Funding information
FATHUM is funded by the UK 'Science for Humanitarian Emergencies and Resilience' (SHEAR) research programme
Grant number NE/P000525/1

Forecasts for Anticipatory Humanitarian Action (FATHUM)

RISK PROFILE REPORT: LANGEBERG MUNICIPALITY, SOUTH AFRICA

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August 2019

COVER PHOTOGRAPHS

Top left: Road damage in the Kogmanskloof pass (Source: Langeberg Municipality)
Middle left: The proximity of the Kogmans River to the R62 road. Steep mountainous topography is also shown. (Source: TheNational.ae)
Middle left: Flooding at the entrance of Montagu in 2003. (Source: iol.co.za)
Middle right: Flood at the Langeberg – Ashton Foods canning factory in 2003. (Breede Valley Winelands Municipality)
Top right: The Keisie River in Montagu flooding a road connecting one part of the town with another. (Source: Climb ZA)
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EXECUTIVE SUMMARY

From 2003 – 2014 the Langeberg Municipality in the Western Cape Province of South Africa was substantially affected by six flood disasters which resulted in almost USD 22 million in damages, caused one fatality and left a total of 6 424 people displaced. Severe weather events during this period had widespread municipal and provincial infrastructural, private agricultural as well as social impacts, which also led to a disruption in service delivery. Literature indicated that these floods were caused by complex and interconnected hazard, vulnerability and disaster risk governance factors, some more prevalent and recurring than other, which increased flood risk.

Topography

Topographically and geo-physically steep mountains increase run-off, forced settlements and infrastructure to be located close to major rivers along with the Kogmanskloof Pass, a critical access route (through the Langeberg Mountains) which had been flooded on several instances, causing logistical and transportation challenges. Specific soil conditions cause poor surface cover, which led to increased vegetation, carried downstream causing more damage.

In addition, elongated and lobed catchment shapes have also isolated farming communities due to disrupted cell phone reception and road access during flooding. Meteorologically and climatically, the municipality is mainly affected by flash flooding due to cut-off lows (COLs) (especially during warmer months), exacerbated by mountainous topography, while mid-latitude cyclones also occur frequently in the area. Environmental and developmental factors such as land-use/land-cover change such as increased agricultural land and impervious surfaces in urban areas have increased run-off. Flood risk within the LM has also risen due to frequent veld fires causing hydrophobic soils, alien vegetation (especially in riparian zones carried downstream while providing good fuel for fires), along with river aggradation and sedimentation due to erosion have also increased flood risk. Lastly, urban expansion has exposed more people and infrastructure to rivers, while developmentally, irregular storm water maintenance in towns has increased risk.

Socio-economics

Socio-economic-demographic characteristics have also increased flood vulnerability and exacerbated flood impacts. These include chronic poverty, dependency, high crime rates,

public health issues and marginalisation (e.g. service delivery which are often most prevalent in certain areas such as Ashbury, Zolani and Nkqubela partly due to South Africa's Apartheid legacy). These conditions are closely linked to seasonal labour and associated travel to work due to the LM which is agriculturally intensive with employment highly determined by agricultural processes and cycles, in turn often leaving people without work during 'off-seasons'.

Urban population growth

The municipality experienced a town-based population increase of +/-150% in only 15 years, while the Black African population doubled and Coloured population also increased substantially. From 1996 – 2011, there was substantial population growth in specific settlements/suburbs such as Ashbury (Afrikaans speaking), Nkqubela, Zolani (IsiXhosa) Happy Valley and Mountain View (Afrikaans). While these claimed a minimal share of the population in the 1990s, in 2011, their combined population (in primarily low income or informal settlements) was greater than 25 000, or more than a quarter of the LM's total population. This rapid urban growth, for a rural area, has had numerous implications for both flood exposure and vulnerability, along with escalating demands on municipal services. In this context, it t has changed the socio-demographic landscape of flash-flood early warning, just as much as biophysical adjustments.

This rapid urban growth has had numerous implications for both flood exposure and vulnerability, along with escalating demands on municipal services. Such socio-economic divisions illustrate the need for nuanced, nonhomogeneous approaches to early warning for severe weather (e.g. early warning in only one language).

Governance

The governance of flood risk involves multiple public and private sector stakeholders such as government departments and ministries, local, provincial and national governmental entities, as well as private landowners. South Africa's disaster management legislation represents a crucial crosscutting mechanism for integrating flood risk management efforts with both development planning, as well as in times of heightened flood risk.

South Africa has a long history of civil protection, emergency medical response and fire brigade services. However, accelerated urgency for disaster-related legislative reform resulted in Green and White Papers on Disaster Management, culminating in a Disaster Management Act (No. 57 of 2002). It was followed by a comprehensive National Disaster Management Framework to guide the implementation of the Act, which had a developmental vulnerability reduction focus as well as wide-ranging consultation across government, private sector and civil society organisations.

However, among its many challenges, the legislation was constrained due to disaster management's designation as a national and provincial competency, and not a municipal competency. Disaster management was therefore viewed as an 'unfunded mandate' for local municipalities, deterring investment at local level, where risk management efforts were most needed. In 2015, the Disaster Management Amendment Act sought to correct this shortcoming. It introduced legal provisions for local municipalities, such as the Langeberg Municipality to establish disaster management capabilities and plans in consultation with district municipalities (in this instance, the Cape Winelands District Municipality). Entrenched perceptions that high impact events are occasional and 'rare', not related to development however still exist which reinforce a reactive approach and disregard developmental risk drivers.

Others challenges include disruptions in governance continuity over the years. The study area first consisted of various magisterial districts, which were then consolidated into the Breede Valley Winelands Municipality, with new boundaries, later renamed to the Langeberg Municipality. The municipality also underwent changes in political leadership.

Apart from the Disaster Management Act, legislation from many other acts and plans exist. These include the National Water Resources Act 36 of 1998, National Veld and Forest Fire Act 101 of 1998, River Maintenance Management Plans (RMMPs), National Environmental Management Act (NEMA) 107 of 1998 and South African Weather Services Amendment Act 48 of 2013 which function in parallel to support flood risk reduction.

Existing flood guidance and monitoring

The South African flash flood guidance system (SAFFG) developed by SAWS was a purely flood prediction system which was never fully operational in the LM area. SAWS, in collaboration with the National and Provincial Disaster Management Centres (NDMC and PDM and local DM officials has since moved towards an Impact-Based Severe Weather Warning System (SWWS), which is based on the United Kingdom Met Office's Impact Based Forecasting and WMO recommendations. This involves local information of the potentially affected areas obtained from local Disaster Management officials to be shared with SAWS to make more accurate forecasts, based on potential impacts in terms of impact (severity) and likelihood (including spatial extent). While this is a step forward, since active informal risk communication takes place on the ground before and during a disaster, formal, inclusive consultations with the public, 'on the ground (e.g. both farmers in high-risk locations and residents in flood-prone areas) need to take place.

Other challenges include limited weather monitoring in the Western Cape and Langeberg. This is not only because of too few instruments such as automatic rainfall stations and river flow gauges to collect real-time data, but also inadequate weather radar coverage which is compromised by the mountainous topography and incorrect height of the C-band radar which is in itself subject to greater interference. Lastly, South Africa's Disaster Management legislation distinguishes between four separate institutional duties for early namely "(i) assessing the threat, (ii) deciding on the need for a warning, (iii) issuing the warning, and (iv) transmitting the warning" while these functions sit with several authorities and at different levels of government. This has caused confusion among authorities about the timing of the above and their specific roles.

Implications

This study illustrated how many inter-related contributing root causes affect flood risk and that consequently, a holistic, up-to-date understanding of these is required to identify most exposed areas and most vulnerable people, in order to focus early warning and impact – based forecasting efforts more efficiently and effectively.

ACKNOWLEDGEMENTS

We would like to particularly acknowledge Johan Stander (South African Weather Services), Anisha Panchia (Stats SA), Roy Veldtman (former Disaster Manager for the Langeberg Municipality), Cape Winelands District Municipality (CWDM) for their support in this research. Last, we wish to express our appreciation for the Langeberg Local Municipality, particularly the Municipal Manager Mr SA Mokweni and Director for Community Services and Disaster Management Ms. EC Liebenberg, who permitting the research in their municipality.

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ACRONYMS

CWDM	Cape Winelands District Municipality
CBOs	Community-based organisations
COL	Cut-off low
DM	Disaster Management
DRR	Disaster Risk Reduction
FATHUM	Forecasts for Anticipatory Humanitarian Action
FbF	Forecast-based Financing
IDP	Integrated Development Plan
LM	Langeberg Municipality
NGOs	Non-governmental organisations
PDMC	Provincial Disaster Management Centre
RADAR	Research Alliance for Disaster and Risk Reduction
RMMPs	River Maintenance Management Plans
SAWS	South African Weather Service
UN	United Nations
UNISDR	United Nations International Strategy for Disaster Reduction

1. INTRODUCTION

Forecast-based Financing (FbF) is a mechanism that uses climate and weather or other forecasts to trigger action before the impacts of the forecasted event are felt (Wilkinson et al. 2018). This mechanism was developed in recognition that there is a window of opportunity between a forecasted warning and a potential disaster. FbF, a framework developed by the German Red Cross in 2015, uses forecasts of natural hazards to release funding for preparedness and relief when a forecast is issued and pre-defined trigger thresholds are reached (Coughlan de Perez et al. 2015; Stephens et al. 2015; Wilkinson et al. 2018). FbF allocates financial resources to selected communities, based on an early action protocol and in response to defined triggers and their thresholds.

Although there are many examples of FbF initiatives implemented and developed across the global South (Wilkinson et al. 2018), the FATHUM initiative focuses on FbF in three African countries. It specifically draws on the FbF experience in National Red Cross Society pilot sites in Mozambique and Uganda, with additional insight drawn from a flash-flood-prone rural site in South Africa, where responsibility for disaster response and humanitarian action resides in government and community structures. This multi-site research sought to probe the roles of local and indigenous knowledge in advancing resilience to floods and droughts, as well as changing patterns in local flood risk drivers (e.g. those embedded in environmental and broader socioeconomic conditions) that could influence future applications of FbF.

The rationale for the multi-site FbF study acknowledged that an incisive understanding of local risk context is integral to both resilience building and short-term humanitarian action. Beyond an appreciation of underpinning environmental and socio-economic conditions, the study also sought to probe current disaster risk management/reduction (DRM/DRR) and early warning capacities, policies, and mechanisms in each site - in addition to institutional arrangements for disaster response and humanitarian action. This aimed at identifying opportunities for technically integrating and aligning FbF with existing systems and structures, as well as leveraging political support where needed. For instance, by exploring local disaster preparedness and response frameworks, for example, FATHUM researchers sought to interrogate how FbF might fit within local and national disaster preparedness and response, in addition to longer-term resilience building.

This risk context report describes the South Africa-based case-study site, the Langeberg Municipality, situated in the Cape Winelands District Municipality of South Africa's Western Cape Province (Figure 1). It provides an overview of the study sites and methodology. Then, drawing primarily on secondary data, the report gives findings on the flood history for the Langeberg, as well as information on disaster risk drivers, risk governance and flood early warning processes, as these relate to the municipality.

2. OVERVIEW OF THE LANGEBERG MUNICIPALITY STUDY SITE

The FATHUM team based at Research Alliance for Disaster and Risk Reduction (RADAR), Stellenbosch University selected the Langeberg Municipality (LM) as the case study site for the FATHUM research. The Western Cape, which is home to over five million people, is known as the 'Cape of Storms', due to frequency of strong, and often destructive, storms experienced in the region (Holloway, Fortune & Chasi 2010).

The LM, is located inland, approximately 170 kilometres from Cape Town, with an estimated population of 103 389 in 2017. It is one of five local municipalities within the Cape Winelands District Municipality (Figure 1), which extends over 21 473 km². Approximately 55% of the Langeberg's residents live in its five main towns; Robertson (21 929), Montagu (15 176), Bonnievale (9 092), Ashton (7 700) and McGregor (3 125) (LM 2017). The remaining population is rurally dispersed throughout the municipality which comprises 4 517.4 km²

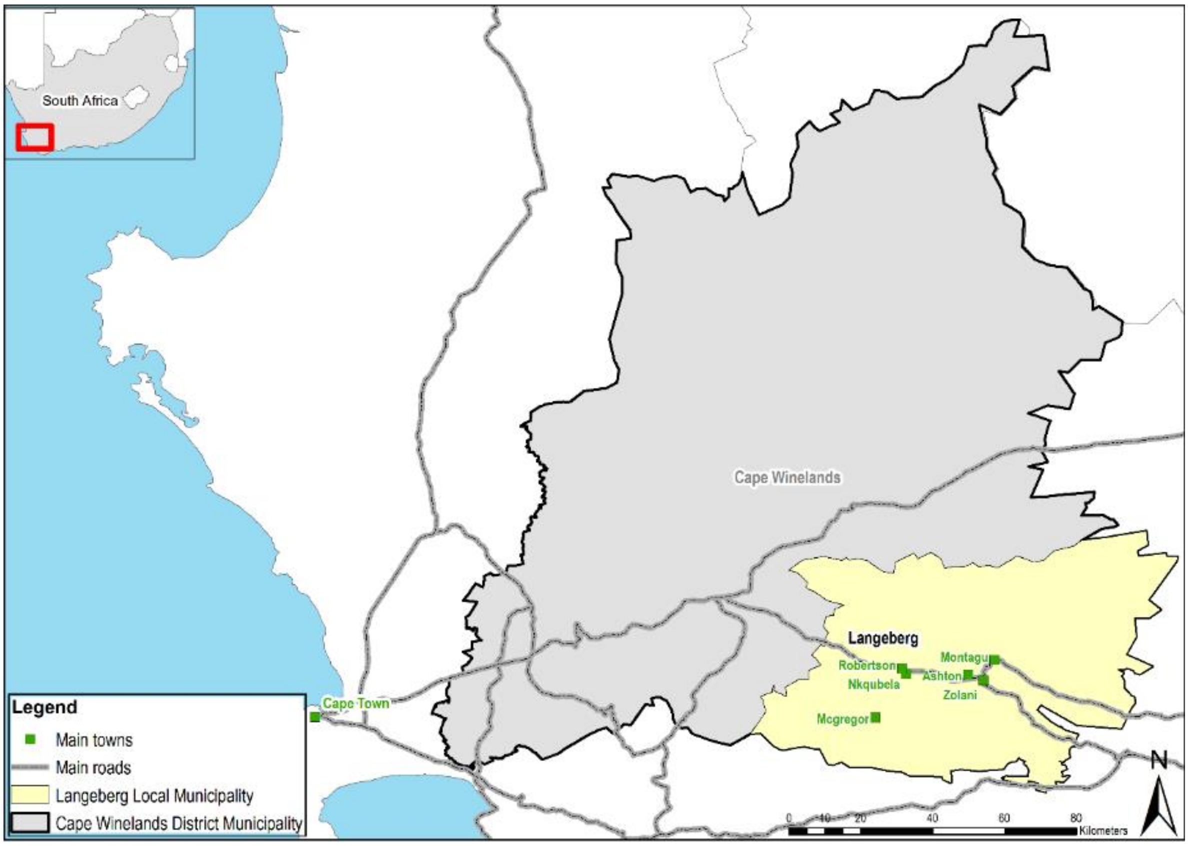

Figure 1: Location of the Langeberg Municipality, Cape Winelands District Municipality, Western Cape Province, South Africa

Geo-physically, the LM has complex mountain topography dominated by the Langeberg Mountain chain, with its highest peak at 2 075 meters dividing the municipality between north (Montagu) and south (Ashton, Robertson, Bonnievale and McGregor), with only the Kogmanskloof pass connection (see Figure 5). The Keisie and Kingna Rivers run through Montagu, becoming the Kogmans River that then runs through the Kogmanskloof Pass to Ashton (Figure 2). A number of isolated farming communities are located in deep valleys along the Keisie and Kinga and their tributaries.

