for the priority hazards identified during the 2006 DRA and new hazards identified during the 2012 DRA.

WCDM IDENTIFIED HAZARDS		
PRIORITY HAZARDS	**2006 RISK ASSESSMENT**	**2012 RISK ASSESSMENT**
Drought	African Horse Sickness	Seismic hazards
HAZMAT: Road, Rail	Municipal elections	Sand-dune migration
Fire	Newcastle disease	Shoreline erosion (coastal erosion)
Storm Surges	Renewable energy sources i.e. wind farms	Dam failure
Floods	Rift Valley Fever	National Key Points
Severe Winds	Social conflict	Nuclear event: Koeberg
Road Accidents	Urbanisation (Saldanha Bay and Malmesbury)	
Animal diseases		
Harmful algal blooms		
Human disease		

Table **1** | WCDM 2006 and 2012 identified hazards

2. DISASTER RISK ASSESSMENTS

2.1 NATURAL HAZARDS

2.1.1 HYDRO-METEOROLOGICAL HAZARDS: ATMOSPHERE-RELATED

2.1.1.1 DROUGHT

1. Early Warning signals

- Soil moisture is usually the first component of the hydrologic system to be affected by drought.
- An increase in the number of wind storms and dust storms.
- Water level is also a key variable in monitoring drought - water levels in streams, rivers, lakes and ponds, a lessening of moisture in the soil and decreases in groundwater availability all are signs of drought.
- Signs of stress in plant life are another key parameter warning of coming drought and include wilting, a decrease in growth or no growth. Foliage appears yellow or yellow green, leaves die earlier, wood or bark cracks, stems and twigs die, flowers fail to open and fruit drops.
- Animal stress is a warning sign of drought. Farmers notice that cattle won't feed as much as the animals when they are simply too hot; cows in that condition do not give as much milk. Chickens will decrease egg-laying[22].
- Meteorological information, agricultural information, production estimates, price trends of food and feed are also key indicators of an impending drought.

2. Hazard frequency

- For the winter-rainfall region of South Africa, the frequency of drought is predicted to increase over the next 100 years. This will have dire consequences for the vegetation of this biodiversity hotspot because it implies that the severity and frequency of droughts will increase[23].
- Probability: 2 (normal)
- The expected decrease in rainfall will result in reduced runoff into rivers and reduced recharge of the Langebaan aquifer. This will lead to a reduction in the yield of surface water and groundwater supply systems and general water shortages[24].
- Severity: 2 (moderate)[25].

3. Areas, communities or households most at risk

The already tightening water supply situation is vulnerable to periodic drought. Especially vulnerable groups in the WCDM include:

- Farmers (smallholders and commercial) particularly wheat farms in the Swartland LM and citrus farms in the Matzikama LM. Low rainfall and soil moisture conditions in the Western Cape will reduce wheat and barley crops[26].
- The urban poor's vulnerability will increase due to rising food prices;
- Casual farm labourers can potentially face longer periods of unemployment[27].
- Emerging farmers who may have limited capacity, resources and skills to adapt to and withstand economic pressures.

2.1.1.1 DROUGHT

- Those that are already under economic stress economically as a result of land degradation, loss of biodiversity, and those at (or close to) the threshold of their climate tolerance.
- Agri-businesses that is dependent on the export market.
- In the Matzikama LM areas identified in workshops include: Bitterfontein, Stofkraal, Kliprand and Orionskraal.
- During Bergrivier's LM workshop the attendees highlighted Piketberg, Eendekuil, Porterville and Redelinghuys as areas vulnerable to drought.
- Jacques Smith of Swartland LM indicated that Chatsworth, Riverlands and Kalbaskraal are specifically vulnerable to droughts as these communities experience accompanying water shortages[28].

4. Likely impacts of hazard

Economic impacts	Environmental impacts	Social impacts
- Loss of economic growth or development - Damage to crop quality and reduced food production - Increase in food prices - Loss of dairy and livestock production - Unavailability of water and which leads to high livestock mortality rates - Disruption of reproduction cycles in animals - Increase in unemployment - Loss to recreational/tourism industry - Loss to industries directly dependent on agricultural production (e.g. fertilizer manufacturers.)	- Increased desertification - Reduction and degradation of animals habitats - Lack of feed and drinking water - Increase in disease outbreaks - Increased fire danger - Increased stress to endangered species - Damage to plant species - Increased risk to soil erosion - Loss of wetlands - Increased groundwater depletion, land subsidence and reduced recharge - Reduced water in the rivers will impact on wetlands and estuaries -Increase in pest infestation.	- Loss of human life from food shortages, heat, suicides and violence - Mental and physical stress - Water use conflicts - Social unrest - Public dissatisfaction with the government's response - Inequity in the distribution of drought relief - Reduced quality of life which leads to changes in lifestyle - Increased poverty - Population migration - Reductions in nutrition[29].

5. Level of risk for different situations and conditions (seasonality)

- Drought is a slow onset hazard that can occur at any time of year, although technically speaking a drought is measured over a long period of time.
- Areas that receive winter rainfall may experience drought in the following summer if rainfalls are below average.

6. Conditions of vulnerability that increase the severity of the hazard

- The level of risk depends on the type of farming community – livestock farming, dairy farms, dryland farming or irrigation farming of permanent crops. If the farm is not diversified, such as the potato farms in the Sandveld Region, it means that insufficient yearly rain will lead to a critical situation. The West Coast District is predominantly a low rainfall area and therefore the only irrigation farming takes place in close vicinity to the rivers.
- For the past couple of years there has been insufficient rainfall and insufficient support from National Treasury to support struggling farmers. The Department of Agriculture (DoA) is not allowed to budget for drought schemes and their dependence on National Treasury for allocating drought scheme funds to identified disaster areas is a cumbersome process[30].
- Climate change will result in warmer temperatures and fewer cold days which means that the area affected by drought increases and this will have further negative consequences[31].
- Overgrazing;
- Land degradation;
- Soil erosion; or
- Deforestation.

2.1.1.1 DROUGHT

- The WCDM is the bulk water service supplier for 22 towns and 876 farms in the southern West Coast District in the municipal areas of Swartland, Saldanha Bay and Bergrivier through an extensive bulk distribution system. Available water in the region is already fully committed in most parts of the region, and there is little scope for further development of the resource (such as constructing new dams). In some catchment areas a water deficit exists, meaning too much water is already being abstracted from the system in a way that threatens the integrity of the ecosystems that depend on this water. This is currently reflected in the poor state of this region's rivers. However, demand continues to grow from agriculture, and the coastal towns[32].
- The declaration of a drought area and the subsequent financial aid will depend during which time of the year the drought was declared. The time of year of the financial and mid-term budget for South Africa determines how long the allocation of a drought scheme will take. There is usually a waiting period of one year[33].

7. Capabilities or resources that exist to manage the risk

- The relevant local municipality will inform all community members of resulting water shortages by means of inserting warnings with their water and electricity bills.
- There is a planned freshwater corridor project for the Western Cape to ensure water security (Elandsbaai to Niewoudtville).
- Currently the Department of Agriculture (DoA) in collaboration with Agri Western Cape supports struggling farmers with drought schemes and animal feed donations. The relevant local municipality's disaster risk manager assists the DoA in this regard. These drought schemes can only be in a payment form to the farmer's local cooperation and the farmer needs to apply with all relevant original documents to the DoA. In addition, to qualify for financial support the farmer will have to make a financial contribution to the drought scheme.
- The biggest obstacle for the DoA is that drought is a slow onset hazard which entails that drought financial aid isn't as readily available from National Treasury as for example the support that a community receives after the outbreak of a structural fire. Currently the National Department of Agriculture is addressing this with National Treasury to attempt to establish a yearly drought financial budget to which the DoA will gain easier access.
- The water level, for example in the Clanwilliam Dam, is monitored by the relevant departments to determine the necessity of water shortages. For example if the walls of the Clanwilliam Dam do not overflow by October, that means the yearly rainfall was insufficient and that the local area will have to incur water shortages for the following year[34].
- SAWS seasonal forecasts.
- Commercial farmers who have made significant long term investments, for example in irrigation systems, processing facilities, and certain cultivars.
- A strategy for mitigating climate change is in the process of being undertaken in conjunction with other stakeholders. This Climate Change Strategy will be developed during the 2012/2013 financial year.
- Research has shown that the West Coast area will become a very dry area with less rainfall and, thus, also less water. The economy of the West Coast area is largely dependent upon water, and to mitigate the risk of not having sufficient water, the possibility of the construction of a desalination plant was investigated as a sustainable long-term alternative water source for the District that is less climate-dependent and provides 100% security of supply. A 25,5 Mega litre/day sea water desalination plant in the Saldanha Bay area was identified as the most cost beneficial alternative – this will be first sea water desalination

plant in the WCDM. The Environmental Impact Assessment for the desalination plant is currently underway[35].

8. Risk increasing or decreasing in the WCDM

Risk increasing:

- There is a general decrease in precipitation across all seasons especially in the far south-west of the Western Cape Province with the highest impact in early and mid-winter. These changes are likely to lead to an associated decrease in water availability.
- Water demand will increase to the point that within the next three decades it will override supply in the WCDM. Lower rainfall levels, increased temperatures and evaporation rates will lead to an increase in the water requirement for irrigation as well as urban garden watering, which will exacerbate the water shortages.
- An increase in invasive plant species in dams.
- Water is already a limiting factor for economic growth in most of the province, projected climate change has serious implications for the competing interests of environmental integrity and socio-economic development.
- With extended drought periods, agricultural production may be affected, with the limited supplies having to be shared over the whole population and thus the possibility of a famine occurring in certain areas[36].
- Increasing risk of fire occurs during periods of drought. Higher temperatures usually go along with drying of the soil and lower water levels. As heat and dry climate conditions continue, the risk of fire increases.
- There was a DoA study conducted regarding the possibility of the outbreak of a drought north of Vredendal, but during October 2012 the Western Cape's Provincial Drought Committee graded the concerned area 4 out of 5 whereas 1 would be a critical area for drought aid[37].

9. Impact the risk has on the development progress in the areas, communities and households it affects

Economic impacts	Environmental impacts	Social impacts
- Reduced business with retailers - Food and energy shortages - Loss of crops for food and income - Reduction of livestock quality - Water scarcity - Loss of jobs, income and property - Less income from tourism and recreation - Forced financial loans	- Increased damage to natural habitats - Reduced forest, crop, and range land productivity - Reduced water levels and quality - Reduced cloud cover - Increased daytime temperature - More dust and sandstorms - Decreased soil productivity - Decreased water resources	- Disrupted distribution of water resources - Reduced grazing quality and crop yields - Employment lay-offs - Increased food insecurity - Increased pollutant concentrations - Inequitable drought relief - Increase in veld fires - Increased urbanization

10. Secondary impacts within areas and communities affected by the risk

Economic impacts	Environmental impacts	Social impacts
- Increased prices for farming commodities - Drastic price increases; expensive -	- Loss of biodiversity - Lower accessibility to water	- Increase of energy consumption for irrigation and crop spraying systems.

2.1.1.1 DROUGHT

imports/substitutes - Increased expense of buying food, loss of income - Sale of livestock at reduced market price - Increased transport costs - Deepening poverty; increased unemployment - Increased debt; increased credit risk for financial institutions - Poses a huge risk not only to the related industries, but also those indirectly being supported by earnings in the sector.	- Increased fire hazard - Crop withering and dying - Increased top soil erosion; increased air pollution - Desertification and soil degradation - Lack of water for feeding and drinking - A change in rainfall pattern, more frequent droughts due to climate change and significant land degradation may, over time, lead to the development of areas of desertification - Loss of wildlife can lead to loss of tourism revenue.	- Forest and bush fires - Food insecurity - Sale of livestock, household and community assets to purchase food - Conflict between water users - Increase in unemployment - Malnutrition and famine - Civil strife and conflict - Public health risks - Social pressure, reduced safety - Potential for population migration - Displacement of communities - Water resources will have to be managed more carefully, and it is likely that water restrictions will be applied

2.1.1.2 STORM SURGES

1. Early Warning signals

Storm surges are usually caused by a combination of extreme spring tide and strong winds and to a lesser extent low pressure. Early warning signals may include:

- Offshore swell height and direction;
- Strong winds and wind setup;
- High tide/spring tide, equinox tide and full moons;
- A deep low pressure system; and
- A Barometric Pressure Drop[38].

If the offshore significant wave height is expected to exceed 3 metres at the time of a spring high tide, and the calculated Storm Surge Value exceeds 0.5 metres, then a Storm Surge Alert should be issued by the relevant role-players.

2. Hazard frequency

- Storm surge by definition is abnormal and they are therefore considered rare occurrences. SAWS indicated that no events, according to provided criteria, were recorded in the past year. However, it should be noted that the criteria should be re-visited on an annual basis[39].
- High swells associated with storm surges occur from autumn to spring, however there are occasional big storms in summer[40]. The NSRI estimates 20-50 operations per annum as a result of rough or damaging seas[41].
- Probability = 1 (unlikely)

3. Areas, communities or households most at risk

Sections of the coast that do not have natural defences are vulnerable to storm surges. The local conditions and level of exposure may determine the level of risk i.e. how far or how high from the wave action. The Sishen railway line and the coastal road near Yzerfontein has highly exposed infrastructure[42].

Saldanha Bay is identified as one of South Africa's most vulnerable coastal areas. Saldanha Bay is sheltered; however, wind direction may influence wave action in a concentrated area causing increased damage[43].

Built-up areas that are close to the sea are at risk. These include but are not limited to:

- Lambert's Bay (caravan park);
- Elands Bay (closed river mouth);
- Danger Bay & Saldanha Bay (in terms of swell direction); and
- Langebaan (estuary & point).

Langebaan is of particular concern as water is funnelled up estuaries, raising the normal tide. Estuaries also experience more wave action at the mouth and the poor coast engineering exacerbates risk in the area[44].

The livelihoods of fishing communities are affected when the swells are too high for them to go to sea or vessels are damaged by waves. If wave height exceeds 5 metres, fishermen won't be able to go out to sea and earn an income[45].

4. Likely impacts of hazard

2.1.1.2 STORM SURGES

- Damaging waves can severely erode beaches, coastal railways and coastal highways;
- Buildings exposed to strong winds can be damaged if their foundations are undermined and weakened by erosion and under scouring;
- Flooding and inundation occurs;
- Salt water intrusion in estuaries endangers the public health, kills vegetation and can send animals fleeing from flooded areas[46]; and
- Direct wave impact can damage marinas and boats, particularly boats that are tied down[47].

5. Level of risk for different situations and conditions (seasonality)

- As referred to above, the level of risk increases where infrastructure exists along the coast. Since rough seas and high swells are strongly associated with strong winds and deep low pressure systems, the level of risk increases during the winter months on the open coast.
- Enclosed areas such as Saldanha Bay may be affected by strong summer winds[48].

6. Conditions of vulnerability that increase the severity of the hazard

- Storm surges are associated with high/spring tides; however, a big weather event can occur at any time of the year and the West Coast is influenced by local weather conditions. Sections of coast sheltered from extreme waves, such as Langebaan and Saldanha Bay, require details of spring high tides and wind direction.
- Setback lines for coastal planning identify coastal areas that are safe as well as those that will be affected by future storm surges. Residential development, services and infrastructure along the coast are more vulnerable to impacts of storm surges[49].
- Sandy shorelines with low gradients are in general more vulnerable than rocky shorelines[50], however; headlands may be more vulnerable in the presence of under scouring[51].

7. Capabilities or resources that exist to manage the risk

- Japie Julies with Saldanha Bay LM indicated that the implementation of dolosse at the vulnerable areas on the Langebaan coast severely decreased the risk to storm surges.
- Since the most dangerous time for any increased swell event will be during high tide, it is useful to note that the times and heights of tides for each year are published in advance by the Hydrographic office of the South African Navy[52].
- NSRI have stations at Yzerfontein, Lambert's Bay, Melkbos, and Mykonos (Langebaan) to assist with any rescue operations in the event of rough seas or damaging waves[53]. The success of the organisation is dependent on donor funding to purchase, maintain and operate equipment as well as the availability and commitment of trained volunteers.
- SAWS can predict wind direction and characteristics of approaching storms. SAWS is responsible for issuing any warnings in line with their criteria for storm surges[54].
- It is recommended to obtain the following data sets[55]:
  - Topography;
  - Geology (from Council for Geoscience);
  - Shore stability (historical data);
  - Meteorological data (from SAWS); and
  - Wave modelling data from the Council for Scientific and Industrial Research (CSIR).

8. Risk increasing or decreasing in the WCDM

2.1.1.2 STORM SURGES

Risk increasing:

- Return periods for extreme wave events have increased in certain areas. Further sea level rise may exacerbate the risk[56].
- The average wind velocity is expected to increase in all seasons in South Africa. If due to climate change, winds become only 10% stronger, then wave height increases by 26%, and coastal sediment transport rates potentially increase by 40% to 100%. The increase in storm activity and severity is likely to be the most visible impact and the first to be noticed. For example, higher sea levels will require smaller storm events to overtop existing storm protection measures.

9. Impact the risk has on the development progress in the areas, communities and households it affects

Setback lines for coastal planning identify safe coastal areas as well as those that will be affected by future storm surges. Further residential development, services and infrastructure should not be developed along the coast due to increased vulnerability to storm surges[57].

10. Secondary impacts within areas and communities affected by the risk

- Cost to repair damaged infrastructure;
- Impact on and loss of biodiversity;
- Pollution;
- Property values decrease[58];
- Coastal dune systems are destroyed;
- Fish factories and aquaculture decline; and
- High swells may inhibit NSRI's vessels from launching[59].

2.1.1.3 SEVERE STORMS (STRONG WIND)

1. Early Warning signals

- Pressure distribution (see the Beaufort Wind Scale in Figure 1);
- Basic movement of air masses; and
- Coastal low pressure systems[60].

Beaufort Wind Scale

	Force & Strength	Description
	**0** < 1km/hr < 1 knot	**Calm** Smoke Rises Vertically
	1 1-5 km/hr 1-3 knots	**Light Air** Wind Direction Shown by smoke drift, not wind vanes
	**2** 6-11 km/hr 4-6 knots	**Light Breeze** Wind felt on face, leaves rustle, wind vanes move by wind
	3 12-19 km/hr 7-10 knots	**Gentle Breeze** Leaves and twigs in constant motion, wind extends a light flag
	**4** 20-28 km/hr 11-16 knots	**Moderate Breeze** Raises dust and loose paper, small branches move
	**5** 29-38 km/hr 17-21 knots	**Fresh Breeze** Small trees sway, crested wavelets form on inland waters
	6 39-49 km/hr 22-27 knots	**Strong Breeze** Large branches move, Umbrellas hard to use
	**7** 50-61 km/hr 28-33 knots	**Near Gale** Whole trees move, breaks twigs off trees, difficulty walking against the wind.
	8 62-74 km/hr 34-40 knots	**Gale** Breaks twigs off trees, generally impedes progress
	**9** 75-88 km/hr 41-47 knots	**Strong Gale** Slight structural damage (eg. Chimney pots, roof tiles removed)
	**10** 89-102 km/hr 48-55 knots	**Storm** Seldom inland, trees uprooted, considerable structural damage

Figure 1 | Beaufort Wind Scale[61]

2.1.1.3 SEVERE STORMS (STRONG WIND)

2. Hazard frequency

Severe storms are atmospheric disturbances usually characterised by strong winds, with rain, flash flooding, hail, thunder and lightning, in various combinations. Severe storms are localised events, usually affecting smaller areas than tropical cyclones and floods, so their devastating impact is often underestimated. The speed and direction of wind is determined by atmospheric pressure and weather systems in a particular area.

Strong winds are more likely to occur during the summer months, with the prevalence of the South-Easter. Strong winds and gusts during winter months are usually caused by strong cold fronts, moving mostly over the southern half of South Africa. Another causal factor is the ridging of the high pressure systems behind the fronts; refer to figure below[62].

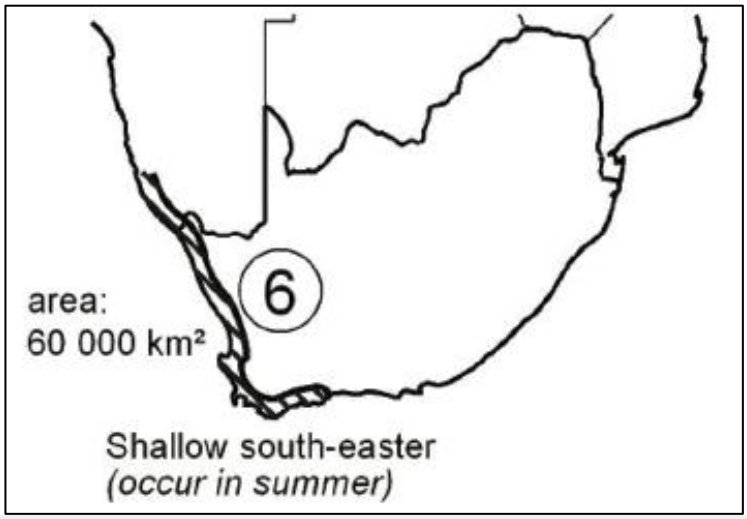


Figure 2| Spatial extent of strong winds on the West Coast[63]

3. Areas, communities or households most at risk

- Fishing and farming communities;
- Informal settlements;
- Enclosed areas such as bays e.g. Saldanha Bay[64];
- Coastal areas;
- Individuals that engage in microlighting;
- Coastal and gravel roads[65]; and
- Attendees at the Bergrivier LM highlighted Velddrif, the PPC in Piketberg and all the coastal towns as areas that experience strong winds.

