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Cyclones in Southern Africa

Volume 2: Foundational and Fundamental Topics

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Editors

Cyclones in Southern Africa

Volume 2: Foundational and Fundamental Topics

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Preface

The movement from the Hyogo Framework for Action (2005–2015), focusing on building the resilience of nations and communities to disaster, to the Sendai Framework on Disaster Risk Reduction (2015–2030) brought new thinking in the space of disaster management. Fundamentally, the shift introduced three main ingredients, namely: (1) broadening of the disaster space from disaster risk management to disaster risk reduction (DRR) and management, (2) having climate change as one of the key disasters to address and (3) bringing in the concept of building back better (BBB) after disasters strike. Other matters arising relate to arguments surrounding the need to move away from the concept of natural disasters to natural hazards. There has also been serious debate on key climate change and other disaster terminologies such as vulnerability, variability, adaptation, maladaptation and resilience. The book also comes at a time when climate change has been framed within the sustainable development discourse, having it embedded in the United Nations' 2030 Agenda for Sustainable Development (AfSD) that seeks to transform our world. The 2030 AfSD is also informed by 17 intertwined Sustainable Development Goals (SDGs), in which SDG 13 deals directly with climate action. From the 2030 AfSD, it is made clear that SDG 13 remains a mandate of the United Nations Framework Convention on Climate Change, with the Paris Agreement as one of the key action platforms. This set-up brings the world to an understanding that dealing with tropical cyclones, extreme weather events and other disasters everywhere in the world, including southern Africa, cannot be a single discipline approach. Rather, it calls for a multi-, trans- and interdisciplinary approach that brings together DRR and management specialists, climate change and environmental specialists, those from the medical profession, development agencies, businesses, labour and politicians, to name but only a few. To this end, the book looks at some of the foundational and fundamental topics in the DRR and management space, particularly revealing alignments in the tropical cyclone space. Matters of systems thinking, the role and interfacing of scientific, indigenous and local knowledge systems in DRR, as well as the role of information technology and communications are some of the topics presented in depth in the book. The disaster cycle that includes preparedness (including early warning), response (search, rescue and relief) and recovery (reconstruction, reformation and reflection—integrating the BBB concept) is also discussed.

Pretoria, South Africa — Godwell Nhamo
Vanderbijlpark, South Africa — Kaitano Dube

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The authors wish to thank the Government of Zimbabwe and traditional leadership structures for granting permissions to undertake the research. Among some of the government ministries and agencies that granted permissions include the Ministry of Local Government, Public Works and National Housing; Ministry of Primary and Secondary Education; Ministry of Health and Child Care; Meteorological Services Department of Zimbabwe; Forestry Commission; the Postal and Telecommunications Regulatory Authority of Zimbabwe (POTRAZ); Manicaland Provincial Administrator's Office; Chimanimani District Administrator's Office; Chimanimani Rural District Council; and the chiefs and other traditional leadership structures in Chimanimani.

The authors also wish to acknowledge the partnership between the UNISA and Chinhoyi University of Technology (CUT) research teams. We are particularly grateful for the gesture by the CUT to provide ten tablets used to administer the household survey questionnaire.

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Part I

Introduction and Background

Tropical Cyclones as an Emerging Global Disaster Risk and Management Issue

1

Kaitano Dube and Godwell Nhamo

Abstract

Climate change is known to result in extreme weather events across the world. Concern has been increasing over the social, environmental and human costs of such extreme weather events. 2019 witnessed some of the most significant record cyclones in southern Africa due to the occurrence of two devastating cyclones, namely tropical cyclones Idai and Kenneth. These were followed by two more tropical cyclones, namely Chalane (2020) and Eloise (2021). The occurrence of these hydrometeorological hazards has raised various questions on the capacity of southern Africa to respond to these hazards, which are on the increase. The question regarding the state and capacity of early warning systems has been brought to the fore, challenging improvements to ensure climate resilience and regional sustainability. This book tackles issues of how southern Africa can view tropical cyclones in the context of climate change and develop early warning systems that can be used as a platform for disaster risk reduction and climate adaptation and resilience. This introduction sets the tone for the book and deals with various thematic issues, such as the meteorological and climatological occurrence of tropical cyclones, tropical cyclones as an emerging disaster risk and human response in the context of the Sendai Framework for Disaster Risk Reduction. A 'building back better' strategy is recommended for both infrastructure and disaster management institution and a de-risking approach to development anchored on clean development mechanisms to address climate change and its associated risks.

Keywords

Tropical cyclones · Disaster Risk Reduction · Early warning system · Climate change · South West Indian Ocean

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1.1 Introduction and Background

Weather-related events seem to be dominating the global, continental and political discourse of late, given their magnitude, frequency and cost. Even during the debilitating challenges that are being imposed by the COVID-19 pandemic, it

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has become clear that the nexus and discourse of the future global scenario post the pandemic cannot be imaged outside of the debate of climate change. While the emergence of COVID-19 as a global disrupter of the century came as a surprise to many, climate change emerged as the number one threat to global economies in both 2020 and 2021 (Nhamo et al., 2020). According to the World Economic Forum (WEF) (2021),

> 'Among the highest likelihood risks of the next ten years are extreme weather, climate action failure and human-led environmental damage; as well as digital power concentration, digital inequality and cybersecurity failure. Among the highest impact risks of the next decade, infectious diseases are in the top spot, followed by climate action failure and other environmental risks; as well as weapons of mass destruction, livelihood crises, debt crises and IT infrastructure breakdown'.

It is therefore clear from the WEF analogy that extreme weather events induced by climate change are one of the ever-present threats to human development. The World Meteorological Organization (WMO) (2021a) announced that 2020 had emerged as one of the three warmest years on record, along with 2016 and 2019. The increased global mean temperature is significant in that global warming is one of the main drivers of climate change (Schiermeier, 2011; Diffenbaugh et al., 2017; Rayer et al., 2020). With an increase in temperature comes a plethora of associated extreme weather events. A recent study by Hébert et al. (2020), using a new global climate model capable of reducing model errors by about 50%, suggests that the world is likely to cross the threshold for dangerous warming (+1.5 °C) between 2027 and 2042. Consequently, climate change is widely viewed as a global emergency that requires global attention. Several climate scientists and global leaders believe that the world has indeed a climate emergency (Ripple et al., 2019; Hulme, 2019; Aron et al., 2020; Gills & Morgan, 2020). One of the largest polls ever conducted by the United Nations Development Programme (2021) indicates that about 64% of the global population believe that the world is in a climate emergency.

At the dawn of 2021, the USA announced devastating and increasing costs of extreme weather events, indicating that it had experienced 22 separate billion-dollar weather and climate disaster events in 2020 alone (National Oceanic and Atmospheric Administration (NOAA)—National Centers for Environmental Information (NCEI), 2021). From Figs. 1.1 and 1.2, it can be seen that the increase in the cost of disasters was also amplified by the costs of tropical cyclones, with seven of the tropical disasters being some of the billion-dollar events referred to earlier. This came at a time when 2020 was declared the most active hurricane season in the Atlantic, with 29 named hurricanes, surpassing 2005 when 28 storms were named (NOAA, 2020). Other climatic events of concern are severe storms and flooding, whose costs are equally on the increase. In the same breath, Africa witnessed multibillion-dollar tropical cyclones, which manifested as two of the biggest cyclones ever to affect southern Africa in the form of tropical cyclones Idai and Kenneth, which made landfall in March and April 2019, respectively. The occurrence and impact of such extreme weather events that cause massive devastation are of concern, as Africa is by and large incapacitated to respond adequately to such events (Leal Filho et al., 2018). Due to this incapacity to act, unmitigated socio-economic and environmental disaster has been experienced in Africa.

In this introductory chapter, meteorological, climatic, social and technological fundamentals of tropical cyclones are considered in the context of disaster management and response.

1.2 Understanding Tropical Cyclones

Tropical cyclones, also known as hurricanes and typhoons, have been part of the history of meteorological developments since time immemorial. Perhaps what is new to humanity is the pattern, impact and cost of these tropical cyclones, which seem to be prevalent in various oceanic basins, namely the Pacific, Indian and Atlantic Oceans. Given the devastating nature of tropical cyclones across the world, there has been increased attention to understanding their patterns and impacts as they pose a significant threat to human devel-

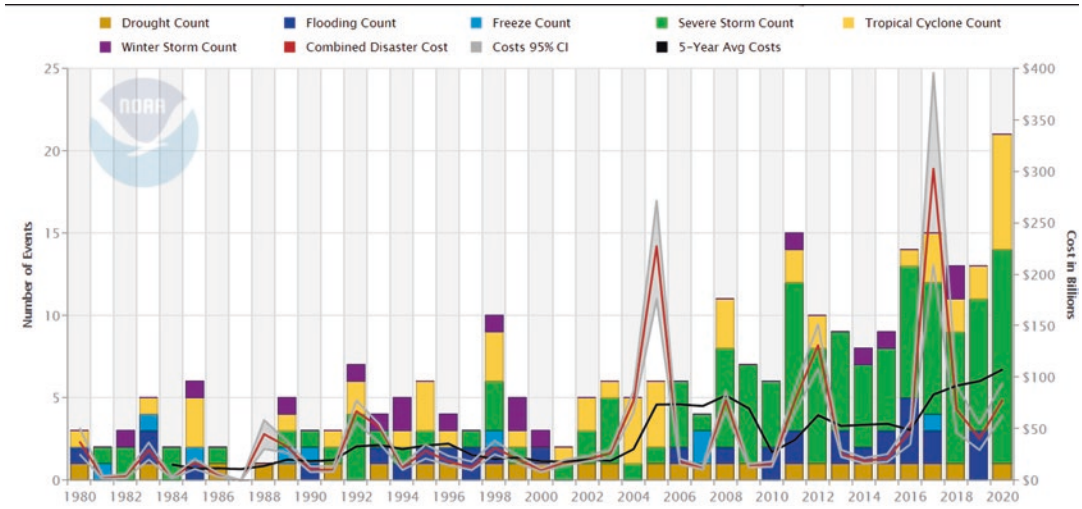

Fig. 1.1 Billion-dollar weather and climate disasters: Time series for the USA. Source: NOAA—NCEI (2021)

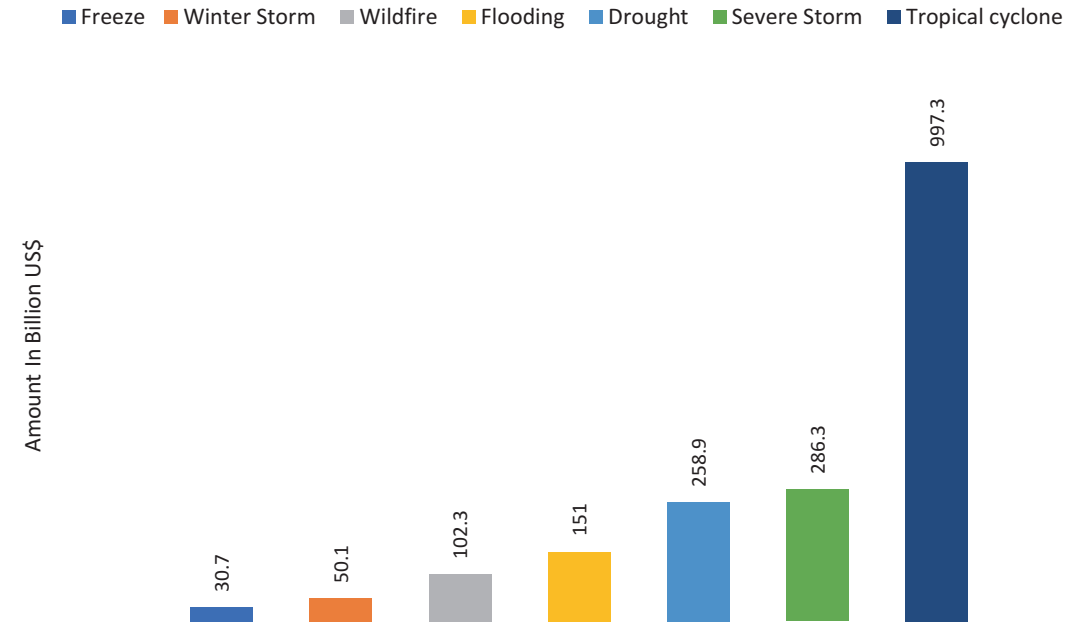

Fig. 1.2 Billion-dollar weather events to affect the USA from 1980 to 2020 (CPI-adjusted)

opment (Peduzzi et al., 2012; Zhang et al., 2017; Wu et al., 2019). While some scholars believe that the impact of climate change on tropical cyclones is largely uncertain and unknown due to their high annual variability (Patricola & Wehner, 2018), there seems to be growing consensus on this issue in recent years among scholars that under a changing climate, the frequency of tropical cyclones will decrease, but the intensity will increase (Sugi et al., 2017).

According to Knutson et al. (2020), there is medium to high confidence that there will be an increase in tropical cyclones that reach categories 4 and 5. This assertion resonates with Bhatia et al. (2018), who, by using High-Resolution Forecast-Oriented Low Ocean Resolution

(HiFLOR), observed the intensification distributions and percentages of tropical cyclones that have become major hurricanes as the twenty-first century progresses. In other words, there is an expectation that tropical cyclones will be more intense. There will therefore be more devastation to community livelihoods and economies. As already highlighted, tropical cyclones are one of the most destructive hydrometeorological events. Evidence shows that Hurricane Katrina alone led to the deaths of as many as 1833 people and cost the US economy US$160 billion in 2005 (Patricola & Wehner, 2018).

Questions are being asked about the characterisation of tropical cyclones in the south west Indian Ocean, more so amidst the devastating socio-economic impact of tropical cyclone Idai (category 3) in March 2019 and tropical cyclone Kenneth (category 4) in April 2019, merely a few days apart. The World Bank (2019) estimated that the cost of a tropical cyclone in Madagascar, Malawi, Mozambique and Zimbabwe was between $2.2 and $2.3 billion. Tropical cyclone Idai is blamed for, among other things, disrupting power (energy) (Zimba et al., 2020) and causing vegetation loss as a consequence of flood destruction (Charrua et al., 2021).

In the south west Indian Ocean, about ten tropical cyclones occur annually within the basin. Of the ten, an average of two cyclones (Fig. 1.3a) make landfall with a standard deviation of 1.5. Evidence shows that over the past 23 years the number of tropical cyclones on average has not changed significantly, although there is evidence of a slight increase (Fig. 1.3b). 2019 had the highest number of tropical cyclones, which seems to be highly variable in terms of the spread of occurrence. They occurred during one of the worst decades in terms of extreme weather events globally. There appears to be a slight decline in the number of tropical cyclones in the basin making landfall in the area over the period of study, although this change is not statistically significant. The increased cost, therefore, might be associated with other factors besides the increase in the intensity of tropical cyclones, such as an increase in affluence, population, infrastructure and wealth (Weinkle et al., 2012). Increased infrastructure development means that when climate extremes occur, the knock-on effect on infrastructure and built-up property is substantial.

1.3 Disaster Risk Reduction in the Context of SDGs and Climate Change

It is expected that under a changing climate, the intensity of extreme weather events will increase, as will the associated costs (Weinkle et al., 2012; Dube et al., 2021; Riden et al., 2021). The occurrence of tropical cyclones in that context becomes a huge concern, particularly for the developing countries that have limited or no capacity to develop appropriate early warning systems (EWSs). In the absence of effective EWSs and with the increasing intensity of tropical cyclones, it is anticipated that the economic cost and human lives lost might increase in some regions. Given that tropical cyclones cause substantial damage, with most of these areas located south west of the Indian Ocean, cyclones need to be viewed and understood as an ever-present threat and disaster. Most coastal towns and communities along Africa's south-east coast are particularly vulnerable to landfall of tropical cyclones.

The increased debate about the occurrence of tropical cyclones as a disaster has given credence to the discussion around disaster risk reduction (DRR) and management. DRR and management can be explained as a systematic approach that is aimed at identifying and assessing risks from disaster. This is done to reduce socio-economic vulnerabilities to disasters, deal with environmental hazards that cause them and build resilience. The Sendai Framework for Disaster Risk Reduction (2015–2030), which was signed by 187 United Nations member states on 18 March 2015, acts as a global blueprint for DRR and

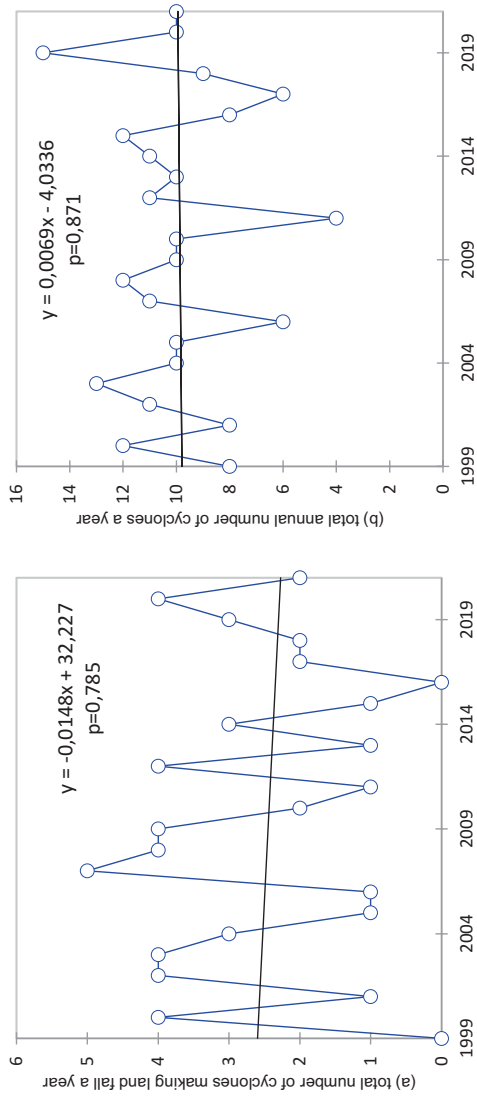

Fig. 1.3 Trend in the total number of tropical cyclones and tropical cyclones making landfall in south west Indian Ocean 1999—January 2021. Source: Data from Meteo France Best Track Archives

Box 1.1 Targets and Action Priorities at Reducing Risks and Disasters

- Understanding disaster risk
- Strengthening disaster risk governance to manage disaster risk
- Investing in disaster reduction for resilience
- Enhancing disaster preparedness for effective response, and to 'Build Back Better' in recovery, rehabilitation and reconstruction
- Source: United Nations Office for Disaster Risk Reduction (2015)

management. The framework identifies four targets and four action priorities aimed at reducing risks and disasters across the world, as shown in Box 1.1.

In a bold statement, the United Nations notes that through the Sendai Framework, the global organisation seeks to minimise losses from disasters by protecting lives and livelihoods through the protection of various economic, social and cultural assets. According to Kelman (2017), there are strong linkages between the Sendai Framework and two other important conventions that were formulated in 2015, namely the Paris Agreement and Agenda 2030 for Sustainable Development (United Nations, 2015). The term 'disaster' is mentioned at least six times in the 2030 Agenda document under five sustainable development goal (SDG) targets (Table 1.1).

It is crucial to note that the huge presence of the DRR thematic issues in the SDG document is not coincidental as disasters, particularly natural hazards, are a global threat to the achievement of the SDGs. Kelman (2017) argues that SDG 13 on climate action, which speaks directly to the Paris Agreement, also links directly to issues of DRR. Climate change resilience and adaptation are aspects that relate to DRR as the aim is to reduce climate change-related disasters and the associated socio-economic and environmental costs. Reducing global disasters, therefore, is strongly linked to climate change mitigation and adaptation (Forino et al., 2017; Botzen et al., 2019; Mannakkara, 2021), an issue dealt with in the Paris Agreement and SDG 13 aimed squarely at reducing a climate disaster. There is a real danger that climate catastrophes pose challenges for global communities. One such challenge is the continuous threat of the tropical cyclones which seem to become more intense in the southern hemisphere, particularly in the Southern African Development Community (SADC) region (Dube, 2019).

The impact of tropical cyclones and other weather extremes on food security is well documented. These phenomena have been blamed for the increase in food insecurity within SADC at a time when global food insecurity is declining in most regions of the world (FAO, 2020). Substantial amounts of croplands were either flooded or swept away during tropical cyclone Idai, rendering many foods insecure and vulnerable to other disasters such as malnutrition and disease outbreak. Chari et al. (2020) observed that post-Idai, the food supply chain in Zimbabwe was seriously disrupted, leaving many hungry and forcing some girls into prostitution as a measure of securing food. One of the biggest contributors to food insecurity and health challenges in Madagascar is the impact of the annual occurrence of tropical cyclones that damage crops. EWSs and adaptation measures should be adopted to buffer them from the climate shocks (Rakotobe et al., 2016).

The nexus between DRR and management in the context of human settlement, particularly in urban settlements, is a point of focus. There has been increased global awareness of the threat of extreme weather events induced by climate change. Given that more than half of the global population now resides in urban areas, there are a number of challenges rendering the urban populace particularly vulnerable to extreme weather events, such as tropical cyclones (Kita, 2017; Dhyani et al., 2018). Cyclones that have affected southern Africa have resulted in massive destruction in several urban areas, with Beira being one of the most affected cities. The city was severely damaged from tropical cyclones Idai, Chalane

Table 1.1 The nexus between SDGs and the Sendai Framework

SDG and Target No.	SGD and Target	Sendai Framework Indicator
Goal 1	**End poverty everywhere**	
SDG 1.5	By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate related extreme events and other economic, social and environmental shocks and disasters.	A1, B1, C1, E1 and E2.
Goal 2	**End global hunger**	
SDG 2.4	By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	
Goal 11	**Make cities and human settlement inclusive, safe, resilient and sustainable**	
SDG 11.5 **SDG 11. b**	• By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations. • By 2020, substantially increase the number of cities and human settlements by adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels.	A1, B1, C1, D1, D5, E1 and E2
SD13	**Take urgent action to combat climate change and its impacts**	
SDG 13.1	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.	A1, B1, E1, E2

and Eloise. Rainfall from Eloise affected other smaller urban and peri-urban communities in Madagascar, Mozambique, South Africa, Zimbabwe and parts of Botswana, resulting in infrastructure damage and loss of homes. Tropical cyclone Kenneth also damaged homes in urban and rural communities in Mozambique. Consequently, most settlements found themselves having to deal with flooding disasters, destroyed homes and bridges and some fatalities. In light of the destructive nature of tropical cyclones, DRR and management become critical tools for achieving the SDGs, especially SDG 11 in urban areas (Amaratunga et al., 2018).

One can argue that natural hazards such as tropical cyclones can disrupt the achievement of the entire chain of the SDGs as they disrupt lives and livelihoods. Tropical cyclones and their ferocious power have driven many people in SADC to hunger and destroyed homes, infrastructure, farms, rural and urban areas, health systems and communication systems. They have also threatened biodiversity as national parks and other protected areas and heritage sites are destroyed by the associated wind, resultant flooding and storm surge flooding of coastal areas, rivers and estuaries.

Unfortunately, although several states are signatory to the Sendai Framework, indications are that very few countries have localised and operationalised this framework; only 81 countries as of 2019 indicated that they had a national DRR strategy based on the Sendai Framework. Only 131 member and observer states use the Sendai Framework to report on the implementation of the Sendai Framework (United Nations, 2020). In light of recent extreme weather events and the threat of climate change, achieving development globally is anchored on the ability to de-risk industries and socio-economic activities. It has to be noted that during the past 20 years the economic losses from disasters have increased by 150%, although there has been disproportionate impact across the world. The bulk of the costs of extreme weather events has been experienced by developing countries (United Nations Office for Disaster Risk Reduction, 2020). One such region that is battling this challenge is Africa. Prior to the adoption of the Sendai Framework, African countries were suffering disasters owing to several factors, including lack of institutional framework, poor risk identification, lack of knowledge management, poor or lack of governance and poor emergency response. More than 5 years after adoption of the Framework, it is not clear if Africa has made significant improvements in these areas.

As extreme weather events are anticipated to increase in the near future, there are increasing calls for part of the future to be adapted to the current and future climate scenarios being experienced across the various global regions. Climate change adaptation forms the core of a sustainable future. However, talking about climate change adaptation in the absence of research and knowledge is futile. Knowledge about current vulnerabilities is crucial in the development of EWSs. An EWS is one of the tools that can be utilised in reducing the severity and impact of weather extremes such as tropical cyclones. The Global Center on Adaptation (2019) made a point that EWSs save lives and properties more than ten times the cost of establishing them. A 24-h EWS notice of a pending storm can cut the cost of damage by as much as 30%. EWSs and climate-resilient infrastructure are touted as a strong package for reducing disaster impact in the context of climate change as climate-resilient infrastructure has a benefit:cost ratio of 4:1.

1.4 Climate Resilience and EWSs in the Context of Tropical Cyclones

Reports indicate that in the past 50 years there have been 11,000 weather and water-related disasters, which came at a whopping cost of US$3.6 trillion (WMO, 2021b). The past decade alone has seen 400,000 lives being lost to extreme weather-related disasters. Notably, between 1970 and 2019, about 79% of disasters that occurred were weather related and 75% of economic losses were attributed to natural hazards (WMO, 2020). Such a scenario calls for a commitment to building resilient infrastructure and investment in EWSs as a way of reducing the ballooning costs of extreme weather events on economies, environment and society. Evidence reveals that 88% of the countries from the low-income developing states and small island developing states that submitted their national determined contributions to the Paris Agreement identified an EWS as a top priority.

Table 1.2 reflects EWS needs that require greater focus and attention as the world embraces the decade of SDGs and climate action running up to 2020–2030 and also what needs to be addressed in the national adaptation plans. There is clear evidence of the need for additional resources to enhance EWSs, particularly for the

Table 1.2 Global EWS needs as indicated in national determined contributions and national adaptation plans

North and Central America	Europe	Asia	South America	Africa	South West Pacific
• Disaster risk knowledge • Detection monitoring, analysis and forecasting • Disaster preparedness and response	• Detection, monitoring, analysis and forecasting • Disaster preparedness and response	• Disaster risk knowledge • Detection, monitoring, analysis and forecasting • Warning dissemination and communication • Disaster preparedness and response	• Disaster risk knowledge • Detection monitoring and forecasting • Warning dissemination and communication • Disaster preparedness and response	• Disaster risk knowledge • Detection, monitoring, analysis and forecasting • Warning dissemination and communication • Disaster preparedness and response	• Disaster risk knowledge • Warning dissemination and communication • Disaster preparedness and response

developing world such as southern Africa. These require intensive investment into scientific research, education and technological development and innovation to capacitate meteorological offices and other key players to be able to detect, monitor, analyse and forecast natural disasters. Technological innovation is a requirement to allow developing countries to offer reliable forecast data. Given the level of development in some parts of Africa, it is worrying that disaster communication remains one of the major challenges in Africa and developing countries. Disaster preparedness requires financial resources and accountable leadership to ensure that budgets and other resources are used for the intended purposes. On this point, Mavhura (2020) notes that even though under increasing pressure from tropical cyclones, Zimbabwe is challenged as it cannot provide financial and material resources to deal with tropical cyclones effectively.

According to the WMO (2020), Africa has the smallest number of people (30%) with access to meteorological hazard EWSs. This is worrying given that the Intergovernmental Panel on Climate Change (IPCC) expects Africa to bear some of the worst extreme weather events due to climate change (IPCC, 2018). There is also no evidence that where these EWSs do exist and people have access to meteorological hazard EWSs; this information is being used to foster early response to avoid the high costs of such disasters. A study by Yore and Walker (2020) found that in the wake of Hurricane Maria in Dominica in 2017, inasmuch as the residents were aware of the approaching storm, they were not sure of its magnitude. This resulted in low levels of evacuation and safety-seeking behaviour, resulting in losses. Lumbroso (2018) argues that in Uganda and other African countries the major challenge with EWSs is that they are not scientifically based and communication is often poor, which results in mistrust among those who use them.

However, evidence suggests that humanity has become better at predicting and forecasting tropical cyclones (Chen et al., 2019; Klotzbach et al., 2020), which has helped save billions of US dollars over the years through early evacuation. Martinez (2020) reports that in the USA since 1972, the cumulative reduction in damage from forecasting was about $82 billion. With the prediction accuracy of tropical cyclone hotspots being extended to as far as 8 months away, there is currently a great deal of meteorological technological advancement that can assist countries in planning better and evacuating people from tropical cyclones. Experience gained from the past four major tropical cyclones that affected southern Africa in 2019–2021 has demonstrated that the prediction of tropical cyclones and their intensification could be done 3–4 weeks ahead of their landfall as they develop in the Indian Ocean. This prediction is done by Meteo France and other agencies such as the Joint Typhoon Warning Center. Regional meteorological organisations

are capable of predicting the level of tropical cyclone activity in the various basins. This knowledge can help most vulnerable countries to be on alert. Experience has also shown that the national meteorological organisations, however, have been rather slow to respond, only making an announcement about 3 days or so before the anticipated landfall.

In the recent past, a number of forecasters and other global meteorological organisations have posted messages on social media of developing tropical cyclones which have been quick to reach the public. A look at Google Trends, for example, shows that the Internet activity for the tropical cyclone Chalane picked up on 20 December 2020. A peak index of 100 was witnessed in Zimbabwe, 74 in Mozambique, 36 in Botswana, 18 in Malawi and 16 in Madagascar on 30 December, a day before the cyclone made landfall just north of Beira in Mozambique. With the exception of Malawi, the other countries were affected by the tropical cyclone. A similar picture was seen regarding Eloise, with Internet activity starting to peak between 17 and 19 January and reaching a peak of 100 on 24 January. On the 23rd the trend was about 75, which was the day the cyclone made landfall in Mozambique. On the 24th the cyclone affected parts of Zimbabwe, South Africa and Eswatini.

Figure 1.4 shows that information was available on the pending Cyclone Eloise, with a greater interest in areas that were most at risk, such as Limpopo, Mpumalanga and KwaZulu-Natal. There was capacity to detect the tropical cyclone days before but whether such information was translated into action and reduced the cost of the disaster remains another subject of debate and further research.

1.5 Policy, Knowledge Systems and Related Approaches to Disaster Management

Responding to tropical cyclones remains a murky subject due to several challenges across the world and Africa. The lack of proper scientific research and documentation of extreme weather disasters and a lack of understanding of how such events develop and occur have been challenging for many communities. Experience has shown that such challenges arise from traditional systems largely driven by myths, religious beliefs and, at times, witchcraft which has slowed down the uptake of science to some extent. Inasmuch as some indigenous knowledge has been found to be valuable in disaster risk management, the absence of an effective framework for integrating this with science to ensure community resilience to environmental hazards has been a major stumbling block (Mercer et al., 2010).

Such challenges have slowed down disaster response and adaptation in some areas. In Africa, poor budgeting (Lumbroso, 2018) means that most of the disaster preparedness needs are often not prioritised, as leadership prefers a relief response that is largely top-down. This is in contrast to other parts of the world where leaders seem to now take a more proactive approach that is more community focused and prioritises readiness (Azad et al., 2019). It would seem that to tackle disasters and to institute disaster management, there is a need for community capacitation. Such an approach should integrate various community partners and stakeholders to achieve resilience.

The top-down approach in dealing with disasters has proven to be full of challenges. The system is often vulnerable to political opportunism, political manipulation, corruption and bureaucracy, which often slows down the response to disasters as seen, for example, during the Cape Town Day Zero Disaster (Nhamo & Agyepong, 2019; Dube et al., 2020). According to Khan and Rahman (2007), a multi-part actor approach to disaster response allows for pulling together resources and expertise. Ensuring the success of such an approach is a challenge as it requires a culture of combined planning and resource sharing in instituting a robust plan of action.

1.6 Research Methodology

A variety of methods were used in compiling this book project. Both primary and secondary data were used with the utilisation of qualitative, quantitative and mixed methods. Primary data was obtained mainly from the affected areas and

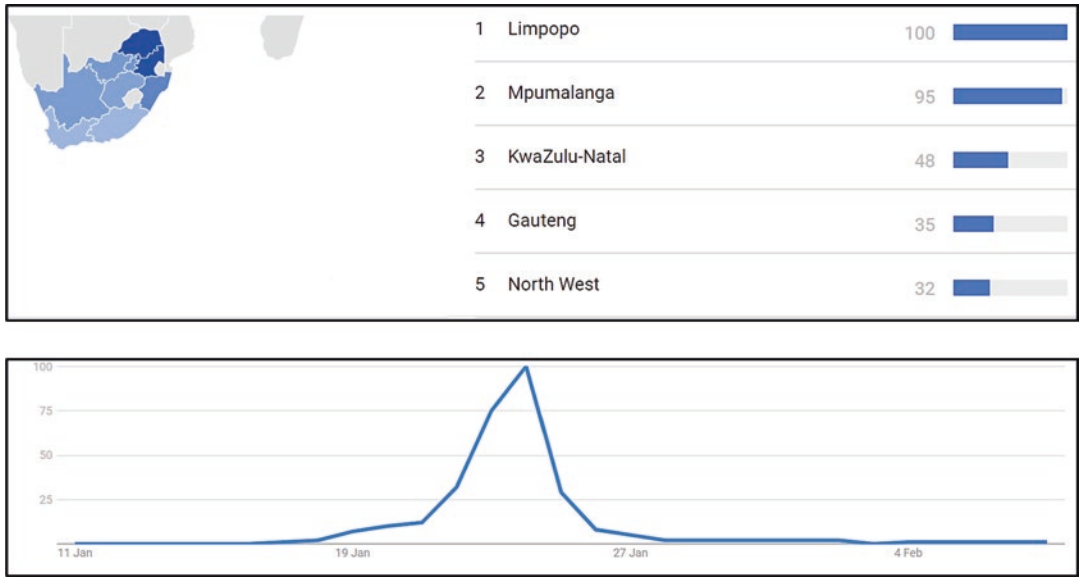

Fig. 1.4 Interest over time for Eloise on Google Trends in 2021

administrative centres in the form of surveys, field observation and key informants. Respondents included affected people, political leadership, traditional leadership, aid organisations and disaster relief experts, among others. One of the key survey tools was a multipronged online questionnaire that was hosted on QuestionPro. The online questionnaire consisted of various questions that were pertinent to each chapter. The questionnaire survey was complemented by key informant interviews that took place in mid- to late 2019 after the occurrence of tropical cyclones Idai and Kenneth. The integration of research tools was aimed at improving and ensuring rigour in the research approach (Krause et al., 2018). The use of key informant interviews was also beneficial to research as rich information could be obtained, the time spent on data collection was limited and the costs of data collection were reduced (Mitchell, 1994; McKenna and Main, 2013). Where key informants were used, multiple numbers of such informants were used to increase validity and reliability of the findings (Kumar et al., 1993). Collecting data soon after the disaster ensured that events were still fresh in respondents' minds and easy to recall.

Besides primary data, the authors made use of secondary data to answer research questions and arrive at conclusions. Data from aid agency reports, government reports and other such authoritative documentation was used to gain insight into the occurrence, impact and response of communities to tropical cyclones Idai and Kenneth. Most of the data that was used was from original data reports that have not been published. Such an approach is widely accepted within academia as noted by Church (2002).

Johnston (2017) argues for the promotion and usage of archived and secondary data to inform research findings. In this study, archival data was also used. For example, data from the International Best Track Archive for Climate Stewardship (IBTrACS) from NOAA and Meteo France was used to track the movement of tropical cyclones. Such sources are reputable and are also used by WMO and are considered official sources of information. Several authors have also made use of this data and published from it (Levinson et al., 2010; Hirano, 2021). Data from infrared satellite images was also utilised in this research. This has been done in the analysis and understanding of tropical cyclones in previous studies as well; see Emery et al. (1986) and Seward et al. (2018), for example.

1.7 Book Structure

The book is divided into Part I to Part V, starting with the introduction and background which sets the tone of the book by presenting major topics of discussion. Part II is on characterisation and tracking of tropical cyclones in order to understand the occurrence of tropical cyclones Kenneth and Idai. The section covers the meteorological understanding of the tropical cyclones and some of the generic observed impacts of the two cyclones. The orogenesis of these tropical cyclones is also tracked up to their dissipation.

Part III of the book deals with tropical cyclones as a disaster and the handling of EWSs in the SADC region, with a focus on the usage and failure of EWSs during tropical cyclones Idai and Kenneth in 2019. This section is underpinned by learnings from the Sendai Framework for Disaster Risk Reduction Framework and other such approaches. This is followed by Part IV, comprising chapters that deal with various knowledge systems adopted in Zimbabwe and the region to deal with disasters such as tropical cyclones and other such meteorological hazards in the region. Roles of various technologies and instruments are explored. The book closes with Part V, which consists of a conclusion section dealing with various policy options that can be undertaken and various recommendations. The book is part of a series with three volumes: 'Cyclones in Southern Africa Vol. 1: Interfacing the Catastrophic Impacts of Cyclone Idai with SDGs in Zimbabwe' and 'Cyclones in Southern Africa Vol 3: Implications for the Sustainable Development Goals'.

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Part II

Characterization and Tracking of Cyclones

2 Meteorological and Climatic Aspects of Cyclone Idai and Kenneth

Kaitano Dube, Lazarus Chapungu, and Jennifer M. Fitchett

Abstract

The year 2019 was a year of weather extremes that included high-intensity fires, droughts, floods and tropical cyclones that affected various countries across the world. These events had a devastating impact on economies globally. Understanding the meteorological and climatic aspects of these events is the sine qua non for effective disaster management. This chapter examines the meteorological aspects of cyclones Idai and Kenneth, which occurred successively in 2019. The chapter is premised on the analysis of archival weather data, document analysis and satellite image interpretation. Results show that there is a slight increase in the number of tropical cyclones in the basin in general and a significant increase of higher category cyclones of categories 4 and 5, with a decline in lower category cyclones. The cyclones had a direct impact on Mozambique, Malawi, Madagascar, the Comoros Islands and Zimbabwe, with a devastating impact on the socio-economic and environmental facets of life within the region, setting back the gains that were made in achieving the Sustainable Development Goals. Given the experiences in 2019, there is a need to revisit and enforce building planning design and construction of more robust infrastructure with the aim of reducing vulnerabilities and reduce losses associated with higher category hurricanes (tropical cyclones). The study also recommends serious investment into seasonal cyclone forecasting through improved modelling, disaster preparedness, communication and management going forward to reduce cyclone-associated losses in the SADC region.

Keywords

Tropical cyclones · Idai · Kenneth · Natural disasters · Flooding · Storm surges

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2.1 Introduction

The World Meteorological Organization (WMO) (2019) reports that the decade from 2010 to 2019 was characterised by extreme weather events across the world and this can be attributed to the changing global climate. Frequent droughts,

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severe floods, tropical cyclones, heatwaves, fires, rising sea levels and high tides amongst other events are predicted to slow down and possibly curtail progress towards the achievement of Sustainable Development Goals (SDGs) in most developing countries. Chapungu (2020) argues that in Southern Africa, such events have devastated and displaced a significant number of individuals and households, shattering their long-term goals and aspirations. Increased sea surface temperatures, influenced by anthropogenic global warming, coupled with changes in vertical shear, are expected to complicate the incidence and storm paths of tropical cyclones and related meteorological phenomena (Sharmila and Walsh, 2018; Pillay and Fitchett, 2020).

There is a significant positive relationship between sea surface temperature (SST) and storm intensity within the South-West Indian Ocean Basin (Pillay and Fitchett, 2019), and in the Southern Hemisphere as a whole (Pillay and Fitchett, 2020). Some scholars have observed that climate change is influencing the pattern and intensity of tropical cyclones (Lighthill et al., 1994; Walsh et al., 2004; Walsh et al. 2016). Sharmila and Walsh (2018) noted that due to climate change, tropical cyclones had over the years shifted poleward latitude altitude. A similar trend has been found for the southwest Indian Ocean (Fitchett and Grab, 2014; Pillay and Fitchett, 2019). There has also been an increase in the intensity of tropical cyclones in the region (Fitchett, 2018), which increases the diameter of the storm size, widening the region under threat. The consequence of such a development is that some areas, which were not vulnerable, will now have to put in place resilient measures to ward off or mitigate the impact of such cyclones. This poleward shifting has been attributed to increased atmospheric carbon concentration, which has led to global warming. Consequently, the tropical belt and Hadley circulation have been observed to be expanding since 1980 (Lucas et al., 2014).

While the effects of climate change on the patterns of tropical cyclones are already known, there remains a deluge of aspects that remain veiled in obscurity. There is a conflicting global view as to the occurrence of tropical cyclones under climate change (Knutson et al. 2019a). Knutson et al. (2010) argue that the characteristics of tropical cyclones have changed or will change in a warming climate, although several proponents argue against this. Although there has been scholarly debate on this matter, what is apparent is that global warming will result in increased intensity of tropical cyclones and the associated risk that comes with cyclones (Peduzzi et al., 2012; Knutson et al. 2019b). The debate of tropical cyclones has heightened in recent years, particularly in Southern Africa given the magnitude and intensity of cyclones on humans, economies and environment (Emanuel, 2005; Kossin, 2018; Muthige et al., 2018; Patricola, 2018). Evidence suggests that the region is particularly vulnerable to tropical storms as they often result in disruption of lives and economic development. In that regard, therefore, the understanding of tropical cyclones is imperative given their impact on the environment and infrastructure, which can run into billions of dollars. This study is therefore aimed at tracking the development and movement of Tropical Cyclone Idai and Tropical Cyclone Kenneth with a view to understand how their life cycle led to a record human, economic and environmental impact in Southern Africa in 2019.

2.2 Literature Review

Tropical cyclones are intense circular storms that originate over warm tropical oceans and are characterised by low atmospheric pressure, high-speed winds and heavy rains (Zehnder, 2019). According to Vitart et al. (2003), tropical cyclones can be defined as cyclonic systems, which have a maximum sustained wind system that is larger than 17 ms^{-1}. Tropical cyclones draw their energy from warm sea surfaces and generate winds that exceed 119 km per hour. In some cases, the winds exceed 240 km per hour. Some gusts may occur which exceed 340 km per hour. Torrential rains and storm surges that are highly destructive usually accompany the strong cyclonic winds. The combination of high winds and water makes cyclones a serious hazard for coastal areas in

tropical and subtropical areas of the world (WMO, 2017; Mark, 2012).

Fitchett and Grab (2014) highlight that there is a huge interannual variability on the occurrence of tropical cyclones in southeast Africa, which could be attributed to atmospheric forcing which includes the El-Niño-Southern Oscillation (ENSO) amongst other factors. Tropical cyclones have made quite an impression in Southern Africa. Most of the tropical cyclones that affect Southern Africa have their orogenesis in the Indian Ocean Mozambique Channel. These cyclones have their genesis within the Mozambique Channel with a devastating impact on the economies of the region. Within the South-West Indian Ocean (SWIO) tropical cyclone incidence is determined by a combination of the sea surface temperature (SST), dipole mean index (DMI) and southern annular mode (SAM) which generally causes the highest landfall (Pillay and Fitchett, 2019).

Jury and Parker (1999) found a varying degree of behaviour and characteristics of tropical cyclones in the SWIO, which has a bearing on the magnitude and impacts. Land objects such as mountains and other physical barriers tend to slow down tropical cyclones, and the loss of water recharge results in declining intensity. On the other hand, poleward recurving tropical cyclones typically go under rapid vortex development (Jury and Parker, 1999). West-moving tropical cyclones are thermally driven, whereas recurving cyclones are dynamically driven (Jury and Parker, 1999).

There are varying statistical narratives with regard to the number of tropical cyclones that affect the SWIO which has to do with the data set used and also the delimitation of the area of study. According to Muthige et al. (2018), there is an average of 9 tropical cyclones that affect the SWIO region every year while a study by Mavume et al. (2009) reported an average of about 13 cyclones a year between 1980 and 2007. However, Maoyi et al. (2018) detected an average of 7.3 ± 2.2 tropical cyclones per year within the region. Bié et al. (2017) highlighted that tropical cyclones that make landfall in the SWIO basin are compounded by storm surges and high freshwater discharge causing severe flooding during the summer period. This leaves areas within the Mozambique Channel at very high risk given that the bulk of the area is around 20 m altitude.

In Southern Africa, there is evidence suggesting that the 2010–2020 decade has been one of the most affected in terms of the frequency and severity of disastrous meteorological events with a consequent increase in costs for remedial action (Fitchett, 2018). The year 2019 was associated with several extreme kinds of weather and climate anomalies that were driven partly by increased sea surface temperatures, rising sea levels, intensity of ocean tides, severity of droughts and tropical cyclones of high magnitude (WMO, 2019; NOAA 2019a).

Cyclones form in the tropical regions and are named differently depending on the location of their incidence. They occur every year during the late summer months in both hemispheres, i.e. July–September in the Northern Hemisphere. In the Southern Hemisphere, various authors put various dates for the beginning and ending periods for tropical cyclones. The tropical cyclones in the SWIO (5°–20°S, 45°–70°E) occur between November and March (Chang-Seng and Jury 2010). With regard to South Indian Ocean Xie et al. (2002) noted that warmer SSTs promote the development of oceanic Rossby waves which have increased tropical cyclones in the South Indian Ocean region.

The formation of tropical cyclones is driven by low-pressure core and by the rotation of Earth, which deflects the path of the wind through Coriolis force (Zehnder, 2010). As a result, tropical cyclones rotate in a counterclockwise direction in the Northern Hemisphere and a clockwise direction in the Southern Hemisphere. Warm-moist air over the ocean rises upward from near the surface, creating a vacuum of low pressure. Air from surrounding areas with higher air pressure is pushed into the low-pressure area. The cool incoming air is warmed up and becomes moist and rises too. The rising air cools adiabatically, forming deep convective clouds. The ocean's heat and moisture continue to feed the cloud and wind-spin system, which progressively grows bigger. The continuous growth and rota-

tion of the system will result in the development of an eye at the centre. The eye is characterised by low pressure, calm and clear conditions. Zehnder (2010) notes that high-pressure air from above flows down into the eye.

The wind speed continues to grow and when it reaches 74 mph (119 km/h) it can be called a tropical cyclone. When the tropical cyclones make landfall, they get weak due to absence of energy generated by warm ocean waters. However, Wang and Wu (2018) observed that the cyclones move inland for greater distances, dumping huge amounts of rain and damaging infrastructure before they die out completely.

Cyclones are put into categories depending on wind speed. Several classification systems are used; the Saffir-Simpson Hurricane Scale is one of the most popularly used scales. The classifications (1–5) (Table 2.1) are intended primarily for use in measuring the potential damage that results from sustained winds at each category upon making landfall.

A look at the scale shows that tropical cyclones have a devastating impact on the natural and human environment which disrupts development in general. Besides the devastating impact of the wind associated with tropical cyclones in coastal areas some of the significant damages that ensue tropical cyclones are storm surges which result in flooding and coastal inundation. Chen et al. (2020) reported that due to global warming peak, intensities of tropical cyclones were expected to increase by ~10% in the near future. They estimated that storm surges which were compounded by rising sea levels were expected to increase by about 8.5% which will push the tide by a further ~1 m between 2075 and 2099. Areas that are prone to tropical cyclones have witnessed an increase in the destructive impact of storm surges such as Bangladesh due to an increase in storm surge height (Murty and El-Sabh, 1992; Ali, 1996). Chang-Seng and Jury (2010) noted that the South-West Indian Ocean was also experiencing increased damage related to rising tidal challenges as a consequence of increased tropical storms that often resulted in flooding. Storm surges and flooding from tropical cyclones hence are some of the biggest threats triggered by tropical cyclones with substantial economic impacts, mainly if the landfall occurs over densely populated areas such as urban areas.

Table 2.1 The Saffir-Simpson Hurricane Wind Scale

Category	Sustained Winds km/h	Damage at Landfall
1	119-153	✓ Very dangerous winds will produce some damage. ✓ People, livestock, and pets struck by flying or falling debris could be injured or killed.
2	154-177	✓ Extremely dangerous winds will cause extensive damage. a substantial risk of injury or death to people, livestock, and pets due to flying and falling debris (some poorly constructed homes at risk.
3	178-208	✓ Devastating damage will occur. ✓ a high risk of injury or death to people, livestock, and pets due to flying and falling debris (most old homes destroyed)
4	209-251	✓ Catastrophic damage will occur. ✓ a very high risk of injury or death to people, livestock, and pets due to flying and falling debris (nearly all older homes destroyed.
5	252+	✓ Catastrophic damage will occur. ✓ People, livestock, and pets are at very high risk of injury or death from flying or falling debris, even if indoors in mobile homes or framed homes. (almost complete destruction)

Source: Authors data from NOAA (2019)

Source: Authors' data from NOAA (2019c)

The year 2019 has been characterised by a significant number of extreme weather events attributed to climate change (WMO, 2019). LeComte (2020) noted that the year 2019 was a year of catastrophic weather events which were punctuated by floods, fires and record hurricanes in several ocean basins. This was also acknowledged by Pasch et al. (2020) who bemoaned the record damage associated with extreme weather events in 2019. The costs of fortifying against weather extremes, reconstructing cyclone-damaged infrastructure and restoring weather-dilapidated societies continue to increase igniting intense fears that climate change-engineered cyclones and related extreme weather events are poised to reverse the gains and humper the attainment of Sustainable Development Goals (Insurance Journal, 2019; World Economic Forum-WEF 2019; Satista 2019; International Monetary Fund 2019). Indications from the World Meteorological Organization, WMO (2019), show that the world is off-track in meeting the Paris Agreement spelling disaster for global climate.

2.3 Research Methods

The study made use of data from archival sources to understand the occurrence of tropical cyclones Kenneth and Idai. This data was complemented by other secondary data sources. Meteorological data observations started way back in history dating as far back as 4000 BC during the Babylonian era where observed data was being recorded on clay tablets (Collier, 1963). Weather archival data in America dates back to 1644–1645. Since then the demand for weather and climate data had seen a grown interest in usage, particularly by environmentalists. The use of such data has been increasing usage even in recent past in various sectors of the environment, particularly in climate change research (Dube and Nhamo, 2020a, b). The USA boasts of one of the largest and richest archival data used across the world, which includes satellite imagery that is collected across the world (Pyle, 1965). To that end, we made use of statistical data on meteorological variables from the National Oceanic and Atmospheric Administration (NOAA) National Hurricane Center. The data from NOAA is reliable and is also used by the World Meteorological Organization. Similar studies in the region have utilised the same data from NOAA making use of IBTrACS database (Fitchett, 2018; Pillay and Fitchett, 2019, 2020). We also made use of Météo France tropical cyclone database, which is the regional monitoring centre for tropical cyclone for the region. Data analysis was done using Microsoft Excel ToolPak. The trend was tested using the Mann-Kendall trend test with confidence interval set at 95%.

2.4 Results and Discussion

The following sections describe the meteorological occurrences of the two devastating cyclones that occurred in South-West Indian Ocean, namely Tropical Cyclone Idai and Tropical Cyclone Kenneth, which had a devastating impact on several Southern African countries. Tropical Cyclone Idai, which took place in March 2019, affected several countries including Madagascar, Malawi, Mozambique and Zimbabwe. Tropical Cyclone Kenneth occurred in April 2019 with the greatest impacts felt in Central and North East coast regions of Mozambique, centred in the city of Beira.

2.4.1 The General Trend of Tropical Cyclones in the South Indian Basin

To understand the context of the occurrence of tropical cyclones Idai and Kenneth, it is imperative to have an overview of the general trend of cyclonic activity in the Southern Indian Ocean Basin. Between 1969 and 2019, there were 626 1–5 category tropical cyclones recorded in the South Indian basin. This translates to a long-term average of about 12.3 events per annum. There is, however, considerable inter-annual heterogeneity in tropical cyclone numbers and intensity (Fig. 2.1).

The study shows that there is a general slight increase in the number of tropical cyclones over time. There are nonetheless variations within

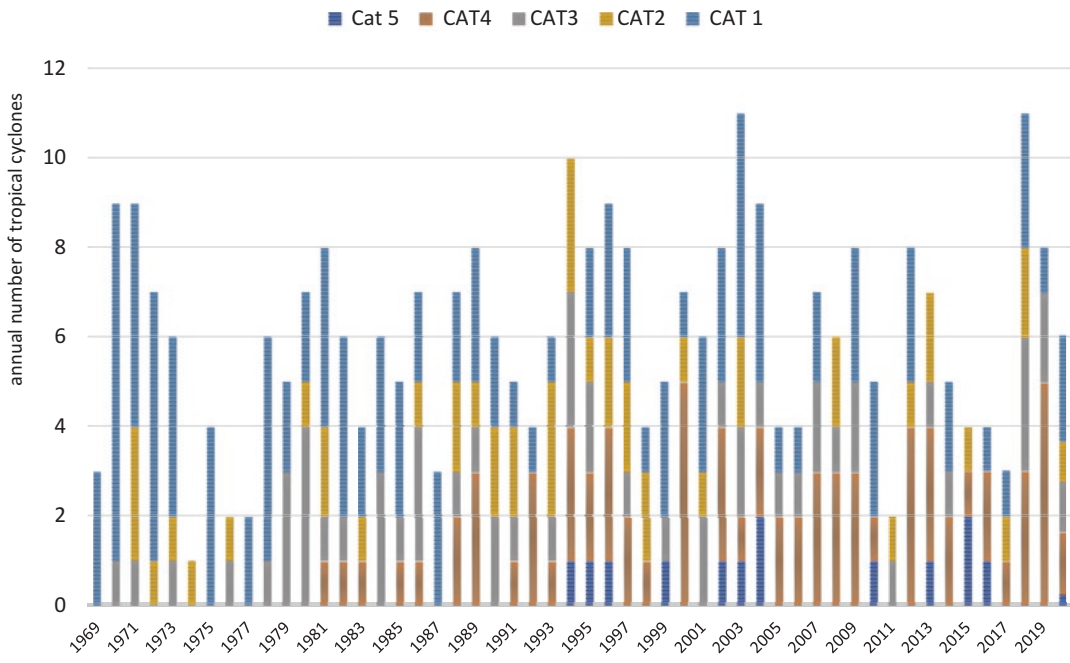

Fig. 2.1 Observed tropical storms and hurricane of categories 1–5 between 1969 and 2019. Source: Authors based on data from NOAA (2019b)

various categories and types of storms with others showing an increase and others showing a decline. An analysis of the five decades also shows trend variations between decades of the various categories of tropical cyclones. Within the first decade of study, there was a general decline in the number of tropical cyclones within the basin. This is also confirmed in Fig. 2.2. In 2019, a record number of tropical cyclones in the basin was nine.

The Mann-Kendall trend test revealed a significant ($p = 0.003$, $\alpha = 0.05$) decline in the frequency of category 1 tropical cyclones. Category 2 and 3 cyclone frequencies are not statistically significant ($p = 0.917$, $p = 0.617$), respectively. There was also a statistically significant increase in tropical cyclones in a higher category of 4 and 5 as shown in Table 2.2.

All in all, we noted a statistically insignificant increase in the total number of tropical cyclones in the basin ($p = 0.446$). The number of tropical cyclones slightly increased from less than six per annum to slightly more than six per annum.

In a bid to understand further the pattern of tropical cyclones, we explored the five categories of storms covered in this study to understand the trend for each. It also emerged that the decline in tropical cyclones reported in Fig. 2.2 can be attributed to declines that are seen in category 1 tropical cyclones as can be seen in Fig. 2.1. The number of tropical cyclones of category 1 magnitude declined from about 4 to about 1 per annum.

On the contrary, category 4 tropical cyclones in the basin increased from 0 in 1969 to about 3 per annum during the last three decades running up to 2020, which denotes an increase. Figure 2.3 shows various trends amongst different categories of tropical cyclones in the basin, which shows a decline in less impactful systems and an increase of high-severity tropical cyclones. The South Indian Basin, therefore, is vulnerable to high-impact cyclones, a trend likely to continue going forward. Such development has serious implications for marine transport, small island states and coastal and other inland areas that are usually affected by tropical cyclone landfalls. Given the understanding of the impact of such tropical cyclone dynamics

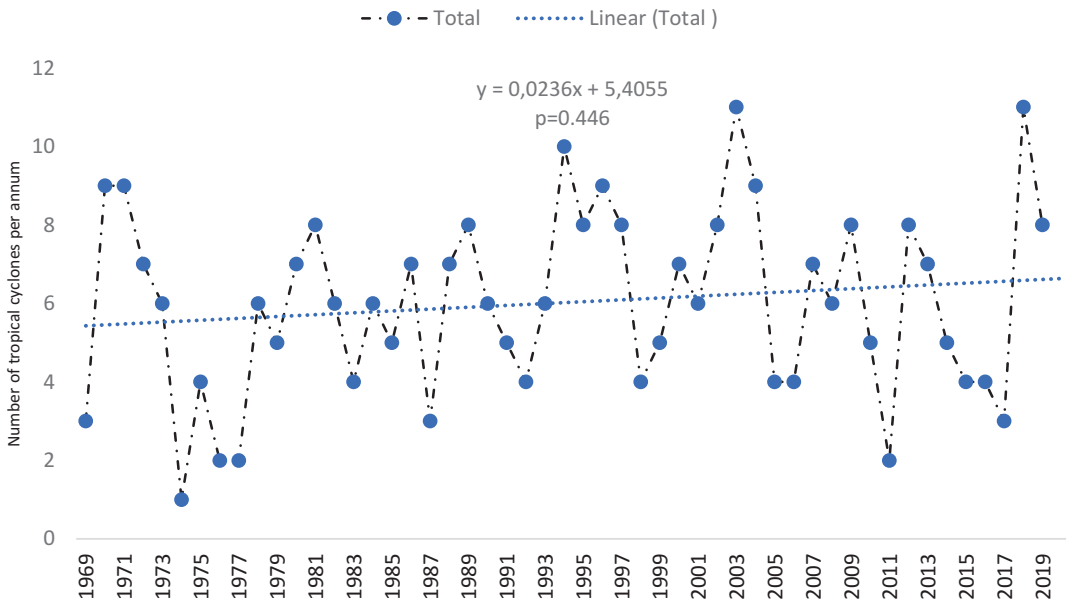

Fig. 2.2 General trend of all categories of tropical cyclones (1969–2019). Source: Authors

Table 2.2 Mann-Kendall trend significance test results for tropical cyclones in the South Indian Ocean Basin, 1969–2019

Category	1	2	3	4	5
p-Value (two tailed)	0.003	0.917	0.716	0.0001	0.007
	Significant decline	No significance	No significance	Significant increase	Significant increase
Mean	2.373	0.902	1.078	1.412	0.255
Standard deviation	1.697	0.944	1.017	1.403	0.523

Source: Authors

(Table 2.1), the region will likely experience economic, human and environmental disruptions as a consequence of the tropical cyclones as we have already seen in previous studies that sought to quantify the impact of tropical cyclones in the region. A study by Fitchett (2018) confirmed that there was an increase in category 5 tropical cyclones within the South Indian Ocean Basin which can be disruptive to lives and economies. Dube et al. (2020) attested to the importance of ocean and tourism economies in the South Indian Ocean area. An increase of disruptive natural hazards will affect the coastal economy, which can inhibit the attainment of SDGs as the blue ocean economy has been identified as one of the cogs for achieving sustainable development.

2.4.2 The 2019 Tropical Cyclone Season in the South-West Indian Ocean

The tropical cyclone season in the South-West Indian Ocean (SWIO) was generally normal if one looks at the average number of tropical cyclones expected in a year which averages nine (Table 2.3). However, a closer look at the 50 years of data shows that the year 2019 was extraordinary as it reported the highest number of category 4 tropical cyclones ever in the basin. While the average number of expected tropical cyclones is three per year, a total of five were witnessed in 2019, which is about 67% more than the expected number. One can, therefore, conclude that 2019

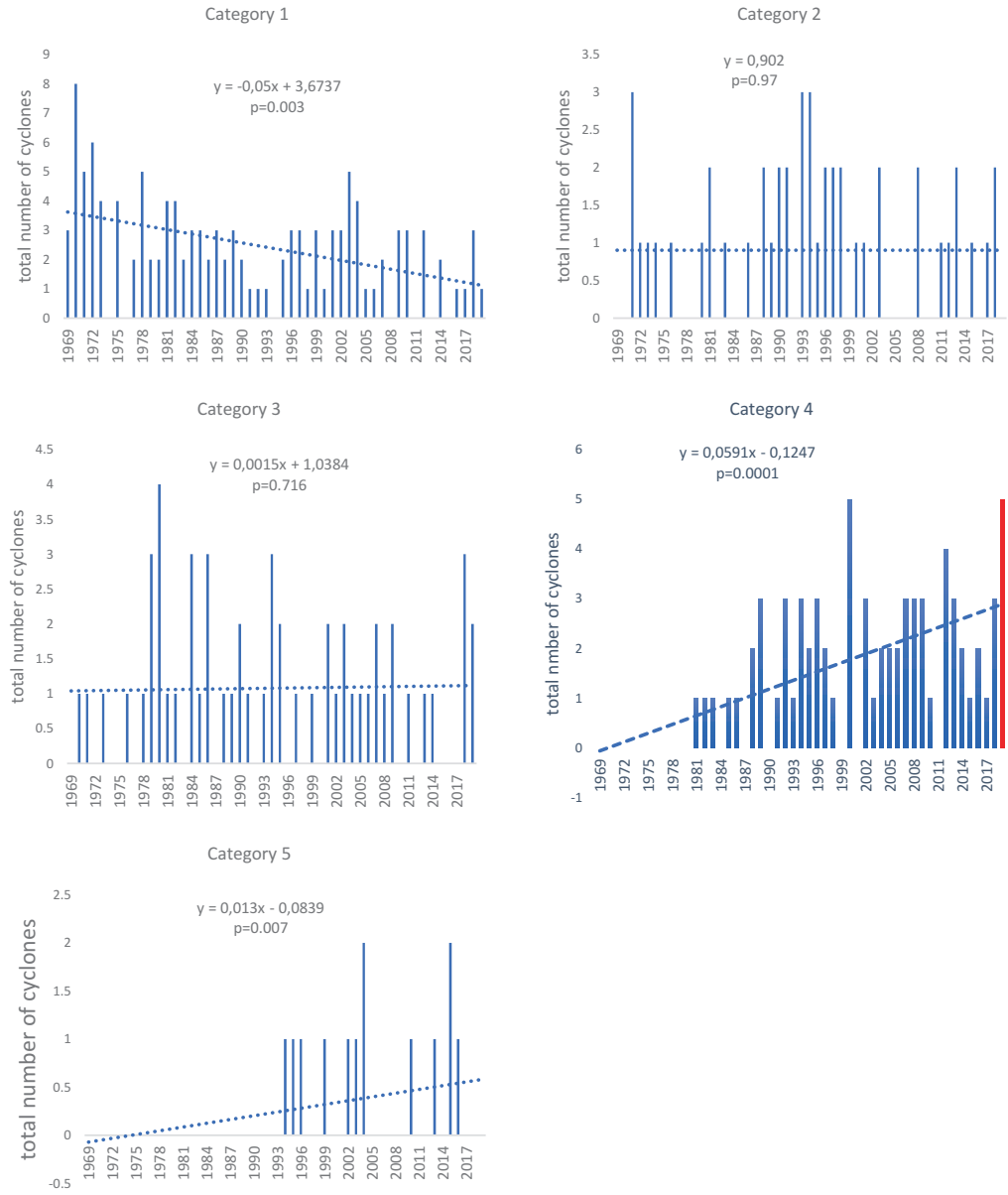

Fig. 2.3 Trend of various categories of tropical storms/cyclones between 1969 and 2019

was a year of weather extremes in the Indian Ocean Basin.

The SWIO also noticed two major tropical cyclone landfalls, namely Tropical Cyclone Idai (a category 3 tropical cyclone on landfall) and Tropical Cyclone Kenneth, which were category 4 tropical cyclones on landfall in March and April, respectively, barely a month apart.

2.4.3 Meteorological Aspects of Tropical Cyclone Idai

Tropical Cyclone Idai (Fig. 2.4) started to develop as tropical depression midnight on the 4th of March 2019 at 18° South and 38° E (Météo France, 2019a). The system moved through the Mozambique Channel with a maximum average

Table 2.3 2019 Tropical cyclones in the South Indian Basin statistics

	Tropical Storms	Category 1 Hurricane	Category 2 Hurricane	Category 3 Hurricane	Category 4 Hurricane	Category 5 Hurricane
Average	3	1	1	1	3	0.5
Total 2019	1	1	0	2	5	0

Source: Authors (2019)

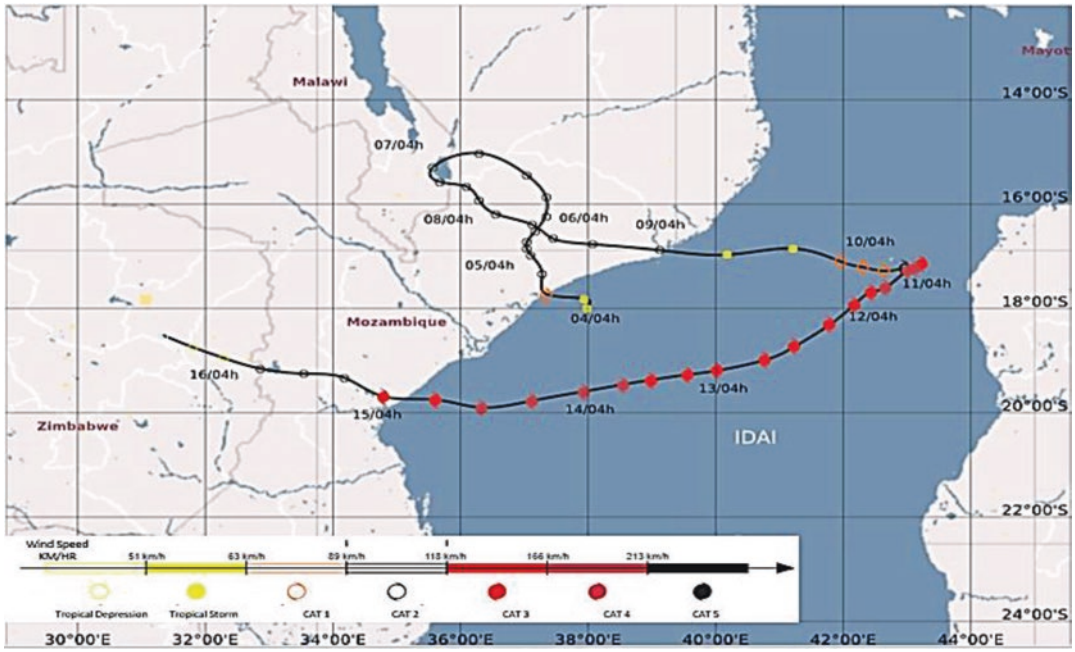

Fig. 2.4 Storm track of Tropical Cyclone Idai. Source: Authors' map adapted from Météo France (2019a)

wind speed of 55 km/h and a wind gust of 75 km/h. The system intensified and moved north-west on the 4th of March and made landfall on Mozambique in the early hours of the 5th. Upon reaching the land, the tropical cyclone lost energy as it travelled at very low speeds dropping to a minimum of 2 km/h. Due to this low speed, the system dumped a lot of rainfall in the affected areas, which resulted in general flooding, particularly in low-lying areas. The system later moved North East of Beira affecting areas such as the Zambezia Province moving to Niassa Province in Mozambique. On the 6th of March, the tropical depression veered north-west into southern districts of Malawi where it led to heavy rainfall and flooding in the Nsanje District. This led to the flooding of areas around Chikwawa and Shire River.

The depression veered South-East back into Mozambique on the 7th of March, passing some of the areas it had affected, and was off the Mozambique coast back into the Indian Ocean on the 9th of March. The depression effectively spent 9 days pounding Mozambique and Malawi travelling at an average speed of 8.80 km/h, which resulted in many areas exceeding their infiltration capacity and triggering flooding in many affected areas. The lowest speed reached during that period was 2 km/h as the depression almost got to be stationary. During the period, a maximum average categorising wind speed was 70 km/h (Figs. 2.5).

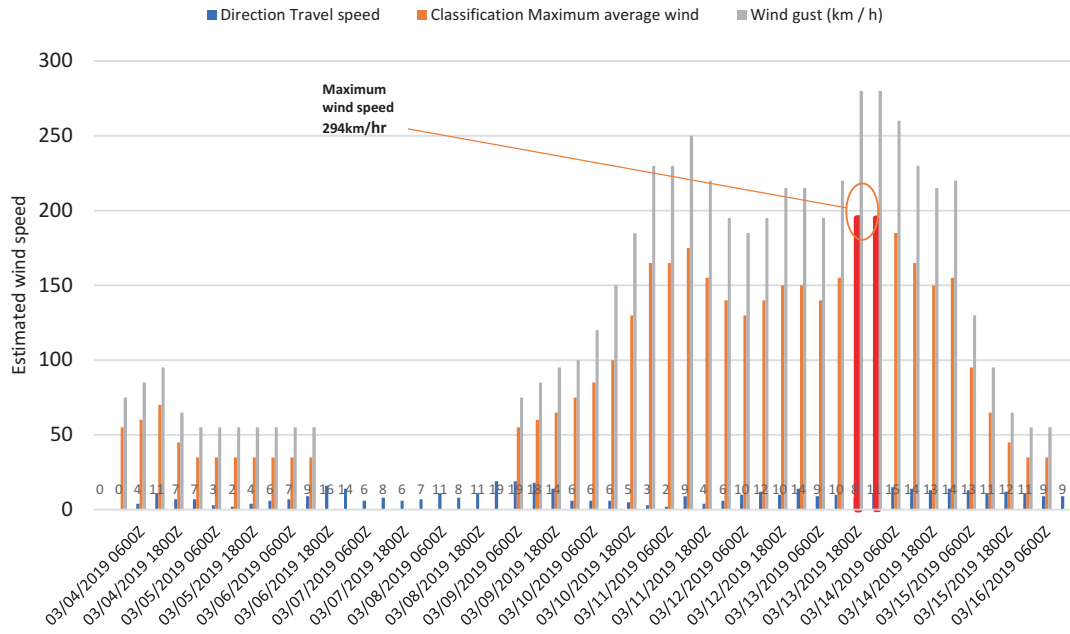

Fig. 2.5 The intensity of Tropical Cyclone Idai, 2019. Source: Authors' data from Météo France (2019a)

Having veered back into the ocean, the depression gained speed and continued moving east into the Indian Ocean intensifying and strengthening into a category 1 hurricane on the 10th of March 2019 at 17.1° South and 42° East. On the 11th in the early morning, the tropical cyclone veered and retracted almost backwards moving in a south-westerly direction as alternating between category 2 and 3 storms with some measurements placing it as category 4. It is on the 11th of March given the positioning of Idai that it deposited large amounts of rainfall that affected North West of Madagascar before veering to make landfall in Mozambique. The tropical cyclone moved west and made landfall in the early hours of the 15th of March 2019 near Beira in Mozambique. Given the classification average wind speed reaching about 294 km/h at the maximum on the 13th and the 15th of March 2019, the movement of tropical cyclone caused extensive wind damages. The tropical cyclone prompted a storm surge of between 2.5 and 4 m, which compounded flooding as it pushed back water from rivers resulting in extended inundation, breaking of flood banks and flooding along the coastlines.

The tropical cyclone had a devastating impact on infrastructure in affected areas, which the tropical cyclone passed through if one considers the actual impact of the observations made during the tropical cyclones. According to the scale homes, schools, buildings, roads, electricity, water supply systems, schools and other poorly constructed homes were devastated by the hurricane associated with the loss of people's lives and animals. Figure 2.5 also shows that the tropical cyclone was on average moving at a very slow speed of less than 10 km/h and as slow as 5 km/h which resulted in heavy soaking of areas in the path of the cyclone which triggered flooding inflicting further damage to infrastructure and human lives particularly in the low-lying areas in Sofala, Manica Province in Mozambique and parts of Manicaland, Masvingo and Midlands province in Zimbabwe. Given that some of the affected areas are agricultural and tourism resort areas extensive damage was witnessed in many tourist resorts such as national parks and other important tourist resorts and recreational areas.

Farmlands were also affected due to flooding and wind action. Progress made in various SDGs such as SDGs on health, education, water and

sanitation, food security and hunger, energy and communication, poverty reduction and biodiversity amongst others was greatly undermined by the cyclone. Industry and trading were also affected as there were severe disruptions at the port of Beira, which had a knock-on effect on regional economies. Power supply between Cahora Bassa Dam and South Africa was also affected, which resulted in a daily load shedding for close to a week, which resulted in an economic blood bath in the South African economy. It is important to note that from a human perspective, many families lost their homes and even months after the disaster most people did not have homes, schools and clinics threatening the livelihood security of many people. The full impacts on infrastructure will be dealt with in the coming chapters.

2.4.4 Meteorological Aspects of Tropical Cyclone Kenneth

Tropical Cyclone Kenneth formed from a vortex on the 17th of April 2019 barely a month after the devastating Tropical Cyclone Idai (Météo France, 2019a, b). Over time, there was a significant increase in deep convection. It was designated Tropical Disturbance 14 on the 21st of April. The disturbance was located in the north of Madagascar, which was characterised by low vertical wind shear and warm sea surface temperatures of 29–30 °C. This environment was conducive for its strengthening into a tropical depression and later a tropical storm, both on the next day. Kenneth then began to intensify rapidly with 10-min sustained winds of 215 km/h and a minimum central pressure of 934 hPa. At that time, the cyclone had a pinhole eye surrounded by very strong convection. However, it later began to undergo an eyewall replacement cycle and weakened slightly, before making landfall later that day as an intense tropical cyclone.

In general, Tropical Cyclone Kenneth was influenced by a low-pressure system, which intensified on the 24th of April 2019. It passed north of the Comoros Islands, reaching the northern island of Ngazidja on the same day. The cyclone moved west and made landfall in Mozambique on the 25th of April. It hit between the districts of Macomia and Mocimboa da Praia in Cabo Delgado province. Cyclone Kenneth was characterised by wind gusts of up to 220 km/h, making it the strongest cyclone to ever hit the African continent until 2019. It made landfall on the coast of far northern Mozambique in the afternoon as a catastrophic category 4 storm. Just before landfall, in the evening, Kenneth's top sustained winds were 120 knots, solidly in the Cat 4 range (JTWC, 2019). Later, Kenneth moved inland and weakened dramatically, with top sustained winds down to 75 knots (JTWC, 2019). Figure 2.6 shows the storm track for Cyclone Kenneth.

Tropical Cyclone Kenneth rapidly grew from tropical storm to category 4 strength in just 36 h. As Kenneth approached the coast, its high-speed winds extended only about 40–45 miles to the south and 30–35 miles to the north. At the city of Pemba, top sustained winds at the time were only about 27 mph, with gusts to 39 mph. Figure 2.7 shows the intensity of Cyclone Kenneth over time. The data shows that the maximum wind speed was obtained on the 25th of April, where a maximum speed was 215 km/h. The cyclone moved a little bit faster than Idai as its speed reached 29 km/day which could have moderated the damaging impact of this category 4 hurricane, which was feared to have a worse devastating impact than Tropical Cyclone Idai. Given the experience with Tropical Cyclone Idai, massive evacuations were also carried out to try to reduce the loss of lives, which also reduced the number of cyclone-induced deaths. However, like TCI, most people lost their homes and livelihoods.

In the past five decades, the northern parts of Mozambique and some closer parts of Tanzania did not record storms of high magnitude as Tropical Cyclone Kenneth. In the previous decades of satellite coverage, only a few tropical depressions and storms of low categories were detected in the landfall location. This has been necessitated by the location's proximity to the equator (12°S) where cyclones cannot gather enough atmospheric spin to form and be sustained.

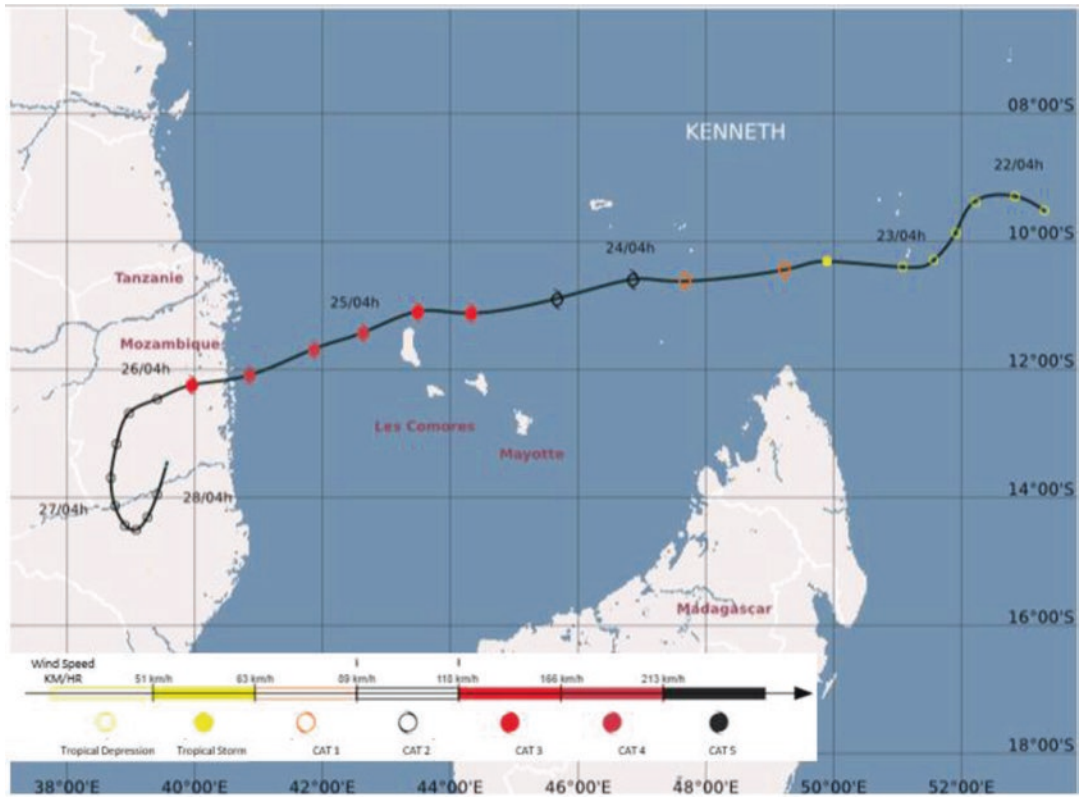

Fig. 2.6 Storm track of Tropical Cyclone Kenneth, 2019. Source: Adapted from Météo France (2019b)

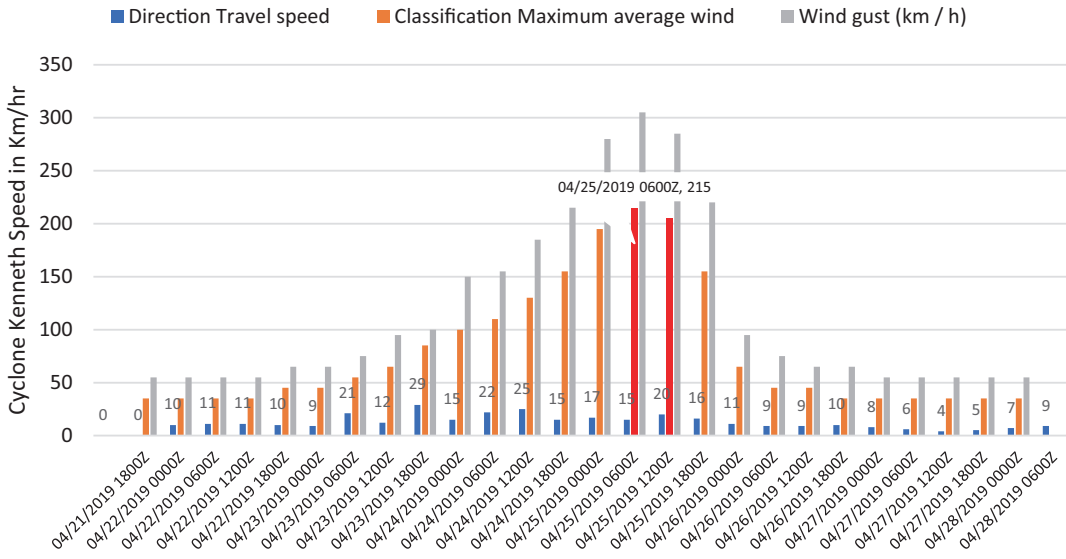

Fig. 2.7 The intensity of Tropical Cyclone Kenneth

Tropical Cyclone Kenneth made one of the strongest landfalls in the history of mainland Africa. Amongst other strong landfalls was Cyclone Leon and Eline, which hit Mozambique on 26 February 2000 with high-speed winds of 134 mph (JTWC, 2000). Although TCK was smaller than TCI, its intensity was much higher. It is important to note that although Kenneth was the strongest, Idai had more destruction.