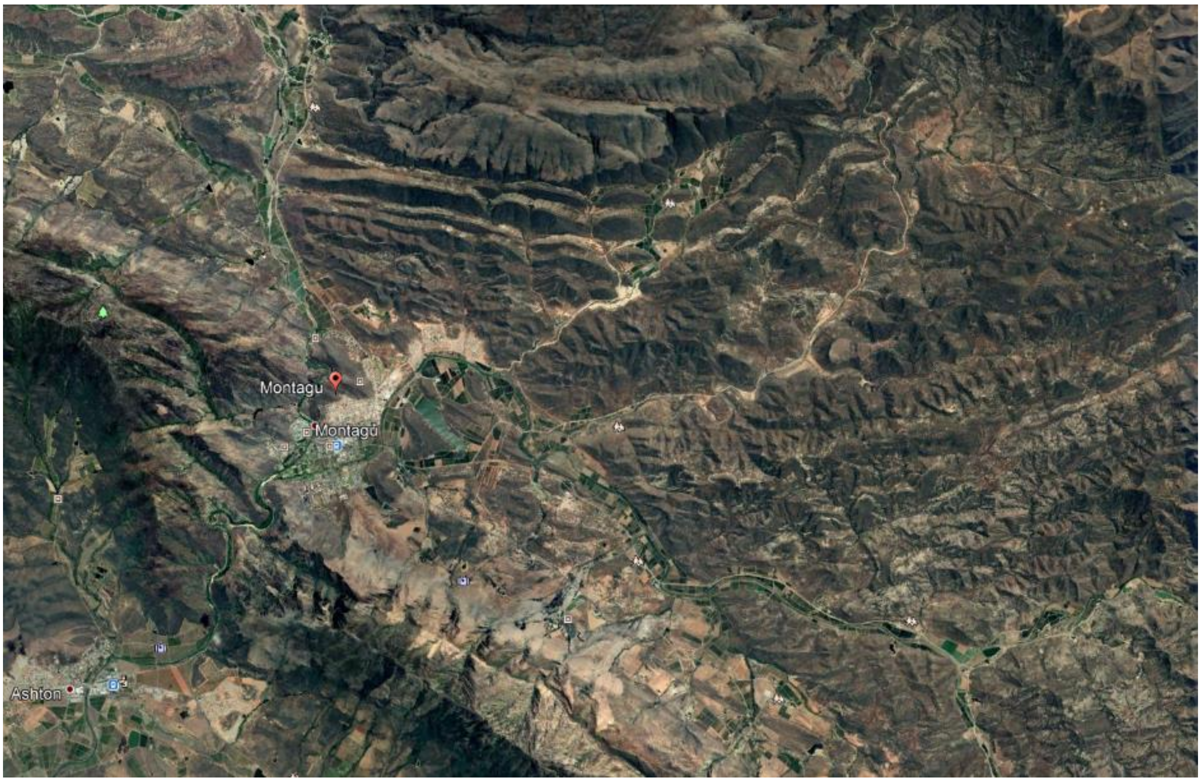

Figure 2: Location of Montagu along with farming communities

(Source: DigitalGlobe 2019)

The steep gradient of the Langeberg Mountains, elongated and lobed shape of the catchments in this area, and close proximity of built-up areas to major rivers all increase the likelihood of flooding, particularly flash flooding (Pharoah et al. 2016).

The municipality is characterised by diverse population groupings, that include semi-formal/RDP (Reconstruction and Development Programme) residents and informal settlement residents, backyard dwellers; pensioners/retirees, second home owners, tourists, commercial farmers, small holding farmers and seasonal labourers and migrants, in addition to high income residents.

It is also reflected in a diverse socio-demographic-economic profile that bears lasting legacies of the apartheid regime's Groups Areas Act. These contrasts include informal/low-cost housing settlements of Nkqubela in Robertson and Zolani in Ashton whose demographic profile is Black African (see Table 3). In contrast, Table 3 shows that Ashbury in Montagu has a Coloured population, while the remaining urban areas in Robertson, Montagu and Ashton comprise mainly White and Coloured population groups (Stats SA 2011). Similarly, in terms of language, IsiXhosa is the mainly spoken in Nkqubele and Zolani, with Afrikaans in the remaining areas.

Along with a highly diverse socio-demographic profile, the municipality's economic activities are also varied. In 2015 Primary sector activities of agriculture, forestry and fisheries constituted 12.8% of local GDP. Secondary sector activities involving manufacturing, electricity, gas and water, as well as construction comprised 25.9% of GDP. The municipality's tertiary sector contributed 61.2% to GDP, including**;** wholesale and retail trade, catering and accommodation, transport, storage and communication, finance insurance, real estate and business services, general government and community, social and personal services.

Despite this healthy economic diversity, the LM faces numerous social and development challenges such as high dependency due to unemployment, illiteracy and crime rates, poverty and marginalisation in some areas, (LM 2017). In addition, shortcomings in basic service provision (storm water infrastructure, water and sanitation) concentrate in areas such as Nkqubela (in Robertson), Zolani (in Ashton) and Ashbury (in Montagu) (DiMP 2003; LM 2017).

The FATHUM South Africa team selected the LM as its study site due to its rural location, history of extensive and complex flood disasters, and the availability of reliable disaster records. The municipality is a high-risk municipality that has experienced recurring disaster losses for longer than 30 years. The public and officials already 'practise' Forecast-based Early Action, but in an informal, unofficial way through various preparedness measures. Last, due to recurrent flood disasters and past research, the study team already had established enabling relationships with municipal official, communities and farmers.

3. OVERVIEW OF METHODOLOGY

3.1 Development of over-arching methodology across sites

In order to align the research methods in the three study-sites, a collaborative methodology was developed jointly with team-members from Uganda and Mozambique, in consultation with other FATHUM researchers. This process (Figure 4) spanned 12-16 months, and included consultation with team members in the Reading, Kampala and Stellenbosch. The process evolved so that the comparative research in three sites could provide valuable insights on the effectiveness of FbF in different settings, including understanding of the enabling and constraining factors for its implementation.

To enable a comparative analysis of findings across all country case study sites, standardised data-gathering tools were gradually developed for the collection of a range of primary and secondary data. The methodology developed comprised both secondary research and field work phases of investigation, enabling the appropriate approach to address the research questions. In developing the relevant methods and tools necessary for capturing data in each case study site, three broad themes (Figure 3) structured the conceptualisation of the research priorities and questions.

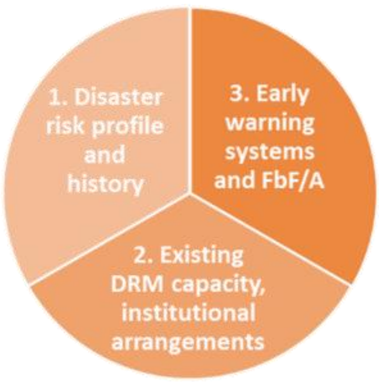

Figure 3: FATHUM case-study research themes identified

3.1.1 Research theme 1: Disaster risk profile and history

This theme focused on understanding the underlying drivers of flood risk, how these have changed over time, and the impact they might have on FbF. This necessitated a study of the biophysical, economic, political, social, and cultural factors that might increase flood risk. It was also necessary to document past hydro-meteorological disasters, probing the underlying drivers for each event, what their impacts were, if any FbF was taken and how. This information was critical for creating a baseline for understanding the disaster context within which decisions and activities related to FbF are being developed and implemented. It may also assist FbF stakeholders in developing better threshold triggers, determining the need for FbF activities and their application to other hazards.

3.1.2 Research theme 2: Existing DRM capacity and institutional arrangements

The Fathum research team gave priority to probe existing local and national capacities. This required the identification of the stakeholders governing disaster risk and response, their responsibilities and capacities, and the relevant governing institutional frameworks. It was also critical to determine what actions had been taken before, during, and after past flood events by various stakeholders. The collected information provided a framework for exploring how FbF fits within existing mechanisms and processes, whether there is the capacity for integrating FbF into these, and the potential governance challenges for scaling up FbF in each site.

3.1.3 Research theme 3: Existing early warning systems and FbF activities

This focused on exploring existing early warning systems and FbF activities and capacities to understand how FbF could potentially add value. It necessitated investigating people's perceptions of FbF activities and the potential for integrating FbF into existing early warning systems. The aim was to map the process of communicating early warnings, identify the stakeholders creating, disseminating, and receiving the warnings, and documenting the timings of these warnings. In addition, the challenges of and perceptions regarding formal and informal early warnings, FbF, and disaster relief and response activities were also investigated.

3.2 Adaptation and application of the research methodology in the Langeberg site

The two research phases and disaster history as an example are described in more detail below in relation to the LM case study in South Africa.

3.2.1 Secondary data assessment, literature and policy review

This research focus incorporated two dimensions; the change in overarching development conditions linked to recognised flood risk drivers, as well as realised flood events.

The secondary data review probed patterns in changing flood risk drivers, including population change, as well as shifts in livelihood activities. Drawing on Blaikie et al's Pressure and Release Model (Blaikie et al, 1994; Wisner et al, 2004), the study examined potential root causes and dynamic pressure (e.g. land degradation, deforestation, population change, risk governance) over a ten-year period (from 2007-2017).

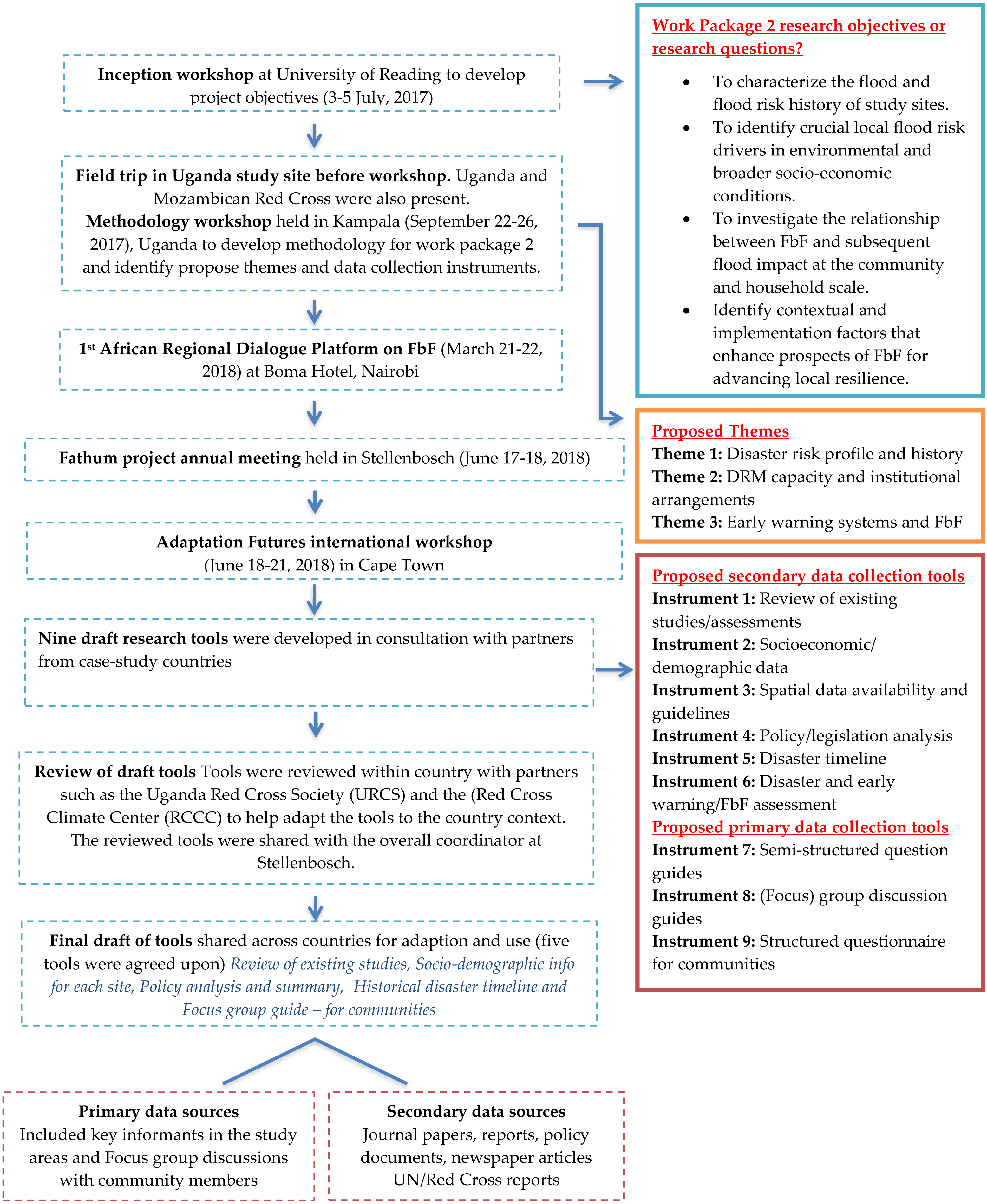

Figure 4: Steps in a co-produced research methodology for parallel implementation and comparative analysis

This process started from the beginning of the project (February 2017) and included a review of existing academic studies, relevant reports, community-based risk assessments, census data, policies, and legislation. Much of the information on study area was accessed through the Cape Winelands District Municipality (CWDM) (Disaster Management), which provides oversight to local Disaster Management officials and centres in smaller municipalities located within its political boundary, including the LM. Information gathered through this process was later consolidated into secondary data collection tools/forms (Figure 4) agreed upon during the methodology workshop held in Kampala.

The secondary data assessment provided insights into historic disaster events, underlying risk drivers, vulnerability indicators, socio-economic and other demographic information, as well as key policies that might either address or exacerbate disaster risk in the LM. It also facilitated the identification of key NGOs, CBOs/civil-society institutions, relevant stakeholders, communities, and individuals to interview during the fieldwork stage.

3.2.2 Disaster history

The secondary data review and preliminary interviews informed the gradual development of a detailed timeline of disaster events that had affected the LM. It contained not only information about when disasters occurred, but also their geographic location and key underlying risk drivers. Responses (at all scales), recorded impacts, longer term economic losses, potential knock-on effects and information about early warnings and early action, including FbF responses were also recorded but not included here. The timeline in turn informed the generation of an interview guide, highlighting issues requiring further investigation.

3.2.3 Fieldwork

The main 'on the ground' fieldwork was undertaken, using key informant interviews and focus group discussions (both translated into Afrikaans) (Figure 4) with adapted questions based on the specific key informant's or focus group's field of expertise and background. Tools were also tested by adding more relevant or removing irrelevant questions as the fieldwork progressed. Fieldwork took place for three weeks in September 2018 where more than 50 semi-structured interviews were conducted with farmers, town residents, community leaders, civil society organisations, government departments and relevant private companies. Focus group discussions were held with the LM; Ashton community members, leaders and community centre, religious and community-based etc.

Follow-up interviews with other stakeholders such as local schools in the study area and SAWS (South African Weather Services), Hortec (Weather Stations, Fruit quality and Analytical services) in Cape Town were conducted in November and December. Table 7 provides a full list of key groups, actors, government departments and organisations in the LM.

Interviews were first transcribed, then translated into English if necessary after which analysis was performed. This was done by establishing common and conflicting points mentioned by the various interviewees and focus groups. These opinions were then groups according overarching themes such as flood history, hazards, vulnerability, early warning etc.

4. FINDINGS

This section explores the estimated disaster losses attributed to floods in the Langeberg Municipality, the area's flood history between 2007 and 2017, the disaster a review of relevant flood risk drivers, risk governance that exists and the early warning systems.

4.1 Recorded occurrence of flood disasters

The LM area has an extensive disaster history, with many of its towns and rural communities at risk of flooding due to destructive storms triggered by cut-off low (COL) pressure systems during the summer and the winter rainy season. Two historic events occurred in 1867 and 1981 where lives were lost, which were followed by more recent events from 2003 - 2014, a period in which the LM experienced six disasters associated with severe weather events caused by COL pressure systems (Pharoah et al. 2016).

The more recent cluster of disasters were characterised by widespread flooding, with impacts reported across the Western Cape. During this period (2003 – 2013), the LM reported total financial losses of nearly US Dollars 22 million, with 6 424 people affected or requiring assistance (Pharoah et al. 2016). Table 1 includes all flood disasters since 1967, but also related disasters such as drought, which could have exacerbated flood damage. As indicated, a number of these events had larger scale impacts where neighbouring municipalities were also affected.

From 2003-2014, six identifiable flood disasters were recorded for the Langeberg Municipality. This was in addition to at least one instance of severe veld fires and one multi-year drought episode. Thirteen people died during flooding in 1981, while in 2012, an ambulance driver died when her vehicle was washed off the road, with the vehicle being swept away and trapped by fast-flowing floodwaters. This incident occurred in pre-dawn darkness when visibility was very low.

Floods have recurrently damaged infrastructure, including roads (e.g. R62 through the Kogmanskloof), bridges (e.g. Voortrekker in Montagu), electricity supplies and sewage pipes and plants and in 2003, forced the evacuation of 500 households, as well as the local primary school. In 2012, the Montagu Springs resort sustained substantial damage and was closed for repairs and reconstruction, reportedly reducing local tourism. Rock climbing-related tourism was also affected due to trail closures. The resort was damaged again in 2014 (Pharoah et al. 2016).