4. Likely impacts of hazard

- In summer, strong winds promote fire and contribute to erosion;
- Damaging waves;
- Damage to infrastructure; and
- Sand-dune migration[66].

5. Level of risk for different situations and conditions (seasonality)

2.1.1.3 SEVERE STORMS (STRONG WIND)

The strength of south-easterly winds increases in summer[67] and according to Jacques Smith, Swartland LM, this increases the likelihood of experiencing strong winds[68].

The annual maximum wind gusts caused by the ridging of the Atlantic Ocean high pressure system are evident along the western and south-western Cape coasts and adjacent interior[69].

6. Conditions of vulnerability that increase the severity of the hazard

- Road structure can increase vulnerability i.e. gravel roads[70]; and
- A lack of thorough implementation of the national building regulations, the resulting weak informal dwellings and the material they are constructed from.

7. Capabilities or resources that exist to manage the risk

- Strong winds are generally predictable therefore it is possible to issue warnings to the public, and these warnings are generally received from SAWS[71].
- In the Saldanha Bay LM the role-players warn the public via Radio West Coast.
- South Africa is divided into strong wind climate zones, which indicate the main sources of annual maximum wind gusts. Wind gust data is recorded by 94 weather stations which has a continuous climate time series of 10 years or longer. All causes for wind gusts are recorded at all the weather stations[72].
- Strengthening of houses and other infrastructure to resist storms.
- Insurance

8. Risk increasing or decreasing in the WCDM

Risk increasing:

- Mild to moderate increase in wind velocity in summer, autumn, and spring.
- Moderate to strong increases in wind velocity in winter.

9. Impact the risk has on the development progress in the areas, communities and households it affects

No impact.

10. Secondary impacts within areas and communities affected by the risk

- Damage to infrastructure;
- Inhibits rescue operations in event of damaging waves[73]; and
- The South-Easter is associated with increased temperatures which form contributing factors for fires[74].

2.1.1.4 HEAT WAVE

1. Early Warning signals

- Heat cramps due to loss of water;
- Profuse sweating;
- Nausea;
- Vomiting;
- Headaches and/or light-headedness;
- Swelling of ankles;
- Inflammation of the skin; and
- Dehydration[75].

2. Hazard frequency

- A range of hazards associated with climate change will affect the livelihoods of people living in the West Coast region. This includes heat stress (the number of very hot days may increase).
- Heat waves were documented in the West Coast region in January 2012 with temperatures of up to 43°C with one labourer from Moorreesburg passing away[76].

3. Areas, communities or households most at risk

- The elderly.
- Infants and young children.
- Communities that have restricted access to potable water.
- The homeless.
- The sick.
- During the Bergrivier LM workshop attendees indicated that all inland areas, with the exception of coastal towns, experience high temperatures.

4. Likely impacts of hazard

- Heat waves can lead to dehydration, increased death rates from heart and respiratory diseases.
- Increased heat stress in livestock and wildlife.
- Increased susceptibility to crop burning.
- Increased threat to infrastructure (fires).
- The increase of anthropogenic and natural climate change will lead to reduced crop yields in warmer regions due to heat stress.
- Increases water demand and water quality problems.
- Increased risk of heat-related mortality - especially for the elderly, chronically sick, very young and socially isolated.
- Increased evaporation and decreased water balance.
- Increased severity of droughts.
- Increased prevalence and incidence of pests such as the fruit fly.
- Increased sea temperatures.

5. Level of risk for different situations and conditions (seasonality)

2.1.1.4 HEAT WAVE

- There are significant warming trends for minimum temperatures during December to March and July to September, and for maximum temperatures during January, May and August. In the West Coast District communities are more at risk during warmer seasons of spring (September – November) and summer (December – February).
- The regional climate is also influenced by coastal low pressure systems, resulting in hot, dry 'berg' winds, blowing from the interior and causing above normal warm conditions during late winter and spring.

6. Conditions of vulnerability that increase the severity of the hazard

- Communities that have restricted access to potable water.
- Impacts to consider are those that affect the agricultural sector and infrastructure. In terms of agriculture, an increase in minimum temperature increases crops' susceptibility to burning and pest infestations. The general trend for precipitation has been increased drying in the lowlands of the Western Cape and a wetting trend in the mountains. The effects tend to shorten the shoulder seasons i.e. autumn and spring. This poses a threat to the deciduous fruit sector translating to significant economic loss.

7. Capabilities or resources that exist to manage the risk

- The SAWS along with the Provincial and District West Coast Disaster Management Centre is responsible for warning residents and visitors of approaching heat waves with accompanying uncomfortable weather conditions[77].
- Some of the precautionary steps include:
  - Drinking sufficient amounts of water;
  - Trying to stay in a cool place;
  - Covering their heads with a hat or umbrella when going out;
  - Wearing sunglasses;
  - Wearing open-toed shoes;
  - Covering yourself with a UV SPF protector sunscreen;
  - Reduce time spent in the sun between 10h00 and 15h00. It is advisable to stay indoors during this time of the day if possible;
  - Pay close attention to any medications (including herbal remedies), as many of them have side-effects which include sun sensitivity;
  - Never leave children or pets unattended especially outside or in motor vehicles;
  - Visit adults at risk at least twice a day and closely watch them for signs of heat exhaustion or heat stroke; and
  - Refrain from throwing cigarette butts out of motor vehicle windows. This is often the cause of runaway fires, especially in hot and windy conditions.

Tips for Babies and Children

- Babies:
  - Ensure that the baby stays hydrated - mothers must remember to also drink a lot of water.
  - Take the baby to the clinic at the first sign of diarrhoea.
  - Keep babies in the shade or indoors.
  - Keep them cool by using a damp cloth to wipe them down.
  - Do not cover babies in a lot of clothing and blankets; light clothing is sufficient.
- Older Children:
  - Avoid sports activities if possible.

- Ensure that there is a lot of water and rehydration solution available.
- Ensure that children wear hats.
- Keep children indoors between 11h00 and 16h00[78].

- Reduction in the use of non-renewable sources of energy and increased use of renewable sources will undoubtedly decrease the emission of Greenhouse Gases (GHGs) substantially. This decrease in the GHGs will have a positive effect on the health and well-being of the people.
- Furthermore, switching to cleaner fuels and energy-efficient technologies will reduce local pollutants and therefore, have an added beneficial impact on health.
- For up-to-date weather reports concerned citizens can listen to alerts on the radio and television, or visit www.weathersa.co.za, or call the weatherline at 082 162.
- Any emergency and/or distress call can be reported to the 107 emergency hotline from a Telkom line, while cellphone users should dial 021 480 7700.

8. Risk increasing or decreasing in the WCDM

Risk increasing:

- A range of hazards associated with climate change will affect the livelihoods of people living in the region. This includes heat stress which means the number of very hot days may increase.
- A temperature trend analysis of data over 30 to 40 years for 12 meteorological stations were obtained from the Institute for Soil, Climate and Water. This analysis showed significant warming trends for minimum temperatures during December to March and July to September, and for maximum temperatures during January, May and August. In summary, very warm days have become warmer or have recurred more regularly during the last decade[79].
- Impacts to consider are those that affect the agricultural sector and infrastructure. In terms of agriculture, an increase in minimum temperature increases crops' susceptibility to burning and incidence of pests. Hewitson and Johnston[80] provide the example of Telkom infrastructure failure as a result of a heat wave in the Clanwilliam area.

9. Impact the risk has on the development progress in the areas, communities and households it affects

- Reduction in quality of life for people in warm areas without appropriate housing;
- Impacts on the elderly, very young and poor; and
- Increased illness and absenteeism.

10. Secondary impacts within areas and communities affected by the risk

- Increased health problems due to vector-borne diseases, contaminated food and water;
- Heat waves will affect a wide-range of species by changing trophic interactions, competition, epidemiology and habitat;
- Increased severity in drought;
- Decrease in relative humidity; and
- Climate change whose projections indicate two major trends: reduced days of precipitation and increased days of temperature inversion.

HYDRO-METEOROLOGICAL HAZARDS: WATER-RELATED

2.1.1.5 FLOODS

1. Early Warning signals

- Cut-off low systems and cold fronts.
- Mid-latitude cyclone couples with a second cold front.
- Prolonged, high-intensity rainfall.
- Violent thunderstorms of short duration cause flash floods.
- Warnings sent from SAWS to the District and/or Provincial Disaster Management Centre.

2. Hazard frequency

- The low-pressure systems bring winter rainfall to the West Coast district by means of a procession of cold fronts, when the westerly waves shift northward. Frontal systems sometimes result in cut-off low pressure conditions that may cause extreme rainfall events during spring and autumn[81].
- Probability: 2 (normal).
- Severity 2(moderate)[82].

3. Areas, communities or households most at risk

- In the Matzikama LM areas identified during the participative workshop includes Kapel, Cape Lime, Lutzville (the Sishen Railway line), the low water bridge in Lutzville and Wes road, and the Molriver road;
- Attendees at the Bergrivier LM workshop indicated that Piketberg, Goedverwacht and Velddrif are vulnerable to flooding. Especially the Bergriver municipality and Cederberg municipality are susceptible to floods as proven by the 2007 floods.
- The community of the informal settlement Middelpos, in Saldanha Bay, are exposed to floods due to structures that are built in low-lying areas with insufficient drainage;
- Farming communities - especially in the Citrusdal and Vredendal area[83];
- Areas situated downstream from the Doringriver and the Olifantsriver[84];
- The urban poor;
- Seasonal/migrant workers;
- Other low-lying areas with insufficient drainage;
- Floodplains of watercourses or areas above major underground infrastructure;
- Areas situated next to stormwater detention/retention ponds[85]; and
- Low lying mountainous areas that have recently burned, results in higher runoff and higher possibility for mudflows.

4. Likely impacts of hazard

Economic impacts	Environmental impacts	Social impacts
- After flooding, government resources are used for aiding or reconstruction, e.g., police force, fire control, aid workers, etc. This leads to greater financial loss to society; - Resources applied in reconstruction of roads, bridges, schools, water supply systems, soil rehabilitation etc.; and - Flooding exerts stress on sewage and stormwater systems and it is costly to restore	- Traffic (flooding will lead to the damages of roads, collapse of bridges or traffic congestion); - Damage to the farmland: loss of boundary fences; loss of soil on permanent crop land; - Damage to crops; soil erosion, inability to cultivate land due to water logging of soils; and	- Food security problems; - Flooding usually leads to infectious diseases: diarrhoea, cholera, waterborne diseases; drinking water quality problems; - Damage to cultural or heritage sites; - Loss of memorabilia; - Uninsured losses; - Depression, nervousness and

2.1.1.5 FLOODS

the damage to critical infrastructure such as water purification systems and sewage systems. The flood of 6-11 June 2007 and of 25-26 June 2007 resulted in damage costs of R128.3million. The flood of 4-9 July 2008 resulted in damage costs of R71.7million[86]. - The Flood Relief Scheme paid out R 9 868 609.56 since June 2008 to affected members of the West Coast (292 detail records)[87].	- Loss of agricultural crops[88].	anxiety in flood survivors; - Adverse effects on quality of surface and groundwater; contamination of water supply; - Drowning; and - Injuries[89].

5. Level of risk for different situations and conditions (seasonality)

- Usually a higher probability of occurrence during winter months from May to August.
- The low-pressure systems bring winter rainfall to the West Coast district by means of a procession of cold fronts, when the westerly waves shift northward. Frontal systems sometimes result in cut-off low pressure conditions that may cause extreme rainfall events during spring and autumn.
- Flash floods can also occur during periods of unexpected rainfall i.e. during summer.

6. Conditions of vulnerability that increase the severity of the hazard

- Communities/households that live below the flood line;
- Lower socio-economic classes. Due to communities' social and economic status they do not have the financial resources to have insurance against damage to their homes and belongings;
- Unemployment coupled with rapid coastal urbanisation;
- Inappropriate land use;
- Poor stormwater systems and drainage;
- Proper policies and framework are in place but due to limited funding, the upgrade, maintenance and extension of the current storm water system is restricted;
- Shortage of availability of flood lines; and
- Obstructions of rivers (for example by fallen trees) which causes flow restrictions and can potentially destroy bridges and roads[90].
- Inappropriate canalisation; and
- Deteriorating water quality[91].

7. Capabilities or resources that exist to manage the risk

- Risk assessments, to quantify the damage are conducted by the DoA in close collaboration with Agri Western Cape that conducts it through its farmer societies[92].
- Construction of flood resistant houses raised above the ground.
- Construction of raised food storage (granaries) facilities.
- Building of dams and reservoirs, dikes and levees, dongas and gully' retaining ponds, flood channels, and flood walls may assist to reduce flooding.
- Warnings issued timeously from SAWS.
- Good collaboration and communication of pre-warnings between stakeholders in the West Cape Province: The Provincial Disaster Management Centre; WCDM, the Department of Agriculture, SAWS and the Department of Water Affairs[93].

8. Risk increasing or decreasing in the WCDM

Risk increasing:

2.1.1.5 FLOODS

- The rainfall for the Doring River varies considerably over the catchment area with the main mountain range contributing towards the runoff including the Cederberg and Winterhoek Mountains[94].
- Informal dwellings in low-lying flood areas are erected on a yearly basis despite the knowledge of the risk.

Risk decreasing:

- As in the case of the repeated flood damage experienced by Chatsworth Jacques Smith of Swartland LM indicated that the municipality decreased the yearly damages by implementing better storm water systems and other drainage pipes in the affected community[95].

9. Impact the risk has on the development progress in the areas, communities and households it affects

Locating development in an area at risk from flooding can lead to property damage, human stress and hardship, problems obtaining property insurance and consequential demands for the expenditure of local authority or central government resources on flood protection works. The construction of protection works either at the time of the development, or at a later date, will incur additional costs, may not provide absolute immunity from the risk of flooding or can, if not appropriately designed, have detrimental effects on flood risk elsewhere.

10. Secondary impacts within areas and communities affected by the risk

- Increased risk of deaths, injuries and infectious, respiratory and skin diseases;
- Disruption of settlements, commerce, transport and societies due to flooding;
- Temporary education: setting up school facilities including sanitation facilities;
- Providing emergency plastic sheeting and food for water-logged communities;
- Providing water storage and extra blankets; and
- Psychosocial counselling required for the affected population.

2.1.2 GEOLOGICAL HAZARDS

COASTAL ZONE PROCESS RELATED

2.1.2.1 SAND DUNE MIGRATION

1. Early Warning signals

- Removal of vegetation through grazing, fire or building works will ultimately cause erosion problems. Especially lack of visibility on the frontal dunes.
- Eroding beaches are characterised by coarse sand and steeply sloping narrow berms that drop sharply into deep water.
- The removal of sand for building materials or agricultural use (sand mining).
- Uncontrolled and unauthorised beach access tracks and pathways through dune cordons can destabilise dunes, increasing their susceptibility to erosion and migration.
- Tracks caused by recreational vehicles such as motor bikes, cars or even horses and people often trigger sand drift and dune blowouts.

2. Hazard frequency

- Sand-dune migration is a slow onset hazard.
- More than 150 meters of beach has been lost at the northern beach of Langebaan since the 1960's, of which 50 meters have been lost in the past five years. The aggressive erosion has resulted in damage to seafront properties, many of which belong to residents from a disadvantaged background. There is potential loss of the town of Langebaan through the loss of an amenity and anticipated detrimental effects to the Ramsar site. In 1997 a 1.5 kilometre temporary rock revetment was constructed as an emergency measure which requires on-going maintenance[96].

3. Areas, communities or households most at risk

- Communities/households/buildings located close to the shoreline or on a low-lying topography; and
- Areas developed in close vicinity to the shoreline, especially those fronted by damaged or destabilised dune cordons.

4. Likely impacts of hazard

- If the vegetation is seriously damaged, it no longer acts to stabilise the sand and wind action will rapidly remove the exposed loose sand, forming a blowout. Once initiated, a blowout can spread rapidly and large areas of dunes can be affected, to the extent that blown sand becomes a major nuisance further inland.
- It causes major problems for landowners inland from the original dune system as sand covers roads, property or farming land. Similarly they can limit access and recreation.
- The creation of reflective rock walls, groynes and breakwaters to protect property on frontal dunes interrupts natural beach processes, sometimes increasing erosion risk, which often necessitates artificial replacement of sand.
- In severe situations dwellings close to the beach or cliff may be undermined by wave activity, causing property damage. Erosion may well continue along adjacent frontages leaving the revetment seaward of the general line of the shore and exposed to ever larger

2.1.2.1 SAND DUNE MIGRATION
waves. Again this may necessitate on-going extension and upgrade of the defences. • Destruction of natural vegetation. • Damage to or changes in dune systems can also leave coastal regions vulnerable to other coastal hazards, as a result of them acting as natural barriers to storm damage, inundation and erosion[97].
5. Level of risk for different situations and conditions (seasonality)
• The risk of shoreline erosion increases during a storm surge that is accompanied by strong winds.
6. Conditions of vulnerability that increase the severity of the hazard
• Coastal urbanisation due to a shortage of employment opportunities inland. • Climate change.
7. Capabilities or resources that exist to manage the risk
• By constructing two groyne structures on the shoreline in the Langebaan and Saldanha Bay area it is hoped to partially restore the beach through replenishment. It is proposed to construct the two groyne structures approximately 500 metres apart and it will be 350 metres in length. Partial replenishment is estimated to be 450 000 m^3, after which natural replenishment is expected[98].
8. Risk increasing or decreasing in the WCDM
Risk increasing: • An average increase in wind velocity is likely to increase across all seasons and notably in coastal areas. This projection is not related to frequency of windy days but to the strength of wind speed[99]. • Sand removal, although necessitated, may further destabilise dunes, causing further migration. Commercial and tourist features may also have to be abandoned in the future due to sand deposition, resulting in the loss of tourism revenue.
9. Impact the risk has on the development progress in the areas, communities and households it affects
Sand-dune migration will especially negatively impact coastline communities who do not have sufficient insurance.
10. Secondary impacts within areas and communities affected by the risk
Dune migration may negatively impact on the Sand Plain Fynbos habitat and the species that depend on it in the area.

2.1.2.2 SHORELINE EROSION (COASTAL EROSION)

1. Early Warning signals

- Foreshore elevation;
- Tidal range;
- Wave height;
- Historical erosion rate;
- Geology (type of rock or sediment);
- Geomorphology type (e.g. Rocky cliff or river mouth);
- Ground cover (e.g. forest/mangrove or urbanised/industrial);
- Wind velocity, duration, and the expanse of open water - the wind blows generating waves that attack and erode the shoreline;
- The loss of protective vegetation is a major trigger for shoreline erosion. This can be induced by grazing, fires, tracks (four-wheel drives, motor bikes, horses) and even foot traffic, and can exacerbate beach erosion[100]; and
- Coastal erosion occurs as a result of storms removing sediment from the normal swell beach profile, forming a storm beach profile. Storm beach profiles generally have gentler gradients as a result of eroded material often being removed from the berm and beach face and deposited in offshore bars[101].

2. Hazard frequency

- The severity of this loss will be dependent on coinciding phenomena such as storm events, equinoxes and spring high-tides[102].
- Sea level rise is most often not felt via the gradual advance of mean sea level, but by the increased frequency of storms and associated storm surge with the higher tidal regime. An analysis of sea level records over recent decades has shown evidence of an increase in extreme sea levels (i.e. those caused by storm surges) worldwide since 1975[103].

3. Areas, communities or households most at risk

- The coastline has many sandy areas that have high potential for erosion as a result of the high energy wave regime.
- Communities/households/buildings located on low-lying topography and situated very close to the high water mark of the coastline is vulnerable to coastal erosion.

4. Likely impacts of hazard

- Infrastructure that may be vulnerable to coastal erosion include roads, railways, electrical cables and substations, stormwater, sewerage and water pipes, coastal wastewater, sewerage treatment and landfill sites, certain harbour structures and coastal amenities. Damage to this infrastructure can have further impacts in that important economic activities might not be able to take place.
- The loss of beach through erosion and the lowering of the beach profile can result in new rip currents, undertows and exposed rocky areas, making previously public bathing beaches unsuitable for visitors and tourists.
- Due to natural coastal habitats already being so restricted, further erosion and shifting of these environments further landwards into developed areas may cause increased habitat and species loss.
- It could cause increased inundation and more frequent flooding of roads, railroads, and

airports, and could have major consequences for port facilities and coastal shipping.
- Destruction of coastal dunes which act as natural sea defence mechanisms[104].