2.4.5 Satellite-Based Tracking of Tropical Cyclones Idai and Kenneth

The Visible Infrared Imaging Radiometer Suite (VIIRS), EUMETSAT Meteosat-8 Visible (0.8 μm) and RealEarth remote sensing products and tools provide information that helps understand the meteorological aspects of TCI and TCK. As shown by remote sensing imagery, TCI moved inland over East African countries. Figure 2.8 shows the image of TCI acquired through Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi NPP satellite. The image was acquired on the 11th of March 2019 as the cyclone spanned the width of the Mozambique Channel. The cyclone carried maximum sustained winds of about 105 knots (120 miles per hour). On its genesis, Tropical Cyclone Idai distributed high winds and heavy rain to Mozambique and Malawi, where it caused hydrological problems through flooding.

As shown in Fig. 2.8, most of Madagascar territory experienced the meteorological hazards associated with the TCI system, which developed in the Mozambique Channel. The disturbance intensified into a major tropical cyclone over the warm channel between the southeast coast of Africa and Madagascar. This was followed by a major landfall in Mozambique a week later, bringing a second round of wind and rain to the region.

At the centre of the storm, an eye is also visible. This is created as the storm system continues to rotate in an anticlockwise direction. It is calm and clear in the eye, with very low air pressure. Higher pressure air from above flows down into the eye.

Figure 2.9 shows the EUMETSAT Meteosat-8 Visible (0.8 μm) image of category 4 Cyclone Kenneth making landfall along the northeast coast of Mozambique (north of Pemba) on the 25th of April 2019.

2.4.6 Tropical Cyclones Kenneth and Idai and the Influence of Climate Change

The landfall of tropical cyclones Kenneth and Idai in Mozambique as category 4 and 3 storms with 140 mph and 110 mph winds, respectively, makes them among the strongest landfalling tropical cyclones ever observed in mainland southeast Africa. Remarkably, their occurrence in the same year raises the question of whether human-induced climate change has contributed to their development. It can be claimed that climate change possibly made the probability of such an unusual occurrence more likely, but the challenge we have is that there has been no effective satellite monitoring of cyclonic events in the basin. Although the first geostationary satellite started in 1989 with non-geostationary satellite imagery starting in 1967, regular satellite imagery of the Southwest Indian Ocean earnestly began in 1998 (Henson, 2019). Climate change is best determined using datasets of 30 years or more (IPCC, 2007; Chapungu and Nhamo, 2016). The 21-year-long satellite data record for the basin makes it problematic to ascertain the effect of climate change on Southwest Indian Ocean tropical cyclones.

However, there is unequivocal evidence that sea surface temperatures are increasing over time (Wang and Wu, 2018). This increase in temperatures influences the behaviour of cyclones in the basin. It should be expected that Tropical Cyclone Kenneth's heavy rains were partly induced by the climate change phenomenon. This is in line with predictions made by hurricane scientists that the projected occurrence of tropical cyclones in a warmer climate will be characterised by heavy rains owing to high moisture content in the atmosphere. Wang and Wu (2018) also found that global warming that occurred since 1980 might

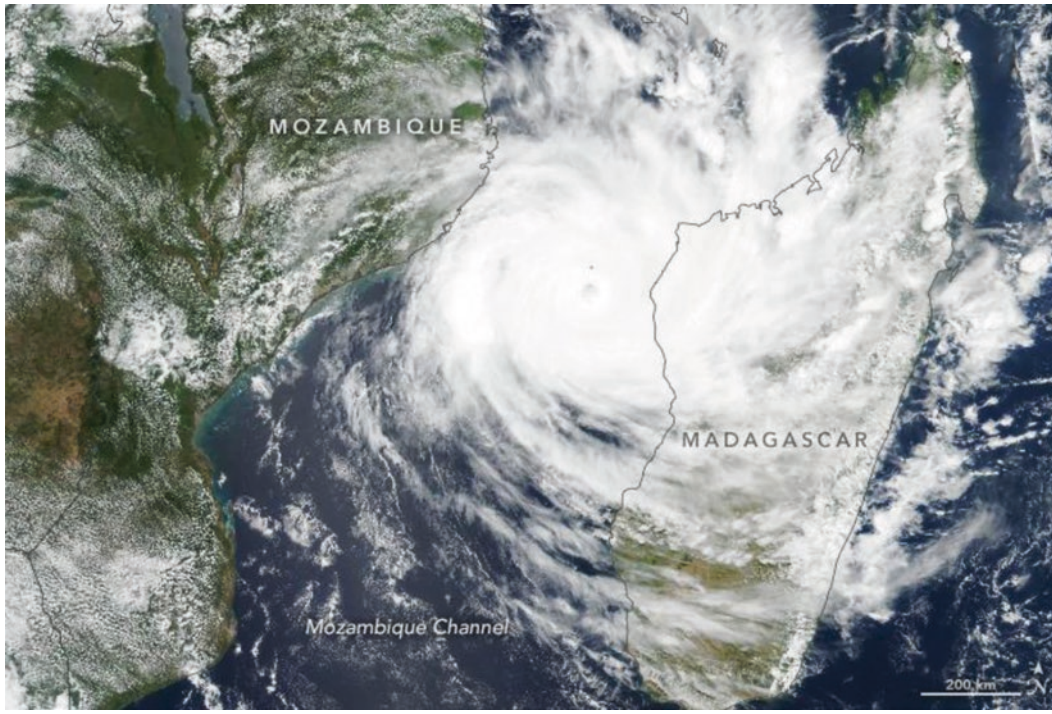

Fig. 2.8 Category 3 Tropical Cyclone Idai shown on the Suomi NPP satellite. Source: Adapted from NASA (2019)

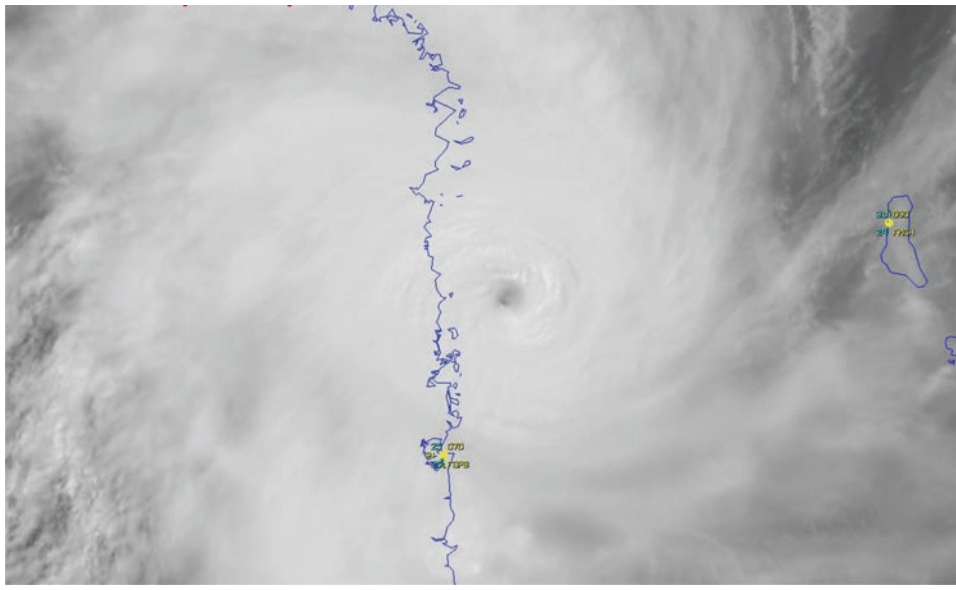

Fig. 2.9 EUMETSAT Meteosat-8 Visible (0.8 μm) image of category 4 Cyclone Kenneth making landfall along the northeast coast of Mozambique. Source: Adapted from NASA (2019)

have increased Hurricane Harvey's high precipitation by 13–37%.

In recent decades, a 4% slowdown in tropical cyclone motion has been observed in the Southwest Indian Ocean (Henson, 2019). The slowdown is associated with highly destructive rainfall. In the case of cyclones Idai and Kenneth, the slow motion, which was less than 10 mph, resulted in their highly destructive rains. It remains veiled in obscurity whether this trend is attributable to human-induced global warming. However, several scientists argue that there are good reasons to believe that this could be the case.

Worldwide, storm surges associated with tropical cyclones are intensifying due to climate change. Cyclones Idai and Kenneth are no exception. Since the last century, global sea levels have increased by about 1.2 m. This additional rise facilitates the storm surge of all tropical cyclones to cause increased destruction.

Bhatia et al. (2018)) projected response of tropical cyclone intensity and intensification, using a high-resolution global climate model (HiFLOR). They projected an intense upsurge in the frequency of rapid intensification due to increase in global temperatures and a 20% increase in the occurrence of major hurricanes globally in the climate of the late twenty-first century. For the South-West Indian Ocean, Bhatia et al. (2018) predicted a significant increase in the number of days of category 3 and stronger cyclones.

2.5 Conclusion and Recommendations

The study sought to investigate the meteorological and climatic aspects of tropical cyclones Idai and Kenneth, which took place in March and April of 2019, respectively. To understand the meteorological and spatial context of the occurrence of the two cyclones, the study examined the historical pattern of tropical cyclones in the South Indian Ocean Basin between 1969 and 2019. The study observed a slight increase in the frequency of tropical cyclone activity and an increase in the intensity and destructiveness of cyclones over the same period within the basin. A statistically significant decline was observed for category 1 tropical cyclones and a statistically significant increase of tropical cyclones 4 and 5 whereas there were no significant changes in category 2 and 3 cyclones. The occurrence of tropical cyclones Idai and Kenneth was therefore in the context of the increase in the number of high-impact-category tropical cyclones in the region. The year 2019 was a year of extremes, with two record-high tropical cyclones occurring within a short space of time. Given the climatological properties of these two tropical cyclones and their geographic disposition, they had a devastating impact on environmental, social and economic aspects in several SADC countries that include Madagascar, Mozambique, Malawi, Zimbabwe and Comoros Islands and left a trail of destruction, with loss of human and animal lives.

The loss of infrastructure and human lives was unprecedented with consequences of reversing the gains that had been made in achieving several Sustainable Development Goals including SDGs that deal with poverty, health, water and sanitation, industry and commerce, and food security to mention but a few. The tropical cyclones demonstrated the region's vulnerability to the increasing occurrence of natural disasters in the form of tropical cyclones and raised questions of capacity and preparedness of the SADC region to deal with such catastrophes going forward. This is unfortunate given that the Sendai Framework had paved the way for countries to make plans to reduce and mitigate such disasters. The study concludes that there is a need for countries to improve their disaster preparedness and management as necessary with a budget set aside to fund disaster management programmes that are aimed at providing relief to the affected humanely. As we saw, even though there were attempts to provide relief by international organisations, such relief fell far from meeting the unprecedented demand due to several factors; despite a spirited effort by the United Nations, very little in terms of relief came forth to assist the affected countries. The study recommends several initiatives that can be instituted by countries to better pre-

pare for the problem that is likely to recur. Chief amongst them are the revision of settlement patterns to ensure that those people settled in known flood-prone areas are relocated and the revision of building codes so as to put in place infrastructure that is resilient to the kind of tropical cyclones that are affecting the region. The government can assist with building better projects, and there might be a need to involve the international community to relieve the burden of costly recovery. In some areas, enforcement of existing bylaws can assist in ensuring that people do not settle in vulnerable areas.

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3 A Review of Tropical Cyclone Idai Forecasting, Warning Message Dissemination and Public Response Aspects of Early Warning Systems in Southern Africa

Patrick Gwimbi

Abstract

The loss of life and destruction of property caused by Tropical Cyclone Idai in southern Africa in 2019 highlight the need for a review of the mainstreaming of early warning system (EWS) into development plans and effectiveness in protecting lives, property and livelihoods in the region. This review examines Tropical Cyclone Idai forecasting, warning message dissemination and public response aspects of EWS in reducing the loss of life, property and livelihoods in three countries of southern Africa impacted by the cyclone. Literature focusing on four elements of the EWS framework of cyclone risk knowledge, forecasting, dissemination of warning messages to the population at risk and public response was reviewed. Results revealed gaps in mainstreaming of EWS into development plans in the region, which compromised its effectiveness. The track, intensity and landfall leading time forecasts were difficult to accurately predict a few days ahead of landfall and warning messages came late, creating ambiguity in the public response to warning communications. Public risk knowledge deficiency combined with a lack of faith in warning communication messages issued contributed to low public response. This review concludes that although EWS are in place in southern Africa, more studies are needed to evaluate their effectiveness in practice.

Keywords

Early warning systems (EWS) · Cyclone Idai · Southern Africa · Tropical cyclone

3.1 Introduction and Background

Tropical Cyclone Idai acutely affected three southern African countries (Mozambique, Zimbabwe, Madagascar and Malawi) in March 2019, with killing over 1000 people due to buildings collapsing while its occupants were inside and people drowning crossing flooded rivers and getting injuries from objects moved by floods (Devi, 2019; UNOCHA, 2019; Mutsaka et al., 2019). Further, approximately three million people were left in need of assistance, while 239,731 houses and more than US$2 billion worth of assets were destroyed (Devi, 2019; Mutsaka et al., 2019). Post-cyclone outbreaks of food and waterborne diseases; skin, measles and respiratory infections; malaria; and mental health disorders attributed to post-traumatic stress disorders

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were reported (Isbell and Bhoojedhur, 2019; Kahn et al., 2019). Against this background, concerns have been raised among disaster risk reduction (DRR) practitioners and policymakers regarding the mainstreaming of cyclone forecasting, warning message dissemination and public response into development plans, and their effectiveness in reducing cyclone-related disasters in the region (Aon, 2019). Regrettably, limited research has been conducted to fill this knowledge gap.

Considerable literature exists on the positive correlation between cyclone EWS investments and reduced losses of life, property and livelihoods in the context of climate change (Rogers and Tsirkunov, 2010; Senaratna et al., 2015; Nhamo et al., 2019). However, in many developing countries, with studies consistently projecting that climate change is likely to increase the intensity of tropical cyclones and related flooding rates (Nguyen et al., 2013), many questions remain unanswered regarding the mainstreaming of such EWS into development plans and their effectiveness in reducing losses of lives, livelihoods and property (Lumbroso, 2018; Tarchiani et al., 2020). Several studies (Roy and Kovordanyi, 2012; Kafle, 2017; Lumbroso, 2018) have put forth the position that the mainstreaming of EWS into development plans is limited, and in some cases virtually non-existent (Villagran et al., 2006; Lumbroso et al., 2014).

In southern Africa, characterized by its relatively strong climate variability directly related to the phenomena of 'El Niño' and 'La Niña', increasing magnitude and frequency of tropical cyclones threaten life, property and socioeconomic development of the region (Reason and Keibel, 2004; Aon, 2019). Incidences in recent years (e.g. Cyclone Eline in 2000, Cyclone Favio in 2007 and Cyclone Idai in 2019) provide evidence of increased risk of such disasters in the region. The Southern Africa Development Community (SADC), which is a regional body of states within southern Africa, has taken steps to develop and implement EWS measures to mitigate the impacts of cyclones and related floods (Stringer et al., 2009; Nhamo et al., 2019). Nevertheless, there is concern that such EWS are not realizing their potential value as they are not mainstreamed into development plans, often resulting in reactionary interventions as opposed to proactive response mechanisms (Nhamo et al., 2019). It seems reasonable to hypothesize that the region has limitations regarding mainstreaming EWS into development plans and their effectiveness.

This study reviews the mainstreaming of risk knowledge, forecasting, warning message dissemination and public response aspects of the EWS into development plans in the region and their effectiveness in reducing the loss of life, property and livelihoods. The effectiveness of Tropical Cyclone Idai EWS is examined from four complementary perspectives:

1. Public risk knowledge.
2. National Meteorological and Hydrological Services (NMHS) monitoring, prediction and forecasting.
3. Civil protection authorities' dissemination and communication of early warning messages.
4. Public response and action to early warning communications.

A multidisciplinary approach, integrating technical and non-technical approaches and embracing systems thinking, was used to analyse and interpret the conceptual framework.

3.2 Conceptual Framework on the Effectiveness of Tropical Cyclone Early Warning Systems

The United Nations International Strategy for Disaster Reduction (UNISDR, 2006, 2) defines early warning as 'the provision of timely and effective information through identified institutions that allows individuals exposed to a hazard to take actions to avoid or reduce their risk and prepare for effective response'. In context, cyclone early warning means getting information about the impending cyclone, communicating that information to those who need it and facili-

tating good decisions and timely response by people in danger (Ebi and Schmier, 2005). This encompasses using both technical and social approaches to achieve an effective warning.

According to the UNISDR (2006), for an EWS to generate an appropriate reaction it must be people centred and must include four interrelated elements: (1) knowledge of the risk that exists, which comes from observing the phenomenon; (2) monitoring, predicting and forecasting of the hazard; (3) dissemination of information as warnings to the at-risk population; and (4) public response capability to the warnings (Fig. 3.1). Each element must function efficiently as its failure could result in a failure of the whole system.

Hoque et al. (2017) assert that risk knowledge is essential for reducing damage by being prepared as part of cyclone disaster management and provides realistic risk scenarios for the future. Risk maps produced can be used by administrators and policymakers to develop future mitigation plans and strategies. These mitigation strategies may include the planning of the proper location of cyclone shelters and appropriate health infrastructure. Thus, risk knowledge can help to reduce the impact of tropical cyclones on people, property and the environment. Translating such risk knowledge into action entails developing tools such as policies and regulations and raising awareness of this information with the public to improve their understanding of the risks and actions they can take to reduce the risk impacts. In context, tropical cyclone risk knowledge boils down to increasing community risk knowledge about cyclone vulnerabilities and building its adaptive capacities (UNISDR, 2006).

Accurate weather monitoring and early warning allow for timely implementation of a safe evacuation, thus preventing drowning which is the leading cause of cyclone deaths. Forecasting involves the prediction of several interrelated features, such as the cyclone's track, intensity and accompanying rainfall and floods, and the areas threatened (Holland, 2009). This places NMHS as active players in forecasting monitoring and generating warning alerts for extreme events such as cyclones (Holland, 2009).

A warning message, according to Lindell and Perry (1987), refers to threat information communicated by civil protection authorities to an affected population. The warning message delivered to the at-risk population describes the pending danger and suggests the courses of actions that will minimize the negative consequences of the impact. The dissemination of early warning messages has a significant role in the effective-

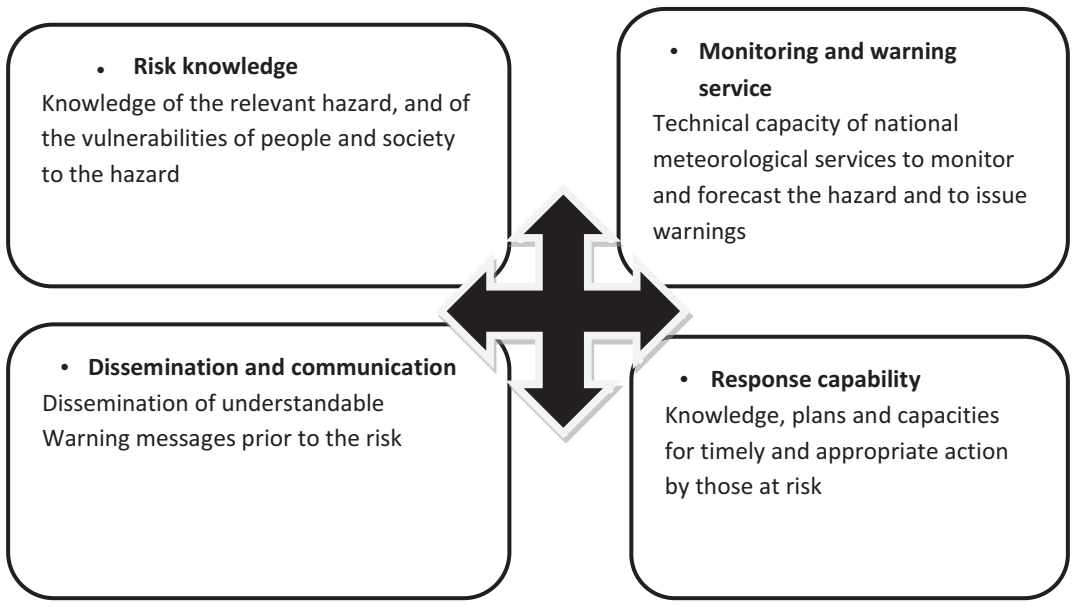


Fig. 3.1 The people-centred early warning system effectiveness conceptual framework. Source: UNISDR (2006)

ness and serviceability in EWS (Nugraheni and de Vries, 2015). Providing the community in a disaster area with adequate dissemination and communication of early warning messages will improve people's awareness and reaction to a natural hazard (Nugraheni and de Vries, 2015).

Conceptually, public immediate response capability is assessed by estimating the time people potentially need to rescue themselves and the time people have. Response capability focuses on building local and national capacities to respond appropriately to early warnings by putting into place well-defined response plans while building upon local capacities and knowledge (UNISDR, 2006).

This study is based on the integration of four EWS elements. The strengths of one element are the strengths of the others. Thus, the effectiveness of EWS is not just centred on one element, but involves all, enabling them to take appropriate corrective actions to avoid danger or to minimize loss and damage. These embrace systems thinking philosophy, with failure of one element leading to failure of the entire system in saving lives, property and livelihoods (UNISDR, 2006).

3.3 Materials and Methods

The research focused on three southern African countries affected by Cyclone Idai, namely Malawi, Mozambique and Zimbabwe. Tropical Cyclone Idai, a category 4 storm on the Saffir-Simpson scale, was one of the deadliest cyclones to strike southern Africa in the last decade. Approximately 1297 people were killed. Winds reached up to 195 km per hour.

A systematic review of the literature was conducted. Online databases such as Web of Science, Scopus, Google Scholar and Science Direct were searched using a comprehensive list of relevant search terms adhering to the elements of people-centred early warning system of cyclone risk knowledge, forecasting, dissemination of warning messages to the population at risk and public response capability to warnings.

The study was carried out in steps. First, keywords such as 'tropical cyclone', 'cyclone risk knowledge', 'cyclone track', 'cyclone intensity', 'cyclone forecasts', 'cyclone prediction', 'cyclone warning information dissemination' and 'public response to cyclone warning messages' were used to select relevant articles. The search was performed using electronic databases such as Web of Science, Scopus, Google Scholar and Science Direct.

Second, the selected titles of all retrieved articles were screened for eligibility for the inclusion criteria. The abstracts of all relevant articles were screened for eligibility by searching for relevance in terms of the study objectives and theoretical framework. If the abstract was found relevant, the full text of the article was checked. The final part of the article, content analysis, consisted of looking at how the contents were relevant to the study objectives. Articles included in the search were in English. After title and abstract screening, 59 articles met the inclusion criteria.

3.4 Results

3.4.1 Risk Knowledge of Tropical Cyclones in Southern Africa

Historical data shows that Mozambique is the most risk-prone country for cyclones and floods in southern Africa (Matyas, 2015; Zehra et al., 2019). Approximately 2700 km of Mozambique's coastal areas are vulnerable and at risk to tropical cyclones that come from the Southwest Indian Ocean basin, which over the years have accounted for 10% of the world's cyclones (Aramuge et al., 2014; Zehra et al., 2019). In recent years, cyclones (e.g. Domoina in 1984; Filao in 1988; Nadia in 1994; Bonita in 1996; Eline in 2000; Favio in 2007 and Idai in 2019) have increased in frequency and impacts (Table 3.1). According to Matyas (2015), in the period of 1948–2010, 94 tropical cyclones developed in the Southwest Indian Ocean, making landfall in Mozambique coast.

Inland flooding often becomes the predominant cause of deaths associated with tropical cyclones in southern Africa. Many inland flooding disasters have been reported in Zambezi,

Table 3.1 Cyclone and depression incidence in Mozambique

Cyclones and depressions	Year	Impact
Cyclone Domoina	1984	350,000 affected; 109 killed
Cyclone Filao	1988	90,000 affected; 100 killed
Cyclone Nadia	1994	900,000 affected; 52 killed
Cyclone Bonita	1996	200,000 affected; 11 killed
Cyclone Lisette	1997	80,000 affected; 87 killed
Tropical storm Gloria	2000	650,000 affected
Cyclone Eline	2000	650,000 affected
Depression Delfina	2002	390,000 affected
Tropical cyclone Japhet	2003	3000 affected

Source: INGC (2003)

Table 3.2 Flood incidence in the country

Rivers	Year	Provinces affected	People affected
Zambezi River	2001	Central region	500,000
Limpopo, Maputo, Umbeluzi, Incomati, Buzi and save Rivers	2000	Manica, Sofala, Tete and Zambezia	2,000,000
Buzi and save Rivers	1999	Inhambane and Sofala	700,000
Buzi, Pungoe and Zambeze Rivers	1997	Central Mozambique	300,000
All southern rivers as far Zambezi River flooded	1996	Southern and Central Mozambique	200,000
Southern Mozambique Rivers	1985	Maputo, Gaza and Inhambane	500,000
Limpopo River	1981	Gaza	500,000

Source: INGC (2003)

Rovuma, Lurio, Licungo, Pungoe, Buzi, Save and Limpopo river basins in Mozambique (INGC, 2003) (Table 3.2); the Lower Shire Valley in southern Malawi; and Muzarabani in Zimbabwe (Mijoni and Izadkhah, 2009; Gwimbi, 2007). The growing vulnerability results from increased exposure to hazards in particular among more deprived groups. One of the primary reasons for the huge loss of life is the absence of an early warning and cyclone-tracking system and evacuation programmes. The literature on effective EWS dictates that inhabitants of such risk-prone areas need to be aware of their risks and roles in reducing their risks to such hazards (Table 3.2).

The major findings of this study revealed that physical and socio-economic factors of human vulnerability significantly determine community vulnerability cyclone-induced disasters. In the case of the 2019 Cyclone Idai, indications are that risk knowledge adaptation in both cyclone- and flood-prone areas was low (IPS, 2019; Zehra et al., 2019). For example, according to the Inter Press Service (IPS, 2019), many people in eastern Zimbabwe were not aware of safe alternative places to flee to when Cyclone Idai hit the area. Zehra et al. (2019) also noted that in Mozambique, people were not aware of elevated shelters they could escape to as well as evacuation routes to follow (Zehra et al., 2019). The highlighted examples suggest that a high number of human casualties and loss of property in disaster-prone areas may be attributed to people's risk knowledge adaptation deficiencies in those areas due to inadequate public awareness, lack of disaster preparedness, weak governance, lack of coordination among the concerned government agencies, inadequate resources and inadequate technical knowledge for mitigating the natural disasters (Tuladhar et al., 2015). These results highlight the importance of community participation in vulnerability and risk assessment as their experience and risk knowledge could give vital input into their adaptation. This suggests that the improvement of residents' knowledge about their environment and associated risks is crucial to increase risk awareness and foster preparedness in cyclone- and flood-prone areas.

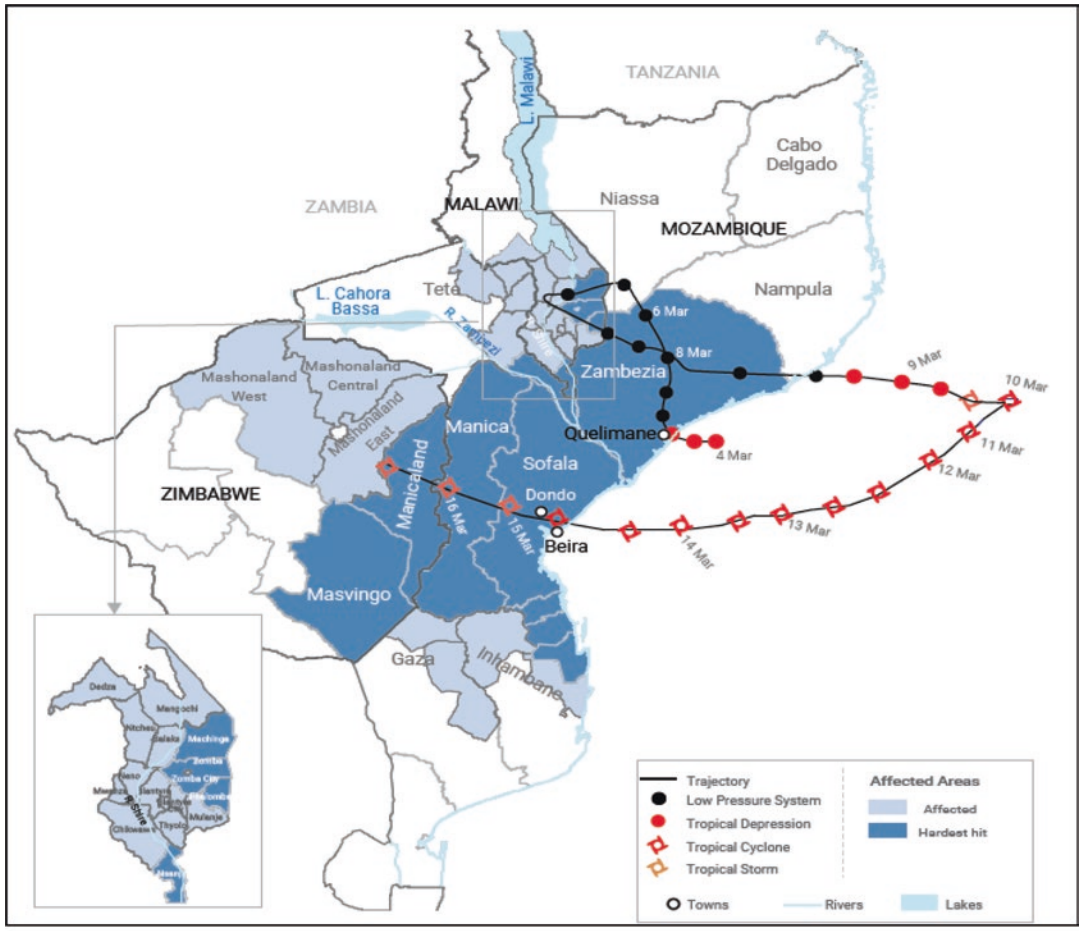
Some authors have argued that the link between flood risk knowledge and awareness and preparedness is not at all straightforward by reporting on results of studies in communities exposed to flood risks (Mijoni and Izadkhah, 2009; One World Sustainable Investments, 2012; Zehra et al., 2019). For example, in the Lower Shire Valley of Malawi (Chidanti-Malunga, 2009*;* Mijoni and Izadkhah, 2009; Teule, 2019) and lower Zambezi basins in Zimbabwe and Mozambique (One World Sustainable Investments, 2012), results have revealed that despite the existence of high risk knowledge among the affected communities of frequent floods in their areas, chronic food insecurity and good farming and fishing opportunities in those areas outweighed risk knowledge. According to Tuladhar et al. (2015) poverty drives people to go live in high-risk marginal areas which make them vulnerable to disasters. This means that residents living in flood-risk areas are significantly aware of flood risks in their area, but are seldom concerned about flood hazards, though their level of preparedness is low. What is missing is risk preparedness which hinders effective response in case of a flood disaster, thus becoming key issues to be considered for effective emergency planning and management.

Jha et al. (2012) are of the view that unplanned developments on floodplains, coupled with low risk knowledge on coping strategies and ineffective policies and legislation in such cyclone- and flood-prone areas, exacerbate the negative impacts.

3.4.2 A Review of NMHS Tropical Cyclone Idai Track and Intensity Forecasting

In southern Africa, tropical cyclone forecasting and warning alerts are issued by NMHS (Jubach and Tokar, 2015). NMHS make use of the forecasts provided by the Regional Specialized Meteorological Centre (RSMC) which has the WMO-mandated responsibility of monitoring and naming tropical cyclones in their regions and provides forecasts to NMHS. The process is in two stages: forecasting and conveying warning alerts to civil protection authorities. The bulletins contain detailed information on the location, size and intensity of the tropical cyclone, in text format designed for the use of operational forecasters at the national level. The NMHS forecasters use a variety of hydrological forecast products produced by national forecasting centres, to prepare their flooding forecasts based on their expert analysis.

Tropical Cyclone Idai was a category 3 cyclone that formed in December 2019 in the Indian Ocean that made its landfall near Beira. According to the Dual-Polarization Sentinel-1 imagery and remote sensing and Météo France



Source: Mühr et al. (2019)

Fig. 3.2 Trajectory of tropical cyclone Idai as of 14th March 2019. Source: Mühr et al. (2019)

data by Yu et al. (2019) and Mühr et al. (2019), the cyclone developed as a tropical disturbance before turning into a tropical depression, with wind speeds of about 55 km/h gusting up to 75 km/h by third March 2019. Within 4 days, the cyclone headed north, then north-westward, before turning back east-south-eastward on seventh March close to the Mozambique-Malawi border. On ninth March, the system moved to the Mozambique Channel where it transformed into an intense tropical cyclone with winds gusting up to 280 km/h. Observed trajectory path for Tropical Cyclone Idai is shown in Fig. 3.2. By 11th March it reversed its track back towards Beira and landfall as an intense tropical cyclone category 3 eventually occurred in the evening of March 14th, around 22 UTC. Cyclonic rainfall produced extensive flooding and associated water damage, notably mudslides and powerful riverine flash flooding in inland Mozambique, eastern Zimbabwe and southern Malawi due to its volume (Mühr et al., 2019; WMO, 2019).

It was observed that the National Meteorology Institute (INAM) accurately projected the track and intensity within 3 days before landfall (Kolstad, 2019). Table 3.3 shows the subsequent forecasts issued by INAM from ninth to 15th March 2019 together with storm intensities and warning alerts in targeted areas. On ninth March 2019 Idai was reported as a tropical depression with sustained winds of 56 kph and gusts of up to 83 km/h (Table 3.3). On March 11th the system

Table 3.3 Tropical Cyclone Idai forecasts issued by INAM

Date	09/03/19	10/03/19	11/03/19	12/03/19	13/03/19	14/03/19	15/03/19
Forecast issued	Tropical depression	Moderate tropical Storm Idai	Intense Tropical Cyclone Idai	Intense Tropical Cyclone Idai	Tropical Cyclone Idai	Intense Tropical Cyclone Idai	EX-Tropical Cyclone Idai
Target Area	Zambézia, Sofala, Manica, and Tete	Mozambique Channel, Zambezia, Sofala, Manica and Tete	Mozambique Channel, Zambézia, Sofala, Manica, and Tete	Mozambique Channel Zambézia and Sofala	Mozambique Channel, Sofala, Manica, Zambezia and Inhambane	Sofala, Manica, Tete, Zambezia and Inhambane	Sofala, Manica, Tete and Inhambane
Observed data	Wind: 56km/h Gust 83km/h Precip(mm): Angoche 30.8	Wind: 120 km/h Gust 167 km/h Precip(mm): below 30	Wind: 176 km/h Gust 250 km/h Precip(mm): Pemba – 55.7; Montepuez – 32.6	Wind: 158 km/h Gust 213 km/h Precip(mm): below 30	Wind: 185km/h Gust 259 Precip(mm): Quelimane – 47.4	Wind: 194 km/h Gust 278 km/h Precip(mm): Above 250 (Satellite estimate)	Wind: 167 km/h Gust 231 km/h Precip(mm): Chimoio – 233.3 Espungabera – 220.6
Alert color code							

Source: World Meteorology Organization (2019)

was upgraded to a tropical cyclone, with winds of 176 kph gusting to 280 km/h.

When the storm curved towards coast on 15th March INAM field officers hoisted red flags in all target areas and suggested that people move to safer places before the onset of the catastrophic event.

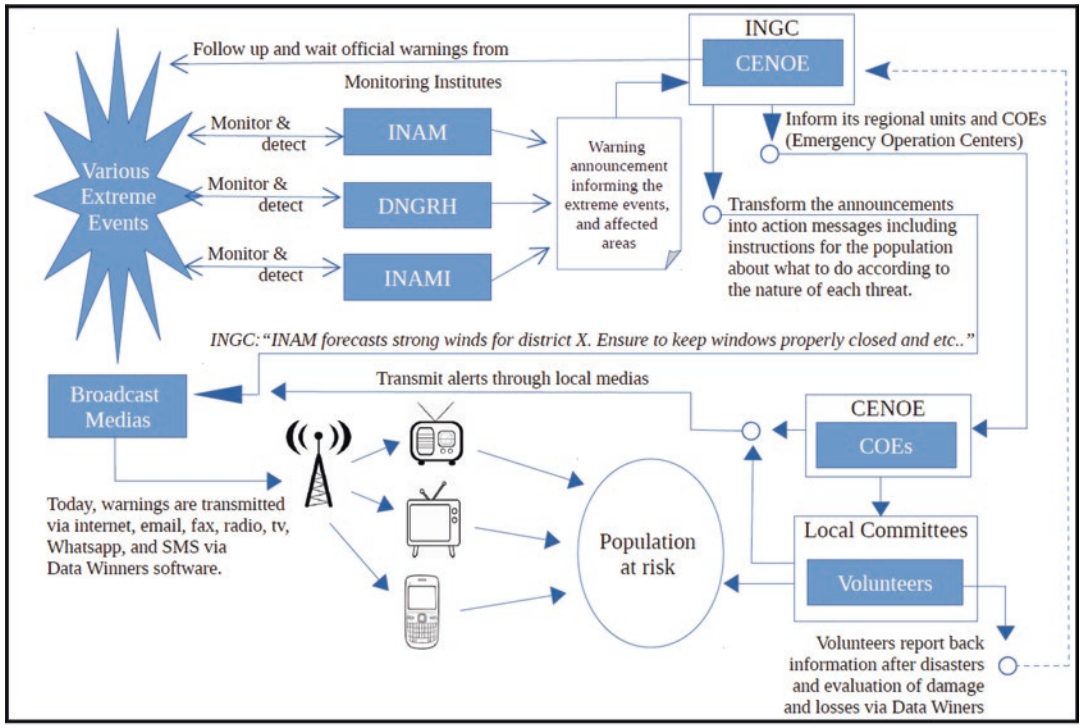
For Zimbabwe, the Meteorological Services Department (MSD) issued a warning alert statement on 14th March 2019, a day before Idai landfall over the eastern part of the country (Zimbabwe Meteorological Services Department, 2019). The National Meteorological Centre of Malawi issued a 5-day weather forecast on 11th March predicting an intense tropical storm Idai in the Mozambique Channel indicating that it would affect the southern areas of the country (Zimbabwe Meteorological Services Department, 2019).

Warning alerts for flooding, based on observations of river levels, also noted the possibility of water release from a dam in the region which could increase the risk of flooding. However, the lack of river discharge observation data precludes flood forecast evaluations in most southern African countries, which is an essential step in providing more skilful and reliable forecasts.

3.4.3 Civil Protection Authorities' Dissemination and Communication of Warning Messages

The civil protection authorities in the three affected countries have the mandate to assess the risks and disseminate warning messages for weather and climate events that are likely to result in harm and loss (Jubach and Tokar, 2015). The risk assessment involves both crisis sensing and threat assessment with the objective of creating and informing dialogue about the nature and mitigation of the risk. Messages regarding an impending cyclone provide individuals with meteorologists' best estimate of anticipated paths, landfall and strength. As a landfall point becomes more apparent, evacuation orders are implemented. The ultimate objective is to lessen the adverse impact of the cyclone.

The reviewed literature contends that the dissemination and communication of warning messages failed with respect to Cyclone Idai. First, the presence, scope and potential impact of Cyclone Idai were not known to the public in advance. It is widely reported that when Cyclone Idai made its landfall, cases of people dying as



Source: Nogueira (2019)

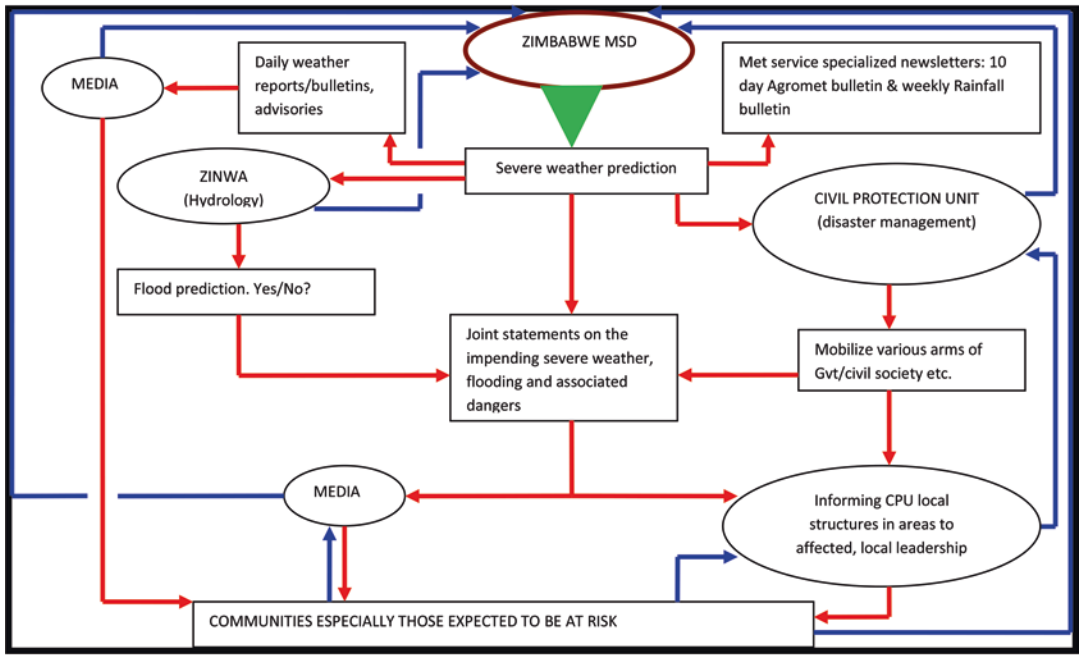
Fig. 3.3 Information flow of early warning systems in Mozambique. Source: Nogueira (2019)

buildings collapsed while its occupants were inside, drowning crossing flooded rivers and injuries from objects moved by floods were significantly high (Devi, 2019; UNOCHA, 2019; Mutsaka et al., 2019). These findings are echoed by Manatsa (2019) in one study in eastern Zimbabwe when examining lessons learnt from Cyclone Idai, citing one survivor as saying: 'No one knows where this water came from, it took us by surprise'.

If the critical function of warning communication was to inform the public about Cyclone Idai risks, critical stakeholders had every opportunity to know about the probability and impacts of its striking in the affected areas. The evacuation language at both pre-Idai levels and in the hours preceding landfall itself was vague and uncertain.

The Cyclone Idai warning information was communicated to the public using a wide variety of dissemination media including warning flags, television, radio, newspaper, fax, cellular phoning and community leaders. The lack of coordination among experts and a limited public dialogue all limit the credibility of risk communication. As a consequence, it was extremely likely, indeed almost axiomatic, that the consensus communication lacked sufficient credibility to be effective with many of its intended audience. In Mozambique, INAM, together with the National Water Resources Management Administration (DNGRH) and the National Institute of Mines (INAMI), is the main provider of hazard forecasts to the National Institute of Disaster Management (INGC) (Fig. 3.3). INGC is the institute responsible for coordinating contingency planning and all actions necessary to mitigate the impact of extreme events and respond in accordance to the hazards reported by the monitoring institutes (Mozambique Disaster Risk Management and Resilience, 2019).

In Zimbabwe, MSD and Zimbabwe National Water Authority (ZINWA) are responsible for forecasting and monitoring extreme weather events and flood events, respectively (Zimbabwe



Source: Zimbabwe Meteorological Services Department Severe Weather Forecasting (2009)

Fig. 3.4 Severe weather information flow. Source: Zimbabwe Meteorological Services Department Severe Weather Forecasting (, 2009)

Meteorological Services Department, 2009). MSD issues alerts of extreme weather forecast to civil protection unit (CPU), ZINWA and the media. In Fig. 3.4, red arrows represent the flow of information from the MSD to various stakeholders while the blue arrows represent the feedback loop.

For Malawi, the Department of Disaster Management Affairs (DoDMA) is the coordinator of all disaster management activities and co-chairs the National Disaster Preparedness and Relief Committee (Trogrlić and van den Homberg, 2018; ZFRA, 2020). DoDMA provides leadership in conducting risk assessments, response and communication among various players; tracks the progress of EWS implementation; and holds regular monitoring and coordination meetings with key stakeholders.

The warning system uses a set of thresholds for the degree or urgency needed for the reaction. In Zimbabwe, alerts are issued in relation to heavy rain and flooding (Zimbabwe Meteorological Services Department, 2009). In Mozambique, the cyclone warnings are communicated through a system of flags with different colours that are hung out by volunteers and by radio messages, whistles, drumbeats and megaphones. The colour alerts in blue, yellow and red indicate that a cyclone is expected to reach a potentially affected area in, respectively, 2 days, 1 day and 6 h (Nogueira, 2019). When the eminence of extreme events is detected and orange or red alert is activated, the technical staff from these monitoring institutes are the first ones to relocate their monitoring activities to take place directly from the headquarters of CENOE to speed up the information flow and enable the emergency authorities to take timely actions (Mozambique Disaster Risk Management and Resilience, 2019). INAM uses three warning colour codes indicating the number of hours before a tropical cyclone makes landfall (blue—between 24 and 48 h; yellow—within 24 h; and red—within 6 h).

The civil protection authorities use several ways to reach the populations at risks. The com-

munication channels include TV and radio broadcasts, but the information is also delivered via the Internet, email, fax and WhatsApp messages and by the time of this research INGC was also implementing the use of fixed sirens at certain locations (Nogueira, 2019).

Despite the signs of progress in the forecasting technologies, major challenges remain in realizing the potential benefits of EWS in southern Africa. Limiting factors identified in this study included infrastructure's inability to fulfil its duties due to inadequate resources to purchase modern equipment, inadequate training of staff and operational expenses (Jubach and Tokar, 2015; Lumbroso, 2018). In Zimbabwe, for example, the MSD acknowledged that there was an under-calculation of the amount of rainfall to hit the Cyclone Idai-affected areas in eastern Zimbabwe (UNESCO Workshop Report, 2019), resulting in the loss of life and property as the right contingency plan was not developed to suit the rainfalls that hit the areas. According to Zimbabwe Meteorological Services Department (2009), the reasons for the dissemination of unreliable and uninformative warning messages by NMHS appear to be related to incomplete data used for forecasting tropical cyclone track and intensity, and limitations of the operational tropical cyclone forecasting technique itself. There are also a limited number of fully functioning water level and flow gauges on major watercourses (Lumbroso, 2018). This paucity of resources seriously limits the effectiveness of EWS. Investing in the acquisition of modern equipment for such valuable public services that this department offers would certainly be mandatory.

In Mozambique, according to WMO (2019), while INAM had access to data and information from various meteorological organizations, including South African Weather Services (SAWS) Regional Centre in Pretoria, European Centre for Medium Range Weather Forecasts (ECMWF) and the UK Met Office, the capacities of their staff to effectively use and interpret some of the high-value products offered by these global and regional centres were lacking. High staff turnover often results in a rapid loss of capacity and prevents the accumulation of embodied context-specific knowledge.

3.4.4 Public Response to Early Warning Messages

Public response to Cyclone Idai warning messages demonstrated many limitations of current dissemination and communication of warning messages. The study showed that the public response to Cyclone Idai warnings was low (Manatsa, 2019; Zehra et al., 2019; Chanza et al., 2020). Numerous factors contributed to the low rate of public's evacuation decisions to evacuate.

To understand people's low response to early warning messages, it is important to identify their reasons for refusing to evacuate. Chanza et al. (2020) summarize the reasons for disregarding early warnings in eastern Zimbabwe as shown in Table 3.4.

Consistent with reasons shown in Table 3.4, results from other studies indicate that lack of access to information, no evacuation planning, absence of cyclone shelters around, poor communication, fear of leaving their houses as their valuables could be stolen and false hopes that the floods would quickly recede are the reasons for

Table 3.4 Reasons for disregarding local early warnings

Reason	Explanation
Fear and confusion	Some people felt that it was still safer than risking their lives at a time when the water level was very high
Experience with previous cyclones	Some strongly believed that the floods would quickly recede, while the voices of those who saw the need to evacuate tended to be weaker
Reluctance to leave valuables	Some people with valuables in their buildings were not prepared to leave their valuables
Hope in external evacuation	Hope that they would be rescued by the following morning
Dominance of key persons	Public figures who tended to be listened to more regardless of the usefulness of their advice

Source: Adapted with modifications from Chanza et al. (2020)

not responding to early warning messages (Devi, 2019; Manatsa, 2019; Zehra et al., 2019).

Manatsa (2019) quoted in a study in eastern Zimbabwe one of the Cyclone Idai victims testifying that: '*No one knows where this water came from, it took us by surprise*', suggesting lack of flood warning messages before landfall. In Rusitu Valley, Chanza et al. (2020) reported that some parts of the area were completely cut off from the rest of the country as roads and bridges were damaged and communication systems were disrupted. According to Chanza et al. (2020), communication systems were down, electricity had gone off, there was no mobile network and phones were inoperative. In Mozambique, Nogueira (2019) reported that warning messages informing people of the probable arrival of Cyclone Idai were disseminated late. Many people, however, indicated that they were unaware of the situation before it happened. Storm surge forecasts were issued late before landfall and advisories were issued late before landfall.

It is argued in the literature that access to safe shelters during cyclones ensures basic assistance by providing survival necessities to homeless and affected people (Gall, 2004). Without access to these shelters, affected people are left to cope with the disastrous situation on their own (Gall, 2004). In eastern Zimbabwe, those who sought alternate shelter places did so in neighbours' homes, police station and other public buildings (Chanza et al., 2020). It was also very difficult for people to find escape routes as the disaster occurred at around 10 p.m. on the night of 15th March 2019 (Chanza et al., 2020). Chanza et al. (2020: 4) quoted one of the survivors as saying '*We only saw water flooding into houses and it was too late for us to evacuate*'. The knowledge deficiency of cyclone and flood hazard risk maps hampered the evacuation success of affected communities.

3.5 Discussion

This literature review found results positively correlating EWS investments with the protection of lives, properties and livelihoods in the face of natural disasters such as cyclones (Garcia and Fearnley, 2012; Marchezini et al., 2017). The four elements of the EWS, risk knowledge; detection, monitoring and warning services; communication and dissemination mechanisms; and preparedness and response capacity, were found relevant. The results showed that Tropical Cyclone Idai EWS failed to adequately forecast and communicate the hazard, resulting in significant loss of life, property and livelihoods and raising questions about its effectiveness in practice. The review findings identified numerous challenges (Table 3.5) responsible for the failure of Tropical Cyclone Idai EWS, pointing to both technical and non-technical components. Given these explanations, there has been a shift towards understanding the mainstreaming of EWS into development plans.

The main finding of this study, that the mainstreaming of tropical cyclone EWS into development plans in southern Africa is inadequate, is consistent with that from previous studies by Lumbroso et al. (2016). Lumbroso et al. (2016), for example, studied the effectiveness of EWS for weather-related hazards in Africa, the Caribbean and South Asia and stated that the main barriers to their effectiveness include lack of technical and technological capacity to generate forecasts. Compared to the findings of Marchezini et al. (2017), the findings of the current study are consistent with failings related to inadequate communication of warnings to end users and poor accessing of warning information by the public. Empirical results from this study showed that Cyclone Idai location and intensity were only accurately predicted 3 days before landfall (Kolstad, 2019; Mühr et al., 2019). The lead time was too short.

It is also worth mentioning that, aside from the cyclone forecasting challenges, public risk knowledge deficiency on adaptation to cyclone-related risks in southern Africa including safety evacuation routes and evacuation shelter, EWS policies and building codes to use in flood-risk areas among others have been cited as contributing to increasing adverse impacts (Chidanti-Malunga, 2009; Teule, 2019). For example, in the Lower Shire Valley in Malawi, poor building

Table 3.5 System challenges experienced in selected southern African countries

System	Challenges
Risk knowledge	• Insufficient information and resources available • No risk assessments used in planning, preparedness, response and to support public education and awareness. • Building codes not suitable to events of the magnitude of cyclone IDAI. • Lack of human and technical capacity to implement EWS policies and guidelines.
Forecast	• The weather forecasting technology was poor • Deficient tropical cyclone forecasting skill • Forecasting centre operates during day only, no night shift • Capacities of staff to effectively use and interpret high value products offered by the global and regional centres are lacking. • Some of the forecasting equipment not operational or is partially operational. • Relationship between meteorological services and civil protection authorities not clearly defined and information exchange not clear.
Dissemination and communication of warning messages	• Inaccurate warnings, particularly for floods in some river basins; • Limited capacities of civil protection authorities in responding to NMHS alerts; • Understaffing of civil protection authorities for effectively delivering of EWS.
Response	• The local communities were not aware • Limited understanding of risk by public • Inefficient communication system • Absence of an evacuation plan • Inaccurate warnings, particularly for floods in some river basins

code practices in flood-risk areas increase the vulnerability of local communities to tropical cyclone-related floods (Teule, 2019). These findings support Harrison et al.'s (2020) suggestion that disaster risk knowledge, which involves assessing risk and vulnerability, building evacuation plans and tailoring warning systems, is a critical component of EWS.

The evacuation efforts were deflated by inconsistent messages regarding evacuation plans. The study findings affirm what other studies have found regarding dissemination and communication of warning message pitfalls (Chatiza, 2019). In Zimbabwe, for example, local authorities were not leading the response, and their substructures were relatively invisible as national government led the response (Chatiza, 2019). The study finding that older populations continue to receive their flood risk information via WhatsApp despite the low levels of literacy is consistent with similar studies on risk communication. Past studies have noted policy gaps arising from delays in instituting the necessary reforms. Construction of rural homes is hardly regulated in Zimbabwe.

Receiving warning information did not appear to have encouraged higher levels of evacuation during Cyclone Idai in eastern Zimbabwe (Chanza et al., 2020). Some villagers considered the warnings they received from mainstream media and government authorities as general and not quite useful in their area (Chanza et al., 2020). Some mistook their minor experiences with previous cyclones to mean they were now experts. This experience was used to inform people's understandings of such cyclone-induced floods and stimulated actions they took.

These explanations suggest that while hazard experience may reduce vulnerability, some people with that experience might be more vulnerable due to a reduction of perceived risk, based on prior low-impact hazard experiences or false warnings. Lessons learned from the public response to Cyclone Idai warning messages in this study demonstrated many limitations of current evacuation plans and capabilities. Understanding of the relationship between dissemination and communication of warning messages and response is important for

DRR. Mandatory evacuation as a policy needs to be realized as well.

These findings carry important policy lessons and implications. First, message preparation before the crisis is essential. Specific messages that in scope from minimal risk to the worst-case scenario should be prepared as part of the disaster management plan. Through such preparation, risk communicators may develop multiple messages for a variety of audience that accompany the specific action plans associated therein. Preplanning, a fundamental function of risk communication, provides an imperative communication arm to the disaster management plan that can be engaged amid other ongoing crisis management functions. To address the challenges, it is essential that EWS must be mainstreamed into development plans. A number of studies have highlighted the potential value of mainstreaming EWS into development plans.

3.6 Conclusion

The premise of this study was on the mainstreaming of cyclone EWS elements such as risk knowledge, forecasting, warning message dissemination and public response into development plans and their effectiveness in reducing the loss of lives, property and livelihoods. The review identified several gaps in the mainstreaming of each of the elements into development plans. To minimize the adverse impact from disasters, especially for areas experiencing recurrent tropical cyclones, adaptation measures aligning with EWS need to be more efficient and effective. The 2019 Tropical Cyclone Idai demonstrated what happens without an effective EWS in place. Information gleaned from the reviewed articles suggests that there are several gaps compromising the effectiveness of EWS. The review shows that further research in this area is needed regarding the effectiveness of tropical cyclone EWS in southern Africa. Hence, further research that could increase the effectiveness of EWS is recommended for improving the capacities of each element of the EWS and increasing the resilience of communities in cyclone-prone areas against such disasters.

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4 Revisiting Zimbabwe's Early Warning Systems in the Light of Tropical Cyclone Idai

Sizwile Khoza and Godwell Nhamo

Abstract

This chapter presents an assessment of the effectiveness of the tropical cyclone early warning system (EWS) in Zimbabwe, with a special focus on Cyclone Idai, which affected the country in March 2019. The study used a household questionnaire survey, interviews, field observations and official documents to identify gaps in major components of the EWS value chain, which contributed to the dysfunction of the EWS, resulting in fatalities, loss and damage of property and infrastructure. Lack of risk knowledge, poor instrumentation for accurate forecasting and nowcasting, weak institutional coordination and inadequate resources—that hinder critical government institutions from executing their mandates in the system—and poor early warning communication are some of the identified factors that contributed to the dysfunction of the EWS. The study proposes a set of enabling conditions, as corrective measures to improve all the EWS components. The private sector is an underutilised actor in the EWS, and we recommend that, rather than engaging the private sector in the post-disaster response, the private sector needs to be incorporated in pre-disaster EWS activities. A people-centred, impact-based and multi-hazard EWS, which is founded on shared resources, risk knowledge and expertise, should be considered. Further research may focus on a cost-benefit analysis of the EWS, to provide an evidence base to inform decisions in EWS investment and strategies.

Keywords

Cyclones · Early warning systems · Idai · Risk knowledge · Forecasting

4.1 Introduction

Climate change projections suggest that there will likely be an overall increase in the number of category 4 and 5 tropical storms and cyclones globally (World Meteorological Organisation (WMO, 2019)). Unfortunately, there is very little that can be done to alter the nature of these hazards. This means countries and at-risk communities will need to avoid creating new risk, manage

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existing risk and contend with residual risk in an effort to protect lives, livelihoods, resources and infrastructure (Gaillard and Mercer, 2013; Chmutina et al., 2019). This substantiates the increasing calls for the integration of disaster risk reduction (DRR) and climate change adaptation (CCA) in sustainable development initiatives. One component of DRR that requires serious attention, especially within the Southern African Development Community (SADC), is the efficacy of early warning systems (EWSs).

EWSs are one approach underpinning successful ex ante DRR strategies and activities. EWSs are high on the economic development and climate change agenda, as can be seen in global frameworks such as the Hyogo Framework of Action, Sendai Framework for DRR, the Cancun Agreement and the Paris Agreement, among others (Rogers and Tsirkunov, 2011b; Zommers et al., 2017), where governments are encouraged to address DRR and CCA through the utilisation of EWSs. Effective and operational EWSs, aimed at reducing fatalities and loss, and damage to property and infrastructure, may help developing countries to adapt to climate change and reduce the associated climate risks (Cools et al., 2016). However, Zommers et al. (2017) lament the silence of the sustainable development goals (SDGs) on addressing EWSs. Yet, empirical evidence highlights the critical role of EWSs in sustainable development, given that the effectiveness of EWSs contributes to protection and preservation of critical development infrastructure and reduces property losses and human fatalities (Glantz, 2004; Collins et al., 2009). Similarly, the success of EWSs is also shaped by certain sustainable development indicators such as gender equality, education, livelihood options and income levels, which, in turn, may determine access to resources (UNEP, 2015). It is indisputable that development policy architecture needs to recognise the role of EWSs in building and strengthening the resilience of communities and the systems within which they exist.

The 2019 hydrometeorological event, namely Cyclone Idai, brought to the fore issues of regional, national and community-level readiness in the operationalisation of effective EWSs to prevent avoidable fatalities, loss and damage. While weather forecasts and advance warnings were issued, the casualties and losses of the recent cyclones and floods call for further interrogation of the EWS provisions, in respective countries and in the region. The recent hydrometeorological disaster offers an opportunity to assess the gaps and strengths of the EWS in Zimbabwe. Studies that assess the effectiveness of the EWS, encompassing all of its components, are rare, specifically in regard to cyclone EWSs in Zimbabwe (Gwimbi, 2007; Cools et al., 2016). Cyclone Idai event raised questions on whether adequate action was taken to implement and fully realise the intent of EWSs in Zimbabwe. This chapter presents an assessment of the effectiveness of the tropical cyclone EWS in Zimbabwe, with a special focus on Cyclone Idai, which also hit Malawi and Mozambique, in March 2019. The chapter emerged from the need to investigate the status quo of Zimbabwe's tropical cyclone EWS. In making the assessment, the study focused on all four major components of the EWS, thereby paying attention to both the technological and social science arms of the EWS.

4.2 Literature Review

This literature review section comprises four subsections, including the following: a focus on early warning systems; putting people at the centre of the EWS; an impact-based EWS and multi-hazard EWS; and tropical cyclones' early warning.

4.2.1 Early Warning Systems

An EWS is defined as a set of capacities required for the generation and sharing of timely and meaningful warning information to enable individuals, communities and organisations, at risk of a hazard, to prepare and take appropriate and timely action that reduces harm, loss, damage or death (Rogers and Tsirkunov, 2011a; UNDRR, 2015). EWSs entail the integration of ex ante activities, systems and processes for monitoring,

forecasting and predicting hazards, risk assessment, communication and preparedness. This allows individuals, government institutions and development partners to act timeously such that disaster risk is reduced (UNISDR, 2009; UN., 2016), especially in the context of extreme events. Therefore, with the imminent probability of climate change contributing to increased occurrences of extreme weather events, EWSs are a necessity for any country or region that seeks to safeguard the well-being of its people and achieve sustainable development.

The latest terminology update for DRR identifies EWSs as an "interrelated set of hazard warning, risk assessment, communication and preparedness activities that enable individuals, communities, businesses and others to take timely action to reduce risks" (UNDRR, 2015: 15). This latest definition further highlights the importance of conducting a risk assessment as part of the EWS, which has also been included among the four components of EWS. These four elements are (1) risk knowledge and risk assessment; (2) risk monitoring and warning services, including detection, analysis and forecasting of the hazards and possible scenarios; (3) dissemination and communication of timely, accurate and actionable warnings, and associated likelihood and impact information; and (4) preparedness and local capabilities to respond to the warnings received (Basher, 2006; UNDRR, 2015). All the four major components should be functional at any given time, as dysfunction of any component translates to the collapse of the entire system (Glantz, 2004). Unfortunately, EWSs for water-based hazards are often hazard-centric and focus on the first two components only (Collins et al., 2009).

Furthermore, the emphasis is on the issuance of a warning of a hazard, not for a disaster. This implies that EWSs are not activated after a predicted hazard has manifested (de León et al., 2006; WMO, 2018). Rather, a properly functional EWS is always operational, creating public familiarity and awareness. Therefore, different components of EWS should run all year round and daily forecasts should be provided. In addition, risk and hazard assessments should be conducted on a continuous basis. Other functionalities include conducting public education and awareness-raising on identified risks, identifying information dissemination platforms and their functionality, establishing evacuation plans and routes and having preparedness plans in place, including simulations and drills (Baudoin et al., 2014). Every component of the EWS should facilitate community participation by all those who are identified to be at risk (Collins et al., 2009). When warnings are timely and early warning communication (EWC) effective, triggering early action, then individuals, households and communities can also recover and rebuild better and quicker than when EWSs are absent, hence the advocacy for community-level participation in the EWS. Likewise, economies can rebound quickly and better from hazards and disasters (Rogers and Tsirkunov, 2011a) when there is preparedness and a well-coordinated response that brings together diverse actors, including the communities at risk (Baudoin et al., 2014), for effective EWS post-disaster recovery and for reconstruction to occur speedily. This way, early warnings enable the efficient allocation and use of often limited resources, be it human, equipment or time (Rogers and Tsirkunov, 2011b).

However, no matter how good, accurate and timely predictions may be, if warning information is not packaged to meet the information needs of different population groups, early warnings may fail to trigger action and response. Therefore, there is a need to safeguard against the subordination of the social arm of the EWS, which is often distinctive of the traditional "last-mile", end-to-end EWS approach (Baudoin et al., 2014). There is an emerging contemporary discourse that suggests a paradigm shift to a "first-mile" EWS approach that advances that EWSs need not be exclusively top-down, with early warning information developed by technical experts. A "first-mile" approach argues that early warning information and predictions can also be locally generated, by at-risk communities, who will feed information into the established EWS through bottom-up processes (Zommers et al., 2017). Basher (2006) also advises that EWSs need to be framed from a systems perspective

that recognises the interrelationships that shape people's lives. Involvement of at-risk communities, as active players, can harness local capacities that may be useful in an EWS, such as local and indigenous knowledge (WMO, 2018). In order to address some of the limitations of traditional top-down EWS approaches, improvements to the effectiveness of EWSs are becoming people centred and impact based and addressing multiple hazards. Each of these aspects will be outlined in the following subsections.

4.2.2 Putting People at the Centre of EWS

There is a critical need to move away from the dominance of EWSs that are designed for use by practitioners and technocrats, to those designed with the people at risk in mind (Baudoin et al., 2014). The true test of an EWS is its reach and coverage of the people at risk, especially in rural and informal settlements, where some of the most vulnerable are found. Governments have the responsibility to provide their citizens with correct information, in the appropriate format, that is disseminated to the correct target groups, giving them ample time to take the required action that may save lives and minimise unavoidable loss and damage to property and infrastructure (Basher, 2006; de León et al., 2006; Cools et al., 2016). People's risk information needs go beyond the usual weather predictions and also include their need to know what may likely happen to them and their assets, infrastructure and surroundings. Therefore, it is important to consider vulnerabilities and meet the risk information needs of diverse groups of people, including key populations such as children, the elderly, women and people with disability. Vulnerability and marginalisation shape the success of EWSs, especially at an individual level, where socio-psychological behaviours and attitudes contribute to individuals' receptiveness to early warnings (Zommers et al., 2017). Hence, modernised technological investments in EWSs are insufficient, unless people are at the centre. Furthermore, a people-centred approach helps to ensure inclusivity and active participation, leaving no one behind in the EWS, thus contributing to the resilience of households, communities and systems (Basher, 2006). EWSs should also strive to protect and preserve the resilience capitals of households and communities by focusing on the impact of hazards. To this end, impact-based EWSs become important.

4.2.3 Impact-Based EWSs and Multi-Hazard EWSs

The EWS also needs to be impact based, meaning more emphasis should be on what the hazard will do than on what the hazard is (WMO, 2019). An impact-based EWS (IBEWS) further requires warnings to be more geographically and activity specific. This means forecasts and warnings need to be risk informed, so that they are more relevant to the targeted end users in different contextual settings. For example, warning that there will be heavy rain of up to 150 mm is insufficient. Users need to gauge the damage likely to occur (if at all) to the farmer, road and other users. Clearly spelling out expected impacts of the predicted hazard may improve people's understanding of hazard implications on their lives, assets and infrastructure, triggering early action by individuals at risk and the institutions that support them (Golnaraghi, 2012). The IBEWS, therefore, calls for a multidisciplinary approach, bringing together diverse actors.

A multi-hazard EWS (MHEWS) facilitates a multidisciplinary and systems-based approach to EWSs, through the pragmatic and logical integration of multiple, frequent and infrequent hazards (Basher, 2006; de León et al., 2006). The multi-hazard approach may reduce the costs associated with establishing fragmented EWSs for each specific hazard, through resource pooling, such as equipment, funds and personnel skills (Rogers and Tsirkunov, 2011b). Other benefits of the MHEWS include the minimisation of duplication and data sharing among stakeholders, resulting in improved efficiency and consistency of early warnings (UNDRR, 2015). Through repeated use and practice for frequent hazards, false alarms

may be minimised, while experiences and lessons learnt may also help to improve the system, such that it is well functioning, even for infrequent high-impact hazards (Rogers and Tsirkunov, 2011a). False alarms are responsible for some of the costs associated with EWSs and may be one of the reasons for reluctance in the implementation of EWSs. This is most likely in cases where obsolete, low-accuracy prediction instrumentation is used. There are social and economic losses associated with false alarms. Shorter lead times are more reliable, but there is an increased chance of high fatalities. MHEWS facilitates identification of trade-offs in terms of timeliness, reliability, costs associated with false alarms and prevention of damage in relation to lead times (Golnaraghi, 2012; Smith et al., 2017).

4.2.4 Tropical Cyclone Early Warning

Tropical cyclones are monitored globally through the Global Tropical Cyclone EWS, led by the WMO. There are six regional specialised meteorological centres (RSMC) responsible for information dissemination, issuing advisories and early warnings. The South African Weather Services (SAWS) hosts the RSMC for Southern Africa. In addition, there are six regional tropical cyclone warning centres (TCWC) based on the six basins over which tropical cyclone systems are monitored. Southern Africa is in the south-western Indian Ocean basin, which is serviced by the La-Reunion TCWC (Meteo France) (WMO, 2019), and the SADC Climate Services Centre (CSC) is a regional service provider that disseminates early warnings on cyclones to ensure preparedness in the region. All these institutions work together with the National Meteorological and Hydrological Services (NMHS) to monitor, analyse and forecast tropical cyclones. Each individual country then incorporates the information received from these centres into their country-specific EWS for cyclones.

4.3 Materials and Methods

An exploratory-sequential mixed-methods research design was applied to collect and analyse data from the areas affected by Tropical Cyclone Idai in Chimanimani District of Zimbabwe. A mixed-methods research design allows for the collection of both qualitative and quantitative data within the same study and in this instance data was collected sequentially, starting with the qualitative data, which was explored through quantitative data collection (Tashakkori and Teddlie, 2010; Creswell and Creswell, 2017). More than 30 key informant interviews, and 2 focus group discussions, were conducted from Kopa, Ngangu (Chimanimani Town), Machongwe, Peacock and other surrounding and affected areas. The location of the study area is shown in Fig. 4.1.

Among those interviewed were professionals from the Meteorological Services Department (MSD), affected communities on the ground in Chimanimani, chiefs and representatives from the Chimanimani Rural District Council, Chimanimani District Development Coordinator's Office, non-governmental organisations (NGOs), development and aid agencies as well as business persons operating in the area. Both purposive and snowballing sampling techniques were employed to identify the key informants. Group discussions and interviews were undertaken by knowledgeable professionals, all of whom undertook training and preparation to research and interview respondents in disaster areas. Questions asked included those dealing with EWS and related DRR and management protocols. Thematic analysis was used in the qualitative data analysis, and the themes used were on the basis of the components of EWSs.

Quantitative data was collected through a cross-sectional survey conducted at household level. A total of 219 complete household interviews were realised, and data was analysed using QuestionPro. The questionnaire survey, uploaded on QuestionPro, was administered

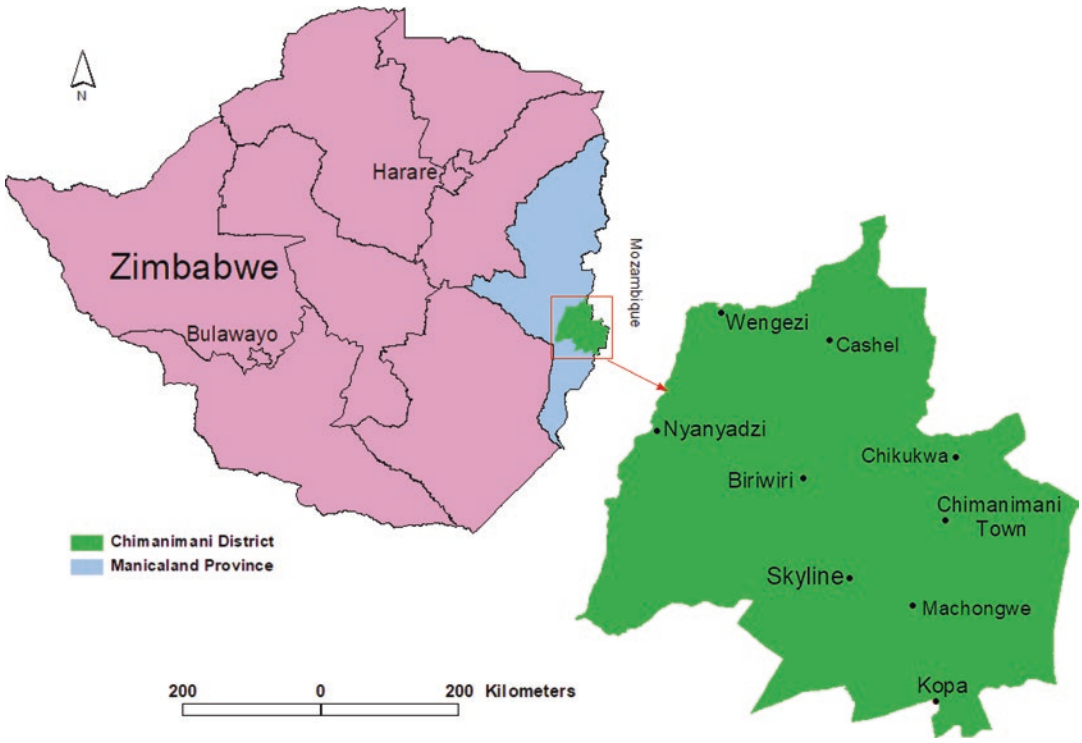

Fig. 4.1 Location of the study area. Source: Authors

offline, by 17 researchers and field workers, for one and a half weeks in October 2019. The process involved working during the day and uploading responses in the evening, as a group, when the internet was available. Prior to administering the questionnaire survey, the instrument was pilot tested, with adjustments made as appropriate. From QuestionPro, descriptive statistics were used to establish distribution and frequency trends of the variables under investigation. The households were purposefully sampled, on a census basis, from severely impacted areas. The qualitative and quantitative findings were integrated, after separate analysis, and are presented in the following section.

4.4 Presentation of Key Findings

This section presents data and key findings from the research. The findings are presented within each of the four components of the EWS, as outlined earlier in the chapter.

4.4.1 Risk Knowledge and Risk Assessments of Cyclones

The study established that general knowledge about the threat of cyclone hazards was high among all stakeholders, including the communities at risk. All study participants were able to identify other cyclones that have affected Zimbabwe, in general, and the Eastern Highlands region, specifically, such as Cyclones Eline (in 2000) and Japhet (in 2003). However, specifically for Cyclone Idai, there was little to no risk knowledge at all. One respondent shared that "people did not have the knowledge at which this thing (sic) was coming" (Civil Society representative), and similar sentiments were echoed by others. It was also established that the risk assessments were not done, as pointed out by one respondent: "We have been preaching the issue (sic) that the first point is for the community to run to higher ground, specifically for floods …" (NGO representative during key informant interview).

Unfortunately, in the case of Cyclone Idai, the higher ground, where communities have been

advised to run to for safety during floods, proved to be the most dangerous zones and this is where most people died, as a result. If risk assessments had been done, it could have been established that the higher terrain was likely to be unsafe, due to "deforestation resulting from land-use changes from forestry to create residential stands", as a community leader narrated. A civil society representative shared that risk assessments were done approximately 2 or 3 days before Zimbabwe was hit by Idai, in reaction to the situation in neighbouring Mozambique. The lack of involvement of academic research on risk knowledge and risk assessments was highlighted as a concerning gap in the EWS. At community level, the communities were not involved in the assessments that were carried out a couple of days before the areas were hit. Several incidences confirmed the challenge local communities had, as they compared the risk of past cyclones to Cyclone Idai. For example, community FGDs in Kopa revealed that there were arguments concerning the maximum levels predicted for the rise in water levels. Communities relied on their previous experiences, during Cyclone Eline, as a benchmark for the worst-case scenario and doubted that they could ever experience a cyclone worse than Eline. This resulted in fatalities, as some people refused to be evacuated when Idai hit Chimanimani.

4.4.2 Monitoring, Analysis and Forecasting of Cyclone Hazards

Cyclone monitoring, analysis and forecasting are conducted at three tiers, with the MSD identified as a key role player for this component. The global and regional tier for forecasting and monitoring, through the SADC CSC, enabled the MSD to monitor, analyse and forecast the cyclone in Zimbabwe and the specific regions that would be affected. The forecasting systems used at this level were able to track the development of Cyclone Idai, from 4th to 14th March 2019, when it made landfall. The MSD indicated that, based on this monitoring and analysis, "around 9 March 2019, it had developed into a full tropical cyclone".