Table 1: Flood history of the LM, including related disasters

Event Type	Date	Location	Consequences of event	Main Drivers
Drought	Ongoing	Western Cape	Loss of production and jobs Water restrictions	Lack of sufficient rain
Floods	03/06/2015	Flash flood on R62	Main road in Montagu closed. Bridges flooded (Voortrekker)	COL – heavy rainfall blockages by reeds Material clogging bridges Catchment characteristics
Floods	06/01/2014	Breede Valley (BV) and LM	Damages to roads and causeways	COL – heavy rainfall
Floods	15/11/2013	Robertson	Damages across the district	COL – heavy rainfall Soil conditions
Floods	07/08/2012	Langeberg (Montagu) area	Road damage (R62) Kogmanskloof Pass closed	COL – heavy rainfall Alien vegetation Catchment characteristics
Floods	09/06/2011	Langeberg Mountain	Rural roads damaged in LM	COL – heavy rainfall Sedimentation
Floods	12/11/2008	Overberg, CWDM and Eden districts	Infrastructure damage Agricultural damages	COL – heavy rainfall Sedimentation Alien vegetation Poor drainage systems
Floods	July 2008	Breede River Winelands (BRW) Municipality	River experienced three floods that year	COL – heavy rainfall Dam collapsed
Thunder st.	26/12/2007	BRW and CWDM	Agricultural damages	Weather related
Floods	21/11/2007	BRW, CWDM and BV municipalities	Damages to infrastructure	COL – heavy rainfall Soil conditions
Fire	7/2/2007	Du Toitskloof Pass	Increased soil erosion	Severe mountain fires
Floods	22/08/2006	BRW and CWDM	R 62 closed for 4 hours Roads damaged	COL - heavy rainfall Topography
Floods	02/08/2006	Montagu	R 62 closed Bridges damaged (Voortrekker)	COL – heavy rainfall Catchment characteristics
Floods	12/04/2005	Montagu	Route (R) 62 closed	COL – heavy rainfall Topography Catchment characteristics
Flash floods	23/12/2004	Robertson	Damage to infrastructure	Severe cloudburst Torrential rainfall Previous drought - deluge Runoff speeds affected
Floods	24/03/2003	'Montagu Floods'	Kogmanskloof Pass closed Agricultural losses Keisie, Kingna and Kogmans Rivers flooded	COL - heavy rainfall Sedimentation Topography, Soil conditions Catchment characteristics Land use change
Fires	29/12/1997	Langeberg Mountain	8000 hectares destroyed	Not available
Floods	22/09/1983	Southern Cape	Not available	Not available
Floods	02/02/1981	Southern Cape	Not available	Not available
Floods	25/01/1981	'Laingsburg Flood' 104 deaths (13 in LM)	Infrastructure damage Agricultural losses	COL - heavy rainfall Impervious areas
Floods	14/12/1906	Southern Cape	Not available	Not available
Floods	14/05/1885	Southern Cape	Not available	Not available
Floods	05/1867	Montagu	Not available	Not available
Floods	08/03/1867	Montagu	Not available	Not available
Floods	11/10/1948	South-Western Districts	Not available	Not available

Source: Peek (2017) & Rogatschnig (2005)

Table 2: Adjusted cost of COL-related flood damage in the LM: 2007-2014 (US Dollar)

Damage cost	November 2007	November 2008	July/August 2012	*November 2013	January 2014	Total
Municipal	9 050.86	1 688 991.16	295 413.93	0.00	105 636.09	2 099 092.04
Provinicial	1 378 816.86	11 183 487.86	2 307 825.94	632 937.51	4 093 090.32	19 596 158.48
Total	**1 387 867.71**	**12 872 479.02**	**2 603 239.87**	**632 937.51**	**4 198 726.41**	**21 695 250.52**

Notes: Provincial agriculture damage could not be disaggregated to municipal scale.
Exchange rate: USD 1 = ZAR 14.50
Base year inflation rate – 2018

Table 2 illustrates the spatially consolidated cost of damage, in US Dollar, adjusted to the base inflation rate of 2018 for COL-related floods is the Langeberg. These costs equivalent to nearly USD 22 million, however, only refer to infrastructural damage, including costs to Western Cape Provincial structures physically located in the LM (Pharoah et al. 2016). They exclude agricultural costs, such as crop damage or livestock deaths are excluded.

This reporting bias is due to the application of a government-required 'Professional Service Provider' (PSP) process which was introduced from 2011 onwards that applied stringent eligibility criteria for reportable infrastructural damage (ibid). Similarly, the reported losses neither include for household-level nor any social impacts, the latter due to the compromised capacity of Provincial Social Services to assess the needs of poor households.

4.2 Flood Risk Drivers in the Langeberg

Although the specific effects of climate change for the Western Cape remain unclear, general projections indicate that the Western Cape will experience warming and drying trends as well as reduced number of rain-days and greater rainfall intensities (Blamey et al. 2014; Godsmark et al. 2019; CSAG 2014). These expectations add to earlier projections of greater climate variability, increased rainfall, increased temperatures and evaporation, dryer soils leading to erosion and runoff and extended drought periods, increased veld fire occurrences, and lastly a greater number of extreme weather events (Midgley et al. 2005; CWDM 2017; Davis-Reddy & Vinvent 2017 & Böckmann 2015).

The latter corresponds with Pharoah et al. (2016) who illustrated an increase in extreme rainfall days and associated losses in the Western Cape and the LM. Apart from these projections, social and environmental issues that increase risk are already evident. These include population growth, resource constraints, class inequality and pollution.

Lastly, in terms of health, Godsmark et al. (2019) provided a summary of health risk factors and broad health impacts linked to climate change that specifically apply to the Western Cape. They foregrounded population migration and environmental refugees, land use change, violence and human conflict. Impact projections included "mental ill-health, non-communicable diseases, injuries, poisonings (e.g. pesticides), food and nutrition insecurity-related diseases, water- and food-borne diseases and reproductive health" (Godsmark et al. 2019, 31). The authors also project that vulnerable populations such as the poor and chronically and mentally ill would be most affected.

According to the UN (2016, 24) underlying disaster risk drivers are: "processes or conditions, often development-related, that influence the level of disaster risk by increasing levels of exposure and vulnerability or reducing capacity." Examples include "…poverty and inequality, climate change and variability, unplanned and rapid urbanization and the lack of disaster risk considerations in land management and environmental and natural resource management, as well as compounding factors such as demographic change, non-disaster risk-informed policies, the lack of regulations and incentives for private disaster risk reduction investment, complex supply chains, the limited availability of technology, unsustainable uses of natural resources, declining ecosystems, pandemics and epidemics (ibid).”

In applying the above definition and example, this section outlines key flood risk drivers in the LM. Based on relevant literature, risk drivers were clustered into four types (topographical/geophysical, meteorological and climatic, environmental/developmental and socio-economic-demographic) and are described below.

4.2.1 Topographical/geo-physical risk drivers

Montagu’s flash flood risk is primarily due to its specific topographical and geo-physical characteristics, river management and other hazards such as drought and veld fire, which create conducive conditions for increased flood risk.

4.2.1.1 Mountainous topography

Three long and steep mountain ranges, the Langeberg, Waboom and Riviersonderend, situated within the LM, increase flood exposure due to the towns’ relative proximity to rivers. The ranges also contribute to vulnerability through unsafe environmental surroundings and potential for being cut-off and isolated due to only one viable road from the northern to the southern part of the LM, that connects Montagu (red arrow) and Ashton (see Figure 5). The R60 in the Kogmanskloof is a critical access route (through the Langeberg Mountains – through the middle of the municipality) which crosses the Kogmans River (south flow) at several points and is otherwise in close proximity to it. This road often floods, causing logistical and transportation challenges, especially for response units such as DM, police, EMS and traffic services. Montagu, located on the northern side of the Kogmanskloof, at the confluence of two major rivers, the Kingna and Keisie, is at particular flash-flood risk.

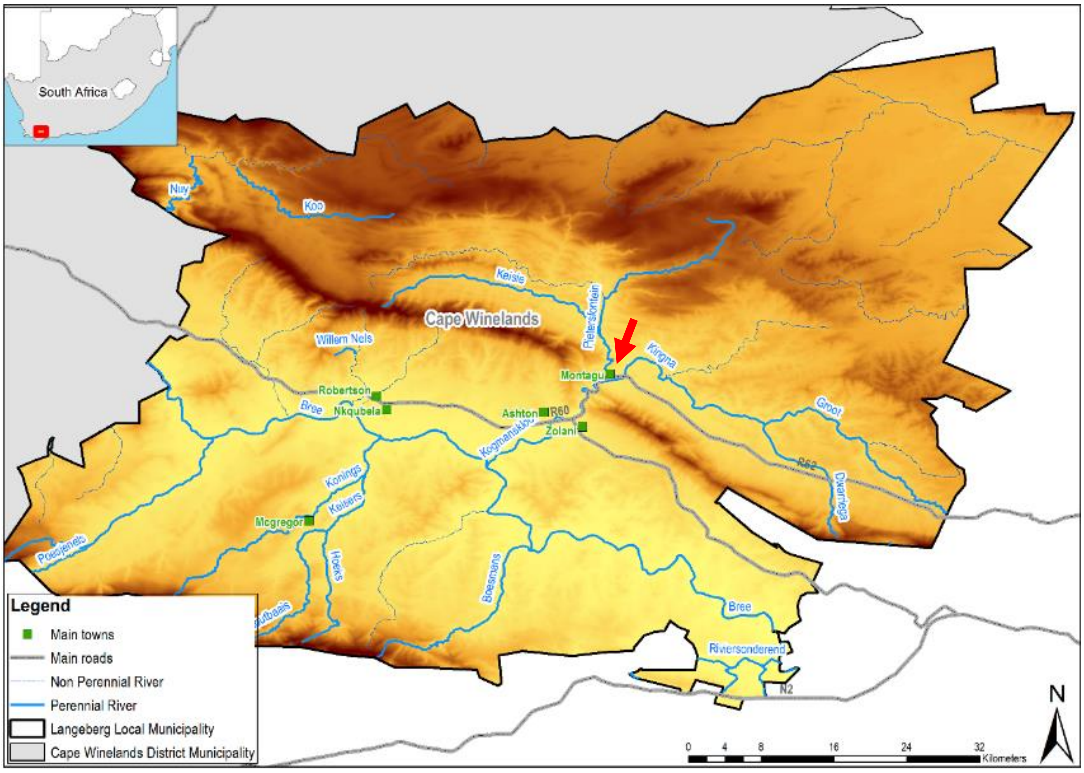

Figure 5: DEM of the LM with rivers, roads and mountain ranges indicated

In addition to rapid run-off associated with the steep gradients that characterise the LM mountain ranges, increased mountain rainfall is also attributed to topographical uplift (DiMP 2003). The 2003 report suggests that Montagu and Ashton could be particularly vulnerable in terms of the combined effect of increased rainfall and run-off due to steeper slopes (ibid; Lange).

Rogatschnig (2005) noted that from 1972-2003, conditions of both the northern (Montagu) and southern (Ashton) slopes as well as foothills of the Langeberg Mountains were poor and susceptible to degradation and erosion due to shallow soils and sparse vegetation cover in the steeper, higher altitude slopes. A combination of increased run-off and rainfall, along with a higher erosion potential along these slopes causing higher sediment and debris loads has increased the vulnerability of Montagu and Ashton.

4.2.1.2 Soil conditions

Many woody alien species including *Acacia mearnsii* and *A. saligna* are found in the Kogmans River Catchment, which form dense canopies, which prevent other vegetation to grow underneath which leads to poor surface cover increasing the potential for erosion (Rowntree 1991 & Rogatschnig 2005). These species favour shallow root systems, which are unable to withstand flash floods, increasing the risk of bank collapse (Rowntree 1991). According to Rogatschnig (2005) this occurrence is significant since flood damage in Montagu can often be attributed to reeds (*Phragmites australis* – 'fluitjiesriet' and *Arundo donax* – 'spaanse riet') and other vegetation and trees in rivers that were uprooted and carried downstream causing blockages against bridges or forces water sideways instead of downstream.

4.2.1.3 Catchment shape

The catchment's (e.g. Kogmans River Catchment) elongated and lobed shape and narrow river channels further increase the risk of flooding (Pharoah et al. 2016). The municipality is also characterised by isolated farming communities such as Baden, Koo, Noree, Dwariga and Agterkliphoogte that are located in valleys that can be cut off during floods. Isolation along with topography can have negative implications for cell phone communication, which is critical during a disaster and consequent possible evacuations. The mountainous topography has further negative effects on accurate forecasts for an area which already has limited radar coverage and instruments to monitor rainfall and river flow (Pharoah et al. 2016) (more detail in Section 5.7).

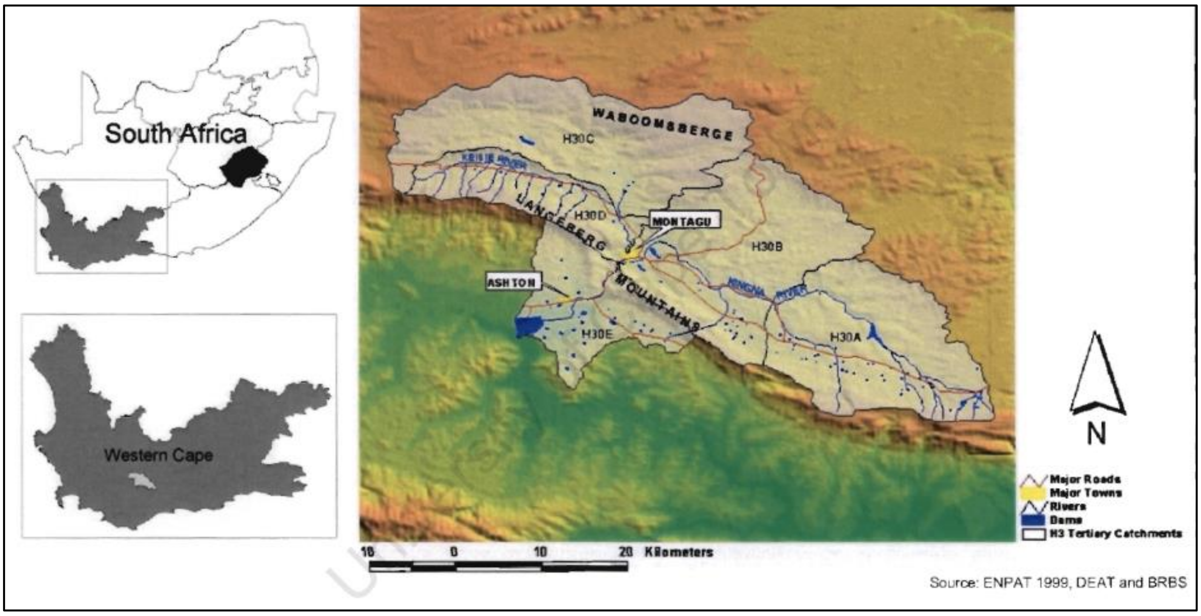

Figure 6: The Kogmans River Catchment in the LM (Source: Rogatschnig 2005)

The agricultural sector is largely served with irrigation water by two dams in the Kogmans River catchment (Figure 6) which were built and are maintained and administered by the Department of Water Affairs and Forestry (DWAF) (Rogatschnig (2005). The Pietersfontein Dam on the Pietersfontein River (completed in 1968) to the north west and Poortjieskloof Dam on the Keisie River (completed in 1955) to the east of the catchment are both Arch dams with heights of 29m and 35m and storage capacities of 2.097 million m^3 and 9.855 million m^3 respectively (DWAF 2003). According to Department of Water and Sanitation (2018) both dams have a 'high (3)' hazard potential which is the highest grading possible.

4.2.1.4 Meteorological and climatic risk drivers

The LM falls within the Western Cape's Mediterranean Climate region and in a winter rainfall region (DWAF 2003). The municipality has a strong seasonal disparity with hot and dry summers, while its winters are wet and humid (ibid). The region's rainfall is also seasonal, with most rainfall occurring between the months of June and August (highest in July with 35mm) and lower in January and February (Langeberg Municipality 2019). Topography has a further effect on rainfall, with the Langeberg mountain range receiving the highest mean rainfall (more than 1000 mm /annum in some places) (Langeberg Municipality 2019), while low-lying areas such as Bonnievale and McGregor receive the lowest (ibid).

In addition, past flood losses within the Langeberg indicate that cut-off low pressure systems play a crucial triggering role for flash flood events within the municipality. While mid-latitude cyclones also occur frequently in the area, COLs are more relevant for their hazard potential.