5. Level of risk for different situations and conditions (seasonality)

- Shoreline erosion is an on-going process that has always occurred. It can happen under any conditions, but it tends to increase when waves are powerful and water levels are high, for instance during storm surges. Continued global warming will cause sea-level rise and increased intensity and frequency of coastal storms[105].
- While the coastline of South Africa is dominated by a sandy shoreline, those with low gradient coastlines are severely affected by erosion.
- Long period swell associated with winter storms has the greatest erosive effect, due to the deeper orbital motion of water particles in waves, which cause increased wave set-up and run-up along the beach and increases the amount of sediment that can be held in suspension.

6. Conditions of vulnerability that increase the severity of the hazard

- The extent of coastal erosion is generally dependent on four factors, namely geology and geomorphology of the coastline, the sediment type, wave climate (period, height and direction) and near shore bathymetry (especially coastline gradient)[106].
- Rainfall intensity - the size and velocity of rain drops is also an important factor;
- Soil structure and composition. Sediments containing more clay tend to be more resistant to erosion than those with sand or silt because the clay helps bind soil particles together;
- The amount of water present in the soil before the precipitation also plays an important role, because it sets limits on the amount of water that can be absorbed by the soil (hence prevented from flowing on the surface as erosive runoff);
- Loss of vegetative cover as the vegetation acts as an interface between the atmosphere and the soil;
- Climate change is expected to have a number of consequences which will detrimentally affect coastal resources. These include: higher sea levels; higher sea temperatures; changes in precipitation patterns and sediment fluxes from rivers; changed oceanic conditions; as well as changes in storm tracks, frequencies and intensities;
- The Southern African wave climate is characterised by high intensity storms. This often makes coastal settlements vulnerable to a variety of associated natural processes. This threat is of special concern considering that urban coastal zones are densely populated and growing rapidly[107];
- Narrow sand depleted bays and beaches, where wave energy is often focused:
  - beaches with a thin covering of sand over rock;
  - beaches where the natural defence mechanism in the form of vegetated dunes, offshore sand bars or reefs have been damaged or removed, or in the case with vegetated dunes replaced with alien vegetation;
  - beaches adjacent to inappropriate or damaged engineered sea defences;
  - beaches with development to close to the high-water mark or within the coastal dune cordon, due to a reduction in natural sand replenishment;
  - beaches with badly planned, inappropriate or poorly maintained stormwater systems;
  - coastal areas drained of groundwater, which results in a loss of sediment cohesiveness; and
- Poorly planned and inappropriate sea defences may cause further loss of sand, resulting in

beach degradation on site and to beaches and properties further along the coast[108].

7. Capabilities or resources that exist to manage the risk

- Reconstruction of adjacent dunes, or actions related to a gradual withdrawal and relocation of buildings and roads.
- Incorporating soft engineering techniques - building with natural processes in mind, relying on natural elements such as sand dunes, vegetation to prevent erosive forces from reaching the built environment, and the use of sandbags and beach nourishment schemes. Re-vegetating dunes with native vegetation.
- Resorting to 'hard' engineering techniques such as seawalls, groynes and revetments. Using permanent concrete and rock constructions to "fix" or consolidate the coastline and protect the inland assets from wave action.
- Planning for existing and future coastline change by positioning all new development (large and small) a 'safe' distance landward of the vegetation line.
- Providing for improved beach cleaning through government and private initiatives, education and awareness efforts, and proper sewage disposal.
- The WCDM is in the process of compiling a Coastal Management Plan (CMP) for the West Coast District Municipality area as required by Section 49 of the Integrated Coastal Management (ICM) Act. Part of the CMP is to develop a Coastal Management By-law to regulate the activities with a view to protecting the coastline. It will legislate the establishment or change of coastal setback lines[109].
- The WCDM developed Estuary Management Plans for the West Coast District (Berg River, Verlorenvlei and Olifantsriver). These estuaries must be managed holistically and any development that must take place should not have a negative impact on the environment[110].
- The National Environmental Management Act (No. 107 of 1998) requires the appointment of an environmental practitioner to undertake a basic assessment for construction or earth moving activities in the sea or within 100 metres inland of the high-water mark of the sea; the prevention of the free movement of sand, including erosion and accretion, by means of planting vegetation, placing synthetic material on dunes and exposed sand surfaces within a distance of 100 metres inland of the high-water mark of the sea[111].

8. Risk increasing or decreasing in the WCDM

Risk increasing:

- Coastal zones are rapidly becoming densely populated which increases the risk of erosion.
- The most important drivers of risk to coastal infrastructure from erosion are waves, tides and future sea level rise. It is the combination of extreme events (sea storms occurring during high tides in conjunction with sea level rise) that will have the greatest impacts and will be the events that increasingly overwhelm existing infrastructure[112].
- Coastal erosion accelerates as the sea level rises. Climate change will likely cause an increase in the intensity and frequency of coastal storms, and with associated sea-level rise cause an increase in coastal erosion, increasing the risk to human life and the natural and built environments.
- Following a storm event the beach profile is out of equilibrium, and attempts to return to its original swell profile shape and position. However, reduced sand availability (often as a result of human development within the coastal zone) prevents beach building from happening, and even normal, constructive waves cause further coastal erosion[113].

2.1.2.2 SHORELINE EROSION (COASTAL EROSION)

9. Impact the risk has on the development progress in the areas, communities and households it affects

- As the coastline is remapped by erosion property along the coast is at high risk of damage or destruction.
- Some properties that are destroyed by coastal erosion are priceless historic landmarks.
- Sand plain Fynbos is highly vulnerable to coastal erosion.

10. Secondary impacts within areas and communities affected by the risk

The tourism industry can be heavily impacted by coastal erosion. Many communities rely on revenue from summer tourism. When beaches are swept away, these communities can be financially devastated.

EARTHQUAKE RELATED

2.1.2.3 SEISMIC HAZARDS

1. Early Warning signals

The abruptness, apparent irregularity and infrequency of earthquake occurrences support a common perception that earthquakes are random unpredictable phenomena[114].

The U.S. Geological Survey (USGS) is developing an Early Warning System (EWS) for the west coast of the United States, based on existing seismic networks to detect moderate to large earthquakes. Depending on the location of the earthquake a warning 60 seconds prior to the arrival of the strong shaking can be issued.

South Africa does not have a dense seismic network or a EWS for earthquakes. The country is viewed as relatively stable in terms of seismic activity, where 80% of earthquakes are caused by mining. This current scenario emphasises the importance of awareness to mitigate the impacts of seismic events.

As can be seen from the figure below, very little warning time can be given for a seismic event[115].

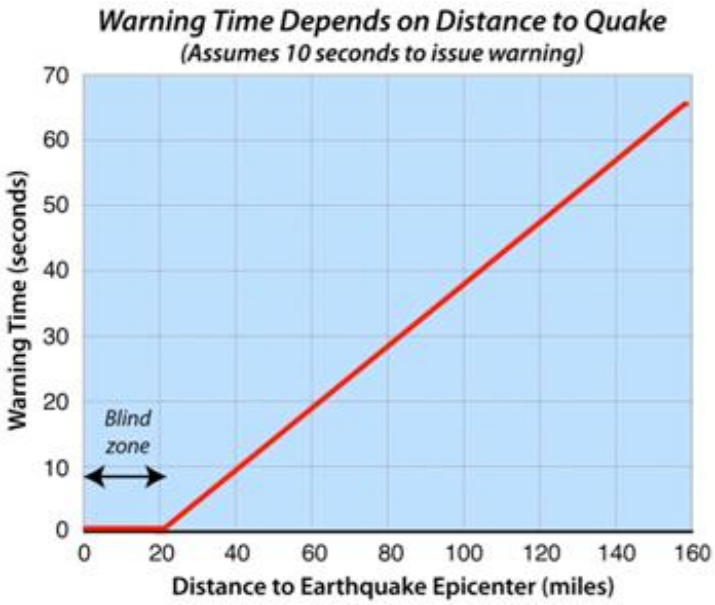


Figure 3 | Warning time vs. distance to earthquake[116]

2. Hazard frequency

- Seismic activity in the earth's history is largely unknown therefore a great deal of uncertainty exists regarding the frequency of seismic activity[117].
- As early as 1620 earth tremors have been recorded in the southwestern Cape. Between 1620 and 1971, 73 tremors were recorded, with at least seven of these tremors considered to have had local magnitudes between 5.1 and 6.5. The first 300 years of this catalogue contains approximately 23 tremors while 53 tremors were recorded in the last 50 years. This does not suggest increased seismicity in the area but rather improved record keeping following 1920[118].

3. Areas, communities or households most at risk

2.1.2.3 SEISMIC HAZARDS

- Ground motion is amplified on sand, low-lying sandy areas are vulnerable to seismic hazards.
- Poorly built structures as found in informal structures, as well as critical infrastructure e.g. hospitals, dams, main roads, fuel pipelines, railways and water mains are at risk[119].
- South Africa is generally classified as a stable continental region, bounded to the northeast by the East African Rift System. The tectonic provinces, illustrated in the figure below, include the Kaapvaal Craton which is separated from the Zimbabwe Craton to the north by the Limpopo Mobile Belt, and from the Cape Fold Mountains to the south by the Namaqua-Natal Mobile Belt[120]. These areas are considered to be most at risk. In an opinion piece by Science in Africa, Hartnady suggests that a major earthquake disaster in South Africa is inevitable because wide areas of southern Africa are affected by the slow southward spread of the East African rift system[121].
- The Tulbagh earthquake of 1969 is known as the most destructive earthquake in South Africa's history. The WCDM is at risk due to the area's proximity to this particular fault.

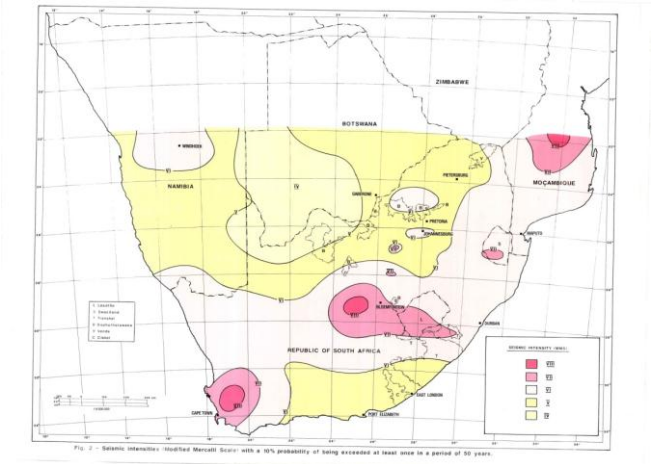


Figure 4 | Seismic Intensities, Southern Africa[122]

4. Likely impacts of hazard

The likely impacts of seismic activity are illustrated in the figure below:

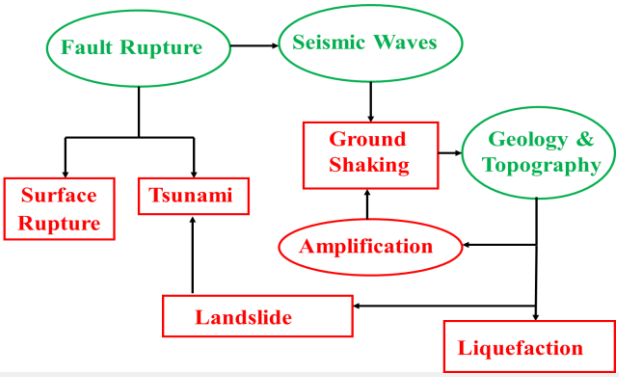


Figure 5 | Likely impacts of seismic activity[123].

Each of these impacts may lead to:

2.1.2.3 SEISMIC HAZARDS

- Damage to infrastructure;
- Slope failure;
- Social disruption[124];
- Economic losses; and
- Injury/death[125].

5. Level of risk for different situations and conditions (seasonality)

- The combination of ground shaking and rain may lead to landslides in mountainous areas[126].

6. Conditions of vulnerability that increase the severity of the hazard

- Location of structures in relation to active faults (i.e. distance from source);
- Nature of buildings/homes;
- Underlying geology;
- Soil profiles (ground motion amplified on sand);
- Site response; and
- Critical infrastructure[127].

7. Capabilities or resources that exist to manage the risk

- Scientists (Geologists/Seismologists etc.);
- Engineers;
- Sensitive buildings may have automated shut-down sequences e.g. Koeberg;
- Authorities (Town council, Local Government);
- Disaster Management; and
- Available financial resources[128].

8. Risk increasing or decreasing in the WCDM

Earthquake risk depends on population density, construction standards (building codes) and emergency preparedness. Therefore, as population density increases in an area, the risk also increases. In addition, most new structures are not considering seismic hazard in their designs[129].

9. Impact the risk has on the development progress in the areas, communities and households it affects

No.

10. Secondary impacts within areas and communities affected by the risk

- Pollution;
- Fire;
- Food and water shortages;
- Inhibited access and communication; and
- Limited services.

2.1.3 BIOLOGICAL HAZARDS

2.1.3.1 ANIMAL DISEASES

1. Early Warning signals

- Presence of the infective agent and vector (agent of transmission) in the area. See the table below for a summary of all the animal diseases prevalent in the WCDM.

Animal disease	Definition	Symptoms
African Horse Sickness (AHS)	This is a highly infectious non-contagious, vector born viral disease affecting all species of Equidae (cattle, pigs, sheep, and goats). It is endemic (occurs naturally) on the African continent.	Respiratory and circulatory damage, accompanied by fever and loss of appetite. AHS manifests in three ways, namely the lung form, the heart form and the mixed form.
Avian Influenza (AI)	AI caused by the influenza virus type'A', can affect several species of food producing birds (chickens, etc.), pet birds and wild birds with some strains resulting in high mortality rates.	Symptoms are minimal and include signs of depression, ruffled feathers, lack of appetite and fever. Hens may at first lay soft-shelled eggs, but soon stop laying eggs.
Newcastle Disease (ND)	Newcastle disease (ND) is a highly contagious and often severe disease found worldwide that affects birds including domestic poultry.	Symptoms depend on the strain of virus, species of bird, concurrent disease and pre-existing immunity. Include: Respiratory: sneezing, gasping for air, Digestive: diarrhoea; Nervousness, depression, muscular tremors, drooping wings, twisting of head and neck, circling, complete paralysis; Partial to complete drop in egg production and thin-shelled eggs; Swelling of the tissues in the eyes and in the neck.
Oroptic scabies (sheep scab)	Sheep scab is a disease where affected flocks are subject to quarantine and dipping regulations.	Symptoms include biting and scratching brought on by intense itching. When large areas are involved, animals gradually become emaciated and suffer from anaemia. It occurs almost exclusively on the woolly parts of the body where it produces large, scaly, crusted lesions.
Porcine Reproductive and Respiratory Syndrome (PRRS)	PRRS, also named blue ear disease, is a widespread disease affecting domestic pigs.	It is characterized by reproductive disorders (late-term abortions, stillborn, mummification, high piglet mortality, and respiratory disease.
Rabies	Rabies is a viral disease that affects the central nervous system of warm-blooded animals, including humans. Rabies is transmitted to the victim in the saliva when bitten by an infected animal.	The virus infects the brain and symptoms appear after 2 to 8 weeks. Symptoms include a change of behaviour, staring at the sky, salivation, deprived appetite, chewing stones, cowering, snapping, paralysis of the lower jaw and tongue. Infected dogs lose territorial instincts and wander aimlessly, fighting and biting whatever crosses their path.
Rift Valley Fever (RVF)	RVF is an acute viral zoonosis that can cause severe disease in domestic animals (such as, cattle, goats and sheep) and humans.	It is a mosquito-borne viral disease characterized by a short incubation period, fever, hepatitis, abortion, and death in young animals. Symptoms in these species are characterized by fever, severe illness, abortions, and a high morbidity and mortality rate.
Salmonellis	This a bacterial disease caused by strains of Salmonella. It occurs in animals and humans. Foods involved include meat, poultry, eggs and egg products[130].	With poultry, most Salmonella infections are without symptoms. In humans symptoms include abdominal cramps, diarrhoea, nausea, vomiting, headache, fever, chills. Symptoms usually show 20-48 hours after ingestion of contaminated food[131].

2. Hazard frequency

- In May 2010 there was an outbreak of Newcastle disease on a farm outside Darling.
- In March 2011 the Mamre area was declared as a Foot and Mouth Disease (FMD) area and

all horse movement was embargoed. Including donkeys, mules and zebras[132].

- In October 2012 there was an outbreak of Rift Valley fever in the West Coast.
- According to Dr Sewellyn Davey it is too complex to rate the severity or probability of the outbreak of animal diseases within the borders of the WCDM.

3. Areas, communities or households most at risk

- The most likely vectors to have introduced Avian Influenza (AI) into the Western Cape ostrich population are the wild waterfowl. The recent outbreak in the Western Cape Province was confirmed to be a "drop out of the sky" incident. Birds to worry about include Egyptian Geese and Water Fowl. They are attracted to feeding troughs and also graze in ostrich pastures during winter, bringing the two birds into direct contact with each other. This suggests that mature ostriches could act as mixing vessels for strains of AI without showing clinical symptoms. The outbreak of a high pathogenic strain of AI is of enormous concern for commercial chicken farms.
- A higher population density suggests that the risk and incidence of outbreaks increases which means that communities in large towns in the West Coast district are more vulnerable. Communities in Malmesbury, Vredenburg and Langebaan are particularly vulnerable where the vast majority of human infections result from direct or indirect contact with the blood or organs of infected animals.
- Smallholding farms are also at a larger risk of suffering negative consequences because of the outbreaks of animal diseases[133].
- Domestic fowls, turkeys, pigeons and parrots are susceptible to Newcastle Disease (ND). A milder strain of the virus is seen in ducks, geese, pheasants, quail, guinea fowl and canaries. Furthermore, ND spreads rapidly among birds kept in confinement, such as commercially raised chickens.
- Young lambs, kids, calves, and puppies are highly susceptible to Rift Valley Fever (RVF). Significant morbidity and mortality occurs in sheep, cattle, and man. There is some evidence that humans can also become infected by ingesting the unpasteurized or uncooked milk of infected animals.
- Rabies is a disease that affects all warm-blooded animals. Dogs and bat-eared foxes are the most common carriers and humans, other dogs and cattle are the most important victims. Inquisitive children and livestock will approach a sick looking animal, only to be bitten viciously. Rabies has been especially predominant in the Piketberg and Darling area.
- AHS is endemic in South Africa and the morbidity and mortality are highest in the young equinae, however the West Coast is historically not an endemic area. Natal and Gauteng, where there are large horse race events, are at a higher risk. The West Coast District is known as the surveillance zone where horses are supposed to be "susceptible" to African Horse Sickness. This buffer zone stretches from Bergriver to Velddrif. The outbreak in 2011 in Mamre was a serotype strain from Upington[134].
- People with socio-economic problems and Human Immunodeficiency Virus (HIV) immune-compromised individuals are further susceptible to contracting animal diseases.

4. Likely impacts of hazard

- The Western Cape lost its FMD Free Status after an outbreak of AHS in 2011. Losing this status meant that no meat exports was allowed to countries of the South African Developing Community (SADC). AHS had other huge trade implications such as that the sale of stud animals between South Africa and Namibia was prohibited. This had direct financial

implications. On 29 October 2012 the National Department of Agriculture approached the World Organisation for Animal Health (OIE) to lift the ban. Furthermore, the majority of horses in Mamre were keep horses and the death of 90 horses was a tremendous social loss to the local community.

- For ND it leads to the destruction of potentially infected birds, and disposal of destroyed birds and potentially contaminated or infected products. The export of poultry and poultry products is suspended if an outbreak is suspected or confirmed.
- The outbreak of RVF in the Western Cape impacted tremendously on the export of animal products (skins and wool), because China as the biggest importer no longer allowed the import of skins. This saw the number of exports decrease. The disease also results in significant economic losses due to death and abortion among RVF-infected livestock.
- AI is a zoonotic disease and can cause death in humans. It can have severe local effects, causing major losses to production and loss of livelihoods of vulnerable people. This means that long term financial losses are expected due to the costs involved in controlling the outbreak. The risk of the movement of migratory birds that can potentially spread the virus to other provinces and countries. The resulting widespread outbreak of the disease could affect trade and poultry production on a global scale.
- Salmonella infection is a public health concern. Many strains of Salmonella are zoonotic agents, spreading to humana from contaminated animal origin food products. In humans, Salmonellosis is one of the most common causes of food poisoning.
- Rabies can cause infection or death in humans[135].