While forecasting and monitoring were commendable at global and regional levels, challenges existed at the national tier, which limited appropriate functioning of the EWS. Firstly, the MSD does not provide round-the-clock services, meaning on the night on which Idai hit on 15th March 2019, and the morning immediately after on 16th March 2019, forecasters were off duty. This can be attributed to a lack of human resources as an inadequate staff complement within the MSD meant that meteorological service provision is limited to office hours, 08:00 to 17:00. Operational challenges including issues such as electricity load-shedding and lack of power backup came into the picture too. As such, the evening forecast for that day did not go out as per the schedule. Rather, the Zimbabwe Broadcasting Corporation (ZBC) had to be called to alert about the pending disaster. One of the respondents from the FGD had this to say:

We did our forecast but we had challenges with electricity that day and we did not have power backup system in the office. The generator had no fuel so the evening forecast for that day did not go anywhere though we managed to call ZBC telling them that we have a disaster and we mentioned the areas it was targeting, but we did not get any positive response. … Our hands were tied up and we could not issue the forecast that day.

Another identified challenge was the lack of adequate instrumentation, especially for nowcasting, such as weather radars. In the absence of relevant instruments and local models to enhance precision, the MSD was dependent on prediction models such as the global flooding system (GFS). In the FGD with MSD, discussants shared how the GFS "downplayed predicted rainfall … picking rainfall of between 50-70 mm, with a maximum of 90 mm". However, on the ground, some weather stations in Chimanimani, including one at Chisenga run by the MSD, recorded between 400 mm and 1000 mm in 24 h, yet the average annual rainfall for Chimanimani is 800 mm. This is an indication that the predicted rainfall was a serious underestimation of actual rainfall received. Rainfall recorded from three stations at

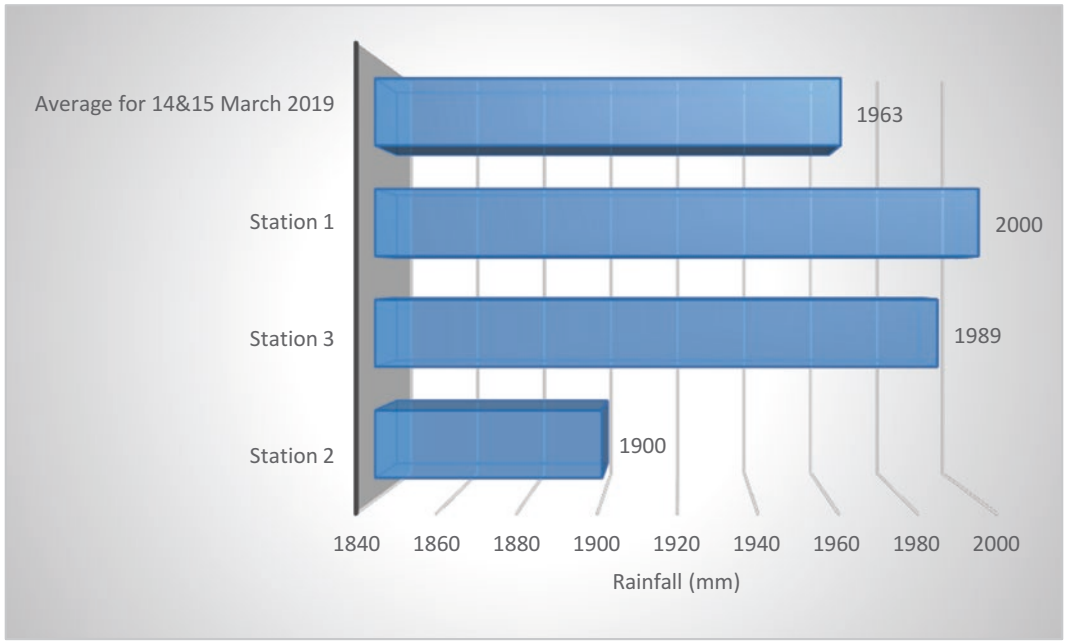

Fig. 4.2 Rainfall from three stations on a citrus farm in Chimanimani. Source: Fieldwork 2019

a citrus farm in Chimanimani, for 14th and 15th March 2019, showed a devastating picture regarding the amount of rainfall received (Fig. 4.2).

Another identified challenge that created weather information gaps was the poor network coverage of meteorological stations. Mutare, the provincial capital, was said to be without a functional meteorological station, although some business entities, such as timber millers, owned private stations to collect weather data for their operations. Zimbabwe has one functioning upper air station at the country's main meteorological station, in Harare, and 47 other stations across the country, including at various airports across the country. These were said to be poorly resourced in regard to both staff and equipment. Notwithstanding the identified challenges, the MSD was able to share forecast information with some key informants, confirming that, based on the forecasts issued, they had known about the impending cyclone and which areas would be hit. At a local level, the MSD had some personnel who were monitoring rainfall on the night of the landfall.

4.4.3 Early Warning and Communication

At the national level, the MSD developed the initial early warning, based on the predicted hazard, which was shared with the Department of Civil Protection (DCP). A meeting should have been convened to facilitate an in-depth discussion between key institutions, including the MSD, DCP and Zimbabwe National Water Authority, who is in charge of hydrological monitoring, as well as the media. The meeting did not happen. However, the DCP, which is responsible for organising preparedness and response, was able to disseminate early warning information to communities at risk through the short messaging service (SMS text). The MSD also shared the early warning with the media, who then broadcasted it to the public through diverse outlets on the radio and television, in print and on various electronic platforms.

Unfortunately, communication was centralised at a national level, without "any community-based information strategies at local level", as

one key informant highlighted. At community level, there was no early warnings, such as "sirens and alarms or people going door-to-door telling people to evacuate and go to the correct places", as one respondent from the community shared during an FGD. Some people or institutions considered as trustworthy communication sources were not used in dissemination of EWC, such as local leaders, "yet, they form part of the local-level civil protection committee (CPC)". Another NGO representative highlighted that CPCs were dysfunctional during the Cyclone Idai early warning process.

Furthermore, some challenges with the EWC and the information dissemination systems used during Cyclone Idai were identified. Respondents identified the major sources of EWC as the radio, neighbours, WhatsApp, SMS, TV and the local school (Fig. 4.3). Approximately 10% indicated not receiving an EWC and less than 5% had accessed early warning information via the internet, church or local leaders, as Fig. 4.3 shows. No respondents had received an EWC via e-mail and other social media platforms, such as Twitter and Facebook. Similarly, there were no respondents who had received an EWC through voice calls, local leadership structures such as chiefs and councillors, local-level institutions such as government extension departments, NGOs or community-based organisations and business entities.

Household respondents highlighted that they owned, at least, a mobile cell phone or a radio or TV. The majority of households indicated that there were at least two cell phones within the household and less than 5% households had no cell phone (Fig. 4.4). Figure 4.4 also illustrates that approximately 60% of households owned one radio, while less than 40% of households did not own a radio. About half the households owned one TV set and less than 45% had none. However, some communities indicated having no access to ZBC radio and television services, because of poor signal transmission.

The majority of the survey respondents concurred that the use of text messages was reliable, with approximately 25% "strongly agreeing". However, at least 17% either "strongly disagreed" or "disagreed" that text messages were reliable. These were respondents who were from areas

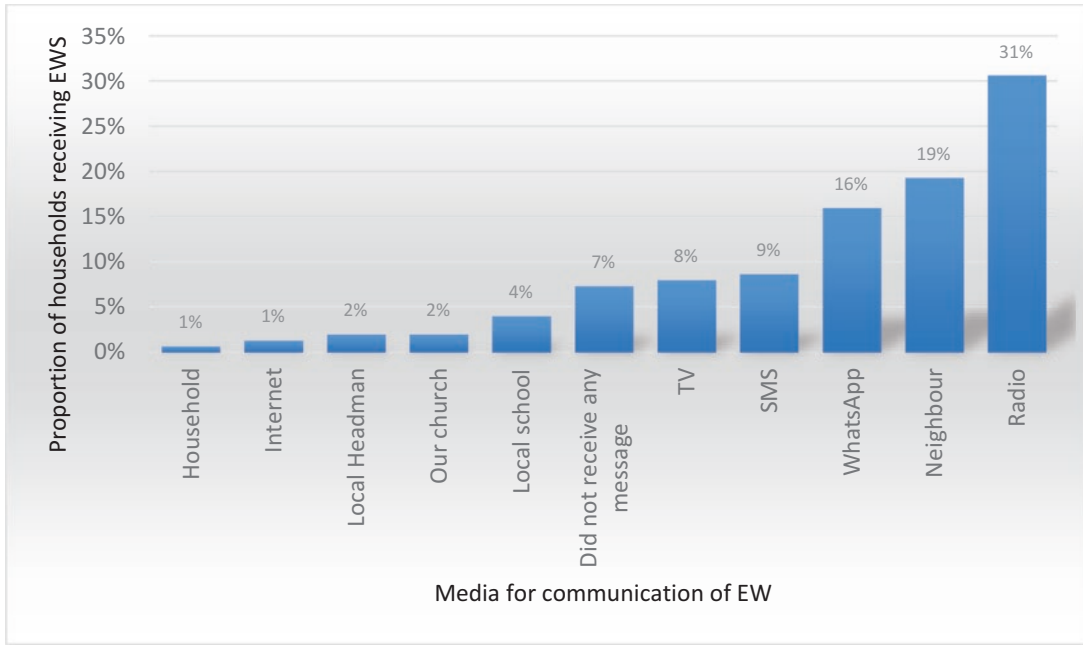

Fig. 4.3 Sources of EWC received by respondents (n = 219). Source: Fieldwork 2019

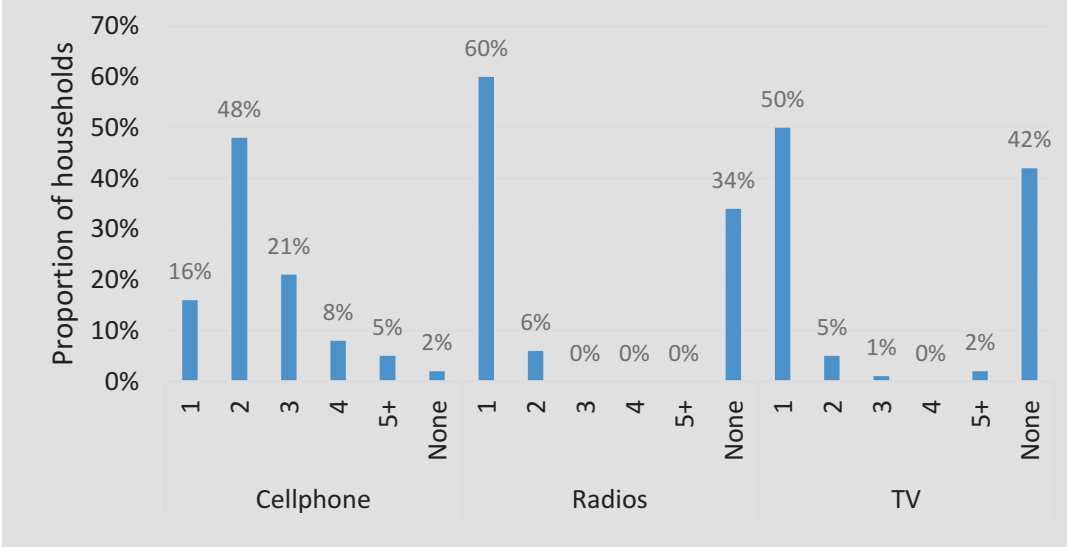

Fig. 4.4 Household access to communication gadgets (n = 219). Source: Fieldwork 2019

where there was no network coverage for Zimbabwe mobile networks and who mainly relied on Mozambican mobile services. Other respondents indicated that early warning was received via WhatsApp, which as at least 25% of respondents agreed was reliable. A further 23% indicated that they were "not sure"—these were mainly households who did not have access to WhatsApp.

Information on Cyclone Idai was not packaged in an easy-to-understand format, as indicated by respondents in the household survey (Fig. 4.5). At least two-thirds of the respondents stated that they did not find the EWC understandable. Notably, approximately 9% of respondents indicated that they had not received any EWC at all.

Lack of a clear and understandable EWC could have resulted in the failure of communication to trigger early action, such as an evacuation, on the day, for those who received communication. Figure 4.5 shows that the majority of respondents (59%) indicated that they were likely to take action only when there was obvious imminent danger or loss of life, while 26% said that they were likely to evacuate upon receipt of communication from government or local councillor. Information dissemination was not timely, as text messages from the DCP reached recipients on the day the cyclone hit. As a result, households were only able to decide to evacuate when danger was imminent (Fig. 4.6). At that point, little could have been done to minimise fatalities and loss and damage to household assets.

Figure 4.6 also shows that, apart from signs of impending danger, evacuation decisions are also shaped by sources of EWC. For instance, the evacuation decision could have been taken immediately after receiving a warning from the local leadership, government institutions, family members or NGOs/CBOs—who form part of the identified trusted sources of EWC (Fig. 4.7). Needless to say that a measly less than a third of the population were prepared to move if a government directive or warning to move at the impending danger was issued. Close to two-thirds of the population would have waited to see the threat before taking action. There is a clear mistrust of government institutions when it pertains to disseminating critical disaster information. The reason given for not wishing to evacuate early was that past tropical cyclones, of which Tropical Cyclone Eline of February 2000 is an example, were still manageable in terms of community damages.

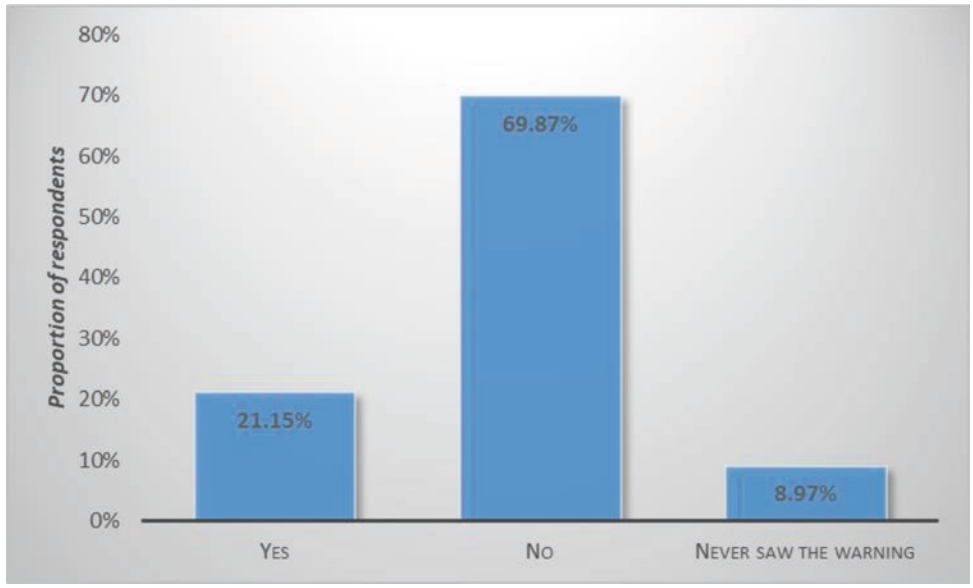

Fig. 4.5 Respondents who indicated that the EWC was clear and easy to understand ($n = 219$). Source: Fieldwork 2019

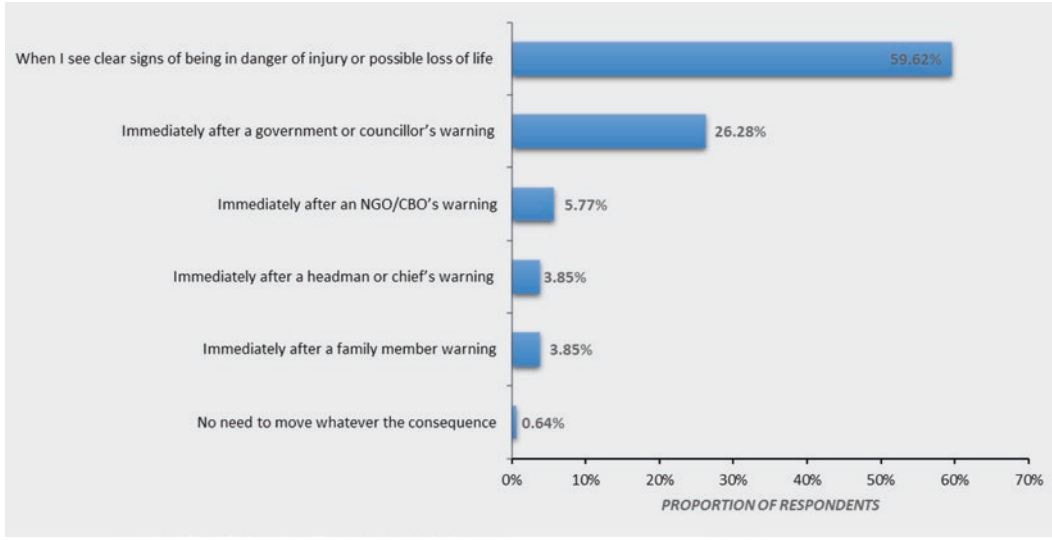

Fig. 4.6 Point at which decision to evacuate is made after early warning is issued ($n = 219$). Source: Fieldwork 2019

The majority of respondents (41%) stated that they trusted radio announcements for EWC, followed by 18%, who indicated that the MSD, or any other government agency, was their trusted source. A combined total of 18% of the respondents identified word of mouth, from various sources (Fig. 4.7), as their trusted sources of EWC. Given the scenario that up to 60% of household respondents had a radio, and that 41% trusted the radio as a source for EWC, the future of EWS in Chimanimani should consider the radio as one of the key platforms. This is regardless of the higher presence of mobile phones in the area, which the respondents do not trust as much as the radio in terms of EWC. However, all the available EWC platforms

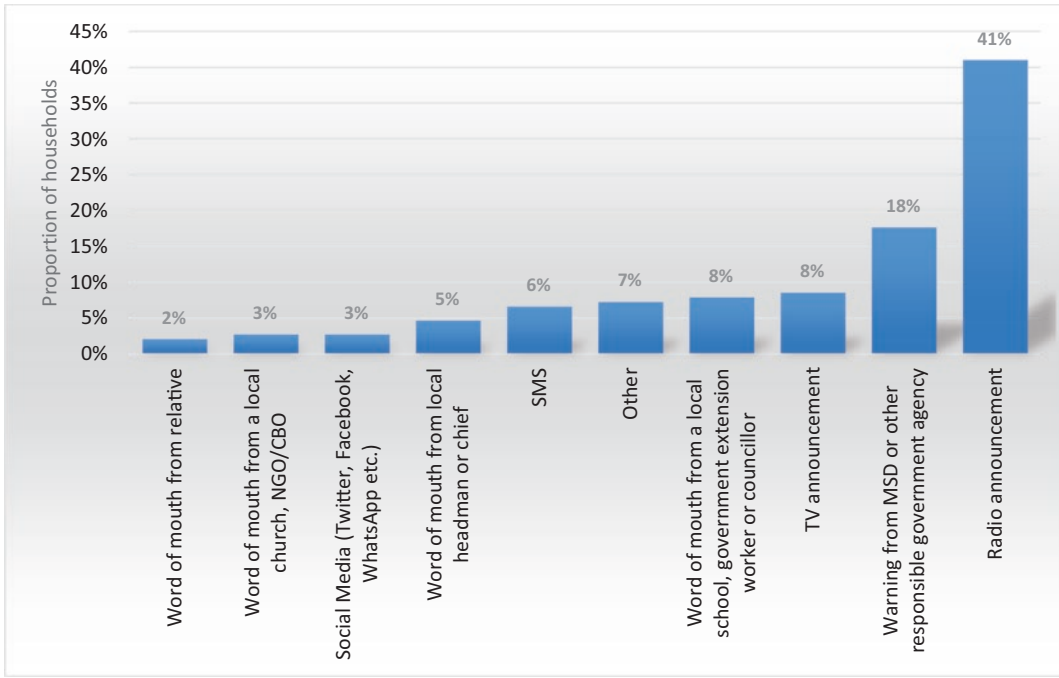

Fig. 4.7 Trusted sources of EWC (n = 219). Source: Fieldwork 2019

should be utilised as appropriate. The SMS is particularly challenging given the coverage, with some service providers likely to face challenges during disasters such as what happened during Tropical Cyclone Idai.

4.4.4 Preparedness and Response

Across the board, from national level to household unit, there was a lack of preparedness in terms of timely dissemination of authoritative EWC that would have triggered evacuation. As one local leader stated, "Idai caught us unprepared, because we thought it would blow over like others", and similar sentiments were echoed throughout the study. These sentiments were corroborated by the findings from the household survey, where respondents stated that they did not have sufficient time to prepare, after receiving the early warning; hence, they were caught unprepared. About 88% (n = 219) of the respondents indicated that they found themselves in this position.

The findings identified that there was no evacuation, resulting in people being caught in the path of the cyclone, which made landfall at night. During that night, people tried to evacuate, and they headed for the mountains, while some shared that they had tried to secure their homes by reinforcing the roofing. However, in terms of the EWC received, respondents stated that there was no clear instruction on what they were supposed to do, with approximately 86% (n = 219) substantiating this observation. There were also no safe shelters for evacuation and as a result, people whose homes had been damaged did not immediately have shelter until hotels, schools and churches started providing alternative shelter, from 15th March 2019. The district-level preparedness meeting for stakeholders was convened by the District Development Co-ordinator and DCP on the Friday afternoon, as shared by one leader, who reported thus: "We attended the meeting from about midday to nearly 5 pm, discussing preparedness for the district". This was the only preparedness action identified, with no other preparedness meeting established at community level. The findings also suggest that there could have been some underlying conflicts about institutional mandates,

which could have affected preparedness and response. One key informant noted:

> the DCP was saying they have the funds from the government and their strategies of responding … the human capital resources that were needed were not in line with what was on the ground and not even sufficient …

There was no pre-positioning of relief assistance and equipment that would have been required for search and rescue operations during the response. As one civil society member highlighted:

> If development partners had the opportunity to involve themselves by bringing in helicopters to assist the people after the cyclone hit, it means they could have been able to provide these same resources for preparedness.

Inadequate preparedness also affected the start of response operations, especially search and rescue. Respondents shared that people were "trapped in trees, mountains and everywhere, as a number of days elapsed before government-led response started".

Some individuals used their social capital to commence the initial response action. For example, the first helicopters that arrived at the scene were mobilised by some local business people, through their friends in the capital, Harare. The first days of the response activities were also marred by poor coordination of responders, which was attributed to lack of a preparedness and response plan for Cyclone Idai. There was no immediate funding for the response from government, primarily attributed to the lack of a disaster fund. The President of Zimbabwe declared a state of disaster, which resulted in an improvement in the response. Funding, rescue teams and equipment eventually started coming in from the government, private sector, citizens, neighbouring countries and international donors, and the coordination of response actors and activities improved. The findings are discussed in the following section and corresponding recommendations made.

4.5 Discussion on the Findings

This section discusses and juxtaposes the findings in relation to previous scientific work. The findings illustrate the failure of the EWS in Zimbabwe, to effect mitigative action, despite the fact that the Tropical Cyclone Idai hazard had been forecasted and monitored over at least 10 days prior to making landfall. There were gaps in all the components of the EWS, which helps to explain the fatalities recorded from Cyclone Idai. This study extends on earlier assertions made by Gwimbi (2007), who previously assessed the status of the EWS in Zimbabwe after the Cyclone Eline in 2000 and established that Zimbabwe's EWS for cyclones was top-down, with poorly disseminated early warning communication that gave little consideration to communities' needs and risk perceptions. Almost two decades later, the same region in Zimbabwe was hit by Cyclone Idai, in which a high death toll was recorded. Countries such as Bangladesh, Cuba and India provide empirical evidence of the possibility of utilising EWSs to reduce fatalities when infrastructural and property loss and damage are unavoidable (Golnaraghi, 2012) and Zimbabwe can adopt a similar approach. This work submits that it is imperative that Zimbabwe improves the EWS for cyclones and any other hazard for that matter. It is inconceivable that a disaster, of whatever magnitude, should catch people "unprepared", as was the case with Cyclone Idai.

It emerged that the risk knowledge and risk assessment component of the EWS were weak. The mere substitution of hazard knowledge, for risk knowledge remains inadequate as the two are different. Knowledge on the hazard profile in the affected region was high, but the same cannot be said about risk knowledge. The creation of risk knowledge requires a routine culture of conducting and updating participatory risk assessments, to ascertain how hazards are likely to interact with existing vulnerabilities and exposure, and identify the coping capacities of the communities (DasGupta and Shaw, 2017). Risk assessments help to identify needs and resource requirements, and they should utilise both quantitative and qualitative data. Routine and up-to-date risk assessments inform decisions and preparedness planning. For instance, in the case of Cyclone Idai, had prior risk assessments been conducted, perhaps the extent of deforestation due to land-use changes, which made higher zones unsafe for evacuation, would have been established in

advance. Safe evacuation routes would have been identified beforehand. Thus, steps towards improving the EWS in Zimbabwe and, indeed the SADC region should correct this aspect.

With regard to hazard monitoring, analysis and forecasting, challenges were uncovered, specifically at the national level, which undermines the timely forecasting achieved through the global and regional prediction and communication systems, such as Meteo France. If the challenges identified herein are left unaddressed, and in the face of increasing disaster risk related to climate change, then higher fatalities may continue unabated should similar cyclones occur in future. The Government of Zimbabwe, and by extension its counterparts within the region, urgently needs to alleviate the problems bedevilling national hydrological and meteorological service institutions, as has been previously established (WMO, 2008, 2019). Primarily, countries should be compelled to invest in modern instrumentation with high resolution and high predictive strength. Use of ensemble numerical weather prediction (NWP) models and radars should be seen as essential instruments for nowcasting at national and local levels. Empirical evidence herein also shows the inaccurate forecasting that emanated from the use of old models and how the lack of nowcasting equipment impacted the outcomes. Radars have the ability to detect the system, its trajectory, water content in the cloud and the water phase. Such data would close the prediction accuracy gap from forecasting equipment.

According to the WMO (2019), meteorological services need to be provided 24 h daily. Results show that in Zimbabwe services are provided during normal business hours, subject to personnel availability. This means that there is a likelihood of information gaps and lack of forecasting, at times. Although it was found that there was monitoring of rainfall at a local level, this work argues that this is inadequate when not enabled by provisions for bottom-up communication of early warning that can trigger early action. The hazard monitoring, analysis and forecasting component maintains a top-down approach that leaves little room for community participation. For instance, in Bangladesh local-level hydrological monitors measure rainfall received and dam/river levels and on the basis of established thresholds, they are able to feed into the EWS (Golnaraghi, 2012). A study by Zommers et al. (2017), in Kenya, assessed the role of indigenous knowledge systems (IKS) and community participation in forecasting, and showed convergence of scientific forecasts and IKS.

The early warning and communication component further showed the extent to which a top-down approach was deeply entrenched into the EWS in Zimbabwe. The conspicuous lack of community participation has been perpetuated for too long, despite calls for improved community participation in the EWS parlance (Baudoin et al., 2014). It is an established fact that early warning needs to trigger action and guide decision-making by those at risk (Cools et al., 2016). This is achievable when early warning dissemination is timely, authoritative, impact based and packaged for easy comprehension by targeted recipients. Some studies have also established that the use of face-to-face EWC, by community volunteers, local leadership and opinion leaders, such as government extension workers, is likely to trigger desired early action (Collins et al., 2009). Unfortunately, in this case there was neither use of face-to-face communication nor local leadership. Moreover, the early communication issued prior to the cyclone lacked authoritativeness, was not impact based and not taken seriously by communities. If the early warning communication had allowed for sufficient lead time to trigger action, then evacuation should have taken place during the day and people would not have been caught in the path of the cyclone at night. Future improvements on the EWS need to adopt a communication system that will include face-to-face communication, sirens, involvement of local leadership and other authoritative opinion leaders as sources of EWC. A clearly outlined EWC framework, which has contributed to Cuba's successful EWS (Golnaraghi, 2012), is a requisite to further strengthen EWSs.

Furthermore, it is within this EWS component that transformation towards the "first-mile" approach for EWS can be driven. An integrated approach that leverages on the strengths of both the first-mile and last-mile approaches is proposed. This will pave the way for increased community participation, with room for communities at risk to generate some early warnings too, based on local hazard indicator observations. In concurrence with Baudoin et al. (2014), this work asserts that such an approach is invaluable for climate change adaptation, where communities may need to adjust to localised changes that affect their lives and development, but do not necessarily attract the same international attention as major disasters. Perhaps developing regions, such as the SADC, could improve the effectiveness of their EWSs, through integrated top-down/bottom-up approaches that facilitate inclusive and active community participation.

The extent to which EWC and dissemination are executed determines the level of preparedness. On this occasion, EWC was marred by concerning gaps, leading to a lack of preparedness. Narrations by some of the respondents—of how people were trying to secure their houses and property at night during a heavy downpour—illustrate that had people been given ample lead time they could have been better prepared, even at household level. Evacuation to the (un)safe highlands during the night when the cyclone made landfall, also shows a lack of preparedness. Lack of preparedness was the culmination of a combination of failures in all the pre-disaster components of the EWS, increasing the vulnerability of the affected communities (Smith et al., 2017). There were insufficiencies within all the pre-disaster EWS components, which was always known (Gwimbi, 2007; WMO, 2008) and, although highlighting them almost sounds rhetorical, this helps to uncover the continuation of previously identified challenges and the preference for a reactionary approach in the EWS.

In the Zimbabwean situation, of all the components of the EWS, the response aspect of the fourth component of the EWS is where most of the positives were recorded. While commendable, it should be highlighted that at that point there had already been avoidable fatalities, loss and damage. We accentuate the need to deliver on all of the components of the EWS. There is no benefit in excellently executing parts of the system while neglecting others. These shortcomings could probably be due to the expensive nature of EWS (Rogers and Tsirkunov, 2011a); however, if parts of the system fail, ultimately, the entire system fails. This might be the case in Zimbabwe where the gaps in the EWS could be attributed to the infrequency of these cyclones. Thus, MHEWS should be considered which, although having different early warning protocols for each hazard, would maximise on pragmatic linkages and effectiveness (Golnaraghi, 2012; Trogrlić et al., 2018). In Zimbabwe, where poor stakeholder coordination was also one of the identified challenges in the EWS, a multi-hazard approach instils a multi-stakeholder approach across all of the components, while recognising the uniqueness of each hazard. MHEWS would afford personnel adequate practice to operationalise the system through less detrimental, but perhaps more frequent hazards, and a review and assessment of the functionality of the system to make adjustments where necessary. This can improve EWS of multiple hazards, as has been the experience with the Shanghai MHEWS in China which is cited as one of the best applications of the system (Rogers and Tsirkunov, 2011b).

This study shows that the first responders were mobilised through the utilisation of social capital by the private sector, before government-led response was initiated. While these actors are barely mentioned in the EWS lexicon, we advance that these are key actors especially in instances where government departments may be resource constrained, as in this case of Zimbabwe. Rather than incorporating private sector and utilising social capital when a disaster has already occurred, an improved EWS would consider incorporating these actors across all EWS components. Apart from social capital, they could also provide financial, physical and human capital for technical backstopping which could all contribute towards strengthening resilience and assisting in climate change adaptation.

Taken in its entirety, this discussion reinforces previous assertions that, for an EWS to be effective all components need to function well (de León et al., 2006; Cools et al., 2016). The identified challenges and missed opportunities that occurred during this disaster indicate that enabling conditions for a people-centred, impact-based MHEWS are vital. Modern technological investments and people-centredness of the EWS cannot yield positive results if an enabling operational environment is not created. Hence, the following indispensable enabling conditions through which identified challenges and opportunities may be addressed, are proposed:

- Political will to transform the EWS, from being reactionary towards a more proactive EWS: Political will is also required to steer the entire transformation process that also includes funding, legislation and institutional provisions, among others. The EWS should be within the purview of an integrated DRR and CCA, with elevation on tackling underlying risk drivers, vulnerability reduction and resilience building.
- The provision of funding for investment in pre-disaster EWS activities, mainly through budgetary allocations and donor support: Funding strategies also need to ensure sustainability of EWS functions, even in the quiet no-disaster periods. This can be realised through MHEWS.
- Regulatory frameworks should be considered to provide for mandatory evacuations. Legislation may also guide funding for DRR and CCA.
- Steps should be undertaken to achieve institutional integration and clearly defined mandates—more so at a local authority level, where the initial front-line capacity is situated. Standard operating procedures may assist in this regard.
- Provision of critical infrastructure and environmental protection.
- Monitoring, evaluation, assessment and learning to identify areas of improvement in the EWS.

4.6 Conclusions

The aim of this chapter was to assess the effectiveness of the tropical cyclone EWS in Zimbabwe. This followed the landfall of Tropical Cyclone Idai in March 2019, which also impacted Malawi and Mozambique. It emerged that the EWS for Cyclone Idai was ineffective in Zimbabwe, with concerning gaps in all of the four components of the system which resulted in fatalities, loss and damage that could have been minimised. Instrumentation challenges for accurate forecasting and nowcasting, poor institutional coordination, lack of community participation in all components and poor EWC are some of the factors that point to an EWS that is neither people centred, impact based nor indicative of the application of a multi-hazard approach. Consequently, the EWS failed to trigger the required pre-disaster early action across all levels and inclusive of all role players, and delayed the onset of the post-disaster response. The top-down operationalisation of the EWS limited the reach of the EWC, even to the "last mile", as some at-risk communities did not receive any warning communication. To this end, there is a need for transformation in the operationalisation of the EWS towards a contemporary approach that integrates both last-mile and first-mile approaches, where at-risk local communities are essential actors whose active involvement is key in the success of the EWS. An enabling environment, comprising political will, institutional provisions and standard operating procedures, sustainable funding and regulatory frameworks, will enhance the functionality of each of the EWS components. Notably, there was limited involvement of local authorities and local leaders, while also highlighting the key contribution of social capital within at-risk communities, which is often overlooked in the EWS. Future EWSs need to consider the community's social capital in all the components of the EWS, not just in the response. Increasing climate-related disaster risk mandates a revolutionised EWS, which contributes towards risk reduction, climate

change adaptation, resilience and risk-informed sustainable development. EWSs also need to be operationalised at the local level, which is the disaster front-line. The situation of the EWS in Zimbabwe, which may be similar in other SADC member states, necessitates a rethink in the design and operationalisation of the EWS in order to save lives, promote quick recovery and reduce economic and infrastructural losses and damages.

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Part III

Disaster Risk Reduction and Early Warning Systems

5 Fundamentals in Disaster Risk Reduction: From Hyogo to Sendai Framework and Beyond with an Elevation on Climate Change

Sizwile Khoza, Livhuwani D. Nemakonde, and Alice Ncube

Abstract

Reducing the risk of disasters including climate change risks calls for dynamic policies, strategies, plans and programmes that are underpinned by global frameworks on disaster risk reduction (DRR), climate change adaptation (CCA) and sustainable development. As with most parts of the world, current DRR policy architecture in southern Africa is predominantly response oriented as evidenced by the 2019 cyclones Idai and Kenneth as well as unprecedented flooding and other hazards that affect the region. This chapter seeks to provide the foundational knowledge on the fundamentals of DRR, converging on resilience, with an amplification of the role played by climate change in increasing disaster risk. An integrative review of literature on DRR and CCA in general, and a documentary review of reports, international policies on DRR and CCA and national policies in the countries affected by the 2019 cyclones and floods, was conducted. The 2019 transboundary cyclones provide an opportunity to review existing DRR strategies whose inadequacy in addressing vulnerability, exposure and disaster risks in the region requires attention. This chapter provides the essential DRR, CCA and sustainable development theoretical grounding for the diverse thematic areas explored in greater detail in this book volume.

Keywords

DRR · Climate change · Adaptation · Vulnerability · Resilience · Cyclones

5.1 Introduction

The disaster profile of the southern African region is dominated by hydrometeorological hazards such as tropical cyclones, thunderstorms, avalanches, coastal storm surges, floods, droughts, heatwaves, cold spells and debris flows (Bhavani et al., 2008). According to World Meteorological Organization (WMO) (2020), between 1970 and 2019, 79% of disasters worldwide involved

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weather, water and climate-related hazards, often accompanied by severe infrastructural damage and loss of lives and livelihoods. WMO (2020) further states that 35% of deaths related to weather, climate and water extremes occurred in Africa. In 2019, southern Africa suffered such devastation when the category 3 Tropical Cyclone Idai affected Malawi, Mozambique and Zimbabwe, while parts of South Africa in the KwaZulu-Natal region experienced unusual flooding. Countries mitigate the impact of hydrometeorological hazards through both structural and non-structural measures (Shreve and Kelman, 2014). However, the non-structural measures tend to be preferred (Coppola, 2015) because structural measures are expensive for developing countries, such as those in southern Africa. Hydrometeorological hazards such as cyclones and storms are likely to increase, necessitating that Southern African Development Community (SADC) member states to transform from management of disasters to management of *disaster risks*.

Furthermore, climate change projections indicate that SADC faces increasing climate risk associated with negative effects of climate change and global warming, hence the label 'climate change hotspot' (Müller et al., 2014). The SADC states are under increasing threat of hydrometeorological hazards of increasing magnitude and frequency (Davis-Reddy and Vincent 2017). These unprecedented hazards are characterised by uncertainty, as was seen in the nature of cyclones Idai and Kenneth. As a result, it is indisputable that pursuit of sustainable development within individual countries and the region at large needs to address disaster risk reduction (DRR) and climate change adaptation (CCA) while also strengthening the resilience of individuals, systems and communities. Exploitation of natural resources and ecosystem services forms the core of the sustainable development ambitions of the region and individual countries. There is increasing value in shifting DRR focus in the region from a predominantly hazard-centric disaster management towards a people-centred approach that interrogates issues of vulnerability and exposure and advocates for increasing attention paid to resilience building (DasGupta and Shaw, 2017). In contrast, a hazard-centric approach places authorities and technocrats at the centre of problem-solving through hazard manipulation, making it a dominantly top-down approach. Hazard-centric DRR tends to resign communities and systems to passivity as often it is said that little can be done to avert disasters.

Based on the preceding, the aim of this chapter is to provide foundational knowledge on the fundamentals of DRR, with an amplification of the role played by climate change in increasing disaster risk. Contemporary perspectives on disasters, disaster risks and disaster impacts concerning climate change are provided. This provides the theoretical grounding for the diverse thematic areas explored in greater detail in this book volume. An integrative review of literature on DRR and CCA in general and documentary review of reports, international policies on DRR and CCA and national policies in the countries affected by the 2019 cyclones and floods were conducted. An integrative literature review is a form of research that reviews, critiques and synthesises representative literature on a topic in an integrated way such that new frameworks and perspectives on the topic are generated (Torraco, 2005, 356). The rest of the chapter is structured as follows: the theoretical underpinnings of DRR that inform the various global, regional and national DRR policy and institutional frameworks are presented after this introduction. Thereafter, the chapter explores various regional efforts being taken towards the implementation and domestication of international frameworks including the Sendai Framework for DRR (SFDRR), Paris Agreement and United Nations 2030 Agenda for Sustainable Development through Sustainable Development Goals (SDGs). Linkages between DRR, CCA and sustainable development including resilience building and challenges to their integration are shared. This culminates to the challenges, lessons and opportunities presented by the 2019 disasters within the SADC regional bloc, and corresponding policy recommendations. However, more specific lessons learnt and challenges are presented in even greater detail across the different thematic chapters that constitute this book volume.

5.2 Theoretical Underpinnings of DRR

The management of disasters has seen dramatic shifts over the years with increasing focus on DRR (de Vet et al., 2019). The latest terminology update defines disaster risk as the likelihood that a hazardous event will occur resulting in devastating effects in a community or system that may be injury, death, and loss of, and damage to, assets and infrastructure, usually linked to a population's livelihoods, at a particular time (UNDRR, 2015). DRR is also defined as '*preventing new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience and therefore to the achievement of sustainable development*' (UNDRR, 2016, 16). Disaster risk is conceptualised as the interactions between a *hazard*, *exposure* and *vulnerability* (DasGupta and Shaw, 2017; UNISDR, 2009). This highlights an apparent need to take measures focusing on stopping the creation of *new* disaster risk, reducing *prevailing* risk and minimising *residual* risk, and strengthening resilience, and all these form the basis of DRR (Chmutina et al., 2019; Gaillard and Mercer, 2013). DRR components fall within four major categories: prevention, mitigation including preparedness, response and recovery, and at any point DRR activities in these categories aim to either avoid creation of new risks or reduce existing risk and also to minimise any unavoidable risk. DRR needs to address disaster risk drivers, including increasing exposure as more people settle in hazardous areas, environmental degradation, land-use changes and poverty, contributing to the achievement of sustainable development (Collins, 2018). Therefore, it is essential that development decisions and plans in the region be risk-informed to avoid emergence of new risks and manage existing and residual risk. This work draws from Opitz-Stapleton et al. (2019) who highlight that if sustainable development is to succeed, it has to be resilient and risk-informed. The success of DRR relies upon the theorisation of disasters and has evolved over time to dispel some of the initial ideologies as discussed in the following subsections.

5.2.1 A People-Centred DRR Focus

Calls for people-centred DRR are founded on the theory that disasters are not natural but socially constructed, resulting from implemented or omitted acts of human beings (Chmutina et al., 2019; DasGupta and Shaw, 2017). While hydrometeorological hazards such as cyclones and floods are natural, the disasters that result are not. The UNDRR (2015) identifies a natural hazard as a natural occurrence which may occur leading to death, injury, illness, environmental degradation, and loss or damage of property and infrastructure, and affecting people's socio-economic well-being and quality of life. Further explanation highlights that not every natural hazard automatically results in a disaster. A disaster is the outcome of complex interactions between a particular hazard, exposure, vulnerability and coping capacity, often leading to disruptions in normal functions of the affected communities (UNISDR, 2009; UNDRR, 2015). A disaster is likely to result where people's vulnerability is due to inequitable access to resources, discrimination, lack of knowledge, marginalisation, poor institutional support and lack of adequate infrastructure (Kelman, 2011; Mora, 2009). As Kelman (2019) argues, disasters are a product of societal processes, activities, attitudes, behaviour, decisions, paradigms and values that create and perpetuate vulnerability. Hence, although cyclones and floods are unavoidable hazards, their escalation into disaster is avoidable. Cyclones Idai and Kenneth and floods that ravaged southern Africa in 2019 escalated to disasters because natural hazards affected communities whose vulnerability and exposure were high, with low coping capacity. However, it is worth highlighting that some disciplines still argue that natural disasters exist, citing earthquakes and tsunamis, and raise concern that the 'no natural disasters' campaign waters down the naturalness of some disasters.

Unfortunately, a dominant focus on 'natural' disasters is often accompanied by corresponding emphasis on hazard-centric technological solutions which try to modify the hazard to reduce risk (DasGupta and Shaw, 2017; Mora, 2009). Yet, events such as Cyclone Idai show that some hazards cannot be modified. The hazard-centric approach is criticised for its insufficiency to address the reduction of risks in communities who may be resigned to deal with the inclement forces of nature (Kelman, 2011; Wisner et al., 2012). In a hazard-dominant paradigm, authorities may focus on modernising their early warning system equipment to predict hazards such as cyclones and not pay any attention to the issues that actually create vulnerability, such as inequality, political and governance systems and lack of access to the early warning system. Perceptions that disasters are natural may be misleading for the SADC region, giving a false impression that there is little that can be done to reduce risk. It also carries the danger that it exonerates humans and the systems they control, which may be political, legal, economic, social and physical, from taking action, being held accountable and assuming responsibility for risk-informed development decisions, or lack thereof, in the region.

Furthermore, people-centred DRR taps into the local coping capacities of communities and is the primary driving force for community-based disaster risk management (CBDRM) and the valuable local and indigenous knowledge systems in DRR (DasGupta and Shaw, 2017). Thus, people-centred DRR also helps theorise DRR not only from a parochial technology-based approach but also through a socio-economic lens that draws attention to people and their interactions with the environment in pursuit of development (Mora, 2009). In cognisance of the region's reliance on ecosystems and natural resources for economic development, ecosystem-based DRR (Eco-DRR) is also being pursued in the region. Eco-DRR is a form of DRR that promotes the sustainable extraction, management, conservation and restoration of natural resources for sustainable development, adaptation and resilience (DasGupta and Shaw, 2017). Thus, people-centred DRR in southern Africa should be informed by a broader understanding of risk, useful in priority setting for vulnerability reduction and resilience building.

5.2.2 Vulnerability Reduction

Vulnerability determines the extent to which society or its elements may be affected by hazards (Kelman, 2019). Therefore, vulnerability reduction needs to form part of the sustainable development agenda in the region. A broader socio-economic lens to DRR draws attention to issues of vulnerability in communities and systems. In turn, this paves way for the assessment of the nuances of vulnerability, economic development and political decision-making. It also brings to the fore critical issues of governance and public administration, power dynamics, resource access, control and distribution and social inequalities which ultimately make one group more vulnerable than the other, and in some cases often results in disproportionate impacts of disasters (Kelman, 2011; Wisner et al., 2012). Risks, and sometimes opportunities, generally arise from interactions between exposure to hazards, vulnerability of both human and natural systems and their coping capability or adaptability (Field et al., 2014). A broad understanding of vulnerability reduction is important given the context-specific intricate connections between root causes and socio-economic processes, politics, historical backgrounds and sociocultural interactions which also shape vulnerability trends in southern Africa. Essential decision makers, planners and other actors within different operational contexts need to be held responsible and accountable for taking steps to reduce vulnerability. This also requires that the legal, political and moral aspects of vulnerability are considered and holding to account those with decision-making responsibility, interrogating the resilient development pathways in individual member states or across the region at large.

5.2.3 Strengthening Resilience in Southern Africa

The strategic direction towards resilient development in southern Africa demands increasing efforts towards strengthening communities' and systems' capacities to build back better or bounce forward beyond each disaster (Manyena, 2016). A systems-based resilience approach to economic development means that states should explore new pragmatic development options that address root causes of vulnerability, promote equitable distribution of resilience capitals, promote adaptation and enhance sustainable development. Thus, the pursuit of resilient development requires inclusive systems building and capacity development where individuals' and communities' needs to better prepare, manage and recover from crises are met. Such perspectives have influenced the DRR policy direction of southern Africa and in 2020 the SADC Secretariat adopted a Regional Resilience Framework 2020–2030 which provides a conceptual model for, and characteristics of, a resilient SADC region through the multisectoral and multidimensional interconnected elements that contribute to the regional aspirations of integration and industrialisation (SADC, 2019). The Resilience Framework conceptualised that in building resilience, all systems and stakeholders are interconnected and therefore it is imperative that the Secretariat, all member states, international co-operating partners (ICPs) and partner organisations (including the private sector) recognise the importance of collective action and resource provision for resilience building at various levels. DRR within the member states and across the region should see increased multi-stakeholder involvement in risk management and reduction, where risk reduction becomes everybody's business including the communities at risk. Therefore, drawing from the Resilience Framework, each member state needs to develop its own strategies and programmes for resilient development to support the achievement of national development priorities, SDGs and other international frameworks, contributing to social, economic and environmental sustainability and resilience building.

An appreciation of the different principles of resilience which shape the characteristics of resilient systems and capacities of resilience (Carpenter et al., 2012; Bahadur et al., 2010) is essential in sustainable and resilient development for the region. Given the role of social inequality in determining who, why, how and what is vulnerable, and where and when vulnerability occurs, it is important that the resilience-building mechanisms in the region also aim to tackle the issue of unequal resource distribution. When resilience-building activities are implemented for sustainable development all across the region at various levels by diverse but well-co-ordinated actors, communities should be able to *'build-back-better, leaving-no-one behind'*, which brings together the aims of both the SFDRR and the SDGs (Khoza et al., 2020).

It is for such reasons that people-centred DRR pays attention to vulnerability reduction and resilience building, focusing mainly on disaster prevention, mitigation, response and recovery. Although a detailed outline of each of these DRR components is beyond the scope of this chapter, it is worth mentioning that these components have shaped the global, regional and national DRR policy and institutional architecture.

5.3 Policy and Institutional Frameworks

In line with global frameworks, most countries in southern African are formulating, reviewing and improving their policy and legislative frameworks for DRR. Both policy and legislative frameworks seek to increasingly tackle vulnerability and prepare for, prevent and mitigate the hazards, addressing various forms of disaster risks including climate risks, which all interact leading to disasters. Annually, the Conference of Parties (COP) under the United Nations Framework for Climate Change Convention meets to review the implementation of the Convention and any other legal instruments the COP adopts. The Intergovernmental Panel on Climate Change (IPCC) prepares comprehensive assessment reports, special reports and method-

ology reports about the state of scientific, technical and socio-economic knowledge on climate change, its impacts and future risks, and options for reducing the rate at which climate change is progressing. Similarly, global leaders have undertaken a number of initiatives towards sustainable development, including the 1992 United Nations Rio Earth Summit in Brazil, the Millennium Development Goals (MDGs) 2005–2015 and the SDGs.

For DRR the initiatives included the declaration of International Decade for Natural Disaster Reduction, initiated in 1990 as the development of the Yokohama Strategy and Plan of Action for a safer world and the Hyogo Framework for Action (HFA), for the period 2005–2015 (UNISDR, 2005). Subsequent to the HFA the SFDRR was adopted for the period 2015–2030 (UNDRR, 2015) and together with the Paris Agreement, SDGs and the New Urban Agenda-Habitat III it forms the post-2015 global development agenda with risk reduction being a common theme across all frameworks. The main outcome of the SFDRR is to substantially reduce disaster risks to avoid loss of lives, livelihoods and health through the protection of the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.

Furthermore, the African Union (AU) adopted an African Strategy for DRR in 2005, contributing to positive developments in DRR in the continent. Domestication of the SFDRR for Africa saw the AU adopt the '*Programme of Action for the Implementation of the Sendai Framework 2015-2030 in Africa (PoA)*' (AU, 2016a). The PoA added five more targets contextualised for African states to achieve provisions of the SFDRR. Ministers and Heads of Delegations responsible for DRR in Africa adopted the *Tunis Declaration on Accelerating the Implementation of the Sendai Framework for Disaster Risk Reduction and the Africa Regional Strategy for Disaster Risk Reduction* at the Africa-Arab Platform on DRR in October 2018, to strengthen the implementation of the PoA and create 'the Africa we want' (AU, 2016b).

At regional level, the SADC Secretariat developed the DRR Strategic Plan and Plan of Action 2018–2030 and the SADC Regional Resilience Framework already alluded to. SADC member states have also made strides in either coming up with DRR and CCA legislation or promulgating various legislation, frameworks and policies to reduce risk in communities and tackle climate change. The member states are attempting to align their policy and legislative frameworks with global frameworks as disasters are a development problem which cannot be isolated from sustainable development. Table 5.1 presents the existing frameworks and country-level efforts in aligning activities with the SFDRR and contributing to sustainable development in the four countries that were affected by the cyclones Idai and Kenneth and unprecedented flooding in 2019.

Table 5.1 shows that South Africa and Malawi have made progress in aligning their DRR policy and/or legislative frameworks with global, continental and regional frameworks while Mozambique and Zimbabwe are lagging behind. Member states that are still using response-based policy and legislative frameworks need to review them in line with global, continental and regional DRR frameworks as disaster risk is not a once-off action and embrace DRR mainstreaming that cuts across sectors. In relation to CCA, Table 5.1 shows that the existing policy frameworks are mainly country response strategies. As indicated elsewhere in this chapter, climate risk is a reality that is amplifying the magnitude and frequency of hydrometeorological hazards in southern Africa. Thus, efforts that incorporate DRR, CCA and sustainable development will enhance risk reduction efforts in the region.

5.4 Disaster Risk Reduction and Climate Change Adaptation

The post-2015 global frameworks raised expectations to build coherence between the different but strongly overlapping DRR, CCA and sustainable

Table 5.1 Legislative and policy frameworks for DRR and CCA in affected member states

Country	CCA Legal and Policy Frameworks	DRR Legal and policy frameworks
Malawi	Environmental Management Act 23/1996 National Adaptation Programme of Action 2006	Disaster Preparedness and Relief Act 1991 [Chapter 33:05] National Disaster Risk Management Policy 2015
Mozambique	National Strategy for Climate Change Adaptation and Mitigation 2012	National Policy on Disaster Management 1999 Bill of the Law of Disaster management 2001 National DRR Indicator Framework 2017
South Africa	National Climate Change Response Strategy 2004 Draft National Climate Change Response Green Paper 2010 National Climate Change Response White Paper 2011	Disaster Management Act 57/2002 [Amendment 16 of 2015] National Disaster Management Framework 2005
Zimbabwe	Environmental Management Act 2002 [Chapter 20:27] National Climate Change Response Strategy 2015	Civil Defence Act 1982, 1982 [Chapter 11:02], repealed in 1989 [Chapter 10:06] (Acts 5/1989, 3/1992, 22/2001) Disaster Risk Management Draft Bill of 2011 DRM Policy 2011

Source: Authors (2020)

development policy areas (Street et al., 2019), particularly at regional and country levels. As Aitsi-Selmi et al. (2015) state, the coincidence of the three global frameworks stimulated opportunity for science, policy and practice in different disciplines to explore the dynamics of emerging risks, joint policy options, options for scientific evidence and technological tools to provide effective solutions to multifaceted developmental challenges. The overhaul of the three international policies in 2015 presented an opportunity for strengthening the links between DRR, CCA and sustainable development (Banwell et al., 2018), as discussed in the following subsections.

5.4.1 Linkages of DRR Frameworks with SDGs and Climate Change Policies

Climate change is projected to shape the nature of many hydrometeorological hazards. Hence, climate-related risks make DRR and CCA key overlapping policy areas whose integration needs to be pursued. The interconnection of the two is based on their common goals that seek to reduce the impacts of extreme events and increase resilience to disasters, especially among vulnerable communities (Solecki et al., 2011). DRR and CCA have common objectives aimed at tackling

exposure and underlying vulnerability, as well as enhancing the resilience of people, assets and ecosystems for sustainable development (Pilli-Sihvola and Väätäinen-Chimpuku, 2016). Borders between DRR and CCA are increasingly becoming blurred even though they developed from different circumstances, eras and use of different terminologies. According to DasGupta and Shaw (2017), the scholarly perspective often views CCA as a subcategory of DRR, the latter being a subcategory of development. Therefore, it is essential to recognise this link when addressing the complex and increasing risks, particularly climate-related ones (Banwell et al., 2018).

Acknowledging linkages across DRR, CCA and sustainable development through the impacts of extreme events has fostered growing advocacy for the integration and/or mainstreaming of the three fields. As such, risk is recognised as central to development and there is growing emphasis on the application of risk management approaches for the protection of existing development gains (Pelling, 2010). UNISDR (2014) argues that achievement of SDGs cannot occur without disaster risk management that pays attention to risks, identification of opportunities and strengthening of resilience in order to achieve sustainable development. On the other hand, Venton and La Trobe (2008) contends that for both DRR and CCA to be effective, they need to be also framed within the broader context of sustainable development and poverty reduction.

As Banwell et al. (2018) note, there is operational value in DRR and CCA integration which helps countries to optimise efficient use of resources be it knowledge and skills, finance or technology, through strategic synergies to achieve common goals. This is important in instances where resource constraints exist, which is likely to be the case in many SADC countries, to avoid duplication. Effectiveness and efficiency of both DRR and CCA may be improved by paying attention to long-term risk and adaptation. Actually, there should not be any construction of DRR and CCA as being opposites or as precluding each other (Kelman et al., 2017). The expectation raised by the adoption of the three frameworks in 2015 must be made practical through joint meetings of technical experts of the three disciplines to create an enabling environment for coherence at regional and national levels and in various sectors. This will assist regional bodies and countries, particularly on the African continent, to leverage on the coherence emerging at international level across the three disciplines and integrate them within their jurisdiction. However, it appears that governments in developing countries still face numerous challenges in integration of DRR, CCA and sustainable development.

5.4.2 Challenges to Integration of DRR and CCA with Sustainable Development

Challenges in integration across the policy areas emanate from a situation whereby some researchers advocate for entrenching CCA within disaster management and DRR (e.g. see Kelman and Gaillard, 2010; Mercer, 2010), while others focus on CCA only, while some argue that DRR is a subset of sustainable development (Wallace, 2017). Consequently, a latent contestation of how to integrate the three fields exists and there has been no consensus on the integration modalities to eliminate operational duplications while comprehensively reducing risk (Rivera, 2016; World Bank, 2016). The driving force for policy integration remains the need to effectively use limited resources and minimise administrative inefficiencies, conflict and competition as well as duplication of functions among sectoral institutions (Mitchell and Van Aalst, 2008).

The biggest challenge is that while there is complementarity between DRR and CCA goals, they belong to different policy and practice spaces guided by different institutional and legislative provisions which also differ across countries (Mysiak et al., 2018). Scholarly lexicon treats them with epistemic distinctiveness, whereas in practice, they have coexisted independently (Florano, 2013). Due to different temporal and spatial scales, diversity of actors involved, different policies and institutional frameworks,

as well as the vocabulary and methodologies applied in research, DRR and CCA have developed and continue to operate as separate policy domains (Florano, 2013, Street et al., 2019). Kelman (2015) singled out the need to improve coordination across disciplines and their intended goals in planning, formulation and operationalisation of global policy frameworks. Attempts have been made to improve coherence across the separate disciplines and sectors as seen in the SDG outcome document and the Paris Agreement preamble that make reference to the SFDRR. However, the extent to which the desired coherence between related objectives, systems and implementation strategies can be achieved still remains to be seen.

In this chapter, integration challenges are viewed through the lens of social dilemmas, where individual rationality may result in collective irrationality (Kollock, 1998). There may be conflict between individual and collective rationality, whose source may be self-interested behaviour, stifling any objective means to improve integration (Olson, 1965). Thus, as Kollock (1998) posits, social dilemmas may be tragic, in this case when the organisations responsible for the three policy areas facing social dilemma at international level may seem to appreciate the need for integration and understand how their actions, or lack thereof, contribute to disastrous outcome yet still do nothing about it. Street et al. (2019) correctly highlight that DRR and CCA actors do not always cooperate, with each discipline sometimes viewing the other as implementing part of their mandate. However, there is truth that some hazards addressed by DRR are not related to climate change, making adaptation irrelevant but that should not prohibit the integration of DRR and CCA.

Additionally, much of the challenges to DRR and CCA integration are perception based, with the DRR discipline in favour of application of DRR policies, tools and procedures to address climate risk too. For instance, Kelman et al. (2017) perceive CCA as a component of DRR, arguing that CCA also includes various activities aimed at risk reduction and exploitation of opportunities that may result from climate change, which forms part of DRR. Conversely, Wallace (2017) argues that DRR should not completely overshadow CCA as disaster risk is part of several CCA objectives, including adaptation in agriculture, infrastructural development, public health and other benefits that may be derived from a changing climate. Viewed separately, both DRR and CCA may be limited in sustainable development due to insufficiencies in addressing some of the critical social system issues of sustainable development (DasGupta and Shaw, 2017). Advocates for DRR and CCA integration in sustainable development argue that both are core developmental issues (Kelman et al., 2017). Such perceptions from the different communities of practice are widening the divide between the three different policy areas, yet integration requires congruence of views. Therefore, it is imperative to use the 2019 disasters in southern Africa to reflect on DRR implementation in the region, identifying challenges and learning opportunities.

5.5 Challenges in DRR Implementation in SADC: Experiences from 2019 Disasters

Most SADC member states are characterised by proliferation of informal settlements in both urban and rural areas, mainly poor housing structures in hazard-prone areas such as wetlands, riverbanks, coastal areas and floodplains. These settlements are accompanied by a growing population with increasing developmental needs, resulting in more poor people left exposed and vulnerable to hydrometeorological hazards. For instance, the massive decimation of the city of Beira and Chimanimani by Cyclone Idai displays weaknesses and non-existence of building codes, respectively, land-use planning and zoning regulations that are not only unique to Mozambique and Zimbabwe but across the wider region.

The 2019 disasters in southern Africa amplify the impacts of extreme weather and climate hazards which interact with vulnerability, exposure

and coping capacity to these events. Risks do not exist in isolation among vulnerable communities in both rural and urban settings. Actually, there were other already existing risks that communities were contending with even before the cyclones and floods hit. For instance, it is a widely known fact that HIV/AIDS remains a risk in most communities within the SADC region (Corno and De Walque, 2012). In the case of South Africa, gender-based violence and femicide are also a risk that may be enhanced by displacements or loss of household livelihoods and property when disasters occur (Le Masson et al., 2016). These scenarios highlight that DRR measures in rural and urban areas in the region need to also pay attention to the systemic disaster risk, vulnerability and hazard interactions. The impetus is to address the underlying drivers of disaster risk, such as poverty, inequality, poor governance and environmental degradation while acknowledging the complexity of risks. Initiatives that target at-risk communities can inform their decisions, especially in terms of spatial planning options (Ran and Nedovic-Budic, 2018).

Accompanying these developmental challenges before Cyclone Idai made landfall in March 2019 was the lack of effective EWS in the affected countries to warn communities of the impending disaster. Despite global forecasting systems and monitoring the development of the cyclone in the affected countries, there was a general lack of preparedness, especially at the local level where communities were at risk. In the absence of operational EWS, many communities could not be forewarned about the cyclone. However, the tracking of Cyclone Idai was conducted by various meteorological institutions from different parts of the world for over a week. Yet, that did not translate to a massive drive for preparedness; rather response resources were readily available almost immediately after landfall. For instance, if helicopters had been availed days before the cyclone hit, probably fatalities could have been minimised as more people could have been evacuated to safety. This is a classic example of reactionary DRR that favours response after a state of disaster has been declared instead of proactive preparedness.

Lack of proper institutional arrangements meant a serious challenge of coordination within and across critical sectors. Poor institutional integration manifested as poor coordination and cooperation before and immediately after landfall. There was a lack of an integrated structure for inter-agency coordination and collaboration at various planning levels, and consequently this compromised quality and timeliness of preparedness and response. Even more concerning are the gaps in preparedness and response at local authority level who make the first-line response and initially incoherent and poorly coordinated humanitarian response activities. Yet, in the field of practice, coordination or lack thereof is in accordance with mandates, resources, power, political stamina and capabilities. The field tends to be an arena for competition rather than complementarity. The challenge of poor coordination also manifested at the regional level where the involvement of the SADC Secretariat was also delayed in the response phase.

Additionally, existing gaps in policy and institutional framework provisions in the affected countries, as discussed earlier, contributed to a weak pre-disaster risk reduction approach. There seems to be little funding for investment in *pre*-disaster risk reduction strategies, such as modern instrumentation for weather stations to strengthen EWS, for example in Zimbabwe (SADC, 2019), or for generating up-to-date risk and vulnerability assessments to inform decision-making. Even response funds and equipment at member state and regional level seem to be inadequate, as seen when the SADC Secretariat launched its Humanitarian Flash Appeal.

The theoretical underpinnings of DRR shared in previous sections shed light on the critical aspects of vulnerability reduction, resilience building, people-centred DRR and its integration with CCA and sustainable development. When viewed through this theoretical lens, the dominance of hazard-centric DRR approaches within member states and across the region is rather conspicuous and largely responsible for the identified challenges, although attempts to address this at a regional level are acknowledged. These challenges constitute little political will and a

poor disaster risk governance landscape that if left unaddressed will continue to negate any meaningful attempt to reduce disaster risks, strengthen resilience and progress towards achievement of SDGs in southern Africa. Hazard-centric DRR has seen governments and their development partners perpetuate a status quo biased towards trying to manipulate hazards, with little attempts to address the underlying risk drivers and other social, political, economic and cultural factors that make certain sections of society more vulnerable to disasters than others as will be further espoused in the sector-specific chapters of this book volume.

5.6 Lessons from Cyclone Idai: New Learnings and Perspectives

The huge impacts of Cyclone Idai offer the affected countries, the SADC Secretariat and its member states, Africa and the world at large an opportunity to reflect on their preparedness for disasters and the importance of DRR. This is invaluable to assist countries in prioritising the reduction of disaster risks, enhancing adaptation and strengthening resilience while remaining on course to the achievement of SDGs. The SADC Secretariat should be commended for documenting the lessons learnt from the 2019 cyclone disasters in the region (SADC, 2019). This subsection borrows from that document and outlines the lessons learnt based on the broad DRR components: prevention, mitigation and preparedness, response and recovery. However, detailed lessons learnt for different thematic areas are shared in other chapters of this book volume.

In terms of prevention, there was very little to almost nothing that could be done to prevent the naturally occurring cyclone hazard. Moreover, some of the loss and damage to existing infrastructure were unavoidable. However, as outlined in earlier sections, there was room for countries, the region and the international development partners to put in place measures that could have reduced residual disaster risk to prevent severe devastation on people's livelihoods and loss of lives. For instance, from a people-centred DRR perspective once the hazard had been forecasted and monitored with precision, at least evacuation should have been done, and temporary shelter provided before landfall.

DRR requires sustained coordination and concerted efforts among diverse actors, at global, regional, national and subnational levels where roles and responsibilities are defined and guide risk management actions. There is a need for disaster risk management to be conducted within the provisions of the existing regional DRR policy architecture which is more proactive. Individual countries and the region need to prioritise investment in, and operationalisation of, DRR strategies such as EWS which should always trigger early action aimed at reduction of loss of lives and livelihoods, and infrastructural loss and damage. Such investment was seen in Mozambique where innovative drone technology was used in post-disaster search and rescue and damage assessment. However, there is a need for more financial and technical investment that will enhance post-disaster recovery and development.

Effective EWS anchor the mitigation and preparedness strategies for any unpreventable hazard. It is worth noting that global and regional weather monitoring and forecasting systems and equipment were able to detect and track the system from its development to landfall and hazard information was relayed to national meteorological institutions in the countries that were affected. The level of fatalities from Cyclone Idai exposes gaps in countries' EWS which need urgent attention given that southern Africa is projected to be a climate change hotspot.

Disaster mitigation and preparedness are also based on risk information, knowledge management and communication which need not be a preserve for technocrats and high-level politicians centralised at national level. At-risk communities need timely access to risk information through relevant communication channels and active participation to guide their decision-making (FAO, 2018). Communities need to participate in hazard, vulnerability and coping capacity assessments conducted regularly, with the risk profile and risk mapping of the region

and each member state regularly updated. There is a need to strengthen and support advocacy, awareness-raising, knowledge management and communication to harness a greater commitment to building more resilient livelihoods. Regional assessments where the SADC Secretariat leads and co-ordinates activities to ensure that regional development decisions are risk-informed are necessary.

Countries need to institute disaster risk governance reforms towards more proactive DRR approaches swiftly to remain on track towards achievement of SDGs. A shift towards proactive DRR compels adequate budgetary provisions at central and local government levels to fund the implementation of mitigation and preparedness strategies. Budget provisions need to be informed by investment requirements, such as skill development requirements and modern forecasting and nowcasting equipment, as well as search-and-rescue operations. This will require political will that will steer amendments of institutional and regulatory frameworks informed by DRR and CCA aimed at protecting critical infrastructure and livelihoods and reducing fatalities. In seeking to ensure building back better, leaving no one behind, governments need to address building standards and codes, as well as informal settlements, zoning and urban planning in the region. Cost-benefit analyses and other pre-disaster DRR research are needed to provide critical evidence to inform decision-making. Moving forward, consorted mitigation measures during recovery need to focus on critical infrastructure, helping affected communities build back better in the shortest possible time for post-disaster recovery. Ultimately, for DRR and CCA to successfully contribute towards sustainable development, governments need to address underlying vulnerability and risk drivers and strengthen resilience-building efforts.

5.7 Conclusions

The purpose of this chapter was to highlight the fundamentals of DRR relevant for southern Africa, including a focus on people-centred DRR, vulnerability reduction and strengthening resilience. A review of DRR and CCA policies in the selected SADC member states affected by the 2019 cyclones and flooding disasters, as well as focus on regional efforts towards implementation and domestication of SFDRR, Paris Agreement and the 2030 United Nations Agenda for Sustainable Development, was done. Linkages between DRR, CCA and sustainable development and challenges to their integration were explored alongside the lessons and opportunities presented by the recent disasters for individual member states and the regional bloc. This chapter shows that disaster management has seen dramatic shifts over the years, informed by the conceptualisation of disasters, and has attracted renewed policy reviews and amendments from global to local levels of governance. This includes the regional efforts that are put in place, particularly in southern African, to align disaster risk management activities with global efforts. With the increase in the number of hydrometeorological hazards in the region, efforts should shift from a dominantly hazard-centric disaster management towards a people-centred approach that tackles vulnerability and exposure and advocates for increased efforts towards resilience building. The devastating effects of large-scale disasters necessitate that countries develop, revise and improve their legal frameworks for DRR, ensuring alignment with international DRR and CCA provisions. Some policy recommendations for consideration by individual member states and the SADC Secretariat are as follows:

- Escalate efforts towards implementation of people-centred DRR and risk-informed decision-making across all sectors in the region.
- Move from reactionary to proactive DRR, by developing, amending and reviewing policy and legislative frameworks in line with global and regional frameworks.
- Integration of sustainable development, DRR and CCA in all development projects from regional to local level: Practitioners, policymakers and researchers need to understand that DRR, CCA and SDGs collectively tackle developmental issues with numerous overlapping targets, compelling a more coherent approach.

- Integrated mainstreaming of DRR and CCA at all levels of development and governance.
- Improve institutional co-ordination in the region and within member states to achieve DRR, CCA and SDGs.
- Increase funding allocated for proactive DRR, such as EWS, to protect development and save lives.

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6 ICT Readiness for Disaster Risk Reduction: Lessons from Tropical Cyclone Idai

Godwell Nhamo and Mariki M. Eloff

Abstract

Tropical Cyclone Idai ripped through Malawi, Madagascar, Mozambique and Zimbabwe in mid-March 2019. Hundreds of lives were lost and a lot more remain unaccounted for. This study investigates the extent to which Zimbabwe's information and communication technology (ICT) is ready for disaster risk reduction (DRR) application and management. The focus was on Chimanimani District, where Cyclone Idai hit eastern Zimbabwe on 15 March 2019. This work further investigates the damage to ICT infrastructure and its resilience to the cyclone. Through the use of a questionnaire survey, interviews, document analysis and field observations, it emerged that Zimbabwe's application of ICT in early warning systems remained low and ineffective due to the lack of appropriate equipment and expertise and unreliable electricity supply. In Chimanimani, some mobile network service providers' base stations were flooded and communication was cut off completely, while mobile penetration at household level is near 100%. Grid electricity was also cut off for close to 1 month, with secondary impacts on charging mobile devices and signal coverage. Mobile phones and social media platforms such as WhatsApp were widely used at all DRR cycle stages, while radio provided the widest reach in terms of public announcements. From these findings, we recommend that authorities should invest heavily in modernising national weather forecasting ICT and promote the use of mobile phones as one of the platforms for DRR, especially in early warning. There is also the need to raise disaster awareness and preparedness among communities in Chimanimani.

Keywords

ICT readiness · Cyclone Idai · Chimanimani · Early warning · Disasters · Extreme weather

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6.1 Introduction

Tropical Cyclone Idai affected a number of countries in southern Africa, making landfalls in Madagascar and Mozambique, before moving inland into Malawi and Zimbabwe in mid-March

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2019. Lives were lost, people were displaced and a lot more people remain unaccounted for. The aftermath of Tropical Cyclone Idai was still being felt late in 2020, as compounded by the COVID-19 pandemic. It was also likely that the impacts would linger for much longer through to 2030, a landmark year when the United Nations expects to have attained the 2030 Agenda for Sustainable Development and the aligned 17 Sustainable Development Goals (SDGs) (United Nations, 2015).

In a study focusing on 10 years of disaster management and the use of ICT, Kaur and Sood (2019, 2020) note that disasters lead to the loss of natural, human and financial resources. Climate change is singled out as magnifying the intensity and extent of the impacts of such disasters. Hence, the exponential growth in the use of ICT in other disciplines has enticed professionals and researchers in disaster risk reduction (DRR) and management to consider how the use of ICT can also be scaled up in this field. This is also supported by the provisions in the 2030 Agenda for Sustainable Development (AfSD) and its 17 sustainable development goals (SDGs) that have several ICT-related indicators embedded throughout (United Nations, 2015; Nhamo et al., 2020).

Given the foregoing, this research investigates the extent of ICT readiness for DRR and management in Zimbabwe, with a special focus on the Chimanimani District where Cyclone Idai had severe impact and caused extensive damage. The work further investigates the damage to ICT infrastructure and its resilience to Cyclone Idai. The ICT readiness is investigated following the key DRR cycles, namely early warning, search and rescue, as well as relief and recovery. To this end, the following research questions are spelt out: (1) to determine ICT readiness for DRR and management in Zimbabwe, with a special focus on the Chimanimani District where Cyclone Idai hit on 15 March 2019, and (2) to establish the extent of damage caused on ICT infrastructure by Cyclone Idai and how authorities restored services thereafter.

6.2 Literature Review

In their analysis, Kaur and Sood (2020) identify three main disaster typologies that include natural, industrial (technological) and humanistic disasters. Under natural disasters, three subcategories emerge, namely hydro-meteorological, geophysical and biological disasters. Further sub-subcategories are also identified with floods, cyclones (also known as hurricanes and typhoons), tornados and wildfires making up the hydro-meteorological disasters. Earthquakes, tsunamis, volcanos and landslides fall under geophysical disasters, while epidemics and pandemics fall under biological disasters. Nuclear accidents, oil spills and power outages fall under industrial disasters, while traffic, war and terrorist attacks make up the humanistic disaster category.

Sakurai and Murayama (2019) highlight that ICT should be utilised across all the stages in DRR and management that include an early warning (preparedness), search and rescue, as well as relief and recovery (see also Firdhous and Karuratane, 2018). ICT is said to play critical roles in recording, exchanging and processing information (including its storage and retrieval), according to Sakurai and Murayama (2019). ICT also plays a fundamental role in early warning systems (EWS). Web browser and mobile applications can be set up to issue out warnings which enhances disaster preparedness. Information is also needed during the search-and-rescue operation stages. For example, authorities need to know where, when and why the disaster occurred; confirm the whereabouts and safety of residents; determine what and how many evacuation centres are needed; recognise temporary shelter needs and forms of transport and nature of relief goods needed; create databases of evacuees and relief agencies and staff; and also issue disaster victims' certificates—be it death, birth, passports or other important documents (generation of Big Data). ICT can also be used in public address systems, mass media, short message services (SMS),

e-mail and online social media (Firdhous and Karuratane, 2018). During recovery, authorities—especially local government and development partners—need the information of beneficiaries of certain schemes as they build back better (Sakurai and Murayama, 2019).

Based on the taxonomy of disasters presented earlier, Tropical Cyclone Idai is classified as a hydro-meteorological natural disaster. Tropical Cyclone Idai made landfall in Beira Mozambique and went on to affect three southern African countries of Malawi, Madagascar and Zimbabwe in March 2019. In Zimbabwe, the cyclone hit on 15 March 2019 (UNECA, 2019). Recorded as one of the worst tropical cyclones in southern Africa (Yu et al., 2019), Idai resulted in over 1000 lives lost, over 2500 injuries, over 275,000 displacements and about three million people being affected (UNECA, 2019). In Zimbabwe, the country studied, and specifically in the hard-hit districts of Chimanimani and Chipinge, Tropical Cyclone Idai left 344 people dead, 200 injured, 16,000 displacements and over 250,000 people affected and many more unaccounted for. While the World Bank estimated the damage in Mozambique at between US$656 and 773 million, in Zimbabwe, the government estimated the damage at US$613 million. From the amount put forward by the Zimbabwean Government, US$300 million was to fund the emergency shelters, logistics and telecommunications (UNECA, 2019). Given that the study area is mainly rural, Firdhous and Karuratane (2018) indicate that such areas were disadvantaged when it comes to DRR and the application of ICT for DRR would be a welcome development.

As the mainstreaming of ICT in DRR and management continues to grow, several concepts require familiarisation. One such is technology (digital) penetration. This term serves as a collective for, among others, the following: mobile phone penetration, internet penetration, broadband penetration and computer penetration. In layman's terms, it refers to the number of people owning, having access to, and able to use these technologies. The more people having such access and usage, the higher the penetration. However, fixed telephone line penetration has decreased (rightfully so) in developing countries over the last decade (UNCTAD, 2019). The quality of the ICT infrastructure, as well as the ability of consumers, businesses and government to connect to and use this infrastructure, plays a major role in digital penetration (Bukht and Heeks, 2018). There are various other factors influencing technology penetration. The first and foremost is access to electricity, followed by the availability and stability of telecommunications networks, the slow international and national bandwidth, the affordability of services such as mobile phones and the cost of data to name but a few (Chari, 2009; Bukht and Heeks, 2018). In addition, when considering DRR and management in the context of ICT, one has to be familiar with the concept of ICT readiness. ICT readiness refers to the availability of digital technology for consumers, businesses and government to use for a variety of purposes and is closely linked to technology penetration because the more people having access to and use of digital technologies, the better the ICT readiness (UNCTAD, 2019). This foregrounding assists in a deeper understanding of the subject under investigation.

The next section details the materials and methods used in generating and analysing the data.

6.3 Materials and Methods

The study took place in Zimbabwe, mainly focusing on the Chimanimani District. The data generated included that from a household questionnaire survey, three focus group discussions, more than 40 key informant interviews, document analysis and field observations. Field observations focused mainly on assessing the damage to ICT infrastructure. These are methods that have been successfully applied in ICT and DRR and managed by authors such as Bui (2019) and Kaur and Sood (2020; 2019). The fieldwork took place during September and October 2019.

The household questionnaire survey was administered on an offline QuestionPro platform, with enumerators working offline in the field during the day and uploading the responses onto the

QuestionPro platform in the evenings. The realised sample was 219 from a total of 248 households that participated in the survey. This gave a response rate of 83.31%. Only households that were directly affected by the cyclone were sampled, and these came mainly from the Ngangu, Kopa and Machongwe areas. The realised average time it took to complete a survey was 55 min.

Some of the questions seeking ICT readiness in the questionnaire, FGD and interviews included those asking for the main sources of mobile and other devices' charging energy, frequency of charging, availability of ICT devices per household, number of smartphones, number of mobile networks used by the household, availability of network coverage during Cyclone Idai, and everyday coverage of ICT in the area. Given that the mobile phone remains part and parcel of modern ICT services, an effort was made to map the existing base stations for three mobile phone service providers in the country, namely NetOne, Econet and Telecel. Some of the base stations are presented in Fig. 6.1 and these include those from Chipinge District, the second most severely impacted district after Chimanimani.