Figure 7 shows COL-induced extreme rainfall between 1983 and 2014 in the Western Cape "Extreme rainfall days are defined as the area-averaged daily rainfall over the Western Cape exceeding the 95th percentile for the period" (RADAR 2016, 9). The red bars show the rainfall for high-impact weather events in 2003, 2005, 2006, 2007 and 2008 in the Western Cape, while the blue bars show events in 2011, 2012, 2013 and 2014. The green arrows highlight rainfall in June 2011, July-August 2012 and November 2013, while the purple arrows point to the rainfall levels for the January 2014 event, which were amongst the highest since 1983. All these events significantly affected the LM, with identifiable impacts.

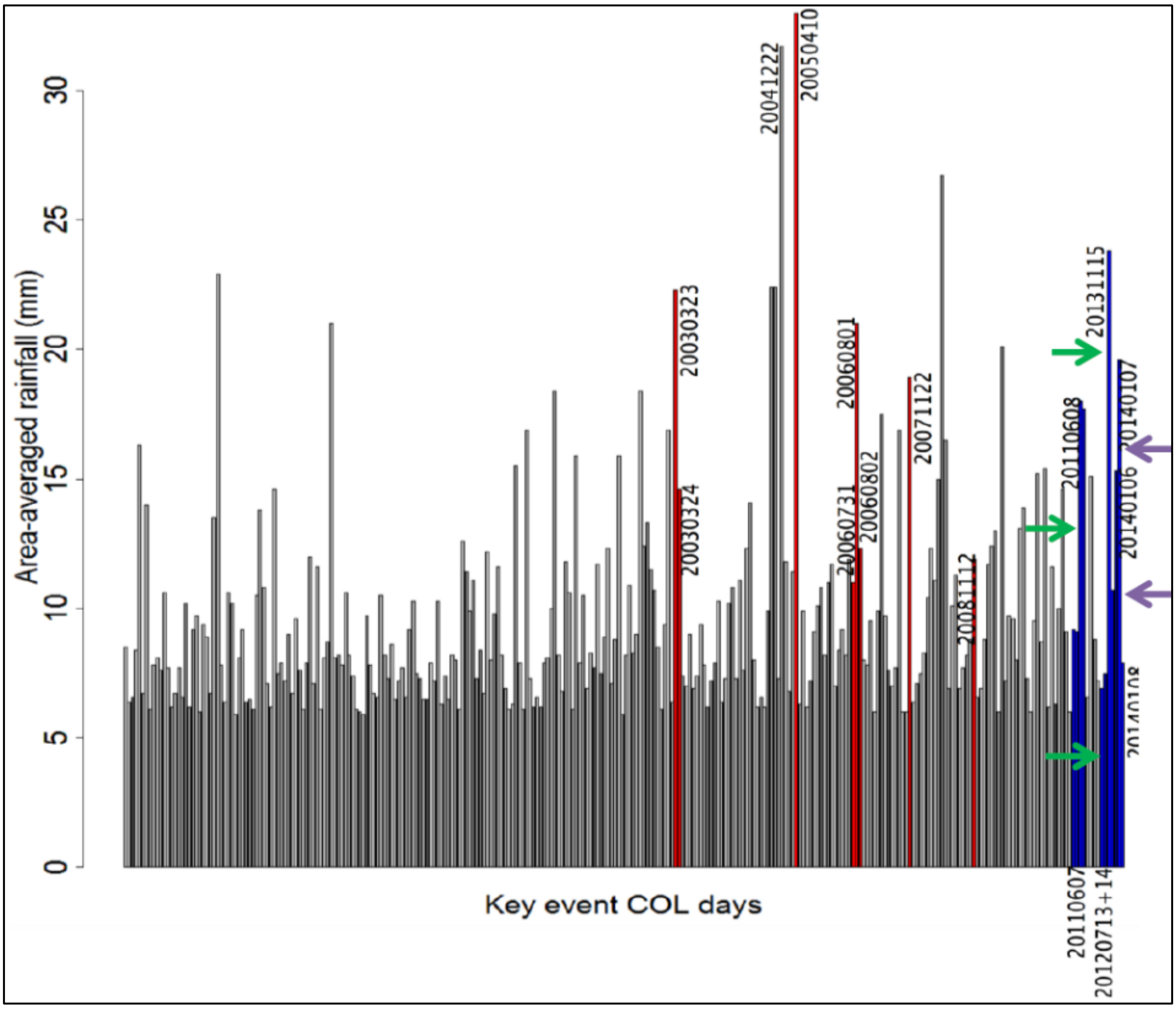

Figure 7: Cut-off low induced rainfall days during the period 1983 to 2014 (Source: RADAR 2016)

According to the World Meteorological Organization (WMO) (2014, 16-17), "Disasters occur when the ability of a population to protect itself from the impact of the weather is overcome. As countries become more developed, the level of protection becomes greater so that natural disasters become restricted to rarer, more extreme events….High impact weather includes not only disasters, but also those weather events whose impacts can be absorbed by society, but at significant cost. For instance, developed countries affected by winter weather, e.g. ice and snow that could kill many people in road accidents and stop business from operating…"

In this context, high impact weather in the Western Cape is often associated with COL weather systems (Engelbrecht et al. 2015). Similarly, Favre et al. (2012) profiled the region as one of the areas of southern Africa with the highest frequency of COLs.

A COL pressure system is an unstable and intense cold front that has become displaced equatorially out of the normal westerly current. It continues independently from the main mid-latitude cyclone to move eastwards as slower rate than a normal cold front, therefore releasing larger amounts of rain over a smaller area (Tyson & Preston-Whyte 2000; Favre et al. 2013). Its potential destructiveness is due to this detachment where the system loses significant momentum (quasi-stationary) and moves relatively slowly and can lead to large amounts of rainfall in a small area (Favre et al. 2013). This is why it has been identified as one of the main triggers for high impact flooding in the Western Cape (Pharoah et al. 2016; Holloway, Fortune & Chasi 2010). These systems are often associated with strong atmospheric instability, including thunderstorms, strong winds and/or widespread heavy precipitation (two or three consecutive days) especially as rain, hail or snow, particularly in coastal and mountain regions (Favre et al. 2013).

Figure 7, in combination with Table 1, underlines the links between extreme rainfall events and flood-related disasters in the Western Cape, and the LM. In terms of seasonality, Singleton & Reason (2007), Favre et al. (2012) and Engelbrecht et al. (2015) demonstrated that historically, COLs occurrences over the South Coast were more likely during autumn (March-May) and least likely in summer (November-January). Pharoah et al. (2016) consequently investigated disaster-triggering COLs from 2003-2014 and found that due to convective conditions, the majority of these events (over a larger area) occurred during the warmer months of September-February. Data for the LM specifically, showed that three such events occurred during the summer and three during autumn/winter.

4.2.2 Environmental/developmental

As is the case in many South African towns, many environmental and developmental factors within the LM aggravate possible flash-flood risk. These are wide-ranging, and include current land use as well as ongoing land-cover changes, urban development/expansion, but also interrelated environmental issues such as veld fires, alien vegetation and erosion.

4.2.2.1 Land-use and land-cover change

Urban and agricultural development changes catchment characteristics and can increase flood risk. Changing land-use patterns linked to among others increased impervious surfaces, which increase surface run-off and flood peaks (Dunne & Leopold 1978; Fletcher et al. 2013), especially in catchments such as Kogmans River in which Montagu is located where <20% of the catchment has undergone land-use change (Pharoah et al. 2016).

Dunne & Leopold (1978) state that outside the urban area, the conversion of land to agricultural uses affects the catchment’s hydrology, with increased run-off as one consequence, depending on the agricultural practice. Furthermore, the removal of natural riparian vegetation to make space for agricultural activities eliminates the natural buffer to reduce the flow rate of floodwaters increases runoff (Douglas 2007). Sabela (2010) found a cumulative increase of only 8% in agricultural land from 1963 – 2007 in the Keisie River catchment, which forms part of the larger Kogmans River catchment. A follow-up investigation will be done in this regard.

4.2.2.2 Veld fires

Apart from altering of catchments, many other contributing factors such as water resistant soils or hydrophobic due to recent veld fire, linked to fire-adapted vegetation (e.g., fynbos, grasslands, Rynosterveld) and alien vegetation (e.g., pine forests) can increase runoff (ibid; DeBano 2000). According to the CWDM (2016) the veld-fire season for LM is usually between December and April. Firefighting personnel have however noticed a change in the peak fire season with fires occurring as early as September that can continue until May, which they attribute to the climate change (ibid). Even though this peak season was identified, fires still occur throughout the year. Firefighters have observed that fires occurring during the summer months are larger in extent and severity (ibid). Langberg Municipality (2016) states that there is an increase in the number of fire incidences in the LM. In 2010 the municipality experienced 85 veld fires, 35 in 2011, 101 in 2012, 123 in 2013 and 91 in 2014 (CWDM 2016). According to Pharoah et al. (2016) veld fires in December 2010 and January 2011 exacerbated the flooding in 2008 and June 2011 by increasing the sediment and debris load in the Kogmans, Kingna and Keisie rivers contributing to blocked thoroughfares, river channels and bridges.

4.2.2.3 Alien vegetation

According to van Wilgen & van Wyk (1999) the Western Cape is different to the rest of the country in that entire catchments are affected by alien plants whereas in the rest of South African alien vegetation specifically dominates the riparian zones. Various species of grasses (such as *Avena, Bromus, Hordeum, Stipa capensis*), saltbushes (Australian desert - *Atriplex* sp. introduced in the mid-1800s for pastures and shrubby *A. nummularia*), trees (*Acacias, Eucalyptus, Prosopis and Hakea*) and reeds ('fluitjies' – *Phragmites* and 'Spaanse' - *Arundo donax*) (Figure 8a and 8b) have invaded indigenous vegetation such as shrubs in the Kogmans River Catchment which had been the cause of natural and human-induced landscape changes (ibid; Milton et al. 1999). Milton et al. (1999) also found that riparian zones, such as those in the Kogmans River Catchment, are especially vulnerable to alien invasion due to increased moisture availability caused by natural and human-induced disturbances such as abandoned fields, road verges, livestock watering points.

Figure 8a: 'Fluitjies' reeds in the Kogmans River (Source: de Kock 2018)

Figure 8b: 'Fluitjies' reeds in the Keisie River (Source: de Kock 2018)

Pharoah et al. (2016) and Rogatschnig (2005) subsequently found that the presence of alien vegetation is still a serious problem, which can also be related to hydrophobic soils. It provides higher fuel loads than indigenous vegetation, increasing the likelihood and intensity of fires, with more intense fires associated with the development of hydrophobic soils (van Wilgen & Richardson 1985; Scott 1993). According to Foxtrot (2008) the presence of alien vegetation during a flood will likely cause its further spread into areas that were previously uninfested. The LM is frequently affected by veld fire and the consequent presence of hydrophobic soils, causing increased run-off rates during flooding and its effects have been experienced.

4.2.2.4 Erosion

Higher runoff rates also increase erosion as consequence, which in turn can lead to sedimentation in river channels and storage dams (Scott 1993). Aggradation is "the increase (or build-up) in land or river bed elevation when sediment deposition exceeds erosion rates (US EPA 2012). There is also an increased sediment build up underneath alien vegetation, but also the removal of alien vegetation during a flood (DWAF 2004). According to US EPA (2012) sediment aggregation increases riverbeds, decreases the channel capacity, increases the width/depth ration of a river and can ultimately lead to river avulsion (Slingerland & Smith 1998) where new channels form, but only after water has caused over-bank flooding (Schumm 2005) in the process. Figure 9 below illustrates aggradation, which took place in Montagu during recent flooding. Increasing sediment accumulation (aggradation) in rivers in the LM is also partly due to poor agricultural practices, but also because of such activities encroaching into riverine areas (riparian zone) for better productivity (Pharoah et al. 2016).

Figure 9: Aggradation beneath the Voortrekker Bridge, Montagu (Source: Jan Durand in Pharoah et al. 2016)

4.2.2.5 Urban expansion/development

The United Nations International Strategy for Disaster Reduction (UNISDR) (2013; 2015a) stated that there is a "…growing global consensus on the links between development and disaster risk…" In the context of urban expansion, DiMP (2003) found that from 1960 – 1999, the Montagu town had grown 112.6% (5.76km^2 to 12.25km^2) while Ashton had grown by 64.6% during the same period. Due to the close proximity of the Kingna and Keisie Rivers, their convergence (Figure 10) and Montagu's rapid urban expansion, the town is increasingly vulnerable to flood damage.

Figure 10 includes the Montagu Springs Resort (at the top of the image, next to the Keisie River) and Ashbury (in the top right). It also shows the Kingna (right) and Keisie (left) rivers running through the town and converging (in the bottom left) to form the Kogmans River which then runs through the Kogmanskloof. While Ashton, on the other side of the pass has expanded mostly away from the R62 and the Kogmans River, the town still remains at risk of flooding (ibid).

Figure 10: Rivers running through Montagu (Source: DigitalGlobe 2019)

Associated with urban expansion, the location of critical infrastructure such as water, sanitation and electricity supply lines, sewage plants, pipelines and bridges, adjacent to these rivers, increased their exposure to flooding during the 2003 event (DiMP 2003; Holloway, Fortune & Chasi 2010).

Neethling (2015) and Pharoah et al. (2016) subsequently found that much of this infrastructure as well as residential and commercial property in most Langeberg towns is still situated in flood plains along major rivers, in river valleys or unsuitable locations in town. Figures 11a (in the Kogmanskloof) and 11b (Montagu Springs Resort) illustrate COL damage to critical road infrastructure that, not only disrupted crucial transport routes, but also led to temporary isolation of households and communities.

Figure 11a: Bridge and road damage in die Kogmanskloof during the 2003 COL (Source: CWDM 2018)

Figure 11b): Damage at the Montagu Springs Resort during the 2008 COL (Source: CWDM 2018)

Figures 12a and 12b show how infrastructure and residential areas have become increasingly exposed to flooding. These images include Montagu East in the bottom left and Ashbury in the top right. The right-hand image (2018) includes red and yellow circles, which illustrate infrastructural and residential expansion, compared to 2003 on the left. The red circle shows the location of Mandela City informal settlement in close proximity to the Kingna River.

Figure 12a: Montagu East in proximity of the Kingna River in 2003 (Source: DigitalGlobe 2019)

Figure 12b): Expansion of infrastructure and Asbury closer to the Kingna River by 2018 (Source: DigitalGlobe 2019)

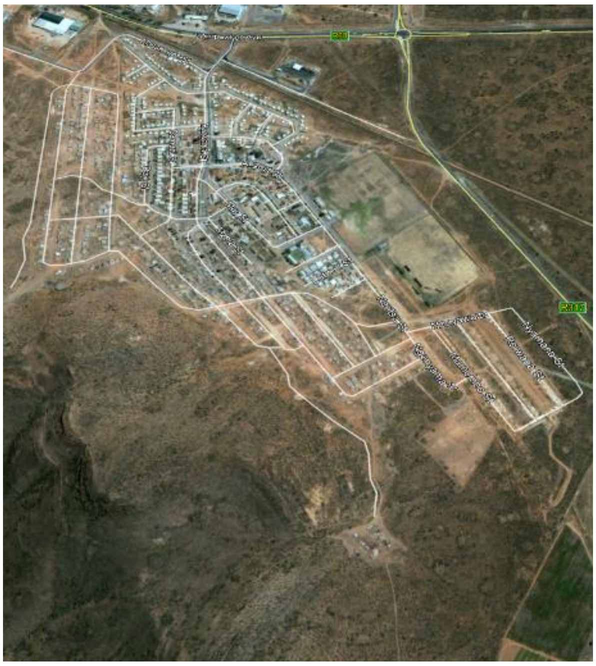

Figure 13a: Nkqubela (Robertson) in 2003 (Source: DigitalGlobe 2019)

Figure 13b): Expansion of Nkqubela by 2019 (Source: DigitalGlobe 2019)

Figures 13a (2003), 13b (2019) and 14 illustrate informal settlement expansion higher up against the mountain in Nkqubela, Robertson which increases residents' exposure to greater run-off. The red and blue circles show formal expansion whereas the yellow circle is informal expansion. Figure 14 shows a street view of this settlement. The close proximity of the mountain to the settlement is clearly visible along with the informal expansion behind the formal area and increasingly up the mountain.