5. Level of risk for different situations and conditions (seasonality)

- During the winter colder weather helps to slow down the spread of the AHS virus, as the virus replication and the vector multiplication are both inhibited. The most important vector in endemic areas is a biting midge which prefers warm, humid conditions. Most animals become infected in the period from sunset to sunrise, when the midges are most active and during the warm, rainy season when midges are plentiful.
- The PRRS virus can be spread through the semen, urine, faeces and possibly as an aerosol under conditions of high humidity, low temperatures and low wind speeds.
- ND can survive for several weeks in a warm and humid environment on bird's feathers, manure and other materials. The virus can survive indefinitely in frozen material; however, the virus is destroyed rapidly by dehydration and by the ultraviolet rays in sunlight[136].

6. Conditions of vulnerability that increase the severity of the hazard

- Human infection with ND is extremely rare and usually occurs only in people who have close direct contact with infected birds - for example, poultry processing workers, veterinarians or laboratory staff[137].
- The following aspects are of crucial importance in judging the risk of specific pathogens to cause an outbreak of disastrous proportions:
  - Infective dose (number of organisms required to cause infection);
  - Pathogenicity (ability of the pathogen to produce disease, measured by the percentage of persons exposed to the pathogen who will develop the disease);
  - Infectivity (the ability of the pathogen to invade the host such as a human or animal);
  - Virulence (an indication of the severity of the disease);
  - Incubation period (time between entry of the pathogen into the host and the appearance of the first sign or symptom of the disease. This can vary from a few hours

to weeks or even years); and
- Condition of the host (persons who are not in good health because they are already burdened by malnutrition, other diseases, poor housing and sanitation, etc. are more susceptible to infection).

- Broiler chickens are vaccinated against ND, but a week before they get slaughtered they are not allowed be vaccinated which in turn increases their chance of contracting the virus and leads to a high mortality rate.
- AHS is a very serious disease because of the high death rate in affected horses. There is no effective treatment for the disease and medicine to treat the symptoms is very costly. Once treatment is administered performing horses cannot be trained as the horse needs absolute rest and a gradual return to activity. The likelihood that AHS will spread increases where no pre-notification movement form has been received by the veterinarian and there are no vet-checks.
- To curb the outbreak of AI farmers need to make their waterholes "water unfriendly water" so as not to attract disease-carrying migratory birds. The cost implications for farmers (both for the water and testing) increase their inability to continue farming.
- PRRS is spread because of a lack of supervision of food that is fed to pigs from harbours. For smallholder farmers the general lack of knowledge/awareness regarding the spread of PRRS impacts on industry as it institutes a trade barrier. So the contamination of pigs continues to occur because of the middleman that operates between ships and pig farms to provide the pig farms with contaminated shoal from the ships[138].

7. Capabilities or resources that exist to manage the risk

- Department of Agriculture, Forestry and Fisheries (DAFF) - Directorate Animal Health has a myriad of contingency plans and emergency procedures to follow to prevent and manage the possible outbreak of animal diseases within the border of the Western Cape.
- For the outbreak of AI there is a low pathogenic occurrence in the WCDM. In case of an outbreak the farm is placed under quarantine; all adjacent farm borders are monitored for their movement; and each consignment of ostrich meat gets tested before it is sent to the market.
- All buffaloes in the West Coast District need to be registered with the DoA.
- For FMD the DoA places immediate control measures in place. This includes ring vaccination within 10 kilometres of confirmed cases as well as the institution of a movement control zone which prevents unauthorised horse movement through, into and out of the relevant magisterial district.
- Industry actively collaborates and supports the DoA in the control of any animal disease outbreaks. This includes role-players from Racing, Onderstepoort and other relevant animal associations.
- The DoA implements surveillance on breeder and lay farms where they test for salmonella as virus-bearing material can be traced on shoes and clothing. Poultry will only be exported to SADC and the local market after the test results come back negative.
- Dogs and cats need to be regularly vaccinated against rabies. Within the WCDM there are a number of dogcatchers and organisations that assist the municipalities in mitigating rabies.
- A vaccine for AHS is available for use in South Africa. However, its use is not permitted in the AHS-free or surveillance zone of the Western Cape Province. To obtain the vaccine in these zones, the Director: Veterinary Services of the Western Cape must be requested to give written permission. In addition, there are strict rules for taking horses, mules and donkeys into the Western Cape Province. Currently there is a ban on selling horses from South Africa

to other countries. A submission is being completed to have the ban lifted (this includes steps of sampling, testing and surveillance).

- For PRRS, immediate control measures will be instituted, which includes strict quarantine measures on the affected farm, movement controls, and limited controlled slaughter of pigs under strict biosecurity measures which includes abattoir hygiene measures. Sometimes it will be necessary to slaughter the remaining animals on the known affected properties. An incentive will then be paid to the affected farmers to forfeit their animals to the state for controlled slaughter and is subject to an undertaking of thorough disinfection of the farms and delay of repopulation for at least 6 weeks after the last positive pig was removed from the area[139].
- Sheep scab is treated as a controlled disease.
- Legislation applicable to the mitigation and response to the outbreak of animal diseases includes:
  - Veterinary Procedural Notices (VPNs)
  - Vaccinate your dog and cat. Beware Rabies kills! Department of Agriculture booklet
  - The Animal Diseases Act (Act No 35 of 1984)
  - The Meat Safety Act 40 (Act 40 of 2000)
  - Identification of animals in terms of Animal Identification Act (Act No. 6 of 2002).
  - The Meat Inspectors Manual Abattoir Hygiene Directorate: Veterinary Services Veterinary Public Health, National Department Of Agriculture Republic Of South Africa January 2007.
  - The Guide for the Medical, Veterinary and allied Professions 2010.

8. Risk increasing or decreasing in the WCDM

The transmission of AI from ostriches to chickens in the West Coast District is unclear as ostrich and commercial poultry productions are separate. Health experts are concerned that the co-existence of human flu viruses and avian flu viruses (especially H5N1) will provide an opportunity for genetic material to be exchanged between species-specific viruses, possibly creating a new virulent influenza strain that is easily transmissible and lethal to humans[140].

9. Impact the risk has on the development progress in the areas, communities and households it affects

- Loss of income;
- Loss of animal stock; and
- An outbreak such as AHS posed both to be an environmental hazard and a public health risk[141].

10. Secondary impacts within areas and communities affected by the risk

- The spread of crop pests;
- The outbreak of disease epidemics; and
- Resulting food insecurity.

2.1.3.2 HUMAN DISEASES

1. Early Warning signals

- Early warning signs include the presence of the infective agent and vector (agent of transmission).
- From the Health Data Advisory and Co-ordinating Committee (HDACC) the following cause-specific mortality rates were used for the Western Cape Mortality Profile 2009:
  1. Major infectious diseases (AIDS, Tuberculosis (TB), diarrhoea and pneumonia combined);
  2. Cardiovascular and metabolic diseases (including stroke and diabetes);
  3. Cancers;
  4. Chronic respiratory diseases (asthma, Chronic Obstructive Pulmonary Disease (COPD), other respiratory); and
  5. Injuries[142].
- Common symptoms of active lung Tuberculosis are cough with sputum and blood at times, chest pains, weakness, weight loss, fever and night sweats.
- The most important behavioural risk factors of heart disease and stroke include unhealthy diet, physical inactivity, tobacco use and harmful use of alcohol. Behavioural risk factors are responsible for about 80% of coronary heart disease and cerebrovascular disease.
- The symptoms of Human Immunodeficiency Virus (HIV) vary depending on the stage of infection. Though people living with HIV tend to be most infectious in the first few months, many are unaware of their status until later stages. The first few weeks after initial infection, individuals may experience no symptoms or a flu-like illness including fever, headache, rash or sore throat[143].

2. Hazard frequency

- There were an estimated 462545 deaths in the Western Cape in 2009 with deaths in the West Coast accounting to 2894 deaths (6.3%).
- Leading causes of death in the West Coast District include:
  - Ischaemic heart disease 304 (10.5%);
  - Tuberculosis 299 (10.3%);
  - Cerebrovascular disease 238 (8.2%);
  - HIV/AIDS 215 (7.4%);
  - Diabetes mellitus 148 (5.1%);
  - COPD 143 (4.9%);
  - Lower respiratory infections 128 (4.4%);
  - Trachea/bronchi/lung 128 (4.4%);
  - Transport injuries 112 (3.9%); and
  - Hypertensive heart disease 105 (3.6%)[144].

3. Areas, communities or households most at risk

- Of these 2894 deaths 1676 fatalities occurred in the male population and 1218 fatalities accounted for in the female population.
- The highest HIV prevalence estimates remain amongst the age groups of 25- 34 years.
- The worst affected areas within the region in terms of transmission rates of HIV in infants are Matzikama LM (12%) and Bergriver LM (8.8%) with Saldanha LM and Swartland LM the lowest at 3.8% and 0.0% respectively[145].
- Specific areas identified in the Matzikama LM, during the participative workshop, includes all farming communities in the Trawal, Klawer, Bitterfontein and Rietpoort area.

2.1.3.2 HUMAN DISEASES
• Children, adults and the elderly are all vulnerable to the risk factors that contribute to noncommunicable diseases, whether from unhealthy diets, physical inactivity, exposure to tobacco smoke or the effects of the harmful use of alcohol.
4. Likely impacts of hazard
• Illness; • Absenteeism; and • Death.
5. Level of risk for different situations and conditions (seasonality)
• Changes in mean climatic conditions and climate variability also can affect human health via indirect pathways, particularly via changes in biological and ecological processes that influence infectious disease transmission and food yields. • Patterns of winter mortality and infectious disease with regards to the cyclic influenza outbreaks occur in late autumn, winter and early spring. This disease pattern may result from increased likelihood of transmission due to indirect social or behavioural adaptations to the cold weather such as crowding indoors. • Epidemics of other infections (e.g. meningococcal meningitis) tend to erupt during the hot and dry season and subside soon after the beginning of winter. • Disease carrying vectors may adapt to changes in temperature by changing geographical distribution. An emergence of malaria in the cooler climates of the African highlands may be a result of the mosquito vector shifting habitats to cope with increased ambient air temperatures[146].
6. Conditions of vulnerability that increase the severity of the hazard
• Concurrent HIV infection is the biggest risk factor for TB. • Social factors include behavioural activities such as increased trade and travel, sexual practices, food consumption patterns, new medical practices, mass migrations of people, human conflict and the deliberate use of pathogens for hostile purposes. • Political factors govern public health access and allocation of resources, including access to prevention programs, prophylaxis, and post-exposure treatment interventions. Additionally, international political factors can have an impact, including limited or non-existent educational programs to support detection, identification and verification, and response, as well as limited or non-existent information technology and telecommunications infrastructure to establish surveillance links with high-risk areas of the globe. • Economic factors arise from insufficient financial investment in research and development to produce interventions, procedures, processes, technology and training. Additionally, economic factors include insufficient support for a large number of beneficial programs including public-private partnerships, market incentives to develop interventions for “neglected” diseases such as malaria, research into disease pathogenesis, notification of outbreaks, infection control programs and technology, and training of health care professionals and laboratory and field researchers. • Tobacco use, alcohol use, unhealthy diet and physical inactivity are the main cancer risk factors worldwide. Chronic infections from hepatitis B (HBV), hepatitis C virus (HCV) and some types of Human Papilloma Virus (HPV) are leading risk factors for cancer in low- and

middle-income countries. Cervical cancer, which is caused by HPV, is a leading cause of cancer death among women in low-income countries[147].

- Environmental degradation, due to climate change, leads to reduced quality of life and productivity.
- At the Bergrivier LM workshop, attendees indicated that influx of seasonal workers and prison inmates contributes to the spread of diseases and infections that is usually unfamiliar to the area. It was also noted that the legality of the patient's confidentiality creates a possible scenario where viruses/diseases can spread in already vulnerable and exposed communities.

7. Capabilities or resources that exist to manage the risk

- Within the WCDM there appears to be an equitable spread of facilities given the capacity of individual municipalities:
  - Saldanha Bay LM has the majority of fixed/permanent structures accounting for eight Clinics and one District Hospital;
  - Cederberg LM followed by Matzikama LM follows closely with six and four clinics respectively. Cederberg displays zero satellite clinics as opposed to Matzikama's five but compares favourably with five mobile clinics compared to Matzikama's four;
  - Swartland LM also compares in equal measure to neighbours Cederberg and Matzikama with five clinics, seven satellite clinics and four mobile clinics; and
  - Bergrivier LM displays the lowest number of health facilities with a notable 3 clinics across the municipality, the lowest within the West Coast District.
- In total the primary healthcare facilities for the West Coast District include: 26 clinics, 24 satellite clinics, 19 mobile clinics and 7 district hospitals.
- The Antiretroviral Treatment (ART) Patient Load has increased by 1 056 from June 2010 to June 2011 while the number of ART sites has also increased substantially from 4 to 17 for the same period across the West Coast. The Swartland Municipality displays the largest ART patient load as well as the second largest increase (267) in this category after Saldanha (302).
- The West Coast District has achieved an immunisation rate of 101.2%. This is the highest in the Province and also well above the 90% benchmark set by the National Department of Health.
- In relation to malnutrition the District has performed well with the lowest number of malnutrition cases (54) in the Western Cape Province. This serves as further indication of the attention to primary welfare of the District's citizens especially that of the infant segment of the population.
- Zero maternal deaths and a moderate teenage delivery rate of 8.45% further strengthen the robust performance of the West Coast District's healthcare system particularly in the areas of immunisation and maternal rates. Teenage delivery rates appear largest in Bergrivier (11.1%), Matzikama (9.2%) and Swartland (9.0%)[148].

8. Risk increasing or decreasing in the WCDM

Risk increasing:

- Cardiovascular diseases, diabetes death rates and injury are high in the West Coast District.

2.1.3.2 HUMAN DISEASES
• Ischaemic heart disease death rates are the highest in West Coast District. • In the Western Cape Cerebrovascular lung cancer was the most common cancer followed by prostate, breast, colon-rectal, cervix and oesophagus cancer. • Drowning rates are highest in the West Coast. • The leading causes of premature mortality is Tuberculosis (12.4%) and HIV/AIDS (10,2%). Risk decreasing: • Of injury death rates due to interpersonal violence as it is the lowest in West Coast[149].
9. Impact the risk has on the development progress in the areas, communities and households it affects
• Human diseases can cause serious public health and economic problems; • Epidemics can result in high levels of worker absenteeism and productivity losses; • In communities, clinics and hospitals can be overwhelmed when large numbers of sick people appear for treatment during peak illness periods; and • In low-resource settings, health-care costs for caring for people living with HIV/Aids, cardiovascular diseases, cancers, diabetes or chronic lung diseases can quickly drain household resources, driving families into poverty[150].
10. Secondary impacts within areas and communities affected by the risk
• Loss of livelihoods due to morbidity; • Isolation; and • Psychosocial trauma.

2.2 TECHNOLOGICAL HAZARDS

TRANSPORT INCIDENTS

2.2.1 ROAD ACCIDENTS

1. Early Warning signals

- Road traffic signs indicating a high accident zone or the speed limitations in that area.

2. Hazard frequency

- The N7 as an abnormal route that transverses the WCDM and it carries abnormal heavy loads.
- Probability: 3 (likely);
- Severity: 2 (moderate)[151].

3. Areas, communities or households most at risk

- The road traffic accident death rate for males is more than two and half times that for females;
- Pedestrians and public transport passengers between the ages of 19 – 29;
- Street vendors[152];
- By 27 December 2012 from the total of 147 people deceased 41% of the fatalities were passengers and 34 % pedestrians. The age distribution of these passengers are 36% for 18 and under and 27% for passengers aged 31 and older;
- During the Matzikama LM workshop the R363 between Vredendal/Lutzville and Vredendal/Klawer was highlighted as a high accident zone. The N7 between Trawel/Klawer and the R27 between Vanrhynsdorp/Vanrhynspas were also identified as high risk areas;
- At the Bergrivier LM workshop the R399 between Velddrif and Piketberg was highlighted as a high risk zone;
- Jacques Smith indicated that the Klipheuwel road, the Paardeberg road, the Darling road, the R27 and the N7 are all critical areas in the Swartland LM[153]; and
- In the Saldanha Bay LM the road at the weighbridge in Vredenburg is a critical area with St Helena Bay and Velddrif also two towns that experience a number of road accidents.

4. Likely impacts of hazard

- Injury levels vary from slight, serious to fatalities of drivers, passengers and pedestrians; and
- Loss of load[154].

5. Level of risk for different situations and conditions (seasonality)

- Generally, road accidents and injury/death rates are the highest in December and lowest in January and February. During the month of December there is a lot of traffic on the roads due to national school holidays. The influx of tourists, individuals unknown with the area, further increases the high incidence of road accidents during this period.
- In the Matzikama LM seasonal traffic is experienced on the Strandfontein road and the R27 between Vredendal's Voortrekkerweg and Bultweg.
- Light conditions have an effect on the number of reported motor accidents with the majority

of serious accidents occurring during dawn/sunrise.

- During night time where the streets are unlit accidents involve pedestrians or animals.
- Road accidents occur predominantly from 19h00 – 23h00 where head-on accident occurs as a result of negligence or a loss of control on the driver's part[155].
- During the week fatal crashes occur on Thursday evening, Friday, Saturday and Sunday.
- During the winter months, especially June and July, the fog on the N7 makes it a particular hazardous road[156]. Mist on the roads adjacent to the coastline also contributes to poor sight and a high accident statistic.

6. Conditions of vulnerability that increase the severity of the hazard

- Rock fall is likely in the Piekenierskloofpas. Combined with heavy rain it makes this area especially hazardous;
- Conditions of road: sharp bend, poor road surface and visibility;
- Negligence including turning into oncoming traffic;
- Unmarked tar roads;
- Long distance traveling;
- Speeding too high for condition;
- Pedestrian jay walking and a lack of pedestrian visibility - pedestrians are unwilling to use safer South African National Roads Agency Limited (SANRAL) allocated detours;
- Tyre burst regularly leads to the vehicle overturning and fatalities[157];
- Mist/fog is a huge concern, especially at the Atlantis and Philadelphia turn-off, and further on the N7 up to Piketberg;
- Lack of communication and contingency plans between role-players: South African Police Services (SAPS) SAPS, WCDM, the Traffic Department and SANRAL;
- Dams next to the N7 are a risk, because they are not always built according to standards. Dam breaks can flood national roads especially during seasonal winter rain. Climate change and the resulting change in rainfall patterns pose a further risk to dam failure and the resulting impact on adjacent roads;
- Municipal budgetary constraints means there is always a shortage for the Pedestrian Management System. This leads to a shortage of financial support for the repairing of fences and bridges;
- Shortage of policing and of proper street lighting;
- Collaboration from farmers: farmers are equally responsible for animal fences – to keep the fences intact. In addition some farmers have more than two entrances to their farmlands. It is problematic changing this to ensure that there is only one entrance, but SANRAL aims to consolidate this[158]; and
- Participants at the Bergrivier LM workshop highlighted the lack of traffic enforcement and traffic staff availability as a cause for concern.

7. Capabilities or resources that exist to manage the risk

- SANRAL conducts routine inspections which includes cutting grass;
- The Incident Management System can assist the trainer, communication with role-players and debriefing after accidents. Currently duplicate subscriptions exists for some incidents, this is due to the fact that contractors used two databases that was both submitted to SANRAL. With the new software this will no longer happen;
- Full implementation of the Pedestrian Management System;
- The 3 E's: Engineering, Education, Enforcement;

2.2.1 ROAD ACCIDENTS

- Education and awareness-raising in the community regarding national roads includes keeping to the speed limitations and adhering to road safety rules such as not walking on/over National roads[159];
- The Traffic Department's implementation of speed bumps, calming the traffic and speed measuring are all actions to decrease the high incidence of road accidents; and
- In the Saldanha Bay LM the Traffic Department implements an awareness campaign in the form of roadblocks and they inform the community via Radio West Coast.

8. Risk increasing or decreasing in the WCDM

Risk increasing:

- A new international airport envisaged for the Cape Metropole will have an impact on traffic and the roads. The proposed location is approximately 26 kilometres north of Durbanville, 8 kilometres south of Malmesbury and 16 kilometres east of Atlantis. This location is in the Swartland Municipal Area in the vicinity of Kalbaskraal. Although work on this project has been on-going for nearly six years now and has faced many challenges, it is now on the verge of being finalised. This development will have a significant effect on the municipal area and its incidence of road accidents[160].

Risk decreasing:

- The Saldanha Bay LM and Traffic Department, since 2009, organises a monthly formal drag race event on the Saldanha Bay airstrip. This successfully targets young people interested in drag racing who usually illegally participated in drag races through the streets of surrounding towns. This is a coordinated approach to successfully receive participation from the drag race community and decrease the risk of road accidents in the Saldanha Bay LM.

9. Impact the risk has on the development progress in the areas, communities and households it affects

A shortage of street lighting and a policy regarding lighting leads to socio-economic degradation where gangsters and thieves lurk in the dark to rob pedestrians.

10. Secondary impacts within areas and communities affected by the risk

Post-traumatic stress disorder resulting from road casualties and fatalities.