The overall ICT readiness in Zimbabwe was investigated using the SDG indicators provided by the United Nations Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs) Tier Classification of 15 October 2018 (IAEG-SDGs, 2018). The indicators covered a total of five SDGs, namely SDG 4 (Quality Education), SDG 5 (Gender), SDG 7 (Sustainable Energy), SDG 9 (Industry and Infrastructure) and SDG 17 (Partnerships) (United Nations, 2015). The data was generated from the Telecommunication Development Sector (ITU-D). Table 6.1 provides further details regarding the SDGs, targets and indicators.

Traditional qualitative data analysis methods were applied for the interviews, focus groups and document data. As for survey data, some were partially analysed using QuestionPro, while other data was exported to MS Excel for plotting graphs. Supporting literature was sifted through and presented in clarifying emerging findings. The next section is dedicated to presenting and discussing key findings.

6.4 Presentation of Key Findings and Discussions

This section comes in three subsections namely a focus on ICT readiness for DRR and management in Zimbabwe; ICT readiness for DRR and management in Chimanimani; and the impact of Tropical Cyclone Idai on ICT and related infrastructure in Chimanimani. Each of these three subsections will now be considered in detail in the following paragraphs.

6.4.1 ICT Readiness for DRR and Management in Zimbabwe

Since DRR and management in the context of Tropical Cyclone Idai rest with weather forecasting and early warning from the concerned national department, the starting point was to investigate readiness in this space. One focus group discussion and two interviews were granted by the authorities from the Zimbabwe Metrological Services Department (ZMSD). In terms of forecasting, the focus group discussion revealed that Tropical Cyclone Idai was picked on the system from 4 March 2019. Monitoring of the system took place and by 9 March 2019, the weather system had developed into a tropical cyclone. The tropical cyclone moved from the Indian Ocean affecting Mozambique and some parts of Malawi before hitting Zimbabwe on 15 March 2019 as a category 3 tropical cyclone. In Zimbabwe, the most affected areas were Chimanimani and Chipinge districts, which are both predominantly rural. Other impacted areas included Masvingo, Bikita, Zaka, Gutu and Buhera districts. From the focus group discussion, the forecast was prepared on Friday, 15 March 2019. However, there were electricity and ICT-related challenges that resulted in the failure of the ZMSD to send the forecast out to the general public.

Fig. 6.1 Mobile phone service providers' base stations. Source: Authors, coordinates provided by Postal and Telecommunications Authority of Zimbabwe (2019)

The challenge with electricity supply shortages and blackouts highlighted by the ZMSD staff is genuine as generally a low percentage of the country's population has access to electricity (Fig. 6.2). The percentage of population with access to electricity was on average 34.25% over 27 years (1990–2016). In addition, the percentage of population with access to electricity stood at 38.15% in 2016. The country's economy has been in freefall since the imposition of economic

Table 6.1 Zimbabwe's ICT readiness based on SDG-related indicators

SDG	Target	Indicator
4	4.4 By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship	4.4.1 Proportion of youth and adults with information and communications technology skills, by type of skill
	4.a Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all	4.a.1 Proportion of schools with access to the internet for pedagogical purposes and/or computers for pedagogical purposes
5	5.b Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women	5.b.1 Proportion of individuals who own a mobile telephone per 100 people
7	7.1 By 2030, ensure universal access to affordable, reliable and modern energy services	7.1.1 Proportion of population with access to electricity
9	9.c Significantly increase access to information and communications technology and strive to provide universal and affordable access to the internet in least developed countries by 2020	9.c.1 Proportion of population covered by a mobile network, by technology
17	17.6 Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms	17.6.2 Fixed internet broadband subscriptions per 100 inhabitants, by speed
	17.8 Fully operationalise the technology bank and science, technology and innovation capacity-building mechanism for least developed countries by 2017 and enhance the use of enabling technology, in particular information and communications technology	17.8.1 Proportion of individuals using the internet (from any location), all individuals (%)

Source: Authors, based on IAEG-SDGs (2018, 1–33)

sanctions in 2000 and this has affected many economic sectors, including energy and electricity supply. This was compounded by the recurrent droughts that have witnessed electricity generation from the main source, Lake Kariba, falling to nearly zero in recent times (Dube and Nhamo, 2020).

The ZMSD does not have equipment for real-time monitoring of heavy tropical cyclones. The radar system remains the appropriate equipment and is also very expensive. The radar is best suited to determine severe weather and it can monitor an area of a 200 km radius. With the available ICT, the ZMSD could only model a threshold of rainfall of between 50 mm and 70 mm in 24 h. Yet the rainfall for Cyclone Idai recordings at Chisengu, which is the station nearest to Chimanimani, was 500 mm plus in 24 h. Field interviews with one of the horticulture-exporting farms, which religiously keeps all the rainfall records, indicated that Chimanimani received a rainfall of over 1950 mm in 2 days between 14 and 15 March 2019. Hence the old equipment from the ZMSD was of no use in predicting the amount of rainfall from Cyclone Idai. To this end, even the EWS would not have worked as there was a gross under-reporting of the volumes of water the area was to receive from the cyclone. The high volumes of water received confirm Sahoo et al.'s (2018) observation that typically a tropical cyclone causes widespread inland flooding as a result of storm surges, with post-landfall events causing severe and extensive damage to infrastructure.

At the time of the fieldwork in September 2019, the ZMSD confirmed that it had 48 functional weather stations (down from 66), with some districts having none. It emerged from the focus group discussion that every district should have a meteorological station. However, the con-

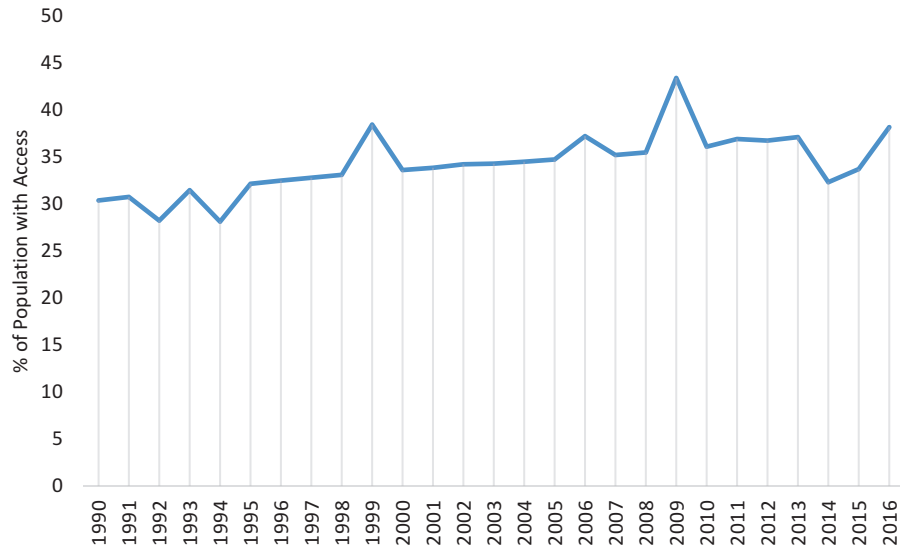

Fig. 6.2 Access to electricity. Source: Authors, data from WDI (2018)

ditions at some of the 48 stations are deplorable, and there was a chance that some of the data and information may not be as accurate as it should have been. While the staff at some of the stations may be required to take measurements at 02:00 h, the physical environment where grasses and bushes have grown tall and thick may not be conducive for such. The main point being highlighted concerns the lack of maintenance of the stations and the resultant security threat to staff.

The ZMSD focus group further highlighted that, based on the World Meteorological Organization (WMO) standards, weather stations should be within a radius of 50 km of each other. Examples were given where between Harare and Masvingo (a 280 km stretch) there was only one station in Chivhu Town, some 150 km away from the nearest station. In the direction of Harare to Mutare (some 268 km), the next station was in Marondera, 75 km away. The grid of weather stations was too widely spaced, with some stations becoming dysfunctional and obsolete. In addition to the challenges outlined, the ZMSD does not operate around the clock. It operates from 08:00 to 16:00 due to a staff shortage. There were also challenges associated with some stations having only one staff member, which would be closed if they fell sick or had to attend a funeral. One station in Matabeleland North Province was given as an example when a staff member lost a daughter and the station went for a month without any data being relayed to the head office. The authors then raised the issue of automated weather stations (AWS). The response was mixed. Although there are AWS, those administered by non-governmental organisations (NGOs) were operating well with the data going directly to the ZMSD server. However, there were challenges with maintenance and inputting of data as the ZMSD did not have adequate skills and staff.

The summary of the nature and functional status of national weather forecasting ICT is also presented in a report by the ZMSD on Cyclone Idai. The ZMSD highlights that the international standards encourage National Meteorological and Hydrological Services (NMHS) to be part of an integrated observation system called Automated Message Switching System (AMSS). The AMSS relays data to the Global Telecommunications System (GTS). In Zimbabwe, the network includes surface observations—staffed meteorological stations (48 sites), 18 AWS sites and 52 rainfall-observing stations (which are all manned by volunteers); upper-air observations—weather balloons (currently with one station at Belvedere, Harare); and weather radars—of which there are none in the country. The ZMSD also noted that the platform

that connects to the GTS, Messir-Aeronet and Messir-Comm, was not working. This compromised the flow and quality of data. Both the Messir-Aeronet and Messir-Comm software licences expired in 2016 and have not been renewed since. In addition, from the 18 AWS stations, only 9 sites were working and sending data to the Central Forecast Office. The nine AWS were operated by NGOs, namely Oxfam (five sites), Red Cross (one site) and Dan Church Aid (three sites). The other eight sites, which were handed over to the ZMSD, had no data bundles, with the one in Muzarabani having been vandalised. Although maintenance protocols stipulate that maintenance of AWS be done at least every 6 months, the ZMSD was failing to do so due to financial constraints. Of particular importance is the need to build EWS in Manicaland Province, which is frequently hit by tropical cyclones. The following drawbacks in effective EWS were noted (ZMSD 2019, 23):

- Poor communication infrastructure that can be used in warning dissemination and emergency operations.
- Absence of critical instruments like weather radars: All of the stations in Manicaland have old and obsolete observation instruments.
- Absence of useful utilities (e.g. electricity and internet connection) and essentials (e.g. torches and raincoats), the poor state of office buildings and understaffing.
- Coarse station network: Manicaland has the roughest terrain in Zimbabwe, but it has only seven meteorological stations (Chisumbanje, Chipinge, Chisengu, Mukandi, Buhera, Nyanga and Rusape) with distances in excess of 100 km between each.

As for ICT-related resources needed for the Manicaland Province alone, the following were noted for instruments: weather radars, seven AWS, digital thermometers, digital barometers, standard rain gauges, sunshine recorders, thermo-hydrographs and dynes (ZMSD, 2019). Additional ICT needed for the provincial office include high-speed broadband connection, four desktops, two laptops, AWS digital display and one landline. As for all the other satellite offices in the province, there was a need for one desktop at each station, one ADSL connection, and one printer at each station. In total, nine offices were identified (five existing that needed repairs and four new sites). One new site was needed in Chimanimani centre.

A presentation was made by Team Zimbabwe during the UNECA building back better planning workshop for climate-resilient investment in reconstruction and development in cyclone-affected regions that took place from 23 to 25 October 2019. From that it emerged that there were significant gaps in ICT readiness for DRR. Top on the list, which also came out of the focus group discussion with the ZMSD staff, was the need to procure radars and hydrological gauging stations on major river systems. The ZMSD does not have any single operational radar, and the discussions highlighted that the Manicaland Province where Chimanimani and Chipinge districts are located must be prioritised. The reason for prioritising this province is that it sits in the pathway of many tropical cyclones that hit Zimbabwe. The ZMSD focus groups further indicated that social media, especially WhatsApp, could be useful in early warning, especially in remote rural areas that still had network coverage. However, there were still some areas in the country that were without radio, TV or mobile network coverage.

Although there was no data for other SDG indicators stipulated in the methodology section, the results regarding ICT readiness in Zimbabwe for some of the indicators are presented in Fig. 6.3. It emerges that the number of individuals with mobile cellular telephones grew drastically from 2.24 inhabitants per 100 inhabitants in 2000 to 89.4 inhabitants per 100 inhabitants in 2018. Although coming from a low base, there has also been some increase in fixed broadband internet subscriptions. This grew from 0.01 inhabitants per 100 inhabitants in 2000 to 1.41 inhabitants per 100 inhabitants in 2018. Not included in the figure is the percentage of individuals using the internet, which stood at 27.06% in 2017 (ITU-D, 2020). In addition, the 2014 data shows that 60.7% of the households in Zimbabwe

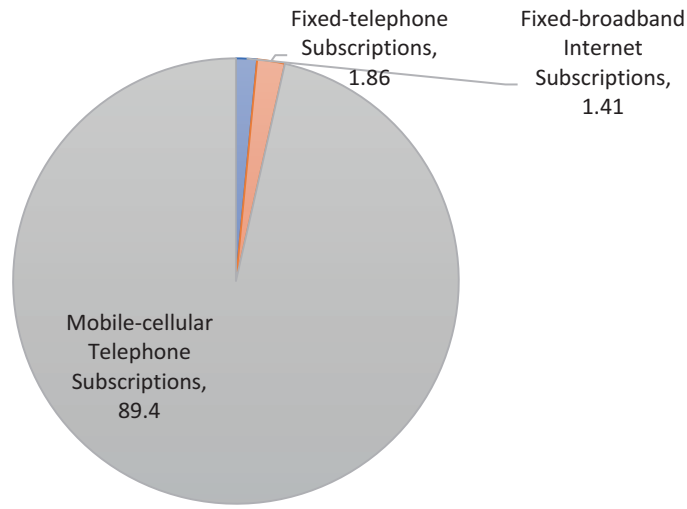

Fig. 6.3 ICT readiness in Zimbabwe for selected indicators (2018). Source: Authors, data from ITU-D (2020)

had a radio, with 40% of households having TV. Further ICT readiness was investigated in Chimanimani from the survey.

Concerning the involvement of mobile network providers (Econet, NetOne and Telecel), the information provided by the Postal and Telecommunications Authority of Zimbabwe (POTRAZ) shows that there has been informal and voluntary cooperation in EWS. The early warning and/or early action messages are sent free of charge to at-risk people and this voluntary arrangement has witnessed some success. However, not all networks are engaged in the arrangement. To streamline DRR and management telecommunications systems, the POTRAZ indicated that it was in the process of setting up two dedicated emergency numbers (112 and 911) that will be managed at a national level. In addition, POTRAZ bought satellite phones for each district Civil Protection Committee in 2012. However, the satellite phones often do not work. Effectively, the technology is not useful and therefore is redundant.

6.4.2 ICT Readiness for DRR and Management in Chimanimani District

In Chimanimani, households were asked to indicate the availability of several ICT platforms and gadgets. Given the huge ownership of mobile cellular telephones in the country, a question was included in the survey that sought to determine household access to electricity. Electricity is needed to charge mobile phones and other gadgets. From a sample of 159 households, 45.91% indicated that they had access to the national grid, while 44.65% did not. The remaining percentage (9.43%) indicated that they were connected to other sources of electricity. A follow-up question was raised to check the source of electricity used to charge mobile phones with the responses shown in Fig. 6.4. Exactly half of the responding households charged their mobile devices from electricity supplied by the national grid. This posed a challenge as the national grid went down for more than a month during and after Tropical Cyclone Idai hit the region in March 2019. In addition, a significant number of households charge their mobile devices using solar energy (45.62%). This too was problematic as many houses were destroyed completely. Many households (53.73%) indicated that they charged their mobile devices daily. Furthermore, 19.4% charged once per week and 14.93% charged twice a week, with 8.96% indicating that they charged their devices three times a week. The remaining percentage charged either four times (1.49%) or five times weekly (1.49%). Overall, as discussed earlier, the national electricity grid has not been that reliable for a long time.

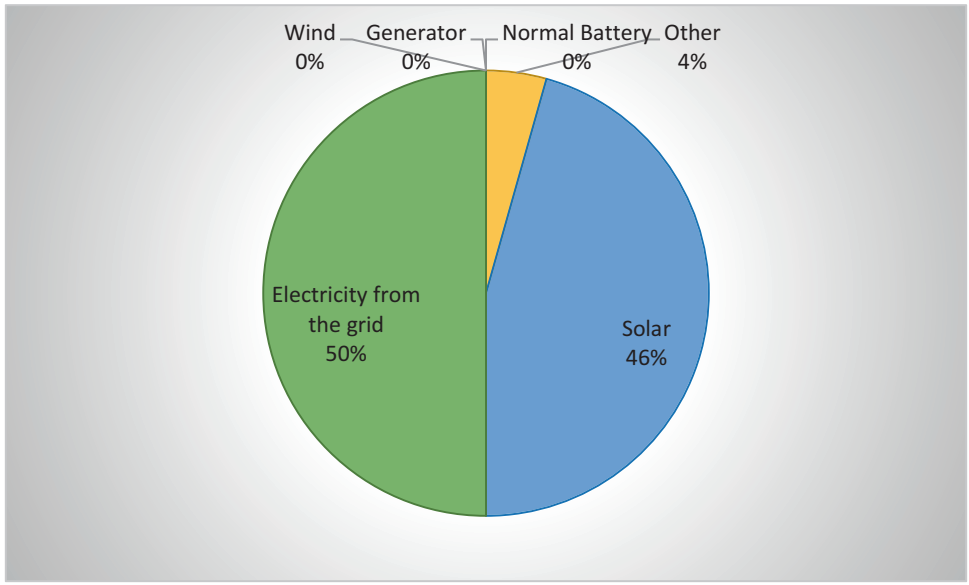

Fig. 6.4 Main source of electricity for charging mobile or other devices (n = 159). Source: Authors, household survey 2019

Households were also requested to indicate the number of ICT gadgets they had. They had to indicate whether they had a fixed telephone line, mobile phone, fax machine, personal computer, laptop, tablet and/or iPad, radio and/or TV. A total of 93.75% revealed that they did not have a fixed telephone line, with only 6.25% having this facility. This observation confirms the very low rate at a national level as presented earlier. As for the mobile phones, the penetration was very high, with many households having more than one mobile phone. Further details are presented in Fig. 6.5. An estimated 98% of households surveyed had at least one mobile phone. The bulk of households had between two and five mobile phones, with 48.39% having two mobile phones in the household. These findings also mirror the national penetration for 2018 figures from the ITU-D, where up to 89.4 inhabitants per 100 inhabitants had a mobile phone. This positioning will enable any future ICT-related EWS to prepare for the use of mobile phone as one of the platforms. A further question requested households to indicate whether they had smartphones (a phone that has WhatsApp, Facebook, Twitter, etc.) and 65.16% responded positively. A study using cross-country data over the 1980–2013 period to estimate the relationship between newly emerging cell phone access/use and disaster-induced fatalities revealed that a standard deviation increase of one (1) in cell phone usage was likely to reduce disaster fatalities by nearly 50% (Toya and Skidmore, 2018).

Another ICT-related device of interest that was investigated was the radio. From the 141 households that answered that question, an estimated 34.04% indicated that they did not have a radio, with the remaining 65.96% indicating that they had a radio. Similarly, 42.28% had a TV, while 57.72% did not have a TV. The responses regarding the mobile network providers the households used were quite interesting, with the majority of households using a single service provider. Up to 23.75% used two network service providers, while 9.38% were connected to all three network service providers (Econet, Telecel and NetOne). Only 1.88% of households were not connected to any mobile network service provider. Linked to mobile phone infrastructure are matters of the availability of reception. Households (n = 143) indicated that overall (across all three networks), signals were always available (61.54%), sometimes available (37.76%) and never available (0.7%). The every-

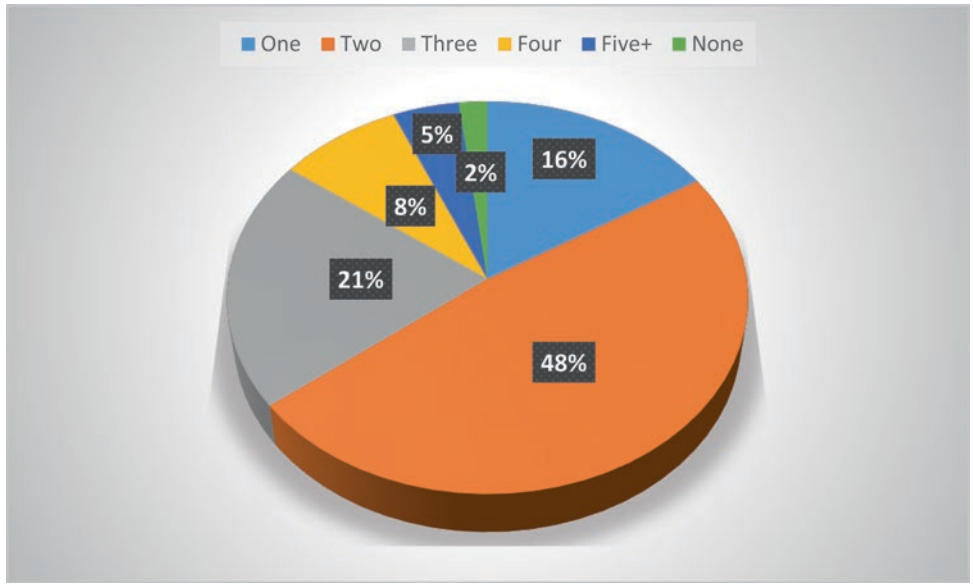

Fig. 6.5 Number of mobile phones per household (n = 155). Source: Authors, household survey 2019

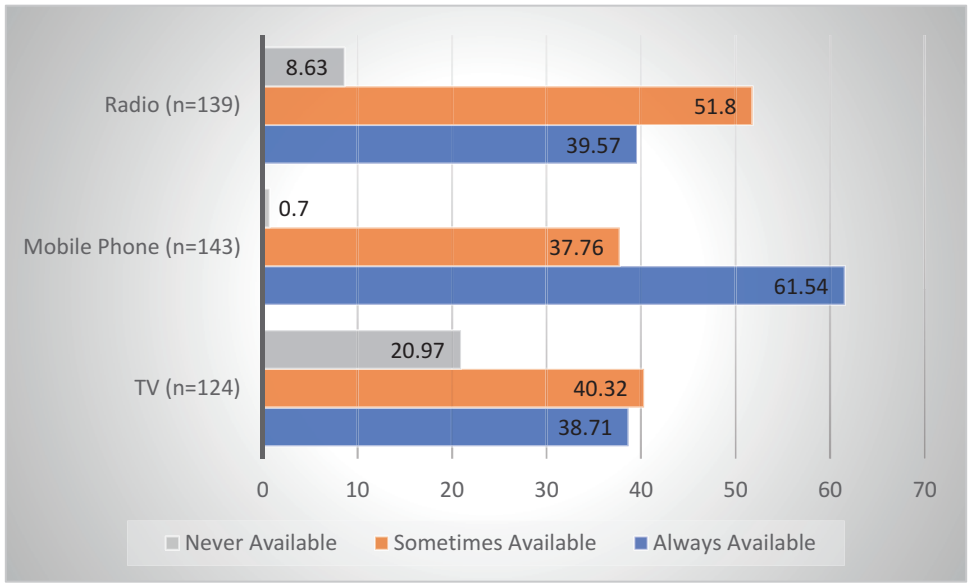

Fig. 6.6 Everyday network availability (signals). Source: Authors, household survey 2019

day signals and availability of other ICT are presented in Fig. 6.6. What comes out clearly is that the mobile phone remains the most readily available in terms of readiness for communication and early warning on DRR and management. The radio is also available, while the TV is the least available. Hence, these other devices can also be used in DRR. Furthermore, the researchers were interested in determining the availability of networks after Tropical Cyclone Idai hit. These results are shown in Fig. 6.7.

Other ICT-related platforms of interest included WhatsApp. The reason for the team to investigate WhatsApp further originated from the

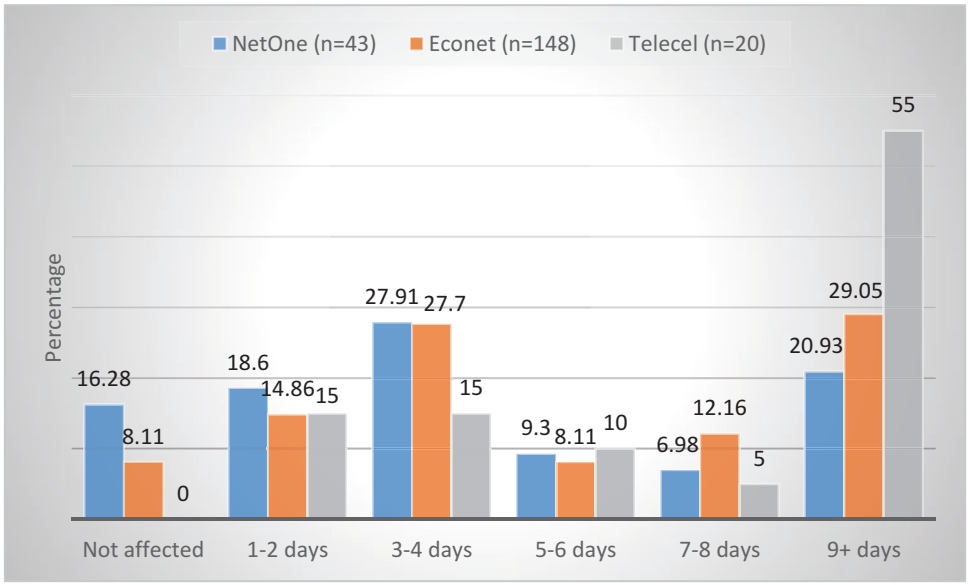

Fig. 6.7 Network availability (signals) during Tropical Cyclone Idai. Source: Authors, household survey 2019

preliminary work, which showed that several people had received the message regarding the cyclone through WhatsApp. From the 153 households that responded to the question, 33.33% revealed that they had at least one person in the household with WhatsApp. About 17% had two people in the household with WhatsApp, while 9.8% had three people in the household with WhatsApp. Furthermore, 3.27% had four or more people in the household with WhatsApp. This left 36.6% of the surveyed households without any person with WhatsApp. Once more, the use of WhatsApp for official DRR and management remains a possibility in the future in Chimanimani. As for Twitter, this was not a common platform, with 90.65% of the 139 households responding to the question indicating that they did not have it. A similar pattern emerged for Facebook, with 74% of the responding households indicating that they did not have it, while the remaining percentage had Facebook.

To find out the reliability of the ICT platforms for early warnings of Tropical Cyclone Idai, households were asked to rate these ICT platforms and the findings are shown in Fig. 6.8. The emerging findings make it clear that mobile phones (voice and text) were perceived to be the most reliable platform in terms of Tropical Cyclone Idai early warning. An estimated 56.66% of household respondents felt that way. This was followed by WhatsApp, with 42.86% approvals. The least reliable platform was Twitter, followed by Facebook. Although Twitter did not come through strongly in terms of reliability, Kryvasheyeu et al. (2016) found it helpful during Hurricane Sandy in the USA.

Lastly, the authors teased out information regarding the platforms that delivered Tropical Cyclone Idai news first to households. From a list of 22 possible platforms, half did not receive any votes (Fig. 6.9). The platform that shared the news first on most occasions was the radio as confirmed by 30.67% of the household respondents. This was followed by a neighbour (19.33%), then WhatsApp (16%), SMS (8.67%) and TV (8%). However, what was most concerning was the fact that there were residents of Chimanimani who did not receive any message at all. Therefore, the role of ICT in future DRR and management cannot ignore the radio, WhatsApp, SMS or TV. With the penetration of the mobile phone in Chimanimani, much more effort should be put into growing this platform for DRR and management.

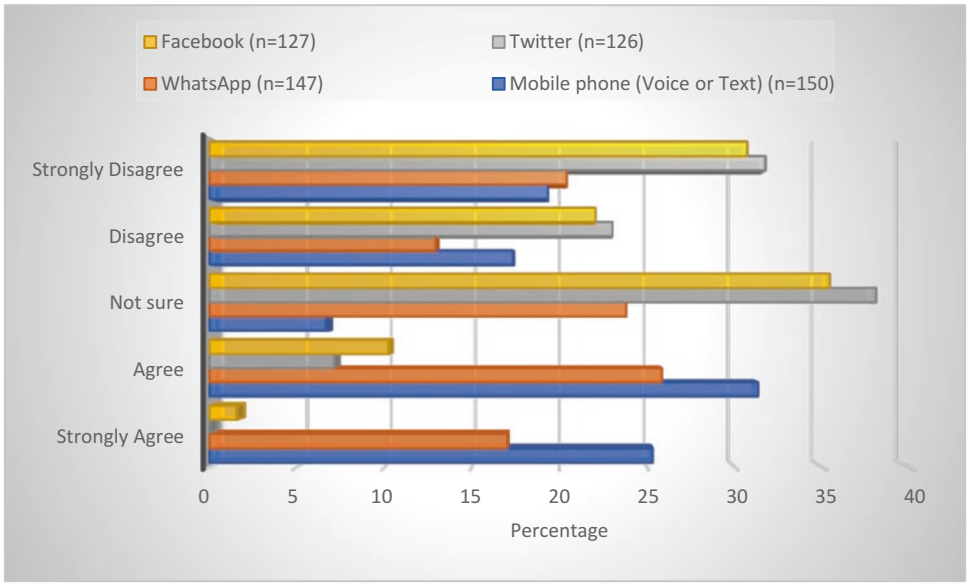

Fig. 6.8 The household ICT facilities' reliability for Cyclone Idai early warning. Source: Authors, household survey 2019

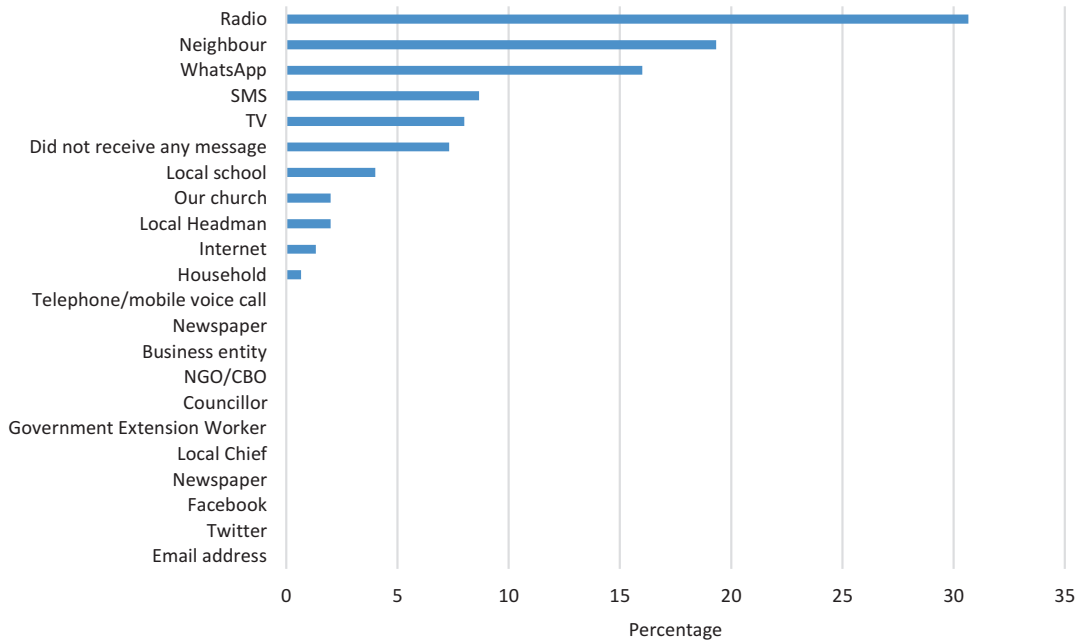

Fig. 6.9 From which platform did you first receive the messages on Tropical Cyclone Idai? ($n = 150$). Source: Authors, household survey 2019

Although social media, particularly WhatsApp, played a critical role in bringing Cyclone Idai news to the communities, Bui (2019) cautions against the spread of rumours or false information from such platforms. Experiences from the use of social media during Hurricane Warning Systems in Puerto Rico revealed that there remains some degree of mis-

trust and unreliability. Decentralised social media EWS showed that there were differences in perceptions by emergency management authorities and community members during and after Hurricane Maria in 2017.

6.4.3 Impact of Cyclone Idai on ICT Infrastructure and Services

Overall, data and information supplied by the Manicaland Provincial Development Coordinator's Office during fieldwork revealed that ICT infrastructure damage across the province was US$2.467 million. This included the cost for constructing an estimated 60 km of overhead lines and running mobile network providers' base stations on diesel. It also emerged that there were four main service providers of ICT infrastructure and services in the affected areas of Chimanimani and Chipinge districts. These service providers included Econet, TelOne, Telecel and NetOne. TelOne is a fixed landline service provider, while the other three are mobile service providers. The extent of damage was also evaluated through the household (n = 147) survey. Up to 66.66% of the respondents indicated that Tropical Cyclone Idai either completely or partially damaged telecommunications infrastructure in Chimanimani. Another 5.44% reported no damage at all, while 13.61% indicated that they did not know and the remaining 14.29% selecting the option "not applicable".

It emerged that when the rains poured on 14 and 15 March 2019, not many people anticipated the nature or extensive damage that was encountered by the ICT sector. Mobile phone providers were negatively impacted as electricity was cut off and some base stations ran out of fuel, with some having water getting into generators. The result was the immediate loss of signals. One of the base stations most impacted was that of Econet at Kopa. Kopa was the worst-hit area by the cyclone. The programme to immediately restore the functionality of base stations across the affected districts was hampered by the damaged roads which cut off the technicians from accessing the area resulting in prolonged communication outage. Other base stations that were affected were in Chimanimani town, specifically at Pock Pie. All three mobile phone service providers have base stations there. From an interview with one of the managers at Chimanimani Hotel, Econet had to permit people from the community to break into their site at Pock Pie as they had mobilised diesel. Up to 200 l of diesel was mobilised and the community had to take it up to Pock Pie base stations in Chimanimani on foot. The Pock Pie base is about 8 km away. Hence, a round trip would be approximately 16 km. The diesel was needed because electricity supplies had gone down. At the time of fieldwork, about 8 months later, one of the mobile service providers had not restored their connectivity.

A focus group discussion with some staff from TelOne revealed that all the mobile phone services went down, leaving the fixed landline service provider as the sole service provider at some point. TelOne started by having the affected community members calling to notify their relatives of the disaster for free. An estimated 300 individuals were assisted in 2 days. However, as the demand increased, many more people were assisted, with a makeshift fixed line provided (Fig. 6.10). Internet services were also provided from the TelOne post office. The staff from TelOne were also involved in taking donated diesel to Pock Pie as well as providing security for the infrastructure as the community had to break into the sites for Econet. The staff also had to inspect the sister company NetOne's base station where they discovered that it had run out of diesel. However, the diesel only came later and had to be airlifted from a place called Skyline some 20 km away.

Although the right ICT infrastructure could be available, there still remains a need to make sure that the community of users accepts protocols of DRR and management, including early warning and calls for evacuation delivered through such. Asked to indicate the source of early warning for pending disasters households (n = 154) trusted and believed to be the most efficient from ten options, the radio announcement was voted first (40.91%). This was followed by a TV announcement (8.44%), SMS (6.49%) and social media

Fig. 6.10 TelOne temporarily fixed a line for Cyclone Idai victims. Source: Authors, fieldwork 2019

platforms (Twitter, Facebook, WhatsApp, etc.) at 2.60%. The remaining percentage was shared by word of mouth either from a relative, local headman or chief; or from local church or NGO and community-based organisations; or from the local school, government extension worker or councillor (these resources added up to 16.89%). The remaining share went to a warning from Meteorological Services Department or another responsible government agency (17.53%) and other sources (7.14%). The surprise finding herein is the low level of trust from an SMS, compared to the coverage of this ICT in the area of nearly 100% of at least a mobile phone per household.

The last potential battle in terms of ICT usage for DRR and management concerns the perceptions of the community members on when it is the right time to vacate after a warning has been issued. From the 156 households that responded to the question asking them at what stage they would be convinced that it is time to quickly move away from a disaster zone after a warning has been issued, 59.62% indicated that they would do so once they see clear signs of being in danger of injury or possible loss of life. An additional 26.28% were of the view that they would leave immediately after a government or councillor's warning. On the opposite side, only 0.64% indicated that they would not go anywhere, with the remaining percentage shared among three other reasons. Therefore, ICT readiness or not, the responsible authorities still need to work with communities in Chimanimani to raise awareness about the disaster and the need to move immediately as directed by the authorities through the platforms communicated to them as official.

6.5 Conclusion and Policy Recommendations

ICT readiness remains a pillar in DRR and management. However, there are clear gaps in ICT readiness for DRR at a national level as revealed by the unreliable electricity supply and the obsolete and outdated weather forecasting equipment. While it emerges that Zimbabwe has high mobile phone ownership, its use in DRR and management remains limited. While on average 89.4 inhabitants per 100 inhabitants have mobile phones, this figure was even higher per household in Chimanimani District with almost all respondents confirming at least one mobile phone per household.

Regarding platforms that conveyed Cyclone Idai news first, the radio remained the most common and trusted, followed by hearing from a neighbour, SMS message, WhatsApp and TV. Needless to indicate that there was also a sig-

nificant number of households that did not get the message at all. When Cyclone Idai hit on 15 March 2019 and deposited heavy rainfall over 2 days, ICT infrastructure was severely damaged, with near-complete blackouts due to grid electricity that went down. As a forest area, huge and mature trees were uprooted, many falling over electricity lines. The repairs took a long time, with the early repairs of some electricity lines completed only a month or so after the disaster. This had a secondary impact on the functioning of ICT infrastructure. One of the mobile service providers could not run its base stations on diesel as this proved too expensive. Hence, by the time fieldwork took place 8 months later, services had not yet been fully restored. The role of fixed telephone lines in DRR and management was elevated as the only service provider; TelOne continued offering free public calling facilities linking up relatives who were divested by Cyclone Idai. There were also limited internet facilities from the fixed telephone line service provider. The ICT infrastructure was indeed resilient to the disaster, although there were damages to the lines linking up the Ngangu Township and Kopa from Chimanimani centre. The damage to the infrastructure was unavoidable given the extent of destruction to the entire settlements in some areas there.

Moving forward, the chapter recommends that the government and other key stakeholders investigate and invest further in mobile phone platforms as this remains widely used by households. Government, particularly the ZMSD, should investigate the use of solar power at the head office premises in Belvedere, Harare. There is also a need to have the ZMSD operating on a 24-h cycle, at least during a disaster period such as Tropical Cyclone Idai. This means putting up complementary infrastructure and logistics such as accommodation and transportation in place. The use of satellite phones needs further investigation and deliberation, with the view to having modern brands, as those currently issued are too old. Lastly, ICT readiness or not, the responsible authorities still need to work with communities in Chimanimani to raise awareness about the disaster and the need to move immediately as directed by the authorities through the platforms communicated to them as official.

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7 Building Inclusive Disaster Management Systems: Opportunities and Constraints in Addressing the Needs of the Vulnerable

Felix Kwabena Donkor and Kevin Mearns

Abstract

Extreme events such as cyclones lead to massive loss of lives and properties and erode developmental gains. The projections of increasing frequency and intensity of extreme events may result in the creation of enduring disaster zones with displaced economies and populations, with disproportionate effects across the social strata. Disadvantaged groups including children, the elderly and the disabled bear the brunt of such events due to pre-existing challenges that exacerbate their vulnerability, thus requiring tailored measures in disaster situations to effectively address their needs. Despite the special protection that children and the disabled receive as stipulated in international human rights laws and standards, they are often ignored in disaster management. This study explores measures and interventions that can assist in achieving inclusive disaster planning and management with reference to the occurrence of cyclones in Mozambique. Qualitative methods involving literature studies are sued to shed insights on this theme. Overcoming the challenges to inclusion involves adopting rights-based approaches and mainstreaming vulnerable groups across all phases from planning to decision-making. Sound institutional collaboration in risk governance coupled with regular reiteration of risk mitigation measures and responsibilities is essential. Ultimately, given that cyclone-related losses have significantly reduced in developed nations due to improved management, Africa has an opportunity to develop tailored interventions that are best suited for its conditions. The study feeds into goal 10 of the 2030 Agenda for Sustainable Development that seeks to address inequalities together with those due to age, disability and opportunity amongst others.

Keywords

Disasters · Cyclones · Mitigation · Sustainable development · Vulnerable

7.1 Introduction and Background

Tropical cyclones are storms that originate from tropical oceans and rely on warm water for their source of energy (Chan and Kepert, 2015). Although there has been substantial progress in meteorological science, the knowledge about tropical cyclones including sophisticated warn-

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ing systems and effects of cyclones both in tropical and subtropical communities is still dire (Roux, 2020; Fedorov et al., 2010). This makes it necessary to reinforce mitigation measures to help limit the impacts of such disasters in vulnerable areas. Moreover, the physical attributes of tropical cyclones cause devastation through strong winds, surges and floods. The fatalities are often the outcome of surges and floods, collectively resulting in destruction of physical infrastructure, housing and resources. The destruction caused by wind is mediated by terrestrial features and land cover (Witvorapong et al., 2015; Virot et al., 2016).

The mammoth size of tropical cyclones is such that they easily overwhelm most terrestrial infrastructure and land cover (Knapp et al., 2010). *Inclusive disaster management frameworks are needed to safeguard the health and well-being of some of the most vulnerable in the society (*Pereira et al., 2017*) and "Leave No One Behind" in terms of disaster management. This chapter investigates the core factors in achieving inclusive disaster management systems. Cyclones and earthquakes are regarded as the most destructive disasters amongst natural phenomena (*Garnier and Desarthe, 2013*). Although there are sophisticated meteorological devices for monitoring these natural phenomena globally to caution vulnerable communities, it is critical to enhance preparedness.*

In the recent past times, cyclones like Katrina (USA), Jeanne (Central America and the Caribbean) as well as Nargis (Myanmar) unleashed incalculable destruction of infrastructure and led to numerous loss of lives (Knutson et al., 2019). It is estimated that around one million people lost their lives due to tropical cyclones over the last five decades (Grinsted et al., 2012). This has been attributed to several interacting factors including population escalation in susceptible areas and poor management measures amongst others. However, it is noteworthy that cyclone-related fatalities have diminished substantially in developed nations as a result of improved management measures. Nevertheless, cost implications of cyclones have significantly increased with Hurricane **Katrina's USD 100 billion bill**, regarded as the highest after its socio-economic impacts in New Orleans in August 2005 (Roux, 2020).

7.1.1 Socio-Economic Impacts of Cyclones

The most susceptible areas for tropical cyclone surges and flooding effects are low-lying plains and beach fronts along the coast. Interestingly, these areas are often the target of housing projects, tourism resorts, coastline resources and fishing establishments (Bender et al., 2010). Recovery is furthermore inhibited by household and community capital, resources and infrastructure. Social costs of cyclones involve the loss of lives and livelihoods, destruction of agricultural produce resulting in food scarcity and damage to essential health and education services (Knutson et al., 2019). Moreover, there are worsened economic indices as governments need to reconstruct destroyed areas and money budgeted for other development initiatives is now rechannelled to repair the destruction caused by the cyclone (Hoarau et al., 2012). The priorities of the community are disrupted as they shift from development to recovery. On the reverse, others argue that one advantageous social impact of cyclones is that they foster social cohesion as people unite to prepare for the cyclone and engage in recovery activities, thus forging new relationships (Hoarau et al., 2012).

7.1.2 Psychological and Environmental Consequences of Tropical Cyclones

Psychiatrists and psychologists argue that there are a wide range of experiential traumas which both victims and responders go through. These include grief, hopelessness, and social and psychological breakdown all contributing to the phenomenon of post-traumatic stress disorder (PTSD). Moreover, climate impacts are forecasted to increase in intensity and frequency

(Donkor et al., 2019; Nhamo and Agyepong, 2019). The destruction to the natural environment reduces landscape functions that support social well-being and cultural heritage (IPCC, 2012). There are also consequential impacts on agriculture (Donkor and Mearns, 2018; Donkor et al., 2020a), tourism destinations, fishing and building materials (Gonzales, 2020). It has also been observed that there are intangible socio-economic and ecosystem consequences where there is loss of species, weed invasion of new locations and migration of labour from income-generating activities to the restoration of the environment (Donkor and Mazumder, 2020).

Cyclonic winds have been observed to cause loss of animal habitats, disrupting and affecting ecosystems. Whilst flying debris can kill individuals and wildlife, there is considerable devastation of infrastructure including power lines, communication towers, bridges and roads (Gonzales, 2020). Cyclonic floods due to ocean water surges can cause drowning of people and wildlife and are often the cause of mass deaths in the event of a cyclone (Roux, 2020; Fedorov et al., 2010). Overflowing waters can destroy homes and buildings in the littoral zones. Flood waters can also devastate vegetation and cause surges into estuaries, destroying the plant and animal lives that exist therein (Gonzales, 2020). Erosion resulting from the powerful cyclonic windstorms can destroy prevailing vegetation and ecosystems causing places to become bare and susceptible to wind erosion. Moreover, the soil that is carried off into new places can destroy the local vegetation (Gonzales, 2020). Cyclonic storm surges can also result in erosion. Waves that extend the shoreline pull sand into the ocean, making the areas extensively eroded. This can destroy beach and dune ecosystems (Gonzales, 2020).

Every year cyclones, typhoons and hurricanes affect **dozens of countries** around the world. Losses of life and material damage are significant due to strong winds, heavy rains, large swells and storm surges. Hazardous phenomena are not only located on islands and coasts. Even mitigated, hurricanes often cause damage inland, through floods and landslides, sometimes hundreds of kilometres away from the ocean (Gonzales, 2020). This makes it imperative to localise sustainability in the context of such extreme events to be able to address them holistically (Mearns, 2012; Dube and Nhamo, 2020). The projections of increasing frequency and intensity of extreme events such as tropical cyclones may result in the creation of enduring disaster zones with displaced economies and diminishing populations, whilst rising intensity exacerbates the loss of lives. The youth tend to be more resilient and emigrate far from the disaster zone to find opportunities in different places to where the destruction has occurred (Pereira et al., 2017; Knutson et al., 2019). The elderly, being more predisposed to ill health and depression, are less resilient to recover from the effects of the cyclones (Tomokawa et al., 2018). Whilst the lessons learned from one disaster help prepare for future events, the experience of the events is probably distorted for everyone, as people select and construct their memories, and prioritise their actions, behaviour and responses (Tomokawa et al., 2018). Any individual has an incomplete and personal experience of a disaster, which affects the way in which they will interpret future warnings and information.

Ultimately extreme events like cyclones have a disproportionate effect across the social strata (Signé, 2017). Thus, some individuals are affected adversely as a result of pre-existing circumstances that affect their vulnerability. Some of the determining influences on people's ability to mitigate the effects of extreme events include gender (Sarrasanti et al., 2020), age, disability, race or ethnicity. It has been observed that women, children, the elderly and the disabled are amongst the most vulnerable and require tailored measures in disaster situations (Sithirajvongsa, 2017). Moreover, although the protection of vulnerable groups is promoted in several international human rights laws and standards, the special needs of vulnerable groups such as children and the disabled are often overlooked in disaster emergencies (Thanthathep, 2015). Furthermore, the fate of the disadvantaged in disaster emergencies has received a dearth of research. This study helps bridge this gap by con-

tributing knowledge on measures that can be adopted to better secure and address the peculiar needs of vulnerable groups such as children and the disabled. This has become urgent as the frequency and impact of extreme events have become more pronounced in Africa as demonstrated by cyclones Idai and Kenneth. The study employs the study of literature on the occurrence of cyclones in Mozambique to shed insights on this topic. The complicated nature of such extreme events calls for a concerted effort by all key stakeholders to ensure a holistic approach to addressing such events (Fig. 7.1).

This includes robust collaboration policymakers, institutions and civic society to foster resilient communities in the larger framework of an inclusive and sustainable development aligned with the SDGs (Fig. 7.1).

The need to ensure that vulnerable populations on the continent are adequately protected and not discriminated against is important to the continent's inclusive development whilst addressing social inequalities (Fig. 7.1). Moreover, it contributes to the Sustainable Development Goals (SDGs) and the African Union's Vision 2063. Furthermore, the recent COVID-19 global lockdowns have highlighted the need for tailored local interventions that address resilience in the absence of external support. This makes it imperative to explore local policy interventions that can adequately address some of the continent's pressing challenges such as this theme. The study commences with the broader problem of the study encapsulated in the study background, which is further detailed in Sect. 7.1. A theoretical framework is used to frame the context of the study which leads to the methods employed to prosecute the objects of the study. This is followed by the main findings and discussions of the finding. Issues addressed include mainstreaming vulnerable populations' (e.g. children and the disabled) needs in disaster planning, relief and

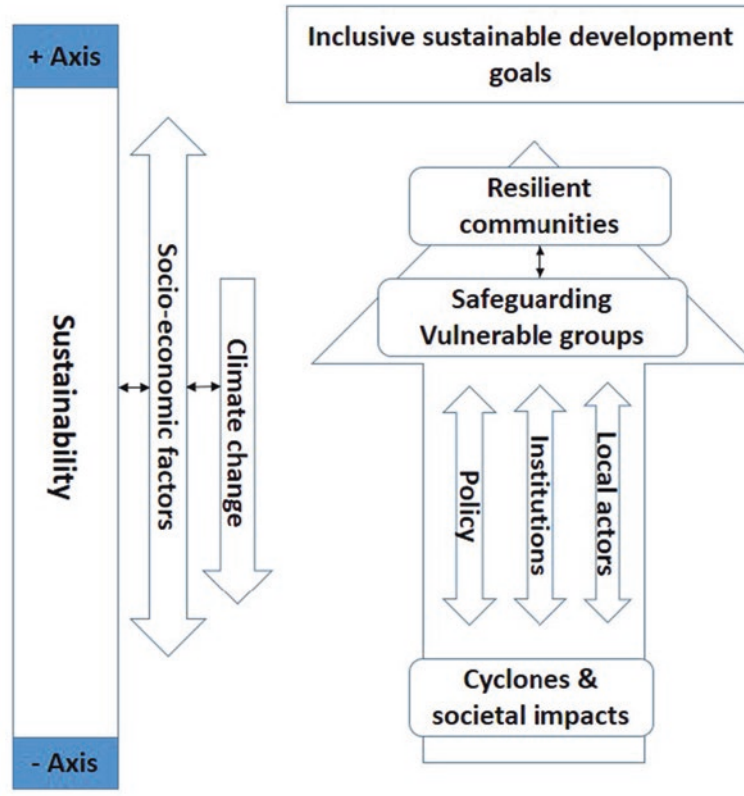

Fig. 7.1 The nexus of cyclones and sustainable development. Source: Authors

recovery from climate-induced extreme events, reinforcing physical infrastructure and compliance with land-use planning, disaster awareness and education. Ultimately, this helps answer questions on main factors affecting the inclusivity of disaster management in the African context with reference to cyclones such as Cyclone Idai in Mozambique.

7.2 Materials and Methods

The port city of Beira (Fig. 7.2) in Mozambique is located on the mouth of the Pungwe and Buzi River along Longitude 34° 50' E and Latitude 19° 51' S. Beira bore the brunt of the Cyclone Idai that hit the country on March 14, 2019. The cyclone caused severe torrential rains, powerful windstorms and massive floods in south-eastern Africa particularly Mozambique, Malawi, Zimbabwe and Madagascar costing in excess of $1 billion (Oxfam, 2020). The majority of communities were under water, all communications lines were interrupted, and there were huge losses of lives and displacement along with the destroying of a number of buildings in Beira (World Vision, 2020). It was estimated that 90% of the area was totally devastated with most of the communities being inaccessible. The area has a populace of circa 500,000 who were forced to seek refuge in makeshift relief camps, built by government and managed by humanitarian organisations (UNOCHA, 2019). A cholera outbreak affecting more than 2000 individuals in the aftermath of the crisis further complicated humanitarian efforts (World Vision, 2020). The storm exacerbated prevailing infrastructural problems like poor roads filled with potholes and litter as well as lack of maintenance of its buildings (Oxfam, 2020). Cyclone Idai left in its aftermath a serious food crisis, as a projected 700,000 hectares of farm produce was destroyed. The enormity of Beira's desolation highlights the susceptibility of areas undergoing accelerated urban growth devoid of sound planning. Rising sea levels and climate change are all factors that led to the disaster (World Vision, 2020).

The theoretical framework for the study stems from socioecological systems theory. Natural systems and social systems are individually complex in their own respect. In addition, many of our environmental and social challenges entail the further intricacy of interaction between social and natural systems (Berkes, 2007). This scenario comes in the face of mounting evidence of the profound impact of human-related factors as drivers of environmental change. Thus, there has been increased demand for creative forms of cross-disciplinary collaborative approaches to tackle social and environmental issues in-depth (Berkes et al., 2003). This has resulted in several concepts with such attributes including socioecological systems (Halliday and Glaser, 2011). These social-ecological systems are intricate adaptive systems consisting of many diverse human and non-human elements that interact. They adapt to fluctuations in their environment and their environment changes as a result (Halliday and Glaser, 2011).

An *impact* refers to a rapid unforeseen event, whilst the impact area connotes the location which has high probability of bearing or has suffered the whole impact of a disaster, thus requiring core life-saving and emergency operations. Furthermore, *mitigations* comprise the activities employed ahead of a disaster seeking to limit or avoid its effects on society and environment. *Vulnerability* on the other hand is a result of being prone to loss and hurdles to the ability to be restored, whilst the ability to gain complete restoration from a catastrophic impact is regarded as resilience (King and Anderson-Berry, 2015). Ultimately, *disaster risk reduction* (DRR) is a systematic method for detecting, evaluating and limiting the hazards of a disaster. It seeks to minimise socio-economic vulnerabilities to disasters and address the ecological and other threats that cause them.

This study is premised on the *case study* approach. Literature and theoretical studies are vital qualitative methods of drawing insights into related thematic areas under consideration (Creswell, 2013). The case study approach of qualitative research was employed in this study. Case studies are utilised as empirical valuations

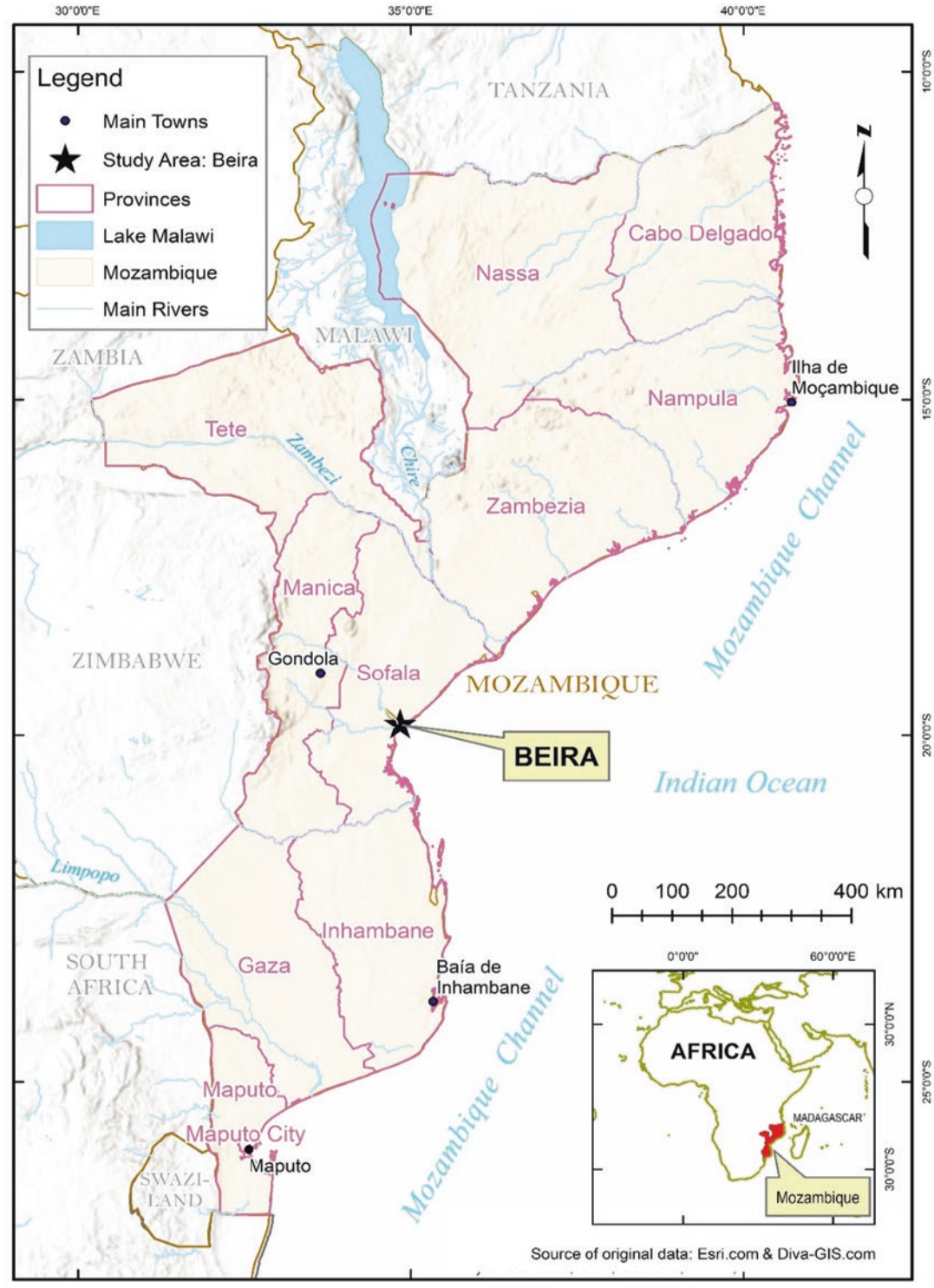

Fig. 7.2 City of Beira and its position in Mozambique and Africa

of contemporary phenomena within real-life settings; when the differences between phenomenon and context are unclear; and in which diverse sources of evidence are used (McCombes, 2020). The case study technique was therefore used to afford profound insights on the nexus of disaster management and vulnerable groups which is the study focus and makes possible the making of valid generalisations.

Additionally, a literature review enables a critical analysis of the current state of scholarship on a phenomenon of interest within a particular time frame (Ralph et al., 2014). Some core documents were scrutinised to draw insights on the diverse thematic areas of this study from websites such as ScienceDirect, Google Scholar and Web of Science. These include publications from the United Nations Office for Disaster Risk Reduction (UNISDR), *Sendai Framework* for Disaster Risk Reduction 2015–2030 (*Sendai Framework*) and Sustainable Development Goals (SDGs). Hence, scientific articles and journals were perused as the core literature sources in the scholarship review process largely within a 10-year period. Systematic searches were conducted on scientific databases like ScienceDirect to gather data on several themes. The searches were structured around specific keywords such as "*Disaster management*", "*Inclusivity*", "*Vulnerable groups*" and "*Cyclone impacts*" which were paired with *Boolean operators* such as *AND* as well as *OR*. Examples of such searches include *Disaster management and vulnerable groups and Cyclone impacts on vulnerable groups amongst others.*

Through a thematic content analysis, the core themes stemming from the literature were pieced together into similar paragraphs by way of *meaning condensation*. Meaning condensation denotes a summarisation of repetitive themes into terse formulations (Creswell, 2013). The meaning condensation technique to analysis involves five core steps: the whole of a selected text is first assessed to enable a comprehensive overview; the *meaning units* are recognised by the researcher; the key thematic areas as per the meaning unit are paraphrased succinctly; the meaning units are then cross evaluated; ultimately, the critical themes of the overall text are merged to compose a descriptive statement (Torraco, 2016).

7.3 Results and Discussions

7.3.1 Creating Room for Kids in Disaster Management

Children are impacted by disasters annually across the globe. The UNISDR (2011) states that children bear the brunt of disasters annually and encourages their involvement in disaster risk reduction activities. Children, particularly in poor nations, suffer disproportionately from burdens caused by disasters such as cyclones. Such burdens can further exacerbate social inequalities and be counterproductive to the SDGs particularly SDG 10 of reducing inequalities as well as the notion of Leave No One Behind. Moreover, children can be proactive partners contributing to disaster risk reduction activities such as those related to cyclones (Pfefferbaum et al., 2018). Their involvement comes with a number of advantages such as improved personal development and problem-solving, survival skills, self-esteem, leadership and teamwork skills. Such measures reflect the Sendai declaration on disaster complexity and its acknowledgement that achieving the framework depends on concerted collective efforts by all stakeholders.

Ultimately, children's involvement facilitates children's overall development by giving them experiences on accepting and adapting to change (USDHHS, 2017). For affected communities, there is the ripple effect of conscious citizens, enhanced social cohesion and disaster readiness. Knowledgeable and engaged children can be adept than those without information and uninvolved to protect themselves and others. Children are, therefore, resources that can be nurtured and organised for disaster readiness, response, rescue and resilience. Stakeholders have to consider methods to adequately integrate children into disaster risk reduction (Pfefferbaum et al., 2018). Such child-centred disaster management is an integration of disaster management and chil-

dren's rights (Sillah, 2015). UNICEF (2019) estimates that over three million people were in need of emergency humanitarian assistance in the wake of Cyclone Idai with children accounting for more than half of those directly impacted. The sheer size of children victims shows that this group needs to be prioritised in future cyclone management planning. Moreover, their training will ensure that a sizeable portion of the population is informed about disaster preparedness. The lack of a child-centred disaster planning could have been the cause of children in Beira being found shocked and helpless in the images following the cyclone event.

7.3.2 Engaging with the Needs of the Disabled

Disabled people comprise 7–10% of the global populace (Alexander, 2015). In the event of disasters such as cyclones, disabled people are faced with physical impediments, communication challenges and other obstacles to access basic services. Thus, disability-inclusive disaster management has gained currency in core international guidelines on disaster management (King et al., 2019). However, disabled people are seldom engaged in the disaster management cycle and tend to be disregarded in all stages (Twigg et al., 2018). Challenges with accessing resources and non-compliance with building codes further worsen the plight of the disabled in disasters (Alexander, 2015). Sensitisation, fighting prejudices and stereotypes will limit vulnerability and lead to enhanced performance in disaster management.

Disabled people's vulnerability in disasters is a function of their impairment, surroundings, societal and institutional framework and culture. Policies often consider their vulnerabilities to the detriment of experiences and resources for coping with hazards and disasters (Stough et al., 2017). The disabled are overlooked in the sharing of warnings prior to a disaster; accessing evacuation paths and refuge centres is challenging; requisite care and refuge centres are absent; and they are often disregarded in emergency response (Twigg et al., 2018). Additionally, disabled people have a higher likelihood of being without employment, socially excluded and sidelined from decision-making practices and residing in harmful settings devoid of basic services. Consequently, the "leaving no one behind" agenda underscores a holistic approach to realising sustainable development for everyone including the disabled. Although disability is referenced in the SDGs several times, the dimensions pertain to growth and employment, inequality and access to human settlements, coupled with data collection and monitoring of the SDGs. The United Nations' #Envision2030 in working to facilitate the integration of disability in the operationalisation of the SDGs encourages coupling these factors to safeguard the disabled.

Disasters such as cyclones can be a substantial source of long-lasting injuries and impairments and can further worsen pre-existing challenges (Twigg et al., 2018). Relief organisations seldom integrate disability in their assessment of measures and there is a dearth of knowledge on the long-term recovery pathways of the disabled (Stough et al., 2017). Relief agencies' accounts indicate that several disabled people in the countries affected by Cyclone Idai were jobless and relied on well-wishers to fend for themselves. The cyclone devastated the livelihoods of the well-wishers who support the disabled, indirectly worsening their plight. This highlights the need for tailored livelihood programmes for the disabled to address their peculiar needs and help limit their vulnerability (UNOCHA, 2020). Moreover, to transform the disability inclusion rhetoric into meaningful action demands supportive approaches, structures and frameworks amongst stakeholders. Engagement in decision-making is regarded as a core problem by disabled people. Disabled people are marginalised in emergency preparation and programming by their governments, especially at the local levels (Kett et al., 2018). The problem of marginalisation and corporation has to be dealt with prior to the occurrence of the disaster or emergency. This includes enhancing the representation of the disabled in decision-making structures at all levels and partnering with them (Zayas et al., 2017).

Nevertheless, it is important to address social norms and discriminatory practices that exclude the disabled access to social networks and other sources of support (Alexander et al., 2015; Le Masson, 2018).

7.3.3 Displacement

A look at the narrative on migration in the aftermath of Cyclone Idai highlights questions of disadvantage and social class. Migration was widespread especially in the disadvantaged groups and people residing in highly populated locations of Beira (Fig. 7.2). Similar patterns were observed after the incidence of Hurricanes Katrina and Rita (Myers et al., 2008). Although the influence for people's decision to leave a place is complicated, financial challenges are significantly correlated with relocation to areas with better opportunities (Alexander et al., 2015). The destruction of homes is a trigger for displacement, but disadvantaged groups such as the blind are unlikely to reside in secure homes. The loss for such groups becomes complicated by the destruction of their fragile livelihoods with implications for further social inequality (Selby and Kagawa, 2014).

It is noteworthy that the social welfare scheme in many countries on the continent including Mozambique is not robust enough to adequately cater for the needs of such vulnerable groups. This makes it critical for the African Union (AU) or regional groupings such as the Southern African Development Community (SADC) to develop a continental or regional policy framework, respectively, that will guide member states in policy formulation regarding the needs of disadvantaged groups. This is because after the tragic loss of lives, there are also lingering social impacts that continue to impact affected communities long after a cyclone (Boon et al., 2011). In the immediate aftermath of Cyclone Idai, several children were said to have been separated from their families whilst many others were allegedly missing or unaccounted for in the following months (UNOCHA, 2019; Oxfam, 2020). Such an experience can result in significant separation anxiety coupled with the psychological distress of becoming an orphan. This is a pointer for developing strong local counselling and trauma management for the region and continent.

Examples from other extreme events show that at least 300,000 learners were separated from their homes and communities after being evacuated in the aftermath of Hurricane Katrina (Peek and Fothergill, 2006). The displacement following a cyclone impacts the disabled as well as children. Scenes from Beira after Cyclone Idai showed how schools were completely damaged and the educational infrastructure was devastated. However, schools are very critical to the recovery of learners from associated psychological trauma (Boon et al., 2011; Boon and Pagliano, 2014). It has been observed that the school environment facilitates children's coping mechanisms and restores them to some form of normalcy. Although the penetration of the insurance industry in many parts of Africa is low, the continent's profile as a climate hotspot is an opportunity to develop innovative insurance schemes that can provide some relief from climate-induced extreme events such as cyclones which are forecasted to increase in frequency and intensity on the continent. This can range across building insurance schemes for critical infrastructure such as schools and hospitals inter alia.

7.3.4 Triaging Tropical Cyclone Hazards

Successful mitigation of the dangers related with tropical cyclones is a cross-disciplinary and multi-institutional activity involving civic organisations, government agencies, non-government organisations and grassroots groups (Ayonga, 2016). The physical infrastructure in coastal areas and other vulnerable locations needs to be reinforced with the introduction of strict building codes and construction of defences like sea walls and levees. Some argue that the presence of such measures should be considered temporary and that they cause communities to rather become complacent (Brown et al., 2018). Nevertheless, the construction of defences reinforces buildings to survive high winds and

localised flooding. This makes it imperative to enhance enforcement and compliance to safeguard vulnerable communities. This needs to be coupled with effective land-use planning for sustainable urban development (Green et al., 2011). For Africa this scenario also points to the need to experiment with novel building materials and methods that are more adapted to our local conditions and facilitate resilience to such extreme methods in the framework of appropriate technology (Ayonga, 2016). Effective mitigation also includes enhanced disaster preparedness. Weather agencies and emergency services have roles to play in communication, warning, sensitisation, preparations and education. Contemporary education hence needs to make sustainability an important component given its importance for sustainable development (Donkor et al., 2020b). Communication not only includes preseason sensitisation campaigns but also embraces mitigation, response and recovery. Furthermore, the media is a crucial partner in spreading knowledge and warnings and keeping the community abreast with developments. The media as partners in this regard will have to be involved in training on the reportage of such events and the ethical dimensions of sensitive reporting and ethical implications regarding vulnerable groups.

7.3.5 Policy Formulation on Vulnerable Groups and Disaster Management

Policy content and dissemination have an influence on policy implementation (Dinham and Scott, 2000). Moreover, policy implementation is enhanced by an efficient coordination and ownership amongst core key stakeholders coupled with the proactive support of central government. This is necessary for the scaling up of disaster risk reduction (DRR) measures (Kahwa, 2014). It is critical in addressing the peculiar needs of the vulnerable that core bottlenecks are addressed. These include ambiguous policies, poor leadership, poor evaluation frameworks, lack of human resources and inadequate public-private collaborations (Kanyasan et al., 2018). In the case of Cyclone Idai, the absence of leadership in emergency response from the central government is often cited as a cause for the delay of relief efforts and prolonged suffering of victims. However, it is also arguable that the Government of Mozambique may not have the capacity to deal with such an event and could have been faced with resource constraints as a poor nation. Nevertheless, this also points to the need to explore local or indigenous knowledge related to disaster management and couple them with modern interventions for relevance and effectiveness. Additionally, it highlights the point that in Africa especially, all stakeholders need to be proactive and do their part. For learners it is vital for schools to mainstream DRR topics such as cyclones and have a disaster assembly point on their premises (Killion, 2015). Learners' awareness of prevention and response measures must be facilitated through textbooks and capacity-building or training programmes involving their teachers. The school curricula must incorporate disaster risk reduction and simulation exercises (Lim et al., 2016). Learners will also have to become familiar with the contacts of emergency services. Teachers' experiences have an influence on learners and the exchange of experiences between teachers is a viable means of enhancing their knowledge and ultimately transferring this to their learners. The exchange of experiences and lessons can be facilitated via exchange platforms such as academic exchanges and site visits, to enhance skill development and capacity building in DRR and cyclone management (Montagu and Bloom, 2009; King and Anderson-Berry, 2015). Cyclone-related policies will however have to be backed with proactive management to be fruitful (Rice, 2010). Studies from countries such as Laos highlight some core strategies for enhanced cyclone disaster recovery interventions. This includes boosting institutional knowledge, capacity building and clear institutional mandate and harmonisation. Furthermore, the absence of a national legislation and practical guidelines on DRR has been observed to be a core hurdle (Saito et al., 2015). In some instances, this challenge has been cited as resulting in ambiguous mandates which compromised stakeholder ownership and affected awareness creation (Donkor et al., 2017) of policies.

7.4 Conclusion

Vulnerable populations form a significant subset of the global populace whose needs deserve focus on disaster management frameworks. Consequently, key global policy documents such as the Sendai Framework and the SDGs acknowledge the complexity of disaster management and emphasise the need for concerted collective efforts by all stakeholders. Holistic approaches in disaster management are gaining global currency and need to guide local measures to engender effective tailored interventions. This includes enhancing the enforcement and compliance to land-use planning and building codes to safeguard vulnerable communities. Furthermore, building materials and methods that are more adapted to local conditions in the framework of appropriate technology need attention. This has to be coupled with disaster awareness and training to improve mitigation, response and recovery. For example, learners' disaster awareness and education can be facilitated through textbooks and capacity-building or training programmes (Donkor et al., 2018) involving their teachers. Social and demographic changes are core issues exacerbating hazard vulnerability, thus requiring robust governance measures. This includes enforcement and compliance of building codes to mitigate cyclone effects whilst securing development gains. Effectiveness of mitigation measures will need close institutional collaboration in risk mitigation coupled with regular reiteration of risk mitigation measures and responsibilities. Critically vulnerable groups like the disabled and children have to be mainstreamed in the entire process and play proactive roles in enhancing inclusivity in disaster management interventions.

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8 The Africa We Want and Extreme Events: Insights from the Nexus of COVID-19, Cyclones, Floods and Continental Sustainability

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Abstract

The Sustainable Development Goals (SDGs) serve as a global blueprint for attaining an enhanced and more sustainable future for all. Such goals are reflected in key global policy documents including the African Union's Agenda 2063. However, socio-economic development globally is often interjected and/or sometimes truncated by disasters that cause substantial social chaos. This compromises sustainable development and is a matter of urgency as developmental gains are reversed with grave consequences for developing nations with scarce resources. Thus, the nexus between sustainable development and disaster management has gained currency. Moreover, climate forecasts indicate increasing intensity and frequency of disasters as highlighted by the prevailing COVID-19 pandemic as well as spikes in floods and cyclones in Africa. This study employs literature reviews to investigate some of the core themes that are being highlighted by the COVID-19 pandemic and echoed in the rising spate of cyclones and floods on the continent's disaster management landscape. The study demonstrates that in charting a future pathway for robust local disaster management; continental sustainability in the post-COVID era should prioritise risk-informed development, enhanced early warning systems and timely response/preparedness. Moreover, it is important to give focus to enhancing local health systems, improving awareness creation to overcome the spread of misinformation and reinforcing governance frameworks in general. Moreover, given the unparalleled scale and impact of the COVID-19 on all aspects of contemporary socio-economy, it is important to assess its impact on core development agenda to tailor robust policy measures that will reinforce disaster management and safeguard continental sustainable development.

Keywords

Pandemic · Climate change · Sustainable development · Disaster management · COVID-19 · Africa

8.1 Introduction

Disasters are regarded as integral risk factors in the dynamics of development and sustainability (UNISDR, 2015; Donkor, 2020). This is because disasters such as cyclones and floods can devastate

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a developing area, causing irreparable socio-economic challenges (Pereira et al., 2017) on affected communities. Moreover, a developmental project can improve or exacerbate the potential of a natural disaster, through their impacts on social vulnerability and background ecological system (Twigg et al., 2017). Through the studying of the dynamics of disasters, crucial knowledge is garnered that enhances resilience and disaster preparedness. A robust understanding of the intricate interaction between development and natural disasters is crucial for safeguarding developmental dividends. Thus, sustainable development is regarded as integral to public policy, given that the ultimate objective of development (in general) is the enhancement of human well-being (Sarrasanti et al., 2020) and ecosystem conservation. Such ideals are equally reflected in key policy documents such as those of the African Union and other global institutions.

The African Union's Agenda 2063 (The Africa We Want) revolves around a set of seven aspirations which come with individual goals to facilitate its vision for the year 2063. These seven aspirations underscore the continent's ambition for shared prosperity and improved well-being, for a united and integrated continental union of free citizenry and extended horizons, where the optimum potential of women and youth is attained, and with freedom from fear, disease and want (African Union, 2020). In addition, Agenda 2063 under its aspiration 1 envisions "A prosperous Africa based on inclusive growth and sustainable development" espousing the desire for eradicating poverty in one generation and building shared prosperity through the socio-economic transformation of the continent. The goals underpinning aspiration 1 include (African Union, 2020):

- A high standard of living, quality of life and well-being for all
- Well-educated citizens and skill revolutions underpinned by science, technology and innovation
- Healthy and well-nourished citizens
- Transformed economies and jobs
- Modern agriculture for increased proactivity and production
- Blue/Ocean Economy for accelerated economic growth
- Environmentally sustainable climate and resilient economies and communities

Disasters such as the prevailing COVID-19 pandemic (Donkor and Mearns, 2020) as well as associated floods and cyclones intersect with such goals and come with consequences on progress made towards their attainment. Cyclones and floods ultimately unleash devastating socio-economic impacts on society. Moreover, climate forecasts indicate increasing frequency and intensity of extreme events (Donkor et al., 2019; Tantoh et al., 2020). Climate change is implicated in the occurrence of the coronavirus crisis as well as the rising spate of cyclones and floods. The Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) stress that nature is being degraded (Tantoh and Mckay, 2020) globally at unparalleled levels in human history—and the rate at which vulnerable species are facing extinction is equally alarming (Díaz et al., 2019; Bridgewater et al., 2019). Moreover, the health of humans, animals and ecosystems is intricately interconnected (Masson-Delmotte et al. 2018). Biodiversity hotspots which are prime tourist attractions are equally becoming spaces where some of these multifaceted challenges are animated (IUCN, 2020). This includes the escalating agricultural frontier (Donkor et al., 2020) and human intrusions into pristine natural areas for logging, mining and other activities that has translated into further habitat loss and fragmentation, increasing contact between human and wildlife and growing exploitation and trade of wild animal products (IUCN, 2020). These serve as channels for the spread of diseases from wildlife to humans who have little or no resistance to them, with the novel coronavirus being the most extensive in its spread and following the patterns of similar zoonotic pandemics, like SARS, MERS and Ebola (IUCN, 2020). Such scenarios are also observed in the incidences of cyclones and floods. Climate-induced cyclones such as Idai and Kenneth with an epicentre in Mozambique ravaged much of

Southern Africa including Zimbabwe and Malawi amongst others. Furthermore, heavy torrential rains in Malawi, Mozambique and Zimbabwe wreaked significant havoc across Southern Africa, causing massive displacement and destruction of livelihoods in an area suffering from chronic poverty and food insecurity (Donkor and Mearns, 2018a, b). The challenges ensuing from the aftermath of such cyclones and floods have now been projected on a macroscale by the prevailing COVID-19 pandemic. This makes it imperative to consider core issues impinging on the continent's effective disaster management to help develop local resilient systems for future occurrences (Pereira et al., 2017). Moreover, it has become necessary to localise sustainability in the context of such extreme events to be able to address them holistically (Mearns, 2012; Dube and Nhamo, 2020).

In recent times, several disciplines such as international development, disaster risk analysis, macroeconomics and public policy have subjected the disaster-development nexus to increasing research focus (Albala-Bertrand 2013; Mochizuki et al., 2014). Moreover, the dynamic theoretical and qualitative implications of disaster risk on developmental prospects have gained widespread recognition (IPCC, 2012). The unique social-ecological environments in which disaster risks emerge are very complicated, as well as their short-term and future consequences. Moreover, the notion of development is similarly multifaceted (Ebhuoma et al., 2020). Given that several climate forecasts and studies point to the increase in frequency and intensity of extreme events in the near future, providing more insights into the dynamic interaction of the disaster-development nexus is necessary (Mochizuki et al., 2014).

8.2 Theoretical Background of Disaster Risk Management

Hypothetically, the dynamic relationship between vulnerability, hazards and disasters is considered as manifesting in three core phases (Blaikie et al. 1994):

- Remote causes: a number of underlying societal elements that work together to create and sustain vulnerability.
- Dynamic pressures: this refers to a number of conditions that drive or direct the impacts of negative cause into insecure environments. This includes an absence of basic social services or amenities or a result of a number of macro factors.
- Unsafe conditions: this phase is the vulnerable setting where individuals and/or properties are exposed to disasters.