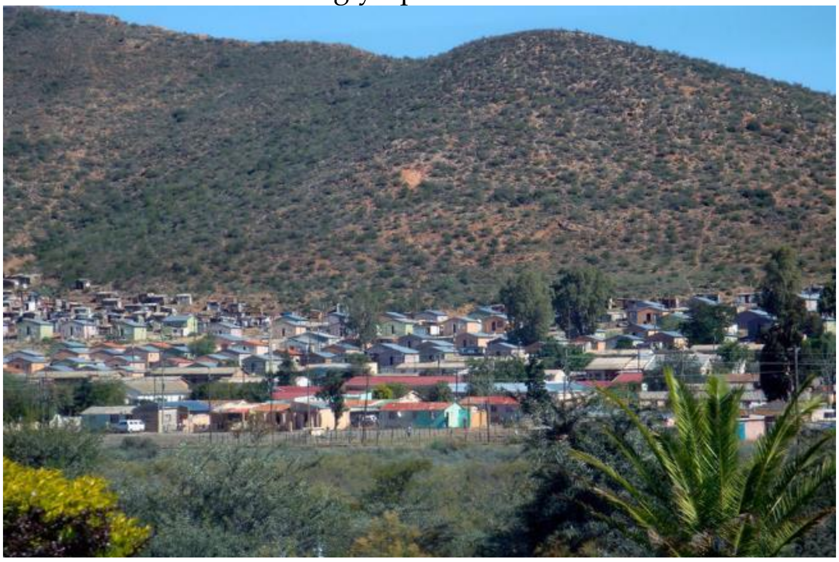

Figure 14: Street view of Nkqubela settlement in Robertson (Source: Peg Murray-Evans)

Midgley et al. (2005) and Pasquini, Cowling & Ziervogel (2013) also argued that the Western Cape could see increased extreme and variable weather, which may affect the lives and infrastructure due to flooding. To reduce flood exposure they propose that infrastructure be located outside of the flood-prone areas. However, because infrastructure often exists already, and there is no option but to build bridges and other structure in high-risk areas, in in the LM, the emphasis must be on reducing infrastructure's vulnerability to flooding (Midgley et al. 2005; Pasquini, Cowling & Ziervogel 2013).

Irregular maintenance of storm water systems was also identified as an increasing risk factor. For instance, litter, rubble and other dumped objects blocking storm water drains and streams, worsening the impact of floods (Knight Piésold Consulting 2014). During the 2003 flood, DiMP (2003) found that 462 dwellings in Nkqubela informal settlement (Robertson) were seriously affected by mountain and storm water run-off, as well as dwellings in Zolani (Ashton), due to blocked storm water drains.

Local and provincial efforts to "build back better" are indicated by the construction of a new arch bridge over the Kogmans River in the town of Ashton after the previous structure repeatedly failed or significantly damaged (Ronné et al. 2018). Recurrent damages were largely due to hydraulically inefficient openings, the number of substructure supports, and a high debris load during flooding (ibid). A detailed economic analysis suggested that the bridge replacement option was a cost-effective decision – complemented by temporarily maintaining the previous bridge until the new structure was completed (ibid).

The Montagu 'Leiwater Gruikersvereniging' (Irrigation Water Users Association) is another positive and a good example of how a civil society group can manage urban water supply effectively. According to montaguleiwater.co.za the original 'leiwater' system was already constructed before 1854, consisted of three parts made out of conduits (later concrete furrows) and would have been a high priority development in order to secure water from the Kingna and Keisie Rivers for the town and its farming activities. Every residential stand sold between

1851 and 1854 was entitled to one hour's irrigation water. Today still these erven have irrigation rights/turns (leibeurte) although the original water rights lapsed with the passing of the National Water Act No. 36 of 1998. Today, this system in use and managed by the Users Association who carefully monitors irrigation water supplied to residences and smallholdings

4.2.3 Socio-economic-demographic risk drivers

This section includes conditions of poverty, vulnerability and marginalisation which are often most prevalent in certain areas. These conditions are closely linked to seasonal labour and associated traveling to work due to the LM which is agriculturally extensive with employment highly determined by agricultural processes and cycles, in turn often leaves people without work during 'off-seasons'.

Table 3 provides a detailed breakdown of population numbers in the LM, according to the five towns (Montagu, Robertson, Ashton, Bonnievale and McGregor), as well as low cost/informal housing settlements of Ashbury in Montagu, Nkqubela in Roberton, Zolani in Ashton and Happy Valley and Mountain View in Bonnievale. Non-urban (NU) population for the towns are also included where available. Population data were further stratified according to the four racial groups in South Africa (White, Black African, Coloured and Asian or Indian), as well as the for three census years (1996, 2001 and 2011).

The common theme in the data is that racial groups are more concentrated in certain areas or settlements. In terms of urban settlement in Montagu, white people are practically located in the town only while the coloured population is spread across the town, but mostly in Ashbury. From 1996 to 2001, the coloured population in Montagu and Montagu NU saw a notable decrease due the establishment of Ashbury after 1996. The municipality, in conjunction with the local farmers, was responsible for this development to rehouse mainly farm workers, which explains its population of more than 3 500 people at its first census in 2001 and a subsequent almost doubling in 2011. Numbers for Black Africans and Indian or Asian residents are significantly lower than the other two groups.

In Robertson, a similar division is evident, except that the Nkqubela is a predominantly Black African settlement which also had a steady increase in numbers from 1996-2011. The rest of Robertson and NU are largely populated by coloured and white South Africans, as well as a Black African population that has noticeably increased since 1996. Bonnievale does not have a significant difference in the three population groups while the Happy Valley and Mountain View low cost housing settlements next to Bonnievale, as well as Ashbury in Montagu, have primarily coloured residents, whose numbers have also grown since 2001.

Table 3 in combination with Table 4 and Figure 15 show how the town-based population of the LM increased by +/-150% in only 15 years, while the Black African population doubled and Coloured population also grew significantly. It also shows that from 1996 – 2011, the populations of five particular settlements/suburbs (Ashbury, Nkqubela, Zolani Happy Valley and Mountain View) increased. While these claimed a minimal share of the population in the 1990s, in 2011, their combined population (in primarily low income or informal settlements) was greater than 25 000, or more than a quarter of the LM's total population. This rapid urban growth, for a rural area, has had numerous implications for both flood exposure and vulnerability, along with escalating demands on municipal services. In this context, it has changed the socio-demographic landscape of flash-flood early warning, just as much as biophysical adjustments.

Table 3: Comparative information on demographics for the LM, by race groups, reported by South Africa Census results 1996, 2001 and 2011

	1996						2001						2011						
	W	**C**	**BA**	**I/A**	**Tot**	**%**	**W**	**C**	**BA**	**I/A**	**Tot**	**%**	**W**	**C**	**BA**	**I/A**	**Tot**	**%**	**Diff. +/-**
Montagu	1 998	6 342	88	13	8 441	13.5	2 252	4 206	109	13	6 580	8.1	2 475	4 553	731	55	7 814	8.1	-5.4
Ashbury	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	3 596	90	1	3 688	4.5	12	6 931	243	28	7 214	7.4	+2.9
Montagu NU	883*	5 272*	196*	0*	6 351*	10.2*	752^	4 775^	297^	1^	5 825^	7.2^	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-3.0
Montagu Subt.	**2 881**	**11 614**	**284**	**13**	**14 792**	**23.7**	**3 005**	**12 577**	**496**	**15**	**16 093**	**19.8**	**2 487**	**11 483**	**974**	**83**	**15 027**	**15.5**	**n.a.**
Robertson	3 950	10 820	297	13	15 080	24.2	3 715	13 378	1 217	28	18 338	22.6	4 063	16 393	1 133	92	21 681	22.4	-1.8
Nkqubela	0	100	2 143	0	2 243	3.6	3	396	2 861	0	3 260	4.0	5	454	5 306	0	5 765	6.0	+2.4
Robertson NU	1 571#	12 429#	808#	15#	14 823#	23.8#	2 098+	15 721+	1 560+	7+	19 386+	23.9+	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	+0.1
Robertson Subt.	**5 521**	**23 349**	**3 248**	**28**	**32 146**	**51.5**	**5 816**	**29 495**	**5 638**	**35**	**40 984**	**50.4**	**4 068**	**16 847**	**6 439**	**92**	**27 446**	**28.3**	**n.a.**
Ashton	697	4 323	46	4	5 070	8.1	757	5 853	1 399	1	8 010	9.9	666	6 671	320	23	7 680	7.9	-0.2
Zolani	0	18	3 255	0	3 273	5.2	42	118	3 476	0	3 636	4.5	4	451	5 128	7	5 590	5.8	+0.6
Ashton NU	incl.*	incl.*	incl.*	incl.*	incl.*	incl.*	incl.^	incl.^	incl.^	incl.^	incl.^	incl.^	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Ashton Subt.	**697**	**4 341**	**3 301**	**4**	**8 343**	**13.4**	**799**	**5 971**	**4 875**	**1**	**11 646**	**14.3**	**670**	**7 122**	**5 448**	**30**	**13 270**	**13.7**	**n.a.**
Bonnievale	1 188	3 812	175	2	5 177	8.3	1 138	3 676	234	6	5 054	6.2	924	513	316	0	1 753	1.8	-6.5
Happy Valley & Mountain View	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	50	1 457	182	0	1 689	2.1	50	6 330	691	21	7 092	7.3	+5.2
Bonnievale NU	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	529	2 554	355	0	3 438	4.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Bonnievale Subt.	**1 188**	**3 812**	**175**	**2**	**5 177**	**8.3**	**1 717**	**7 687**	**771**	**6**	**10 181**	**12.5**	**974**	**6 843**	**1 007**	**21**	**8 845**	**9.1**	**n.a.**
McGregor	245	1 534	144	1	1 924	3.1	318	2 001	48	0	2 367	2.9	400	2 586	102	28	3 116	3.2	+0.1
McGregor NU	incl.#	incl.#	incl.#	incl.#	incl.#	incl.#	incl.+	incl.+	incl.+	incl.+	incl.+	incl.+	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
McGregor Subt.	**245**	**1 534**	**144**	**1**	**1 924**	**3.1**	**318**	**2 001**	**48**	**0**	**2 367**	**2.9**	**400**	**2 586**	**102**	**28**	**3 116**	**3.2**	**n.a.**
Langeberg NU	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**3 383**	**23 827**	**1 911**	**57**	**29 178**	**30.1**	**n.a.**
Total	**10 532**	**44 650**	**7 152**	**48**	**62 382**	**100**	**11 655**	**57 731**	**11 828**	**57**	**81 271**	**100**	**11 982**	**68 708**	**15 881**	**311**	**96 882**	**100**	

Notes: As Ashbury; Happy Valley and Mountain View did not exist in 1996, data are not applicable., n.a. otherwise means not available
NU stands for Non-Urban. The 2011 census did not disaggregate this population for each town, only for the entire Municipality.
Due to different municipal boudaries in 1996 and 2001 some areas were groups together i.e. Ashton NU is included in Montagu NU (* for 1996 and ^ for 2001) and McGregor NU with Robertson NU (# for 1996 and + for 2001).
W = White; C = Coloured; BA = Black African; I/A = Indian/Asian

Table 4: Summary of demographic profile for the LM, by race groups

	Census Year					
	1996		2001		2011	
Pop. group	No.	%	No.	%	No.	%
White	10 532	16.9	11 665	14.4	11 982	12.4
Coloured	44 650	71.6	57 731	71.0	68 708	70.9
Black African	7 152	11.5	11 828	14.6	15 881	16.4
Indian/Asian	48	0.1	57	0.1	311	0.3
Total	**62 382**		**81 271**		**96 882**	

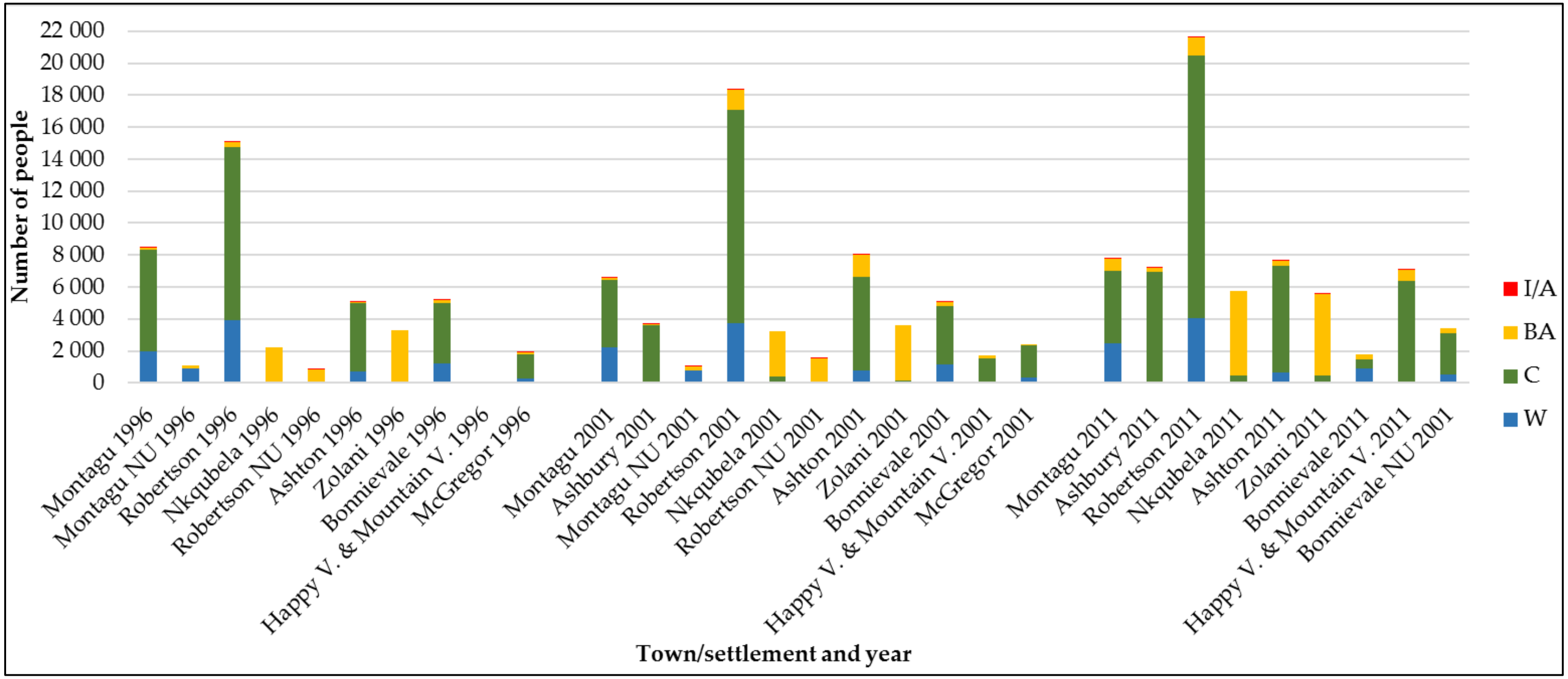

Figure 15: Graphic comparison of demographics for the LM, by census year, race and town/settlement

Table 5 illustrates how language is closely linked to specific areas in the LM. Afrikaans is predominantly spoken throughout the municipality, except for Nkqubela and Zolani where IsiXhosa is the main language. However, Table 5 also indicates changes over time in language preferences. For instance, from 1996-2011, the Afrikaans-speaking populations in Montagu and Bonnievale declined to 86% and 77% respectively. Similarly, the number of IsiXhosa speaking residents in Nkqubela and Zolani respectively decreased to 69% and 83% from at least 95% in 1996. This can attributed to an increase in other languages such as IsiZulu, Sesotho, Setswana and IsiNdebele spoken across South Africa - reflecting in-migration patterns during this period.

Table 5: Demographics (in %) according to language (1996, 2001 and 2011)

	Afrikaans			English			IsiXhosa		
	1996	2001	2011	1996	2001	2011	1996	2001	2011
Montagu	94.8	90.8	85.8	4.3	8.2	10.3	0.4	0.2	1.8
Ashbury	n.a.	97.9	96.3	n.a.	0.1	0.9	n.a.	3.0	1.8
Montagu NU	96.7*	94.3^	n.a.	1.1*	1.4^	n.a.	1.2*	1.3^	n.a.
Robertson	97.7	93.0	92.9	1.7	1.8	3.7	0.5	4.9	0.9
Nkqubela	4.4	13.2	9.8	0.0	0.0	1.5	94.5	84.2	69.2
Robertson NU	95.1#	94.3+	n.a.	1.0#	1.2+	n.a.	3.3#	4.2+	n.a.
Ashton	98.9	82.8	95.1	0.7	0.8	1.3	0.0	15.7	1.0
Zolani	0.8	4.7	9.1	0.0	0.0	1.7	98.7	93.3	82.8
Ashton NU	incl.*	incl.^	n.a.	incl.*	incl.^	n.a.	incl.*	incl.^	n.a.
Bonnievale	96.5	95.8	77.2	1.0	0.9	3.5	1.6	2.9	12.7
Happy Valley and Mountain View	n.a.	91.0	93.1	n.a.	0.6	1.2	n.a.	7.9	4.2
Bonnievale NU	n.a.	91.6	n.a.	n.a.	1.8	n.a.	n.a.	6.6	n.a.
McGregor	89.3	88.6	86.6	10.0	10.0	10.4	0.4	1.4	1.7
McGregor NU	incl.#	incl.+	n.a.	incl.#	incl.+	n.a.	incl.#	incl.+	n.a.
Langeberg NU	n.a.	n.a.	93.3	n.a.	n.a.	2.3	n.a.	n.a.	1.9

Notes: Refer to the notes for Table 3. Percentages for the three most prominent languages spoken in the LM are illustrated while the remaining numbers for others languages are not shown.