2.2.2 AIRCRAFT INCIDENTS

1. Early Warning signals

Pilots may indicate if an aircraft is in distress (e.g. engine failure, hijacking), via radio or squawking[161]. The necessary information is then forwarded to the relevant stakeholders from the Control Tower[162].

2. Hazard frequency

- The probability of aircraft incidents is generally low. Large carriers are designed to minimise risk and commercial pilots in South Africa are well-trained.
- Smaller/light aircraft that are used to spray crops, those that are used for skydiving are at relatively higher risk i.e. medium risk[163].
- Fuel Contamination: accident between Yzerfontein and Saldanha on 24 July 2005[164];
- Metal fatigue, overheating, engine failure: accident between Cape Town and Saldanha on 4 October 2002; accident near Citrusdal on 16 June 2002[165];
- Overheating: fire caused by overheated brakes and tyres at Citrusdal on 17 February 2002;
- Private pilots that do not fly on a day-to-day basis that are not receiving enough practice; and
- Low flying/wire collisions: accident on Oranjeskraal Farm, Moorreesburg on 25 July 2005.

3. Areas, communities or households most at risk

- Areas below flight paths – few flight paths over WCDM;
- Private aerodromes e.g. Yzerfontein, Saldanha and Moorreesburg[166];
- Skydiving sites e.g. Citrusdal[167];
- Agricultural areas that rely on light aircraft for crop spraying; and
- Langebaan airstrip due to training that takes place at the aerodrome[168].

4. Likely impacts of hazard

- Damage to infrastructure – electricity services, roads, rail, water services;
- Contamination of soil and groundwater;
- HAZMAT spills;
- Fire;
- Pollution;
- Economic losses; and
- Injury/death[169].

5. Level of risk for different situations and conditions (seasonality)

- Winter: low visibility, water on runway, cross winds;
- Informal landing strips that are not appropriately managed therefore less control;
- Inadequate or no preflight inspections;
- More movement in the peak season;
- Smaller aerodromes without security;
- On ground: fuel leaks lead to contamination; maintenance; parked over grassy area leads to fire; and
- Damage to aircraft that goes unreported[170].

2.2.2 AIRCRAFT INCIDENTS

6. Conditions of vulnerability that increase the severity of the hazard

- Fires – toxic gases and smoke;
- Wind strength/direction; and
- Dry grass may lead to veld fires[171].

7. Capabilities or resources that exist to manage the risk

- There is a relatively low risk of an aircraft incident occurrence in the Western Cape due to the extensive aviation safety programmes and contingency plans in place for commercial movement.
- In addition, all aircraft to be airworthy must be certified by the Civil Aviation Authority[172].

8. Risk increasing or decreasing in the WCDM

Risk increasing:

- There is a relative increase in risk due to increased movement, particular in peak season over summer. Generally the risk however remains low.
- The increase in number of people being transported in larger carriers over the peak season may impact on the accident ratio.

Risk decreasing:

- In the WCDM there aren't big sprawling cities but mostly agricultural land which lowers the risk in terms of loss of life.

9. Impact the risk has on the development progress in the areas, communities and households it affects

No impact.

10. Secondary impacts within areas and communities affected by the risk

- Insurance claims;
- Job losses;
- Spread of disease;
- Food security;
- Tourism; and
- Credibility – in the event of accident, business continuity slows down which puts pressure on other airlines. The potential increase in number of flights increases prices resulting in spill over economic impacts. On the other hand, an increase in domestic flights requires faster turnaround times which may lead to standards of checks being lowered. These potential risks are specific to carriers[173].

BIOLOGICAL AND/OR TECHNOLOGICAL HAZARDS: URBAN AND/OR INDUSTRIAL INCIDENTS

2.2.3 FIRE: VELD AND STRUCTURAL

1. Early Warning signals

- Vegetation dryness (moisture content and amount of living vegetation);
- Changes in weather and climate variables that influence fire spread and intensity (El Niño)[174];
- Availability of combustibles;
- Imbalance in biodiversity;
- Wind speed[175];
- Long term drought in the dry season; and
- Absence of, or no access to, an early warning system[176].

2. Hazard frequency

- Veld fires occur during the 'fire season', November to February. The frequency would depend on the early warning signals noted above as well as local fire regimes.
- Structural fires can occur at any time of the year; however, fires in the formal sector are much less frequent and therefore have a lower disaster risk than informal structures[177].
- Informal structures can generally be considered to be a substantial fuel source. The structures are usually located very close together in informal settlements or in back yards and often have limited access to roads, water, sanitation, and drainage and electricity infrastructure.

3. Areas, communities or households most at risk

- The agricultural sector, particularly the wheat industry, is largely at risk in the WCDM[178].
- Road sides and areas at the urban edge are additional areas at risk.
- Any informal settlements adjacent to public open spaces are at risk. Informal structures mostly do not comply with the planned environment or with building regulations, and are typically constructed with corrugated iron sheets, or of any other type of available materials, cladding a wooden frame. The structures are usually located very close together in informal settlements or in back yards. They can generally be considered to be a substantial fuel source.
- In terms of accessibility, households that are located far from access roads, in rugged terrain or far from the Fire Station are at greater risk.
- DAFF notes farms that are at risk in mountainous areas e.g. Porterville and Groot Winterhoek.
- Resorts or holiday accommodation such as in Aurora is at risk due to location on the mountain side[179].
- During the Matzikama LM workshop participants highlighted the Khayalitsha informal settlement in Vredendal and Mbeki Square in Lutzville as high risk structural fire areas. Areas vulnerable to veldfires include Unionskraal, Graafberg, Onderberg and Vanrhynsdorp.
- Velddrif was identified as a vulnerable area to structural fires at the workshop held in the Bergrivier LM.
- In the Saldanha Bay LM vulnerable areas to veld fires includes Hopefield, fynbos areas and smallholdings. Areas vulnerable to structural fires include the informal settlements of George Courage (Louwville in Vredenburg) and Middelpos (Saldanha Bay).

2.2.3 FIRE: VELD AND STRUCTURAL

- According to Jacques Smith, Swartland LM, footpaths are critical areas as they will burn due to pedestrians throwing away their cigarette butts in this area[180].

4. Likely impacts of hazard

Environmental:

- Changes to biodiversity if vegetation is burnt too regularly or if fires burn vegetation completely[181];
- Specie loss or habitat loss if untimed or extreme;
- Damage to soil structure;
- Pollution; and
- Spread of fire-adapted alien invasive plant species.

Socio-economic:

- Resource recovery;
- Job losses;
- Insurance claims;
- Smoke inhalation;
- Damage to infrastructure;
- Disruption of road traffic and reduced visibility; and
- Injury/death of people and livestock[182].

Vegetation fires contribute to global warming and climate change through the release of CO^2. However, research has been undertaken that suggests that CO^2 from veld fires is less of an impact to global warming due to the veld taking up more CO^2 again afterwards than it lost due to the fire. Bush encroachment would reverse this situation[183].

5. Level of risk for different situations and conditions (seasonality)

- Informal settlements are at greater risk during the winter months, as a result of increased use of paraffin for heating.
- Jacques Smith, Swartland LM, indicated that during the summer months the wheat fields and the fynbos are susceptible to fire due to their degree of dryness[184].

6. Conditions of vulnerability that increase the severity of the hazard

- Existence of susceptible sub-populations - the very young or pregnant, the elderly, those having; pre-existing respiratory and/or decreased lung function or those with a cardiac disease;
- Occupational exposure - outdoor workers, fire fighters, emergency response workers;
- Lack of interventions to reduce pollutants exposures;
- Fynbos found in West Coast National Park;
- Urban edge – vegetation environment / housing characteristics, i.e. inadequate fire-breaks;
- An inadequate early warning system;
- Location from the fire brigade station;
- Membership to Fire Protection Associations (FPAs) and level of commitment of landowners[185];
- Satellite imagery can be used to detect fires, however, in cloudy weather conditions in

winter, satellite images don't show fires;

- Informal structures that are located close together in informal settlements or in back yards and often have limited access to roads, water, sanitation, and drainage and electricity infrastructure. A critical issue within informal settlements is the density of the settlement i.e. the higher the density of the settlements and poorer the quality of building materials (higher flammable degree) the greater the risk[186];
- Climate, vegetation and fire are linked as any changes will influence fire spread and intensity and it will result in differences in the prevailing fire regime. Changes in fire regimes may threaten plant and animal species[187]. DAFF remarks that the fire intensity is linked to the available fuel load of fynbos or alien vegetation. The prevalence of wind and wind speed, coupled with the last rain event during the fire season influences fire ignition and the spread of fire[188]; and
- A general lack of trained and available fire personnel at local municipality level was highlighted at each workshop.

7. Capabilities or resources that exist to manage the risk

The National Veld and Forest Fire Act aims to facilitate an integrated approach to the management of 'veld', forest and mountain fires. It links natural resource management by property owners - collectively or individually - to the integrated fire management system including:

- FPAs and Working on Fire contributes to mitigating the risk;
- The farmers assist by maintaining their fire breaks; and
- Fire Management strategies and plans.

FPAs effectiveness depends on the involvement of landowners (commercial or non-commercial farmers) and whether minimum standards are being applied and implemented[189].

The Fire Brigade Services Act provides for the establishment, coordination and standardisation of fire brigade services. The WCDM has a station at Moorreesburg. Municipalities need to allocate budget for fire services – particularly low for B-municipalities within the WCDM[190].

Advanced Fire Information System (AFIS) is a satellite-based fire detection tool developed by the Council for Scientific and Industrial Research (CSIR), in collaboration with Eskom that delivers locations of active fires in near-real time over southern and eastern Africa. The application of satellite remote sensing coupled with cell phone technology enables the distribution of alert messages via SMSs. The tool allows for government departments, such as DAFF, civil organizations such as Working on Fire and local FPAs, and utilities such as Eskom, to set up predefined user profiles to assist them in their tasks at national, municipal and provincial levels. For example, Eskom receives alerts whenever fires burn within one km of their transmission lines, which may cause line faults[191].

Tailored school programmes focusing on the prevention of structural fires, in the Bergrivier LM, has led to a decrease of structural fires.

In the Saldanha Bay LM awareness campaigns include making use of translators as there is an influx of people from the Eastern Cape. They settled in this municipality because they assumed that the oil and gas industry will provide them with employment opportunities.

Fire protection is included in the IDPs of local municipalities. As in the case of Swartland LM this includes building the informal housing structures further apart, implementing national building regulations and regulating the safety of the structures and the distance of the structures from each other.

2.2.3 FIRE: VELD AND STRUCTURAL

The WCDM is responsible for focusing on veld fires and HAZMAT spills. B-level municipalities are responsible for responding to structural fires and road accidents.

8. Risk increasing or decreasing in the WCDM

Risk increasing:

- In general, there is an increase in veld fires due to climate change, in areas where there has been an increase in fuel loads. The wildland fire situation has reportedly worsened significantly across South Africa during the past several years[192]. There is also evidence that fire return intervals are decreasing in some areas of the Fynbos Biome[193], at least in the western and central region[194].
- DAFF notes that grass grows quicker than fynbos, therefore frequently increasing the fuel load. Where FPAs are organised and active, the fuel load and frequency of fires may be reduced[195].
- Incidents in informal structures may increase due to increased population, and use of candles, in informal settlements. The increased use of paraffin for heating in winter months[196].
- The expansion of towns and changing land use patterns causes an expansion of the urban-rural interface. This may result in a larger amount of assets being exposed to veld fires[197].
- The influx of people from the Eastern Cape in the Saldanha Bay LM increases the risk of structural fires as these people usually settle themselves as backyard dwellers. The close location of structures in backyards increases the risk that the resulting fire can spread rapidly from one dwelling to another.

9. Impact the risk has on the development progress in the areas, communities and households it affects

- An increase in frequency and distribution of fires will have a serious effect on global warming and land cover change;
- The destruction of infrastructure; and
- Ultimately, loss of life;

10. Secondary impacts within areas and communities affected by the risk

- Flooding as a result of burnt vegetation; and
- Erosion[198].

2.2.4 KOEBERG NUCLEAR POWER STATION: NUCLEAR EVENT AND NATIONAL KEY POINT

1. Early Warning signals

- In the Koeberg plant there are manual trigger points (control room alarms and indicator release) for four different classifications of events and three Emergency Planning Zones to prepare for. The four emergency classes include: Unusual Events; Alerts; Site Emergency; and/or General Emergency.
- The Integrated Koeberg Nuclear Emergency Plan addresses the emergency conditions that would involve alerting, or activating progressively larger segments of the emergency organisation[199]. The steps for these events include: alert, site emergency and general emergency.

2. Hazard frequency

- There have been no nuclear accidents since the Koeberg plant has been in operation since 1984.
- There have been approximately 30 reported unusual incidents since 1984. These unusual incidents involve motor accidents on the R27, strikes by Greenpeace International, an increase in the jelly fish population (which impacts on the Koeberg plant by clogging the intake of sea water), unusual weather and events with radioactive waste.
- Radioactive waste is usually transported on a three week basis through roads, especially the N7, to which the WCDM has access. This has not occurred during 2012 due to amendments being made. The low-level and intermediate radioactive waste is safely stored onsite in concrete blocks[200].

- Probability: 1 (unlikely)
  The probability of a nuclear incident involving the release of radioactive materials is considered as highly unlikely due to the risk reduction measures inherent in the design and operation of the station. The calculated probability of the type of incident that would result in a release of radio-active material and deposition of such materials in an area of 5 kilometres around Koeberg is 1 in a million. The worst case risk of affecting areas up to 16 kilometres from Koeberg has been calculated at 1 in 100 million. Probability is therefore rated as unlikely.

- Severity: 3 (extreme)
  If this unlikely event however occurs, the severity would be high. Severity is therefore considered as extreme[201].

3. Areas, communities or households most at risk

- The KNPS has three Precautionary Action Zones (PAZs) – the areas around a facility for which arrangements have been made to take urgent protective actions in the event of a nuclear or radiological emergency to reduce the risk of severe deterministic health effects off the site. Protective actions within this area are to be taken before or shortly after a release of radioactive material or an exposure on the basis of the prevailing conditions at the facility.
- Communities and households located within a 5 kilometre radius to the Koeberg facility in the PAZ – PEB: This is an area around a facility for which arrangements have been made to take urgent protective actions in the event of a nuclear or radiological emergency to reduce the risk of severe deterministic health effects off the site. Protective actions within this area are to be taken before or shortly after a release of radioactive material or an exposure on

the basis of the prevailing conditions at the facility;

- Communities and households located within the 5 to 16 kilometre radius to the Koeberg facility in the Urgent Protective Action Planning Zone: This is an area around a facility for which arrangements have been made to take urgent protective actions in the event of a nuclear or radiological emergency to avert doses off the site in accordance with international safety standards. Protective actions within this area are to be taken on the basis of environmental monitoring – or, as appropriate, prevailing conditions at the facility. This includes the town of Atlantis;
- Communities and households in the 16 to 80 kilometre radius to the Koeberg facility are located in the Longer Term Protective Action Zone (LPZ) – PEB – 80 km: The pre-designated area around a nuclear installation in which contingency plans and procedure are in place for taking effective protective actions to reduce the long term exposure due to deposited radionuclides in the event of a nuclear accident[202]. This area will not experience severe or acute effects, but will have long term affects;
- Other communities, households and areas in the WCDM through which the radioactive waste is transported are also exposed to radioactive contamination[203].

4. Likely impacts of hazard

- There are several different types of radio-active materials that have different radiation properties, and the effects of radiation will depend on the specific material as well as the extent and duration of exposure.
- The proximity of the nuclear explosion will determine the damage. In a nuclear explosion most people within a few kilometres of the explosion would be killed or seriously injured by the blast, heat or initial radiation. People in the lighter damage areas would be endangered by the blast and the heat effects. Thousands of people are located in the lighter damage zone and with survivors their main danger would be from radioactive fallout.
- As a national key point a nuclear accident poses an environmental and security risk. The primary impact of a worstcase nuclear incident at Koeberg will be environmental pollution through the release of radioactive vapours and/or effluent. This could include deposits of radioactive material on the ground or other surfaces including the skin or clothes of humans, the inhalation of such materials by humans or the ingestion of such materials through foodstuffs. The environmental pollution will affect animals in the same way as humans. Exposure to radiation can lead to illness or death, depending on the dose received.
- Radiation is natural and the normal human receives regular small doses of radiation from natural sources on an on-going basis. It is only large doses of radiation that is physically damaging. During normal operations at Koeberg a person standing naked at Koeberg's fence for a period of 10 years would, over that 10-year period, have received an additional (above normal) dose of about two millirem – less than a passenger on a flight from Cape Town to Johannesburg would be exposed to Radio Equivalent Man (REM), is a measure of radiation dose and its impact on human tissue. To be lethal, a dose of radiation, received at one time, has to be more than 200 000 millirem[204].

5. Level of risk for different situations and conditions (seasonality)

- No season[205].

6. Conditions of vulnerability that increase the severity of the hazard

- The most probable way in which radioactive matter could be released from Koeberg would

be in the form of radio-active vapour escaping from the containment building. Dispersal of these airborne radioactive materials would depend on wind direction, wind speed, the stability of the wind, as well as whether it is raining. The dominant winds experienced at Koeberg are South-East and North-West. This means that populations to the South-East and North-West of the station will be most vulnerable in the case of a radioactive release.

- The temporary or permanent relocation of large amounts of people due to the contamination of an area will have severe impact on economic activity. Many businesses will need to close down and may not survive the interruption while other businesses will lose the majority of their client base. The cost of relocation and rehabilitation, if this is attempted, will be significant and although these costs will be the responsibility of the polluter it will affect the national economy negatively. Economical vulnerability is therefore considered extreme.
- Koeberg itself is a critical facility that will in all likelihood either ceases to operate or will only be able to retain the use of one of its two nuclear reactors after an incident involving the release of radioactive material from a single reactor. The electricity that Koeberg generates contributes to the energy that is provided to other critical facilities and the absence of Koeberg will cause instability in the national power grid and will have a long-term negative effect on the availability of energy. Facilities that are directly affected by deposits of radio-active material will have to be abandoned on a temporary or long-term basis. Critical facilities vulnerability is considered to be extreme.
- Environmental vulnerability to a nuclear event is high because the environment can be affected to such a degree that it cannot be used for agriculture. Some of the public protective measures that will be instituted include a ban on the consumption of water and foodstuffs, including animal products that come from affected area. Although the extent of the affected area will vary according to the volume and length of release as well as prevailing weather conditions, large scale decontamination of infrastructure in the built environment will be required if affected areas are to be used for human activity again. Environmental vulnerability is therefore considered as extreme.
- Survivability is highly dependent on factors such as if one is indoors or out, the size of the explosion, the proximity to the explosion, and to a lesser degree the direction of the wind carrying fallout. Death is highly likely and radiation poisoning is almost certain if one is caught in the open with no terrain or building masking effects within a radius of 0–3 kilometres from a 1 megaton airburst, and the 50% chance of death from the blast extends out to 8 kilometres from the same 1 megaton atmospheric explosion.

7. Capabilities or resources that exist to manage the risk

- The Integrated Koeberg Nuclear Emergency Plan is applicable to any nuclear emergency that has or is expected to have a radiological effect within or outside the boundaries of the KNPS that could require an emergency response by several government organisations; Eskom, its agents, the general public and those organisations that participate in the maintenance or execution of the Integrated Koeberg Nuclear Emergency Plan; and any emergency that involves the transport of radioactive material related to Koeberg by land, sea or air.
- The National Department of Mineral and Energy Affairs is the national government department charged with nuclear incident response. Eskom has specified responsibilities, and both the City of Cape Town and the Provincial Government of the Western Cape have specified responsibilities, in terms of a joint plan to deal with Koeberg emergencies. There is a mutual aid agreement with the WCDM to assist the City of Cape Town and the Western Cape Provincial Disaster Management Centre.