In addition, the record of disasters worldwide shows some patterns with poor nations being worst affected (by way of loss of lives due to their high vulnerability). For example, out of the whole population of people worldwide with exposure to natural hazards like earthquakes, floods, droughts and cyclones, merely 11% are located in nations with a low Human Development Index (HDI). However these nations are disproportionally accountable for 53% of total disaster casualties between 1980 and 2000 (UNISDR, 2009). Furthermore, an assessment of the shared burden of economic losses demonstrates that an increase in people and assets along disaster-prone areas in both economies translates into escalated financial losses in those nations. In modern times some of the most costly disasters in absolute terms have been recorded in both advanced and emerging economies.

Notable examples include Hurricane Katrina in 2005 occurring in the United States ($125 billion), as well as the 2008 Sichuan Earthquake observed in China ($85 billion). Furthermore, Japan's Great East Tsunami in 2011 ($210 billion) as well as the 2011 Floods in Thailand ($40 billion) also present more cases (Mochizuki et al., 2014). Furthermore, small islands and low-income nations, especially, are disproportionately susceptible to natural disasters owing to their poor capacity to cope with large external shocks impacting the economy (World Bank, 2013). It has therefore been acknowledged that some of the most costly disasters in comparison to GDP include the 2010 Haiti earthquake (167% of GDP) and Grenada's 2004 cyclone (149% of

GDP). Other poignant cases include the 2005 floods in Guyana (56% of GDP) as well as the 2004 Maldives earthquake and tsunami (45% of GDP) (Mochizuki et al., 2014).

The poor financial capacities of such nations as evidenced by the poor public fiscus and limited insurance penetration of several low-income nations are a core issue. Moreover, the erosion of vital assets due to natural disasters can immensely affect wealth accumulation and growth potential (Mechler, 2009; World Bank, 2013). Moreover, given that such nations are also largely dependent on foreign aid, enhanced disaster management is crucial to safeguard developmental dividends. As several incidences of crises in general such as cyclones and floods have demonstrated, years of developmental investments could be eroded by frequent occurrence of natural disasters (UNISDR, 2009; World Bank, 2013). Cyclone Idai, Cyclone Kenneth, floods and now COVID-19 have occurred in rapid sequence in some areas. However, these impacts of repeated disasters on household vulnerability and resilience over time are some of the less understood topics of disaster and development linkages (Mechler, 2009; Mochizuki et al., 2014). This makes the comprehensive understanding of the disaster-sustainable development imperative and its implications for the LNOB (Mochizuki et al., 2014). Moreover, a core theme in the SDGs is the need for knowledge generation to inform policy and forming of robust partnerships to drive sustainable development. Given the unique scale and impact of the COVID-19 pandemic since the Spanish Flu a century ago, it makes it necessary to study the social consequences to inform policy.

The disruption in the continent's productivity is a threat to its sustainable development agenda and affects progress towards both the Sustainable Development Goals (SDGs) (Donkor et al., 2017) and the African Union's Agenda 2063 or The Africa We Want. This situation that has been caused by the prevailing COVID-19 crisis and reflected in the incidences of floods of cyclones presents a unique challenge but also an opportune moment for the continent to develop and enhance its disaster management capabilities. This study considers some of the key themes that are being highlighted by the COVID-19 pandemic which point to related challenges in disaster and emergency management, and charts a way forward for a local resilient disaster management infrastructure. Such challenges have been equally echoed in the rising spate of cyclones and floods on the continent, albeit on a microscale which further highlights the urgency of this theme. Moreover, given the unparalleled scale and impact of the COVID-19 on all aspects of contemporary socio-economy, it is important to assess its impact on core development agenda to tailor robust policy measures that will reinforce disaster management and safeguard the continent's sustainable development. This chapter thus throws the spotlight on this theme and its socio-economic implications with a focus on the impact of COVID-19 as well as cyclones and floods. It has been observed that issues bordering on economic and institutional factors like corruption and public expenditure are often given importance over considerations like environmental challenges, societal vulnerability (Donkor et al., 2018) as well as human development concerns (Mochizuki et al., 2014).

8.3 Materials and Methods

This study is conducted from the *case study* approach. Literature and theoretical studies are critical qualitative techniques for drawing insights into associated thematic areas under investigation (Creswell, 2013). The case study approach in qualitative research was utilised in this study. Case studies are utilised as empirical assessments of contemporary phenomena in real-life contexts; when the differences between phenomenon and context are not clear or seem ambiguous; and in which multiple sources of proof are employed (McCombes, 2020). The case study technique was therefore used to facilitate insights on the nexus of disaster management and the continental development agenda (Agenda 2063) which is of focus and enables the making of valid generalisations.

In addition, a literature review permits critical analysis of the current state of scholarship on a

theme of interest within a certain time frame (Ralph et al., 2014). Some important documents were perused to appreciate the current scholarship on the diverse thematic areas of this study from scholarly websites such as ScienceDirect, Google Scholar and Web of Science together with popular science media articles on the topic which had been subjected to review such as from the *Conversation Africa*. This includes publications from the African Union on the Agenda 2063, the Sendai Framework, the United Nations Office for Disaster Risk Reduction (UNISDR), Sendai Framework for Disaster Risk Reduction 2015–2030, the Organisation for Economic Co-operation and Development (OECD) and experts in the field amongst others. Thus, scientific articles and journals were studied as the principal information sources during the literature review framework mainly within a 10-year period. Systematic searches on scientific databases such as Google Scholar and Web of Science were utilised to harness data on diverse thematic areas of the study. The searches were premised on specific keywords such as "*Covid-19*", "*Cyclones*", "*Floods*", "*Agenda 2063*", "*Sustainable development*" and "*Disaster management*" which were coupled with *Boolean operators* such as *AND* as well as *OR*. Typologies of such searches include *Disaster management and Covid-19, Sustainable development and extreme events,* and *Cyclones and floods in Africa* inter alia. The article publication period was largely within a 10-year frame. A principal inclusion criterion was that selected articles had to relate with disaster management, or extreme events such as cyclones and their interaction with sustainable development. Thus, articles that were not related with these thematic areas were excluded.

By way of the thematic content analysis, the principal themes emanating from the literature were stringed together into common paragraphs through *meaning condensation*. Meaning condensation refers to the summarisation of repetitive themes into succinct formulations (Creswell, 2013). The meaning condensation method of analysis embraces five main steps: the entirety of a chosen text is first evaluated to afford a comprehensive overview; the *meaning units* are identified and isolated by the researcher; the principal thematic areas as per the meaning units are then paraphrased concisely; the meaning units are then juxtaposed; ultimately, the core thematic areas of the entire text are merged to formulate a descriptive statement (Torraco, 2016).

8.4 Results and Discussions

The impact of a disaster like a flood or a cyclone can cause extensive havoc in urban development by devastating local infrastructure, houses and injuring or causing the deaths of numerous individuals. This can compromise the ideals of the sustainable development goals in terms of building resilient communities amongst others. Moreover, the social and economic set-up of a society is a core determining factor of the susceptibility of the population to the consequences of disasters. This informs the variances in the effect of disasters and environmental emergencies across the entire global populace. To appreciate the several factors in the framework of the African Union's Vision 2030 that have the capacity to affect its disaster resilience and compromise its sustainable development, the core issues highlighted by the COVID-19 pandemic as well as the incidences of cyclones and floods are analysed in the context of remote causes, dynamic pressures and unsafe conditions (Blaikie et al. 1994).

8.4.1 Risk Communication, Stigmatisation and Overcoming Disinformation

Effective communication is critical to successful efforts in combating disasters. It is essential to produce translated tailored messages such as that relating to COVID-19 awareness materials into local languages and disseminating via ubiquitous platforms such as radio programs, and publications on billboards (WHO, 2020a, b). Public distrust, misinformation and disinformation have emerged as key challenges in combatting COVID-19 on the continent and globally (Chen,

2021). In many instances, this has been attributed to extensive dismissal of burgeoning cases as solely *infections of international travellers*, *illness of the elite* and an *avenue for siphoning* relief funds amongst others. Furthermore, conspiracy theories have been rife in the pandemic being propagated from diverse traditional and online media outlets (Chen, 2021). This has led to the phenomenon of an "infodemic" as described by the World Health Organization. This has translated into cases of non-compliance with lockdown regulations such as self-isolation and social distancing guidelines. In the prevailing corona outbreak, there has been widespread cases of individuals being reluctant to undergo tests because of the fear of becoming victims of stigmatisation by the community.

In some cases this can be attributed to residing in densely populated areas that make them unable, or in other cases utter disdain for health guidelines and thus becoming sources of spread for their households and communities. In addition, it has been acknowledged that patients frequently fail in presenting themselves to the medical services in time (WHO, 2020a, b). These practices have been argued to undermine the effectiveness of containment interventions rolled out by governments on the continent (Ugwu et al., 2020), with negative implications for coordinating both misinformation and fact-checking capacities (Weismueller et al., 2020). This points to the need to engage with core media outlets to address the challenge of COVID-19 misinformation akin to the World Health Organization's dialogue with key social media platforms to collaborate and help combat what the United Nations has referred to as a global *infodemic* (Weismueller et al. 2020).

It is also argued that in combatting misinformation, it is vital to engage with a large spectrum of independent and transparent fact checkers to limit the possibility of bias. Ultimately, one of the most viable courses of action is for government and online platforms to enhance their awareness creation with regard to false claims and improve on their effective fact-checking capabilities. This is important for combating negative propaganda and amplifying healthy messages and communication. Such measures characterise remote causes and dynamic pressures critical in safeguarding human life, especially vulnerable groups from the human security angle (Ishiwatari et al., 2020).

Moreover, grassroots organisations have critical roles in disaster management, and risk information that is buttressed by scientific information is indispensable (Chen, 2021). This points to the need to partner with local traditional media channels prior to disasters to circulate accurate information. This helps overcome rumours, misinformation and false information on social media which usually proliferates before, during and after disasters and emergencies. Moreover, although such malicious material cannot be eliminated, first-responder organisations can employ diverse measures and interventions to offset bad information. Furthermore, evidence from disaster management indicates that various organisations deserve focus on coordinating to effectively address misinformation to reinforce disaster management. Finally, sustainable development is compromised when disasters are left to undermine economic growth and social progress (UNISDR, 2019).

Daniels (2019) in assessing the challenge of misinformation in the Cyclone Idai aftermath gives some interesting pointers. There is the critique that having age-old journalists who are specialists writing about particular areas like science and education has become rare (Daniels, 2019). Moreover, roles such as editing articles and fact checking for truth have been largely sacrificed. This has led to an upsurge in erroneous publications. Furthermore, social media is in part filling the gaps left by traditional media. However, it has created an avenue for misinformation, malinformation (disinformation with malicious intent) propaganda and general falsehoods (Daniels, 2019). This contributed to the spread of fake news on social media concerning Mozambique, Zimbabwe and Malawi in the wake of the devastating Tropical Cyclone Idai. It is also argued that due to the poor coverage of the floods, news consumers had to resort to foreign news channels in lieu of local media for a true picture. Media companies will have to handle the shift to digital media properly to play their role effectively as information gatekeepers.

8.4.2 Fragile Health Systems

A key issue in the nexus of COVID-19 implications for cyclones and floods is the need to reinforce local health systems. The WHO reports that a country like Somalia is ranked 194th out of 195 on the Global Health Security Index with the local health infrastructure destroyed by years of civil conflict (WHO, 2020a, b). Furthermore, it is critical to increase the number of qualified health professionals. It is noteworthy that global benchmark for healthcare workers is 25 per 100,000 people, but a country such as Somalia is currently recording 2 healthcare workers per 100,000 people (WHO, 2020a, b). It is regarded as one of the worst prepared nations globally with the requisite capacity in detecting and reporting epidemics, or in executing a swift response that can aid in the mitigation of additional spread of disease (WHO, 2020a, b). It has become clear that there is a need to improve local capacities for screening, infection prevention and control, as well as surveillance whilst simultaneously boosting containment and mitigation measures. There are lessons to learn from other pandemic situations both in Africa and Asia such as those of the Ebola and SARS outbreaks, where there were several riots and civil unrests, with health professionals and public officials being subjected to attacks when they visited local communities. It is argued that such civil disobedience and public outrage are common when people are convinced that local authorities are not living up to the responsibilities and are to be blamed (Hoffmann et al., 2020). Nevertheless, this scenario further complicates the unsafe environment dimension of disaster management.

Moreover, in many countries on the continent such as the Democratic Republic of Congo (DRC), the outbreak is a grave challenge. This is because the country is already in the midst of other epidemics such as the second most lethal Ebola outbreak, the worst measles outbreak globally and prevailing cholera outbreak (Kasumba, 2020). In view of the largely fragile nature of healthcare systems on the continent, the COVID-19 comes as a further strain on already poor health infrastructure. Some of the principal hurdles have been widely acknowledged in the unfolding pandemic on the continent that include the lack of infrastructure, equipment, funds and requisite information (Kasumba, 2020). This is also mirrored in past emergency recovery efforts in the aftermath of cyclones and floods. However, a poignant observation in the COVID-19 pandemic is that the traditional development partners, that countries on the continent have been known to depend on in past crises, including disease outbreaks and disasters, are equally struggling (in some cases overwhelmed themselves) by COVID-19 pandemic. The continent is therefore largely forced to lead and manage its reaction to the pandemic with limited operational contribution from its traditional development or international partners (Kasumba, 2020). This may be an opportune time for the continent to develop and reinforce its disaster management capabilities to cope with such future incidences. This includes capacity building in disaster risk awareness, disaster financing and disaster risk reduction (OECD, 2019) tailored to local conditions amongst others.

Another key challenge with local disaster management systems has been the poor institutional capacities with forecasting, prevention and preparatory measures against principal public health dangers (Kahn et al., 2019). The continent has been awash with foreign perspectives and insights on life-saving approaches as well as treatment protocols. But it cannot afford to be utterly dependent on approaches developed in foreign nations given its unique diversity and location. Local medical research and debate would have been highly enriched with Africa's contribution in this regard. For example, countries on the continent such as the Democratic Republic of Congo (DRC) have been vital in conducting trials that have produced highly acclaimed Ebola virus treatments and vaccines. However, the same cannot be said of the COVID-19 pandemic with the exception of South Africa. The absence of robust institutional support for the development of science and research has largely translated into lack of insights premised on lessons from the Ebola experience. These lessons would have been helpful in con-

ducting research trials to provide vital local solutions to other diseases and pathogens that will benefit the global community as well. Africa needs to address its failures in this regard and enhance its health and emergency systems for the benefit of the future (Kasumba, 2020).

However, evidence from the continent's handling of the crisis indicates that this is far from the truth as health systems are being overrun by the COVID-19 pandemic (de Villiers et al. 2020). This can be attributed to a number of factors. Governments on the continent have failed to invest adequate resources to equip national health systems with the improved laboratory services, health capacities, conducive working environments and sponsorship for biomedical education, research and development (Kasumba, 2020). The academic, scientific and civic communities are also key stakeholders who need to assume greater influence and roles in effectively communicating and advocating with governments and the general populace. It is undeniable that a drastic change is essential to transform the continent's public health systems as well as its capacities for preventing and responding to disease outbreaks more effectively (Kasumba, 2020). The continent needs to invest more in developing a well-coordinated and enabling scientific and innovative research infrastructure. Such a system is critical for the continent to better understand its problems, therefore aiding in developing the requisite preventive, responsive and developmental measures that will facilitate its local immediate and future needs (de Villiers et al. 2020). The possibility of the continent weathering the storm from the COVID-19 pandemic and harnessing the opportunities presented will depend on its ability to innovate and react. Its capacity to engage in objective introspection assessing its performance, learn from past mistakes and introduce reforms will steer its eventual success. It would have been anticipated that given the continent's several decades of experience in managing previous viral outbreaks, its related infrastructure and disaster management systems would be in a strong position to cope with the present pandemic such as spontaneously developing and performing surveillance and testing. Furthermore, it would not be out of place in hoping that institutions would be dependent and guided by research to take evidence-based interventions. But the pandemic has exposed the continent's fault lines in disaster management and preparedness, which echoes events from cyclones Idai and Kenneth.

Cyclone Idai caused hundreds of thousands to be cut off from healthcare and other essential services. In Malawi, Zimbabwe, Madagascar and Mozambique, damaged facilities were in need of rehabilitation. Mobile clinics had to be set up to access persons cut off from aid and medical and logistical supplies (Kahn et al., 2019). A cholera outbreak and spread of waterborne diseases due to the poor sanitation further complicated relief efforts (Cambaza et al., 2019). However, these are capital-intensive activities and the COVID-19 pandemic has further dried up the funding opportunities and sustained humanitarian assistance. It has become necessary to consider how public health interventions help mitigate the debilitating impacts of disasters (Makanga et al., 2017). In addition, policy must address how disasters impact individuals' decision-making regarding critical health behaviours. This will help tailor risk-coping measures, to help community members manage in the aftermath of serious disasters and limit disaster-induced poor health decision-making.

8.4.3 Governance and Management of Emergencies

The rate of infection of the COVID-19 has stimulated heated debates about government responses worldwide, highlighting effectiveness of measures and unintended consequences (de Villiers et al., 2020). In many settlements on the continent, the lack of residential planning has resulted in densely populated cities, which provide the conducive conditions for the rapid spread of COVID-19. Such dynamic pressures in disaster management have been exacerbated by related issues such as population escalation, poor healthcare systems and accessibility, and high levels of poverty amongst other socio-economic factors. Our African institutions can only be robust when

the citizenry is proactive and remains involved in public life to hold public officials accountable. The World Bank in a bid to promote good governance globally has introduced *voice and accountability* as amongst six indicators it considers in assessing its worldwide governance index. This index considers the perspective of citizen engagement in the election of government, coupled with other factors such as freedoms of expression, association and media. The prevailing challenges brought about by the COVID-19 outbreak have thrown the spotlight on weak and strong governance systems across the globe (de Villiers et al., 2020). Countries that have received global commendation for their COVID-19 responses such as Norway and New Zealand have been observed to score high marks on the index whilst countries that are argued to have not performed in managing the pandemic such as Brazil and the United States are further down the list (Hoffmann et al., 2020). Rallying around a common cause, such as the fight against the COVID-19, can serve to unite people. In the case of Africa it is a chance to develop a blueprint to fighting disasters on the continent, developing local infrastructure and allocating sufficient resources to this objective. It is critical for the continent to sufficiently address such challenges without being overly dependent on external aid (Hoffmann et al., 2020). This is also critical to ensure that public officials are held accountable through different means including social activism. Governments that lose credibility will fail in effectively marshalling the requisite goodwill and shared resources required to successfully fight the pandemic. Moreover, it has been observed that credibility is immensely crucial in terms of the power of persuasion, which is one of the principal avenues available to governments to encourage behavioural change due to the pandemic situation (Hoffmann et al., 2020). This is very important given that the absence of any officially effective drug in combatting the COVID-19 pandemic makes behavioural change very critical in the dynamics of the pandemic. In many areas embroiled in violent conflict, healthcare workers are faced with the threat of violence. Several healthcare workers have been killed in Somalia caught in the cross-fire between state security and insurgent groups (WHO, 2020a, b). Furthermore, in a country like Somalia that is already battling the effects of the worst locust outbreak in a quarter of a century, this has exacerbated food insecurity and led to the declaration of a state of emergency in February. The locust infestation has intersected with heavy floods that translated into the displacement of more than 500,000 individuals and nurtured the conducive atmosphere for the breeding and flourishing of locusts (WHO, 2020a, b). In addition to these challenges, the COVID-19 pandemic further worsened the situation in a nation that is confronting several grave threats to its development, including terrorist organisations which seized large sections of its remote areas and pervasive corruption in the nation (WHO, 2020a, b).

Fighting corruption is a key factor in the framework of governance. There has been several cases of abuse of emergency COVID-19 funds across the continent with unscrupulous officials and businesses looting resources meant to fight COVID-19. This includes high-level cases in Kenya, Nigeria, Somalia and South Africa amongst others. This has caused the World Health Organization (WHO) to slam such actions and describe it as "murder" of vulnerable people. In Somalia, not long after the first cases of COVID-19 were recorded, ten high-level public officials were issued warrants of arrest on fraud charges (WHO, 2020a, b). Anecdotal evidence indicates a possible change in the aid relationship between the Global South and the Global North. It is argued that several traditional Western donors are reconsidering the role of aid even as they protect their individual national interests. It is noteworthy that four principal global development policies and targets were unveiled in 2015 including the Paris Agreement, the Addis Ababa Action Agenda on Financing for Development, the Sendai Framework for Disaster Risk Reduction and the 2030 Agenda for Sustainable Development. The international development agenda currently embraces several targets on poverty alleviation, economic cooperation and ecosystem which is transforming the dynamics of aid. This is crafting a fresh narrative that integrates aid with climate change and humanitarian

crises, providing an avenue to recalibrate the future of North-South relations (Nhamo and Agyepong, 2019; Banik and Hegertun, 2020). The introduction of the development goals has reinforced the narrative that the task for attaining sustainable development lies equally on all nations downplaying the rich-poor country dichotomy. African nations can learn from their South-South cooperation partners such as China and India and nurture cost-effective, available and adaptable technologies whilst building a track record of solving developmental challenges which has proven largely elusive in the framework of development diplomacy (Banik and Hegertun, 2020). This has become urgent in the face of increasing debt burdens leading to African nations asking for debt relief in the midst of the COVID-19 pandemic. This makes it imperative to promote and strengthen good governance and liberal values (Banik and Hegertun, 2020). This will help build community resilience and bottom-up efforts towards sustainability as the complex picture of Cyclone Idai and COVID-19 becomes clearer.

The intersection of COVID-19 and Cyclone Idai has further worsened the plight of already vulnerable communities and livelihoods in the Southern African region. For example, the $72 million Zimbabwe Idai Recovery Project (ZIRP), which was set up by the Zimbabwean Government and development partners, is facing immense pressure (OCHA, 2021). The ZIRP was set up to rebuild lives and livelihoods through diverse forms of support towards trade, boosting the local economy and bolstering agriculture. However the impact of the COVID-19 pandemic has been such that the activities of the ZIRP have been disrupted with no further flow of cash from partners, who are equally suffering from the economic meltdown (OCHA, 2021). Moreover, foreign experts who were helping at the beginning are unable to travel due to the COVID-19 travel restrictions. Beneficiaries of agricultural inputs could not sell their produce due to health containment measures which prohibited movement and selling their wares in the open. This condition has compromised the disaster resilience which was envisaged and the partnerships with local communities. The over 240,000 beneficiaries of support through the programme are left helpless as the organisations that were assisting are themselves struggling to survive (OCHA, 2021). Communities like Chimanimani and Chipinge, which bear the brunt of Cyclone Idai, are now in disbelief as the signs of recovery seem to be slipping with the impact of COVID-19 (OCHA, 2021). This situation points to the need to give attention to community-driven infrastructure restoration projects to help build resilience at the community level. Another critical issue is to address the disproportionate effects of these twin disasters on vulnerable groups such as women and girls (Sarrasanti et al., 2020). Continental sustainability in the post-COVID era will need to foreground risk-informed development, reinforce post-disaster coordinating and build stakeholder capacities in managing disaster risk. There is also an urgent need to enhance monitoring and targeting mechanisms across scales to facilitate prevention, early warning and timely response. Informed decision-making is critical to reinforcing resilience and facilitating disaster preparedness.

8.5 Conclusion

Creating a conducive environment to facilitate continuous development is critical to the ideals of sustainable development including the African Union's Vision 2063. This is because the development gains that benefit the poorest and contribute to not leaving them behind can be eroded. Disasters such as that brought about by the ongoing COVID-19 pandemic as well as recorded cyclones and floods affect a number of key socioeconomic indices critical to human development and social advancement such as public health and education amongst others. This is counterproductive to the goals of the continent's steady attainment of the SDGs in general and the LNOB in particular. However, times of crises also provide unique opportunities. Continental sustainability in the post-COVID era will need to foreground risk-informed development, reinforce post-disaster coordinating and build stakeholder capacities in managing disaster risk. There is also an urgent need to enhance monitoring and targeting mecha-

nisms across scales to facilitate prevention, early warning and timely response. Informed decision-making will be critical to reinforcing resilience and facilitating disaster preparedness. In addition, policies must address how disasters impact individuals' decision-making regarding critical health behaviours. This will help tailor risk-coping measures, to help community members manage in the aftermath of serious disasters and limit disaster-induced poor health decision-making. Given the prominence of traditional media sources such as radio and television, their capacity building and support will be crucial. Moreover, the transition to digitisation by traditional media channels will need to be enhanced and social media influences engaged in public information. Media companies will have to play their role effectively as information gatekeepers. Additionally, the COVID-19 crisis and incidences of disasters such as cyclones and floods have thrown the spotlight on creating robust local solutions including remote learning and enhanced guidelines on human-environment interactions amongst others for the benefit of sustainability. Nevertheless, the pandemic has highlighted the need to prioritise the needs of vulnerable groups such as women, the aged and the disabled in disaster situations. In this regard, a rights-based approach to disaster management will help address the exacerbated social inequalities and related challenges due to disasters. In charting a future pathway for robust local disaster management, it is important to give focus to enhancing local health systems, improving awareness creation to overcome the spread of misinformation and reinforcing governance frameworks in general.

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9 Challenges and Opportunities of Implementing the SADC Legal and Institutional Framework for Disaster Risk Reduction During Cyclone Idai: Case of Zimbabwe and South Africa

Beauty Vambe, Amos Saurombe, and Leon Rodney Kenny

Abstract

In March 2019, Mozambique, Malawi and Zimbabwe were hard hit by Tropical Cyclone Idai resulting in loss of lives, livelihoods and damage to infrastructure. Drought, flooding and cyclones are on the increase in the Southern African Development Community (SADC) and their destructive trail threatens SADC's common agenda of trade liberalization through regional economic integration. This chapter focuses on Zimbabwe and South Africa's intervention measures against the adverse effects of Tropical Cyclone Idai. The main problem is that SADC member states appear unprepared to mitigate the adverse effects of tropical cyclones. The chapter questions the extent to which Zimbabwe and South Africa used the legal provisions of the SADC Treaty of 1992, the Hyogo Framework of Action (2005–2015) and the Sendai Framework for Disaster Risk Reduction (SFDRR) (2015–2030) to manifest regional cooperation in disaster risk management. The chapter argues that if SADC member states continue failing to detect vulnerability from natural disasters, this will prevent the region from effectively building a culture of resilience for disaster risk reduction and management. The chapter recommends that SADC member states should adopt vulnerability and resilience approaches to enable their countries to better understand the scope and violent behaviour of extreme weather events such as tropical cyclones.

Keywords

SADC · Legal framework · Cyclone Idai · Risk · Vulnerability · Mitigation · Resilience

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9.1 Introduction and Background

A significant number of natural disasters have been witnessed in the SADC. The African Development Bank Group (2019: iv) notes that

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"Southern African Region's climate is highly variable, with frequent floods, droughts, cyclones and other related disasters that have increased in frequency and intensity, particularly in Mozambique, Malawi and Zimbabwe." These natural disasters destroy human life and livelihoods and damage infrastructure such as roads, bridges and buildings. According to Mavhura (2018: 72) the main challenge posed by natural disasters is that many vulnerability drivers causing these natural disasters in the SADC "[a]re often hidden and remote from triggering events, and as such they need to be analysed using approaches that unpack the nonlinear interactions."

However, the approaches used to understand and frame the scope, severity and impact of natural disasters on SADC countries differ just as the responses, which are not the same, by these countries to those natural disasters. Additionally, the region's economies are not at the same levels of economic development (Viljoen, 2014). Furthermore, the legal and institutional frameworks for disaster risk reduction (DRR) and management are not well or effectively developed to the same levels of sophistication to enable a member state to effectively mitigate the shocks from natural disasters (Gathii, 2011). Saurombe (2017:353) notes that most SADC countries do not have adequate transit facilities such as well-maintained roads and bridges. He says: "if South Africa is removed from the equation, the whole SADC region shows the poor state of road, rail and aviation networks that is also poorly regulated." Road networks and related infrastructure remain relevant in DRR and management as such are needed during and after the tropical and other disasters hit. Good infrastructure enables first responders to access disaster-prone and/or affected areas faster. Hence, poor infrastructure is likely to undermine the ability of affected individual member states and their neighbours to respond rapidly in order to reach people in areas affected by flooding, drought or cyclones.

Most SADC member states seem not to have put in place internationally accepted benchmarks and norms of DRR methods such as early warning systems (EWS). Neyer and Wolf (2005: 45) suggest that countries whose physical infrastructure and legal frameworks for disaster risk management do not match or align to international standards and norms can be considered a form of "initial non-compliance and compliance crisis." For the critics, initial non-compliance

> may occur as a result of a member state's lack of the necessary resources, financial and human, to implement regulations and directives, a consequence of an elastic or ambiguous rule or obligation… a lack of effective monitoring capacity, and [sometimes] a deliberate process on the part of the member state to avoid the cost of compliance (Fagbayibo, 2012: 70).

Non-compliance to following established protocols of DRR and management may not be manifested openly by a member state. Mangena (2013) has shown that depending on the reactive or proactive ways of dealing with the challenges posed by natural disasters, a member state may adopt one or two or all the three DRR paradigms, namely, hazard, vulnerability and resilience. In the 1930s, the hazard paradigm promoted the view that hazards were disasters per se, and as such they could not be prevented (ibid.). This perspective promoted disaster legislation that enabled people to cope with disaster rather than building resilience in the people to view disaster as complex, changing in forms but whose negative effects could be mitigated. In the vulnerability paradigm, natural hazards have varying impact on different communities. "As a result numerous frameworks and conceptual models were developed to advance the vulnerability theory, practice, policy and legal applications". The vulnerability paradigm is inbuilt in the SADC Treaty Art 5 and mentioned in the SADC Protocol on Transport and Meteorology and therefore is of relevance to this study in so far as the vulnerability might have informed South Africa's approach to the challenges posed by the Tropical Cyclone Idai in Mozambique, Malawi and Zimbabwe (Chatiza, 2019).

On the other hand, Bowles et al. (2016:1) acknowledge the essence of the vulnerability paradigm, but they emphasize the significance of the resilience paradigm. In their view "community resilience is the existence, development and engagement of community resources by commu-

nity members to thrive in an environment characterised by change, uncertainty, unpredictability and surprise." Additionally, resilient communities are "… able to respond to unexpected, and unwelcomed events in ways that enable the groups and individuals to work together to minimize the adverse consequences of such crises." The resilience paradigm is very relevant to this study. This is so because the framework is informed by a philosophy in which the community has the capacity to own, control and mitigate disasters that threaten them and their livelihoods. The shift from focusing on the "natural" towards the human capacity to adapt or change the course or full impact of a disaster confers on affected communities the power to mitigate the impact of natural disasters through DRR prior plans. Mavhura (2016) notes that the resilience paradigm emerged in the 2000s. This followed some lessons from the implementation of International Decade for Natural Disaster Reduction (IDNDR) (1990–1999). Resilience was then popularized through the International Strategy for Disaster Reduction adopted as the Hyogo Framework of Action (2005–2015) focusing on building the resilience of nation and communities to disasters (ISDR 2005). To this end, highlighted international legal and institutional frameworks have become the key instruments for ensuring that DRR and management become a national and local priority that have strong institutional basis.

Given the foregoing, this study seeks to determine the extent to which the SADC Treaty provisions empower member states to protect their citizens from unexpected disasters arising from climatic changes. Art 5 (a), (g) and (i) of the SADC Treaty aim to "promote sustainable and equitable economic growth and socio-economic development that will ensure poverty alleviation, enhance the standard and quality of life, achieve sustainable utilization of natural resources and effective protection of the environment, and combat HIV/AIDS or other deadly and communicable diseases." The SADC Treaty amendments are further supported by the creation of databases such as the Development of the Inventory of the Disaster Risk Management (DRM) Status, Resources and Services, and Implementation of DRM Programmes in South Africa. Its main objective is to enhance national and regional capacities in respect of DRR, management, and coordination and support of humanitarian assistance. The coordination of this programme is undertaken by the Secretariat (Art 15). The SADC Treaty does not specifically mention the types of natural disasters that might undermine the member states' common agenda of trade liberalization through economic integration. However, Art 22 (1) empowers states to "conclude such protocols as may be necessary in each area of co-operation which shall spell out the objectives and scope of, and institutional mechanisms for, co-operation and integration." SADC member states are responsible for implementing the legal and institutional framework for DRR in their respective territories. In March 2019, Mozambique, Malawi and Zimbabwe were directly affected by the Tropical Cyclone Idai. This study is limited to analysing how Zimbabwe and South Africa used their legal and institutional framework to enable the two countries to deal with the negative effects brought about by the Tropical Cyclone Idai and in the period after the disaster.

9.2 Methodology

Three research questions were raised for this study as follows: (1) What are the provisions of the SADC Treaty, the Hyogo Framework of Action and Sendai Disaster Risk Reduction regarding the prevention, mitigation and building of resilience communities against the unforeseen negative impact of natural disasters such as the Tropical Cyclone Idai on the lives and livelihoods of the SADC citizens? (2) To what extent were Zimbabwe and South Africa's legal and institutional frameworks prepared to address the problems brought to Zimbabwe, Mozambique and Malawi by the Tropical Cyclone Idai? (3) What lessons were learnt and how can the gaps in the legal and institutional frameworks of Zimbabwe and South Africa be addressed to mitigate the impact of tropical cyclones that are becoming more intense?

This desktop study relies on interpreting international statutes such as the Hyogo Framework

of Action, the provisions of the SADC Treaty and its amendments, and the laws governing SADC member states' national legislation on DRR as primary sources. Scholarly works, commissioned reports and proceedings from conferences provide the basis of secondary sources that reveal the changes occurring in understanding DRR in academia. Most SADC member states appear to have adopted insights from scholarly work, particularly those works in which any natural disaster is invariably conceptualized as hazard, vulnerability or an opportunity to emphasize the building of community resilience or capacity to absorb shock. This methodology reveals that countries in Southern Africa have embraced and applied a historical approach/paradigm that is based on the periodization of the understanding of disasters as hazard, vulnerability and resilience at different times before and during Cyclone Idai. This is in line with the view that building community reliance is a flexible process in which "communities should be encouraged to use any tool or process rather than struggling to find a perfect tool" (Bowles et al., 2016, 1).

In addition, a systematic method employed in responding to the impact of disasters should consider the period before and during Cyclone Idai disaster and the post-disaster period. This might enable us to estimate, quantify and probe the effectiveness of the legal instruments used by Zimbabwe and South Africa to mitigate the effects of Idai. In addition, drawing from neighbour countries will likely reveal the methods of interventions, and where and what forms of assistance the two countries could command to deploy. The descriptive, analytical and interpretive approaches are used in this current study to reveal the extent to which the SADC legal and institutional provisions and mandates on DRR inform or enable the operationalization of the risk governance structures and contingency plans of Zimbabwe and South Africa during Cyclone Idai. Sound infrastructure, availability of resources or lack thereof, levels of a country's economic development, flexibilities built in the legal and institutional frameworks, smart partnerships for disaster risk reduction management and political will (World Economic Situation Prospects, 2020) are increasingly being considered as significant drivers in the management/mitigation of natural disasters.

A comparative study of how Zimbabwe and South Africa framed the disaster induced by Cyclone Idai is crucial in identifying the spaces of vulnerability (Pourazar, 2017, 2) or forms of risks and explaining critically the different methodologies used by the two countries to mitigate the negative impacts arising from Cyclone Idai. Zimbabwe was directly impacted, while South Africa played a crucial role in mitigating the negative impact of Cyclone Idai in both Mozambique and Zimbabwe. On the one hand, how disasters are framed can influence or determine or indicate the kind of political will power needed by the affected people, needed to build community resilience. Framing a disaster "can clarify what the problem is, and suggests how policy intends to address the disaster" (Chipangura et al., 2017, 2). On the other hand, how disaster is framed also reveals other factors at play during DRR, such as the degree of [un]preparedness, and the extent to which the affected community had built resilience. Correct framing of a disaster can point to the gaps that need to be addressed in order to create proactive synergies between the existing legal and institutional frameworks for DRR and the actual hard work of implementing disaster management plans.

9.3 History and Patterns of Natural Disasters in Zimbabwe Since 1980

Zimbabwe is increasingly becoming susceptible to natural disasters. Between 1982 and 2012 the top ten natural disasters in Zimbabwe were of a hydro-meteorological and epidemic nature (Mavhura, 2016). These include drought, flooding and spread of gastrointestinal tract infectious diseases such as cholera, diarrhoea and typhoid. Drought and flooding have affected the livelihoods of people, animals and plants resulting in famine. Tongogara refugee camp, which is home to nearly 19,000 refugees from the Democratic Republic of Congo and Mozambique, was hard

hit (Chapungu, 2020). Flooding has destroyed infrastructure such as roads and bridges, making it difficult to reach affected communities on time. Flooding brings with it waterborne diseases which have wreaked havoc in Zimbabwe. These natural disasters occur periodically, but sometimes singly or in a combination these have visited Zimbabwe and affected economic development (ibid.). Coupled with the economic meltdown of Zimbabwe between 2000 and 2020, Zimbabwe's economy and her capacity to absorb the shock of major disasters were significantly compromised.

Two cyclones affected Zimbabwe since 2000 and these are Cyclone Eline (2000) and Cyclone Japhet (2003). Unlike the "traditional" and sometimes localized disasters such as drought and flooding already known to Zimbabweans, and to a large extent understood by the local population, Cyclone Eline and Cyclone Japhet represented natural disasters of a massive scale and their negative impact on the lives of locals was far reaching. Mavhura (2016, 609) points out that "Cyclone Eline induced floods in the northern lowveld of Zimbabwe that left 120 people dead, 250 000 people affected and approximately USD7.5 million in economic loses…thereby creating financial stress on the already poor people."

Huge floods induced by Cyclones Eline and Japhet also spread gastrointestinal tract infections (GTIs) such as cholera, diarrhoea and typhoid that could be linked to the 2008/2009 death of 4000 people in Zimbabwe long after the cyclone had passed. The more cyclones become frequent in Zimbabwe, the more the intensity of their destruction is felt in the lives of Zimbabweans. In this context of vulnerability of Zimbabwe to natural disasters, Cyclone Idai made its landing in Chipinge and the Chimanimani areas in the eastern border with Mozambique. Cyclone Idai hit Zimbabwe between the 15th and 17th March, 2019. According to Chatiza (2019), the cyclone brought heavy rains and strong winds that induced flooding, landslide and destruction of human and animal lives and property. This resulted in the "loss to life, damages to homes, fields, schools, and roads and destruction of livelihoods. Areas in Chipinge and Chimanimani were hit hardest. Seven other districts in Manicaland, Masvingo and Mashonaland east were also affected" (2019, 5). Cyclone Idai killed 340 people in Zimbabwe, destroyed crops and washed away homes. Bridges and roads were severely damaged, making it difficult to render assistance to affected people. These problems were compounded with the arrival of coronavirus disease 2019 (COVID-19) in post-Cyclone Idai Zimbabwe. In Mutare, near the Zimbabwe's eastern border with Mozambique, at Nyamatanda camp, Zimbabweans who survived the cyclone were dying from COVID-19 (s). The magnitude and intensity of destruction of humans and livelihood in Zimbabwe by Cyclone Idai beg the question regarding legal and institutional framework of the country's DRR. In order to better understand how such destruction could happen when Zimbabwe has a functioning disaster risk reduction management system, we need to analyse the country's "disaster legislation" (Mavhura, 2016). The key components of Zimbabwe's legal and institutional framework are discussed next.

9.4 Zimbabwe's Legal Framework to Mitigate the Effects of Cyclone Idai

Before 1980, Zimbabwe's (then Rhodesia) DRR was referred to as civil defence and continued to be administered under the Civil Defence Act (1982). The Civil Protection Act (CPA) (Chap. 10:06) was enacted in 1989, and then revised in 1992 and 2001 (Government of Zimbabwe 2009). The legal structure had catered mainly for a minority white settler population during the liberation war (Civil Protection Act: Acts 5/1989, 3/1992, 3/2001). As provided for in the Civil Protection Unit (1989) central government initiates hazard reduction measures through coordination with relevant sector ministries with the local administration tasked with implementing the disaster management plan. This means that the DRR follows a top-down process since a disaster has to be declared by the head of the state following numerous reports from provincial, district and local authorities. This is a time-consuming process that might take several days

to a week, within which time the burden of initiating DRR falls on the locally affected people, who often do not have necessary funds, skills and authority to access certain areas affected by disasters. The reactive in-built components of the civil protection legislative framework for disaster management in Zimbabwe were designed prior to independence in 1980, when the country was not facing the types of disasters like cyclones (Chatiza, 2019).

Within the CPA is the Civil Protection Organisation (CPO) that provides the legal framework for disaster management and directs provinces, districts and local authorities to protect the citizens, through the use of a National Civil Protection Fund (NCPF) to make finances available for protection activities (Bongo & Mangena, 2015). In 2004, a bill was put before parliament to reveal some sections of the CPA and introduce other new structures as it had become apparent that the types of disasters Zimbabwe had become prone to like drought and flooding whose severity of destruction of human life and property was increasing were becoming more frequent (United Nations Environment Programme 2009). The bill proposed to replace the CPA with the Emergency Preparedness and Disaster Management Act (EPDMA) which amongst other things would:

- Develop a risk reduction strategy to minimize vulnerability to natural, man-made and technologically induced disasters
- Establish and integrate early warning systems for emergencies and disasters
- Promote research in DRR
- Establish funding for disaster management
- Capacitate local authorities to manage and mitigate disasters as first responders (Betera, 2011)

On paper, the objectives of the EPDMA sound solid in building preparedness and community resilience to unexpected disasters. However, as the African Development Bank Group notes, in reality, the Civil Protection Act is still a weak legal and institutional framework to use in mitigating the negative impact of cyclones. Cyclone Idai wrecked greater havoc leading to loss of lives, injuries, displacements and damages to infrastructure and property in Zimbabwe (Africa Development Bank Group, 2019, iv).

The Civil Protection Unit (CPU) of Zimbabwe is legally empowered by the Civil Protection Act (1989) to work with other stakeholders such as multinational entities, non-governmental organizations and traditional rural/urban authorities (Chatiza, 2019, 8). Other civil organisations such as the Environmental Management Authority (EMA) also are mandated by the CPA to provide relevant data regarding early warning systems for impending disasters that might destroy human lives and threaten the environmental ecosystem. In addition, the outcomes of the December 2012 and November 2013 workshops on the Zimbabwe National Contingency Plan prioritized imminent disasters such as flooding, drought and GTIs. All these legislative initiatives in existence in Zimbabwe are in line with the expectations of the Hyogo Framework of Action (HFA) and SADC Treaty provisions on the environment and disaster management.

In addition, Article 3 of the International Law Commission (ILC) defines disaster as calamitous events or series of events resulting in widespread loss of life, great human suffering or distress, or large-scale material or environmental damage, thereby seriously disrupting the functioning of society. The ILC also states that the negative implications of disaster to any country should not prevent the affected community from receiving bona fide assistance on the basis of preserving the doctrine of non-interference in the affairs of individual states. Accordingly, in terms of Art 9 of the ILC, it is the affected state that by virtue of its sovereignty has the duty to ensure the protection of persons and provision of disaster relief and assistance over its territory. However, under Art 11, the provision of disaster relief and assistance requires the consent of the affected state. Once states are in agreement on a common agenda, it is legally expected that such states remain bound by the said agreement.

From the above description of international statutes available to CPA in Zimbabwe, clearly, it is not the lack of existing and supportive legal frameworks that accounts for the "failure" of the CPA to effectively mitigate the impact of Cyclone Idai. In fact, the Civil Protection Act (1989) of Zimbabwe is supported by a raft of international and regional legal and institutional frameworks to implement effective DRR management processes both before an anticipated disaster such as Cyclone Idai or in the post-management of the negative effects of Cyclone Idai on human life and the environment. Therefore, to explain why the Civil Protection Act could not adequately address the vulnerabilities of humans, property and animals in Chipinge and Chimanimani district areas on the eastern border with Mozambique from the negative impact of Cyclone Idai in March 2019, it is imperative to discuss the gaps, weaknesses precipitated by officials and natural impediments that the legal framework could not and would not handle.

9.4.1 Discussion of Civil Protection Act (CPA)

In July 2003, the CPU worked with the Ministry of Education to create pamphlets with comprehensive guidelines on emergency procedures for schools and educational institutions, and processes are ongoing in integrating disaster risk reduction in education curriculum. Before Idai these measures had to some extent raised awareness amongst people as to how they could rank hazards in terms of severity. A study by Manyena et al. (2016a) on disaster risk reduction knowledge amongst children in Muzarabani district, Zimbabwe, revealed that drought and flooding are cited as the most common threats. This momentum of building resilient communities as a form of response developed in past was not strengthened over the years to minimize the severity of more intense cyclones. Thus, while the CPA empowers authorities at national, provincial, district and local levels to continually review their practices as a proactive and mitigating measure, the response during Idai was reactive. This lack of preparedness on the part of officials is evidenced from the fact that forecasts had been previously made of an impending disaster described as that of a tropical category developing off the coast of Mozambique. Zimbabwe Meteorology had also raised an alarm 2 weeks before Idai landed in Mozambique and Zimbabwe in March 2019, but the officials responsible for operationalizing and deploying human and physical materials did not do so. Thompson (2019) argues that by the time Idai landed in Zimbabwe, no action had been taken to close schools or evacuate people to higher ground or safe facilities. Thus, in the hardest hit Zimbabwe districts of Chipinge and Chimanimani, Tongogara refugee camp and Nyamatanda refugee camp were hit hardest. Official statistics suggest that 340 lost their lives. This number does not include missing people who drowned.

Some NGOs have testified that the assistance they offered to Zimbabwe during Cyclone Idai went a long way to provide food to affected people. World Vision Zimbabwe assisted in rehabilitating more than 400 houses, rebuilding classrooms and providing furniture and water tanks to affected schools. Assistance to the people of Chipinge and Chimanimani has also come in the form of building latrines and wells and preparing farmers for the 2020–2021 season. Furthermore, these immediate few success stories of the effectiveness of the CPA in the wake of Cyclone Idai are attributed to the fact that Zimbabwe has an operation Disaster National Contingency Plan though it covers a shorter period of 1 year or less (Report on the SADC Disaster Risk Reduction and Preparedness Planning workshop, 2010). More significantly, the success of Zimbabwe legal and institutional framework provided by the Civil Protection Unit and the CPA also comes from working with other partnerships in the NGOs and private sectors. This cooperation is aligned to the African Development Bank Group's "Programme Post Idai and Kenneth Emergency Recovery and

Resilience Programme for Mozambique, Malawi and Zimbabwe" (PCIREP).

9.4.2 Weaknesses in Implementing Zimbabwe DRR Through the CPU

We suggest that the CPA could have been operationalized in an alternative way before, during and after Cyclone Idai in ways that could have improved to a higher degree its efficacy and capacity to mitigate the human loss, destruction of infrastructure and damage to property induced by Cyclone Idai. Mavhura (2016) argues, for instance, that the main handicaps to an effective operationalization arise from both conceptual and practice realities of the structure of the CPA itself. Since in the past big disasters were rare in Zimbabwe, there was a lacklustre political will amongst officials in Zimbabwe Government to invest in robust training programmes for DRR and, therefore, weak legislation affected pre- and post-DRR measures used by communities at risk (608). At a conceptual level, the officials focused more on the "natural" disaster as hazard. Response to disaster is reactive than proactive as it is believed in the hazard paradigm that "nothing" or little can be done to prevent natural disasters. The very term "Civil Protection" that describes Zimbabwe's legal and institutional framework for DRR is limited in addressing all aspects of the disaster management cycle since new terms such as resilience, vulnerability, mitigation and contingency plans appear to be underemphasized (ibid.). Failure to place more stress on vulnerability and on building resilience to disaster risk management underestimates the willpower to effectively and fully address the management cycle (UNCTAD, 2020). Cyclone Idai coincided with and worsened Zimbabwe's fragile economy due to poor governance structures, corruption and a chaotic land reform that resulted in capital flight from Zimbabwe (Vambe, 2019; African Development Bank Group, 2019).

To support the above point, Westermann (quoted in Chatiza, 2019, 12) points to the difficulties faced by TSURO (a Zimbabwean NGO) in getting the issue of the impact of Cyclone Idai on the Council's agenda. National, provincial and district officials prefer to work with NGOs, and third-party partners who agree with or do not write reports that end up criticizing the misuse or corrupt activities of the officials in the military-led government are implicated during the distribution of clothes, food and funds during and in the post-recovery period from Cyclone Idai. As Chatiza points out, "the full cost of Cyclone Idai is difficult to quantify" (Chatiza, 2019, 15) because of lack of reliable data and information on the extent of damage of lives and livelihoods that have not been effectively documented.

As the frequency and intensity of destruction of property by cyclones in Zimbabwe appear to increase, Zimbabwe's legal and institutional framework ought to embed the vulnerability and resilience paradigms. Such a legal move might prevent the practice using a single perspective in attempting to solve the complexity of understanding the behaviour and changing patterns of climatic weather patterns. Disaster risk problems should not be viewed as unitary and state centred, but as diverse and multicentred. Incorporating a community perspective can include ordinary people in framing the nature of disasters in order to design appropriate disaster risk reduction strategies. This is probably evidenced by the fact that many of the first responders in disaster risk reduction in Chipinge and Chimanimani were ordinary people coming from the affected communities.

9.4.3 Findings of the Study on Zimbabwe's Disaster Risk Management

On the first question of the study, it was revealed that there are international, regional and national supportive legal and institutional frameworks for disaster reduction available to Zimbabwe. The SADC Treaty, Hyogo Framework of Action (2005–2015) and the Sendai Framework for Disaster Risk Reduction (SFDRR) (2015–2030) have been identified. On the second question of this current study regarding Zimbabwe's use of

available legal and institutional frameworks to leverage DRR, the study found out that, despite a raft of international, regional and national legal and institutional frameworks to mitigate risk disasters such as Cyclone Idai, there is little evidence that the country used these frameworks both as a buffer to vulnerability and to build community resilience for DRR. Zimbabwe has not been susceptible to natural disasters of the magnitude and intensity posed by Cyclone Idai in the last three decades, and this appears to have discouraged the country from updating and strengthening her disaster risk reduction management programmes. This dereliction of her obligations under the SADC Treaty amounts to non-compliance with international norms and standards on disaster risk reduction management. While "initial non-compliance" is described as a function of availability of resources, "compliance crisis" refers to a member state's conscious desire to not fulfil the obligations it has signed (Fagbayibo, 2012; Chayes & Chayes, 1993). It appears that Zimbabwe is caught up in the vicious cycles of these two forms of non-compliance. Manyena et al. (2013) conclude their study on Zimbabwe's adaptability to international disaster risk reduction norms by observing that the country's DRR system continues to place less emphasis on processes that reduce vulnerability and building resilience. The evidence for this is the death of 340 people due to the negative impact of Idai.

9.5 Objective of South Africa's Disaster Management Act (2002)

Unlike Zimbabwe that is an inland country, most of South Africa is surrounded by coastal areas, especially in the Northern Cape, Western Cape, Eastern Cape and KwaZulu-Natal provinces. The country has been subjected to the hazards associated with tropical storms and numerous cyclones. In addition, localized flooding, intermittent drought and gastrointestinal tract infections (GTIs) have also pledged the country. With a longer history of colonial occupation, South Africa has also consistently developed, adapted and amended its legislation on DRR. However, the most far-reaching disaster legislation has been the Gazetting by the Government of South Africa of the Disaster Management Act of 2002 (No. 24252) (hereafter the Act). The Act provides for integrated and coordinated disaster management policies focusing on preventing or reducing the risk of disasters or mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery. This objective would be given effect through the establishment of national, provincial and municipal centres through training of disaster management volunteers.

However, the South African disaster risk reduction management system requires to be further strengthened through periodic reviews. This is so because some of the KwaZulu-Natal flood victims are still homeless and this flood occurred almost at the same time as Idai (Blumberg & Jassat, 2020). Furthermore, numerous lawsuits regarding the Covid-19 also suggest that the South African disaster risk reduction management system has been viewed as a threat to the livelihoods of corporations and some individuals (Broodry, 2020).

9.5.1 Resilience Drivers in the Act (2002)

Key drivers of the legal structure and provisions of the Act arise out of the repeal of some provisions of the Civil Protection Act of 1977 (no. 77). The Act (2002) reformulates the context of interpretation, application and administration redefining concepts related to disaster management 1(b), embracing the vulnerability paradigm and the resilience paradigm through emphasis on disaster mitigation in the management cycle in both the pre- and post-recovery disaster period (Chap. 1). Chapter 2 of the Act sets out to describe the stakeholders in disaster management as the intergovernmental committee, organized labour, business, agriculture, higher education and statutory regulatory bodies on standards of practice. In addition, Art 7 (2) makes provision of South African cooperation with international disaster

management and regional cooperation with disaster management bodies in Southern Africa.

However, it is arguable that the extent to which human drivers can mitigate disaster risk reduction is shaped by availability of resources and state of economic development (Neyer & Zum, 2005). In addition, political will is critical in implementing disaster risk reduction management systems. Commenting on the European experience—which is relevant to this study—Neyer and Zum (2001) view the role of legalization as central in fostering compliance because "legalization leads member states to do things they did not initially want to do" (Neyer & Zum, 2001, 21). In other words when SADC member states view Cyclone Idai as a natural disaster that disrupted their economies, lives and livelihoods, the problems posed by Cyclone Idai can at the same time be an opportunity to meet this challenge constructively through a strategy of building up robust institutional requisites in the post-disaster recovery and rehabilitation period. In the case of South Africa devolution of responsibility at national and provincial centres can minimize the bureaucratic processes associated with a top-down disaster management linked to the hazard approach to DRR. The Act also specifies what powers local authorities have to identify, frame and declare disaster, and methods to communicate and make use of funds raised locally. The Act nearly embeds the bottom-up or community approach to disaster management in which the affected people participate in the processes aimed at mitigating natural or man-made disasters. However, Siswana (2007) shows that the South African disaster risk reduction management process is not foolproof against administration abuse of resources by officials at the national, provincial and district centres of disaster risk reduction. There are complaints by ordinary South Africans against officials at provincial and district levels who mismanage resources meant to be directed at mitigating natural and man-made disasters (Republic of South Africa Department of Health, 2017).

Chapters 4 and 5 of the Act elaborate on the powers of officials in disaster management at provincial and municipal levels. Chapter 6 of the Act is critical in that it makes provisions regarding the sourcing of funding and its use at national, provincial and municipal levels. In addition, Chap. 6 also openly makes provisions and pronounces on the ways in which NGOs and other stakeholders such as Rescue South Africa may assist in mobilizing funds that can be used in disaster contexts within and outside the country. Yet, despite this picture of an impeccable legal structure of Act, South Africa experienced drought in 1991 that cost the economy USD1 million and in 2004 another drought affected 15 million people. The Act facilitated a shift in traditional disaster thinking to disaster reduction, prevention and mitigation, though implementing the Act was met with inadequate funding and lack of deeper knowledge of DRR for big disasters (Van Niekerk, 2014, 858).

9.5.2 Disaster Management Amendment Act (2015)

The Act (2002) was supported in its operation by the establishment of the South African National Disaster Management Framework (NDMF) (2005). Within the global context of the Hyogo Framework Act (2005–2015) debates on disaster management were shifting towards disaster risk management in the context of understanding the dynamics of prevention and mitigation in both the pre-disaster and post-recovery periods. At a regional level, South Africa continued to work towards DRR within the ambit of the SADC Treaty that provides the legal and institutional framework on matters of promoting effective use of natural resources and the environment (Art 5 (g), Art 21 (f)). Van Niekerk argues that both the Act (2002) and the NDMF (2005) of South Africa appear to have been hindered by a lack of a strong institutional basis to be used beyond the borders of South Africa in times of natural disasters. This fact, amongst other reasons, encouraged the South African Government to amend the Act (2002) in 2015 and 2020.

The Disaster Management Amendment Act (2015) is very relevant to this current study in explaining how South Africa got to a position of having the capacity of assisting Mozambique, Malawi and Zimbabwe in March 2019 when Cyclone Idai hit these countries. South Africa also continued offering assistance to these SADC countries in the Cyclone Idai post-recovery period. It is arguable that most of the provisions in the Disaster Management Amendment Act (DMAA) (2015) sought to clarify and further strengthen the provisions of the Act (2002) and NDMF (2005) in the disaster risk management context where South Africa finds herself experiencing frequent cyclones of unexpected magnitude in terms of the intensity of destruction they bring to South Africa and her sister SADC member states. The main objectives of the DMAA relevant to the discussion of the status of SADC member states' legal and institutional framework for DRR are defined as the need (a) to "clarify policy on rehabilitation and functioning of disasters centres" and (b) to "provide for the South African National Defense forces, South African National Police Service and any other organ of State to assist the disaster management structures" within and outside the borders of South Africa.

Notable key drivers of the DMAA are found in the amendment of section 1 of Act 57 of 2002 that re-conceptualizes DRR by introducing terms such as "disaster risk management" Art 1 (d); "improving resilience" Art 1 (c); "emergency preparedness" 1 f (a); "mitigation" 1 g (a): "post-disaster recovery and rehabilitation" 1 (j); and "risk assessment and vulnerability" 1 (k). As argued by Mavhura (2016), Chipangura et al. (2019) and Van Niekerk (2014), how a natural disaster is framed can suggest the kinds of solutions that might be applied to the problem. Therefore the embrace of flexible terminologies that describe the disaster management cycles reveals how South Africa is complying with the new scholarship and international legal frameworks for DRM. As Van Niekerk et al. (2020, 179) argue, South Africa has seriously used the new vocabulary on DRM in order to identify specific target application in Africa in implementing the Sendai Framework for Disaster Risk Reduction (2015–30) (SFDRR). Six of the SFDRR's seven targets in the global effort in DRR are global mortality, protect affected people, prevent or minimize economic loss, reduce damage to infrastructure, build robust national disaster risk reduction strategies and develop early warning systems by 2030. It seems to us that the seventh target of the SFDRR speaks the most to the research questions that motivated this study regarding the preparedness of member states to effectively mitigate the negative effects of natural disasters. The emphasis in the SFDRR target that South Africa has embedded in the DMAA is the commitment to "enhance international cooperation to developing countries through adequate and sustainable support to complement their actions for the implementation of this framework by 2030" (Van Niekerk et al., 2020, 181). This regional vision in SADC to fulfil national obligations regarding the declared targets of the Sendai Framework is also expressed and supported by the African Development Bank Group (2019).

Another important key driver in the DMAA is found in the amendment of section 5 of Act (2002), which now includes focus on traditional leaders, women, children and people with disabilities as critical focus groups who should participate in producing disaster risk management plans and educational materials that ought to influence policy implementation of DRR. However, the most distinct provision to be added into the DMAA (2015) was the provision "for the South African Defense Forces, South African Police Service and any other organ of the State to assist the disaster management structures" both within and outside the borders of South Africa. Cyclones Idai and Kenneth that hit the Southern African region, in March 2019, and hard-hit Mozambique, Malawi and Zimbabwe are examples of vulnerability drivers that DMAA seeks to address (Van Niekerk et al., 2020, 180). The ADBG's May 2019 report and recommendations on developing new strategies for disaster risk reduction emphasize the need to foster stronger ties to adopt regional integration in disaster risk reduction, building of community resilience, rapid reconstruction of infrastructure and donor coordination. Such collective and bot-

tom-up strategies to mitigate the negative effects of natural and man-made disasters should encourage participation by affected people in identifying, designing and implementing national and regional disaster risk reduction plans.

South Africa has gone further in establishing legislation that seek to be used to respond proactively to natural disasters. On 15th December 2020, the South African Department of Cooperative Governance (No. 1346) made further amendments to the Act (2002) in terms of section 27 (2) gazetted mandatory protocols to be followed in public places regarding efforts at mitigating the negative impact of Covid-19. Although Cyclone Idai encouraged the spread of gastrointestinal tract infections (GTIs), the continuation of the negative effects of Cyclone Idai has further complicated the lives of SADC citizens. Thus, to have put in place legislation on Covid-19 demonstrates South Africa's commitment to strengthen her preparedness to previously unknown diseases. This strategic planning is recommended to the African continent's regional economic communities by the African Union Centre for Disease Control programmes. It comes as no surprise that South Africa had over the years built its national resilience with which it intervened and assisted Mozambique, Malawi and Zimbabwe when these countries were hard hit by Cyclone Idai in March 2019.

9.5.3 Forms of South African Assistance to Mozambique, Malawi and Zimbabwe During and After Cyclone Idai

South African state has always played an active and visible role in mitigating the disaster brought by cyclones to the people of Mozambique since the floods of 2000. In March 2019, President Cyril Ramaphosa "authorized" the deployment of some members of the South African National Defence Force (SANDF) and the South African Police Service and Health personnel to assist Mozambique, Malawi and Zimbabwe during Cyclone Idai in March 2019 (USAID, 2019). Apart from sending military personnel, South Africa provided R5 million to Malawi and R10 million to Zimbabwe for immediate relief (Vuku'zenzele: Government Communication , 2019). The South African legal and institutional framework for DRM allows and encourages the private sector to participate in the processes of conceptualizing, designing and implementing programmes for disaster risk reduction and mitigation. As a result of South Africa's liberalizing of its laws on DRR, it was possible that Rescue South Africa which is an NGO was one of the first responders to set foot in Beira during Cyclone Idai. Rescue South Africa's crew of 15 engineers assisted more than 4000 emergency service personnel from Southern African countries with the support from USAID/OFDA. The NGO's staff used boats, swimmer rescues and helicopters and saved 25 people from drowning. In response to the threat of the spread of diseases in the aftermath of Cyclone Idai, the World Health Organization dispatched 90,000,000 doses of cholera vaccine to Mozambique. The United Nations World Food Programme, the UN Refugee Agency, private companies and business entities provided food and medicine for immediate relief to Zimbabwe (Chari et al., 2020, 2). At the time of writing this current study (24–25 January 2021), Mozambique was being pounded by another Cyclone Eline that also brought flooding in Zimbabwe and some parts of South Africa such as the Limpopo province. While South Africa is still providing post-recovery assistance and rehabilitation to Mozambique and Zimbabwe in line with the provisions of DMAA (2015) and the protocols on Covid-19 gazetted in December 2020 to prevent the spread of this deadly communicable disease, South Africa will likely find herself stretching her resources to assist Zimbabwe and Mozambique.

9.5.4 Key Findings on South Africa's DRR

Regarding question one of the current study, it was found out that South Africa has to a large extend followed and complied with its own laws on DRR, and also made use of the regional and international statutes for DRR provided for in the SADC Treaty, the Hyogo Framework of Action (2005–2015) as well as the Sendai Framework for Disaster Risk Reduction (SFDRR) (2015–2030). South Africa has continued to review its legal and institutional framework for DRR as was demonstrated in the amendments to the Act (2002) that resulted in BMAA (2015) and the protocols on Covid-19 gazetted on 15th December 2020 in the face of a more formidable natural disaster posed by coronavirus-19 and its different but deadly mutating variants discovered in 2021 in South Africa, the United Kingdom and Brazil. The South African Government appears to have a credible and realistic understanding that "it is a fundamental norm of international law [that] *pacta sunt seervanda* (treaties are to be obeyed" (Chayes & Chayes, 1993, 185). For South Africa compliance to treaty obligations ensures that the "final result will represent, to some degree, an accommodation of the interests of the negotiating states."

Regarding question two of the study, it was revealed that South Africa extensively consults with her stakeholders in the country and international organizations on best practices for DRR. South Africa's legal and institutional framework for DRM and the processes of disaster risk management are to a large extent decentralized. The South African Government works closely with NGOs, donor communities, the World Bank, UN Refugee Agency and United Nations World Food Programme to source funding apart from the fact that Chap. 6 of BMAA (2015) obligates the national, provincial and local authorities to raise funds that are deployed for DRR. It was expressed that this perspective that anticipates severe disasters is best poised to create awareness of vulnerability to natural and man-made disasters out of which the commitment to build communities of resilience at policy, institutional and administrative levels is largely made possible. It was argued in favour of South Africa that because to a larger extent South African approaches are proactive, this has enabled her to assist Mozambique, Malawi and Zimbabwe during and after Cyclone Idai.

Admittedly, we also argued that although South Africa can be described as a "Lead Nation" (Kent & Malan, 2003, 6) within the SADC economic communities, the country's DRR systems still need to be improved. This is so because although it is not possible to entirely eliminate natural and man-made disasters, there is a wiggle room for improvement when a country complies with its own laws and those from the international organizations. This appears to be unlikely in the case of Zimbabwe that tends to comply only as "… in the area of international human rights…into an international agreement on disaster risk reduction "agreement to appease a domestic or international constituency but have little intention of carrying it out" (Chayes & Chayes, 1993, pp 187–8). In short, regarding question two of the current study, South Africa shows political will to put in place policy measures and legal and institutional framework for DRR to protect not only its citizens but those of neighbouring SADC states like Mozambique, Malawi and Zimbabwe. This political choice is also dictated by South Africa's foreign interests in the region. As the African Development Bank Group (2019) has noted, South Africa has business interests within the region and, therefore, if Mozambique, Malawi and Zimbabwe are threatened by cyclones or gastrointestinal tract infections or Covid-19, South African interests in this part of the subregion are also equally jeopardized and this will slow down trade liberalization in the region.

Regarding question three, the current study found out that by and large the South African Act (2002), the BMAA (2015) and amendments to the protocols on Covid-19 that were gazetted on 15th December 2020 can enable the country to mitigate disaster risks from flooding, drought and veld fire. The study positively noted that the South African Government periodically amends its disaster risk management legal instruments to align them with international best practices and

also as a proactive response to the ever-frequent increase in cyclones whose destruction of human life, livelihoods and animals and damage to infrastructure are on the increase. South African scholars and disaster risk policy implementers have shifted their focus from "naturalness" of disasters towards embracing vulnerability and resilient paradigms that promote building communities of resilience. This ideological shift in the use of the vocabulary in the discipline of disaster risk management is to be lauded. However, the study also found out that to the extent that South Africa continues to be vulnerable from flooding, intermittent drought and adverse effects of gastrointestinal tract infection and upper respiratory-related diseases associated with Covid-19, it means that for the country, there is no "holiday" from constantly updating. As we conclude this current study Cyclone Eloise pummelled Mozambique and by the time Eloise reached Northern Limpopo, Eloise had become a tropical storm but submerging homes, destroying roads and drowning animals. The study, thus, revealed that in South Africa, the design of funding DRR mechanisms does not always ensure that the objectives of the relevant legislation are safeguarded and that officers who implement disaster risk reduction programmes are always transparent. Van Niekerk et al. (2020) have shown that there have never been adequate funds, equity in the distribution of funds and administrative efficiencies in the implementation of the Act (2002) and BMAA. These are gaps that need timeous attention.

Therefore, although the South African legal and institutional framework for disaster risk reduction encourages synergies with external donors, there is need for South Africa to find a way to influence processes of self-assessing national statutes of SADC member states without exercising hegemony over member states with weak legal and institutional frameworks. This is possible in the SADC context where member states "promote intra-regional or bilateral trade where economic and political desire drives the process" (Saurombe, 2013, 447). As starkly put by Saurombe (2013, 447), in the SADC economic community, "there are merits to employing soft or informal law in certain circumstances. The advantages may be greater and more effective than those that come as a result of enforcing compliance with hard law." This view does fit SADC member states who are at uneven levels of economic development. In essence, the assistance offered to Mozambique, Malawi and Zimbabwe by South Africa during Cyclone Idai and in the post-recovery and rehabilitation shows what can be achieved when member states work together for the common good of their citizens. This finding of the current study resonates with Chayes and Chayes' view that when parties to an agreement work together in disaster risk reduction settings, "not even the strongest state will be able to achieve all of its objectives, and some participants may have to settle for much less" (1993, 183).

9.5.5 Discussion of South Africa's DRR During Cyclone Idai

A critical review of the Act (2002) showed that there was robust political will to want to make this legislation work effectively to minimize vulnerability from natural and man-made disasters. The Act (2002) appears informed by latest thinking in the field of disaster risk paradigms. The Act (2002) is clear and appears impeccable in the ways it clarifies who does what in the disaster management cycle, where the funding of DRR will come from and its propensity to encourage decentring of responsibilities in DRR in the country. The policy framework and the legal and institutional framework are morphed together in a way that suggests the vision to construct a disaster risk mechanism that aims at building cultures of resilience to disasters at national, provincial and district levels where authorities who frame and declare disasters exist. However, despite these comprehensive attributes of the Act (2002), it still appears that the "more difficult question is the extent to which in reality, one can ascertain the South African model based on neatly regimented levels of authorities … are functioning and whether their activities are having a trickle-down effect in terms of improving

disaster risk reduction at community level" (The International federation of Red Cross and Red crescent, 2020, 43).

In addition to the above point, Van Niekerk et al. (2020) argue that the HFA (2002) and the SFDRR upon which the Act (2002) and BMAA (2015) align were constructed not with Africa in mind and may not fit the African context in toto. Vyas-Doorgapopersa and Lukanda (2012) are of the view that scholarly field of disaster risk management has become so interdisciplinary to a point where singling one variable such as the legal and institutional framework of DRR at the expense of policy perspectives and administrative approaches and well-meaning interventions may not always be effectively coordinated to achieve the best results in disaster risk reduction programmes. In the South African context, periodic amendments of the Act (2002) may point to a culture of self-reflexivity. However, such changes to part of legislation, though important, can also be a symptom of the fact that since disasters are not easily predictable when and where they affect and with what intensities of destruction, research in disaster risk reduction will always aim to play catch-up with the ever-changing climate.

The questions raised above regarding the lack of capacity or preparedness by Mozambique, Malawi and Zimbabwe to effectively mitigate the negative effects of Cyclone Idai, and the fact that the required capacity (though not all of it) had to come from South Africa, suggest that the country can be described as a "Lead Nation" in SADC's efforts to build resilience to disaster risk reduction induced by Cyclone Idai and Kenneth. According to Kent and Malan (2003, 6):

> The Lead Nation in conjunction with the mandatory is to provide guidance in financing, logistical support for sustaining the mission…. These guidelines will cover issues emanating from the mandate, concept of operations, mission structure command and control, administration and logistics, health, care and equipment requirements….

If we agree with the description of South Africa as a possible "Lead Nation" in SADC's efforts to build regional resilience in order to mitigate the effects of Cyclone Idai, this proposition finds legal resonance and is recognized and accepted in SADC's Regional Indicative Strategic Development Plan (RISDP) (2030). The RISDP (2015) identifies building climate service centres as the needful thing to do for disaster risk reduction in the region (Ngwawi, 2014).

The RISDP is SADC instrument that allows some SADC countries that have built capacity and national resilience to natural disasters to go ahead with assisting other member states whose legal and institutional frameworks still need to be strengthened in order to enable them to catch up. This flexibility is at the core of the functioning of SADC. Flexible integration is a viable regional approach to disaster risk reduction and management to combat the after-effects of Cyclone Idai. According to Saurombe (2012, 102), flexible integration in DRR can provide "a vehicle by which governments can concentrate on what unites them rather than on what separates them." As a theoretical approach that is already embedded in some of the mutually agreed SADC mandates amongst the member states, flexible integration [is] "… a means by which the member states agree to disagree about their differences, but permit at least certain of their number to press ahead with an objective which they share as a group (ibid, 109)." Preventing and mitigating the effects of Cyclone Idai by building consensus and cooperation in areas of mutual benefit remains the pillar of SADC member states' approach to disasters—whether natural or man-made—that threaten to derail the SADC common agenda of achieving optimum trade liberalization through regional economic integration by 2063.

9.6 Recommendations of the Study for Future DRR and Management in SADC

In light of the reality that cyclones are increasingly threatening to become the determining factor to the achievement of goals of the SADC Treaty's commitment to eradicate poverty and improve the lives of the citizens in this region we make the following recommendations. Firstly, SADC member states have to understand that natural disasters, especially linked to violent

cyclones, have become new forms of non-tariff barriers that can put breaks on SADC trade liberalization through regional economic integration. To the extent that natural disasters cannot be totally eliminated, SADC member states have to design disaster risk mechanisms that can mitigate the adverse effects of flooding, drought, cyclone-induced destruction of roads and other SADC infrastructure. SADC member states will have to work together, to establish funds that will be used for pre-cyclone activities and post-recovery and rehabilitation period. Secondly, SADC member states should share information on the most recent scholarly work that can influence their government to avert vulnerability while assisting the countries build resilient cultures to problems posed by cyclones. Thirdly, there is a need for dedicated research on disaster risk reduction mandated by a protocol that is detailed to address the different contexts of SADC member states. Fourthly, cognizant of the fact that SADC member states are at different stages of economic development, there is a need to bring the policy perspectives, the legal and institutional framework perspectives and the administrative perspectives in designing disaster risk mechanisms so that the approaches to DRR are not fragmented, and work only to solve the problems of specific countries. Fifthly, the silenced frames that have not been used in SADC disaster risk management need to be manifested and experimented with. Sixthly, and lastly, SADC member states need to always remember that the focus of disaster risk problems needs to be found in the communities in which disaster is generated and experienced (Chipangura et al., 2017). This might empower the affected people to build and contribute their own cultures of resilience to disaster risk management plans and mainstream them into national curriculum.

9.7 Conclusions

The aim of this study was to compare the extent to which the legal and institutional frameworks of Zimbabwe and South Africa could be considered as enablers or drivers in the disaster brought to Mozambique, Malawi and Zimbabwe by Cyclone Idai. It was stated that the Chipinge and Chimanimani districts of Zimbabwe at the eastern border with Mozambique were hit the hardest. 340 people lost their lives, property was destroyed, infrastructure was damaged and crops were swept leaving people on the brink of starvation. The Zimbabwean Government used its CPU to assist people whose livelihoods were destroyed. However, Zimbabwe had not effectively prepared to mitigate the adverse effects of Cyclone Idai. The CPA is a legal instrument still informed by the hazard model in disaster management cycles; this paradigm has been displaced by the vulnerability and resilience paradigms that encourage countries to be proactive in their response to disasters whose magnitude they have not experienced before. Zimbabwean authorities have not created a fund that could be used to ameliorate the effects of cyclone in the post-recovery and rehabilitation period. This is a massive failure for a country known for directing huge financial resources to regime survival at the expense of the citizens. Thus, while disasters cannot be totally eliminated, Zimbabwe's response was reactive. The failure by Zimbabwe to protect her citizens is not because there are no credible, legal and institutional frameworks from which to borrow best practices. Zimbabwe found herself being assisted by South Africa, some NGOs and multinational organizations such as the United Nations World Food Programme that provided food to a nation that was once described as the bread basket of SADC.

In contrast, South Africa's Act (2002) to a large extent clearly identifies the main key drivers in the fight to mitigate natural disasters such as Cyclone Idai. Periodically, South Africa amends her Act (2002) through BMAA (2015) and the introduction of the Covid-19 protocols gazetted in 2020. This is a proactive approach that anticipates disaster and concentrates in building resilient cultures to offset and minimize the adverse effects of natural and man-made disasters. In March 2019, South Africa found herself assisting Mozambique, Malawi and Zimbabwe that have suffered the most from Cyclone Idai. South Africa allows individuals, businesses and NGOs such as Rescue South

Africa to design and implement disaster risk mechanisms that work with and alongside government initiatives. South Africa understands that natural disasters could very well become new forms of non-tariff barriers that will eventually put brakes to the SADC common agenda of trade liberalization through regional economic integration.

Sauka (2020) suggests that it is possible to generate opportunities in the construction industry, food industry and agricultural sectors of SADC countries if only the governments are determined to double their resolve to invest in these sectors that are most hit hard by natural disasters. This can be done by decentring disaster risk capacity management programmes within the communities of both the urban and rural poor by empowering youth to see in vulnerability the opportunity to imagine more inclusive, people-centred approach that takes those affected by disasters as the subjects and objects of socio-economic development aimed to mitigate vulnerability. Furthermore, SADC coastal cities in the SADC region could turn disasters into opportunities for employment creation if only the local people develop community resilient plans to fund projects that will lead to rehabilitating of the damaged infrastructure of these coastal cities. The painful lessons learnt from the experiences of Zimbabwe and South Africa during Cyclone Idai and the post-recovery rehabilitation could instigate the creation of and research into the simulation and futuristic studies about what is possible. Best- and worst-case scenario creation in mitigating disasters can assist youth in building skill-based resilience that should inform future policies when designing disaster risk mechanisms that should minimize the adverse effects of unexpected disasters.

The legal and institutional frameworks for disaster risk management available to member states need to be updated, and in some cases more content needs to be added to their provisions. This is in line with the spirit of the SADC Treaty that empowers member states to "conclude such Protocols as may be necessary in each area of co-operation which shall spell out the objectives and scope of, and institutional mechanisms for cooperation and integration," Art 22 (1). Therefore, SADC member states must base their interstate agreements on legally binding commitments that can be enforced through soft and hard power, where it is required. This is important to jog countries like Zimbabwe so she finds common ground in pursuit of disaster risk reduction programmes that she would not have ordinarily wanted to carry out for her citizens. South Africa will not continue assisting SADC member states during every natural disaster. South Africa's resources are finite. Therefore, in matters of disaster risk reduction, SADC states need to critically engage each other to enable reluctant member states to eventually begin to not only "… weigh the benefits and burdens of commitment but explore, redefine and sometimes discover their interests" (Chayes & Chayes, 1993, 180).

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Part IV

Knowledge Systems and Related Approaches

Natural Disasters and the Role of Pharmacists: A Focus on Policy and Protocols in South Africa

10

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Abstract

Breakdown of health systems is a common outcome of natural disasters, which include tropical cyclones. Pharmacists interact with population, which might be at risk from disasters without the need for an appointment. This differs from other healthcare professionals such as medical doctors. Pharmacists can therefore develop trust and a working relationship with the community and can play a central role in the provision of healthcare in the communities they serve during disasters. This study explores the potential mechanism for the execution of the role of pharmacists in the South African disaster risk management (DRM) context as part of disaster health system and/or medicine. A combination of policy analysis and analysis of the professional scope of practice of pharmacists in DRM in South Africa is adopted as the main strategy of inquiry. Results show that the current roles and conduct boundaries of the South African pharmacists in DRM are limited by the legislation and code of conduct governing the scope of their professional practice. Hence, we recommend that the adaptation to DRM roles of pharmacists is necessary and suggestions for practice modifications are required.