In this context, Table 5 is highly instructive for guiding locally meaningful risk communication and early warning efforts. Not only does it foreground an increasing diversity in languages spoken and culture, it also practically underlines the need for locally nuanced risk communication and early warning efforts. The table's results show the need for warning and risk reduction planning to go beyond one or two languages, and the importance of aligning risk communication strategies with the languages and cultures in specific localities.

4.2.3.1 Poor and marginalised households

A study conducted by Andrews, Zamchiya & Hall (2009, 180) on the Breede River Winelands Municipality (renamed as the 'Langeberg Municipality' in 2009) stated that "the demise of apartheid has not changed the conditions in the townships and shack villages that stand alongside lush green vineyards and hectares of peach and apricot orchards." They further stated that Nkqubela, Ashton is the fourth poorest township in the Western Cape (ibid). A wealth gap between the white landowners and the poor and marginalised was also identified, which is evident in the high demand for land (75%).

The 2003 Montagu Flood Report (DiMP 2003) showed that the poor, vulnerable and marginalised households in Zolani and Ashton were severely affected during the 2003 extreme flood event. The greatest losses experienced by low-income households whose houses lacked structural integrity and who were residing in riverine areas along the Kingna River in Ashbury (Montagu). The Langeberg Municipality (2017) subsequently showed parts of Zolani and Ashbury were still in poverty and marginalised.

During the 2003 flood (March), households reported damages to "TVs, fridges, hi-fis, washing machines, carpets, mattresses, blankets and clothing", while some houses in Ashbury structurally failed (DiMP 2003, 65). The authors further stated: "Many of the weather-affected households in Ashbury live in chronic conditions of poverty and livelihood insecurity, surviving from one unpredictable weekly wage to another. Food insecurity is a constant pressure in the months outside the farming season, as most seasonal workers are unemployed. The heavy rains, flooding and disruption of road links had powerful impacts on already vulnerable households with fragile livelihood strategies (DiMP 2003, 79)." The loss of information sources such as TVs and radios has implications for early warning to be received.

4.2.3.2 Seasonal employment, and implications for flood risk

As the LM is an agriculturally oriented municipality, it depends heavily on seasonal labour during the harvest period (October/November - April). During this period the municipality experiences a significant increase in additional farm labourers. Linked to the agriculture sector is a fruit processing factory (Langeberg – Ashton Foods - Division of Tiger Consumer Brands) in Ashton which employs a significant number of seasonal labourers annually (including on-farm labour). According to CPUT (2008) average employment figures obtained from Tiger Brands illustrate a low of 700 in October to 6 000 and 5,000 respectively for December and January.

As there is insufficient and inadequate accommodation on commercial farms, workers often live in Ashbury, Zolani or Nkqubela and travel long distances to work. During high-season periods, an influx of people from outside the municipality puts additional stress on a housing provision sector already under pressure, as well as on other municipal services such as water and sanitation, electricity, refuse removal and employment competition. During the 2003 flood, only 24 permanent employees of the factory were provided accommodation and subsistence for 11 days until the pass reopened, while seasonal labourers had to rely on family and friends in Ashton, Robertson or Bonnievale (DiMP 2003).

As previously stated, communities within the LM remain largely differentiated by race and language. In specific areas like Zolani, Ashbury and Nkqubela, this differentiation has socio-developmental implications, including dependency due to unemployment, illiteracy and crime rates, poverty, basic services delivery, public health problems and marginalisation (LM 2017). CPUT (2008) and DiMP (2003) noted that, during off-season, casual workers do not have alternative sources of income and are not entitled to access the Unemployment Insurance Fund (UIF), but rely on pensions and child and disability grants. This greatly contributes to poverty in the area.

The combination of a seasonally increased workforce (that is both located far from its place of work and depends on functioning road routes and transport services), and the potential coinciding disruptive severe weather events during these months (illustrated in section 4.2.1.4) that suddenly disrupt access to work, places this population at particular risk. The 2003 COL and its impacts starkly foregrounded this relationship when many workers at the canning factory in Ashton (but who lived in in Ashbury, Montagu) could not travel through the Kogmanskloof pass to get to work due to road damage (DiMP 2003).

In this context, past studies (DiMP 2003; Holloway, Fortune & Chasi 2010; Pharoah et al. 2016) highlight how social-economic circumstances exacerbate flood impacts in these areas. Such socio-economic divisions speak to the need for nuanced, nonhomogeneous approaches to early warning for severe weather (e.g. early warning in only one language).

5. DISASTER RISK GOVERNANCE

5.1 Evolution of disaster management legislation in South Africa

As the governance of flash-flood risks is a cross-sectoral and multi-scalar process, it involves multiple public and private sector stakeholders. These include numerous government departments and ministries, local, provincial and national governmental entities, as well as private landowners. In this context, South Africa's disaster management legislation represents a crucial crosscutting mechanism for integrating flood risk management efforts with both development planning, as well as in times of heightened flood risk.

South Africa has a long history of civil protection, emergency medical response and fire brigade services. However, accelerated urgency for disaster-related legislative reform became evident in June 1994 due to severe floods in Cape Town's poorest informal settlements (Pelling & Holloway 2006). In the ensuing 11 years, consultative and legislative processes resulted in Green and White Papers on Disaster Management, culminating in a Disaster Management Act (No. 57 of 2002) that was promulgated in January 2003 (ibid). This ambitious legislation, that pre-dated the Hyogo Framework for Action, made provisions for

- "an integrated and co-ordinated disaster management policy that focuses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery and rehabilitation;
- the establishment and functioning of national, provincial and municipal disaster management centres;
- disaster management volunteers" (Republic of South Africa 2003)."

It was followed two years later by a comprehensive National Disaster Management Framework to guide the implementation of the Act (Republic of South Africa 2005). Box 1 foregrounds the Framework's aspirational intent on developmental vulnerability reduction as well as wide-ranging consultation across government, private sector and civil society organisations.

Box 1: Focus of the National Disaster Management Framework, excerpted from South Africa's Disaster Management Act

Contents of the national disaster management framework

7. (1) The national disaster management framework must provide a coherent, transparent and inclusive policy on disaster management for the Republic as a whole.

(2) The national disaster management framework must reflect a proportionate emphasis on disasters of different kinds, severity and magnitude that occur or may occur in southern Africa, place emphasis on measures that reduce the vulnerability of disaster prone areas, Communities and households, and must –

…

(f) facilitate –

(i) the involvement of the private sector, non-governmental organisations, traditional Leaders, technical experts and volunteers in disaster management.

(ii) Community participation in disaster management; and

(iii) Partnerships for purposes of subparagraphs (i) and (ii) between organs of state and the private sector, non-governmental organisations and communities.

Source: Republic of South Africa (2003); Pelling & Holloway (2006)

The founding legislation foresaw a complex architecture of structures and policy instruments to be implemented both transversally across government, as well as vertically from municipal to national scales. These included the establishment of staffed and funded disaster management centres at national, provincial and district/metro scales, as well as a suite of policy and planning instruments to embed disaster management with integrated development planning across all spheres of government.

However, among its many challenges, the legislation was constrained by designations "in Part A of Schedule 4 of the Constitution of the Republic of South Africa that 'disaster management' should be an area of concurrent national and provincial competency, and not a municipal competency" (Pelling & Holloway 2006, 23). This designation resulted in disaster management being viewed as an 'unfunded mandate' for local municipalities, actively, counter-intuitively, deterring investment in disaster risk management at local level, where risk management efforts were most needed.

In 2015, the Disaster Management Amendment Act sought to correct this disaster governance shortcoming. It introduced legal provisions for local municipalities, such as the Langeberg Municipality to establish disaster management capabilities and plans in consultation with district municipalities (in this instance, the Cape Winelands District Municipality). The amendment specified that:

> "(3) A local municipality must establish capacity for the development and co-ordination of a disaster management plan and the implementation of a disaster management function for the municipality which forms part of the disaster management plan as approved by the relevant municipal disaster management centre.
>
> (4) A local municipality may establish a disaster management centre in consultation with the relevant district municipality in accordance with the terms set out in a service level agreement between the two parties, in alignment with national norms and standards" (Republic of South Africa 2015).

Prior to the promulgation of the 2015 legislation, no legal provision existed empowering local municipalities to establish their own capability for disaster management.

5.2 National and provincial structures for disaster management[1]

South Africa's disaster management architecture is complex and multi-scalar. The range and scope of activities is illustrated by Figure 16 as an organogram showing the functional structure of the National Disaster Management Centre, situated in Pretoria.

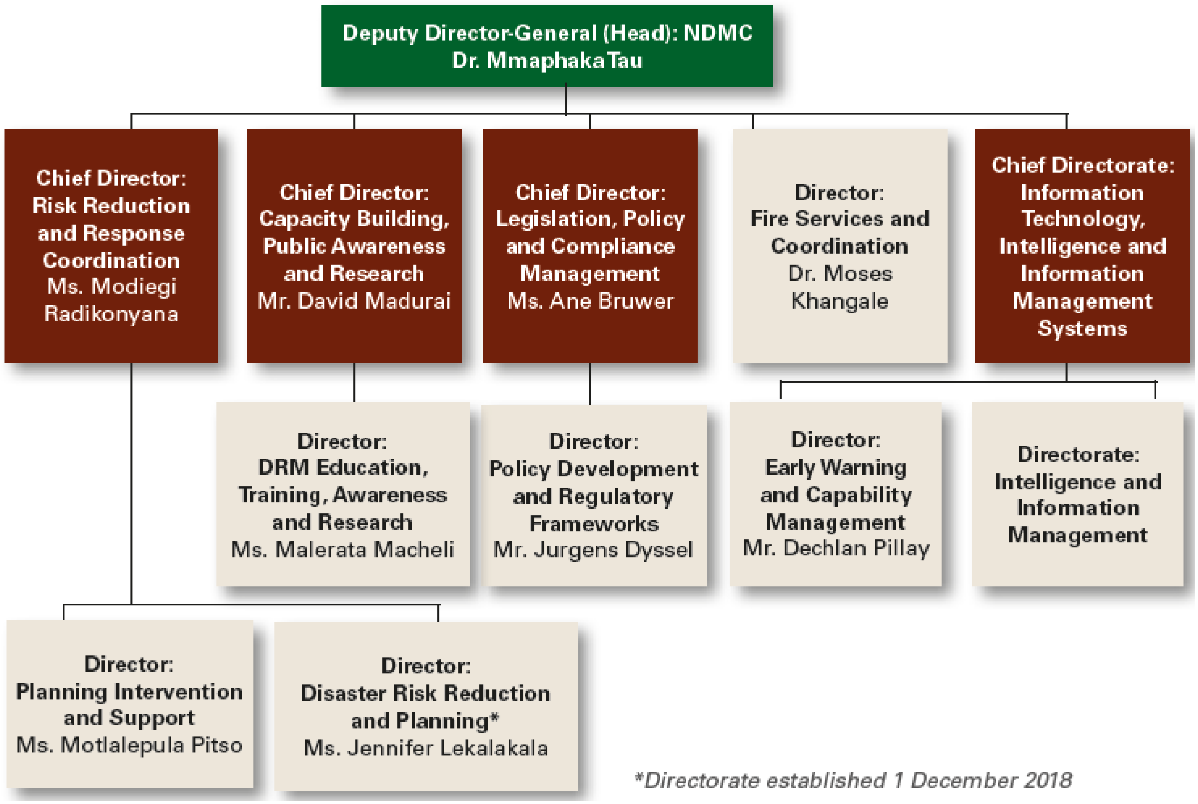

Figure 16: Functional structure of the National Disaster Management Centre (NDMC) Source: Republic of South Africa (2018)

Similarly, Figure 17 below schematically represents the articulation of disaster management functions across national, provincial and municipal spheres. It illustrates how the 'DMAFs' (National, Provincial and Municipal Disaster Management Advisory Forums) play advisory roles in each sphere of government. The organogram also shows how the operational 'DMCs' (National, Provincial and Municipal) articulate vertically, and foregrounds the crucial role played by the Intergovernmental Committee on Disaster Management (ICDM) – an inter-ministerial policy-setting forum, in shaping transversal disaster risk-related policy and strategy. (Republic of South Africa 2018, 94-95).

[1] See the National Disaster Management Centre's 2017-2018 report for detailed explanation of its activities, funding and structures at http://www.ndmc.gov.za/AnnualReports/NDMC%20Annual%20Report%202017-18.pdf

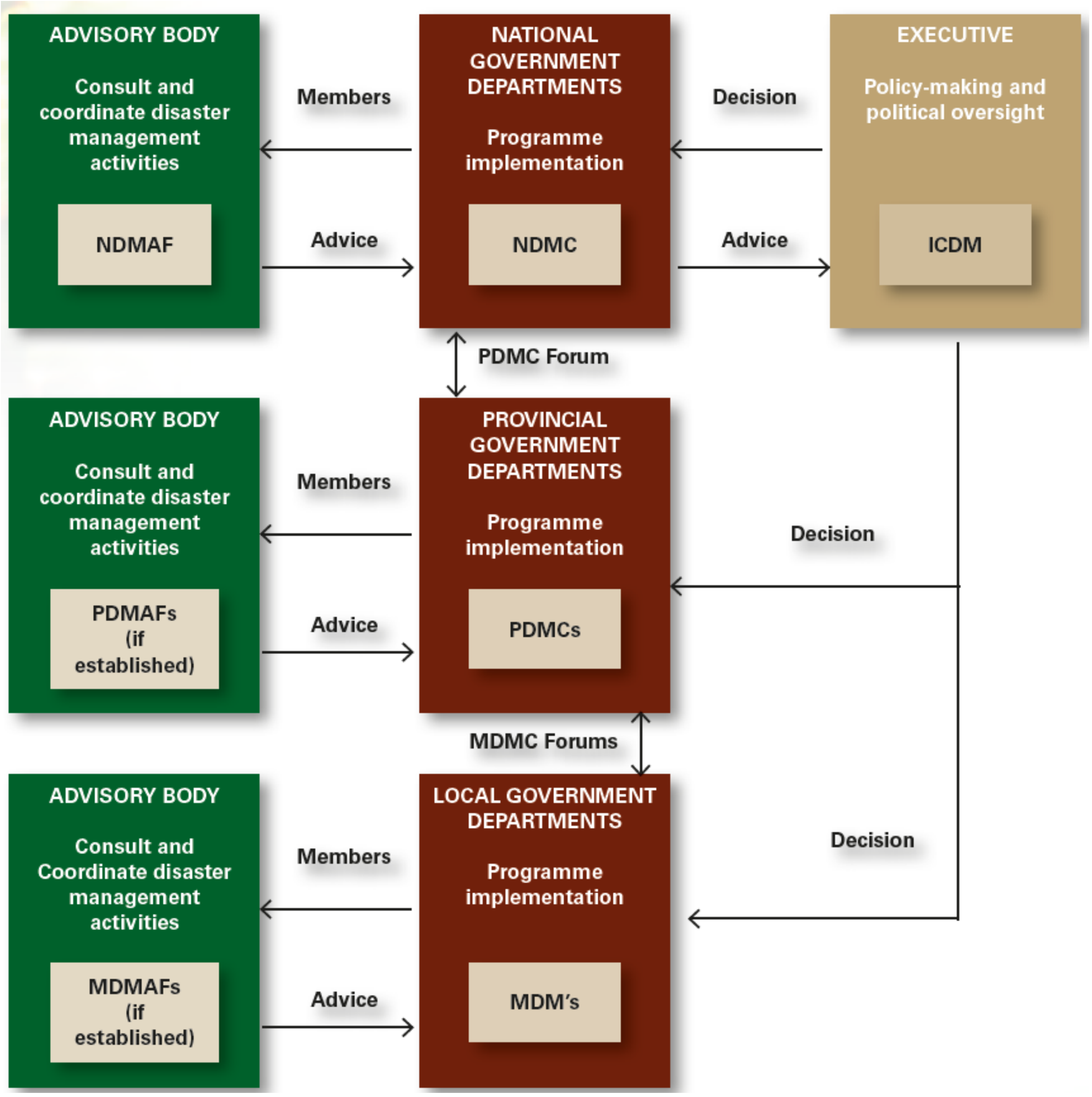

Figure 17: Institutional structures and coordination for disaster management across the three spheres of government (Source: Republic of South Africa 2018)