2.2.4 KOEBERG NUCLEAR POWER STATION: NUCLEAR EVENT AND NATIONAL KEY POINT

- Koeberg is responsible for technical and radiological assessments during all phases of a nuclear emergency and based on such assessment Koeberg is responsible for implementing on-site protective actions and recommending offsite public protective actions to the Disaster Co-ordination Team based on formal procedures.
- In the Disaster Management Act of 2002 it was pre-agreed by government that in the event where a "general emergency" at the Koeberg facility is declared it will be immediately escalated to a National Disaster. The National Disaster Management Centre is responsible to declare a National Disaster on the recommendation of the Disaster Co-ordination Team. Thus meaning that the Koeberg facility will gain access and support from local, provincial and national government.
- In collaboration with the City of the Cape Town, Eskom has a downwind sector agreement. To evacuate everyone in a 5 kilometre radius within 4 hours and to evacuate all communities in a 5 to 16 kilometre radius within 16 hours. There is no requirement to evacuate any communities outside the 16 kilometre radius. A public siren system is in place in all areas within 16 kilometres of Koeberg to alert residents of an incident and to inform them of the implementation of public protective actions.
- For the transport of radioactive waste Eskom hosts a roadshow for one week on a bi-yearly basis where they make ten stops in one week in communities of Vredendal, Piketberg and Moorreesburg. This is facilitated in conjunction with the West Coast Disaster Risk Management Centre. This roadshow is presented to all emergency service and first-line responders where the attendees can view the trucks, be introduced to the drivers and see where the emergency equipment is stored. This radioactive waste is solidified in concrete blocks and therefore poses no threat in terms of spillage. Furthermore, it is monitored under international levels[206].
- The Koeberg Power Station Manager is responsible for the execution of the onsite aspects of the Integrated Koeberg Nuclear Emergency Plan, including technical support and Radiation Protection[207].
- Existing Risk Reduction Measures include: Barriers; Design – back-ups of back-ups; and Training.
- Although situated against the sea, Koeberg is protected against storm surges and tidal waves by the terrace on which Koeberg is built, which is 8 metres above sea level.
- Additional risk reduction measures include:
  - Formal audits by the International Atomic Energy Agency.
  - On-going watchdog role performed by on-site NNR personnel.
  - Voluntary membership of WANO – through which peer reviews are carried out.
  - Engineering and science graduates need to complete two years of on-the-job training, additional to their degrees, before they are considered fully trained.
  - Reactor operators, licensed by the NNR, undergo re-training one week in every six weeks.
  - It takes seven years to develop a really proficient senior reactor operator.
- The Koeberg Nuclear Emergency Plan covers the possibility of radioactive releases, by air or by liquid effluent.
- Radiation protection: Natural background radiation at sea level is 200millirem per annum. Average radiation exposure to workers is 13millirem per annum. The radioactive releases, known as the Annual Authorized Discharge Quantity (AADQ), are controlled by the NNR.
- The Koeberg Radiation Protection Personnel and the City of Cape Town Environmental Health Practitioners will be responsible to monitor, assess and refer potentially contaminated persons.
- The Disaster Co-ordination Team co-ordinates a long-term health monitoring programme for

contaminated infrastructure and exposed people with probable deterministic effects, initiate epidemiological studies and implement long-term radiological monitoring in relocated or resettled areas. They are also responsible for terminating the late phase of the nuclear emergency in consultation with all relevant authorities[208].

- In the case of the issuance of a Control Room alarm the Emergency Control Centre will be made aware of it. Emergency Control Centre staff work on one-hour standby shifts with approximately 40 personnel per shift. For the period of one hour or shorter, until the Emergency Control Centre is in operation, the Control Room of Koeberg has the authority to make decisions[209].

8. Risk increasing or decreasing in the WCDM

No, there have been approximately 6 unusual events reported between 2006 and 2012[210].

9. Impact the risk has on the development progress in the areas, communities and households it affects

- A radiological release will potentially impact on WCDM by requiring the municipality's resources and assistance to erect mass care facilities for the injured and displaced. Longer term impacts can include temporary relocation;
- The immediate impact will be on economic and social activity as well as the electricity generation capacity of Koeberg;
- Banning of food and water in the plume affected area – especially the Swartland region will be impacted in this regard until the period of analysis is complete and the food declared safe[211]; and
- The Disaster Co-ordination Team, must co-ordinate deployment of emergency response teams to implement contaminated food and water ban in areas as recommended by the Koeberg Emergency Controller.

10. Secondary impacts within areas and communities affected by the risk

- Long term effects includes developing cataracts, cancer, in utero birth defects, trans-generational genetic damage and infectious diseases caused by contaminated water, untreated sewage, crowded living conditions, poor standard of living, and lack of vaccines in the aftermath. These diseases include: Dysentery, Typhoid, Infectious hepatitis, Salmonellosis, Cholera, Meningococcal meningitis, Polio and Tuberculosis[212].
- The injuries, illness or death resulting from radiation exposure is seen as the secondary impact of a worstcase nuclear incident at Koeberg.

2.2.5 HAZMAT: ROAD OR RAIL SPILL

1. Early Warning signals

Unpredictable.

2. Hazard frequency

Less than once per month[213].

3. Areas, communities or households most at risk

Road:

- Transport routes, particularly the N7;
- General public in Malmesbury area;
- Pedestrians; and
- Other drivers[214].

Rail:

- R27 Sishen to Saldanha e.g. derailment near Vredenburg in 2010[215]. This particular welded line suffers from fatigue cracks, which leads to complete breaks in the rail[216].
- Rail transportation may be associated with the occasional and unpredictable bulk transportation of mixed high risk and hazardous cargoes that increases the vulnerability of settlements, communities and the environment along their trajectories.

At the Bergrivier LM workshop attendees highlighted the R399 between Velddrif and Piketberg, the road between Piketberg and Porterville, and the road between Eendekuil and Saron as potential areas where a HAZMAT spill could occur.

4. Likely impacts of hazard

- Road closure;
- Pollution;
- Fire;
- Injury;
- Death; and
- Economic losses - breaks have caused derailments costing around R50 million per event[217].

5. Level of risk for different situations and conditions (seasonality)

Meteorological conditions may impact the level of risk in the following ways:

- Rain may cause a chemical reaction with spilled material; and
- Wind may disperse gaseous material[218].

6. Conditions of vulnerability that increase the severity of the hazard

- Proximity to major transport routes;
- Proximity to natural habitats and water sources;
- Hazardous chemical materials as vehicles are ignitions sources; and
- Communities living downwind from major transport routes.
- During the Matzikama LM workshop it was highlighted that the closest HAZMAT support unit

is located in Malmesbury.

7. Capabilities or resources that exist to manage the risk

- Municipalities have Contingency Plans that indicate the necessary measures of response to HAZMAT incidents. South African legislation includes but is not limited to:
  - Hazardous Substances Act;
  - Occupational Health and Safety;
  - Major Hazardous Installations Regulations; and
  - National Land Transport Act.
- Railway operators commonly inspect rails by using conventional ultrasonic inspection techniques. These require ultrasonic probes to be drawn along the length of the rail. It is a labour-intensive process that can only be conducted periodically and can interfere with the normal schedule of trains.
- The Institute of Maritime Technology was contracted by Spoornet to develop an alternate method for continuously monitoring its heavy duty iron-ore line between Sishen and Saldanha. Ultrasonic waves are transmitted along the rail between transmit and receive 'stations' that are placed alternately along the length of the rail. If the required ultrasonic signals are not received, an alarm is activated indicating a broken rail. With this technology, it is possible to continuously monitor the entire 850 kilometres of rail and also allows the railway operators to know in which section the rail break has occurred[219].
- Certain personnel at the West Coast Disaster Management Centre are trained in HAZMAT. Furthermore, there are numerous HAZMAT clean-up companies in the private sector.
- Since 2009 Transnet has a yearly awareness campaign in the Saldanha Bay LM. The Saldanha Bay LM Traffic Department supports this initiative by stopping motorists at allocated roadblocks so that Transnet personnel can inform them and increase their awareness.
- Attendees at the Bergrivier LM workshop indicated that there is good declaration and communication from Koeberg when they transport hazardous material. The problem exists where other companies fail to communicate with the relevant traffic department and disaster management personnel.

8. Risk increasing or decreasing in the WCDM

The risk depends whether it occurs in a town or outside of a town and is relative to increased movement; however the risk remains low.

9. Impact the risk has on the development progress in the areas, communities and households it affects

None.

10. Secondary impacts within areas and communities affected by the risk

None.

2.2.6 HAZMAT OIL SPILL AT SEA

1. Early Warning signals

- Reports of ships in distress and prevalence of oiled birds;
- Water quality monitoring[220];
- DAFF Control Room monitors large fishing vessels;
- Cape Town Radio for ship to shore distress signals;
- Automatic Identification System (AIS), both land-based and satellite detection, within South African territorial waters, the Economic Exclusion Zone and even towards Antarctica;
- Long Range Identification & Tracking (LRIT) for large vessels;
- Vessel Monitoring System;
- Port Authority VTS system; and
- MRCC screens ships daily[221].

2. Hazard frequency

Prevailing sea conditions have led to numerous pollution incidents off the South African coast. Oil is also released into the marine environment as a result of human error or pipeline failure at marine terminals. Furthermore, ships need to pump out bilge water which may contain oil from the vessel's engine. Albeit a small amount of oil that is released, the cumulative effects are considerable[222].

Probability: 3 (likely)

On 6 August 1983, the Castillo de Bellver incident resulted in 190 000 tons of crude oil being released off the West Coast. The Castillo de Bellver oil tanker caught fire northwest of Cape Town, then drifted before finally breaking apart 25 miles off the coast[223]. This spill is listed in the top ten worst spills in the world and is one of South Africa's worst marine environmental disasters. The bow section was towed far away from the coast by Altatech, a marine services company, then scuttled and sunk in a controlled manner to minimize pollution[224].

On 23 June 1994, an oil slick washing ashore on Dassen Island threatened a colony of endangered Jackass penguins and polluted mainland beaches. It was confirmed on 28 June 1994 that the Chinese bulk carrier, Apollo Sea, was believed to have sunk on June 20 shortly after leaving Saldanha Bay[225].

DEA has database of incidents – still to provide.

3. Areas, communities or households most at risk

- All marine traffic, calling at South African ports or in transit around the coast, is at risk particularly smaller fishing vessels that do not carry transponders ;
- Oil spills threaten the water basin at Koeberg Nuclear Power;
- Commercial activities such as fishing, refinery and aquaculture;
- Military resources i.e. SAS at Saldanha and Special Forces Regiments at Langebaan;
- Sea birds are particularly vulnerable as they become water-logged and may drown. Others may lose insulation[226];
- Fish and bird spawning sites or homes of endangered or threatened species;
- Rocky areas that cannot be cleaned;
- Estuarine environments i.e. Langebaan are vulnerable since oil is likely to get trapped;
- Beaches, recreational activities and mariner developments;
- RAMSAR sites, marine reserves and sanctuaries i.e. Langebaan are more sensitive to environmental risks[227]; and
- Dwarskersbos and Velddrif were highlighted as vulnerable communities, during the Bergrivier LM workshop, because of their coastal location.

4. Likely impacts of hazard

2.2.6 HAZMAT OIL SPILL AT SEA

In port, marine traffic is at risk to collisions, groundings, bunker transfers and operational spills[228].

Likely impacts of shipping incidents and consequent oil spills include:

- Loss of sea and bird life;
- Loss of biodiversity;
- Economic impacts for the fishing industry; and
- Contamination of spawning areas, recreational areas and environmentally sensitive environments[229].

5. Level of risk for different situations and conditions (seasonality)

- Age of vessel:
  The risk associated with shipping incidents increases with the increasing age of the vessel. Fishing vessels nearing end of life is at a higher risk of sinking.
- Hazardous and noxious gases:
  There are nine classes of hazardous substances that need to be dealt with in the appropriate manner. Risk of combustion increases if varying classes of gases are transported in one container[230].
- Oil type:
  Different types of oil can be released from vessels and some types have more damaging effects than others. For example, crude oil is a more natural state therefore breaks down easier than heavy fuel oil. No dispersants can be used for heavy fuel oil.
- Seasonality:
  Prevailing sea conditions during the winter months increase the risk of accidents at sea;
  Oil spills can have a more damaging effect if its occurrence coincides with harmful algal blooms that are more likely to occur during autumn and spring; and
  Spawning seasons.
- Meteorological:
  Strong winds and rough seas during winter may limit response; and
  Calm sea conditions may increase costs of containment[231].
- Tides:
  Tides contribute to oil layer mixing, influencing the natural breakdown of oil compounds.

6. Conditions of vulnerability that increase the severity of the hazard

- Increased development poses an increased threat of pollution e.g. expansion of the port at Saldanha Bay.
- Older vessels are more susceptible to structural failure and oil release; and
- Due to the increased pirating in the Suez Canal, more marine traffic is being experienced along the South African coast.

7. Capabilities or resources that exist to manage the risk

South Africa is signatory to a number of Conventions that prioritise saving lives e.g. Basal Convention & Safety Of Life At Sea (SOLAS), an international convention that prioritises saving lives and protection of the marine environment[232].

A series of Coastal Oil Spill Contingency plans (COSCPs) for South African coastline compiled by DEA, including the roles of SAMSA, local authorities SANCCOB and Nature Reserves or other stakeholders. The local plans make recommendations for protecting estuaries; these include sand barriers and booms. MRCC alerts Principal Officers along the coastline of any vessels in distress (see figure below).

2.2.6 HAZMAT OIL SPILL AT SEA

Line functions are responsible for further necessary actions[233].

Various stakeholders contribute to managing the risk with the resources listed below:

- Water quality monitoring[234];
- DAFF control room monitors large fishing vessels;
- Cape Town Radio for ship to shore distress signals;
- Satellite ARS and long range identification & tracking for large vessels;
- Port Authority VTS system;
- Emergency Response Tug, the Smit Amandla; and
- MRCC screens ships daily[235].

The Department of Environmental Affairs (DEA) manages stocks for combating oil pollutions and has access to patrol vessels that are fitted with dispersant spraying equipment and breaker nets. Equipment stocks include:

- A K9 surveillance aircraft;
- Poortbooms, Riverbooms, Seaguardian and Shoreguardian booms;
- Skimmers;
- Floating and fast tanks;
- Drum vacuum unit; and
- High pressure water washer[236].

SAMSA notes problems associated with taking passengers/crew members ashore. Insufficient resources exist to manage the risk e.g. hospital facilities along the West Coast[237].

At the Saldanha Bay LM the relevant stakeholders were involved in a PetroSA assimilation of an oil-spill where PetroSA would not be able to cope with its available resources, but require external assistance.

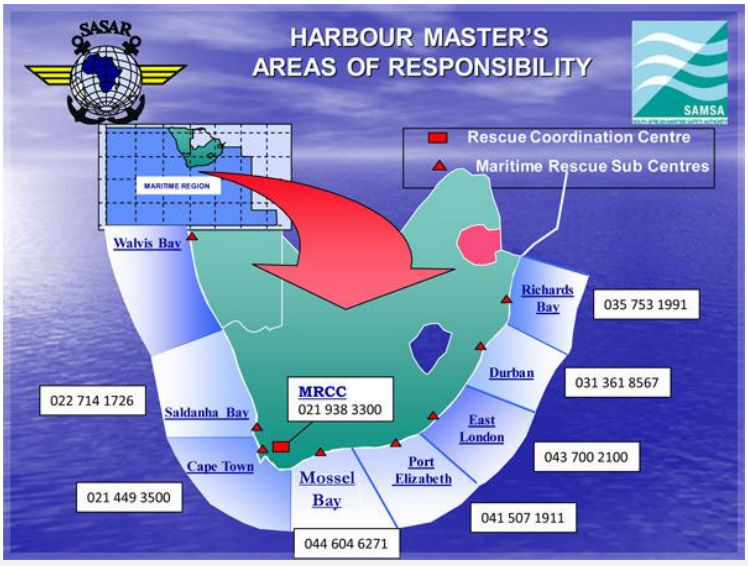


Figure 6 | Harbour Master's Areas of Responsibility[238]

8. Risk increasing or decreasing in the WCDM

Risk increasing:

- Increased development is likely to increase traffic and the number of oil spill incidents[239].

2.2.6 HAZMAT OIL SPILL AT SEA
• An increased movement along the South African coastline for disposing of vehicles in India is noted[240]. • Increased piracy in the Suez Canal has resulted in approximately 7-10% increase in traffic along South Africa's coastline.
9. Impact the risk has on the development progress in the areas, communities and households it affects
No.
10. Secondary impacts within areas and communities affected by the risk
The following risks exist when responding to oil spill incidents: • Waste from clean-up operations; • Splitting breeding pairs may impact on reproduction patterns; • Toxic fumes in confined spaces; • Risks associated with handling equipment; • Slipping; and • Risks associated with handling oiled wildlife[241].

2.2.7 DAM FAILURE

1. Early Warning signals

Unusual conditions or early warning signs include:

- Instability indicated by cracks, slips, sags and bulges in the slopes and/or movements in the crest of the dam and reservoir basin slope should be noted and new seepage water discharge points observed on a weekly basis (during floods). The location and dimensions of movement or seepage should be determined, photographed and pegged to mark the position.
- The occurrence and slow development of any of the following at the dam surface should be inspected on a daily basis.
  - Turbid seepage water (during floods).
  - Transverse and longitudinal cracks with opening widths larger than 5 mm, or cracks longer than 1 metre.
  - Observable displacement across a longitudinal crack.
  - Ground movement of more than 100 mm between two inspections.
  - Concentrated settlement less than 25 m² in area.
  - Settlement of the dam crest below the design level.
  - Concentrated seepage discharges at new locations with flows larger than 0.2 ℓ/s (during floods).
- Floods that result in the water level in the reservoir rising to within 200 mm of the embankment crest (in the case of a spillway blockage) should be monitored continuously until the water subsides below this level.

2. Hazard frequency

- A risk exists during the winter (May to August) which is known for a higher rainfall and the empty dams fill up too quickly. It is important to take note that dam failure is not connected to floods, but is known as 'sunny day incidents'[242].
- There has been a relatively low incidence of the catastrophic failure of large dams in South Africa.
- Probability: 2 (normal) runoff is not impossible although it tends to occur on side branches of the rivers so it is more localised.
- Severity: 2 (moderate) with localised floods[243].

3. Areas, communities or households most at risk

- Communities located in the vicinity of the Misverstanddam, Bulshoek dam, Doringriver, Olifantsriver, the mouth point where the Olifantsriver and the Doringriver meet and in close vicinity to the Clanwilliam dam. These especially include the towns situated close to the dams or on a lower topography such as Citrusdal, Klawer, Hopefield, Kalbaskraal, Vredendal and Moorreesburg. These towns are downstream from dams in the West Coast and include small farms in the upper reach, and residential houses and other public and private utilities.
- Farming communities, under the category of agriculture, is the second biggest sector of water users after the City of Cape Town.
- Roads and other critical infrastructure situated close to the dam for example water purification systems and water sewage plants[244].

4. Likely impacts of hazard

2.2.7 DAM FAILURE

- Inundation;
- Roads get washed away[245];
- Biggest impact on water purification systems and sewage systems;
- Harm to the public;
- Damage to property and water pumps; and
- Damage to resource quality and the saltwater level[246].

5. Level of risk for different situations and conditions (seasonality)

Depends on whether the dam is downstream and whether it occurs during a flood year[247].

6. Conditions of vulnerability that increase the severity of the hazard

- River obstructions cause problems that affect water flow, especially in the Moorreesburg and Hopefield area, which increases the negative impact of dam breaks[248].
- In the Swartland LM the Dieprivier dam is being put at risk of experiencing a dam break due to the underground movement of moles.
- Unregistered dams.
- The cumbersome process of receiving financial aid from National Treasury through the DoA's application process causes already damaged dams to be exceptionally vulnerable to additional hazards such as hailstorms, floods and droughts. In some cases dams were temporarily restored by farmers but in the majority of cases farmers were unable to afford to repair damaged dams brought upon by floods[249].
- Conditions affecting the safety of a dam means any condition of, or event in respect of a dam with a safety risk, or component thereof, including:
  - Significant damage of the dam wall or spillway caused by natural phenomena such as flash floods and earthquakes;
  - Failure or unusual movements or subsidence of any part of the dam or foundation thereof;
  - Unusual seepage or leaks which occur or which increase abnormally in the course of time or which remove material;
  - Defects in the dam wall or its components, which could lead to the failure of the dam;
  - Deterioration of the dam wall or the forming of cracks, including the starting of new cracks or the lengthening or widening of existing cracks;
  - The occurrence of sinkholes in the dam wall or reservoir;
  - The movement of material masses near the perimeter of the reservoir;
  - Abnormal instrument readings;
  - Significant damage to slope protection;
  - Unservicability of spillways and floodgates;
  - Unservicability of outlet works required for lowering of the water-level in an emergency; and
  - Incidents of sabotage or vandalism[250].

7. Capabilities or resources that exist to manage the risk

- There is good collaboration between stakeholders in the Western Cape Province: DWA; SAWS; and the Provincial and West Coast Disaster Management Centre to warn dam schemes that they can expect a high rainfall number.
- The Department of Water Affairs (DWA) is responsible for the maintenance and management of dams in the Western Cape. This includes monitoring the measures and flow of river systems.
- There are three legal requirements that must be met before a person may

construct/alter/repair a dam, namely with regard to (1) dam safety, (2) entitlement to water use, and (3) the environment. DWA's Dam Safety Office has a registration protocol where all dams with a safety risk should be registered, DWA must be notified of any changes of particulars (dam owner, address, telephone numbers, person in control, etc.) and the dam must be operated and maintained in a responsible manner. Category 3 dams need to be measured on a five-year basis and the competent assessor team will include a procedure in emergency preparedness plans and a flow chart of relevant contact details[251]. For example, the Dam Safety Inspection Report of the Clanwilliam Dam indicated that the dam walls need to be strengthened and extended.