Keywords

Disasters · Medical treatment · Code of conduct · Degree outcomes · Pharmacists

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10.1 Introduction

Natural disasters have impacts on the healthcare of the affected populations through direct and indirect outcomes. For example, both tropical cyclones Idai and Kenneth that made landfall in Mozambique in 2019 wiped out significant water

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and sanitation infrastructure. Yet the secondary impact of a subsequent cholera outbreak led to no significant number of disease cases in some areas of the country (Cambaza et al., 2019). One of the main reasons was the coordinated disaster response approach of the Mozambican Government, which worked with non-governmental organisations (NGOs) and the affected communities and implemented lessons learnt from previous disasters (Cambaza et al., 2019). Outside assistance from international stakeholders working in the field of disaster risk reduction (DRR) and management was also necessary in dealing with the cholera outbreak during Tropical Cyclone Idai (2019) in the city of Beira and other areas of Mozambique (Mongo et al., 2020). Both outbreaks were caused by the breakdown in the water, sanitation and hygiene (WASH) infrastructure and the damage of housing stock. Such challenges put pressure on the frontline healthcare workers and the disaster risk management professionals (DRMPs). The resulting situation can be exacerbated by the fact that some countries might have systems for disaster risk management (DRM), as well as approaches to DRR that are still (primarily) focused on the response phase of the disaster management cycle (Mavhura, 2020). Examples of the impacts of the above-mentioned hydro-meteorological disasters indicate massive and destructive effects on healthcare provision. These have been in part linked to climate change, which will thus have a significant effect on the provision of healthcare in disaster zones.

Maintaining provision of healthcare in disaster zones is related to the necessity to guarantee and maintain the adherence to certain (basic) human rights. The right to health is one of such fundamental rights of every human being on earth regardless of where they are (UNHCR/WHO, 2008). This right should be realised by the actions of the country's government for the benefit of the country's population, irrespective of the financial and other resources available to governments in that country. The right to health and the right to the highest attainable standard of healthcare for a country's population should be achieved by involving the healthcare providers and the patients into the planning and execution of the relevant activities/unit operations (UNHCR/WHO, 2008). Local execution of these rights will be linked to the situation on the ground and to local ethical, cultural, social and legal norms.

On the African continent, the right to physical and mental health is enshrined, at least from an ethical perspective in Article 16 of the Banjul Charter (African Commission on Human and Peoples' Rights, 2020). In addition, many countries in Africa are state parties to the international human rights standards and frameworks. Thus the provision of healthcare is binding on African governments in the context of DRM and DRR on the continent. Recently, there has been an ongoing policy and philosophical shift from the response and recovery phases of the disaster management cycle to the preparedness and mitigation phases of that cycle (Mukandavire et al., 2011). There has also been the introduction of mitigation health measures such as vaccination campaigns around the globe that focus on the epidemic and the pathogens, which can be causative agents of first-generation disasters as identified by Bulíková et al. (2011) and Walldorf et al. (2017). The implementation of human rights related to health is impacted by the resources available to the respective government, the socio-economic variables of the country and its population, as well as the conditions under which healthcare delivery is executed.

The landscape of the DRR and DRM has witnessed an increasing number of stakeholders involved, where each stakeholder is required to collaborate with the others in the execution of their duties and responsibilities (Adekola et al., 2020). Among such stakeholders are pharmacists. In addition, the disaster risk profile, hazard registers and vulnerability profiles must be linked to the health outcomes of disasters in a geographical area (Dar et al., 2014). The shortage of medicines and healthcare personnel can become an issue and can also impede healthcare provision in the response phase of the disaster management cycle (Zhong et al., 2014). Hence, the involvement of the healthcare personnel on the ground, who are the closest to the disaster-prone or

affected communities, and who permanently practise in these areas such as pharmacists, might play a significant role in healthcare provisions in disaster zones, including South Africa (Aruru et al., 2020).

The total count of pharmacists per 10,000 population in South Africa was reported to vary between 2.35 and 2.85 for the 2004–2016 period (WHO, 2020a; Vhiriri, 2020). In the same country, the number of medical doctors per 10,000 population varied between 6.99 and 8 for the same time frame (WHO, 2020b; Vhiriri, 2020). Finally, the total count of nurses and/or midwives per 10,000 population in South Africa ranged from 7.75 to 39.01 between 2004 and 2016 (WHO, 2020c). Based on these data, it is clear that the number of pharmacists per 10,000 population in South Africa has been stable over the time. In comparison to other healthcare professionals and based on the nature of their profession, no appointments are generally required to consult a pharmacist by the general public. To this end, pharmacists can play an integral role in healthcare provision at the community and local levels in South Africa, especially during disasters (Bheeki & Bradley, 2016). This can be exploited positively as a tool in the maintenance of healthcare provision at the local level in the scope of DRM in South Africa.

The chapter sets an objective to document the possible roles and practical engagements of South African pharmacists as part of the healthcare function in DRR and DRM in the country. It also explores the policy provisions for such to happen.

10.2 Materials and Methods

The methodology adopted uses a combination of policy analysis and analysis of the professional scope of practice of pharmacists as healthcare professionals in DRM in South Africa. The legislative standards of the pharmacy profession and common law elements, that are likely to apply to execution of pharmacists' professional duties in disaster situations, are identified first. Then the profession and ethical challenges are deduced through links to practical impacts of disasters on healthcare provision, for example, the interruption of the ability of a pharmacist to obtain a prescription to dispense antibiotics to a patient with diarrhoea in disaster zones, and the potential ways a pharmacist in South Africa could navigate the DRM landscape in the country. Finally, modifications are suggested to the existing legal and professional frameworks of the pharmacy profession in South Africa, in order to improve the preparedness of healthcare systems in the country to deal with outcomes of disasters.

10.3 Results and Discussion

10.3.1 Legislation and Common Law Governing Roles of Pharmacists in South Africa

Concerning the disaster management cycle, a (South African) pharmacist will likely be involved in dealing with outbreaks of infectious communicable diseases, provision of vaccines as a preventative measure, management of patient care-related non-communicable diseases and outcomes of gender-based violence or sexual violence (WHO, 2014; The Sphere Handbook, 2018). Examples of infectious disease outbreaks, which can occur in disaster zones, can be demonstrated for the cyclone-impact zones. The examples include shigellosis, dengue fever, parasitic infections and acute haemorrhagic conjunctivitis (Zheng et al., 2017). Severe storms and tropical cyclones in South Africa have been reported to result in a diarrhoeal outbreak, which was suggested to be caused by *Aeromonas hydrophila* (Tandlich et al., 2016). Apart from South Africa, sub-Saharan Africa is a known site of common outbreaks of cholera, which can also occur in the cyclone-impact zones (Hope, 2019). These diseases must be taken into account when designing the pharmacy response plans to disasters and when considering all four phases of the disaster management cycle. As disasters often lead to the disruption of the normal healthcare system operations, pharmacists must understand and be able to execute their roles and mandate in emergency

medical treatment and under conditions when dispensing of medicines might have to be done without a prescription/prescriber being available. Emergency medical treatment is relevant to disasters in the context of South Africa, as it will outline the legal content and the processes available or desirable for the provision of fast and professional response to and dealing with disasters in the country.

In medical or healthcare emergencies, the following South African legislation must be considered. The National Health Act No. 61 of 2003, especially Chapter 2 (5), which states that "health workers, healthcare providers or health establishments may not refuse emergency medical treatment" (NDOH 2003-present). In South Africa, pharmacists are classified as health workers and function as custodians of medicines. Medicines are defined in section 1(1) of the Medicines and Related Substances Act, 1965 no. 101 of 1965 as amended (South African Government, 1965–2002), as:

> Any substance or mixture of substances used or purporting to be suitable for use or manufactured or sold for use in—(a) the diagnosis, treatment, mitigation, modification or prevention of disease, abnormal physical or mental state or the symptoms thereof in man; or (b) restoring, correcting or modifying any somatic or psychic or organic function in man, and includes any veterinary medicine; [Definition of "medicine" substituted by s. 1 of Act 17/79].

Disasters will be related to the need to sustain and protect human life, and this in turn is closely related to the execution of emergency medical treatment. Pharmacists will be likely placed in situations where quick actions, amounting to emergency medical treatment, might and will likely be required. For this reason, a clear and general definition of emergency management is required.

Section 27(3) of The Constitution of South Africa of 1996 contains the following wording regarding emergency medical treatment: "no one may be refused emergency medical treatment" (South African Government, 1996). This implies that everyone has a right to emergency medical treatment. A series of court cases have been filed seeking clarity on emergency medical treatment. The judgements that were handed down in this context provide further clarity on the definition. Those court cases have implications on the disaster healthcare and medicine in South Africa in as far as developments during the democratic dispensation are concerned. Although these are not directly linked to pharmacy practice, they have implications for the practice of the pharmacy profession. One such case is the Oppelt vs. Department of Health (Provincial Administration Western Cape), Western Cape 2016 (1) SA 325 (CC) case at the Constitutional Court of South Africa (South African Law Reports, 1947–2019). The judgement describes the right to emergency treatment as a "process of ensuring that treatment is given during an emergency and is not inhibited or complicated by governed/government requirements. For example, treatment is required to be given in the fastest possible way" (South African Law Reports, 1947–2019).

Practical execution of this Constitutional Court of South Africa judgement will depend on the professional judgment of healthcare workers, including pharmacists. From the literature, a public health emergency can be defined as "a sudden event, which might be characterised by a level of suffering that needs immediate attention and relief measures" (Moore et al., 2007). As opposed to disaster, an emergency does not exceed the capacity level of the given disaster management system or the healthcare system to deal with it and can be resolved quicker than a disaster. However, definitions of a disaster vary, and it is possible in South Africa that local healthcare capacity will be overwhelmed even in emergencies. This is so, especially in the public sector where problems such as stock-outs of medicines, shortage of medical supplies, understaffing, poor salaries, labour disputes and highly challenging conditions of service for healthcare professionals are rife (Koomen et al., 2019). The most important principle, which is derived from the Constitutional Court judgement in the previous paragraph, is the implication that emergency medical treatment must be provided in the fastest possible way. Actions of healthcare workers/professionals in disaster zones must also be as quick as possible to minimise the negative health out-

comes and impacts of disasters on the well-being of the South African population. This will be a principle, along with other regulatory, legislative and ethical principles governing the conduct of specific healthcare professionals that should drive the actions of healthcare professionals such as pharmacists in disaster zones in South Africa.

The Medicines and Related Substances Act no. 101 of 1965 as amended speaks of the selling or supplying of medicines and their dispensing to patients in emergencies (South African Government, 1965–2002 s 22A ss 3–5 and 6j-l). The Act does not define what constitutes an emergency. Medicines, as defined earlier in this section, are classified in schedules, which are to be seen as categories that are related to prescribing, or a lack thereof, and dispensing of the scheduled medicines to a patient. The increasing number of a schedule indicates an increasing need to control the supply, prescribing and dispensing/sale of the medicine in question by healthcare professionals to patients. For Schedules 0–2 no prescription is required; Schedule 0 can be sold or dispensed in any shop, including pharmacies; and Schedules 1–2 may be sold in pharmacy/dispensary settings, e.g. under the supervision of a pharmacist (South African Government, 1965–2002 s 22A ss 3 and 4). However, maximum quantities might be imposed, for example with paracetamol (acetaminophen) which is an analgesic. Schedules 0–2 will be most readily available if the disaster strikes and the outside resources might not be available to assist with healthcare provision. Schedule 3 and higher can only be dispensed by a pharmacist, or people working under their supervision, or a healthcare practitioner with a particular dispensing licence with a verbal or a written prescription from "an authorised prescriber" (South African Government, 1965–2002 s 22A ss 5b).

The text of paragraph 6 (j) in section 22(A) of the Medicines and Related Substances Act no. 101 of 1965 as amended states that in an emergency a Schedule 6 medicine, such as opioids, can be ordered via telephone or fax from a wholesaler by a pharmacist or a healthcare professional. The wholesaler can supply the smallest necessary amount or number of dosage forms. Furthermore, a record must be kept of the supply provided and a written order is obtained within 7 days of the supplying taking place (South African Government, 1965–2002 s 22A ss 6j). This is an important section of legislation that could very likely govern the conduct of a wholesale pharmacist in disaster situations. Therefore, the medicines dispensed to the patient will generally take place along the axis of prescriber-wholesaler-dispenser-patient.

If a disaster strikes in an area where a pharmacist is providing their services to the public and a direct link to a prescriber is cut for a written prescription, then the text of paragraph 6 (k) in section 22(A) of the Medicines and Related Substances Act no. 101 of 1965 as amended (South African Government, 1965–2002 s 22A ss 6k) will provide a possible way for a pharmacist to facilitate pain alleviation during the initial stages of the disaster response without an immediately available prescription. The requirements to sell/supply medicines in emergencies for Schedules 5 and 6 (see Table 10.2) include that they can be supplied only for a period not exceeding 48 h and this should be upon a verbal instruction from a prescriber known to the pharmacist and registered under the Health Professionals Act, 1974 (South African Government, 1965–2002 s 22A ss 6k). This should then be followed by a written prescription from the prescriber within 72 h.

With regard to dispensing medicines belonging to Schedules 2–4, a pharmacist may supply quantities not exceeding 30 days, only if there was a pre-existing prescription in place, where required (South African Government, 1965–2002 s 22A ss 6l). The particulars of such a supply should be recorded in a prescription book or other permanent record as required by the Act.

Regulations of the Pharmacy Act no. 53 of 1974 as amended that deals with rules relating to the code of conduct of a pharmacist include the control of medicines (South African Government, 1974–2002; SAPC, 2008). Section 1.9.8 dealing with the control of medicines under regulations relating to the code of conduct of a pharmacist speaks of an emergency supply of medicines or scheduled substances. The Pharmacy Act 53 of

Table 10.1 Medicines forming part of the emergency trolley[a]

Medicine	Indication	Schedule	Dispensing and prescriber
Antibiotics (range depends on local disaster risks, hazard profile/register and vulnerability profile of the population)	For community-acquired infections such as bacterial pneumonia, cholera, genito-urinary tract infections that are sexually transmitted	Varies based on the medicine in question	Pharmacist can dispense only upon a doctor's prescription
Antihistamine (e.g. promethazine)	Urticaria, acute anaphylaxis, treatment of motion sickness, sedation (particularly in children), nausea and vomiting	Varies based on the medicine in question	Pharmacist can dispense only upon a doctor's prescription
Amiodarone (antiarrhythmic)	Treatment and prophylaxis of supraventricular and ventricular arrhythmias	S4[b]	Pharmacist can dispense only upon a doctor's prescription
Adrenaline	Treats acute anaphylaxis	S4	Pharmacist can dispense only upon a doctor's prescription
Aspirin	Prophylaxis for stroke and heart attack, treatment of pain and fever	Unscheduled/S0	Pharmacist can dispense, but should counsel the patient about the potential of aspirin toxicity, e.g. in the GIT
Atropine (bronchodilator or pharmacist can dispense only upon a doctor's prescription)	Treats bradycardia, antidote for overdose in cholinergic drugs	S2 page 139	Pharmacist can dispense with or without the doctor's prescription
Beta-stimulant nebulisation such as salbutamol (this medicine must be available with an inhaler and an adjoining spacer)	Asthma and reversible airway obstruction	S2	Pharmacist can dispense without the doctor's prescription
	Uncomplicated preterm labour	S4	Pharmacist can dispense only upon a doctor's prescription
Calcium chloride 10% IV	Hypocalcaemia	S3	Pharmacist can dispense only upon a doctor's prescription
Dextrose 50% IV	Carbohydrate replacement in energy-deficient patients as a result of undernutrition, burn patients, severe illness	S1	Pharmacist can dispense without prescription
Furosemide	Treats oedema	S3	Pharmacist can dispense only upon a doctor's prescription
Glucagon (hyperglycaemic agent)	Treatment of hypoglycaemia	S4	Pharmacist can dispense only upon a doctor's prescription
Hydrocortisone	Severe anaphylaxis	S4	Pharmacist can dispense only upon a doctor's prescription
Insulin	Insulin replacement in diabetic patients	S3	Pharmacist can dispense only upon a doctor's prescription
Ipratropium nebulisation and inhaler with spacer	Relief of bronchospasm	S2-S3	Pharmacist can dispense without prescription or upon a doctor's prescription

(continued)

Table 10.1 (continued)

Medicine	Indication	Schedule	Dispensing and prescriber
Lignocaine	Suppression of ventricular arrhythmias	S4	Pharmacist can dispense only upon a doctor's prescription
Medical oxygen			
Potassium chloride	Administered for hypokalaemia, maintains water balance, osmotic equilibrium and acid-base balance	S2	Pharmacist can dispense without prescription
Magnesium (sulphate)	Prophylaxis and treatment of hypomagnesaemia, treatment of convulsions	S3	Pharmacist can dispense only upon a doctor's prescription
Naloxone	Antidote for opioid overdose	S4	Pharmacist can dispense only upon a doctor's prescription
Sodium bicarbonate 8.5%	Treatment of hyperkalaemia	Unscheduled/S0	Pharmacist can dispense without prescription
Thiamine	Treatment of beriberi neuritis	Unscheduled/S0	Pharmacist can dispense without prescription
IV solution Ringer's lactate or equivalent balanced salt solution	Fluid and electrolyte replacement and transport medium for medication via IV	S3	Pharmacist can dispense only upon a doctor's prescription
IV solution of sodium chloride (concentration 0.9% w/v)	Sodium and fluid replacement as well as diluting medication administered intravenously	Must be administered by a trained healthcare professional	Pharmacist must take the necessary steps to ensure adherence with legal requirements for administration
IV solution of dextrose (concentration 10% w/v)	Treats low blood sugar and dehydration	Must be administered by a trained healthcare professional	Pharmacist must take the necessary steps to ensure adherence with legal requirements for administration
Neonatalyte	Electrolyte and glucose supplement	Must be administered by a trained healthcare professional	Pharmacist must take the necessary steps to ensure adherence with legal requirements for administration

Source: Emergency Medicine Society of South Africa (EMSSA, 2008–2010)

[a]Based on the names of medicines extracted from the brochure and document published by EMSSA (2008–2010) and stated as under copyright protection. The authors disclose that the copyright is not violated as the names of the medicines in question are common names of medicines that are used all over the world and on a daily basis. Information about the schedules of individual medicines, as applying to South Africa, has been based on the information from Rossiter (2016), government gazette and provincial departments of health documents (KZN Health, 2013) and the Emergency Medicine Society of South Africa (EMSSA, 2008–2010).

[b]Schedules are based on the classification of medicines that are linked to the type of symptom or indication/disease or medical condition which a particular medicine is aimed at treating. The potential for negative side effects, that can arise from self-medication or inappropriate use of the medicines, is also taken into account in determining the schedule, i.e. the need for the authorisation of the dispensing of a particular medicine through a prescription or not. S0 stands for free sale of the drugs in any store, S1 requires that sale take place at a designated pharmacy and S2 and above require additional measures and restrictions on dispensing/sale to prevent adverse impacts on the human health.

1974 also does not define emergencies. The code of conduct of a pharmacist relating to the control of medicines is about Section 22A of the Medicines and Related Substances Act 101 of 1965 and states that "A pharmacist must do everything reasonably possible to assist a person in need of emergency treatment or emergency supply of medicines …." (South African

Government, 1974–2002; SAPC, 2008). This forms part of the ethical principles of a pharmacist where the supply of medicine will be at the discretion and professional judgement of the pharmacist. As established by the acts and regulations discussed herein, the scope of practice of a pharmacist in disaster situations is limited. The role of a pharmacist can be limited by the absence of a prescriber, as far as the legislation is concerned. However, there must be a continuity of healthcare provision after a disaster has struck and some adjustments with the practice of pharmacy have been developed and published to deal with the 2020 COVID-19 pandemic implications on healthcare provision in South Africa.

The Medicines and Related Substances Act 101 of 1965 classifies most hormonal contraceptives as Schedule 3 and 4 substances. Hence, these can only be issued upon a written prescription from an authorised prescriber. In emergencies, a pharmacist may legally dispense these contraceptives upon a verbal prescription from a prescriber known to the pharmacist (South African Government, 1965–2002 s 22A ss 6k). Currently, the only exception to this dispensing rule is the dispensing of the emergency contraceptive pill. A rescheduling of all hormonal products used for emergency post-coital contraception was gazetted by the South African Health Products Regulatory Authority to Schedule 2 medicines in 2000 (South African Government Gazette No. 21687; McFayden et al., 2003). This meant that South Africa joined many countries that make emergency contraception pills available from the pharmacist to a patient in the absence of a written or verbal order by an authorised prescriber (Blanchard et al., 2005; Maharaj & Rogan, 2007). This rescheduling and dispensing of post-coital contraception, along the pharmacist-patient chain without a prescriber, could provide a potential dispensing mechanism in post-disaster situations. Such an alternative provides contraception within the pharmacist's scope of practice and ensures quick and easy access by removing the barriers associated with obtaining a prescription from a healthcare provider (Blanchard et al., 2005). If the dispensing of medicines wihtout prescription can be extended to other medicines, under strict conditions then a potential wider mechanism for pharmacist-driven healthcare provision in post-disaster situation could be developed in South Africa.

10.3.2 Ethical and Additional Guidelines for South African Pharmacists in DRM and DRR

The previous sections indicate that there are some existing tools in the mandate of professional conduct for pharmacists to carry out their duties in disaster healthcare in South Africa. The potential additional ethical tools, which could be utilised in South Africa to allow pharmacists to perform healthcare duties and to assist in the provision of healthcare during a disaster and in disaster zones when parts of the system are not working, include the code of conduct of South African pharmacists, as stipulated by the South African Pharmacy Council (SAPC, 2008).

Section 1.7.1(f) of the Code of Conduct for pharmacists (SAPC, 2008) contains the following text: "Pharmacists may make known to the general public and erect remote direction signs indicating" and further under (iv) "emergency services provided." This indicates that the pharmacist could put up signs about the emergency healthcare services they could provide if the local disaster conditions might prevent access of outside assistance to the population or when leaving the disaster zone might become problematic for practical reasons, for example in patient's seeking certain types of medical treatment. The Code of Conduct for South African pharmacists further contains text in section 1.7.2 (b) that states "Publicity should not contain matters other than:" and this is followed by text of letter ii which states "arrangements made for emergency services" (SAPC, 2008). Qualifications of said pharmacist might also be publicised as stated in section 1.7.2 (b) letter iv (SAPC, 2008). This allows pharmacists to advertise and raise awareness about the emergency and disaster services a pharmacist could provide to the disaster-prone or affected community. Section 1.9.8 of the pharma-

cists' Code of Conduct deals with emergency medicine supply, as already described in detail in the previous section.

The National Health Act no. 61 of 2003 contains section 52, where the South African National Minister of Health can publish regulations governing the deployment, management and allocation of human resources and/or their roles in the (public) health systems in the country. Specifically, subsections (e), (g) and (h) highlight that the Minister of Health can "prescribe strategies for the recruitment and retention of health care personnel within the national health system," "ensure the availability of institutional capacity at national, provincial and district levels of the national health system to plan for, develop and manage human resources" and "ensure the definition and clarification of the roles and functions of the national department, provincial departments and municipalities with regard to the planning, production and management of human resources," respectively. Section 52 would allow the Minister to draft regulations delegating some powers to pharmacists to carry out disaster-related healthcare tasks (NDOH, 2003–present).

The pharmacist in hospital settings in South Africa must keep a stocked emergency trolley, otherwise known as a "crash cart" internationally (Rajeswaran & Ehlers, 2012). The emergency trolley must contain a selection of medicines and other healthcare resources, which can be used in the situation where a patient's life is in immediate threat of death. This is for the nurses and doctors to use after hours and not for the pharmacist to dispense, but pharmacists manage and stock the emergency trolley daily. One example of the list of the emergency trolley and the medicines on it can be found in the guidelines provided by the Emergency Medicine Society of South Africa as referred to earlier (Table 10.1). International suggested equivalent was constructed based on the information from the International Pharmaceutical Federation (FIP, 2016: 29–31) and the details are shown in Table 10.2. Information about the schedules of individual medicines, as applying to South Africa, has been based on the information from Rossiter (2016), government gazette and provincial departments of health documents (KZN Health, 2013) and the Emergency Medicine Society of South Africa (EMSSA, 2008–2010).

The international suggestions include the list of medicines, which should be available during disasters, and list of medicines and stock list for the emergency trolley and the disaster medicines are similar. Thus the emergency trolley list of medicines could be used to devise the list of disaster medicines, which a pharmacist could look after and dispense in disaster zones in South Africa, if regulations and instructions are given accordingly, e.g. regulations issued under the Disaster Management Act no. 57 of 2002, more specifically section 26 subsection 2b), and Sections 27 and 59 (DMA, 2002).

Requirements for Schedules 3–6 in Tables 10.1 and 10.2, where a prescriber must provide a prescription to pharmacists prior to dispensing to a patient, pose a problem in disaster situations. Emergency treatment as defined in the previous section of this chapter can lead to the need for a pharmacist to overstep their professional mandate. This can be mitigated by the implementation of the mechanisms such as the standard order instruction (Levine, 2018). Such a mechanism is legislated in some states in the USA and it allows a pharmacist to register with a prescriber and to get the ability to administer naloxone to a patient, who is suspected in the pharmacist's opinion to be suffering from an opioid overdose. Training could be provided to South African pharmacists with such an approach as part of their continuous professional development (Vhiriri, 2020). In addition, the special dispensing powers could be granted to pharmacists by a regulation under the Disaster Management Act no. 57 of 2002, more specifically section 26 subsection 2b, and Sections 27 and 59 (DMA, 2002). Such regulations should be published after consultation with the South African Pharmacy Council and the Minister of Health.

Medicines in Tables 10.1 and 10.2 will be applied in disaster zones depending on the types of injuries and diseases and the type of disaster that has struck. Rotheray et al. (2012) studied the nature and frequency of the injuries and ailments that were recorded in the Hong Kong public emergency medical centres during cyclones and

Table 10.2 Example list of medicines to stock for emergency situations

Medicine	Indication/disaster conditions	Schedule	Dispensing and prescriber
Oral rehydration therapy/gastrointestinal related			
Zinc sulphate	Prophylaxis and treatment of zinc deficiency. Oral rehydration in children who have diarrhoea	Unscheduled	Pharmacist can dispense without prescription
Aluminium hydroxide + magnesium hydroxide	Dietary supplement	S2	Pharmacist can dispense without prescription
Calcium carbonate	Calcium supplement	S0	Pharmacist can dispense without prescription
Loperamide	Relief of diarrhoea	S2	Pharmacist can dispense without prescription
Bismuth subsalicylate	Relief of diarrhoea	S2	Pharmacist can dispense without prescription
Respiratory tract related medicines			
Theophylline	Asthma, treatment of reversible airway obstruction	S2	Pharmacist can dispense without prescription
Salbutamol	Asthma, treatment of reversible airway obstruction	S2—aerosol/dry powder for inhalations S3—if in the form of a nebuliser solution	Pharmacist can dispense without prescription or upon a doctor's prescription
Antiseptics			
Povidone-iodine (eye drops)	Lubricates chronically dry eyes, thus reducing infections	S0	Pharmacist can dispense without prescription
Chlorohexidine gluconate	Prevents infections through the skin that is burnt and injured and after surgery	S0—antiseptic cream Medicated dressing	Pharmacist can dispense without prescription
Antifungals			
Ketoconazole	Recurring vaginal candidacies, dermatophyte of hair, skin and nail infections unresponsive after topical treatment Topical treatment of cutaneous candidiasis and dermatophytes	S4—tablets S1—antifungal cream	Pharmacist can dispense without prescription or upon a doctor's prescription
Miconazole cream	Cutaneous candidiasis and dermatophytosis Oral candidiasis	S1—topical cream S2—oral gel	Pharmacist can dispense without prescription
Benzoic acid + salicylic acid	Action against dermatophytes	S0	Pharmacist can dispense without prescription
Antibacterials			
Amoxicillin	Mainly used to treat respiratory infections caused by both gram-positive and gram-negative bacteria	S4	Pharmacist can dispense upon a doctor's prescription

(continued)

Table 10.2 (continued)

Medicine	Indication/disaster conditions	Schedule	Dispensing and prescriber
Cloxacillin	Community-acquired *S. aureus* resistant to aminopenicillins and benzylpenicillin	S4	Pharmacist can dispense upon a doctor's prescription
Co-trimoxazole (trimethoprim + sulfamethoxazole)	Prophylaxis and treatment of *Pneumocystis jirovecii* pneumonia, *Isospora belli* diarrhoea, toxoplasmosis	S4	Pharmacist can dispense upon a doctor's prescription
Anti-infectives			
Albendazole	Intestinal parasite infections: roundworm, pinworm, hookworm	S4	Pharmacist can dispense upon a doctor's prescription
Metronidazole	Vulvovaginal candidiasis	S3—topical gel S4—tablets S2—vaginal cream	Pharmacist can dispense without prescription or upon a doctor's prescription
Anti-allergic medicines			
Diphenhydramine	Treatment of allergies, hay fever, common cold symptoms such as rash, itching and watery eyes, itchy nose, runny nose	S2—tablets	Pharmacist can dispense without prescription
Chlorpheniramine maleate		S2	Pharmacist can dispense without prescription
Dexamethasone phosphate (only available via section 21 approval from SAHPRA) Replaced with equivalent dose of **betamethasone**	Allergic skin reactions	S4	Pharmacist can dispense upon a doctor's prescription
Analgesics, non-steroidal anti-inflammatory drugs (NSAIDs)			
Acetylsalicylic acid	Treatment of pain	S0	Pharmacist can dispense without prescription
Paracetamol	Treatment of pain	S0 S1—lower volumes/masses of medicine S3—IV infusion	Pharmacist can dispense without prescription or upon a doctor's prescription
Ibuprofen	Treatment of pain	S1 S2 S3	Pharmacist can dispense without prescription or upon a doctor's prescription
Morphine hydrochloride	Treatment of severe pain	S6	Pharmacist can dispense upon a doctor's prescription

for the period from 2004 until 2009. Their analyses showed that during cyclones, populations suffered from head injuries, injuries to upper limbs, contusions and lacerations (Rotheray et al., 2012). The tropical cyclones Idai and Kenneth that made back-to-back landfall in Mozambique between March and April 2019 recorded up to 1400 cases of cholera in the Tropical Cyclone Idai disaster zone (World Vision, 2019). The destruction of water and sanitation infrastructure has been documented in cyclone-related disaster zones (ReliefWeb, 2019–2021).

In addition to cyclones, South Africa also experiences climate change-related severe thun-

derstorms that often lead to the destruction of settlements. Climate change has been known to impact the health of the human population since at least the beginning of the twenty-first century (London, 2004). Myers et al. (2011a, 2011b) listed various detrimental effects of climate changes on the human health, particularly those caused by water scarcity (Lategan et al., 2020). Effects of climate change are reflected in local shifts of disease patterns that include the seasonal and spatial fluctuations of diarrhoeal disease outbreaks, especially in some regions in the middle-income countries (Sweijd et al., 2015). Rises in the ambient temperatures might impact the incubation period of the *Aedes aegypti*-transmitted viruses in coastal areas of South Africa, as discussed by Rotz (2018). These are examples of the secondary effects of climate change on healthcare, namely shifting disease patterns (Bowles & Butler, 2014). The secondary effects occur on various spatial and temporal scales. In addition, there are tertiary effects of climate change on human health and healthcare provision, which are linked to socio-economic conditions on the ground and political will to drive the change of the healthcare systems towards resilience.

Natural disasters have been on the increase in the twenty-first century and have led to a more and more complex profile of the impacts of human health (Wright et al., 2014). More diarrhoea, cases of pain related to conditions such as the crush syndrome (Li et al., 2009) and other impacts from the changing climate and other natural disasters demand treatment and increasing role of pharmacists in DRM in South Africa. The list of medicines in Tables 10.1 and 10.2 will cover majority of the immediate health outcomes of natural disasters. The practice and stocking inventory of the emergency trolley, as a guide to a starting point, could be used to develop specialised disaster medicine stockpiles ready to be deployed in the immediate aftermath of disasters. Pharmacists would play an active role in the management of such disaster medicine stockpiles as custodians of medicines. Some assistance, in terms of disaster challenges linked to the prescriber-pharmacist-patient chain, has recently been extended to South African pharmacists. Examples of such assistance include the actions by the South African National Minister of Health who has, in response to the disaster conditions of COVID-19, published an emergency extension for the validity of prescriptions for chronic medicines from 6 to 12 months (Mkhize, 2020a, 2020b). The medicines from Schedules 2–4 were exempted from the validity of the Medicines and Related Substances Act, 1965 (no. 101 of 1965) and the validity of prescriptions was extended to 12 months under section 36(1) of the Medicines and Related Substances Act, 1965 (no. 101 of 1965). This could facilitate dispensing in the disaster situations such as COVID-19, but the long-term impact on the scope of pharmacists' practice will have to be evaluated, for example in the domain of professional indemnity insurance and professional ethics of pharmacists.

Pharmacists often function as health awareness agents at the local level and interact with the communities they serve. This mandate could be extended to include a role similar to that of a school pharmacist from Japan (Epp et al., 2016). A pharmacist is assigned a school in their geographical area of practice and they visit there once a month to check on sanitation, healthcare and other related subjects. Such roles could be assigned to the pharmacists under section 52 of the National Health Act no. 61 of 2003 and the section of the Disaster Management Act could be used. These regulations should provide clear lines of conduct for pharmacists in disasters, indemnify them as necessary and provide protection of the pharmacists in the context of specific disasters which have relevant territory in South Africa. Such regulations can be altered on an ongoing basis with the focus on the changing context and landscape of disasters in South Africa, with regard to the communities, government stakeholders and pharmacists. Regulations for the continuous professional development of South African pharmacists (NDOH, 2019a) will have to be updated to include new disaster-related skills.

10.4 Conclusions

The chapter outlines the legal and ethical implications of the practice of pharmacists in South Africa under disaster conditions. Potential chal-

lenges that pharmacists could face under the conditions of emergency medical treatment, as well as conditions which might arise in disaster zones in the country, are discussed. This can originate from the interruptions in the prescriber-dispenser-patient chain, interruption of medicine supply and lifeline interruptions, to name but a few challenges. There are comparable standards which are stipulated for pharmacists as disaster dispensers in South Africa and in other countries such as the USA. Beneficence and non-maleficence must be at the heart of the pharmacist role in the provision of healthcare in the disaster zones in South Africa.

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11

Impact of Cyclones and Extreme Floods on Traditional Medicines and Indigenous Knowledge Systems in Chimanimani, Zimbabwe

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Abstract

Indigenous knowledge systems, including traditional medicines, are an important part of the livelihood of many communities around the globe. In sub-Saharan Africa, the use of modern medicines has never fully replaced the indigenous system, and it is estimated that a great majority of the population relies on traditional medicine not only as its primary healthcare option but also as a significant source of income. Despite their wealth of knowledge and practices, indigenous cultures are not exempt from the threat of environmental change. Over the past 10 years, sub-Saharan Africa has experienced more frequent and extreme climate events such as Cyclone Idai and Cyclone Kenneth. There is evidence to show that these extreme weather events are causing noticeable effects not just on human and animal life but also on the life cycles and distribution of plant species, including medicinal plants. This chapter outlines the role of traditional medicines and indigenous/traditional medicinal knowledge systems in public healthcare in Chimanimani, especially during the 2019 Cyclone Idai event, and the impact that the cyclone-induced floods and landslides had on the availability of medicinal plants. Data was collected from in-depth interviews with medicinal practitioners and a questionnaire-based survey of local community members. The study found that, as a result of the tropical cyclone, medicinal plant species mainly along riverine areas were lost, and also some of the traditional medical practitioners were deceased. The effect of the loss of vital medicinal species cannot be overstated as it is likely to have major consequences on the livelihoods of large numbers of vulnerable people who rely on traditional medicines for their primary healthcare needs. The protection of medicinal plant sites is therefore important for the sustenance of traditional medicinal practice.

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Keywords

Traditional medicine · Indigenous Knowledge Systems (IKS) · Climate change · Cyclones · Floods · Southern Africa

11.1 Introduction and Background

Traditional medicinal practice is a health system comprising the traditional medical practitioners (the knowers), medicinal resources (herbal remedies) and actual healing process (the practice). Traditional medicinal practice is an important aspect of indigenous people's cultural heritage. Indigenous communities, who comprise the majority of the population in countries of the global south, are heavily reliant on traditional medicinal practices for health purposes as they have limited access to modern healthcare (WHO, 2002). Traditional medicinal practice, therefore, has a role to play in fulfilling Sustainable Development Goal 3 (SDG 3) to 'Ensure healthy lives and promote well-being for all at all ages,' as well as SDG 10 to 'Reduce inequality within and among countries' by ensuring access to healthcare (United Nations, 2015). This is particularly so in southern Africa, including Zimbabwe where traditional medicines are an integral part of primary healthcare for the majority of the rural communities (see Chigora et al., 2007).

According to the World Health Organization (WHO), approximately 80% of the rural population in developing counties relies on traditional medicines for its healthcare needs (WHO Regional Office for Africa, 2000; WHO, 2002). Additionally, there are increasing trends in the use of traditional and complementary medicines in both developed and developing countries globally, indicating a growing market for herbal remedies (WHO Regional Office for Africa, 2000; Payyappallimana, 2010; Karunamoorthi et al., 2013; WHO, 2013) due to their natural origin, ease of use and lesser side effects. It should also be noted that a significant proportion of modern medicines are derived from traditional herbal medicines (Payyappallimana, 2010; Yuan et al., 2016). However, despite the wide use of traditional medicines by indigenous communities, traditional medicines are usually marginalised and excluded in formal discourses on community health that are dominated by Western medicinal practices (Abdullahi, 2011; Chakawa, 2015). This points to the need for contextual realignment to embrace the important role of traditional medicinal practice in the provision of primary healthcare. A recent case in point is the national acknowledgement of the use of the traditional medicinal herb *Artemisia annua* in Madagascar to treat affected patients during the onset of coronavirus (COVID-19) global pandemic in 2020 (WHO, 2020).

This chapter focuses on two aspects, namely (i) the role that traditional medicine played in providing healthcare to the local communities during the peak of the cyclone period and (ii) the effects of the March 2019 Cyclone Idai and the resultant floods on traditional medicinal practice in the area of Chimanimani. Chimanimani district is located in the Eastern Highlands of Zimbabwe. The name Chimanimani derives from the indigenous Ndau-speaking people in the area, meaning a mountain gorge or gap. Traditional health practitioners from Chimanimani district and neighbouring Chipinge district in Zimbabwe are famous among the wider indigenous Zimbabwean community, as well as beyond the Zimbabwean borders, for their healing prowess and medicinal knowledge. This can be attributed to the high plant species diversity in the area, characterised by a high degree of species endemism (Mapaura, 2002). There is therefore a link between the natural environment, traditional medicinal practice and human health.

The vegetation of Chimanimani comprises high-altitude, medium-altitude and lowland Afromontane rainforest and grassland ecosystems. This Afromontane ecosystem stretches into neighbouring Mozambique. From a conservation perspective, the lowland rainforests are protected by the Haroni and Rusitu Botanical Reserves and the Makuripini Forest Reserve. The entire montane area is protected as the Chimanimani National Park. The area is drained by the Bundi,

Haroni, Makuripini and Rusitu rivers. The Chimanimani forest area stretching into Mozambique is now a gazetted Transfrontier Conservation Area (TFCA) (Timberlake et al., 2016). Chimanimani forms part of the Eastern Afromontane Biodiversity Hotspot, with the Chimanimani mountains representing a key biodiversity area. Most of the forests in Chimanimani and the surrounding areas are culturally sacred and therefore traditionally protected by the indigenous communities.

The economic activities in Chimanimani district comprise small-scale farms, commercial horticulture farms and commercial forestry areas dominated by pine forests. Besides farming and forestry, ecotourism in the montane forest areas is another key economic activity. The majority of the indigenous population in Chimanimani comprises smallholder farmers.

The increasing frequency and intensity of extreme weather events such as cyclones and their associated floods are the consequences of global climate change (IPCC, 2007; Nhamo et al., 2021). Due to its proximity to the coastal zone of Mozambique, Chimanimani district is prone to cyclone and flood events as evidenced by Cyclone Eline in 2000 (Reason & Keibel, 2004) and the recent and more devastating Cyclone Idai. This chapter explores the role of traditional medicinal practice in responding to community health needs during Cyclone Idai and the impacts that the cyclone-provoked catastrophic flash floods and landslide floods had on traditional medical practitioners and medicinal plant resources in the area.

11.2 Research Methodology

A qualitative approach involving the use of a semi-structured questionnaire-based survey administered through face-to-face interactions with ten participants in the Chimanimani communities (namely Chimanimani Village, Ngagu Township, Ndima Village and Kopa Growth Point) affected by Cyclone Idai in March 2019 and in-depth individual interviews with two purposefully selected traditional medicinal practitioners (based on prior knowledge of one of the researchers who resided in the area) and two traditional chiefs was done on-site in October 2019. The face-to-face questionnaire-based survey and interviews were done to enhance responses from participants. The approach enabled deeper probing to elicit more in-depth responses to the open-ended questions asked and to gather the information that was not available from published sources. The focus of the questionnaire-based survey and the interviews was to explore the use of medicinal plants during the cyclone period (the 3-day period of intense floods and landslides, 15–17 March 2019) and to assess the impacts of the cyclone on medicinal plant resources and practices in the area.

The cyclone period was selected to identify medicinal plants used during emergency in disaster events. The community questionnaire was aimed at identifying health issues during the cyclone and flood period and access to health resources by the affected community. The interviews with the traditional medical practitioners primarily focused on health issues (diseases, epidemics) during the cyclone and flood period and their treatment (knowledge, resources, practices). The interviews also explored the access and availability of medicinal resources (species availability or loss, and access to or lack of access to medicinal plants) to the traditional medical practitioners during and after the cyclone and flood period. Both the questionnaire-based survey and in-depth interviews were audio-recorded and later transcribed for analysis. Data was then analysed by coding and grouping it into emerging thematic areas.

11.3 Key Findings

Traditional medicinal practice relies on the interconnected nexus between indigenous medicinal knowledge, ecological resources (access to plant biodiversity and its conservation) and human health. Catastrophic weather extremes such as cyclones and their associated floods have a devastating effect on the environment, resulting in habitat loss, biodiversity loss and environmental

degradation. Such events have significant negative implications on access to and the availability of medicinal plant resources, which in turn impacts on the provision of traditional primary healthcare within the affected communities. During March 2019, Cyclone Idai and its associated landslides and flash floods had significant impacts on traditional medicinal practice in Chimanimani district as discussed below.

11.3.1 Common Ailments and Their Treatment During Cyclone Idai

While there were no major disease outbreaks during the cyclone and flood period, the common ailments that affected the displaced population were colds, flu and pneumonia (especially among children) due to the prevailing cold weather during the floods, physical injuries and diarrhoea due to the contaminated water supply. During the peak of the cyclone and the resultant landslides and flash floods, the communities stated that they were reliant on the local traditional medicinal knowledge and remedies as access to modern healthcare facilities and medical supplies was cut off. However, this changed when relief was provided post the cyclone and flood damage and access was provided to modern medicines and healthcare facilities. The role of traditional medicine in the affected community during the peak of the cyclone and floods was therefore marginalised by the influx of modern medical assistance during the period immediately after the disaster. However, the reliance on traditional medicines by the communities is expected to increase after local communities' livelihoods stabilise post the cyclone disaster period, especially considering the ephemeral nature of disaster-related external medical assistance. The medicinal plants used to treat ailments during the peak of Cyclone Idai are given in Table 11.1.

Table 11.1 Medicinal plants used to treat ailments during Cyclone Idai in 2019

Botanical name	Common name	Uses
Pterocarpus angolensis	Mubvamaropa	Sap from the bark used to treat wounds as well as stomach ailments
Cymbopogon citratus	Lemon grass	Used to treat coughs, colds, influenza, pneumonia and other chest-related ailments
Citrus limon	Ndimu, lemons	Used to treat coughs, colds, influenza, pneumonia and other chest-related ailments. Leaves were used for steaming. Juice from the fruit is drunk to boost immunity
Eucalyptus grandis	Gumtree	Used to treat coughs, colds, influenza, pneumonia and other chest-related ailments. Leaves are used for steaming
Zingiber officinale	Tsangamidzi, ginger	Used to treat coughs, colds, influenza, pneumonia, other chest-related ailments and stomach ailments. The tuber is crushed or ground, added to hot water and drunk

A combination of both indigenous and introduced cultivated plants was used in traditional treatment of ailments. Most of the plants used during the peak cyclone and flood events were exotic species. This reveals that indigenous communities in Chimanimani have over time adopted some of the exotic plants for medicinal purposes (see Semenya et al., 2012). It could also be attributed to the finding that most indigenous medicinal plants were either inaccessible or unknown to the majority of people in the affected communities. The knowledge of the medicinal uses of most of these exotic medicinal plants appeared to be popular and public domain knowledge within the Chimanimani communities. The availability of this medicinal plant knowledge in the public domain was also indicative of the sharing of knowledge on the treatment of common ailments among community members.

There is a direct link between access to (availability of) medicinal plants and traditional medi-

cal practice, implying that traditional medicinal practice is a biodiversity-dependent service (see Payyappallimana & Fadeeva, 2013). Loss of medicinal plant species therefore directly impacts traditional healers' medicinal practices. The traditional medical practitioners stated that the following plant species (Table 11.2) were lost due to the cyclone and flood effects:

Most of the medicinal plant species that were lost were reported to have been washed away from the riverine areas by the heavy floods and landslides which uprooted and transported away even tall mature trees. The participating traditional medical practitioners indicated that it was not only the loss of medicinal plant species but also loss of access to sites with medicinal plant resources due to cyclone and flood damage that affected their practice. Loss of medicinal plant species negatively impacted the provision of healthcare by traditional medical practitioners to the local community. The participating traditional healers indicated that they now would have to go further afield to access medicinal plants as either local medicinal plant species were lost or their sites were rendered inaccessible due to environmental transformations (landslides, river modifications, infrastructural damage) caused by cyclone and flood damage. However, when losses from cyclone damage are assessed, socio-economic losses are prioritised and ecological losses are rarely considered or prioritised (see for example GFDRR, 2019).

11.3.2 Deceased Traditional Medical Health Practitioners and Their Specialisations

Traditional medical practitioners are the custodians of knowledge and practices of traditional healing that is used to serve the health needs of communities they live in. The tragic demise of traditional health practitioners from sudden unexpected events such as Cyclone Idai disrupts the traditional intergenerational transmission of such medicinal knowledge and practices and results in their loss, thereby creating knowledge and practice gaps. This is because traditional medicinal practice is largely secretive as an in-built indigenous mechanism to protect the knowledge and practice, and the knowledge is transmitted orally. Among the recorded fatalities during Cyclone Idai, three traditional health practitioners were reported to be deceased. These are listed in Table 11.3.

The loss of the traditional healers due to Cyclone Idai floods unfortunately also meant the

Table 11.2 Medicinal plant species lost or severely damaged due to Cyclone Idai and its associated floods

Botanical name	Common name	Uses
Nymphaea caerulea	maHapa, water lily	Used to treat colic in infants
Crossopteryx febrifuga	Mukomberwa, mukombegwa	Used to treat colic in infants, toddlers and adolescence
Unknown	Gotakota	Used as an aphrodisiac, to improve vision and as an anti-ageing herbal therapy
Musa paradisiaca	Banana	The milky sap from the flowering part is used to treat toothache
Khaya anthotheca (Khaya nyasica)	Muwawa, Mubawa, red mahogany	Bark from the east and west of the trunk used for treating a variety of ailments including bleeding gums, stomach ache and period pains in women
Pittosporum viridiflorum	Muchemedzambuya	The bark is used as a male aphrodisiac (keeps penis erect and the user experiences multiple orgasms)
Lannea edulis	Mutsambatsi	Used to treat fontanel problems in infants
Unknown	Mukudza	Used to lengthen the size of the penis
Aloe munchii	Gavakava, Chimanimani aloe	Used to treat high blood pressure and diabetes mellitus
Ficus capensis, F. sycomorus	Muonde	Fruit used to treat fontanel problem in infants, the milk sap is used to treat wounds
Steganotaenia araliacea	Mupomboshori	Used to treat roundworms and tapeworm infections

Table 11.3 Traditional medical practitioners deceased during Cyclone Idai

Practitioner	Gender	Specialisation
1	Female	Treatment of fontanel (nhova) problems in infants
2	Male	Treatment of high blood pressure, sugar diabetes, low libido in men and women, health issues in young children, fontanel (nhova) problems in infants, diarrhoea, herpes zoster, eye infection
3	Female	Not specified

loss of the healing knowledge and practices of these healers. Since this specialised medicinal knowledge is sacred, it is held on behalf of the community by the individual custodian traditional healers and is not commonly shared within the community.

11.3.3 Traditional Conservation Practices for Medicinal Plants

The value of indigenous plant biodiversity to indigenous communities in the Chimanimani district is evident in their traditional forest conservation practices. The larger and more well-known Haroni (traditionally named Nyakwaa), Makuripini and Rusitu (traditionally named Chizire) Forests have been traditionally conserved as spiritually sacred forests (magwasha) by the surrounding communities before their designation by the government as botanical reserves (see Chidakwa, 2003; Ndumeya, 2019). However, according to one participating chief, there are many more culturally sacred forests (though smaller in size) in Chimanimani that are traditionally managed by local chiefs and spirit mediums as they are believed to harbour forest spirits (marombo), including those listed in Table 11.4.

Traditional conservation practices maintain a reciprocal relationship between indigenous communities and natural ecosystems they live in. They reflect a sustainable 'ethic of caring' for the natural ecosystems that communities are dependent upon as exemplified by the inextricable link between medicinal plant species and traditional medicinal practice. This is in line with SDG 15 whose aim is to 'Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss' (United Nations, 2015). Sacred forests are also known to be habitats of a diverse variety of local fauna. These sacred forests are said to be maintained through the observation of various cultural taboos that regulate the utilisation of forest resources.

Table 11.4 Scared forests in Chimanimani

Area chief	Sacred forests/magwasha
Chikukwa	Mawenje, Peza
Mutambara	Guhune
Muusha	Dziike, Nditore, Nyamazha, Teterere
Ngorima	Jiha, Masongoni
Saurombe	Bwaranganda, Chikandavaroyi, Muzinda, Rusvingo, Tengeza

These taboos include the prohibition of the indiscriminate cutting down of trees and the performance of other activities that would desecrate these sacred sites, protection of water sources and protection of plant species of nutritional, medicinal and spiritual value (see Rusinga & Maphosa, 2010). These taboos also extended to certain sacred animal species such as the pangolin, haka, which should not be killed. Such custodial cultural practices are infused into the local communities' everyday lives as a collective responsibility. Breaking these spiritually embedded taboos is said to have dire consequences for the individual and the community from the ancestors as punishment, usually in the form of calamities. During the March 2019 Cyclone Idai and its associated catastrophic flood events, most of the sacred forest areas remained largely intact (unaffected). This is exemplified by one of the chiefs who stated that 'Dzese nzvimbo dzinoera maSaurombe hapana yakakanganisika …' translating to mean that 'all the sacred sites in Saurombe area were not damaged by the cyclone and its associated floods and landslides.'

The traditional importance of community stewardship of sacred forests and the intertwined

reciprocal relationship between community well-being and forest well-being could also be linked to why some participants interpreted the cyclone-induced flash floods and landslide events as divine punishment from God and ancestors for the desecration of sacred sites and destruction of their vegetation, such as one site mentioned by participants in a hill in Ngangu Township. Such cultural beliefs are also shared by other indigenous groups across the globe (see for example Quilo et al., 2015).

11.3.4 Negative Effects of Environmental Degradation

Most participants observed that one of the reasons for the devastating effects of the cyclone-induced floods and landslides was the occurrence of localised environmental degradation such as deforestation caused by the clearing of forest vegetation to provide land for agriculture and to pave way for urban human settlements, veld fire damage, as well as illegal timber harvesting and alluvial gold panning activities. This degradation left some areas of Chimanimani bare and therefore more exposed to landslides and flood impacts. Another observation made by the participants was that the Kopa Growth Point settlement, which was completely washed away by the flash floods and landslides, was located at the confluence of three rivers, Nyahode, Rusitu and Chipita. This settlement was poorly sited in a riparian zone without an environmental impact assessment to determine the potential environmental risks, making Kopa Growth Point highly vulnerable to the cyclone flash floods and landslides.

Participants in this study claimed that, way back in the past, the area where Kopa settlement was situated used to be a wetland (doro) where they grew madhumbe (*Colocasia esculenta*), an edible root tuber crop. Traditionally, such sites were prohibited for settlement purposes. However, such traditional prohibitions were overlooked in the development of the Kopa settlement in the post-independence era. If this ecologically sensitive site had been prohibited for human settlement purposes as traditionally stipulated, the human and economic losses from the Cyclone Idai disaster could have been avoided (Kundzewicz, 2002). One of the participating chiefs emphasised the fact that water catchment areas where water has flowed in the past will always remain waterways in the future, ‘mvura haikanganwi payakambofamba’—meaning water does not forget its pathway. The traditional knowledge of the unsuitability of the Kopa site for human settlement was evidenced through one of the traditional chiefs refusing to have a school named in his honour (Ndima Secondary School) located at this site and having it located elsewhere. Likewise, most banana plantations that were grown in wetland areas (matoro/madwayi) were washed away by the floods, revealing the negative impacts of streambank cultivation. Mention was also made of the more recent culturally unlawful and indiscriminate cutting down of trees that are associated with riverine areas and are traditionally associated with bringing rain such as the muonde (wild fig tree, *Ficus sycomorus*), mutsamvu (wild fig, *Ficus ingens*) and mukute (water berry, *Syzygium guineense*). These trees are used as sacred species (mirombo) for ritual offerings for rains and good harvests. Among these above-mentioned sacred tree species were those also indicated to have medicinal uses that were lost due to the floods and landslides during Cyclone Idai, implying that the deforestation of riverine vegetation could have contributed to the washing away of the remaining medicinal tree species in these ecologically sensitive areas. The loss of medicinal plant species threatens the sustainability of traditional medicinal practices that are directly reliant on these medicinal plant resources. According to the participants, their loss is also traditionally believed to negatively affect rainfall availability of the area in the future, a fact that is scientifically supported (Webb et al., 2005; Ellison et al., 2012; Ellison et al., 2017).

11.4 Discussion of Findings

Indigenous communities are reliant on traditional medical practice for their primary healthcare needs. This was evident during the Cyclone Idai and the associated floods and landslides, where the primary source of healthcare during the peak of the disaster was traditional medicine. However, the role of traditional medicines was temporarily overshadowed by the provision of modern healthcare by external donor assistance post the cyclone and flood damage events. In addition, socio-economic impacts were given more weight in the post-cyclone period compared to ecological consequences of cyclone-related flood and landslide damage such as loss of biodiversity and ecosystems. Furthermore, post-disaster recovery emphasis has been on building resilient infrastructure and not on restoring non-structural defences such as forests and riverine vegetation (Hendel, 2010).

Participants from the indigenous communities in Chimanimani recognise the important role of indigenous forests in their livelihood sustenance, including health provision, and employ a conscious cultural strategy to protect them through traditional conservation practices such as protected sacred forests—magwasha (Rusinga & Maphosa, 2010; Muzondi, 2014; Muyambo, 2018). Traditional vegetation conservation is also practised by many indigenous communities across the globe (Byers et al., 2001; Kumalo & Bernard, 2004; Clark, 2011; Ross et al., 2011; Hecht et al., 2014; Diatta et al., 2020), revealing a prevailing culture-nature nexus. The loss of indigenous medicinal plants due to Cyclone Idai and its associated flood events has negatively impacted on the provision of traditional medical remedies as alluded to by the participating traditional medical practitioners, thereby affecting the provision of primary healthcare to the local communities that rely on traditional medicinal practice. This finding has been supported by separate reports of failure by some traditional medical practitioners based in Chimanimani to treat certain ailments post the 2019 Cyclone Idai catastrophic event as their source of medicinal plants had been washed away by the floods (see for example Tuso, 2020). It is therefore important to revive and strengthen indigenous conservation practices which are important for biodiversity conservation.

Vegetation, as a non-structural defence mechanism (green infrastructure), plays an important role in mitigating the impacts of cyclones and floods and in the conservation of medicinal plant resources (Hendel, 2010; Bredemeier, 2011; Jha et al., 2011). Non-structural measures to mitigate cyclones and their associated flood damage should therefore include vegetation conservation, vegetation restoration and informed urban planning that ensures avoidance of human settlements in ecologically sensitive environments such as river flood plains, watershed areas and wetlands. Forests as well as riverine vegetation can play an important role in reducing the impacts of cyclone and flood damage by providing a natural barrier to these extreme weather events. For example, minimal damage was reported in the densely vegetated areas of Chimanimani during Cyclone Idai. Vegetation directly intercepts precipitation, absorbs moisture, promotes higher soil infiltration rates, enhances soil stability and provides a natural barrier that resists and slows down flood water movement during heavy rains. Vegetation conservation and restoration therefore play an important role in providing non-structural defence to cyclone and flood impacts, but it also serves as an important source of medicinal plant resources for traditional medicinal practice for the present and future generations. Non-structural flood protection makes a significant contribution towards sustainability through supporting long-term climate action (SDG 13) and life on land (SDG 15) (United Nations, 2015).

11.5 Conclusion

Traditional medicines provide an immediate source of remedies to human ailments and injuries during the peak of natural disaster events when external medicine supplies and facilities are inaccessible. However, these extreme weather events, such as Cyclone Idai and its associated flash floods and landslides that caused wide-

spread destruction in Chimanimani, threaten the sustainability of traditional medicinal practice through the loss of medicinal plant biodiversity and plant habitats and the death of knowledgeable traditional health practitioners. This in turn negatively affects the provision of primary healthcare to rural communities that are largely dependent on traditional medicine. The loss of medicinal plants is due to human disturbance of their natural habitats, causing environmental degradation that leaves them vulnerable to weather vagaries. Traditionally, forest vegetation that provides medicinal plant resources has been protected as sacred forests (magwasha) through indigenous conservation practices in Chimanimani. Such sacred forests also serve as natural barriers that mitigate the negative impacts of cyclone and flood events in an area. We therefore recommend that non-structural measures for cyclone and flood mitigation should include sustainable nature-based solutions such as forest conservation, conservation of sensitive vegetation (such as wetlands and riverine vegetation) and vegetation restoration. Such ecological interventions, besides providing natural cyclone and flood defences, can play an important role in the conservation of medicinal plant resources used in traditional medicinal practice.

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12 Uncertainty in Disaster Risk Management: A Reflection on Cyclone Idai Using the Systems Thinking Approach

Shingirirai S. Mutanga and Wilfred Lunga

Abstract

The increasing frequency of disasters induced by anthropogenic and natural hazards has epitomised the complex nature of dealing with uncertainty. Cyclone Idai-induced floods in Southern Africa had a series of foreseeable and unforeseeable risks that affected vulnerable communities in Malawi, Mozambique and Zimbabwe. Thus a key question to address is what systems and mechanisms can vulnerable countries to disasters apply to effectively respond and mitigate challenges posed by disasters. The effects of Cyclone Idai during and after the disaster across the human and physical spheres of society as alluded to in this chapter highlight the need for suitable tools that can assist in unpacking the complexity of disaster management challenges. Adopting a mixed method approach, this chapter proposes systems thinking as a tool that can be applied in disaster risk reduction, taking into consideration that communities constitute intersected and intra- and interdependent subsystems. This chapter advances the need for disaster risk reduction which goes beyond linear approaches of risk management to non-linear frameworks. Essentially, the chapter applies complex systems thinking to enrich existing approaches by recognising known/knowable and unknown risks as well as the interconnectivity between policy, institutions and the society.

Keywords

Systems thinking · Cyclone Idai · Disaster risk management · Disaster risk reduction

12.1 Introduction

The 2019 Cyclone Idai and floods in the Southern African Development Community (SADC) affecting Malawi, Mozambique, Madagascar and Zimbabwe epitomised the complex nature of dealing with the uncertainty posed by both anthropogenic and natural hazards. Evidence from the Cyclone Idai experience in the region has shown

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that a series of foreseeable risks and those that are unforeseeable may be unique (Mbah, 2019). Reifels et al. (2018) posit that some disasters such as emerging infectious diseases (EIDs) that have not been observed before have an inherent cause-effect that makes it difficult to plan for and respond to. According to Jaya and Tuah (2012) such scenarios require systems thinking which provides a holistic understanding of a disaster in time and space, as well as appreciating the uncertainty involved in disaster risk reduction (DRR). Systems thinking approach makes patterns of system behaviour clearer through unpacking of the entire structure under complex situations such as that presented in a disaster situation of any kind. Systems thinking draws from the basic concept of a system. It can be defined as a collection of various structural and non-structural elements that are linked and organised in a way to achieve specific objectives by controlling and distributing measurable resources, energy and information—among others.

Often predefined frameworks and approaches, i.e. disaster preparedness and early warning systems, do not consider complex interdependent risks. In addition, most disaster risk reduction approaches are linear in nature. The linearity gap needs to be closed through intersected holistic approaches that deal properly with interconnected risk factors. This chapter advances the need for DRR moving beyond linear approaches that consider using a systems thinking approach to look at the connectivity between various factors prior, during and post the recently experienced cyclones in Southern Africa. The chapter enriches existing approaches in DRR, recognising known/knowable and unknown risks as well as the interconnectivity between policy, institutions and society through complex systems thinking.

Before the disasters, a series of interrelated connectivity sects need to be considered in terms of both forecasting and planning for disasters (Weems, 2019). The process of enhancing DRR is a huge task, especially for countries with a high disaster profile within SADC region. Depending on the hazard, Arifah et al. (2019) posit that the DRR activities may involve both structural and non-structural measures. In the context of cyclones, Jiang et al. (2019) mention structural measures to include the construction of strong walls, dykes and strong shelters; non-structural measures to consider include building codes, strategic alignment of resources, early warning systems (EWSs), land-use planning, evacuation, training and drills. The above aspects are usually not in place in most SADC countries and this results in many development agencies and other humanitarian organisations facing challenges when disaster events happen. In some SADC countries, there are huge challenges of scaling capacity, improving operational efficiency and improving institutional knowledge. Operating in most countries like Malawi, Mozambique and Zimbabwe during a disaster situation is increasingly challenging for there is poor or inexistent infrastructure and weak coordination (Davis-Reddy & Vincent, 2017).

Preparing for disasters, especially cyclones, calls for good planning and execution of response and recovery measures. Mohapatra et al. (2012) perceive that disaster preparedness has good linkages with early warning systems (EWSs). Early warning from a trusted source that raises risk perceptions of people to act is fundamental (Kolen & van Gelder, 2018). Usually, trusted sources of early warning information trigger positive early responses among the communities at risk (Kyne et al., 2018). This is because anticipation is linked to prior knowledge and experience with the type of disaster they experience frequently (Terti et al., 2015).

Challenges that are associated with improving preparedness, response and recovery need to ensure that the population at risk participates and understands the nature of the threat; this requirement also extends to those who come in to assist so that they can connect and understand the context of the affected. Many processes like prepositioning resources, drills, simulations and rehearsals need to happen before disaster strikes (Kanakis & McShane, 2016). Nakaya et al. (2018) stress that DRR measures need critical assessments to determine strengths and weaknesses in the context of the threatened communities. In the SADC region, most countries'

efforts—especially Malawi, Mozambique and Zimbabwe—to enhance DRR are relatively marginal (Davis-Reddy & Vincent, 2017). Disaster policies in most SADC countries put emphasis on reactive approaches to disasters instead of a proactive focus (Mavhura, 2016). Currently Malawi, Mozambique and Zimbabwe are facing challenges in contributing to the realisation of the Sendai Framework for Disaster Risk Reduction (SFDRR) goals (UNISDR, 2015). Key players and institutions that provide response and recovery services require methods and tools that allow all stakeholders to capture feedback processes, accumulations, delays and non-linear relationships. It is also important to be able to visualise complex systems, in particular their structures and policies that produce the dynamics that include the regulation of performance during a disaster event.

12.2 Literature Review

12.2.1 Systems Thinking Theory

Systems thinking is a conceptual framework which makes system behaviour purer through unpacking of the entire structure under complex situations (Senge, 1999). Essentially, systems thinking stems from the basic concept of a system. It is defined as a collection of several structural and non-structural elements connected and organised in a way to achieve some specific objective through control and distribution of material resources, energy and information (Simonovi'c, 2011). The approach is a paradigm concerned with systems and interrelationships among their components (Cabrera et al., 2008). In systems thinking, there is recognition that factors behind the problematic situations are interdependent. Causal effect between factors is often two-way. The impact of an action is neither instantaneous nor linear. Mutanga and De Vries (2018) assert that systems thinking is a formal, abstract and structured cognitive endeavour in general.

Modern-day society witnesses an increasing need for appropriate tools that can assist in dealing with disaster events worldwide. Disaster occurrences in the SADC region have seen an upsurge in the complexity of disaster management challenges, considering the impact on the environment and the introduction of the sustainability principles (Senge, 1999). Systems thinking is a tool which has evolved over the years and is classified into two divisions, namely the hard and soft systems. The hard systems thinking approach encompasses both qualitative (casual loop diagrams) and quantitative (simulation models). It maps and simulates the dynamic behaviour of complex real-world problems (Anderson & Johnson, 1997). The operationalisation of this approach is encountering numerous challenges due to the reductionist model on which most disaster risk reduction (DRR) strategies are formulated (Simonovi'c, 2011). The soft systems thinking approach identifies its own interfaces, controls and boundaries and assists us to forecast the behaviours, thereby exploring a problem situation from several viewpoints.

Sustainable management of disasters entails a broader understanding of the non-linear systems and how they interact with each other encompassing socio-economic, natural and constructed systems. While the socio-economic factors focus on laws, regulations and policies, the natural systems often look at the global commons or the physical environment and the constructed systems encompass physical infrastructure, i.e. transport systems, water supply, drainage and electricity among many. According to Simonovic, 2012, systems thinking works on different timescales including different processes as parts of a whole. The systems approach helps us better deal with the complexities of interacting non-linear systems for enhanced DRR.

12.2.2 Disaster Risk Reduction

The DRR field rose to prominence from the time of the declaration of the International Decade of Disaster Risk Reduction (IDDRR) between 1990 and 2000 (Coetzee & Van Niekerk, 2018). DRR provided the motivation for a change from the predominant paradigm of disaster response to

that of DRR. This became the means of addressing the underlying drivers which lead to disasters. The United Nations International Strategy for Disaster Reduction (UNISDR), the principal agency for DRR within the UN structures, developed policies and strategies to provide conceptual and practical guidance to how disasters should be reduced. Invariably, systems thinking has redefined the education of disaster management professionals, with increased ability to work in interdisciplinary environments, providing lenses for hazard mitigation, preparation, crisis management and recovery—taking into account complex socio-economic conditions. It, thus, provides a precursor for disaster management in situations of uncertainty.

Cyclones Idai and Kenneth experienced in Malawi, Mozambique and Zimbabwe have shown that disasters are becoming worse in the SADC region (EM-DAT (Emergency Events Database), 2019; Mbah, 2019). Most countries in SADC experience scarcity of resources and high prevalence of limited coping mechanisms (Chesterman et al., 2020). There is limited capacity to develop and adopt strategies to reduce vulnerability to climate change-induced hazards.

Disasters are, in most cases, drastic, sudden and tragic. They have the potential to reconfigure social relationships (Sweet, 1998). Storms (such as tropical cyclones) are responsible for displacing people, with an estimated 1.7 million being left homeless during the period 1980 and 2016 in the SADC region (Davis-Reddy & Vincent, 2017). The experience of cyclones in the region is contributing to additional knowledge through policy documents which incorporate disaster risk reduction, anticipation, preparedness and resilience. There has been a realisation that disaster risk is a dynamic thing (Davis-Reddy & Vincent, 2017). The ability to reduce risk hinges on maintaining awareness of the situation. Lessons from disaster around the world have been incorporated into the United Nations' Sendai Framework for Disaster Risk Reduction (SFDRR) which is a 15-year road map. The United Nation (UN) member states adopted the SFDRR in 2015 in order to make communities safer and more resilient to disasters. Thus, the thinking in dealing with disasters has shifted towards disaster risk reduction, not elimination.

The question that arises is how can countries move towards disaster risk reduction? The United Nations International Strategy for Disaster Reduction (UNISDR), who coordinates DRR strategy, conceptualises DRR as the concept and practice of reducing disaster risk (UNISDR, 2007). DRR is done through systematic efforts to analyse and reduce causal factors of disasters. In DRR there is also the management of the causal factors of disasters, including exposure reduction to hazards, lessening of people's vulnerability and property, wise management of land and the environment, and improved preparedness for adverse effects. Disaster reduction strategies include vulnerability and risk assessment, several institutional capacities and operational abilities. Vulnerability assessment of critical facilities, use of effective early warning systems, social and economic infrastructure, applied scientific types, and technical and other skilled abilities are all essential features of DRR (UNISDR, 2014). UNISDR acknowledges that DRR is everybody business from society, professionals, governments and the private sector. However, the disaster risk reduction strategies being adopted target known hazards. There seems to be a neglect of the fact that disasters are interdependent and systemic. Disasters can trigger cascading effects and are hard to predict (United Nations University, 2011). The unexpected is part of life for many vulnerable communities in the SADC countries. Extreme life events, such as disasters, are not easily forgotten. Several narratives emerge to keep alive the memory of a disaster, its precursors and its consequences in the minds of those who experience it. Thus, there is a need to anticipate and prepare for what vulnerable communities cannot predict and communicate.

Being able to foretell the future has the potential to greatly contribute towards humans' ability to evade possible disasters. Steffen et al. (2015) posit that the changing global environment and advancements in the socio-economic area, technology and information have provided society with the ability to fairly foresee the outcomes of a chosen developmental trajectory. According to

Zalasiewicz et al. (2020), society has developed the skills to change the natural system on which life is dependent. Anticipation of future risks and engaging in DRR behaviour can be an important key to social survival.

12.2.3 Anticipation in Disaster Risk Reduction

Since time immemorial, humans have engaged with the future in order to manage disaster risks. Anticipation is one way of engaging with the future in order to manage emerging disaster risks. Anticipation thinking in the field of disaster risk reduction is likened to predictability, foresight, early warning and preparedness. The concept builds on actor-specific perceptions and practices. Forecasts are long-term change, such as climate change, but the future of societal transformation or economic development remains highly uncertain, and is forecasted using scientific methods.

When there are conditions of uncertainty, decision-making lacks a factual orientation and then resorts to alternative reasoning, like 'gut feelings,' social learning and experience. Disaster events are most of the time planned around the development of a set of scenarios. The scenarios may or may not play out. Sanderson and Sharma (2016) explain that the scenarios give several option decisions based on the assumption that the past is a blueprint for future work. The assumption made is that the future will look the same based on past experiences. In real-life situations, such a line of thinking has contributed to increasing the impacts of disasters and losses over the last decade from 2005 to 2014 (United Nations International Strategy for Disaster Reduction, 2007; Achuta & Otto, 2019).

Society lives and functions in complex adaptive socioecological linked systems (Coetzee et al., 2016). Some of the examples of the complex adaptive socioecological linked systems include small island states consisting of humans, environment, climate, microbes, literature and art—among others—that interact with each other over time. The interaction of components can be ascribed to the system's ability to adapt to changes that happen therein. All complex systems can change to a new state (Poli, 2013). When a disaster strikes, communities recover and, in most instances, it causes people to rethink and change their habits. The changes in habits are a result of communities who, after experiencing a disaster, tend to plan in the present, based on the experiences of the past (Poli, 2013). However, the existence of anthropogenic climate change, full of unknowns, complicates prediction, early warning and adaptation. These factors then lead to a breakdown in anticipation. Nuttall (2010) notes that while adaptation is about responses to disaster risk, it includes action, imagination, possibility and choice. Anticipation is also uncertain, fearful and apprehensive (Nuttall 2010). Anticipation in risk reduction involves acting on the future in the present.

The SFDRR 2015–2030 recommends several actions that include early warning systems (EWSs) to deal with anticipation (Wisner, 2006). However, there is limited information about their means of implementation. The phases of emergency management are cyclical and overlap during the disaster life cycle (FEMA, 2019). In emergency management, mitigation identifies the risks and vulnerabilities to reduce the damages and withstand the impacts of disasters. Early warning systems (EWSs) and preparedness support the capacities and capabilities before hazards, such as reducing these risks and vulnerabilities. Response actions are the direct activities to meet the life, health and safety needs of the community (Garcia & Fearnley, 2012). In most cases, lessons learned throughout each phase of the cycle during a disaster assess and inform new knowledge for DRR. Lessons learnt also have implications for risk anticipation, planning, mitigation, response and recovery.

12.2.4 Early Warning Systems in DRR

EWSs are much more than simple systems for providing a warning for communities to move from an impending disaster (Mizutori, 2020). The example of COVID-19 shows that many

countries ignored warnings of a pandemic, despite mounting evidence. When one takes a glance at EWSs developed for hazards such as cyclones and floods, these may seem inappropriate for other hazards like COVID-19. EIDs are not like hazards induced by climate change that require organised evacuation from a crisis point. EIDs require people to stay put, so as to cut off transmission routes. Vulnerable communities protect themselves by moving away from danger in the case of environmental hazards but with the epidemic, people must protect others through their immobility (Mizutori, 2020; Weems, 2019).

EWSs which are effective should be embedded in a system of observation and communication (Global Preparedness Monitoring Board, 2019). The integration of different expert and policy cohorts, communication mediums, tipping points and iconographies, for the provision of timely warnings to people, is paramount. The aim is to minimise loss of life, including social and economic impact reduction. Arguably the SADC region has not developed an EWS such as the well-known Pacific Tsunami Early Warning System (TWS). The TWS program serves as the operational centre for the Pacific issuing bulletins and warnings to participating members and other nations in the Pacific Ocean area of responsibility. EWS is intended to convey risk levels in an easy-to-understand format (Garcia & Fearnley, 2012). However, EWSs have been the subject of political and scientific experimentation since 1949. ISDR (2006) states that EWS can provide evidenced 'lessons learned' on how to translate scientific observations into alert systems. When we build a warning system to address vulnerable needs, there is a need to bring together expertise from all areas of disaster management. Stakeholders may help to establish and manage effective EWSs for the government bodies that will use it to trigger protocols. In the interconnected world, EWS will be needed to deal with disaster events. Disasters in any part of SADC unfold differently, e.g. disease, cyclones and floods. Disaster risk also has different monitoring systems in place and the behaviours expected or required of individuals in times of crisis are always different. When disaster events strike, they involve many of the same governmental organisations and industries and deal with the same publics. The main questions EWSs rely on, which are relevant to any disaster, include the following questions in Box 12.1.

Box 12.1: Key Questions Considered When Developing an Early Warning System

1. How can a multiscaled EWS work, maintain communication, and remain accountable and transparent across stakeholders (communities, politicians, scientists, etc.)?
2. Are there any combinations of text and iconographies that work across traditional and social spheres to indicate risk levels and advised actions?
3. What other elements can be usefully standardised to provide cross-border guidance?
4. What EWS elements can effectively communicate risk and guidance at the local and regional level?

Source: Global Preparedness Monitoring Board, 2019.

Addressing such questions may require looking at issues from a systems perspective. Systems thinking through its inherent feedback loops with causal effects could provide the necessary linkages between the various stakeholders and the agencies for integrated EWS, response and recovery. Disaster impacts experienced in the region continue to expose these weaknesses, and hence the need to consider complex interdependent disaster risks which need to be closed through intersected holistic approaches dealing appropriately with interconnected risk factors. According to Simonovi'c (2011), contemporary

disaster management problems lead to an increase in the complexity of decision-making processes.

Most countries in the SADC region exhibit limited capacity and ingredients for effective EWS, which demands integration and coordinated actions from diverse actors of EWS, namely risk knowledge, monitoring and warning service, dissemination and communication, and response capability (eNCA, 2019; Mbah, 2019; Reliefweb, 2019). Major constraints for most countries include the limited disaster-related data and the ever-increasing natural variability of domain variables in time and space. These usually lead to an upsurge of uncertainty in DRR decision-making. Often the data required for the management of disasters is costly, and is collected by different agencies. Most countries' government agencies responsible for data collection have serious financial constraints, which limits their capacity to undertake effective data collection programmes.

12.2.5 Disaster Management Subsystems

Essentially, disaster management comprises four linked subsystems which include individuals, organisations and the society—which is a component within the environment. The behaviour of the society and organisations is driven by individuals. The actions of individuals inform the decisions in so far as disaster mitigation, preparedness, response and recovery are concerned. Organisations, therefore, become the mechanisms through which outcomes are obtained, and they are controlled by the available information and/or resources. To put it into perspective, society is a system of which individuals and organisations are subsets containing the relationships people have with one another, the norms of behaviour and the mechanisms used to regulate behaviour (Simonovic, 2015). The environment has elements like water and air, raw materials and natural systems. It also encompasses the universe of ideas, including the concept of 'future.' Simonovi'c (2011) offers seven disaster management principles which point towards systems perspective intervention in Box 12.2.

Box 12.2: Disaster Management Principles

- First principle: Sustainable disaster management calls for proper integration and interaction between individuals, organisations, society and the environment.
- Second principle: Resource and information flows are the conduit through which persons, organisations, society and environment subsystems are interlinked.
- Third principle: Resource needs for each subsystem set the limits of their exploitation and determine the behavioural pattern within the system.
- Fourth principle: Information remains one of the key cornerstones for informing subsystem decisions and the environment.
- Fifth principle: Values shape information flows used to determine resources used in the subsystems.
- Sixth principle: Conditioning access to resources remains one of the most effective disaster management strategies.
- Seventh principle: Systems approach to disaster management may fast-track the understanding of different management strategies and how they may best work.

Source: Simonovi'c (2011).

The principles above capture some of the salient shortcomings in most disaster management approaches, which include narrow recognition of risks due to inadequate mobilisation and understanding of the inherent subsystem dynamics, limited involvement of the human agency, limited appreciation of the critical role of knowledge gaps and unsynchronised stakeholders (Powell, 2016). Operationalisation of emergency preparedness remains difficult given the complex

Box 12.3: Operationalisation of Emergency Preparedness Elements

- Governance: Coordination mechanisms should take into account national policies and legislative instruments for emergency preparedness.
- Capacities: Risk assessments and abilities to decide on priorities for emergency preparedness, information management for surveillance and early warning, as well as access to emergency diagnostic services.
- Risk communications: Research and development, together with monitoring and evaluation for informed and accelerated emergency preparedness.
- Resources: Funding for emergency readiness and contingency response; mechanisms for logistics and necessary health supplies; and human resources (devoted, trained and equipped) for emergency response. One of the major challenges has been sustained funding from national and international financial institutions.