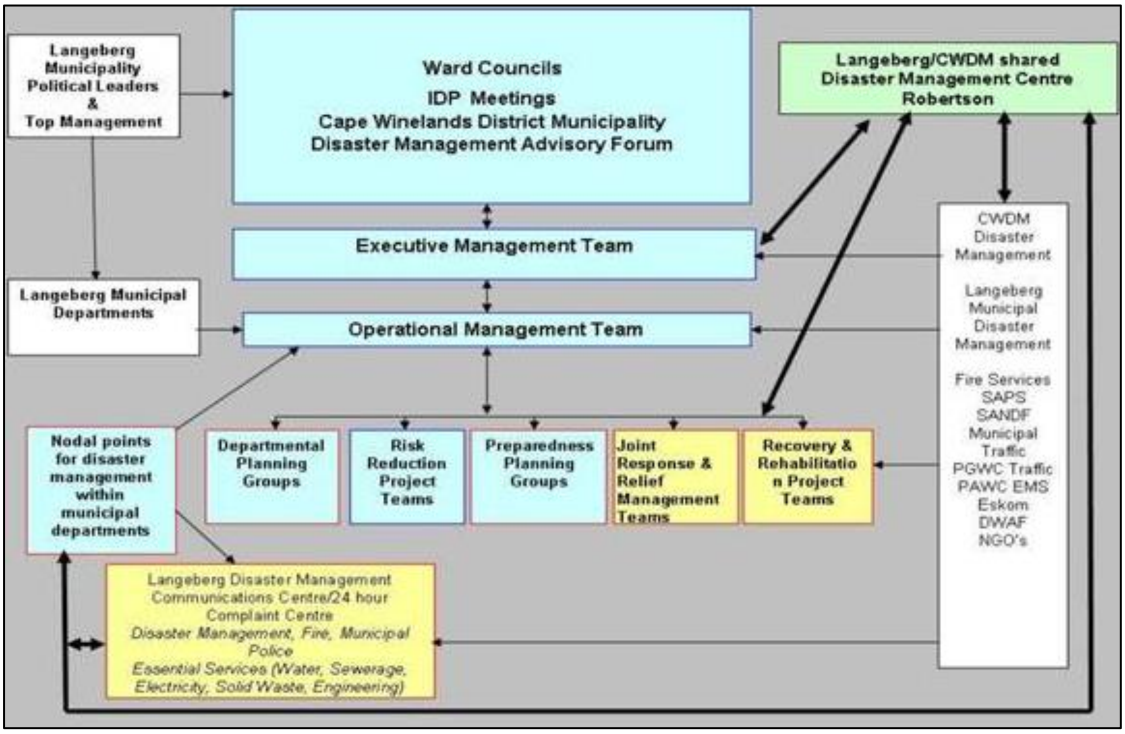

Figure 18: Corporate Disaster Management Structure of the LM (Source: LM 2018)

Figure 18 shows how Disaster Management is institutionally and structurally located within the LM. After Municipal Disaster Management Centres have been established the municipalities are expected to have a Disaster Management Plan which can be seen below in Figure 19. It illustrates the 'instruments', plans and documents that allow for DM to be integrated with other planning processes.

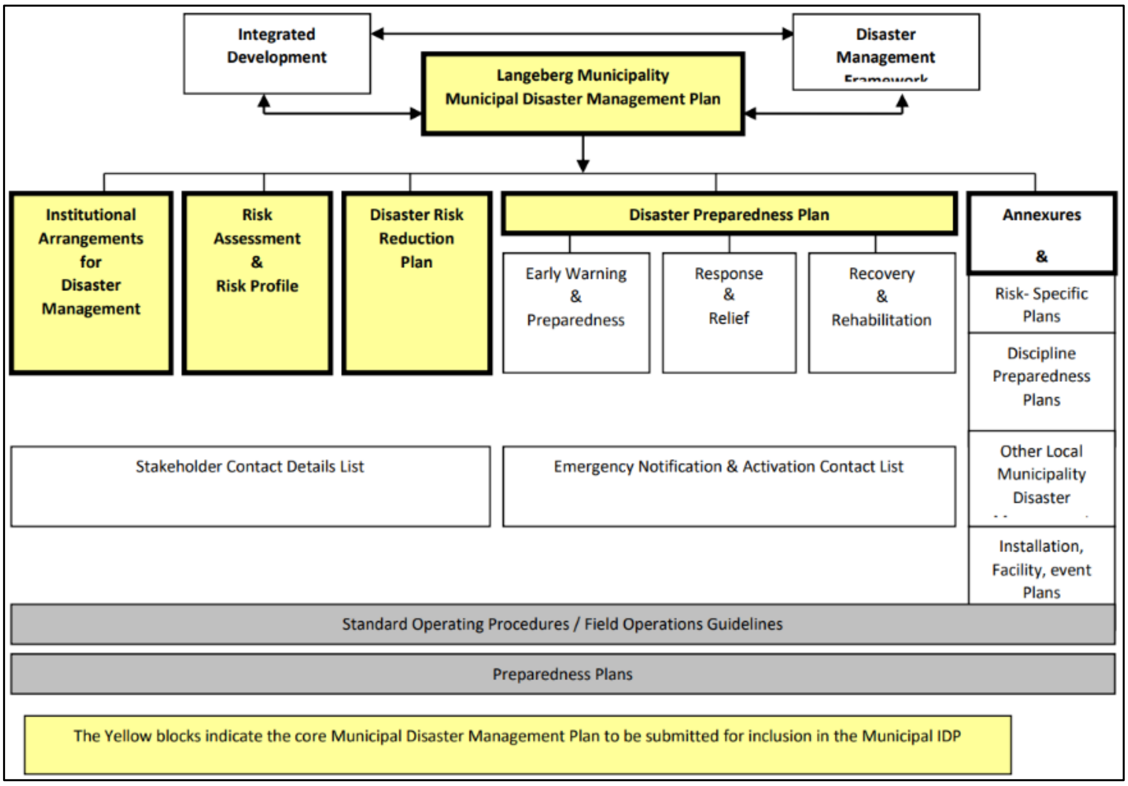

Figure 19: The Municipal Disaster Management Plan of the LM (Source: LM 2018)

5.3 Disaster risk related legislation, plans and organisations

Table 6: Legislation, plans and organisations related to disaster risk management (Source: IFRC 2012, Republic of South Africa, 2018)

Legislation, plan or organisation	Description
National Water Resources Act 36 of 1998 Water Services Act 108 of 1997 Working on Water (WoW)	Regulates the protection, use, conservation, management of water resources (rivers, springs, canals, wetlands, dams, surface water, estuaries and aquifers), excluding the supply of potable water. Progressively becoming the responsibility of Catchment Management Agencies (CMAs). Deals with the provision of potable water. (Responsibility if local governments with oversight on provincial and national government). The WoW programme specialises in alien vegetation by reducing the density of established, terrestrial, invasive alien plants, through labour intensive, mechanical and chemical control.
National Veld and Forest Fire Act 101 of 1998 Fire Protections Associations (FPA) Working on Fire (WoF)	Administered by the Department of Agriculture, Forestry and Fisheries. Intended to prevent and combat veld fires. Strong DRR focus through the fire danger rating system and firebreaks. Key to the functioning of the above are fire protection associations (FPAs) which are associations of landowners empowered to deal with all aspects of veld fire prevention and firefighting. Although not legislation WoF is administered under the auspices of the Department of Water and Environmental Affairs. WoF is a government funded, multi-partner organization focusing on integrated fire management, poverty alleviation and job creation.
National Climate Change Response Green Paper 2010	Identifies the actions needed in three key mitigation sectors (energy, industry and transport), three adaptation sectors (water, agriculture and human health), and further outlines the implications of climate change integration on a number of other sectors, including the disaster management sector. Acknowledges disaster management legislation that sets out a comprehensive approach to disaster management and identifies the roles and responsibilities of key institutions and disaster management agencies.
South African Weather Service Amendment Act 48 of 2013	The SAWS is mandated by its Act to be the sole provider of severe weather-related warnings over South Africa in order to ensure that there is a single authoritative voice in this regard. The SAWS has therefore established links for dissemination of advisories and warnings to the National Disaster Management Centre and a number of the Provincial and Municipal Disaster Management Centres. Its officials also participate in the National and Provincial Disaster Management Advisory Forums, and in meetings and conferences related to disaster management activities (NDMC 2006). Forecasters of the National Forecasting Centre in Pretoria and Regional Forecasting Offices in Durban, Port Elizabeth, Cape Town and Bloemfontein issue advisories

	and warnings for severe weather. Warnings are also issued via SMS specifically to disaster managers in relevant regions in support of their decision-making. The SAWS maintains a climatological database of weather data over South Africa that is used regularly in disaster risk reduction and mitigation activities by various role-players.
River Maintenance Management Plans (RMMPs)	The development of River Maintenance Management Plans (RMMPs) across the Western Cape now offers an alternative avenue to expedite the Environment Impact Assessment (EIA) process (ibid). A catchment-specific RMMP is collectively established by various relevant stakeholders such as water specialists, the Department of Agriculture, Department of Environmental Affairs and Development Planning, catchment management agencies, water users associations, Cape Nature, land owners etc. which should provide land owners clear guidelines when a certain activity is allowed within a river.
Conservation of Agricultural Resources Act 43 of 1983 (CARA)	Allows for control measures, issues directions and establishes schemes, all of which may pertain to various forms of DRR or relief. Control measures are applicable to land users and may relate for example, to the prevention and control of veld fires, or the restoration or reclamation of eroded land.
National Environmental Management Act 107 of 1998 (NEMA)	Framework for environmental management in South Africa. It requires that an environmental impact assessment (EIA) be carried out prior to certain listed activities. The subsequent National Environmental Management Laws Amendment Act (Republic of South Africa 2014) only provides for work in rivers during an emergency (Pharoah et al. 2016).
National Biodiversity Act 10 of 2004	Provides for the management and conservation of South Africa's biodiversity within NEMA; the protection of species and ecosystems that warrant protection and the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources.
Working on Wetlands	This is a joint initiative of the Departments of Environmental Affairs (DEA), Water and Sanitation (DWS) and Agriculture, Forestry and Fisheries (DAFF) which focusses on the rehabilitation, wise use and protection of wetlands in a manner that maximises employment creation, supports small businesses and transfers relevant and marketable skills to beneficiaries.
Public Finance Management Act 1999 (Act No. 1. of 1999)	Regulates financial management in the national government and provincial governments and ensures that all revenue, expenditure, assets and liabilities of those governments are managed efficiently and effectively.
Local Government: Municipal Finance Management Act, 2003 (Act No 56 of 2003)	Secures sound and sustainable management of the financial affairs of municipalities and other institutions in the local sphere of government and, establishes treasury norms and standards for the local sphere of government.
Local Government: Municipal Systems Act 32 of 2000)	Provides for the core principles, mechanisms and processes that are necessary to enable municipalities to move progressively towards the social and economic upliftment of local communities, and ensures universal access to essential services that are affordable to all; It also defines the legal nature of a municipality as including the local municipality within the municipal area, working in partnership with the municipality’s political and administrative structures;

Appropriation Act 7 of 2017)MANDATE 1)	Appropriates money from the National Revenue Fund (NRF) for the requirements of the state for the 2017/18 financial year and prescribes conditions for the spending of funds withdrawn for the 2017/18 financial year before the commencement of the Appropriation Act for that financial year;
Division of Revenue Act 3 of 2017	Provides for the equitable division of revenue raised nationally among the national, provincial and local spheres of government for the 2015/16 financial year, the determination of each province's equitable share and allocations to provinces, local government and municipalities from national government's equitable share and the responsibilities of all three spheres pursuant to such division and allocations,
The Intergovernmental Relations Framework Act 13 of 2005	Facilitates coordination by the three spheres of government in the implementation of policy and legislation. As a framework Act, it allows for flexibility among the spheres in meeting the challenges within the conduct and practice of cooperative government and provides for the basic architecture of intergovernmental structures.
Intergovernmental Fiscal Relations Act 97 of 1997	Promotes cooperation among the national, provincial and local spheres of government on fiscal, budgetary and financial matters and prescribes a process for the determination of an equitable sharing allocation of revenue raised nationally.
Fire Brigade Services Act 99 of 1987	Provides for the establishment, maintenance, employment, coordination and standardisation of the fire brigade services.

5.4 Relevant Disaster Management Actors and Organisations in LM

Unlike the study areas in Uganda and Mozambique the LM has no history of international humanitarian assistance. However, local DM, Fire Services, NGOs, CBOs, and religious/cultural/civil society organisations are present, mainly in a disaster response capacity.

To address the questions identified for the Langeberg Fathum study, the research team identified a preliminary list of key actors and organisations for interviews. These were clustered by civil society, governmental and private sector (Table 7):

Table 7: Key groups, actors, government departments and organisations in the LM

Civil Society	Governmental	Private sector
Farmers	LM (Disaster Manager, Town Manager and Civil Engineer)	Packaging company (Langeberg – Ashton Foods)
Town residents	Traffic services	Earth moving company
Community leaders	Emergency Management Services (EMS)	Environmental Consultancies
Religious organisations	Cape Nature	Engineering firms
Civil society organisations	CWDM (Disaster Management)	Blue Science Fresh Water Specialists
NGOs	Provincial Disaster Management Centre (PDMC)	
Community Service Centres	Western Cape Department of Agriculture	
Community Police Forum	SAWS	
Agricultural unions	Department of Water and Sanitation (Infrastructure)	
Water users associations/Irrigation Boards	Water users associations/Irrigation Boards	
Breede-Gouritz Catchment Management Agency	Breede-Gouritz Catchment Management Agency	

5.5 Change in government structures

Since the 1990s, the Western Cape Province, districts and towns have experienced administrative changes that have had implications for governance continuity. For instance, according to South Africa's 1996 census data (Stats SA) and Hoddinott, Adato & Haddad (2005,) the Cape Winelands District Municipality (in which the Langeberg Municipality is located), was formerly known as the "Boland District Municipality". This comprised various magisterial districts such as Montagu, Robertson, Worcester, Swellendam etc. each with different boundaries than today's municipalities.

After 1996, these district municipalities (including the former Boland District Municipality), or parts thereof, were systematically amalgamated to form new local and district municipalities. The Breede River/Winelands Local Municipality, within the newly formed Cape Winelands District Municipality, contained the towns of Robertson, Montagu, Ashton, Bonnievale and McGregor. In 2009, the Montagu Municipality's name changed to the "Langeberg Local Municipality".

In addition to the boundary and name change, from 2000 – 2016, the Langeberg Municipality also experienced political and leadership changes. For instance, in 2006 the African National Congress (ANC) party took leadership from the Democratic Alliance (DA). Political leadership reverted to the DA in 2011 where it has continued since. These changes in administration and ideology presumably would have had a profound effect on continuity in terms of disaster risk governance and reduction, and service delivery.

5.6 Challenges with flood risk management in the Western Cape

In terms of flood risk management, Pharoah et el. (2016) found that its implementation is poorly reflected in municipal planning, including infrastructural developments and maintenance. The authors found that this is due to an entrenched perception that high impact events are occasional and 'rare', not related to development and the sole responsibility of Disaster Management authorities. Such perceptions reinforce a reactive approach and disregard developmental risk drivers which can be addressed through "…risk-aware planning, environmental interventions, construction, and in the maintenance and upgrading of infrastructure. In addition, the prospect of changing rainfall intensities and extremes, along with landscape changes in many catchments, has specific implications for the design, maintenance and upgrading of road and storm-water infrastructure, including bridges and culverts (ibid, 46).

Incomplete clearing of alien vegetation has been identified as another major risk driver, while solutions face obstructive and lengthy regulatory barriers within the Department of Environmental Affairs and Development Planning (DEA & DP) and one of the guiding acts, the National Environmental Management Act (NEMA) and the. These lengthy procedures severely challenge and discourage the necessary flood preparedness measures to be taken (Pharoah et al. 2016). E.g. compliance failures to remove cleared vegetation above the 20-year flood-line have been encountered in the LM (ibid). Figure 20 below illustrates the extent of debris clogging and over-bank flooding in Montagu.