- Legislation governing dams in South Africa:
  - National Water Act (Act no. 36 of 1998);
  - Dam Safety Regulations (Government Notice R. 139 of 24 February 2012);
  - Dam Safety Regulations (Government Notice R. 138 of 24 February 2012);
  - Summary of Legal Requirements for prospective and existing dam owners, 22 May 2012; and
  - Pollution control dams at mines must also comply with the Regulations on use of water for mining and related activities aimed at the protection of water resources (Government Gazette 20119, Notice 704)[252].
- The hydrological safety of large dams is one of the more complex issues in design. The designer must create a flood passage design that caters for "small" events as well as for large, potentially damaging events.
- A dam safety programme should set out the nature and frequency of dam safety inspections. Aspects of dam safety should be inspected on a daily, weekly, monthly, annually or five-yearly basis depending on the circumstances. The nature of inspections varies from simple observation of seepage flows (daily) to complex stress measurements (annual or five-yearly). Most regulatory systems call for at least a five-yearly intensive safety inspection of the dam by a specialised dam engineer. More frequent inspections than required by regulation make business sense from a risk mitigation perspective and extensive annual inspections are recommended for most dams[253].
- The DWA need to predict a year in advance (the deadline is usually 1 November of the preceding year) if there are any droughts expected and what the municipal area's water limitations should entail as it will impact on dams. This then needs to be sent to the Regional Office before there is an approval of issuing public notices[254].

8. Risk increasing or decreasing in the WCDM

Risk increasing:

- Increased risk of dam breaks due to increasing rainfall that leads to floods and inundation;
- Overtopping due to failure of the penstock with concurrent extreme rainfall;
- Internal (piping) erosion;
- Slope failure;
- Seismic event (earthquake); and
- A lack of maintenance of municipal dams from the local municipality's side[255].

9. Impact the risk has on the development progress in the areas, communities and households it affects

- Affect travelling to schools, work etc.;
- Possible displacement of certain households;
- Impact on the fishing industry[256]; and

2.2.7 DAM FAILURE
• The energy of the water stored behind the dam is capable of causing rapid and unexpected flooding downstream, resulting in loss of life and great property damage.
10. Secondary impacts within areas and communities affected by the risk
Reconstruction of the dam walls and damaged pathways can take a considerable amount of time and local resources which will then impact on affected areas and communities' time to recuperate.

2.2.8 NATIONAL KEY POINTS

National key points are by definition buildings, airports and strategic installations such as provincial legislatures and the Union Buildings that are considered worthy of tight security so as to prevent an act of damage or sabotage taking place. The loss, damage, disruption or immobilisation may prejudice the country.

NATIONAL KEY POINTS

- Chlorine pollution due to failure in chlorination system

Special safety precautionary measures apply in terms of the Occupational Health and Safety Act. Compliance to the conditions laid down should prevent potentially disastrous situations developing.

- Interruption in ESKOM electricity supply

This is not considered to be a major problem at this stage as most of the bulk water facilities have emergency alternative/backup sources of electricity supply. See section 2.2.4.

2.3 ENVIRONMENTAL DEGRADATION

2.3.1 HARMFUL ALGAL BLOOMS

1. Early Warning signals

- High phytoplankton concentrations downstream from the strong upwelling center;
- Patches of low oxygenated water;
- Reduced catches; and
- Lobsters inshore[257].

2. Hazard frequency

There is a seasonal signal for the occurrence of HABs, predominantly in late summer to autumn. When surface waters warm, limiting the speed at which oxygen can be mixed with deep waters.

Probability = 2 (normal)

20 lobster strandings have occurred along the West Coast since the 1960's. In the 70's and 80's, one or two strandings where recorded per decade and during the 1990's, five such events were recorded[258].

3. Areas, communities or households most at risk

- During the upwelling season, the bottom waters become deoxygenated and the lobsters are forced towards aerated surface waters. If not rescued when the tide recedes, the lobsters die on the beach from asphyxiation and desiccation[259].
- The stranding in the 1990's were recorded as the most severe events in South Africa (refer to Table 2 below).

Town	Date	Duration (days)	Tonnes stranded	Tonnes saved
Lambert's Bay	February 1993	14	10	
Eland's Bay	February 1994	38	5	
Dwarskersbos	March 1994		3	
St. Helena Bay	March 1994		60	
Eland's Bay	March 1997	67	225	40
Eland's Bay	April 1997		1700	250
Dwarskersbos	May 1997		30	18
Dwarskersbos	April/May 1998	14	30	15
Eland's Bay	April 1999	25	200	72

Table 2: Lobster strandings in the 1990's Source: Cockcroft[260]

- Further strandings took place along the Cape West Coast in February/March 2002 where an estimated 1200 tonnes of lobster were stranded in Elands Bay[261]. Only 10% were estimated to be saved. Other events are recorded for Lambert's Bay to Doring Bay in 2002, 2007 and 2012; Eland's Bay to Doring Bay in 2009 and 2012.
- The entire coastline of the WCDM is at risk, besides the 'hotspots' at Elands Bay and Lambert's Bay, are highlighted as high risk areas such as St. Helena Bay, Paternoster, Cape Columbine and Dwarskersbos where blooms may be concentrated inshore as a result of wind direction[262].
- In March 2012, 1.5 tonnes of lobster were stranded in Rooiduin, north of Lamberts Bay of which 100 kilogram were picked up and returned to sea. A further 200 kilogram were picked up in Elands Bay and kept in holding tanks and transported to St. Helena Bay where they were returned to sea. A reported 150 kilogram of lobsters died in the tanks. There was another incident where 10 tonnes of lobsters were stranded between Dwarskersbos and Laaiplek. 3 tonnes were collected and returned to sea at St. Helena Bay and Saldanha Bay.

- Kob, hagfish, rays, eels, hottentot fish and urchins washed up on sea. This leaves communities and households that are dependent on the fishing industry at an added risk[263].

4. Likely impacts of hazard

- As described above, lobster strandings are a likely occurrence of oxygen depletion resulting from HABs. Economic impacts include loss of revenue for coastal fisheries, aquaculture and harvested resources. This impact creates a microlevel economic vulnerability. Pillay noted a steady decline in the available amount of lobster over the years which directly impacts on the livelihoods of local fishermen[264].
- Other losses include potential reduction in tourism and effects on public health.
- Health impacts include acute vomiting and diarrhoea, liver and kidney toxicity as well as neurotoxicity. Toxins produced by certain dinoflagellates are some of the most potent poisons known to man, causing disruption to normal nerve functions and mortality in living marine resources.
- The impacts of a HAB can range from cell and tissue damage to organism mortality. As a result, a bloom may affect many living organisms of the coastal ecosystem, from zooplankton to fish larvae to people[265]. Filter feeders such as mussels, clams and oysters are particularly vulnerable to HABs as they feed by filtering particles from the water[266]. They note an event where dinoflagellate Gonyaulax catenella destroyed an entire adult mussel population in Elands Bay in 1980.

Figure 7 below illustrates the general impact of Harmful Algal Blooms.

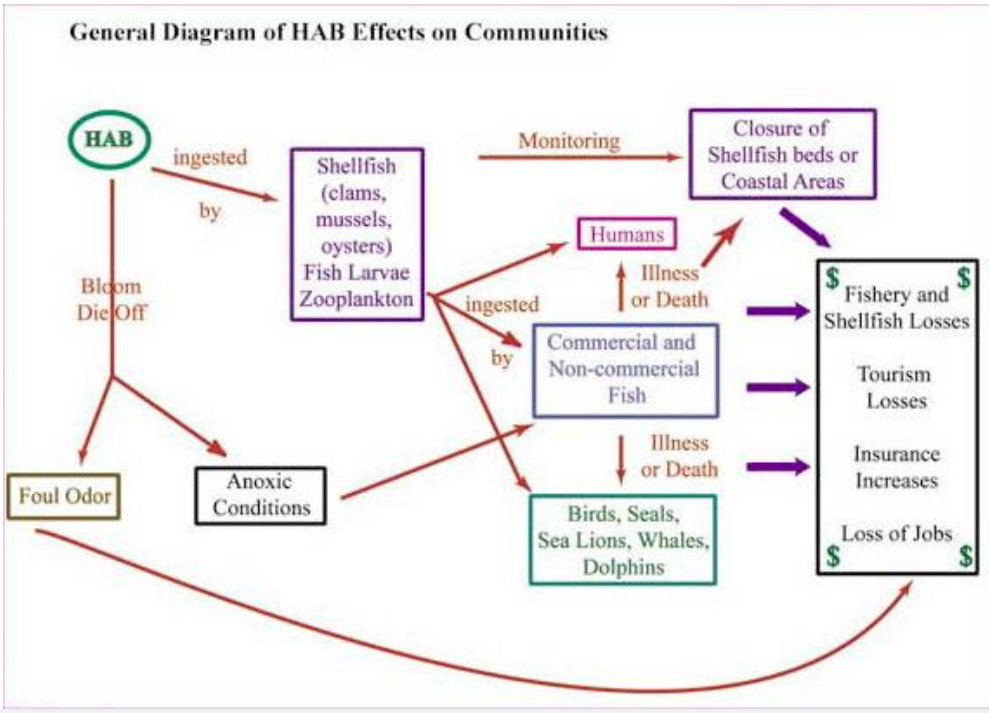


Figure 7 | Impacts of algal blooms on communities[267].

5. Level of risk for different situations and conditions (seasonality)

- Level of risk increased in late summer when surface waters warm and the speed at which oxygen can mix with deep waters is limited;
- Strong winds; and

- Wind direction may determine whether the bloom is concentrated inshore[268].

6. Conditions of vulnerability that increase the severity of the hazard

- Coastal areas that experience endemic poverty;
- Bay characteristics that increase bloom concentration; and
- Areas with increased nitrogen levels[269].

7. Capabilities or resources that exist to manage the risk

Contingency Plans include:

- Memorandums of Understanding (MOU) between DAFF and Matzikama Municipality;
- MOU between DAFF and Saldanha Bay Municipality;
- MOU between DAFF and WCDM; and
- MOU between DAFF and Matzikama District Municipality[270].

The Contingency Plan identifies role players and methods of salvaging, including equipment and resources that will be made available from different supporting agencies.

Pillay suggests that in the Contingency Plan an appropriate risk and vulnerability assessment should be the basis of an integrated framework in order to formulate a Disaster Management Plan. It is further recommended that command posts and communication require further attention. There are early warning systems in place to detect signs of HABs i.e. remote sensing[271].

During the Bergrivier LM workshop the indigenous knowledge systems of the fishing communities, such as having the ability to smell an advancing HAB in the Dwarskersbos and Velddrif communities, were highlighted as a coping mechanism. Other coping mechanisms include the mutual aid agreements that exist with for example the National Defence Force that assists the municipality to get rid of the lobsters.

8. Risk increasing or decreasing in the WCDM

Risk increasing:

- It is suggested that HABs are occurring with increasing intensity and frequency over a wider global distribution. A possible cause of this may be as a result of human activities. i.e nutrient enrichment through various forms of pollution and subtle changes ascribed to the greenhouse effect[272].
- Possible reasons for increased frequency and expanding geographic occurrence of HABs include:
  - Improved methods of protection and monitoring;
  - Introduction of exotic species via ballast water exchange or aquaculture practices;
  - Climate change; and
  - Increased pollution.

However some sources motivate that an increase is HABs is not substantiated with significant causal evidence. Massive HABs have been occurring long before human land-based activities altered the coastal oceans. In addition, the HABs often occur slightly distant from the areas of maximum land-based inputs. Land-based activities have increased loadings to estuaries and coastal oceans of nutrients and other excess materials from agricultural and industrial activities, and humans have altered the physical nature of estuarine and coastal habitats. The findings of the report is of the opinion that scientists do not sufficiently understand the complex ecosystem responses (including algal growth, species changes, and food web transfer) to link inputs from land-based activities to specific responses, such as HABs[273].

2.3.1 HARMFUL ALGAL BLOOMS
9. Impact the risk has on the development progress in the areas, communities and households it affects
• Economic impact on harvested resources and tourism. • The most conspicuous effects of HABs are the associated wildlife mortalities of marine and coastal species of fish, birds, marine mammals, and other organisms.
10. Secondary impacts within areas and communities affected by the risk
• Economic impact in fishing industry and associated job losses; • Poaching has an impact on the market – selling inferior products; • Causal links to ecosystem; • Commercial and recreational impacts; and • Insurance increases[274].

3 SUMMARY AND CONCLUSION

The West Coast District is an important industrial and agricultural growth area for the Western Cape. If the district is to develop in a sustainable manner, concerted effort is required to reduce disaster risks in its area by:

- Increasing community and infrastructure resilience;
- Strengthening capacity to anticipate significant events and disasters; and
- Improving the management of such events in order to limit the effects wherever possible.

It also requires the development and implementation of appropriate risk reduction strategies and interventions that are integrated into development plans and programmes, as well as the management of high risk developments.

Challenges

CHALLENGES	IMPACT
Financial challenges	Without adequate finances there is no way to fund the provisions of skilled and trained staff, capacity building programmes, resources, volunteers, risk reduction projects, adequate emergency relief supplies, post-disaster recovery and rehabilitation activities necessary for ensuring that DRM is implemented to the levels recommended in the national legislation.
Lack of equipment, trained and skilled personnel	The generic problem of staff incapacity and equipment is encountered in the WCDM.
Lack of political will	This includes a non-commitment of local government officials and politicians to disaster risk management and in attending advisory forum meetings.
Lack of involvement of government departments	This is required in order to comply with the requirements of the Disaster Management Act of 2002. Lack of representation may influence the findings in the workshops and also impact on line functions taking ownership of their risks.
Lack of community participation	Participation of local communities is crucial in understanding local needs and empowering people to address those needs as well as to send out a message to local communities that their voice is valued.
Lack of communication strategies	This is crucial to ensure collaboration and up to date information.
Addressing climate change	Climate change should be taken into consideration as it is a cross-boundary reality that threatens the WCDM's and the global community's shared carbon space. Climate change poses a risk to the ecosystems, food security, economic development, disaster management and the realisation of sustainable development within the WCDM. Drought has been highlighted as one of the district's high risks and will be exacerbated by climate change.
Lack of integration of development plans	Incorporating risk reduction initiatives in development plans is crucial for disaster risk reduction.

Potential

The WCDM's aim with this update is to provide the district with a user-friendly document that can be applied in daily operations. The ultimate direction is to create a platform of understanding where the disaster management role-players and other interested parties can maintain the DRA by reviewing and updating it annually. The inclusion of local municipal and district role-players is crucial to the successful implementation of this DRA. This will mean that the document will have local buy-in and ownership. This will support the LMs for the inclusion of relevant data in their Integrated Development Plans (IDPs) and aligning disaster risk reduction with their IDPs. This report must be read in conjunction with the existing disaster management plans of the WCDM.

Key findings

The district should focus on pre-disaster risk reduction (KPA 3) in the form of corporate and departmental risk reduction projects related to the priority risks identified, namely:

- Veld fire;
- Drought;
- Storm surge;
- Seismic hazards;
- Road accidents;
- Structural fires; and
- Social conflict.

It is critical to address the fire and drought risks in the area as climate, vegetation and fire are linked as changes in these variables influence fire spread and intensity. Higher temperatures usually accompany drying of the soil and lower water levels; thereby increasing risk of fire during periods of drought. A general lack of trained and available fire personnel at local municipality level was highlighted at each workshop and should be addressed. The knock on effects of drought in the area has ramifications for both subsistence and commercial farmers in terms of employment, increased production costs and food prices (which is passed onto consumers). Relevant government departments need to prioritise increasing resilience and adaptation in order to withstand the economic pressure of drought and mainstream sustainable farming practices.

The West Coast DM's coastal areas are affected by storm surges and in this respect certain coastal development, infrastructure and livelihoods of fishermen will be under threat of damage. Therefore it is critical that setback lines for coastal planning be identified, implemented and enforced. Risk reduction efforts should be targeted for sections of the coast that do not have natural defences and are vulnerable to storm surges. Particular consideration should be given to estuaries as water is funnelled up, raising the normal tide.

This DRA is required to establish the case for proactive and a comprehensive disaster risk management and to establish an enabling environment for disaster risk management in the WCDM. The district is required to raise awareness in the local community of the WCDM to secure a solid appreciation and understanding of the relevance of disaster risk reduction and to secure its mainstreaming into development and greater accountability for disaster-related losses.

4 ANNEXURES

ANNEXURE A: Disaster Risk Quantification

BACKGROUND

Risk assessments are fundamental for disaster risk reduction in order to understand the interaction between hazards, vulnerability and capacity. The approach and application of the WCDMC's standardised methodology means that the information obtained through the assessment can be compared with other district municipalities DRAs. It is critical that continual assessment should take place for regularly updating information in order to facilitate sustainable decision-making.

OBJECTIVE

A HVC assessment is a diagnostic tool that contributes to disaster risk reduction. It aims to identify and understand specific risks and their underlying causes. It assists in the development of programmes in priority areas. Furthermore it raises the public's awareness of hazards, vulnerabilities and capacities and the risk taken by society.

It is the local government that is the first responder, and the one responsible for community development and sustainable disaster risk reduction. A HVC assessment tool assists advocacy for local level disaster risk reduction and the empowerment of local governments and relevant stakeholders to actively collaborate and contribute to solving global issues while providing a space for stakeholders to work together.

WHAT IS A HVC ASSESSMENT TOOL: THE FORMULA

Hazards in themselves do not constitute disasters. Put simply disaster risk is the function of the combination of three elements – vulnerability, coping capacity and hazard (UNISDR 2002:41). The relationship of these elements can be expressed as a simple formula that is not mathematical in nature.

$$\text{Disaster Risk} = \frac{\text{Hazard x Vulnerability}}{\text{Capacity to cope}}$$

It is used to determine the disaster risk by assessing the potential impact of a hazard on a community, as a means of quantifying the root causes of vulnerability and identifying the available capacity to cope:

- Any increase in value of the component above the line (Hazard or Vulnerability) will lead to an increase to the Disaster Risk value, where as a decrease above the line will lead to a decrease risk value;
- Any increase in capacity value (below the line) will lead to a decrease in disaster risk, while a decrease below the line will lead to an increase in the disaster risk value.

This interaction also forms the basis for disaster risk reduction planning. The aim of disaster risk reduction planning will be to facilitate one, two or all three of the following:

- Reduce the **hazard** level, by changing either the severity of the hazard, or the probability of the hazard occurring;
- Decrease the **vulnerability** of the receiving entity by changing the physical, social, economic or environmental characteristics of the receiving entity; and

- Increasing the **capacity** of the affected community, society or organization by increasing the physical, institutional, social or economic means as well as skilled personnel or collective attributes such as leadership and management.

WHAT IS A HVC ASSESSMENT TOOL: HAZARD

The tool assists to identify the nature, location, intensity and likelihood of major hazards prevailing by assessing the hazard's probability (frequency) and severity (intensity).

The probability of a hazard occurring is assessed and classified in four categories, namely:

Probability Classification		
Rating	**Percentage Probability to occur within the next five years**	**Description**
1	0 %– 25%	Rare
2	26% - 50%	Unlikely
3	51% - 75%	Likely
4	76% - 100%	Very Likely

The severity of the hazards will be assessed to determine the harmful consequences or expected losses resulting from the hazards. Hazards will be classified into the following four categories:

Severity Classification					
Rating	**General Description**	**Society**	**Economy**	**Environment**	**Infrastructure**
1	Negligible impact	No injuries, illness or fatalities	No disruption of economic activity	No damage to environment	No damage to infrastructure
2	Minor impact	Low number of injuries, illness or fatalities	Minor and/or short term disruption of economic activity	Minor damage to environment	Minor damage to infrastructure
3	Serious impact	Serious injuries, illness or fatalities	Severe and/or medium terms disruption of economic activity	Severe damage to environment	Severe damage to infrastructure
4	Major impact	Extreme injuries, illness and high number of fatalities	Extreme and/or long term disruption of economic activities	Total destruction of environment. Extensive rehabilitation required	Total destruction of buildings and infrastructure

By using GIS, each identified hazard will then be captured separately, and then aggregated spatially to determine areas of high expected hazard impact

WHAT IS A HVC ASSESSMENT TOOL: VULNERABILITY

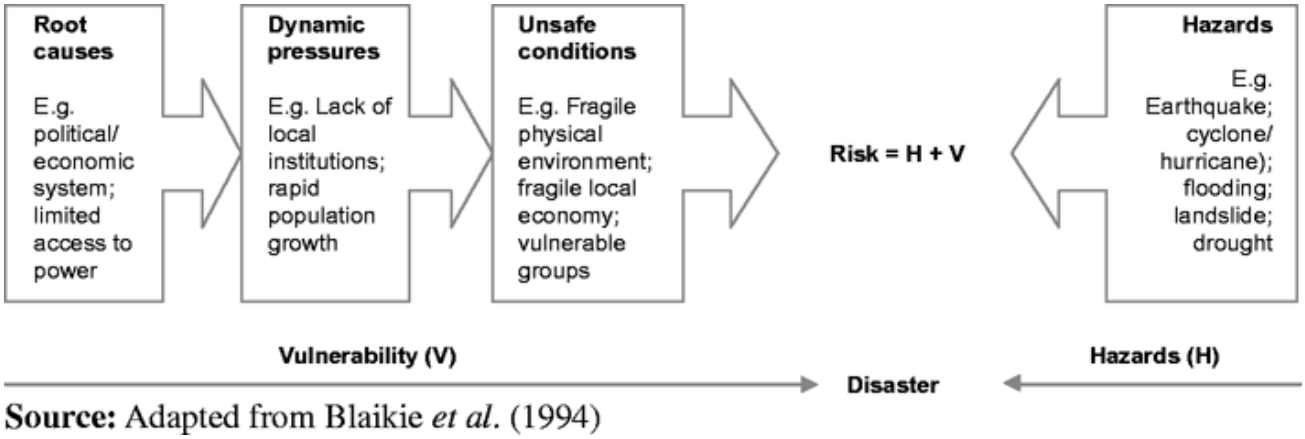
The tool assists to determine a set of conditions resulting from the societal, economical environmental, technological, political and legal factors, which increase the susceptibility of a community or area to a hazard. The economic dimension of vulnerability acknowledges economic damage potential, which can be understood as anything concrete that affects the represents a risk to production, distribution and consumption. The eradication of poverty therefore is crucial to vulnerability reduction.