Source: Powell et al., 2016.

and multidimensional processes. Common elements include the following in Box 12.3.

12.3 Methodological Framework

The unfolding and effects of disasters require analysis that addresses structural political-economic conditions, alongside processes that reflect complexity, uncertainty, exigency and context-specific factors. Thus, the theoretical framework which underpins this study is drawn from the anticipation of disaster risk reduction. The chapter draws insights from Cyclone Idai and field observations, together with the assessment of the impacts of Cyclone Idai in Zimbabwe emanating from empirical research conducted by the authors in 2019–2020 for a cluster of humanitarian organisations. This chapter contends that the reduction of disaster risk is plausible with the aid of systems thinking through the predominant paradigm of DRR policy and practice. The following section describes the key components which guided this chapter's framework. Among these has been the adaption of qualitative systems thinking using causal loop diagrams, undertaking situational analysis within the realm of systems perspective.

Theoretical and grey literature review was used to provide insights on the government's preparedness in meeting its international commitments in disaster risk reduction. The literature review also unpacked some of the salient elements of disaster risk management and how systems theory could shape and broaden the understanding of DRR.

This was done through a consultative workshop of multidisciplinary experts assisted in providing a situational analysis of Cyclone Idai impacts in the region. This was complemented with consultations with humanitarian, aid and faith-based organisations such as the Zimbabwe Catholic Community in South Africa, Caritas Zimbabwe and also non-governmental organisations such as Red Cross, Gift of Givers and the Zimbabwean Government through the embassy officials in South Africa. The outcomes of the initial workshop, captured in a workshop report, assisted in shaping the analysis.

This chapter demonstrates the use of qualitative systems analysis in disaster management with special reference to Cyclone Idai. The World Institute for Disaster Risk Management (DRM) has recognised the systems approach as one of the key approaches that could assist in disaster management.

The systems approach model links the elements of risk analysis, vulnerability and risk assessment. The overall risk mitigation tools are needed. To move away from scientific Taylorism, the development of new methods and measures for supporting prevention and intervention undertakings is key. Decision support tools for frontline decision makers on monitoring, evacuation preparedness, forecasting and early warnings are important. Systems thinking proffers such an opportunity.

Powell et al. (2016) articulated how to analyse causal loop diagrams which are summarised in this chapter for convenience purposes. Essentially, the causal loop diagrams are closed and cyclical in structure to depict causality effect. According to Powell et al. (2016) these operate in concert to regulate the system output under the effect of disruptions deriving from variables both on the border of and within the system. Each CLD may have several loops (Sterman, 2000) which can be combined using systems software such as STELLA or Vensim which have the inherent ability to manipulate behaviour towards the desired system outputs. Two examples have been selected to demonstrate the utility of systems thinking in disaster risk reduction which is articulated in the section on findings.

12.4 Study Findings and Discussion

12.4.1 Level of Preparedness

Preparedness levels remain uneven across and within SADC countries (Davis-Reddy & Vincent, 2017; Mbah, 2019). The lack of preparedness has left communities and states at risk of significant short- and long-term health and other societal impacts. Cyclone Idai plunged most districts in Chimanimani, Zimbabwe, into disarray. The flow of and acting on scientific and indigenous knowledge regarding the cyclone was slow. EWSs designed to respond and for recovery were very weak and disjointed in the already under-resourced and unprepared communities. This has highlighted the urgency of resilience building and systems thinking.

12.4.2 Impact of Cyclone Idai on Food Systems

One of the salient impacts of Cyclone Idai has been the destruction of food production systems which resulted in acute food insecurity within the affected zones. Essentially, we hypothesise that the net effect of reduced food production is derived from multiple ripple effects, among which is the diminishing of food crops as a result of cropland destruction. The decline in environmental quality which could be in the form of both cropland and destroyed water reservoirs all occurred during the crop season severely affecting food availability. Possibly, this could have been exacerbated by the level of people displacements in the area.

Inherently this could have led to reduced agricultural labour, affecting production. As shown in Fig. 12.1, seed destruction as well as other farm inputs compounded the declining food production system. Many of the worst affected areas are in the Eastern parts of the country. The disruption of the production system led, therefore, to reduced agricultural income, especially to the farmers and the households that relied by and large on farming for household income. This ultimately resulted in acute food insecurity.

Perhaps one key variable for inclusion would have been the period. Immediately after the cyclone, many households were left desperate for immediate food relief, and in the medium- to long-term scenario, most of these households were left with high food insecurity. Social networks could have served as the immediate response through food relief and social protection. Much as the multinational agencies, government and private sector could assist in providing farm inputs as a response strategy, not much evidence at the time of this writing has been demonstrated other than the immediate temporary response rendered in the form of food relief, evacuation and basic commodities. This analysis demonstrates how a discrete event such as Cyclone Idai can produce the increased likelihood of disruption of supply during and post the event, with catastrophic food supply loss (Fig. 12.2).

12.4.3 Broadening the Understanding of Non-linear Systems in Disaster Risk Reduction

The second example illustrated in Fig. 12.2 shows attempts to broaden our understanding of

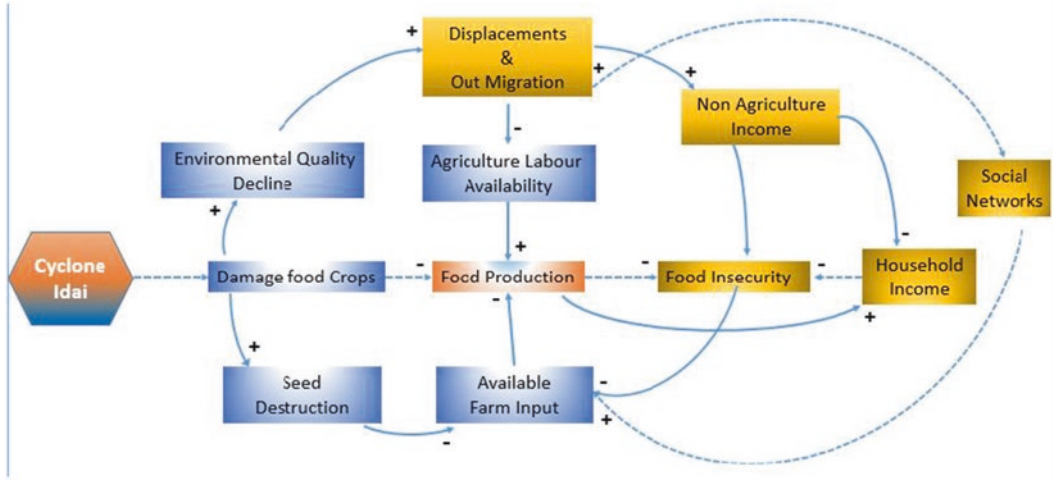

Fig. 12.1 A simplified causal loop illustrating food security impact of Cyclone Idai on communities in Chimanimani, Zimbabwe

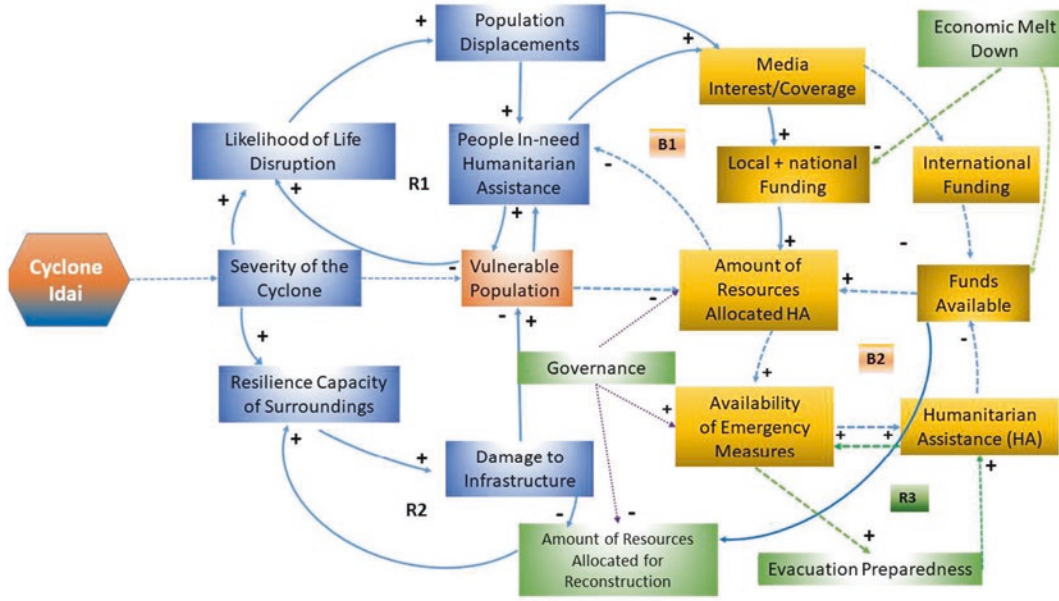

Fig. 12.2 A simplified causal loop illustrating the human and physical impact of Cyclone Idai and the response mechanism for communities in Chimanimani, Zimbabwe

three kinds of non-linear systems which work differently in terms of time and scale through different processes. Essentially it links the physical, socio-economic and political lenses drawing insights from the experience of Cyclone Idai. We hypothesise that the degree of severity of the cyclone influences the likelihood of disruption to livelihoods. Severe disasters, such as Cyclone Idai, increase the likelihood of physical disruption, which leads to human suffering and displacements as witnessed in Chimanimani; thus they increase the total number of people in need of humanitarian assistance. The higher the humanitarian assistance pool, the higher the total number of vulnerable people in the area. To close the loop, vulnerable populations may have a

bearing on the likely loss of life, creating a reinforcing loop (R1) as illustrated in Fig. 12.2. Simultaneously, the higher the severity the higher the probability of overpowering the resilience capacity of the surrounding population, which may result in increased infrastructure damage. The ripple effect could be increased demand for resources needed to reconstruct the destroyed infrastructure. Resources permit resilience to become a factor for consideration, and these elements thus create yet another closed loop (R2) illustrated in Fig. 12.2.

An increase in displaced population plus the people in need of humanitarian assistance may increase media interest (radio, television, print as well as social media) which could attract funding or organisations offering humanitarian support. This could increase the pool of resources needed to respond to disasters. The availability of funds for disaster management may influence the resources allocated for humanitarian assistance. In this scenario, we assume that minimal external influencing factors will be experienced. Thus the people in need of humanitarian assistance will decline—creating a closed balancing loop (B1). However, these depend largely on governance structures and transparency in the subsystem for the donated goods and funds to reach the intended beneficiaries. Politicisation and corruption in the process may lead to the diversion of the funds and resources away from the disaster event.

The socio-economic subsection shows that funds available can determine the amount of resources allocated for humanitarian assistance. This can positively influence the availability of emergency measures which can positively impact humanitarian assistance. The more the humanitarian assistance, the lesser the available funds closing the loop with a negative polarity—thus creating a balancing loop (B2) as shown in Fig. 12.2. The trio, namely availability of emergency responses, evacuation preparedness and humanitarian assistance, create a reinforcing loop (R3). The additional element of evacuation preparedness described above has been explained by Fariza et al. (2015) as a key process that involves establishing authorities and responsibilities for emergency actions and garnering the resources to support them. The causal loop diagram demonstrates that inherently the evacuation preparedness is intertwined and interrelated and depends on other factors.

The above broadening of understanding of complex non-linear systems demonstrates the significance of systems thinking as a tool contributing towards building dynamic resilience of communities to climate change-influenced hydrometeorological disasters. This corroborates a study by Kathy Tang et al. (2016) which applied system dynamics to model social vulnerability and resilience to coastal hazards. Similarly the global change research group developed an integrated climate change impact assessment tool for urban policymakers using systems analysis (APN, 2014). The systems thinking case presented in this study is a step in the build-up to holistic integrated frameworks for dealing with uncertainty in disaster risk reduction.

12.5 Conclusion

This chapter stresses the point that disaster risk is complex and requires approaches such as systems thinking to be applied, for it is a diagnostic tool. Disasters affect communities who constitute an interconnected and intra- and interdependent subsystem including people, numerous physical and virtual infrastructure, organisations, multiple decision makers, political leaders and many other stakeholders. An amalgam of these shows that they constitute systems with multiple subsystems, functions, operations and constituencies. The complex nature of disaster risk requires effective solutions that follow thorough assessments and diagnosis. Essentially, systems thinking proffers an alternative way of examining problems more completely and accurately before acting. It allows us to ask better questions before jumping to conclusions, through consideration of event observations or data, identifying of patterns of behaviour over time and surfacing of the underlying structures that drive those events and patterns. Through the understanding of structural changes that are not helping us well (together with our mental models and perceptions), we can

magnify the choices available to vulnerable communities and create more satisfying, long-term solutions to disasters of all kinds. The systems thinking approach, therefore, assists to articulate problems in new and different ways. The increasing frequency of disasters such as Cyclone Idai continually challenges us to find novel ways of confronting such disasters, with far-reaching consequences.

The systems approach and management tools can assist in unpacking complexities of cooperating non-linear systems. Community well-being and infrastructure's physical state are functions of time; thus, risk analysis, time frame and preparedness are of utmost significance. In addition, the vulnerability and resilience of a system (physical or natural) to a specific threat (initiating event) are manifestations of the states of the system. Therefore, the risk to a targeted system from a specific threat is a function of the state, vulnerability and resilience of the system, as well as the time frame, and the specific threat.

Systems thinking is, therefore, a building block which can assist in designing systems for managing disasters, and we can remodel them, but chances of success will come only if decision makers and stakeholders pay attention to the behaviour of the system, contribute to the management and respond to feedback. The integration of disaster risk-related concerns in the national plans, with undertakings such as capacity building (CB), provides noteworthy prospects for stakeholders and societies to get a holistic picture in developing synergies between actions intended to strengthen DRR. Systems thinking is one such tool which can assist in articulating the causality effect. This chapter posits that the complex technical, structural and communication processes related to preparedness for, response to and recovery from natural disasters are synonymous with the process of disaster risk reduction through assessment, management and communication. The extricable link between the physical environment, socio-economic evaluation and political lenses can thus be unpacked using systems thinking.

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13 The Role of Hunhu/Ubuntu as a Local Community Response to Floods and Cyclones in Chimanimani, Zimbabwe

Talkmore Saurombe and Soul Shava

Abstract

Cyclones and floods pose immediate threats to local community livelihoods and well-being. Indigenous local communities respond differently to emergencies such as floods and cyclones compared to westernised humanitarian responses. While Western responses emphasise national and international emergency relief approaches which focus on temporal evacuation and provision of shelter, treatment and food relief, indigenous responses on the other hand pay attention to both immediate and long-term community resilience, based on Ubuntu/Hunhu, an indigenous ethic of care and humanity. Ubuntu/Hunhu is based on a relational foundation where the individual is always viewed concerning his/her roles and responsibilities in broader family and community context. Drawing from in-depth interviews and focus group discussions, this chapter explores how the Ubuntu/Hunhu philosophy was applied in responding to Tropical Cyclone Idai-induced disasters such as the recent (March 2019) floods and landslides in Chimanimani District in Zimbabwe. Such responses included the provision of shelter and food to the affected people, looking after the vulnerable community members (orphans, widows, the elderly), and the burial of the dead.

Keywords

Community resilience · Landslides · Floods · Cyclone Idai · Indigenous Knowledge Systems (IKS) · Hunhu/Ubuntu

13.1 Introduction and Background to the Study

This explorative study was conducted in Chimanimani District, Manicaland Province, Zimbabwe. Chimanimani experienced a severe Tropical Cyclone Idai-induced disaster during the weekend of 15–17 March 2019 (Oxfam, 2019). The district, being the epicentre of the cyclone, suffered the destruction of roads, bridges, buildings and other infrastructure, and the loss of lives. Due to the destruction of roads and bridges, Chimanimani was cut off and isolated from the outside world which would have brought external responses to the disaster. Thus, the first responses

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and post-disaster recovery actions during and immediately after Tropical Cyclone Idai were mobilised by local community members. Due to the inability of external sources of help arriving to kick-start the disaster risk reduction process, local community empathy and mobilisation based on Hunhu/Ubuntu provided an in-built response and resilience strategy to the cyclone-induced disaster.

The majority of the people in Chimanimani District belong to the Ndau tribe, a language of the ethnic Shona group, which is found spanning both sides of the border between Zimbabwe and Mozambique, with the majority of the tribe found on the Mozambican side. Communities on both sides of the border are connected through language, origin and marriage. For example, the people on the upper Chikukwa section of Zimbabwe share the same Chief with Mozambique (SADC, 2017). In Zimbabwe, the use of the Ndau dialect spreads out to Bikita, Chipinge and parts of Chiredzi. Beyond Zimbabwe, Ndau is the indigenous language spoken in several districts in Mozambique. Ethnology records state that Ndau language has 1.4 million speakers residing in central Mozambique and south eastern Zimbabwe (Kiprop, 2017).

Ndau communities are well known for their adherence to their traditional beliefs and ways of knowing, doing, living and being. They rely heavily on indigenous cultural heritage and local knowledge systems for survival. Their livelihood comprises mixed subsistence farming and semi-commercial fruit farming. The Chimanimani communities survive through trading in agricultural produce, employment in technical trades and manufacturing, tourism and small-scale mining. Forestry plantations are more common among corporate and commercial farmers, but these benefit the local people who are employed in forestry and related activities.

Since the catastrophic events that were induced by Tropical Cyclone Idai between 15 and 18 March 2019, there have been several publications written in a bid to fully understand this phenomenon (ACAPS Zimbabwe, 2019; Mutsaka et al., 2019). However, these publications have covered the events around Cyclone Idai from the donor community perspective of disaster risk reduction (DRR) and climate change action (CCA). This chapter seeks to fill the gap from an indigenous/local knowledge perspective informed by how the indigenous communities employed the African philosophy of Hunhu/Ubuntu to implement bottom-up interventions to respond to the effects of the cyclone-induced damages. While there is evidence on how the Ndau people utilise collaborative communal survival and resilience-building practices such as *humwe/mukote* (work party) (Muyambo, 2019) and *magogogo* (hunting parties), which are primarily based on Ubuntu, there is not much literature regarding how indigenous knowledge *(ruziyo rwechivantu)* and its associated practices have been used in catastrophic events that push them to their limits in Chimanimani (Muyambo, 2019). This chapter explores how Ubuntu philosophy of "*kubata pamwechete*"—"community collaboration" informed DRR and CCA in Chimanimani that enabled community resilience during and after Tropical Cyclone Idai-induced disaster.

13.2 Literature Review

13.2.1 Local Community Knowledge on Disaster Risk Reduction

It has been argued that, for community-level development to succeed, the interventions at the community level are dependent on the availability of relevant local culture, knowledge and adaptability to indigenous practices (ISDR, 2008). International organisations such as the World Bank (2004) and the United Nations (2007, 2015), through the Sendai Framework for Disaster Risk Reduction (2015–2030), support indigenous/local knowledge as a resource that contributes towards attaining sustainable development. Hiwasaki et al. (2014) point out that indigenous knowledge has been receiving attention in the field of disaster management lately. The Hyogo Framework sees the incorporation of indigenous knowledge as important in assisting mainstream disaster risk reduction (ISDR, 2008). Studies on communities in India have shown the value of integrating indigenous knowledge into

disaster management (Jha & Jha, 2011). Some indigenous communities in the Philippines rely on the integration of intergenerational local knowledge into urban disaster governance to create more appropriate and sensitive ways for coping with and establishing local resilience to natural disasters such as flooding (Molina, 2016).

When disaster strikes, communities come together to try and ameliorate the impacts of that disaster through collective community interventions using human and other resources within their community. Delica-Wilson and Gaillard (2012) assert that community participation is essential to fully address the needs and capacities of those affected by disasters as no one knows better than the community what these needs and capacities are. However, national governments, faith-based organisations (FBOs) and non-governmental organisations (NGOs) usually craft their approaches to disaster relief from an outsider's standpoint, disregarding local capabilities, capacities, knowledge and resources. This usually leads to the imposition of solutions that are not compatible with the cultural values and norms of the affected populations and can result in such interventions being rejected because these communities do not relate with them.

When disasters occur, they mostly affect people who live in that specific community, and they are the ones who bear the challenges brought by the disaster before receiving external help. Therefore, community-based disaster risk reduction (CBDRR) provides an opportunity to dovetail indigenous knowledge for disaster risk reduction into mainstream risk reduction at community level (Habiba et al., 2013). Failure to recognise this valuable resource results in poorly tailored strategies, policies and plans with limited impact on reducing disaster vulnerabilities (Twigg, 2015).

Various disasters have affected African societies in different epochs. From communities in the very distant past to contemporary African communities, the indigenous philosophy of Ubuntu is the foundation upon which indigenous societies' disaster management activities are built on. According to Dudley (1988), indigenous institutions are essential for sustainable disaster mitigation. Rumbach and Foley (2014) also assert that understanding indigenous knowledge and institutions that regulate and transmit indigenous knowledge is important to community-based or bottom-up disaster management policies and practice. We, therefore, argue that international agencies should tap from these local community institutions when responding to disaster events.

From the year 2000 when Tropical Cyclone Eline devastated over 2000 km stretch from the east coast to the west coast of southern Africa, there has been an increase in the climate change phenomenon-induced natural disasters. There have been other cyclones such as Dera in March 2001, Cyprien in December 2001, Flavio in 2007, Irina in 2011–2012, Japhet in 2007, Jokwe in 2008, Haruna in February 2013 and Dineo in 2017 and most recently Idai and Kenneth in 2019. These cyclones dumped a lot of precipitation resulting in different types of flooding with associated losses of human lives. Mitigatory processes have taken various forms, with local communities carving out responses as informed by local knowledge systems, but the greater part of responses was informed by international knowledge on DRR.

At a global level, as weather-related natural disasters and emergencies are becoming more severe, frequent and damaging (Niang et al., 2014), there has been a paradigm shift towards integration of local knowledge systems in DRR informed by such disasters as the Asian Tsunami among others (US/IOTWS, 2008). Indigenous communities can be disproportionately affected by emergencies due to their remoteness, capacity and population dynamics. The field of disaster risk reduction has started to look at the contribution of local knowledge of indigenous emergencies to craft response strategies that are informed by experiences and knowledge of the place. The Sendai Priority 1 states that DRR strategies ought to be tailored to the context 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 the context" (UNISDR, 2015:15).

13.2.2 Ubuntu/Hunhu as an Indigenous Philosophy for Community Resilience

Community resilience is evidently expressed in the Ndau song *"Ngatimire se Musambangwena"*—"let's stand together like the willow plant." Musambangwena, *Salix subserrata*, is an indigenous riverine shrub that has a flexible trunk and branches, enabling it to bend without breaking during a flood while remaining resilient to stand upright again after the flood has receded. Community resilience mirrors the Musambangwena phenomenon, enabling "bouncing back" and/or "building back better" after a disaster.

After disaster strikes, communities have to together work towards rebuilding their livelihoods. Disaster resilience is part of the broader concept of resilience which communities have to implement to re-establish their livelihoods based on the resources available to them post-disaster. Resilience here is defined as "… the ability of individuals, communities … and their institutions to absorb and recover from shocks, whilst positively adapting and transforming their structures and means for living in the face of long-term changes and uncertainty" (OECD, 2013:1).

In the context of disasters in Africa, the Bantu people who populate much of sub-Saharan Africa "… cannot conceive a man *(or any human being)* as an individual existing by himself, unrelated to the animate and inanimate forces surrounding him" (Tempels, 1959:36). Thus, they go to great lengths to take great care of fellow beings. *Ubuntu/Hunhu* enshrines the individual to be situated within a reciprocal connection with other people; thus, one exists only because others *(do also)* exist as Masango (2006) summarily stated as *munhu vanhu*, *umuntu ngumuntu ngabantu*. Mupedziswa et al. (2019)) argue that Ubuntu is vitally concerned with the dignity and worth of individuals and communities. Thus, no individual's rights are greater than another's, and every individual in a community should be heard and respected. Ubuntu/Hunhu emphasises norms for interpersonal relationships that contribute to social justice, such as "reciprocity, selflessness and symbiosis" (Osei-Hwedie, 2014:109).

Ubuntu also connotes generosity, consideration and humaneness towards others (Mugumbate & Nyanguru, 2013; Sekudu, 2019). Generosity requires people to be aware of and attentive to the needs of those around them, rather than focusing only on their own needs. It shares much in common with the strength perspective's emphasis on "caring, caretaking, and context" (Saleebey, 2013:20). In many African communities, it is argued that Ubuntu/Hunhu speaks to common African humanity and the responsibility that flows from an African interconnectedness (Mapaure, 2011). The scholars cited above speak to what is at the heart of Ubuntu/Hunhu, that is, how human beings in Africa relate with each other in a community context whether during disasters or in normal life situations. Ubuntu at its simplest is all about "human-ness" (Eze, 2010:24). Literature attests that "Ubuntu is found in diverse forms in many societies throughout Africa" (Murithi, 2007:28). Ubuntu is the basis of African communal cultural life. It expresses the interconnectedness, common humanity and responsibility of individuals to each other (Koster, 1996; Nussbaum, 2003).

Ubuntu tenets draw from the principle of communality of existence within the African cultural world view. The corresponding values are survival, solidarity, compassion, respect and dignity (Mbigi, 1997). Ubuntu is a relational philosophy; its frequent articulation as "I am because we are" points towards a strongly constructivist ontology in which a person's sense of being cannot be detached from the social context in which they find themselves (Bolden, 2014). Thus, Ubuntu may be understood as a form of *sharing, caring, supporting and helping out others*. In the context of the indigenous peoples of sub-Saharan Africa, life can only be enjoyed when it benefits collective humanity.

13.2.3 Ubuntu/Hunhu and Indigenous Community Resilience Strategies in DRR

When disaster strikes, human beings and the environment suffer its effects in varying magnitudes. While some literature portrays a picture that disasters could be mitigated, it has become increasingly clear that humanity can only become better informed about its vulnerability to these hazards, and thereby be more knowledgeable about ways to mitigate the impacts of only these hazards (Nielsen & Lidstone, 1999). Communities, therefore, must build resilience to withstand and recover from disasters through a preparedness that takes advantage of communities' strengths (Nuwayhid et al., 2011). Therefore, since "… each community holds a unique relationship with and an understanding of its environment and knows how to adapt any knowledge or experience to its specific context" (Baumwoll, 2008:2), the application of local knowledge embedded within Ubuntu/Hunhu philosophy becomes an important strategy.

According to resilience theory (RT) (Van Breda, 2018), local/indigenous knowledge and practices are important in building resilience in communities (Aiena et al., 2015), thereby promoting the physical, emotional and social wellbeing of communities that have been exposed to disasters. Community resilience building therefore focuses on the adaptive capacity of individuals, households and community resources through collective strategic action, social networks/capital, knowledge, skills and learning to enable communities to recover from the shocks of disasters (Cutter et al., 2006; Berkes & Ross, 2012).

Mupedziswa et al. (2019) argue that the concept of community as an organising principle for life in most indigenous communities has become one of the communities' resilience practices. By living as a community, human solidarity, empathy and dignity are enhanced. It has to be acknowledged that the focus on communal living is underpinned by values of *cooperation* and *collaboration* as propagated under Ubuntu/Hunhu philosophy. It is this act of "… living collective*(ly)* as a network of people, whose wellbeing and functioning are inextricably linked as members of one family that enable societies to thrive in the face of adversities such as natural disasters." Mugumbate and Nyanguru (2013) observe that communities can build economic, social, psychological and physical resilience in the way they interrelate to overcome the negative consequences of disasters.

13.3 Research Methodology and Research Design

This study was conducted following what Bolden (2014) termed an "… interpretivist epistemology in which precedence is given to qualitative methods that enable an inductive understanding of how individuals and groups make sense of the world around them." This interpretivist approach was guided by indigenous epistemology, that is, a cultural group's ways of thinking and of creating, (*re*)formulating and theorising about knowledge via traditional discourses and media of communication (Gegeo & Watson-Gegeo, 2001, 2002). The culture referenced in this study is the Ndau culture, which is the dominant culture in Chimanimani. The human experiences were captured through ethno-methodological in-depth interviews (Žukauskas et al., 2018). Holden and Lynch (2004) argue that methodological choice in a study should be related to the philosophical position of the researcher*(s)* and the analysed social science phenomenon. This study sought to analyse and document the indigenous coping and resilience mechanisms adopted by the people of Chimanimani District in their response to the disaster situation caused by the extreme weather conditions induced by the Tropical Cyclone Idai.

The study intended to answer the following questions: (1) What were/are the indigenous assistance approaches in emergency flood and cyclone situations? (2) How were these indigenous assistance approaches manifested during Tropical Cyclone Idai? (3) What can be considered as Ubuntu/Hunhu indigenous community resilience strategies in emergencies such as Tropical Cyclone Idai disaster?

The study used an in-depth semi-structured interview guide to collect data. This followed the indigenous storytelling/narrative data collection process (Wulff, 2010:1291) and had to satisfy what Wilson (2008) defined as the manifestation of indigenous values and beliefs. The data collection process adhered to Smith's (2001) cultural protocols, values and behaviours that are acceptable to the dominant culture of the place, to yield authentic and valid data (Muwanga-Zake, 2010).

Data collection focused on purposefully selected areas that were most affected by the Tropical Cyclone Idai-associated flooding and landslides, namely Chimanimani village, Ngangu High-Density Township, Kopa Growth Point and other farming and residential places in the district which were located in the path of the Tropical Cyclone Idai within Chimanimani District. Participants included traditional leaders (chiefs) and local community members in areas affected by Cyclone Idai damage. Throughout the research process, community-appropriate research methodologies and the use of effective, appropriate and culturally sensitive research procedures in relation to ethics and protocols were observed (Rigney, 2006:34).

In-depth interviews were used to explore the participant's understanding of the impact of disaster (Quarantelli, 2002). The research strategy provided an opportunity for interviewees to bring out their thoughts freely (Willis, 2006:145). Data were recorded as audios while field notes were made in a diary to capture verbal expressions, social interactions, emotions, body language and gestures as participants responded to the given questions (Haines et al., 2017). Data was collected through involvement of local people and traditional leadership in the data collection process. Data were also collected as researchers performed walkabouts in the cyclone-affected areas of Chimanimani to observe the effects of community-based strategies that were employed during and after the disaster. In-depth interviews took between 45 min and 2 h. Data were recorded on a digital voice recorder. Additional observational data that elicited itself during these in-depth interviews were recorded in journal format.

During the data analysis process, interview audios were transcribed into text and iteratively read alongside field notes for the researchers to be acquainted with the content of the interviews. The manual coding process was informed by emerging thematic identification approach (King et al., 2003). The branches and sub-branches of relational codes in the data were formed from themes and sub-themes based on observed practices aligned to the tenets of Ubuntu philosophy.

13.4 Key Findings

This study explored Chimanimani indigenous community responses to Cyclone Idai-induced disaster in March 2020. Findings from the study show evidence of the application of the Ubuntu/Hunhu ethic by community members in **caring** for those affected by Tropical Cyclone Idai. The Ndau idiom "*Makudo ndimamwe, panjodzi anorwirana*" (baboons are one; they fight for each other when the danger from an external agent strikes) was found to have manifested. The collaborative community disaster risk management activities had occurred before the arrival of external help.

13.4.1 Providing Early Warning

Several community members indicated that they had gone out of their way to warn other members unaware of the extent of the impending disaster. This is demonstrated in the following quoted statements.

One of the participants (P1) narrated the following incident during the Cyclone Idai-associated floods:

> *First thing ndeyekuti, mvura yeIdai yakanaya just for two days … isusu takatanga tiripasi pebridge iro tiri kumasowe musi weChina up to Friday takarara usiku hwese tiri ipapo … After Friday na3 o'clock yange yaakunaya zvisingaiti ndobva taenda kumba. Taenda kumba, zvakanzi nemweya, "Ndaona nzvimbo ino yaparara." Asi hapana anga achifungudzira kuti zvingaitika zvingaitike. MaRadio akatsinha akati "Ndaona kwauya mvura yeCyclone Idai." Vanhu vakati Cyclone Eline yakauya 2000, haina kudzupura dzimba…*

This translates to:

> *First thing was that the Cyclone Idai rains lasted for just two days … we were under the bridge in prayer and fasting on Thursday to Friday and we spent the whole night there … On Friday after three o'clock the rains were so heavy that we went back home. When we arrived home the Holy Spirit said to us "I saw this place destroyed." However, nobody believed that what happened would really happen. The radios supported this revelation in announcing that "Cyclone Idai heavy rains and floods are coming." People said Cyclone Eline came in 2000, it did not uproot houses…*

In summary, people received warning of the impeding Cyclone Idai from both spiritual sources and news broadcasts. However, they did not heed the warning based on the argument that Cyclone Eline came in 2000 but it did not destroy any property.

Another participant (P2) also narrated a spiritual revelation in the following extract:

> *My son … had a dream two weeks before the disaster. In the dream, Ngangu was flooded and people were dead.*

In reflecting people not heading to early warnings, one of the participants (P3) said the following:

> *Paimba yamurikuona yakasara apo iyo, varidzi vemo vakafa, umwe musikana akazoponera mumuti …, asi anga atoudzwa nemuenzi anga asvikepo kuti, "Budai imomo nokuti mvura iyi irikunzi yakaipa." Zvikanzi "2000 yakanga iriko, moda kutibira."*

This translates to:

> *The remaining house that you see there, the owners died, only one girl … escaped by clinging onto a tree, but they had been warned by a visitor who said "get out of there because the rains that are coming are said to be very heavy." They answered: "in 2000 we had heavy rains, you want to remain stealing from us."*

Despite the warning of the coming cyclone, people did not heed them, citing no destructive experiences from Cyclone Eline in 2000.

The narrative by one of the participants (P4) below also reveals a flood warning that was not heeded, leading to loss of life and property:

> *By the time we drove, the river had risen quite substantially. As we passed the river, there were a number of cars parked by the river, 3 or 4 cars, and we actually had conversations with the drivers that the water level was rising and that they should move away from the bridge. Incidentally, this is where the Nyahode and Mutandagwari rivers meet. The Nyahode River flooded and it was getting dark. The four cars were literally washed away after we had left and there was a loss of life ... It was getting dark and raining heavily, we proceeded to Chimanimani and to Peacock Business Centre and literally stopped there and shouted out to the people there to evacuate. Unfortunately, we lost 17 lives at Peacock and we had 4 survivors.*

Spreading warnings is an indigenous practice to avert danger. However, it was unfortunate that most of the early warnings went unheeded by most of the Chimanimani community. Surviving community members stated that when people were warned they referred to Cyclone Eline of 2000 which caused heavy rains but did not result in flash flooding and landslide damage. This was an indication of relaxation under the anticipation that the forthcoming cyclone would likewise not be catastrophic.

13.4.2 Saving People Trapped by the Floods

Community members went out of their way to try to save people trapped by the floods and landslides. This is narrated in the incidences below.

One participant (P4) narrated the following incident:

> *Umwe murume ... ndiye akati, "No, mvura iyi yava nepressure saka ndaakubuda muno," ndokupinda mumvura ndokunobudira apo, ndokunopinda mushop iri apo yaakanopihwa rope ndokuuya ndokuisungirira pamuti uyo, ndiyo yaicrossa kunosvika kupole yanga iri apo kucamp yepolice ... Murume … akabva ati vanhu huyai mubate rope mubude. Vanhu vakabata rope ndookubuda … Saka paakadaro ... akakwanisa kutora vanhu 60, netambo yaanga akasunga papole remagetsi, achiunza kuno uko.*

In the above incident, the narrator describes how one man used a rope to rescue 60 people from across the river trapped by the flood.

Ndakatanga kuita sendirikurohwa nedzikirira, ndikamutsa mudzimai ndichiti ambonzva zvirikuitika kunze uko. Ndobva ndatomuti ini ndaakumuka iyi ndiyo mhepo yakashata iyi yairehwa inotiuraya tirimumba muno. Ndobva ndamutsa sekuru vangu ndikati, "Sekuru timutse vanhu kumusoro uko. Tichibuda panze wane yaa too late, tirikuona mafoni netorch vanhu varikuridza mhere. Road yataiziva yanga yaoverlappa nemvura. Mvura yanga yatovhara manje vanhu varara, yaakutoerera nepanapa. Ndikati, "Sekuru ngatipinde mumvura tishingise vanhu ava kuti vauye." Nasekuru vangundookupinda tichidaidzira vanhu kuti vauye. Mvura iya ndookuwedzera, tonndookubuda ndobva tauya futi uko, ndookufamba tichimutsa vanhu, vamwe vachiramba ndichivaudza kuti kunze kurikufiwa … Pane vanhu vandakazouya navo tikaita seven. Ndokusunga tambo tikati vanhu vanokwanisa kuuya ngavauye, vanhu ndokuuya.

In the above passage the male participant (P1) describes how he woke up to hear strong winds and when he got out of the house, he noticed that the place was flooding. He then called out to people in the neighbourhoods to warn them and used a rope to save people from the floods.

A male participant (P5) at Chisengu weather station narrated:

A woman and child trapped by rocks were rescued. A family of a husband, wife and three children who were trapped on an Island were saved by the community.

One of the chiefs (P6) narrated:

At Peacock settlement, people who were monitoring water levels in the river went door to door waking up people so they could move to places of safety, as a result of that act 13 people escaped being washed away by the flooded river.

Some surviving (P1 and P2) community members at Kopa Growth Point, the most affected site in the district, stated:

We spearheaded the rescuing of people who had been marooned at the Growth Point as the Nyahode river broke into two and formed an island.

The above accounts provide evidence of how the community organised itself to rescue people trapped by the floods.

13.4.3 Searching for and Burial of the Dead

Male community members voluntarily availed themselves to search for and bury the people killed by the floods and landslides. This is demonstrated in the statements captured below.

Takabva tatanga kubatsira kutakura vanhu vanga vafa tichiisa pachipatara … Ndokubva ndaenda kumortuary kunogezesa vana vakafa. Taiviga vanhu vaviri muguva.

The participant (P7) above discusses how they ferried bodies of the dead to the hospital mortuary and how they helped to bury the deceased, two people per grave.

Another participant (P8) narrated the following incident in which people helped to bury the dead:

The first two days council was trying to bury people because there were bodies everywhere, a lot of them being taken to the church and so forth and we said now we had to deal with this. So, the church got involved, the registrar general issued death certificates and it was a coordinated effort to bury people ...

13.4.4 Provision of Shelter

Many people in Chimanimani lost their homes due to floods and landslides. During the peak of the floods, other community members whose properties were not affected by the floods provided shelter to the affected community members.

One of the participants (P9) who managed one of the local hotels that provided shelter to the community state:

It was now getting to about 11 am on Saturday. I went upstairs and looked out the window and I saw people walking in numbers, carrying whatever it is they could carry. … in my mind, I was thinking, "Where are these people going?" So, I went down and found one of our porters and I said to him, "I've seen a lot of people coming up in the direction of the village, where are they going?" and he told me that they are all huddled up by the shops … Most of them were sitting and

waiting there and they had salvaged whatever they could from their homes and they were looking for shelter. So, I told him to go there and get those people to come into the hotel. I also instructed to start fires so that the people could get warm because they were visibly cold and were holding a few belongings they could salvage. So, people started coming in slowly, 20, 30, 40, 50 and 100 eventually. So, we then separated and said let the women and children sit in the lounge area and the men and boys could go to the conference room. We got the two fireplaces going at the same and I just said let's get as many people as we can in here …

At one of the farms, the farm manager who was a participant (P10) said:

I had to house 60 families in a 12-bedroom house ...

One prominent businessman in the area (P11) had this to say:

During the disaster our main purpose was to save lives, life is important. Because people had been exposed to cold wet weather during the rain we had to accommodate over 500 people from the community on the first night. Also had to put fire in the fireplace so that people could be warm …

One participant (P12) who had lost his home shared the following statement:

Ini ndiri kutochengetwawo … pahama asi ndiri kuchengetwa nenyaya yekushaya pekugara nekuti zvese zvakaenda.

The community member was explaining that he was being offered accommodation by one of his relatives after he lost his home.

A participant (P3) from the vicinity of Chisengu meteorological weather station said:

I took three children to keep at my house and many other people took in other people whose houses were destroyed to stay with them.

13.4.5 Sharing of Resources

One of the participants (P9) who managed a local hotel that provided shelter to the stranded community members shared the following:

So, we looked after the people and fed them and there were around 500 of them. We got help from some church groups and they gave us extra plates and it was still Saturday. We had a bit of maize meal in our storeroom so we prepared a meal. g …We got to the shops and we asked them for whatever they had, rather than it being spoilt in the fridge since there was no power, lets cook it and feed the people. Whatever, it costs, let's pay for it. So, we had people like … he had opened a tab for us at Nyamatanda, he did the same for the people in Ngangu. When he came to see me he said "You've got $2 000 so buy whatever you need" and we said "thanks." With that money we managed to feed about 700 people even though we had 500 at hotel because some would come for places elsewhere. We didn't have enough food so we devised a plan whereby people would eat mid-day, mid-afternoon and if possible at night to make at least two meals a day. Women and children were a priority.

One participant (P3) from near Chisengu weather station stated:

… people cooked food together and shared the food with those who had lost their food to flooding.

One participant (P13) from Chimanimani District Education Office expressed:

In schools, people brought food ingredients together to cook communal meals for 2–3 weeks.

13.4.6 Reconstruction of Access Roads

One manager (P14) who works for an NGO in the Chimanimani area highlighted the role of the community in resuscitating infrastructure in the following statement:

At Rushinga School, 495 people turned up to do trenching of the water pipes. The young traditional leader (headman) was working with the community.

Similarly, the workers' community at one of the nearby farms opened up a road right up to Chimanimani town centre.

13.5 Discussion

Local responses to Tropical Cyclone Idai-induced floods and landslides across communities in Chimanimani District demonstrated the Ubuntu/

Hunhu ethic of caring among community members through their sharing of resources and working collectively. This Ubuntu/Hunhu ethic provided the foundation upon which resilience building was facilitated in local communities. It has to be acknowledged that most indigenous societies rely on intangible assets such as traditional customs and indigenous knowledge, practices, beliefs, skills, social institutions, language and identity (Schech & Haggis, 2000; Adato & Meinzen-Dik, 2002) in building resilience towards natural disasters.

13.5.1 The Ubuntu/Hunhu Ethic of Caring for Community Members During Disasters

In the wake of Tropical Cyclone Idai in Chimanimani, people lost lives, goods, livelihoods and infrastructure, while some were injured, maimed and wounded. People needed immediate means of sustenance. For community members to provide such care to the less fortunate during the disaster they had to be driven by empathy, caring and care-taking (Broodryk, 2006; Sigger et al., 2010; Museka & Madondo, 2012; Saleebey, 2013; Bolden, 2014:2). There is accumulated evidence suggesting that countries that have succeeded in mitigating devastating effects of disasters have utilised the indigenous knowledge held by the local communities affected by these disasters as a resilience strategy (see Iloka, 2016; Rahman et al., 2016). In Chimanimani, the indigenous cultural knowledge was employed in caring for victims of the cyclone disaster to address their immediate needs such as lack of shelter, food and clothing before access to external help. This is corroborated by Dube and Munsaka (2018) who argue that, through the use of their indigenous knowledge, people can respond to different kinds of hazards and disasters before the arrival of disaster risk reduction practitioners.

13.5.2 The Ubuntu Ethic of Compassion and Disasters

Compassion flows out of people who are in a position to observe where help is needed and have a conscience to identify with those in need while seeing in themselves the ability to extend assistance to those who are less fortunate. During Tropical Cyclone Idai disaster in Chimanimani, communities whose Ubuntu/Hunhu values were prominent showed *compassion* (Mbigi, 1997; Broodryk, 2006; Poovan, 2005; Sigger et al., 2010; Museka & Madondo, 2012). This was due to the "commitment and loyalty to the social group of inhabitants of Chimanimani who teamed up in their different capacities to provide material and other kinds of help" (Karsten & Illa, 2005: 613).

13.5.3 The Ubuntu Ethic of Sharing Resources

During the Tropical Cyclone Idai, community members shared resources as a way of fostering community resilience. Ubuntu is focused on sharing and does not accommodate the qualities of greed and selfishness (Broodryk, 2006: 22). Generosity considerations and humaneness towards others (Mugumbate & Nyanguru, 2013) and sharing (Broodryk, 2006; Battiste, 2010) come from an African tradition of Ubuntu/Hunhu whose values and virtues include "… humanness, compassion, care … and empathy" (Rwelamila et al., 1999: 338).

13.5.4 The Ubuntu Ethic of Communalism (Collective Togetherness) in DRR

According to African cosmology, intimacy—being present, being available to help even when you have no financial or material resources—

contributes greatly towards the Ubuntu/Hunhu virtues of humanness, kindness, compassion and humanity as a present individual contributes by providing physical assistance. Ubuntu/Hunhu revolves around empathy. *Empathy* is to be able to put yourself in the place and situation of another.

Community resilience during the Cyclone Idai in Chimanimani was built upon *relationships* (Ki-Zerbo, 2003; Baumwoll, 2008) and the *respect* for human life (Museka and Madondo (2012). Relational resilience is evident in African Ubuntu tenets and values, which emphasise social connections as the crucible of personhood. Some authors use the term "interdependence" (Theron & Phasha, 2015), collectiveness (Bangura, 2005) or what Mapaure (2011) refers to as "African interconnectedness" when addressing resilience of African local communities. For example, the fact that as many as 600 people were housed, fed, had warm baths and were provided with fire for warmth at a local hotel from the first day of Tropical Cyclone Idai until the arrival of external help was the testimony of Ubuntu/Hunhu instrumentality in building resilience within the community. Furthermore, individual community members helped in numerous ways by providing accommodation, practising communal cooking of meals to include those whose foodstuffs had been washed away, collectively monitoring water levels and using traditional strategies of rescuing people that were trapped by the floods, which all showed the *selflessness* (Osei-Hwedie, 2014; Nussbaum, 2003), *compassion* (Khoza, 2012) and community *solidarity* (Bolden, 2014) in the face of adversity.

As asserted by Samkange and Samkange (1980:34) *Ubuntu/Hunhu* "sets a premium on human relations." This manifested itself in how people of Chimanimani portrayed the *interconnectedness of community* (Vaughan, 2016), through *collaboration* (Bangura, 2005; Bolden, 2014) and *cooperation* (Bolden, 2014). As highlighted earlier on in the introduction, Ndau people are found both in Zimbabwe and in Mozambique, so these people are united by blood, culture and chieftaincies. During and after Tropical Cyclone Idai, people on the Mozambican side took photos of bodies that were washed away by floods and posted them on WhatsApp groups, while others communicated with traditional leadership on the Zimbabwean side, notifying them of the numerous bodies that were dumped in Mozambique by the floods which they had buried. All this *communal survival* and *resilience* (Muyambo, 2019) dovetail with Ubuntu as a strategy of building resilience. This aspect of caring, generosity and humanness towards others during the disaster in Chimanimani showed that communities can build resilience to adversity when they work together.

13.6 Conclusion

This chapter revealed how local people in Chimanimani District applied Ubuntu/Hunhu survival strategies in DRR and post-disaster resilience building in communities that were ravaged by Tropical Cyclone Idai in mid-March 2019. While literature attests that recognition and incorporation of indigenous knowledge into DRR continue to be at a minimal due to its marginalisation by mainstream disaster science and policy (Shaw et al., 2009; Mercer et al., 2010) which has historically been strongly influenced by disciplines such as sociology, psychology, civil defence, public administration and development studies (Quarantelli, 1986; Tierney et al., 1988), there is a need to recognise how indigenous constructs of resilience (Kirmayer et al., 2011) can enable indigenous communities to manage and recover from disasters (Kelman et al., 2012). Over-reliance on exogenous knowledge, theories and practices of DRR and resilience building may be counterproductive, especially when applied in unique indigenous communities which rely upon lifelong cultural values and norms.

Empirical results from this study show that during the peak of the severe Tropical Cyclone Idai disaster, communities in Chimanimani mostly relied on the local knowledge and expertise. Their DRR and management practices revealed application of the tenets of Ubuntu/Hunhu philosophy which strongly permeate everyday activities of the predominantly indige-

nous Ndau people who populate the area. While communities have a vulnerability to natural disasters, local knowledge is useful in mitigating the health, social, economic and environmental consequences brought upon societies. In DRR, resilience building needs to tap into local cultural knowledge on disaster coping mechanism. Humanitarian practice in the region by various organisations working in the area of disaster reduction and response has revealed a multitude of undocumented and overlooked practices in many indigenous communities (Shaw et al., 2009).

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14

Exploring Linkages Between Indigenous Knowledge Systems and Conventional Flood Forecasting in the Aftermath of Tropical Cyclone Idai in Chikwawa, Malawi

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Abstract

This study explores links between IKS and climate science for flood forecasting in a flood-prone area, affected by Tropical Cyclone Idai, in Malawi. Rural communities' perceptions of flood trends and risks were collected using household interviews (n = 60), key informant interviews (n = 10) and mixed gender focus group discussions in Chikwawa District. Flood frequency analysis was performed using rainfall and discharge data from nearby weather stations and Mwanza and Shire Rivers. There is a decline in localised rainfall, but increase in flooding from rainfall in upstream catchment. Both communities highlighted reliable IKS (flora, fauna and atmospheric observations) used before the onset of and during the rainfall events for flooding forecasts. However, most of the IK indicators are threatened by environmental degradation and may not be suited to forecasts of patterns or intensity of rainfall at large spatial and temporal scales, such as floods from rainfall in upstream catchment. Therefore, IK indicators may not provide sufficient foreknowledge to respond to climate events such as cyclones. Scientific climate knowledge may provide forecasts at both small and large spatial and temporal scales. Therefore, integration of contextualised IK and scientific climate knowledge can produce robust flood forecasts in the poorly resourced settings.

Keywords

Flooding · Indigenous knowledge systems · IKS science integration · Tropical Cyclone Idai

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14.1 Introduction

The role of local or indigenous knowledge (IK) is increasingly recognised in generating climate knowledge and adaptation strategies (Finucane, 2009; Joshua et al., 2017; Mafongoya & Ajayi, 2017) as well as developing robust flood warning systems. There is no standard definition of IK. This chapter adopts the Berkes (2012) definition which states that IK is "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment."

Several studies have documented how, for many decades, communities in Africa have relied on IK for informed disaster prevention and mitigation, early warning preparedness and response (Kalanda-Joshua et al., 2011; Pareek & Trivedi, 2011; Berkes, 2012; Kasei et al., 2019). The decisions to manage the climate risks are based on their long-term observations of flora indicators, fauna behaviour and astronomy (Nyong et al., 2007; Roncoli et al., 2009; Kangalawe et al., 2011; Kalanda-Joshua et al., 2011; Kijazi et al., 2013; Nkomwa et al., 2014; Kasei et al., 2019). For example, in Swaziland, the local people observe wind direction, the shape of a crescent moon and "nest heights of emahloko birds (*Ploceus* spp.) in trees" to predict the occurrence of floods (Mafongoya & Ajayi, 2017 p40). In this regard, IK has been found useful in predicting the imminent rainfall events, floods and droughts and hence mitigating the effects of possible disasters.

Although parameters used in observations are diverse, there is increasing evidence in literature that shows the convergence of IK system forecasts with scientific forecasts, climate change and seasonal predictions (Kalanda-Joshua et al., 2011; Joshua et al., 2017; Mafongoya et al., 2017). Indigenous knowledge "contributes to climate science by offering observations and interpretation at a much smaller spatial scale with considerable temporal depth, and by highlighting aspects that may not be considered by climate scientists" (Mafongoya & Ajayi, 2017, p. 19). In sub-Saharan Africa, weather and climate forecasting based on climate science is "often criticised for not delivering concise information on local climatic variation" mainly because of its poor communication (Kalanda-Joshua et al., 2011; Nkiaka et al., 2019). Weather forecast messages are said to be "too scientific and technical" for local people with low education (Kasei et al., 2019, p. 185) and often covering large spatial and temporal scales. Further, studies have reported that there is increased uncertainty in seasonal rainfall prediction in many parts of Africa due to increased climate variability (Kotir, 2011; Sutcliffe et al., 2016). Scientists, therefore, face greater challenges in their efforts to improve the accuracy and reliability of forecasts due to the increased uncertainty in the climate regime (Joshua et al., 2017; Kasei et al., 2019). In this regard, over the past 10 years, many IPCC reports have repeatedly highlighted the value of IK in climate and weather forecasting and consequently in informing affordable and sustainable climate change adaptation approaches (IPCC, 2007, 2010). Similarly, Whyte (2013) and Joshua et al. (2017) argue that IK is a "collaborative concept that combined with scientific approaches can be applied to produce better knowledge systems and informed policies that are context-specific." Integration of IK-based flood predictions is therefore instrumental in building people's resilience, especially in hazard-prone areas and hence contributes to the attainment of sustainable development goal 13: climate action.

Although the use of IK in climate or weather predictions in rural areas, specifically in Africa, has received considerable attention Joshua et al., 2012; Joshua et al., 2017; Chanza & Mafongoya, 2017; Mafongoya et al., 2017; Mubaya et al., 2017), the relevance of integration of scientific climate and weather forecasting and IK in flood prediction for flood-prone areas in rural Malawi is understudied. IK and its relevance are often considered site specific (Kalanda-Joshua et al., 2011; Nkomwa et al., 2014). Hence, there is a need for contextualised integration of climate science and indigenous knowledge. This study contributes to addressing this gap for Malawi using Mpasu and Mphampha villages (located in

Chikwawa District) as case studies. In this context, the study explores linkages between indigenous knowledge systems and conventional flood forecasting in the aftermath of Tropical Cyclone Idai in Chikwawa, Malawi. Thus, the study assesses the effect of indigenous flood early warning systems in preparing communities to better manage the imminent floods. In addition, the study assesses the relevance of integration of Western and indigenous knowledge in an early warning on flood risks for flood-prone areas in rural Malawi. Specifically, the objectives of the study are to (i) analyse climate trends and flood occurrence, (ii) explore the application of conventional science and IK in flood forecasting and (iii) analyse the relevance of integration of IK and conventional science in flood forecasting.

14.2 Materials and Methods

14.2.1 Description of the Study Site

Malawi is prone to several climate shocks including droughts and floods and also tropical cyclones (Fig. 14.1). Cyclones and floods affect over half of Malawi's 28 districts (Fig. 14.1). Chikwawa District, southern Malawi, is one of the most prone to flooding events (Winsemius et al., 2015). The two case study villages (*Mphapha* and *Mpasu*) are located in this District, therefore representing a village community prone to weather extremes.

Flood occurrence has largely been associated with El Niño Southern Oscillation (UNECA, 2015; McSweeney et al., 2008; Environmental Affairs Department, 2002). El Niño conditions are normally characterised by drought and dry spells in large parts of central and southern Malawi. On the other hand, La Niña conditions are associated with increased rainfall activity and potential for flooding (UNECA, 2015; World Bank, 2017; McSweeney et al., 2008; Environmental Affairs Department, 2002). Malawi has recorded severe floods since 1946 (Nilsson et al., 2010; DoDMA, 2013; UNECA, 2015).

The 2015 flood is the worst flooding event on record "*in terms of geographical coverage, the severity of damage and extent of loss.*" The event affected over 600,000 people by mid-January and over 1 million by the end of January 2015 (Government of Malawi, 2015, 2017). The flood record shows that the severity of the 2015 flood is

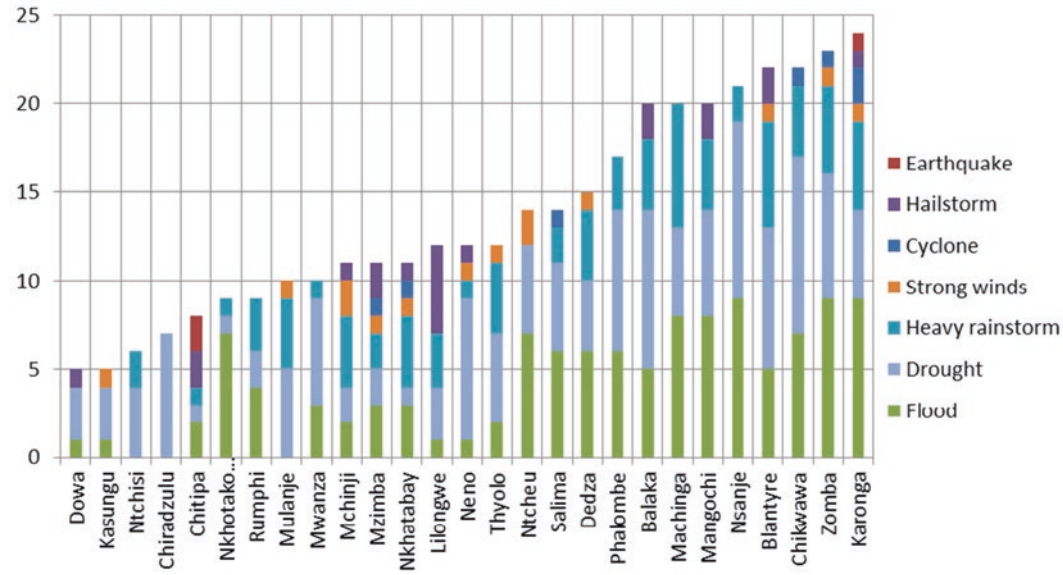

Fig. 14.1 Frequency of shocks by district (2000–2013), excluding Likoma District. Source: Adapted from World Bank (2017)

closely followed by the March 2019 floods, caused by Tropical Cyclone Idai, which affected about 975,600 people (Government of Malawi, 2019). After its occurrence, the Government of Malawi declared a State of Disaster in the 15 districts and 2 cities affected. Thus, understanding how to reduce risk through reliable forecasts for vulnerable communities is important.

The case study villages (*Mpasu* and *Mphampha*) are located in Mbewe Extension Planning Area (EPA), one of the six EPAs of Chikwawa District, in the Lower Shire River valley agroecological zone (Fig. 14.2). The Shire River valley is a rift valley at an altitude of about 2–300 m above mean sea level, and contains Shire River, Malawi's largest river and the only outlet from Lake Malawi. Mphampha and Mpasu villages are located on the borders of Lengwe National Park, about 6 km and 26 km away from the main road to Mozambique, respectively. Mpasu Village has a total of 120 households while Mphampha has 60 households (NSO, 2018).

14.2.2 Data Collection and Analysis

The study used a mixed methodological (quantitative and qualitative) approach to have a comprehensive understanding of the issues under study and enhance the validity of the findings (Brannen, 1992; Barbour, 2008; Hennink et al., 2011). Rural communities' perceptions of flood trends and risks were collected using household interviews (n = 60), key informant interviews (n = 10) and mixed gender focus group discussions in Chikwawa District. The qualitative information was complemented with hydro-climatological data and analysis such as flood frequency analysis using rainfall and discharge data from nearby weather stations and Mwanza and Shire Rivers.

This study builds on a previous study by Joshua et al. (2017) that was undertaken in the study sites. However, the focus in that study was on indigenous knowledge indicators of climate and climate change in general and not specifically on floods, as in this study. Following the 2020 floods, additional data more specifically on indigenous knowledge indicators related to flooding occurrences was therefore collected from the two study sites through focus group discussions (FGDs) of different age groups (age range from 18 to over 70 years) and mixed gender (n = 2) and key informant interviews (n = 10) using checklists. The earlier study by Joshua et al. (2017) also used mixed methods to gather and triangulate relevant information: key informant interviews (KII) (n = 10) with village chiefs, Agricultural Extension and Development Officers (AEDO), Agricultural Extension and Development Coordinators (AEDC) and selected elderly people with standing peerage; focus group discussions (FGDs) (n = 2) mixed by gender and household interviews (n = 60); and document analysis of official flooding records. The households were randomly selected from Mpasu (40) and Mphampha (20) villages, representing a third of a sampling frame. The document analysis focused on the following topics on indigenous knowledge: the prediction of weather, climate, season quality, and management of climatic risks and disasters including floods resulting from Tropical Cyclone Idai. Similar issues were explored in the field survey with farmers through individual interviews, FGDs and KII. In addition to the above-mentioned topics, the FGDs and KIIs explored indicators of IKS commonly used for weather and climate forecasting in the villages, their meanings and use, relevance of IKS in contemporary situations and reasons for related challenges.

The main unit of analysis for household survey was the household—defined as those living within the same compound, and who worked or contributed food or income to the unit. The use of this definition has limitations, especially when applied across countries and diverse cultures, and not all households regard themselves in the same way. However, it was the most relevant for this survey. The data collected from FGDs and KIIs were thematically analysed and that on the perception of climate trends was compared with scientific hydro-meteorological data from the nearby Chikwawa, Ngabu, Nchalo Sugar Estate Stations, Mwanza River at

Fig. 14.2 The location of Mphampha and Mpasu villages in Chikwawa District

Tomali and Shire River at Chikwawa in Chikwawa District, which allowed analysis of the applicability of identified IK in flood forecasting.

Daily rainfall data for three meteorological stations (Chikwawa, Nchalo Illovo and Ngabu) in the study area were collected from the Malawi Department of Climate Change and Meteorological

Table 14.1 Climate stations used in rainfall analysis

Serial	Climate station	Lat (°S)	Long (°E)	Alt (m.asl)	Record period
1	Chikwawa	−16.03	34.78	107	1970–2015
2	Ngabu	−16.50	34.95	102	1960–2016
3	Nchalo Illovo	−16.23	34.93	64	1971–2015

Services (DCCMS) (Table 14.1). A simple average of the rainfall at the three stations was used to represent a regional rainfall for the full common period of 1971–2014. From the daily data, long-term monthly averages and total annual rainfall were derived to understand the nature of the rainfall climatology and temporal variations. In addition, the study derived 11 extreme rainfall indices (Table 14.2) using the package RClimDex by Zhang and Yang (2004) in R statistical software (R Core Team, 2020). The indices are among a whole set of temperature and rainfall extreme indices defined by the Expert Team on Climate Change Detection and Indices (ETCCDI) and are recommended by the World Meteorological Organization–Commission for Climatology (WMO–CCL) and the Research Programme on Climate Variability and Predictability (CLIVAR) for the analysis of rainfall extremes. Significance of trends in the rainfall variables was analysed using the Mann-Kendall (MK) test (Mann, 1945; Kendall, 1975). The MK test is recommended by the World Meteorological Organization (WMO, 1988).

To derive the expected magnitudes of AMS 1 (annual 1-day maximum rainfall series) and AMS 5 rainfall extremes in the study area, the study adopted the rainfall quantiles described by Ngongondo et al. (2011) for homogenous regions of southern Malawi. The respective regional rainfall quantiles were multiplied by the mean 1xDay and 1x5Day rainfall for comparison with the rainfall magnitudes that were experienced during Cyclone Idai.

Table 14.2 Extreme rainfall indices

Code	Name	Definition	Unit
RX1day	Max 1-day precipitation amount	Monthly maximum 1-day precipitation	mm
Rx5day	Max 5-day precipitation amount	Monthly maximum of consecutive 5-day precipitation	mm
SDII	Simple daily intensity index	Annual total precipitation divided by the number of wet days (defined as PRCP> = 1.0 mm) in the year	mm/day
R10	Number of heavy precipitation days	Annual count of days when PRCP> = 10 mm	Days
R20	Number of very heavy precipitation days	Annual count of days when PRCP> = 20 mm	Days
CDD	Consecutive dry days	Maximum number of consecutive days with RR < 1 mm	Days
CWD	Consecutive wet days	Maximum number of consecutive days with RR > =1 mm	Days
R95p	Very wet days	Annual total PRCP when RR > 95th percentile	mm
R99p	Extremely wet days	Annual total PRCP when RR > 99th percentile	mm
PRCPTOT	Annual total wet-day precipitation	Annual total PRCP in wet days (RR > =1 mm)	mm

Source: Zhang and Yang (2004)

Table 14.3 People's perceptions on climate change in the three villages, focus group perspective

	Village and year of study			
	Mphampha village		Mpasu village	
Climate trend	2015	2019	2015	2019
Rainfall—Declining amounts, more erratic, high variability, a shift in the onset date (from Sept/Oct to Dec/Jan)	√	√	√	√
Rainfall—Early cessation	√	√	√	√
Temperature—Increased in comparison to the 1990s	√	√	√	√
Floods—More frequent	x	√	x	√
Droughts—More frequent	√	√	√	x
Prolonged dry spells—More frequent	√	√	√	√
Winds—Becoming very windy, strong winds often disperse the rain clouds affecting the rainfall pattern	√	√	√	√
Source	Joshua et al. (2016)	This study	Joshua et al. (2016)	This study

14.3 Results and Discussion

14.3.1 Climate Trends and Flood Occurrence

The FGDs reported that both Mpasu and Mphampha villages are characterised by year-round extremely high temperatures and irregular rainfall patterns in the rainy season. However, they perceived a change in climatic variables in recent years, notably since 1992 (Table 14.3). Respondents in FGDs and the KIIs particularly perceived high variability in rainfall patterns. For example, the local people can no longer predict the likely arrival, duration of the season or rainfall amounts. In other cases, there may be good rainfall activity at the start of the season, only to be replaced by dry spells midseason.

The respondents at FGDs also perceived a declining trend in the amount of rainfall resulting in frequent prolonged dry spells and droughts in recent years. However, the key informants' perspective, based on gauged data, was that the total amount of rainfall received had not changed significantly. However, they generally agreed that dry spells had become more frequent and prolonged. For example, in the 2011/2012 growing season, the longest dry spell was 24 days instead of the more common 10–12 days. The area had experienced worse conditions of prolonged dry spells and midseason droughts every year since 2007/2008 growing season.

Temperatures were perceived to be increasing annually with the warmer periods beginning earlier than in the past. These high temperatures used to be associated with a high probability of a rainfall event but this is no longer the case. Further, the FGDs reported that there has been a notable increase in strong winds. The household respondents reported that floods are now less frequent in Mpasu and Mphampha Villages (61%, 91%). In addition, seasonal droughts, erratic rains, intra-seasonal dry spells, strong winds and high temperatures are more frequent in all villages where stormy winds are becoming less frequent. Table 14.4 provides a summary of major climatic events that had occurred in Mpasu and Mphampha since the 1980s, based on focus group discussions in the earlier work and recent study after Tropical Cyclone Idai. The perspectives from the FGDs and KIIs are that the two villages have experienced repeated and almost annual flooding conditions since 2015 (Table 14.4). The recent flooding events result from both local and upstream rainfall activities.

During the period 1961–2015, Chikwawa District received mean (from three stations) annual rainfall of 741 mm. The mean annual rainfall at the individual stations was 763.8 mm, 763.4 mm and 696.0 mm at Chikwawa, Ngabu and Nchalo meteorological stations, respectively. Rainfall events in November–April

Table 14.4 Major climatic events and their associated impacts in the village

Year	Event	Village	
		Mpasu	Mphampha
1980/1981–1981/1982	Drought	√	–
1986/1987	Drought	√	√
	Floods	–	√
1989	Floods	–	–
1991/1992	Drought	–	√
1992/1993	Drought	√	–
1993/1994	Drought	–	√
1997/1998	Floods	√	√
1998/1999	Strong winds	√	–
2000/2001	Drought	√	–
2001/2002	Drought	–	√
	Floods/excessive rains	√	–
	Strong winds		√
2005/2006	Floods and drought	–	√
2007/2008–2012	Prolonged dry spells and midseason drought	–	√
	Prolonged dry spells/ drought for 5 consecutive years	√	–
2012	Prolonged dry spells and midseason drought	√	–
2015–2016	Floods and drought	√	√
2019	Floods	√	√

Source: Joshua et al. (2016, 2017); focus group discussions (2019)

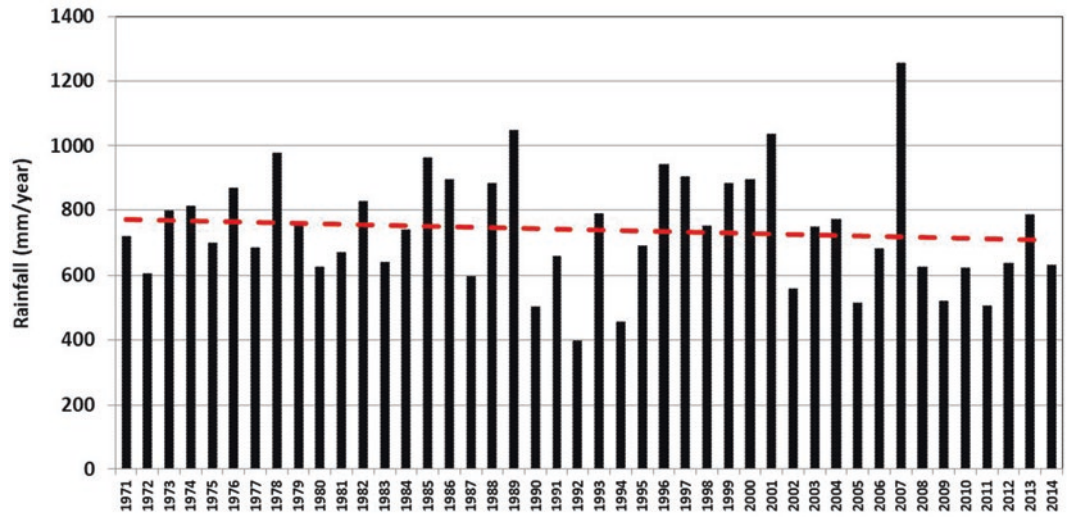

Fig. 14.3 Bar graph showing the mean annual rainfall for Chikwawa area based on Chikwawa, Nchalo and Ngabu stations from 1961 to 2014. Dashed is the linear regression trendline

account for over 80% of the total annual rainfall at all the stations. Rainfall peaks during the months of January, February and March at all the stations (Fig. 14.3). These are also the months when most of the devastating cyclones occur in Chikwawa and in recent years, these have been noted to have increased in frequency (Fitchett, 2018).

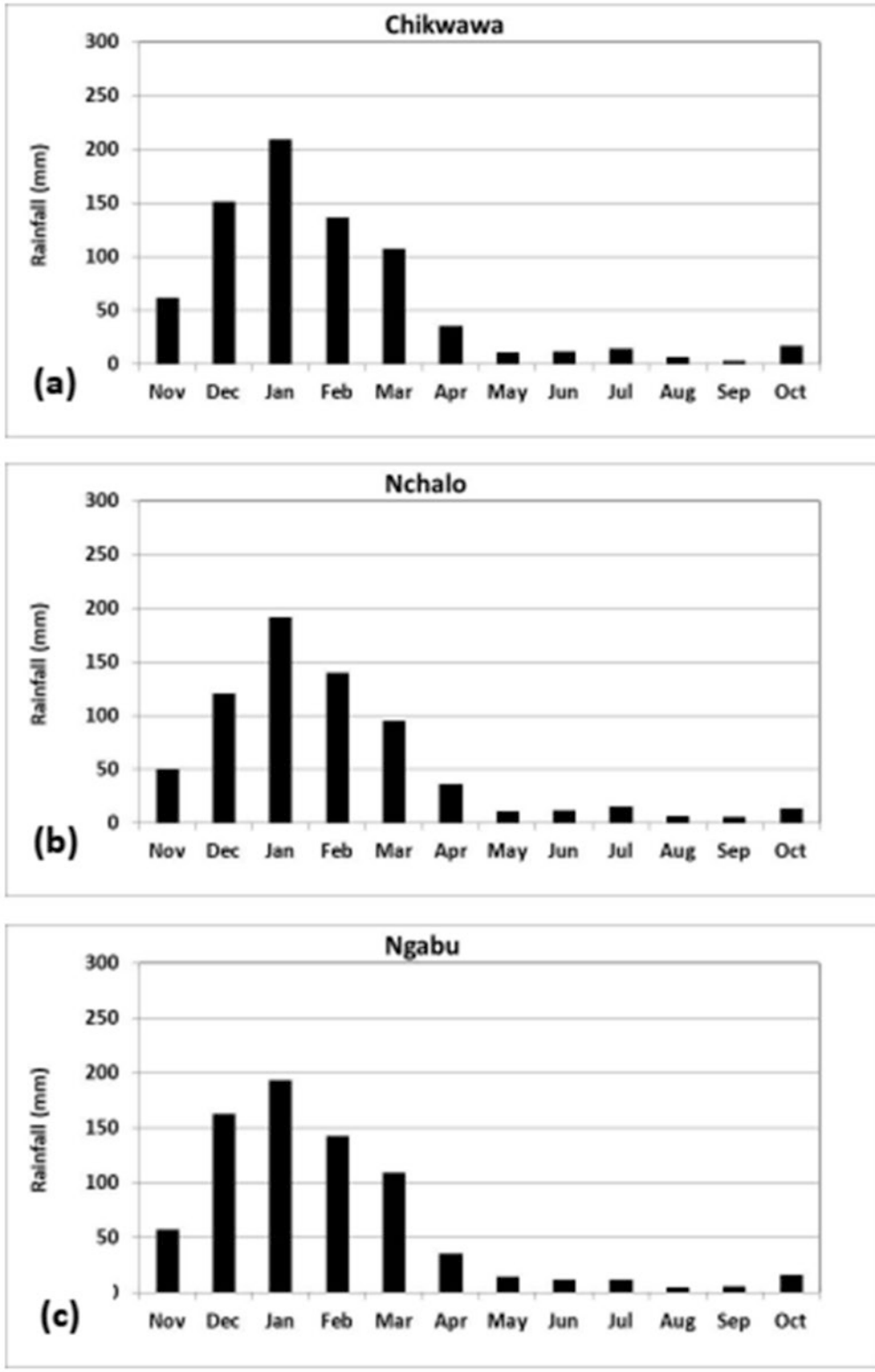

Fig. 14.4 Rainfall climatology from 1961 to 2014 at the three stations: 5(a) Chikwawa; 5(b) Nchalo; and 5(c) Ngabu

During the period, none of the three stations had significant trends in the annual rainfall regime (according to the Mann-Kendall (MK) statistic) at $\alpha = 0.05$ significance level (Fig. 14.4). Similar trends in the annual rainfall have been reported by other studies including Ngongondo et al. (2011) for the period 1961–2007 and Ngongondo (2011) for the period 1978–2007. The highest wet-season rainfall amounts experienced during the period of available data were total rainfall of 1237.9 mm at Chikwawa in 2007, 1280.4 mm at Nchalo in 2007 and 1254.9 mm at Ngabu in 2001. The driest years were 2005 at Chikwawa (402 mm), 1992 at Nchalo (302 mm) and 1987 at Ngabu (410 mm). The daily rainfall maxima were as follows: Chikwawa: 147.7 mm on 11 January 2003; Nchalo: 179.5 mm on 30 April 1987; and Ngabu: 165 mm on 12 March 2000.

Rainfall extremes in many parts of Malawi have been intensifying recently (Ngongondo et al., 2014). The results at the individual stations for the study area show positive trends (Table 14.5) for CDD (at Nchalo and Chikwawa), SDII (at Nchalo) and Rx5Day (at Ngabu). For the regionally averaged rainfall during the common period between 1971 and 2014, the results show that only CDD and SDII had increased significantly at $\alpha = 0.05$ level, with Chikwawa and Nchalo having the larger increase in CDD, whereas Nchalo had a larger increase in SDII (Fig. 14.5). The temporal trends of the indices suggest that individual rainfall events from 1971 to 2014 have intensified (increased SDII), while the number of dry days between individual rainfall events has also increased. The SDII trend can partly explain the increased frequency of flood-generating storms as individual storm magnitudes have increased, while the total annual rainfall has not changed significantly, agreeing with Ngongondo et al. (2014). These trends are to a greater extent consistent with local people's perceptions of the study areas' climate trends.

The study by Ngongondo et al. (2011) identified the generalised extreme value (GEV) distribution and Pearson type 3 as the most suitable for analysis of 1-day and 5-day annual maximum rainfall in Chikwawa District, respectively. The mean 1-day maximum rainfall is 79.0 mm whereas the 5-day annual maximum had a mean of 139.3 mm. The expected magnitudes for annual 1-day and 5-day maximum rainfall and their return periods are shown in Fig. 14.6.

During Cyclone Idai, Chikwawa District received a total of 160.1 mm of rainfall between 6 and 7 March 2019. This was a rare event and corresponds to a return period of a chance of occurring about once every 100–175 years (Fig. 14.6). This 1-day rainfall amount is equivalent to 21% of the total mean rainfall for the Chikwawa area (mean = 741 mm). During the period from 1 March to 10 March 2019, Chikwawa recorded 224.6 mm (Malawi Climate Change and Meteorological Services Bulletin, CCMS, 2019). These storm magnitudes correspond to return periods of about 220 years for Chikwawa (Fig. 14.6) if compared to the 5-day annual maximum, and are equivalent to 30% of the annual total for the Chikwawa area. According to CCMS (2019), some individual stations like Makhanga station close to the Chikwawa area recorded 376.7 mm. This is an indication that Cyclone Idai's intensity varied considerably across southern Malawi.