Figure 20: Debris clogging Voortrekker Bridge leading into Montagu during the 2015 flood (Source: Patrick O'Shea in Pharoah et al. 2016)

5.7 Flash Flood Guidance System (SAFFG)

Contrary to the perceptions of emergency responders and local disaster managers, the South African flash flood guidance system (SAFFG) developed by SAWS is also not fully operational in the LM area (Pharoah et al. 2016). "The system pre-calculates available hydrological information for each small river basin to estimate the rainfall needed to trigger a flash flood. When rain falls over a river basin, the SAFFG software (probabilistic precipitation forecasts generated by the deterministic Unified Model (UM) from the UK Met Office) compares the actual rainfall with the pre-calculated 'flash-flood' value to identify river basins in danger of flooding" (Pharoah et al. 2016, 28; Poolman, Rautenbach & Vogel 2014).

However, there is limited weather monitoring in the Western Cape and Langeberg. This is not only because of too few instruments such as automatic rainfall stations and river flow gauges to collect real-time data in place collecting the data. It is also due to inadequate weather radar coverage and inaccurate flash-flood forecasting which are compromised by the mountainous topography and incorrect height of the C-band radar which is in itself subject to greater interference (Pharoah et al. 2016). Figure 21 below indicates the radar coverage of the Western Cape, which excludes most the province including the LM. It shows that only weather systems approaching from the south-east are identifiable.

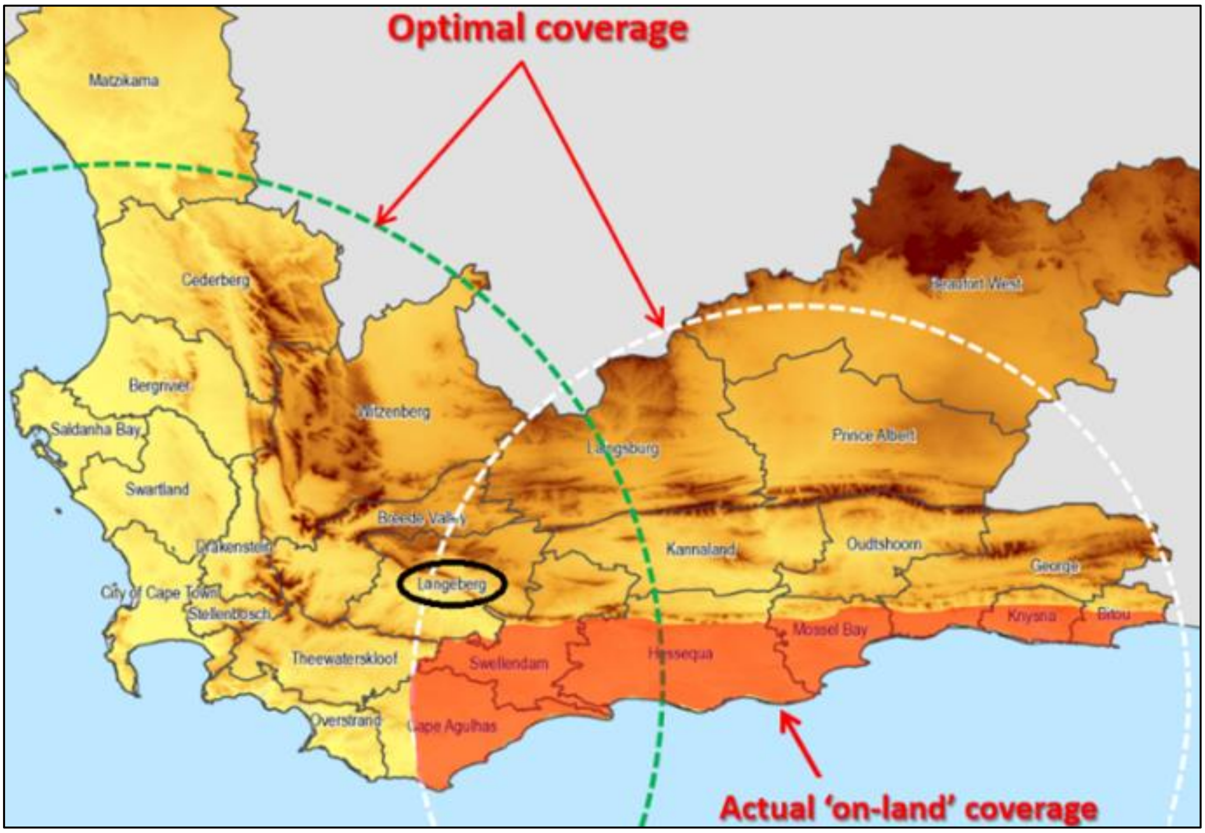

Figure 21: Map of the Western Cape showing optimal weather radar coverage (green and white circles – C-band) compared with actual (red shading) weather radar coverage (Source: Gillian Fortune in Pharoah et al. 2016)

The implications were highlighted during the 2011 and 2012 flood events, when weather warnings disseminated by SAWS did not specify areas such as the LM (Pharoah et al. 2016). Preparedness mechanisms that should have been activated were not triggered during those events, as flash flood warnings were not issued for the LM. In the aftermath of the 2003 COL-triggered flood, continuing dependence on SMS dissemination of largely uninterpretable flood warnings proved inadequate (DiMP, 2007). This has led to compromised risk communication to government departments and civil society, especially those most at risk.

The IFRC (2012) and UNDP (2014) noted that South Africa's Disaster Management Law might not be that practical in terms of early warnings. UNDP (2014, 36) state that the law distinguishes between four separate institutional duties namely "(i) assessing the threat, (ii) deciding on the need for a warning, (iii) issuing the warning, and (iv) transmitting the warning" while the IFRC (2012) found that these functions sit with several authorities and at different levels of government. The authors subsequently showed that most authorities involved were unsure about the timing or the distinction between their roles (UNDP 2014; IFRC 2012).

Again, during the 2003 flood event, farmers and residents took the initiative to provide early warning and evacuation, "uncoordinated in the formal sense", to farm workers along the Kogmans River in Ashton (DiMP 2003, 71). This 'uncoordinated', informal manner of early warning dissemination in the LM, along with the disconnect between informal and formal methods, leading to poor risk communication were also identified by Weir (2017). Such an informal system, due to an unreliable formal system, can lead to areas not receiving early warning at all.

5.8 Impact-based Forecasting

SAWS, in collaboration with the NDMC, PDMC and local DM officials has since moved towards Impact-Based Forecasting. This involves local information of the potentially affected areas to be shared with SAWS to make more accurate forecasts, based on potential impacts in terms of impact (severity) and likelihood (including spatial extent) (Figure 22). Such a paradigm shift from 'what weather will be' to 'what weather will do' was deemed necessary due to severe weather conditions causing significant damage in certain areas and limited damage elsewhere, and variability in the vulnerability of communities (i.e. densely populated cities, vast rural communities, agricultural areas and varied infrastructure distribution) (Poolman et al. 2018).

The organisational structure is illustrated in Figure 23. While this demonstrates the connections between National and Provincial level SWWS and community level early warning, the actual channels through which the people 'on the ground' would receive warning are unclear.

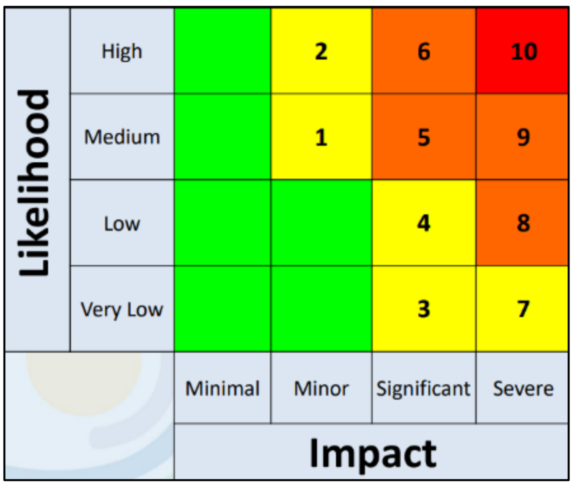

Figure 22: South Africa's Impact Based SWWS Warning Risk Level (green, orange or red) (Source: Poolman et al. 2018)

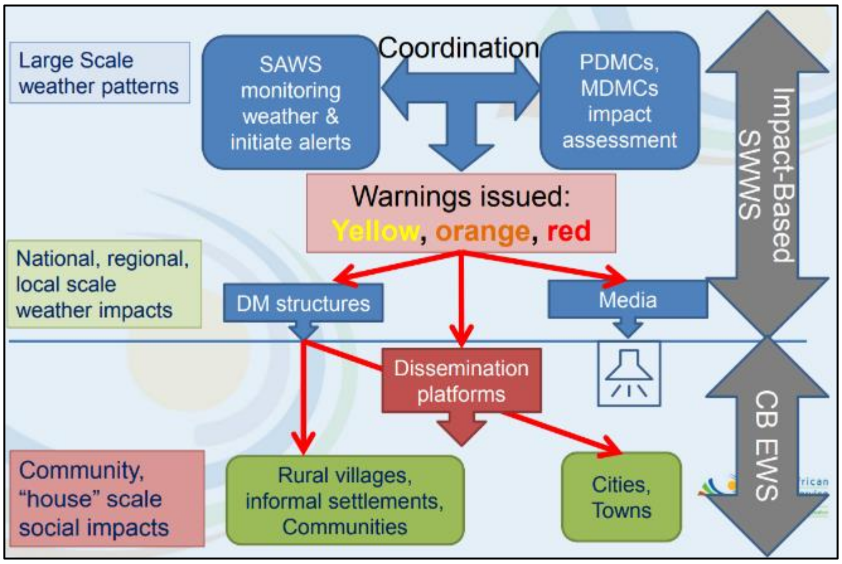

Figure 23: End-to-End Early Warning Systems (Source: Sebego & Poolman 2017)

Guiding global frameworks such at the Sendai Framework for Disaster Risk Reduction 2015 – 2030 and the 2030 Agenda for Sustainable Development (United Nations 2015 highlight the importance of local knowledge and its inclusion with 'scientific' knowledge in decision-making. This is a call to "ensure the use of traditional, indigenous and local knowledge and practices, as appropriate, to complement scientific knowledge in disaster risk assessment and the development and implementation of policies, strategies, plans and programmes of specific sectors, with a cross-sectoral approach, which should be tailored to localities and to the context…" (UNISDR 2015b, 15).

As with the SAFFG, hydro-meteorological modelling still relies on probabilistic precipitation forecasts generated by the United Kingdom Met Office. South Africa's Impact Based SWWS was based on the UK's Impact Based Forecasting (already implemented in 2011) and WMO recommendations, while incorporating local risk conditions obtained from the PDMC and local DM departments into decision making. This development is still in the pilot phase across the country. While this is a step forward, since active informal risk communication takes place on the ground before and during a disaster, formal, inclusive consultations with the public, 'on the ground (e.g. both farmers in high-risk locations and residents in flood-prone areas) need to take place. As with RMMPs the effectiveness of Impact-based Forecasting's still needs to be investigated.

6. CONCLUSIONS

Although the LM area does not have any Red Cross presence or FbF as such, the case study is still relevant to the FATHUM project because it provides a baseline for FbA in a highly exposed and vulnerable part of a more developed sub-Saharan African country, rather than other published FbA baselines, which are in developing countries. The LM area represents a high-risk inland municipality that already practises FbA informally and unofficially. The area faces recurring losses and damages from flooding, and therefore has scope for improving early warning systems, disaster risk reduction and risk governance capacities. Findings showed that flooding was caused by complex and interconnected hazard, vulnerability and disaster risk governance factors, some more prevalent and recurring than others.

Topographically and geo-physically, steep mountains increase run-off and rainfall, while they have forced settlements and infrastructure close to major rivers such as the flood-prone Kingna, Keisie, Kogmans Rivers and Kogmanskloof pass, a critical access route (through the Langeberg Mountains). Specific soil conditions cause poor surface cover which lead to increased debris and sediment carried downstream, causing more damage. Elongated and lobed catchments shapes have also isolated farming communities due to disrupted cell phone reception and road access, which have early warning and flood response implications. Meteorologically and climatically, the municipality is mainly affected by flash flooding due to COLs (especially during warmer months), exacerbated by mountainous topography. Environmental and developmental factors such as land-use/land-cover change have increased run-off, urban expansion has exposed more people and infrastructure to rivers while developmentally, irregular storm water maintenance in towns has increased risk. Frequent veld fires causing hydrophobic soils, alien vegetation especially in riparian zones carried downstream while providing good fuel for fires, along with river aggradation and sedimentation due to erosion have also increased flood risk.

Socio-economically and demographically the LM is characterised by various factors such as chronic poverty, dependency, high crime rates, public health issues and marginalisation e.g. service delivery which increases vulnerability and exacerbates flood impacts. These circumstances are often most prevalent in specific areas such as Ashbury, Zolani and Nkqubela. Such conditions are closely linked to seasonal labour and associated travel to work.

The municipality has seen a rapid increase in population numbers from 1996-2011. Some areas such as Ashbury (predominantly a Coloured, Afrikaans speaking settlement), Nkqubela, Zolani (Black African, IsiXhosa speaking settlements) have experienced substantial increases. The municipality is also stratified according to race, economics and language, in specific towns and settlements. This rapid urban growth, for a rural area, has had numerous implications flood exposure, vulnerability, in the face of escalating demands on municipal services governance capacity. Such socio-economic divisions illustrate the need for nuanced, nonhomogeneous approaches to early warning.

The governance of flood risk in South Africa involves multiple public and private sector stakeholders such as government departments and ministries, local, provincial and national governmental entities, as well as private landowners. South Africa's disaster management legislation therefore represents a crucial crosscutting mechanism for integrating flood risk management efforts with both development planning. The Green and White Papers on Disaster Management resulted in the Disaster Management Act (No. 57 of 2002) which was followed by the National Disaster Management Framework to guide the implementation of the Act. The Framework has a developmental vulnerability reduction focus as well as wide-ranging consultation across government, private sector and civil society organisations. Among other challenges, the legislation was constrained due to disaster management's designation as a national and provincial competency, and not a municipal competency. Disaster management was therefore viewed as an 'unfunded mandate' for local municipalities, therefore deterring investment at local level, where risk management efforts were most needed. In 2015, the Disaster Management Amendment Act subsequently introduced legal provisions for local municipalities to establish disaster management capabilities and plans in consultation with district municipalities. Various governance challenges however still remain such as entrenched perceptions that high impact events are occasional and ‘rare’, not related to development, which reinforce a reactive approach and disregard developmental risk drivers. Other challenges include disruptions in governance (boundary and political leadership and name changes) continuity over the years. Apart from the Disaster Management legislation, many other supporting acts and plans exist such as the National Water Resources Act 36 of 1998, National Veld and Forest Fire Act 101 of 1998, River Maintenance Management Plans (RMMPs), National Environmental Management Act (NEMA) 107 of 1998 and South African Weather Services Amendment Act 48 of 2013.

The South African flash flood guidance system (SAFFG) developed by SAWS was followed by an Impact-Based Severe Weather Warning System (SWWS) where local information of the potentially affected areas obtained from local Disaster Management officials is shared with SAWS to make more accurate forecasts, based on potential impacts in terms of impact (severity) and likelihood (including spatial extent).

A disconnect still exists however, between formal and informal systems, since active informal risk communication takes place on the ground before and during a disaster, while formal, inclusive consultations with the public, ‘on the ground’ are still lacking. Other challenges in terms of limited weather monitoring include too few instruments such as automatic rainfall stations and river flow gauges to collect real-time data, but also inadequate weather radar coverage. Lastly, South Africa’s Disaster Management legislation distinguishes between four separate institutional duties for early warning, namely “(i) assessing the threat, (ii) deciding on the need for a warning, (iii) issuing the warning, and (iv) transmitting the warning”. However, as these functions also sit with several authorities and at different levels of government, there is scope for confusion among authorities about the timing of actions and their specific roles.

This study illustrated how multiple hazard and vulnerability characteristics, some more prevalent than others, are highly inter-related while affecting flood risk, often in specific areas. Critical existing DRM capacity and institutional arrangements affecting the governance of the above flood risk also need to be understood. It is therefore essential to study there factors in combination of each other, in order to firstly identify at-risk areas, in this case, Montagu, Ashbury, Mandela City, Nkqubela and Zolani. After certain areas have been identified can early warning and impact – based forecasting planning be applied more efficiently and effectively.

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