The social dimension of vulnerability acknowledges the vulnerability of people. Especially weak and poor population groups are considered vulnerable. Levels of education, literacy and training, safety and security, access to basic human rights, social equity, information and awareness, strong cultural beliefs and traditional values, morality, good governance and a well-organised cohesive civil society, all contribute to social wellbeing with physical, mental and psychological health being critical aspects.

The environmental dimension of vulnerability acknowledges how different kinds of natural environments cope with and recover from different hazards.
The infrastructure dimension of vulnerability takes the regional infrastructure into consideration.

The Pressure And Release (PAR) Model
The PAR model indicates that there are certain underlying causes, dynamic pressures and unsafe conditions which contribute to vulnerability and increases the risk in communities.
Vulnerability is depicted in the model as the progression of three stages:

• Underlying causes: a deep-rooted set of factors within a society that together form and maintain vulnerability.
• Dynamic pressures: a translating process that channels the effects of a negative cause into unsafe conditions; this process may be due to a lack of basic services or provision or it may result from a series of macro-forces.
• Unsafe conditions: the vulnerable context where women and men and property are exposed to the risk of disaster; the fragile physical environment is one element; other factors include an unstable economy and low-income levels.
The pressure through the progression of vulnerability needs to be reversed.



Source: Adapted from Blaikie *et al.* (1994)

WHAT IS A HVC ASSESSMENT TOOL: CAPACITY
The reverse of vulnerability is capacity, which can be described as the resources of individuals, households, communities, institutions and nations to resist the impact of a hazard. The tool focuses on the coping strategies of local authority management capabilities, government response, public awareness and early warning.

OR: physical planning and engineering; societal capacity; economic capacity; management and institution capacity; early warning systems.

INDICATORS

The use of the indicator system is as an instrument based on a clear conceptual framework that brings the many components and relationships of disaster risk together. This helps to standardize the input from role-players.

DISASTER RISK PROFILE

The tool will finally allocate a relative risk priority to each hazard. It is quantified as follows:

Extreme (intolerable) Risks (Relative Risk Priority ≥ 10): Potentially *destructive* risk with a high probability of occurrence with a high level of *unpreparedness*. This combination equates to an *intolerably high risk* and may be a disaster in the making. For these *very high risks* urgent risk reduction interventions are required.

High Risk (Relative Risk Priority 4.1 to 9.9): The risks to which these communities are exposed are potentially *destructive,* but the community is modestly prepared for the hazard event occurrence. This combination equates to a *high risk* and a combination of *risk reduction interventions* and *preparedness plans* must be initiated for these risks.

Medium Risk (Relative Risk Priority 3.6 to 4): Translate in very little risk for a largely prepared community. This combination equates to a *tolerable / moderate risk* and *preparedness plans* for these risks must be prepared.

Low Risk (*Relative Risk Priority ≤ 3.5):* Translate in a low risk indicating a prepared community, but on-going preparedness is still required.

RISK ASSESSMENT 4 X 4 MATRIX

In this DRA report and during the workshops hazards were rated in terms of their severity and their likelihood of occurrence. A basic 4 x 4 risk matrix was used for undertaking the rating and classification of identified hazard events, the existing vulnerabilities and capacity available to

mitigate or respond to the hazard. The figure below provides an illustration of the risk classification matrix.

LIKELIHOOD					
	Very Likely				
	Likely				
	Unlikely				
	Rare				
	What is the chance that it will happen?	Negligible	Minor	Serious	Major
		SEVERITY			

HVC ASSESSMENT: INDICATORS				
HAZARD				
Probability	**1**	**2**	**3**	**4**
	Rare	**Unlikely**	**Likely**	**Very likely**
	No chance.	Slight possibility.	Very good chance.	100% certainty.
Frequency	**1**	**2**	**3**	**4**
	Will occur monthly or weekly.	Will occur every 1 to 2 years.	Will happen every 2 to 5 years.	Will happen every 5 to 10 years.
Severity	**1**	**2**	**3**	**4**
	Negligible	**Minor**	**Serious**	**Major**
	Affects only a small part of a local municipality. No persons injured and/or displaced. Limited damage.	Affects a part of the local municipality. Some displacement of people. Some environmental damage to non-critical habitats and species. Short duration of impact.	Affects a part of the district. Fatalities and injuries. Displacement of whole communities. Environmental damage to endemism hotspots. Medium duration of impact.	Affects most of the area. Multiple deaths and injuries. Large displacement of people. National impact. Significant environmental damage, critical habitats or species affected. Extended period of impact. Extreme damage caused.

VULNERABILITY				
	1	**2**	**3**	**4**
	Not vulnerable	**Slightly vulnerable**	**Seriously vulnerable**	**Extremely vulnerable**
Political	Very stable political condition.	Limited cooperation between all political parties which is conducive to development which means there is limited political instability.	Disruptive political activities with uncertainty in the local community.	Dysfunctional political structures negatively influence the community life and could result in civil unrest.
Economic	Local economy of affected area is not susceptible, insignificant impact on national economy.	Local economy of affected area is slightly susceptible for a small number of families.	Serious financial and economic impact on the local community. Consequences for the district.	Local economy is seriously susceptible, will have significant negative impact on the district, provincial and/or national economy.
Social	The community is resilient, well prepared, mitigation / risk reduction in place.	Limited defence which could lead to slight injuries and discomfort of individuals and short-term displacement.	Multiple and fatal injuries and/or displacement of a large number of families.	The community is highly susceptible and unprepared which could lead to multiple fatalities and injuries. Permanent displacement of the total community. Low perception of risk.
Technological	No impact or destruction of affected area, critical infrastructure and services. Good protection against hazard.	Limited damage to affected area, critical infrastructure and services. Moderate protection against hazard.	Serious damage to affected area, infrastructure and services.	Total destruction of affected area, critical infrastructure and disruption of services. No or limited protection against hazard will take an extensive period of time to recover.
Environmental	Less important habitats and species within affected area. Effective environmental protection and resource management in place.	Limited impact on important habitats and species with affected area.	Serious impact on habitats and species particularly where there is high numbers of endemic species.	Impact is extreme on critical habitats and species within affected area. Limited environmental protection in place - period of rehabilitation will be extensive.
CAPACITY				
	1	**2**	**3**	**4**
	Very poor	**Poor**	**Good**	**Very good**
Physical planning and engineering	No resources and risk reduction in place in terms of land use planning, building codes, maintenance, preventative structures and environmental management. Risk reduction mostly ignored in development planning.	Limited application of land use planning, building codes, maintenance, preventative structures and environmental management.	Well established application of land use planning, building codes, maintenance, preventative structures and environmental management.	Risk reduction is integrated into development planning through land use planning, building codes, maintenance, preventative structures and environmental management.
Societal capacity	There is no public participation or interest from public. Serious lack of tailored public awareness programmes, modules in school curricula or involvement during emergency response and/or evacuation drills.	There is limited public participation in hazard risk reduction, preparedness and response with some public awareness programmes and public participation in emergency response and/or evacuation drills.	Good implementation of public awareness programmes, risk reduction modules in school curricula, public participation in emergency response and/or evacuation drills.	There is wide public participation in hazard risk reduction, preparedness and response. This is facilitated through public awareness programmes, risk management groups/forums and modules in school curricula.
Economic capacity	No or limited budget in the form of emergency funds (district/national/international) and insurance.	Provincial and national departments have some resources or budget to respond to disasters in the form of emergency funds.	Good access to local/national/international emergency funds. Insurance in place.	Significant resources and budget to respond to the disasters in the form of local emergency funds. Insurance in place. Access to mitigation and reconstruction loans.
People capacity and competencies	No or limited training conducted for selected role-players.	Basic training conducted for all role-players.	Well-balanced training programme implemented to capacitate all role-players.	Integrated multi-disciplinary and multi-sectoral teams that are fully trained and operate at 100%.
Institutional capacity	No or limited programme capacity.	Level 1 DMP in place.	Full compliance with the DM Act and Framework.	100% demonstrated and tested DMPs and readiness plans in place. 100% understood and implemented by all role-players.
Management capacity	Insufficient service delivery due to limited institutional arrangements. Inadequate skills and experience. No or limited capability at municipal level for leadership directed at the DM function. No tailored DRA, DMP, risk maps, DMC or early warning system.	Limited capability which is increasing due to functional arrangements i.e. some staff exclusively allocated to Disaster Management. Disaster Management Centre established but not operating optimally / sufficiently equipped. Some degree of skills and experience. Limited communication and early warning system.	Well established institutional arrangements with leadership taking an active role in DM matters. Tailored DMP and DRA available. Established and fully-functional DMC, early warning system and communication centre.	High levels of skill and experience which leads to well-balanced managerial capacity. Good continuity in management which leads to sufficient service delivery. Disaster Management Centre established, fully functional, well equipped and resourced. Staff allocated exclusively to Disaster Management. Hazard within mandate of municipality.

ANNEXURE B: Disaster Risk Prioritisation Register

West Coast District Municipality: Disaster Risk Register

HAZARD CATEGORY	HAZARD	HAZARD				Vulnerability						CAPACITY								
SCORE		Score: 4. Very Likely 3. Likely 2. Unlikely 1. Rare	Score: 4. Monthly/weekly 3. Every 1 - 2 years 2. Every 2 - 5 years 1. Every 5 - 10 years	Score: 4. Major 3. Serious 2. Minor 1. Negligible	Hazard Rating	Vulnerability Score: 4. Extremely Vulnerable 3. Seriously Vulnerable 2. Slightly Vulnerable 1. Not Vulnerable					Vulnerability Rating	Capacity Score: 4. Very Good 3. Good 2. Poor 1. Very Poor						Capacity Rating	Relative Risk Rating	Relative Risk Priority
		Probability	Frequency	Severity		Political	Econ	Social	Tech	Enviro		Physical Planning and Engineering	Societal Capacity	Economic Capacity	People Capacity and Competencies	Management Capacity	Institutional capacity			
Natural - Biological	Veld fire	4	4	3	11	2	3	3	3	4	15	2	2	2	3	3	3	15	11.000	extremely high
Natural - Atmosphere	Drought	3	3	3	9	2	3	3	2	3	13	3	3	2	2	3	3	16	7.313	high
Natural -Oceanographic	Storm surge	3	4	3	10	2	3	2	3	3	13	3	2	2	2	2	2	13	10.000	high
Natural - Geological	Seismic hazards	1	1	4	6	1	4	4	4	3	16	2	2	2	2	2	2	12	8.000	high
Technological - Transport incidents	Road incident	4	4	3	11	1	3	3	2	1	10	2	2	2	3	3	2	14	7.857	high
Technological - Industrial	Structural Fires	4	4	3	11	2	2	3	2	2	11	2	2	2	2	2	2	12	10.083	high
Technological - Industrial	Social Conflict	3	4	3	10	3	3	3	2	2	13	2	2	2	2	2	3	13	10.000	high
Natural - Biological	Animal diseases	3	3	3	9	1	3	3	2	2	11	3	3	3	3	3	3	18	5.500	tolerable
Natural - Biological	Human diseases	4	4	3	11	2	3	3	1	1	10	3	3	2	3	3	3	17	6.471	tolerable
Natural - Biological	Sand dune migration	3	4	2	9	1	2	2	2	3	10	3	2	2	3	2	3	15	6.000	tolerable
Natural - Geological	Coastal erosion	3	4	2	9	1	2	2	3	3	11	2	2	2	3	3	3	15	6.600	tolerable
Natural - Atmosphere	Heat waves	4	4	2	10	1	2	2	2	2	9	3	3	3	3	3	3	18	5.000	tolerable
Natural - Atmosphere	Severe weather (strong wind)	4	4	2	10	1	2	2	2	2	9	2	3	3	3	3	3	17	5.294	tolerable
Natural - Water	Floods	3	3	3	9	1	3	3	3	3	13	2	3	3	3	3	3	17	6.882	tolerable
Technological - Industrial	Nuclear event	2	1	4	7	1	4	4	4	4	17	4	4	4	4	3	3	22	5.409	tolerable
Technological - Industrial	HAZMAT: road or rail	3	4	3	10	1	3	3	2	3	12	3	3	3	3	3	3	18	6.667	tolerable
Technological - Industrial	HAZMAT: ocean spill	3	3	4	10	1	3	3	1	4	12	3	2	3	3	3	3	17	7.059	tolerable
Environmental	Harmful algal blooms	3	3	3	9	1	3	3	2	3	12	3	2	2	3	3	3	16	6.750	tolerable
Technological - Critical	Dam failure	1	1	3	5	1	3	3	3	2	12	3	3	2	3	3	3	17	3.529	low
Technological - Transport	Aircraft incident	2	2	3	7	1	2	2	2	2	9	3	3	3	3	3	3	18	3.500	low

ANNEXURE C: List of stakeholders

HAZARD	DATE	STAKEHOLDER
Storm surges	11 October 2012 9 October 2012 3 October 2012	CSIR: A. Theron NSRI: M. Hughes SAWS: C. Fillis
Severe storms (Strong wind)	3 October 2012 9 October 2012	SAWS: C. Fillis NSRI: M. Hughes
Harmful algal blooms	5 October 2012 12 October 2012	CoCT: G. Pillay DAFF: DAFF: M. Mdledle, G. Pitcher, T. Probyn, D. Fredericks, A. Visser, T. Vico, K. Prochazka, W. Cockrill, W. Basson, W.Shilubane & D. van Zyl
Fire	29 October 2012 5 October 2012 6 December 2012	DAFF: J. Syphys & M. Mangani PDMC: A. Lambrecht-Vertue Swartland LM: J. Smith
Seismic (geological hazards)	26 October 2012	CGS: M. Grobbelaar & V. Midzi,
HAZMAT	25 October 2012 05 October 2012 11 October 2012	SAMSA: R. Naicker & J. Blows DEA: F. Albertus & M. Mandleni SANRAL: D. Fritz
Floods **Dam failure**	01 November 2012 01 November 2012 22 October 2012 26 October 2012 19 October 2012	DoA: C. van den Heever DoA: A. Roux DWA: F. Mouski DWA: B. van Zyl Aurecon : DJ Hagen
Drought	01 November 2012	DoA: Callie van den Heever
Road accidents	01 October 2012 7 December 2012	SANRAL: C. van der Walt Saldanha Bay LM: J. Julies
Nuclear event	19 October 2012	ESKOM: Gary Thomson
National key points	19 October 2012	ESKOM: Gary Thomson
Animal disease (include pest infestation)	04 October 2012	DoA State Vet: Dr. S. Davey
Human disease	05 October 2012	WCDM Health: H. van Zyl

		MRC: S. Bok
Aircraft incidents	31 October 2012	ACSA: H. Meyer
Critical infrastructure: Service disruption	01 November 2012	WCDM: N. Faasen, B. B. van der Merwe and G. Titus.

ANNEXURE D: List of workshop participants

LOCAL MUNICIPALITY	NAME AND SURNAME	DIVISION	CONTACT DETAILS
Matzikama Local Municipality	Ellin Flink	Matzikama LM	0272013439 / 074 779 6230 ellinflink@gmail.com
	Prens Galant	Matzikama LM	027 201 3439 / 073 0515 192 traffic@matzikamamun.co.za
	Riaan Wiid	Matzikama LM	027 201 3439 / 083 487 0767 traffic@matzikamamun.co.za
	Andile Mpoki	WCDM	022 433 8700 / 079 927 6828
	Johan Basson	Provincial Traffic: Vredendal	027 213 1269 / 082 907 9090 cbasson@pgwc.gov.za
	Zama Mabunzi	Matzikama EMS	027 213 4006 / 076 872 431 zamabungi@gmail.com
	Edmund Neethling	Matzikama: Forensic Pathology	027 213 3161/ 078 318 2925 Edneethl@westerncape.gov.za
	Patrick Sikhondo		079 048 5763 patricksikhondo@gmail.com
Cederberg Local Municpality	Warrant Officer M.M. van Zyl	SAPS Graafwater	027 422 1122 / 083 658 5424 Graafwater.saps@saps.org.za
	J.P. Kotza	Cederberg LM	027 482 1481 / 082 883 4437 jevonk@cederbergraad.co.za
	N.Scholtz	WCDM Fire Brigade Service	027 482 1775 / 072 129 5945 clanwilliamfire@gmail.com
	C. van der Schyff	Provincial Disaster Management Centre	021 937 0791 Cobus.Vanderschyff@westerncape.gov.za
	Riaan Mattys	Cederberg LM: Municipal Traffic	027 482 1055 / 079 869 2143 RiaanM@cederbergraad.co.za
	Warrant Officer Francois Pieters	SAPS Lambert's Bay	027 432 8260 / 079 894 1620 lambertsybaysaps@saps.org.za
	J.R. Solomons	SAPS: Clanwilliam	027 482 8182 / 079 894 1628 Clanwilliam_Saps@saps.org.za
	Samantha Schroder	Greater Cederberg Fire Protection Assosiation	023 004 0219 / 082 069 9671 Samantha@cederbergfpa.co.za
Bergrivier Local Municipality	Seon Swartz	Bergrivier LM	022 913 6000 / 083 272 3714 swartzs@bergmun.org.za
	Jackie Strumpher	Bergrivier LM	022 913 6000 / 083 655 4567 strumpherj@bergmun.org.za
	Magdaline Sandt	Dept of Health Bergriver LM	022 913 3223 / 071 0171 211 edietrich@telkomsa.net
	Sylvia Botha	Dept of Health Bergrivier LM	022 913 1337 / 082 971 9630 edietrich@telkomsa.net

	Jamie-Lee van Zyl	Dept of Environmental Affiars	021 483 8347 Jamie-Lee.VanZyl@westerncape.gov.za
	Pieter Lewis	Dept of Social Development	022 7132272 / 083 8866056 plewis@westerncape.gov.za
Swartland Local Municipality	Jacques Smith	Swartland LM	022 4879479 / 082 7714 009 SmithJ@swartland.org.za
Saldanha Bay Local Municipality	Japie Julies	Saldanha Bay LM	022 701 6900 / 083 412 3568 Japie.Julies@sbm.gov.za

ANNEXURE E: GIS maps

ANNEXURE F: The West Coast District: Hazard classification

HAZARDS A potentially damaging physical event, phenomenon or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.		
Hazards pertinent in the West Coast District Municipality		
NATURAL HAZARDS These are natural processes or phenomena occurring in the biosphere that may constitute a damaging event. Natural Hazards are typically classified into:		
Geological Hazards: Geological hazards include internal earth processes, such as earthquakes and related geophysical processes such as mass movements, landslides, rockslides, surface collapses, debris or mud flows.	Earthquake-related Slope instability-related Coastal zone process-related Cosmic-related	Sand-dune migration Shoreline erosion (coastal erosion) Seismic hazards
Hydro-Meteorological Hazards: Natural processes or phenomena of atmospheric, hydrological or oceanographic nature.	Atmosphere-related Water-related	Drought Storm surges Severe weather (strong wind) Heat waves Floods
Biological Hazards: Processes of organic origin or those conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances.	Animal diseases Human diseases Veld fire risk	Newcastle disease PPRS African horse sickness Avian influenza HIV/Aids Tuberculosis Veld fires
TECHNOLOGICAL HAZARDS: Technological hazards are defined as danger originating from technological or industrial accidents, dangerous procedures or certain human activities, which may cause the loss of life or injury, property damage, social and economic degradation.	Transport Incidents Urban and/or Industrial incidents Critical infrastructure disruption Key national points Socio-economic disruption	Road accidents Aircraft incidents Fire- structural and informal Nuclear event HAZMAT: Road and rail spill HAZMAT: oil spill Dam failure National key points Social unrest

ENVIRONMENTAL HAZARDS: These are 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[275].		Harmful algal blooms

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