Daily river discharge for the Mwanza River at Tomali and Shire River at Chikwawa was analysed for their temporal characteristics. The results show daily mean discharges of about 6.605 $m^3 s^{-1}$ for the Mwanza and 590.4 $m^3 s^{-1}$ for the larger Shire River. It should be noted that Shire River flows are regulated at Kamuzu Barrage in Liwonde, about 150 km upstream to

Table 14.5 Significance of trends in rainfall extreme indices

Station	PRCPT	CDD	CWD	R10mm	R20mm	R25mm	Rx1Day	Rx5Day	SDII	R95P	R99p
Chikwawa	NT	+S	NT	NT	NT	NT	NT	NT	NT	NT	NT
Nchalo	NT	+S	NT	NT	NT	NT	NT	NT	+S	NT	NT
Ngabu	NT	NT	NT	NT	NT	NT	NT	+S	NT	NT	NT

NT* = no trend; +S = significant positive trend; −S = significant negative trend

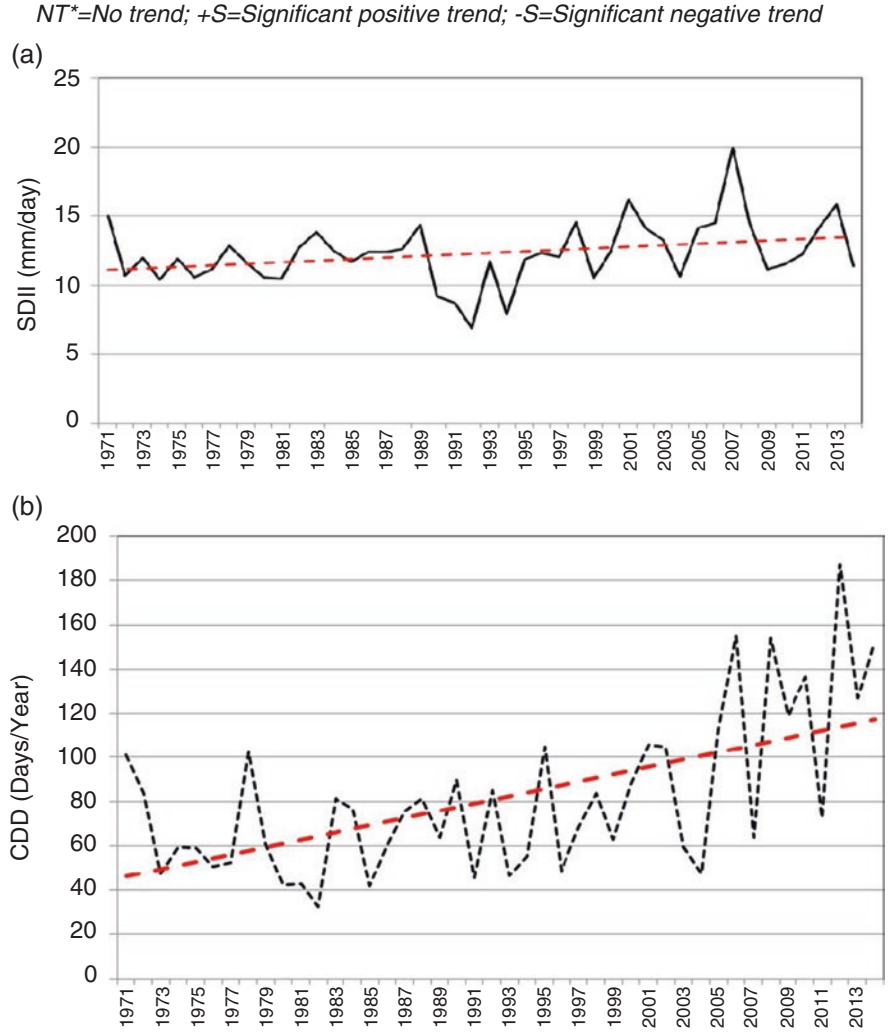

Fig. 14.5 (**a**) Temporal pattern of SDII, (**b**) temporal pattern of CDD from 1971 to 2014 at Chikwawa

ensure a minimum downstream of 150 m^3 s^{-1} during the driest periods. The Kamuzu Barrage gates are fully opened for structural integrity reasons only when the upper Shire basin, including the Lake Malawi Basin, experiences heavy rainfall. The barrage has rarely been opened since 1992 and therefore a good part of the total flow component for the Shire at Chikwawa is inflows from its key tributaries after the Kamuzu Barrage. During Cyclone Idai, flows at the Kamuzu Barrage were reduced from 200 m^3 s^{-1} to 40 m^3 s^{-1} which further resulted in a reduction of flood magnitudes from the tributaries' contributions (World Bank, 2019).

The results further show that the largest daily discharge for Mwanza River was 1643 m^3 s^{-1} recorded on 8 March 1989. On the other hand, the largest discharge for the Shire River was 2074 m^3 s^{-1} on 23 March 1978. The results further show that the maximum value for the Mwanza River is comparable to the average flow for the Shire River of 1537.6 m^3 s^{-1} on the same date. The rainfall data for Chikwawa station confirms this aspect and shows that a total of 402 mm of rainfall was observed between 1 March and 8 March 1989, of which 336.5 mm was in only 3 days (5–8 March 1989), suggesting

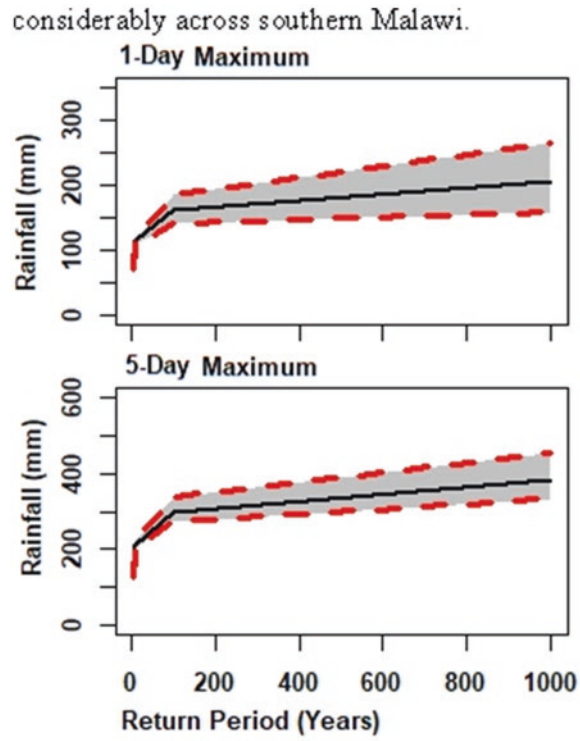

Fig. 14.6 Expected magnitude of 1-day and 5-day annual maximum rainfall in Chikwawa. Red dashed lines are outer bounds of 95% confidence interval (shaded area)

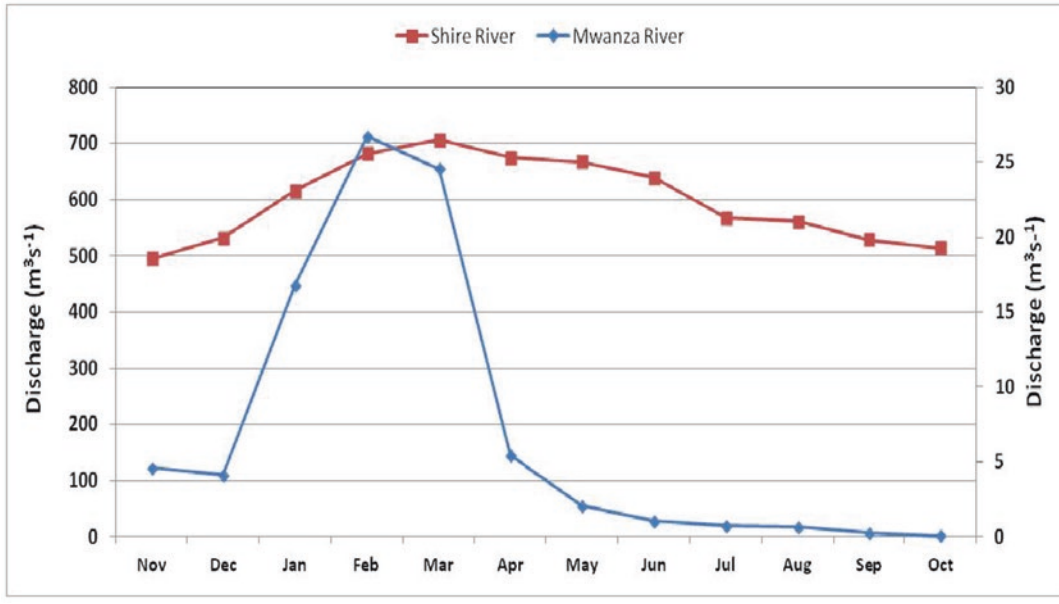

Fig. 14.7 Flow regimes for the Shire River at Chikwawa (1977 to 2009) and Mwanza River at Tomali (1952–1997)

considerable rainfall activities and potential flooding conditions in the Lower Shire Valley.

Both rivers show seasonality effects on their discharge; however, the Shire is perennial with a more stable and largely high-flow regime

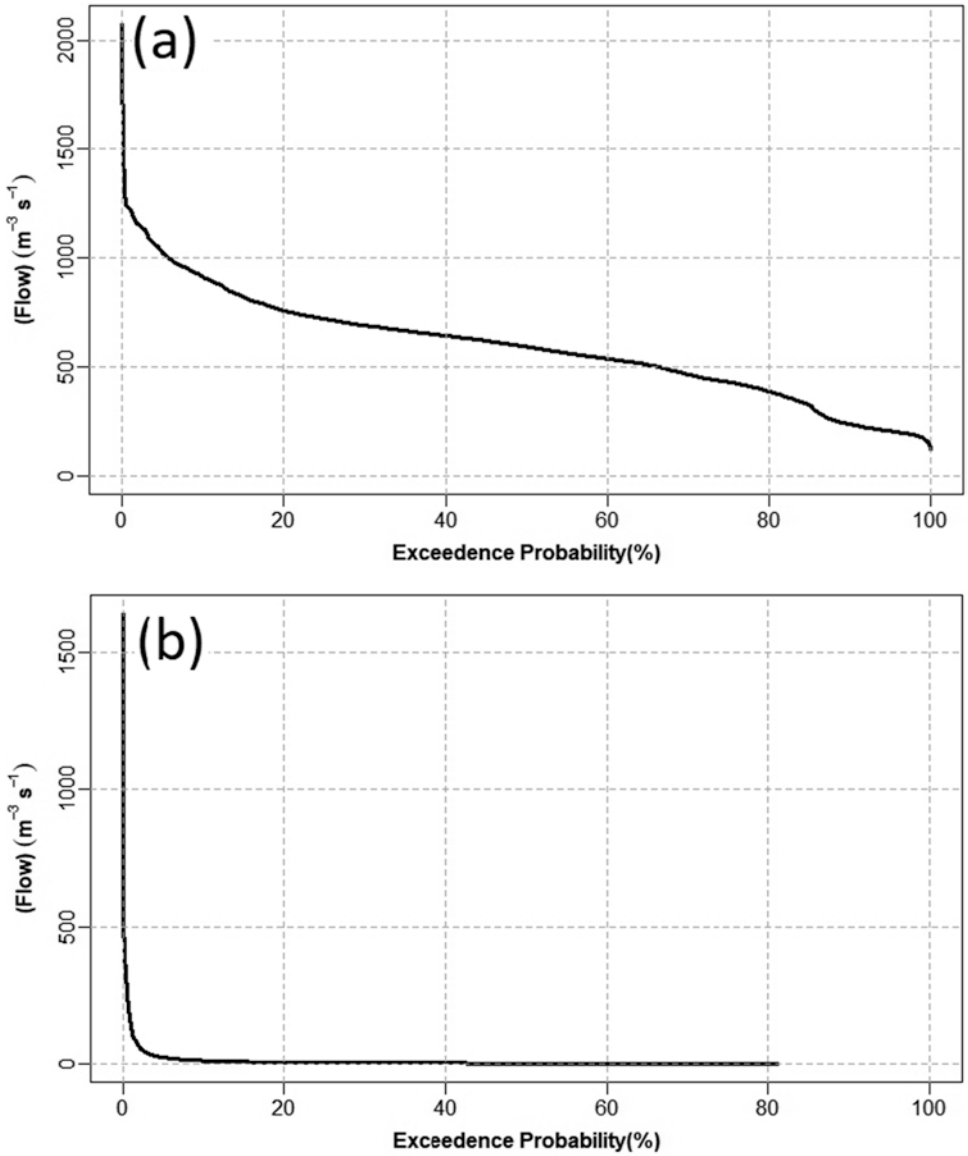

Fig. 14.8 Flow duration curves for (**a**) the Mwanza River at Tomali and (**b**) Shire River at Chikwawa

Table 14.6 MK trend statistics for river discharge variables

River	Shire	Mwanza
Daily	+S	−S
Monthly	+NT	−S
Annual	+NT	−NT

(Fig. 14.7). Mwanza River largely flows and peaks during the rainfall-season months between November and April and has extremely low flows in the dry season. Mwanza River only flows up to 80% of the time. On the other hand, Shire River flows 100% of the times, mostly over 500 m^3 s^{-1} (Fig. 14.8). This can partly be attributed to the regulation at Kamuzu Barrage. The MK trend results (Table 14.6) show a significant positive trend for the daily discharge of the Shire River at $\alpha = 0.05$ level, but not significant at mean monthly and annual values. On the other hand, the

Mwanza River had a significant negative trend in mean daily and monthly flows, but not significant at the annual mean flows.

The flood characteristics of the two rivers were assessed using peak over threshold (POT) analysis as in the studies of Ngongondo et al. (2011) and Ngongondo et al. (2020). This method was pre-chosen over the annual maxima series (AMS) analysis as it ensured a good record due to data gaps in the daily time series for both rivers. The mean excess plot (MEP) was used to select the threshold of flows above which can be considered to be potential for floods. The flows above the selected threshold were then fitted to the generalised Pareto distribution (GPA), a member of the extreme value distribution (EVD) family, to determine the flow magnitudes and their return periods.

The results show that the Shire River at Chikwawa has a flow threshold of about 1130 $m^3\ s^{-1}$ above which flooding is likely to occur. On the other hand, the Mwanza River at Tomali has a flow threshold of about 380 $m^3\ s^{-1}$. The floods associated with Cyclone Idai were estimated to be the worst in over 50 years (World Bank, 2019). The equivalent expected magnitudes of this event are 1600 $m^3\ s^{-1}$ for the Mwanza River and 2135 $m^3\ s^{-1}$ for the Shire River (Table 14.7). Since flows at the Kamuzu Barrage gates were reduced to below 40 $m^3\ s^{-1}$ during Cyclone Idai, it can be noted from the flows of the Shire and Mwanza Rivers that the cyclone had a large spatial coverage over the Lower Shire area, generating most of the flows observed in the Shire (over 2000 $m^3\ s^{-1}$). The frequency of such events has in recent years intensified, as the Idai flooding events closely followed the 2015 flooding.

Table 14.7 Flood magnitudes and their return periods for the Shire River (at Chikwawa) and the Mwanza River (at Tomali)

Return period (T-years)	Mwanza ($m^3\ s^{-1}$)	Shire ($m^3\ s^{-1}$)
10	619	1537.3
50	1600	2135.4
100	2640	2574.4
500	9371	4395.6
1000	16,529	5742.4

The FFA of the river flows agrees to a large extent with the perceptions of flooding trends in Mpasu and Mphampha villages. Respondents reported that Mphampha and Mpasu villages were prone to flooding and this is confirmed in the statistical analysis and our earlier study (Kalanda-Joshua et al., 2017). The key informant interviews and documentary review revealed that both Mpasu and Mphampha were affected by the floods which resulted from the Tropical Cyclone Idai. However, the extent varied with Mphampha suffering the most. Mphampha is recorded in the district's flood reports as one of the villages in Chikwawa affected most by the recent floods including Tropical Cyclone Idai in March 2019. Tropical Cyclone Idai led to the loss of livestock, farm produce and houses compared to Mpasu which reported minimal damage to houses and loss of other household assets. These results support findings from the hydro-climatic data analysis and varied intensity of Cyclone Idai across southern Malawi.

14.3.2 Use of Conventional Science and IK in Flood Forecasting

FGDs and key informants in both villages reported that they received advisories on flood occurrence as a result of Tropical Cyclone Idai. The weather information from the DCCMS was accessed through radios, non-governmental organisation staff working in the area as well as local agricultural extension officers. However, the FGDs reported heavy dependency on indigenous knowledge systems in the study area. The study captured several IK indicators that are used in the study villages in flood forecasting, and weather and climate predictions in general (see Table 14.8 for a complete list and Kalanda-Joshua et al. (2017) for a detailed analysis). Similar to earlier findings (Kalanda-Joshua et al., 2011; Joshua et al., 2017), these are based on environmental observations and cultural beliefs. An example of cultural belief included the morning star: the local people indicated that for 3 years, 2013/2014, 2014/2015 and 2015/2016, the star was appearing in the East and these were drought

Table 14.8 Traditional weather prediction and climate indicators in study villages

Occurrence	Indicator of	Mpasu	Mphampha
Poor fruiting of *Nyenza*, mango (*Mangifera indica*), baobab (*Adansonia digitata*), masau (*Ziziphus mauritiana*), Mtondo (*Cordyla Africana*) trees	Low rainfall season—a bad year	√	√
New foliage on one side and heavy fruiting on the other side of a mango tree	Heavy rains and the possibility of floods	√	
Many flowers on *nkhukhu* tree (*Acacia albida/Acacia tortilis*)	Drought	√	
Peculiar sounds of a male goat	Imminent rains		√
Large numbers of ants	High rainfall amounts (good year)	√	√
Large numbers of *Nkhululu* (*Brachytrypes membranaceus*)	High rainfall amounts	√	
Nthusi (*Hodotermes mossambicus*) collecting food to its hole before rains (October)	High rainfall (good rainfall season)	√	
Frequent occurrence of flying ants (*Macrotermes subhyalinus*)	High rainfall amounts		√
Increased occurrence of small black ants (*Cataulacus nr intrudens*)	High rainfall amounts (good rains)	√	
Sound of large numbers of *nyenje* (*Ioba leopardina*)	Heavy rains	√	
Sound of Ming'omba (big bird/*Bucorvus leadbeateri*) singing	Imminent rains	√	
Sound of (white) frogs	Imminent rains	√	
Onset of westerly winds	Onset of rainy season (if early—early onset of rains)		√
Winds blowing in all directions	Good rainfall season (also floods)	√	
Winds blowing from south (east) to north	Drought	√	
Moon appearing in thawale (waterlike image)	Heavy/good rains	√	
Extended cold days reaching end September or October	Drought		√
Very high temperatures in September and October	High rainfall season	√	√
Cold weather mid rainy season	Dry spell	√	
Nthanda/mtsinamowa (morning star) appearing in the east	Drought	√	
Nthanda/mtsinamowa (morning star) appearing in the west	High rainfall amounts (good rainfall season)	√	
Black cloud	Imminent and good rains	√	
Black cloud in the west	Floods	√	
Ngulu (cumulonimbus clouds) in a hilly area	Imminent rains	√	
White birds (Akakowa/*Bubulcus ibis*) in a group flying from east to west	Imminent rains	√	
Sun with a greenish circle	Low rainfall	√	
Prolonged rainfall season	Very cold season		√
Appearance of a moon during the rainfall season	Low rainy days		√

Source: Kalanda-Joshua et al. (2017); focus groups and key informant interviews

years. Some of the common indicators used include behaviour of some animals, birds, ants and insects. The people also use the timing of flowering and fruiting as well as level of fruit production of certain tree species to predict weather and climate (Table 14.8).

It is worth noting that other indicators of heavy rains (e.g. winds blowing in all directions) can also signify the likelihood of floods to occur in the rainfall season. Similarly, winds blowing in all directions suggest a high rainfall season, an indicator of floods. A dark or black cloud is indicative of imminent and good rains while a black cloud in the West is an indicator of imminent floods, and hence people have to move upland. Use of a dark cloud is also documented in earlier studies conducted in Mpasu village (Kalinga-Chirwa et al., 2011; Nkomwa et al., 2014). The study established that over the past decade, villagers largely accessed weather data from the DCCMS through radio and extension services. They also receive information on the weather forecast from NGOs working in the study villages. However, the provided weather information is usually at large spatial scales and therefore has limited application at the village and/or farm level. This is partly because the rainfall events in Malawi and tropical regions are characterised by high spatial variability (Ngongondo et al., 2011).

Most of the IK indicators shown in Table 14.8 seem to be suitable for possible predictions of the quality of a rainy season and the likelihood of an imminent rainfall event (Ayal et al., 2015). However, they may not be suited to the prediction of long-term trends of rainfall patterns in the season, the medium-term likelihood of rainfall events or the intensity of the rainfall event. In addition, the prediction of the imminent rainfall event is limited to a small spatial scale, which fails to predict floods arising from a rainfall event somewhere else in the catchment. Hence, it may leave the local people with little time to prepare for responses (Ayal et al., 2015) to sporadic climate events such as cyclones. Nevertheless, although IK may often be imprecise and qualitative, it is valuable because it is based on observations over long periods. The focus groups indicated that to be confident with their flood predictions, local people use a combination of indicators, not just focussing on one. If there are some observed patterns (occurring at the same time) indicating a flooding pattern, reliable conclusions are drawn. Additionally, they emphasised that indicators based on flora patterns still apply especially where the indicator species are still available. This particularly applies to Mpasu which has maintained some vegetative cover comprising indicator indigenous species.

However, the application of IKS is challenged by a combination of factors such as high inter-annual rainfall variability because of climate change and degradation of the environment. The relevance of some of the local indicators is being challenged in recent times, specifically about the indicators of imminent rains and flood occurrence. For example, initially, the local people would predict that rains would fall in a few days (in a week) through observations highlighted in Table 14.8. In recent years, those signs may not always apply as the onset may take 2–3 weeks to settle. In the past decade in villages, extremely high temperatures have not been associated with imminent rains. Similarly, traditional prediction of flood occurrence is challenged by events that suddenly result from heavy rains from upland areas—not from local rains. These problems are largely attributed to climate change and increased rainfall variability effects and loss of biological indicators which are traditionally used for flood forecasting. For example, FGDs in Mpasu and Mphampha villages reported that the value of IK has partially declined due to vegetation loss especially for specific indicators that are determined by observing patterns in flora. Repeated droughts or low rainfall means low river flow and a reduced number of aquatic biodiversity that may be used for studying fauna behaviour. This finding is similar to earlier findings by multiple studies in many areas including Zimbabwe (Makwara, 2013; Joshua et al., 2012), Kenya (Kipkorir et al. 2010) and Malawi (Kalanda-Joshua et al., 2011; Kalinga-Chirwa et al., 2011; Nkomwa et al., 2014). Such studies highlight additional factors contributing to IK erosion including teaching in contemporary religions which may contrast traditional beliefs, poor doc-

umentation, modern education that disregards the value of IK and limited transfer of IK from knowledge holder and the new generation (Makwara, 2013; Nakashima et al., 2012; Chang'a et al., 2010). However, taking into consideration the findings of the current study, the applicability of IK in flood prediction should be contextualised. Such an approach would reduce the reported repeated faulty forecasts and enhance the significance of valid IK in flood predictions and consequently reduction of loss and damage from floods.

14.3.3 Relevance of Integration of IKS and Scientific Information for Small-Scale Flood Forecasting

The results show the coexistence of the two knowledge systems, modern science and IKS, in each village. In the context of IKS, each village can tell weather patterns using traditional indicators. The differing effects of the Tropical Cyclone Idai on the two study villages highlight the significance of IK in flood risk preparedness and response. Although over time the value of some indicators is threatened or declining due to environmental changes, the local people continue to depend heavily on them compared to scientific forecasts due to their lack of local applicability, at short term. In this regard, despite repeated failures, the local people are still relying on IK. This is probably because IK is dynamic and practices get established after long-term experiments or observations (Ziervogel & Opere, 2010) and a combination of indicators produces reliable results. This finding suggests that addressing the environmental challenges that are threatening IK value can enhance applicability. The criticism that IK has short-term forecast—not reliable for long-term trends relative to scientific knowledge and hence cannot adequately prepare local people for long-term responses (Ayal et al., 2015)—can be addressed through integration with the scientific knowledge.

In contrast to IK, scientific knowledge has the capacity to provide long-term forecasts and trends at both small and large spatial and temporal scales. However, in most developing countries, these are not adequately and/or reliably disseminated as the required short-term and local scale forecasts. In this regard, similar to earlier studies, this finding suggests that combining IK and scientific knowledge can produce robust and rigorous flood forecasts (Makwara, 2013; Nakashima et al., 2012). At the time of the study, the Met Office had started to work with one of the study villages, Mphampha, to provide seasonal forecast at local scale but still less reliable due to data handling and dissemination challenges at the local level. From DCCMS perspective, limited network coverage of weather stations and lack of commitment of the village volunteers recording the weather data pose a challenge in producing local-based flood forecasts (Kalanda-Joshua et al., 2017).

14.4 Conclusions

The debate on the integration of indigenous knowledge systems (IKS) in forecasting and mitigating potential impacts of climate-related crises such as floods has received increased attention in the wake of the devastating Tropical Cyclone Idai in southern Africa. This study has assessed the relevance of IK in flood forecasting at village scale for reducing local people's vulnerability using a case study of flood-prone areas, which were also affected by Tropical Cyclone Idai in 2019. People's perceptions indicate a considerable level of knowledge on climate trends, proneness of the villages to climate disasters and varied occurrence of flooding events and forecasting. These perceptions have been validated using a flood frequency analysis (FFA) using data from weather and river gauge stations in the area. Both the FFA and community perceptions suggest a decline in localised rainfall, with increasing events of flooding due to rainfall activities in upstream catchment. As regards weather information, shared through mass media and government staff, the communities felt that the information had limited application at their required low spatial and temporal scales. The rural communities, therefore, found their IK more reli-

able. Both communities highlighted IKS (flora, fauna and atmospheric observations) used before the onset of and during the rainfall events for flooding forecasts/predictions. However, most of the IK indicators are threatened by environmental degradation and climate change. In addition, they may not be suited to the prediction of long-term trends of rainfall patterns in the season, or the intensity of the rainfall event. Further, the prediction of the imminent rainfall event is limited to a small spatial scale, which fails to predict floods arising from a rainfall event somewhere else in the catchment. Hence, it may leave the local people with little time to prepare for responses to sporadic climate events such as cyclones. On the other hand, scientific climate knowledge has the potential to provide long-term forecasts and trends at both small and large spatial and temporal scales. In this regard, integration of contextualised IK and scientific knowledge can produce robust flood forecasts in the poorly resourced settings. The strengths are enhanced when both knowledge systems are integrated in flood forecasting. IK is more relevant at local level and short term while scientific knowledge can also be applied in long-term predictions and responses.

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15 Disaster Risk Reduction Governance in Southern Africa: Focus on Budgets and Institutional Competencies

David Chikodzi and Leon Rodney Kenny

Abstract

Southern Africa has seen an increasing trend in the occurrence of both natural and man-made disasters which are having a huge socio-economic impact. However, as a region Southern Africa has not developed a protocol on disaster risk reduction and does not have a standing budget to deal with disasters. The chapter aims at assessing the different governance approaches to budgeting for disasters across selected Southern African countries. It also gives a critical analysis of the institutional set-up in disaster management across selected countries in view of assessing their competencies and capability to deal with potential disasters. Critical document analysis supported by qualitative techniques was the main source of information in the chapter. These included the use of the reports, official documents and in-depth interviews. The results showed the context of disaster management, highlighted the strengths and gaps that exist in the current approaches to budgeting for disasters in South Africa and Zimbabwe and then recommended best practices to be adopted.

Keywords

Budgeting for disaster · Disaster management institutions · Disaster risk reduction · Southern Africa · SANDF

15.1 Introduction and Background

The incidences of extreme events in Southern Africa have reached the tipping point and are now impacting negatively the sustainable development. Tropical Cyclone Idai for example hit the eastern parts of Zimbabwe on the 16th of March 2019. The magnitude of impacts induced by Cyclone Idai represents the most destructive natural disaster ever to hit Mozambique and Zimbabwe (World Bank, 2019). In Zimbabwe, the most devastated places were mostly in the Manicaland Province and in particular the Chimanimani and Chipinge districts. The cyclone brought with it strong winds, widespread flooding and landslides that led to significant infrastructural damage, displacement communities and extensive agricultural losses. An estimated two million people from Malawi, Mozambique

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and Zimbabwe were affected (RINA, 2019). Tropical Cyclone Idai was not the first to make landfall in Southern Africa; others like Kenneth, Dineo, Japhet, Eline and Favio have previously hit the region (Mavhura, 2015).

In 2019 heavy rainfall accompanied by strong winds caused widespread flooding and extensive damage to property in the KwaZulu-Natal and Eastern Cape Provinces of South Africa (De Greef, 2019). The KwaZulu-Natal floods triggered mudslides, sinkholes and collapse of structures which resulted in at least 70 deaths and damages of over R650 million (Ibid.). The floodwaters also brought with them significant levels of plastic pollution to several beaches in the areas as well as the Durban harbour creating both an economic and ecological disaster for the eThekwini Municipality. The immense inrush of mainly plastic debris into the Durban harbour also resulted in the movement of ships being constrained (Singh, 2019). A chronicle of these extreme weather events shows that their frequency and magnitude are increasing, yet Southern Africa seems to have not learnt from previous disasters in as much as disaster risk reduction (DRR) is concerned.

Goal 11 of the 2030 Agenda for Sustainable Development endeavours to make "cities and human settlements inclusive, safe, resilient and sustainable". Target 11.5 of Goal 11 aims by 2030 to "significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people invulnerable situations" (UN, 2019, 24). Further, target 11b aims by the 2020 to "substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters in line with the Sendai Framework for Disaster Risk Reduction" (SFDRR) (UN, 2019, 25). Goal 13 aims at taking urgent action to fight climate change and its host of impacts. Specifically target 13.1 "endeavours to strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries" (UN, 2019, 28). For the above targets to be satisfied by 2030, there is a need for well-engineered institutional frameworks in DRR that are supported with viable budgets and human resources.

The SFDRR provides a structure for DRR at all levels of society. DRR is the "systematic development and application of policies, strategies and practices to prevent or prepare for hazards, or to mitigate their adverse effects" (UNISDR, 2015). The SFDRR recognises that disasters exact a significant toll to communities and compromise their safety and quality of life. The framework identifies four priority areas in DRR which are "understanding disaster risk; strengthening disaster risk governance to manage disaster risk; investing in DRR for resilience and enhancing disaster preparedness for effective response and to 'Build Back Better' (BBB) in recovery, rehabilitation and reconstruction". Effective disaster preparedness, response and mitigation as noted in the Sendai Framework are hinged upon good budgeting and a well-engineered institutional framework for DRR. Thus, the effect of a catastrophe is a function of not only the "magnitude of the hazard event" (UNISDR, 2015), but also the extent to which the exposed society is equipped to handle it (Kusenbach et al., 2010). It has been observed that countries that create policy, legislative frameworks, institutional architecture and associated investment vehicles for DRR in line with the objectives, targets and priorities for action of the SFDRR have greater capacity to manage disaster risk. The chapter therefore aims at assessing the different approaches to budgeting for DRR in South Africa and Zimbabwe and also analysing the institutional set-up in DRR in these countries in view of assessing their competencies and capacity in dealing with potential disasters.

15.2 Literature Survey

After analysing the extent of financial and insurance costs due to natural disasters world over, Ghesquiere and Mahul (2010) followed by Benali and Feki (2017) highlighted the mounting evidence that the occurrence and intensity of these

disasters were on the rise. Disasters have negatively led to increases in the economic and fiscal exposure of the global south countries every year (Attary et al., 2020). Ishiwatari and Surjan (2019) observed a pressing need for increased funding of DRR activities through the combined efforts of global players; national, local and regional governments; and local actors such as corporate citizens, individual citizens as well as NGOs. They noted that financing of DRR activities needs to be everybody's concern. However, in most countries of the global south, the burden of budgeting for DRR mainly falls with the different tiers of governments (Twigg, 2015). A study done by Ishiwatari and Surjan (2019) shows that even comparatively poor nations can dedicate reasonable amount of funds towards DRR initiatives in their national budgets. This is argued by Watson et al. (2015) to yield competent disaster readiness systems when compared to DRR assistance initiatives from international donor organisations. Three mechanisms have been noted to be commonly used to budget and finance DRR activities in countries of the global south. These are firstly integrating DRR into countrywide development plans (Prabhakar et al., 2015), secondly having stand-alone DRR funding mechanisms and thirdly division of DRR costs between the local governments and communities (Van Niekerk et al., 2018; Ishiwatari and Surjan, 2019).

There has been an observed need for continued investment in DRR because as economies expand and the climate changes, infrastructure and spaces previously relatively free from disasters will become very vulnerable. The World Bank approximated the global yearly requirements of flood and coastal protection to be at USD104.32 billion (Blankespoor et al., 2010). Investment in DRR has been observed to be more cost effective compared to doing little and responding only after disaster has occurred. It is projected that yearly investments of US$6 billion in DRR may well produce "total risk reduction benefits" of up to US$360 billion until 2030 (UNISDR, 2015). Investing in DRR also stimulates economic growth throughout normal periods as well as decreases economic losses when disasters strike (Tanner and Rentschler, 2015). For example, the private sector generally favours investing in areas that are protected from potential hazards such as those with flood prevention systems. An analysis made by the Red Cross showed that every US$1 spent on DRR can save up to US$7 in terms of post-disaster spending on recovery, restoration and reconstruction (Van Niekerk et al., 2018).

It has been observed that most countries from the global south have limited access to finance for early response in DRR. The countries often have constrained fiscal headroom and find it tough to "reallocate budgetary funds quickly without facing difficult expenditure trade-offs" (World Bank, 2019). The countries also have constrained capacity to borrow huge sums of money on short notice from multilateral banks (Ishiwatari and Surjan, 2019) because of poor credit rating. Private insurance penetration rates are largely low in the global south; hence private insurance pay-outs for disaster recovery are of limited utility and often take way too long to be paid out. Humanitarian assistance, which is an essential part of post-disaster financing, frequently comes with delays and often below pledged sums (Clarke and Dercon, 2016).

Over the past years, an international consensus has emerged among policymakers and technical experts that countries in the global south require new financing mechanisms or alternative funding, to mitigate the effect of disasters. The SFDRR calls for "mechanisms for disaster risk transfer and insurance, risk-sharing and retention and financial protection, as appropriate, for both public and private investment in order to reduce the financial impact of disasters" (UNISDR, 2015, 19). In the Paris Agreement, the Warsaw International Mechanism for Loss and Damage refers to risk insurance facilities, climate risk pooling and other insurance solutions as possible areas for collaboration and facilitation (UN, 2015). Between 2002 and 2014 close to 13% of total multilateral financing was invested in DRR activities (Caravani, 2015). Establishments of direct or dedicated public and private investments in DRR need to be encouraged in order to manage the financial toll disasters are putting on governments of the global south.

15.3 Materials and Methods

The study highlights examples from relevant Southern African countries but specifically narrows its focus to experiences from South Africa and Zimbabwe. Generally Southern Africa is vulnerable to both man-made and natural disasters that can have negative impacts on the achievement of SDGs (Sambo and Chikodzi, 2020). These hazards include tropical cyclones, floods, wildfires, drought and pandemics (Ibid.). The financial, institutional and technical capability to respond and recover from these hazards is not uniform across this region just so much (Sambo and Chikodzi, 2020). Figure 15.1 shows the Southern African countries and specifically Zimbabwe and South Africa.

Critical document analysis supported by qualitative primary data provided the main source of data informing this chapter. Critical document analysis is principally used in qualitative research where documented information is analysed by the investigator to yield meaning on the research questions (Nhamo et al., 2020). The method codes and integrates content into merging themes in the same way as focus group discussions and in-depth interviews. Three main forms of documents that were available for analysis in this study include public records for public organisation's activities, for example laws; policies; military records on the Operations Chariot and Arabella; personal documents like first-person accounts, experiences, incident reports and newspapers; and physical evidence like posters, agendas, handbooks and training materials. Primary data collection using in-depth interviews was also carried out in the study area. These were mostly done to collect information not available through secondary sources and to validate some of the themes identified during document analy-

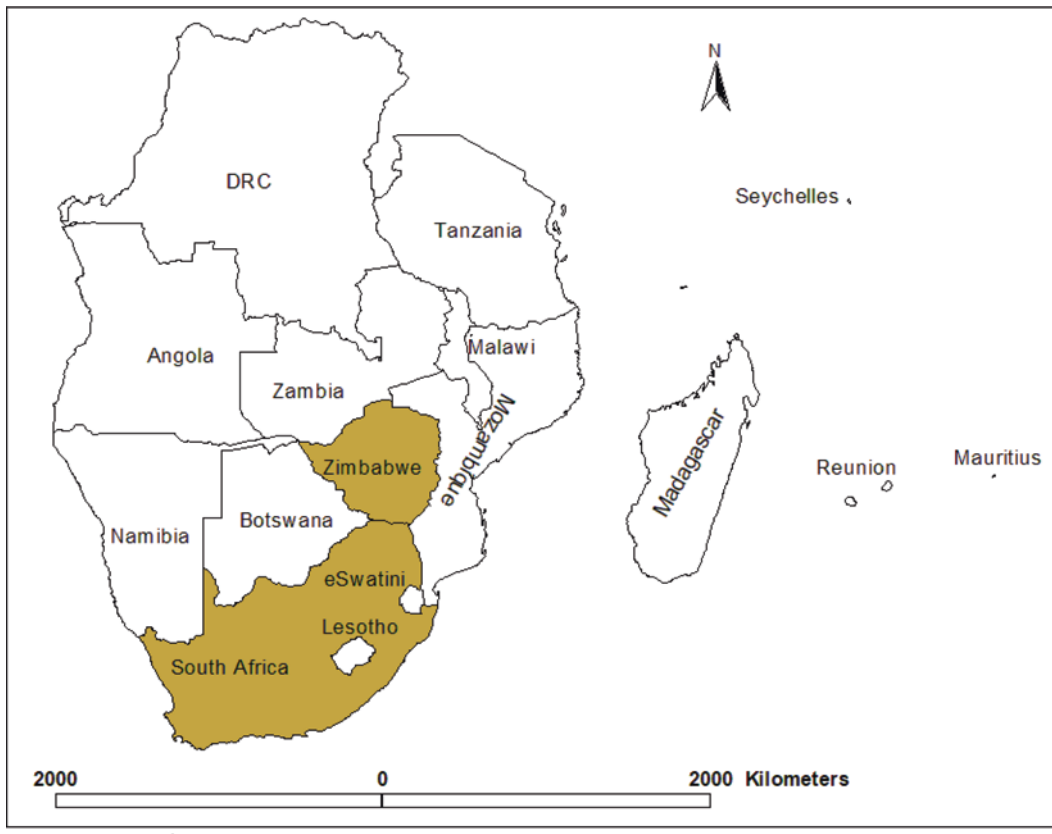

Fig. 15.1 Study area: Southern Africa showing Zimbabwe and South Africa. Source: Authors

sis. In-depth interviews and questionnaire surveys were done in Chimanimani district of Zimbabwe which was the hotspot of Tropical Cyclone Idai and in South Africa's Port Saint Johns in the Eastern Cape Province which was devastated by floods in April 2019. Numerous themes were identified during document analysis and in-depth interviews formed the groundwork for the discussion of the findings. Triangulation was then done through cross-referencing with numerous recent research findings on the highlighted issues. Similar studies for example by Nhamo et al. (2020) have adopted such a methodology.

15.4 Findings and Discussions

15.4.1 Institutional Framework in Disaster Management in Zimbabwe and South Africa

In Zimbabwe the institutional framework covers mainly emergency and disaster response and recovery programmes with the education and early warning components being very limited. Community participation in DRR projects is very limited in the disaster legislation. In addition, there are also no guidelines for stakeholder involvement at grassroots level, especially multisectoral interventions. Although local authorities are important DRR players in their jurisdictional areas (Bang, 2014), the Civil Protection Act is silent about their role in performing this function. Furthermore, the Act does not give room for the involvement of traditional leaderships in the prevention and mitigation of disasters (Table 15.1). Yet these institutions are important players in these respects (Manyena et al., 2013).

Because of the noted gaps in the Civil Protection Act of 1989, the Zimbabwean Parliament has since the year 2003 been trying to repeal the Act and replace it with the Emergency Preparedness and Disaster Management Act. The Emergency Preparedness and Disaster Management Bill is still as of the year 2020 at consultation stage and has been delayed several times due to the extremely polarised Zimbabwean legislature (Mavhura, 2015). As observed by Madamombe (2004), the new Act would allow the formation of a stand-alone Emergency Preparedness and Disaster Management Authority. The Authority will be assigned with key activities such as the forecasting and planning for emergencies at different levels of public administration such as from the local authority

Table 15.1 Institutional arrangements in DRR for Zimbabwe and South Africa

Country	Institutional framework	Key performance areas	Mandate	Expected output
Zimbabwe	• Civil Defence Act of 1982 • Civil Protection Act (Chap. 10:06) in 1989 • Department of Civil Protection	• Prevention/mitigation of disaster risks • Preparedness planning timely early warning and response to rehabilitate affected elements	• Overall coordination of DRR actors	• Improve preparedness and capacity to cope with disasters and threats to communities
South Africa	• Civil Defence Act of 1966 • Civil Protection Act of 1977 • Disaster Management Act of 2002 • National Disaster Management Centre	• Integrated and co-ordinated disaster management policy • Prevention or reduction of risk to disasters • Emergency preparedness • Mitigating the severity of disasters, rapid and effective response to disasters and post-disaster recovery	• Establishment of national, provincial and municipal disaster management centres and a framework	• Synergies from all spheres of government, civil society and the private sector

Source: Authors

and district, provincial and national levels. The above-stated tiers of government will be required to produce operational disaster emergency preparedness and response plans which would be activated when a disaster occurs. The new Act must also make provision for the setting up of emergency planning and disaster management committees which will be composed of all key stakeholders including research institutions, private sectors and non-governmental organisations.

In South Africa it has however been observed that there was a challenge in establishing uniform mechanisms and guidelines to facilitate the rapid and effective processing of disaster classifications and declarations, with the process and procedures for declaring states of disasters being unclear and cumbersome, hence taking longer than necessary. There is also no clarity on the roles of the district municipalities and provinces, and that of the National Disaster Management Centre (NDMC) during disaster. The significant emphasis on the role of the NDMC in the classification and declaration of a state of disaster is noted in many instances as being against the spirit of the Disaster Management Act which essentially aims to decentralise DRR. This essentially disempowers municipalities in declaring a state of disaster (Van Niekerk, 2014).

Duplication of declarations has also been an observed problem associated with the process of declaring of a state of disaster. Once the Disaster Management Act has been invoked, other acts like the Fund-Raising Act of 1978 will also need to be evoked in order to unlock funds for necessary interventions during DRR operations. This legislation is administered by the Department of Social Development which does not administer the Disaster Management Act and has its own procedures to be evoked. The Fund-Raising Act aims to address relief efforts and social distress subsequent from disaster incidences. Evoking these two acts brings about both duplication and contradictions in the sense that both deal with disasters but on the one hand the Fund-Raising Act can only be declared by the President at national level when an incident exceeds the ability and resources of the affected community to deal with its consequences. On the other hand, the Disaster Management Act can be evoked at provincial or municipal levels. Table 15.1 summarises the institutional arrangements and their key competences during the process of DRR in South Africa and Zimbabwe.

15.4.2 Budgeting for DRR in Zimbabwe

As noted earlier, the Department of Civil Protection (DCP) is the principal institution in DRR in Zimbabwe. Figure 15.2 shows the percentage budget allocated to the DCP in relation to the total budget of the Ministry of Local Government and Public Works under which it is resident. It can be noted that the budget allocated for the DCP is simply not sufficient for any one of its mandates and a disaster in itself. In addition to the limited budget, the total allocation to the department has been on the decline from 2012 till 2018. This implies that DDR issues do not take prominence in the parent ministry and the nations at large. This is in sharp contrast with the fact that the country is prone to both human and natural disasters which need interventions from the department. This leaves the country being reactive to disasters instead of addressing all the phases of the disaster management cycle especially putting in place a robust early warning system and building resilience.

The Civil Protection Act provides for the creation of a "national civil protection fund" which is handled by the DCP. The fund is, however, poorly financed and insufficient for the civil protection needs and requirements of the country given its risk profile. Furthermore, the non-existence of procedures and guidelines on the sum of resources that need to be assigned to the fund from the national annual budget magnifies the shortage of funds. To give an example by November 2018, DCP had already exhausted a meagre $3 m budget assigned to it in April in dealing with a cholera outbreak, 70 bus accidents and a sequence of fires that had damaged property in the country's urban settlements. For its 2018/2019 budget, DCP required at least US$10 million to fulfil its man-

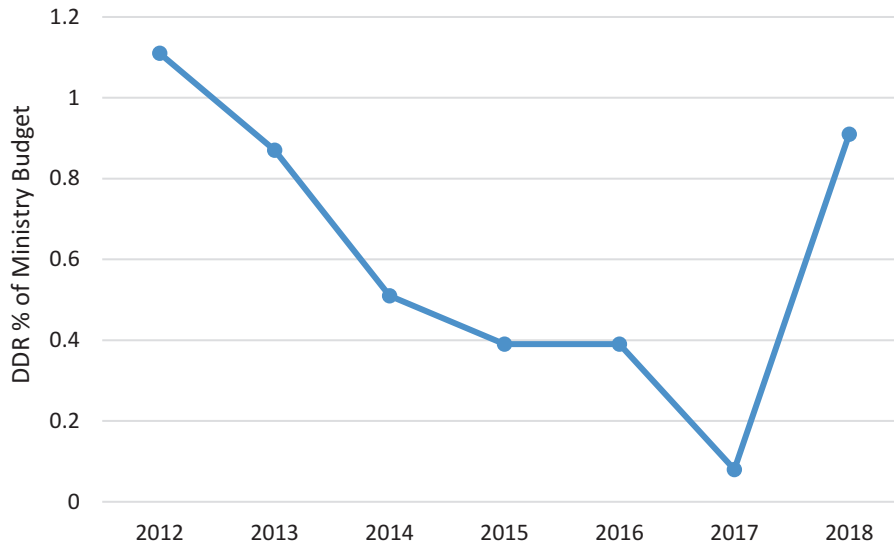

Fig. 15.2 DCP budget allocation from the ministry budget. Source: Authors, data from Chatiza (2019)

date but got just below US$2.4 million (Chatiza, 2019) which was less than 24% of its requirements. These were also the funds allocated to it when Tropical Cyclone Idai occurred. It therefore becomes imperative for the country to invest in a viable budget for the DCP if DRR activities are to be raised to the levels required in the SFDRR. Soon after Tropical Cyclone Idai hit Zimbabwe, the Ministry of Finance disbursed Zim$50 million[1] for emergency and infrastructure restoration; however, the amount which was directly allocated to DRR activities was only 4.2% of the total amount (Chatiza, 2019). This shows that DRR responsibilities lacked prominence in terms of financing and the figure fell short of the over 600 million required to build back better (RINA, 2019).

In addition to the direct financing of the activities of the DCP by the government, the budget lines in specific ministries such as Ministries of Agriculture, Environment and Health also have components which support DRR. These components, however, are still poorly funded given the broader scope of the mandate that these ministries have. For example, key informants highlighted that after Cyclone Idai hit Chimanimani in March 2019, most of the sewer system and portable water supply network were completely wiped out. With limited funds, the Chimanimani Rural District Council (RDC) had to move in to prevent a health disaster by restoring water supply and other basic services. However, on humanitarian grounds, the council could not bill or charge the whole town for water, for 9 months even though water is one of the municipal's key revenue sources. The RDC also lost most of its key revenue areas to the cyclone, yet it was still expected to provide services to the citizens. The RDC had to survive on a grant that was given by the parent ministry (the Ministry of Local Government).

To supplement the limited budgets of the DCP and line ministries that deal with DRR in Zimbabwe, ad hoc DRR funds are lobbied for by the Government of Zimbabwe (GoZ) after a presidential disaster declaration. Funds will normally be provided in different forms from grants, cash, equipment and humanitarian aid from development partners, private sector, foreign countries and multilateral organisations. These typically render assistance during the hot phase of the disaster where the emphasis is on search and rescue and also partially during the recovery phase. International banks such as the World Bank and the African Development Bank played a vital role in funding key projects and activities in the post-Cyclone Idai period in Zimbabwe, Malawi and Mozambique.

[1]Exchange rate was 1:4 with the US dollar.

In April 2019, the World Bank and the GoZ undertook an exercise to assess the losses and damages arising from Cyclone Idai and to advance a plan for immediate recovery and long-term resilience building. This produced a document called the Zimbabwe Rapid Impact and Needs Assessment (RINA). RINA aimed at assessing and quantifying the cyclone recovery and resilience-building needs across ten key sectors in the affected areas (RINA, 2019). It was observed in RINA that damages and losses suffered due to the cyclone were between US$542 and US$616 million across all the nine affected districts. More than half of the damages occurred in the Chimanimani and Chipinge districts and close to 90% of the overall damages were on the transport (US$164 million), agriculture (US$155 million) and housing (US$132 million) sectors (World Bank, 2019).

Comparing damage incurred to the funds unveiled or pledged by the government and its development partners shows an "extraordinary level of unmet needs". Compared to the estimated US$542–US$616 million damages due to Cyclone Idai in Zimbabwe, the total fund required for full recovery across the ten sectors was estimated between US$584 and 803 million. This is because the recovery was underlined by the need to BBB which is more expensive but produces resilient structures (RINA 2019). The highest recovery needs were for transport (US$197 million), then disaster risk management (US$106 million), agriculture (US$60 million), social protection (US$60 million), housing (US$36 million), environment (US$31 million) and water supply and sanitation (US$28 million) (World Bank, 2019). RINA (2019) estimated that a reconstruction and recovery funding gap of close to $500 million remained after factoring all the pledges made and if BBB and smarter costs are also inputted. Given that a total of US$137.6 million had been made available or pledged as of December 2019, against an estimated recovery and reconstruction need of US$803 million (World Bank, 2019), then this immense gap of unmet needs may take many years to fill, potentially holding back the recovery and development of the affected societies.

During the post-Idai phase, the World Bank advanced Zimbabwe with an exceptional financing grant of US$72 million through the United Nations Office for Project Services. This was necessitated by the fact that GoZ was financially handicapped to effectively deal with the humanitarian and development crisis imposed by Cyclone Idai. This led to huge funding gaps for cyclone recovery even after factoring in the funding made available through other development partners (World Bank, 2019). Zimbabwe has not been able to borrow funds from international lenders since 1999, when it started defaulting on its debt, and has arrears of around $2.5 billion with the World Bank, the African Development Bank and European Investment Bank (World Bank, 2019). The imposition of sanctions in 2000 also cut it off from the international finance system, a factor which also affected relief financing during Tropical Cyclone Idai operations. The World Bank through an urgent and exceptional financial package funded a project called the Zimbabwe Idai Recovery Project (ZIRP) which was meant to "mitigate the impacts of the cyclone on the most affected communities and lay a foundation for regional recovery and longer-term resilience". The grant complemented Zimbabwe's ongoing and planned interventions to respond to the humanitarian conditions created by the cyclone. The project's focus was geared towards immediate recovery, livelihood support and restoration of public infrastructure and social services (World Bank, 2019).

Some of the priority actions funded by the bank included $150,000 to undertake a comprehensive post-disaster "infrastructure, environmental damage and needs assessments". Emergency livelihood needs in eight affected districts were also included here. An apportionment of $500,000 was disbursed to deliver instant funding to essential government functions for emergency development response coordination and recovery planning and communication in the disaster area. Close to $2.5 million was allocated for emergency livelihood support through gender-sensitive emergency employment, enterprise recovery and cash-based assistance in the impacted places. To facilitate emergency voca-

tional training of youths in construction and related skills, $2.5 million was allocated to fund the development and roll-out of safe construction guidelines and techniques for BBB and guidelines for resettlement planning (World Bank, 2019).

African Development Bank (ADB) also provided Zimbabwe with a financial grant of US$27.85 through a programme called the Post Cyclone Idai and Kenneth Emergency Recovery and Resilience Programme. The project aimed to restore livelihoods and well-being and build resilience of the communities in the three affected countries (Zimbabwe, Malawi and Mozambique) with the emphasis on "reaching the furthest behind first" (ADB, 2019). The Programme also furthered solutions on confronting recovery and resilience processes in a medium- to long-term standpoint through a multisectoral and BBB approach to "infrastructure rehabilitation, restoration of agricultural livelihoods and promotion of resilience to climate shocks, disasters, and extreme weather events in order to enhance the adaptive capacities and preparedness of institutions and communities" (Ibid.). The project execution was over a 4-year period with an estimated one million beneficiaries from all the impacted countries. The three segments of the project were enhanced agriculture productivity and resilience; sustainable socio-economic infrastructure and institutional strengthening; and project coordination. As of January 2021, the fund had been disbursed and affected communities were benefiting. The data on how successful the programme has been is still to be made public.

Crowdfunding has also been used to raise funds for victims of disasters in Zimbabwe. During and in the aftermath of Cyclone Idai in Zimbabwe, crowdfunding was widely used by individuals, communities and church organisations to raise funds for the victims in order to assist them in the recovery process. The technique emphasises on raising small amounts of money from a large number of people. The medium of interface is usually through either the internet/social media or mobile money platforms. The crowdfunding model needs three types of actors to be possible: the project motivator, individuals or groups who subscribe to the idea and the platform which brings the parties together to promote the idea. A good example was the Jesuit Community of Southern Africa who initiated a programme called "Beyond Idai" that was funded purely from crowdfunding. The programme as highlighted by key informants was aimed at raising US$3 million towards "reconstruction, recovery and restoration of livelihoods lost or damaged during tropical cyclone Idai". By October 2019, the crowdfund reached US$1 million point. The reconstruction targeted health, education and faith-based centres. The funds raised targeted the three countries hit by Cyclone Idai (Zimbabwe, Mozambique and Malawi). Mozambique, which was the worst hit, got half of the money from the fund and the rest was shared between Zimbabwe and Malawi. To improve transparency, progress and updates were shared openly and financial reports were published periodically and audited by renowned internal auditors.

The private sector and philanthropic individuals are also playing an increasingly important role in financing DRR efforts. Private entities and persons are financing the capacity enhancement of the local communities they are operating in to be resilient to and also recover from disaster. During Cyclone Idai in Zimbabwe the private sector provided funds, equipment, medical facilities, food aid and technical advice and complemented government efforts to assist the victims of the cyclone to recover their livelihoods. Some private organisations rebuilt damaged schools and paid fees for vulnerable and disadvantaged students and some pledged to reconstruct houses for those made homeless during the disaster. Key informants highlighted the need to acknowledge the civil society and private sector in Zimbabwe for their role in mobilising the much-needed support and for showing great solidarity with the affected people during Cyclone Idai.

These funding initiatives went a long way in benefiting the victims of the cyclone especially during the emergency phase. However, funding for long-term recovery and resilience shows huge gaps in terms of what has been raised or pledged and what is required for communities to build back better. As of January 2021, some of the

pledged funds were still to be disbursed and some victims were still living in temporary shelter.

15.4.3 Budgeting in South Africa

The incident reports produced by district municipalities form the basis for financing and declaration of state of emergency of disasters in South Africa. Table 15.2 shows the cost estimates of impact and damage caused by heavy rains and strong winds for the Ray Nkonyeni Municipality district disaster in the KwaZulu-Natal Province of South Africa. The disaster affected 99 households and a total of 522 people. The incidents ranged across houses that were washed away, houses flooded, bridges that collapsed, trees uprooted and falling over the roads and houses, mudslides into the roads and three fatalities (Ray Nkonyeni Municipality, 2019).

In terms of Section 55(1) (a) (b) of the Disaster Management Act No. 57 of 2002, a local municipality may declare a local state of disaster if contingency arrangements and financial capacity do not adequately provide for that municipality to deal effectively with the disaster. For this reason and backed by the incident report, the Ray Nkonyeni Municipality was declared a disaster area. This then activated a series of acts that are highlighted below.

A battery of legislation and policies provide the framework through which DRR activities can be budgeted for and financed in South Africa. The Disaster Management Act, in Sections 56 and 57, gives provision for disaster funding in situations where measures in place like DRR measures and contingency are exceeded by the effects of the hazard and the impacted municipalities are unable to cope using local funds and resources. This implies that funding mechanisms under this Act are only obtainable in the post-disaster recovery and rehabilitation phase. Two principles are used to finance disaster recovery when such an event is declared. In the first principle, the national, provincial and local organs of the government may contribute funds to response efforts and post-disaster recovery and rehabilitation. Principle two gives the duty to replace and repair infrastructure to the branch of government in charge of the maintenance of such infrastructure. However, through section 57 of the Act, a municipality or provincial government can appeal for funds for recovery and rehabilitation from the central government. The Act encourages municipalities to budget for DRR through threshold financing through section 56(3) which allows the "Minister for Provincial and Local Government to prescribe a percentage of the budget of a provincial or municipal organ of the state as a threshold for accessing national funding for disaster response efforts" (Van Niekerk et al., 2018). The extent to which these parties have instigated DRR efforts will also be taken into consideration when providing funds.

The National Disaster Management Framework sets out the structure of financing options for DRR in terms of the category and the role to be played by each level of government with its devoted financing tools. The financing tools are based on activities which are "the start-up activities or costs; ongoing activities or costs; DRR; disaster response; recovery and rehabilitation and education, training and capacity building programmes. The possible source of funding are given for each of the activities that it prescribes" (Van Niekerk et al., 2018).

The Public Finance Management Act No. 1 of 1999 also directs the release of money when disasters occur. The Act allows the Minister of Finance or MEC to appropriate money from their coffers to use it during emergency periods. However, the funds must not surpass a certain

Table 15.2 Estimated costs of flood impact and damage—Ray Nkonyeni Municipality (KZN)

Damage	Cost
Partially damaged and totally damaged house	R191,063,900–00
Infrastructure damages: roads	R287,678,535–00
Beach damages	R4,000,000–00
Municipal building damages	R3,000,000–00
Electrical damages	R3,000,000–00
Total	R488,742,435–00

Source: Ray Nkonyeni Municipality Incident Report (2019)

threshold of the "total amount appropriated in the annual budget" (Van Niekerk et al., 2018). Municipal Finance Management Act No. 56 of 2003 allows the mayor of a municipality to authorise unexpected and unescapable spending during disaster periods. This spending must, however, be appropriated in the adjustment budget within 60 days, or else the spending will be deemed unauthorised. The Act also limits the total amount of money obtainable to respond to disasters to a given threshold of the municipal budget which varies with municipality. The Amended Municipal Systems Act of 2000 gives the cabinet member, MEC or other arms of the state initiating an assignment of a function or power to a municipality to take appropriate steps to guarantee that adequate funds are available and capacity-building initiatives exist for the execution of such allocated function. This is especially applicable in DRR where the duty to implement is imposed on the municipality; hence the Act imposes new constitutional responsibilities on local government. Since DRR involves events that require funding, appropriate action needs to be taken by those assigning the responsibility to guarantee that enough funds and capacity are obtainable. Municipal Systems Act and the Disaster Management Act also highlight the importance of incorporating DRR in development planning at all levels of government (Botha et al., 2011) in order to circumvent budgeting constraints and also looking at it as being detached from local development plans.

Solidarity Response Funds (SRF) can also be created in South Africa during disaster periods. The Solidarity Respond Funds are vehicles through which government and the private sector can pool funds together in order to achieve the purpose of DRR. A classic example was the occurrence of the COVID-19 pandemic in 2020 which was declared a state of disaster in South Africa. This led to the creation of the COVID-19 Solidarity Fund, as a means of escalating measures to combat the epidemic. The government provided seed funding amounting to R150 million with further pledges running into billions of rand. The SRF was independently and professionally administered with transparency and accountability of the funds being the driving theme (Nhamo et al., 2020).

15.4.4 South African Defence Forces and DRR Activities

The Department of Defence's (DOD) Strategic Plan 2020–2025 noted that climate change may result in increased regional flooding and/or drought, requiring the South African National Defence Force (SANDF) to provide increasing humanitarian assistance (Operation Arabella) and disaster relief (Operation Chariot) during General Military Assistance (GMA) operations both domestically and in the SADC region. The SANDF is already committed to providing disaster aid and relief, and search-and-rescue operations, on request. A projected R54.8 million is provided over the medium term in the Force Employment programme for activities related to internal operations. The 2020 Annual Performance Plan stated that the SANDF will continue to provide assistance including drought relief support, helicopters from the respective Air Force squadrons for firefighting, and land and sea search-and-rescue capabilities.

An area of concern is the economic recession as a lower economic growth for South Africa is expected for the year 2020, and the weakening of the RSA currency against other major currencies will further adversely affect economic growth, which was estimated at 1.1% for the financial year (FY) 2019/2020 (DefenceWeb, 2018). Unemployment within the traditional workforce sectors, including mining and agriculture, may contribute to industrial strikes which will further affect the economy and national security to which the SANDF may be called upon in support of government intent. Statistics South Africa has indicated that unemployment increased by 27.7% for the first and second quarters of 2018 and the latest Statistic South Africa survey indicates poverty levels to be as high as 55.5% among the South African population, estimated at approximately 57,387,892 people (Asara and Pretorius, 2019). These economic factors may slow down job creation in the country, which will increas-

ingly create the possibility of conflict emanating from the unemployed and unemployable youth and affect the budget allocation for defence spending (DefenceWeb, 2018). The above scenario has been exacerbated by the COVID-19 pandemic which has further slowed down economic growth and increased the levels of unemployment.

The SANDF has many increasing priorities in DRR both internally and externally but is being hampered by a lack of funding. In the 2019 Annual Performance Plan, Defence and Military Veterans Minister stated: "the Department of Defence continues to face the challenge of a persistent disjuncture between the defence mandate and the departmental budget allocation, which has an adverse impact on the ability of the Department of Defence to execute its legislative mandate". The minister reiterated that the impact of continued departmental budget reductions will begin to impact adversely the ability of the South African National Defence Force to execute its mandate and responsibilities through the eroding of defence capabilities. Ongoing budget reduction will continue to hamper the activation of Operations Chariot and Arabella in the near future (SA Defence Review 2019).

Whilst there is always a risk of a global economic downturn, generally, global economic growth rates are expected to improve and, more particularly, economic growth rates on the African continent are expected to be above the global average. Conversely, the growth in the South African economy has remained flat to negative since the 2008/2009 world economic recession, resulting in ongoing significant fiscal pressures for South Africa (DefenceWeb, 2018). The underperformance of the different RSA economic sectors has resulted in the delayed implementation of the developmental initiatives in support of the National Development Plan (NDP), "Vision 2030". Coupled to this are the increasing socio-economic demands and competing priorities for service delivery that further aggravate an already constrained fiscal outlook. It is therefore envisaged that the defence funding forecast is more likely to decline in real terms over the period of this Plan. The economic forecast and the current trends in the defence funding allocation continue to constrain the implementation of the National Policy on Defence (SA Defence Review 2019), with a profound adverse impact on the availability and modernisation of required defence capabilities. The South African economic outlook has weakened since the 2018 Medium-Term Budget Policy Statement (MTBPS), and the gross domestic product (GDP) growth outlook has been revised down to 0.9% from an estimated 1.7% due to electricity supply concerns. The World Bank forecast RSA GDP growth averaging at 1.4% in the FY2021/2022 if structural reforms and policy uncertainty are addressed as well as recovery in public and private sector investment (World Bank, 2020).

Uneven and extreme global weather conditions as a result of climate change may occur more often affecting the SADC region. Resource scarcity, population growth and climate change may increase the potential for conflict over disputed land and increasing water scarcity. More volatile food and energy prices may increase the stresses on fragile countries with specific reference to the SADC (DefenceWeb, 2018). Associated with climate change remains the forecast for an increased and associated detrimental impact of global warming with severe ramifications for the well-being of the global population. Natural disasters remain a reality and may have catastrophic effects domestically, regionally and continentally. It is inevitable that the DOD will in the foreseeable future be called upon, through the conducting of both humanitarian and disaster operations, to assist local government authorities and other state departments both internally and in the SADC region. The recurrent disasters in the SADC region require the DOD to have the appropriate capacity to timeously respond to such situations. Southern African Development Community Regional Indicative Strategic Development Plan (the RISDP) was formulated in March 2001 and approved by the SADC Summit in August 2003.

The DOD stated that the decrease in defence allocations will continue into the medium-term expenditure framework from 0.98% of GDP in 2018 to 0.97% in 2019. The DOD budget alloca-

tion for the 2019 MTEF will have a direct bearing on the implementation of government policy as articulated through the SA Defence Review (2015) deliverables and will affect defence renewal programs and the ability of the SANDF to prepare and employ forces for internal and external commitments and to execute its constitutional mandate effectively.

The reduction in the budget allocation of the DOD from R50.6 billion to an amount of R47.9 billion resulted in a shortfall of R2.6 billion in both operating and capital budget to the Department for the 2018 MTEF (Defence Review Implementation Plan, 2019). For the SANDF, the ongoing budget reduction will result in the inability to meet the governmental and regional outcomes. Furthermore, this has an impact on the SANDF's ability to provide trained forces, to renew and maintain combat operational capabilities, to ensure aviation safety during deployments and to counter the deterioration of facilities as well as the renewal of required technology and departmental information systems.

15.4.5 Household DRR Financing

Figure 15.3 shows the major factors hindering households from recovering from the impacts of disasters in Port Saint Johns Municipality of South Africa and Chimanimani of Zimbabwe. It is clear that the lack of institutional finances from either banks, development partners or government was the major handicap for communities to recover from the impacts of the disasters in both Port Saint Johns (34%) and Chimanimani (35.4%).

Likewise, limited household finance was the second most cited reason drawing the participants back from recovering from the impacts of the disasters. These had frequencies of 24% and 20.6% for Port Saint Johns and Chimanimani, respectively. Households highlighted that their levels of income did not allow them to be financially prepared for disasters since in most cases they were living from hand to mouth. Insurance which plays a leading role in societies of the Global North to help recover from the impact of disasters is almost non-existent in the studied communities. Other reasons noted by the participants such as the lack of technical capacity, shortage of building material and responsible authorities not taking charge in the recovery process point either to limited budgets or lack of proper investment in DRR activities on the part of the authorities in both Port Saint Johns and Chimanimani. There is a need therefore to explore ways for alternative financing for disasters in these areas to complement what is available because it is in most cases inadequate. Both the at-risk population and the intervening institutions lack the means to finance DRR without

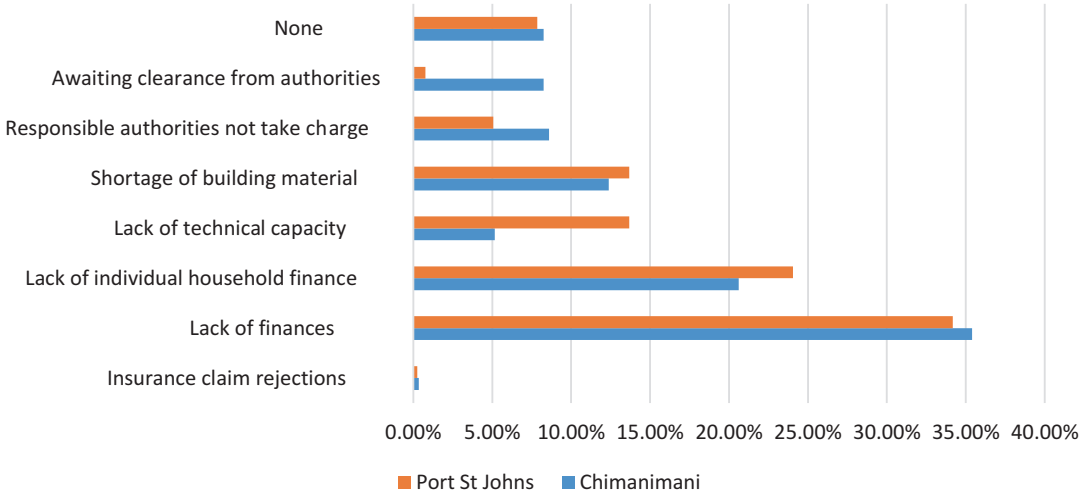

Fig. 15.3 Factors hindering household recovery from disaster. Source: Authors

external help, hence the need to put up structures for partnerships in this endeavour. These partnerships could take the form of government to government or different levels of government with the private sector as well as working with interested civic groups.

15.5 Conclusions and Recommendations

Adequate budgeting and financing of DRR activities are still limited in both Zimbabwe and South Africa; however, South African is performing better when compared to Zimbabwe in terms of DRR initiatives. In Zimbabwe there is a need for a new act that will direct DDR activities given the fact that the Civil Protection Act no longer reflects contemporary issues in disaster management. In both countries, there is a need for institutional re-engineering to improve DRR governance and improve access to funds. In South Africa, the DMA needs to make more provision for the application and implementation of DRR within local municipalities unlike the current situation where it is a competency of the district municipalities. In both Zimbabwe and South Africa there must be a drive towards decentralisation of DRR with emphasis on local ownership. The current funding for DRR activities in both countries puts most of the burden on the government; given their financial limitations, there is a need to explore alternative funding which includes both the governments and the private sector. Given the importance of DRR issues in both South Africa and Zimbabwe, there is a need for it to be placed and operated from the highest political offices in the two countries. Since DDR is cross-sectoral and involves many governmental players, its placement should ideally be where effective discharge of its duties is made easy. There is a need to improve funding and capacitation of the defence forces given the unique role that they play during disaster periods. DRR financing needs to be integrated into normal development planning by every sector of the society and needs to start at household level and upscaled to local, provincial, national and regional levels.

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16

Media Discourses on Natural Disasters and Management: A Case of Cyclones Idai and Kenneth and Floods in Four Southern African Countries

Lynn Mafofo, Tinashe P. Kanosvamhira, and Joseph Olanyo

Abstract

Due to the magnitude in which natural disasters affect people, their occurrence is without a doubt attractive to mass media as hard news content. As such, mass media plays an important role in disseminating information on predictable disasters, their occurrence, impacts and mitigating strategies. Digitisation of media and multiplicity of news platforms offer wider access for the audience and open stiff competition among media houses as they scramble for material. This chapter presents an analysis of the different media textual constructions in reporting on natural disaster preparedness, effects and management strategies. It particularly investigates the effectiveness of the role of media in disaster awareness and management of the most recent tropical cyclones Idai and Kenneth and local floods that occurred in Southern Africa in 2019. The study used content analysis to gather online reports on the disasters and carried out a critical multisemiotic discourse analysis to interpret the newspaper reports on cyclones and floods. It reveals the kinds of semiotics used to create social constructions and how they shape the audience's schemata of the events and readiness to participate. It further discusses the effectiveness of such reports in influencing the mitigation and implementation processes of the SDGs.

Keywords

Media reporting · Cyclones · Floods · Southern Africa · Sustainable development

16.1 Introduction

Climate change has seen an increase in the frequency and intensity of natural disasters globally. Empirical evidence shows that natural disasters such as tropical cyclones have increased in intensity and frequency in the South-West Indian Ocean (Mavume et al., 2009; Matyas, 2015). Such hydrometeorological disasters continue to affect livelihoods globally by destroying landscapes, buildings and lives and through shortages

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of food and outbreak of diseases (Mavhura, 2019). The occurrence of tropical cyclones stifles any progress made towards the fulfilment of the Sustainable Development Goals (SDGs). For instance, the destruction of infrastructure affects Sustainable Development Goals 4 and 6 which relate to the quality of education and the provision of clean water, respectively. Therefore, effective management of such disasters is crucial to ensure the fulfilment of the SDGs.

Disaster management remains the main crucial component in mitigating the effects of natural disasters. The literature highlights the importance of mainstreaming media into all efforts geared towards disaster risk reduction and management activities (Vasterman et al., 2005; Olivia and Jane, 2017). Disaster risk reduction is essential in ensuring that socio-economic development is not halted. The media plays a crucial role in providing vital information on natural disasters and taking the events to the wider society (Tong, 2017). Access to accurate information in different geographical areas is important and critical to public and mitigating organisations. While doing so, it is essential to concentrate on how the media depicts a representation of catastrophes, conflict and human suffering, and the scope of coverage of such events. Recent examples of media coverage in humanitarian disasters such as the tropical cyclones Idai and Kenneth as well as local floods that occurred in South Africa, Malawi, Zimbabwe and Mozambique during 2019 have highlighted how the media favours certain events against others depending on the characteristics such as the economic and political impact or the notion of cultural proximity (Emerton et al., 2020). As a result, there is an imbalance in the level of media attention, which complicates disaster management in those cases where media coverage is much lower.

The media's role in disaster management has improved significantly in recent years by introducing new technology and technical experts who can better describe the causes and consequences of disasters. The fact that technology has made possible things such as remote television transmission or satellite communication has led to a proliferation of information and the reports of humanitarian events whenever and wherever they occur (Rattien, 1990). Communication in times of crisis seeks to prevent the negative results of a particular episode and, above all, fulfils two functions: one informative and the other persuasive (Spence et al., 2007). Messages must create a rational understanding of risk and then encourage the public to avoid a possible threat or mitigate the consequences of such events. Disaster management requires planning, mobilisation and integration of public power and private institutions, corps of volunteer actors, afflicted communities and media (Lin Moe and Pathranarakul, 2006). Information or the lack of it can positively or negatively influence all phases of the disaster. In this sense, the media plays a critical role in communicating and understanding disasters and their implications (Pantti et al., 2012).

When natural disasters strike, mass media plays a crucial role in communicating disaster-related information to a large audience. Generally, the media is expected to perform several roles during natural disaster management, which includes updating the public on the different phases of the disaster and providing mitigation measures against the disaster. As a disaster unfolds, effective communication remains a crucial part of disaster management to ensure that every stakeholder is adequately informed about the timeline of events related to it. In other words, the misinformation and inadequate information can significantly affect disaster management affecting recovery efforts, relief work and rescue efforts. Media reporting on natural disasters can impact the level of disaster aid provided for victims (Berlemann and Thomas, 2019). Media reporting can also affect the preparedness of individuals before the disaster. Furthermore, due to the digitisation of media, the process of crowdsourcing is now common linking main media to social media in increasing communication and participation of many people ranging across the affected, the individual and organisations' well-wishers; however, different sources in media report news in different ways across various media platforms.

Despite the critical role the media plays amidst natural disasters, there is scarce research highlighting how it affects different stakeholders in disaster management. In 2019, two cyclones made landfall in Mozambique, affecting several neighbouring countries. Considering that in most cases when disasters strike, media not only is central to gather news for profiteering purposes but must also allow the public to access information, the objective of this chapter was to critically analyse the effectiveness of the role of media in disaster awareness and management of the most recent tropical cyclones Idai and Kenneth and local floods that occurred in Southern Africa in 2019. This includes ascertaining the kind of semiotics used to socially construct meanings through the case studies of the recent Cyclones Idai and Kenneth and floods in Mozambique, Malawi, Zimbabwe and South Africa. It sought to critically showcase how different meanings were divulged through different semiotics used to compile the texts in the media reports and how these meanings shape the audience's schemata of the events and readiness to participate and the usefulness of such reports to responsible organisations as role players in implementing and maintaining successful SDGs. The chapter outline is as follows: a brief on media texts and critical multisemiotic discourse analysis, materials and methods used in the study, findings and discussion of the study and conclusion.

16.2 Media Texts and Critical Multisemiotic Discourse Analysis

The internet has become a useful media platform disseminating information to massive audience in different geographical areas in a short space of time. Luhmann (2000) notes the complex relationship between texts and social events due to the mediation processes in mass media using technology to disseminate communication. For example, news reaches people in different geographical areas in different media, be it television, radio, newspapers or social media platforms. Mediation becomes an important process in which circulations of texts and meanings make what Fairclough (2003, 30) calls "chains or networks of texts". Due to globalisation, circulations of texts can enhance wider consumption of texts including having influential people or organisations "to act upon and shape the actions of others over considerable distances of space and time" and ability to control the processes of mediation that are facilitated through mass media such as television or internet (Fairclough, 2003, 30; Giddens, 1991). For example, the media texts on the cyclones Idai and Kenneth were reported widely from the local to global spaces and the texts were reshaped and circulated based on the contexts of consumption they found themselves in. As our societies' daily activities are expressed in the stories we are told in the media, Bell and Garrett (1998, 65) contend: "news is a major register of language". As such, understanding how it works is very important.

Disseminating information right from the warning, disasters and casualties from mass media is vital. Due to such disasters' seriousness, news related to them is grouped as hard news to be objectively and truthfully reported. According to Bell and Garrett (1998, 69) hard news "are the kind of news we recognise as the staple of daily media". Stories such as disasters, dangers and all manner of mayhem that can befall human life can be grouped under hard news. According to Bell and Garrett (1998, 89) in hard news reporting, "negativity has a high priority [as] bad news is more newsworthy than good news". It ties in with unexpectedness, usually a shocking sudden event. Thus, negativity and unexpectedness together create the "shock-horror" effect required to capture people's attention. Additionally, "person centredness is another important factor determining newsworthiness, and it explains why mega-tragedies stories are often illustrated by the highlighting of one particular victim or victims …" (Bell and Garrett, 1998, 89). White (1997, 107) points out that "headlines aim to serve a variety of functions". Firstly it is to summarise the story, and secondly, to attract the reader to the particular story and to the newspaper itself.

In support of all this information, Bell and Garrett (1998, 65) added that "as a text is central

to news, the news content is not independent of its expression, and we can only hope to have a clear understanding of the nature of news content by a close analysis of the news text". With this analysis, they emphasised that it would illuminate how stories are made. Also, a close analysis according to Bell and Garrett (1998, 66) "makes us aware of the complexity and ambiguity of news". To understand the complexity of such texts in the case of disasters and management thereof, it is important to note that mediated discourses are controlled by the powerful societal organisations be it media houses, government or political organisations and that texts are never neutral. Critical multisemiotic discourse analysis that considers textual analytical tools of critical discourse analysis elements of intertextuality and interdiscursivity (Fairclough, 1993, 2003) and resemiotisation (Iedema, 2003) was applied to interpret the data. Media texts are intertextual and dialogical and their circulations for consumptions and reproductions form both hegemonic and ideological discourses in different contexts. Also, media texts are multimodal in nature as they include words, images and other graphological devices as meaning-making resources. As such, a textual analysis that looks at all the semiotics as part of the meaning-making resources of the texts is important. The newspapers' selected headlines and accompanying semiotics were closely analysed to identify how the different meanings were divulged through different semiotics used to compile the texts and how these meanings shape the audience's schemata of the events and readiness to participate. This includes looking at the possible impact of such meanings in realising the SDGs amidst a natural disaster.

16.3 Materials and Methods

This chapter focuses on four Southern African countries (Fig. 16.1), which were affected by cyclones Idai and Kenneth and floods in 2019, namely Mozambique, Malawi, Zimbabwe and South Africa. Before these cyclones, at least nine tropical cyclones have made landfall on Mozambique and surrounding Southern African countries, for instance, Tropical Cyclone Eline in 2000, a category 3 cyclone that culminated in devastating floods in Mozambique, Zimbabwe and South Africa causing property damage and loss of lives (Reason and Keibel, 2004). The aforementioned countries were all directly affected by the cyclones and floods during the period in question. Cyclone Idai developed along the channel between Mozambique and Madagascar. Cyclone Kenneth emanated between the Mozambique Channel and the north of Madagascar (Mawren et al., 2020). Mozambique, the hardest hit of the four countries, is located in the Southeast of Africa bordered by the Indian Ocean, where both cyclones emanated. It is prone to the effects of cyclones due to its proximity to the Indian Ocean, where there are plenty warm ocean waters of approximately 26 °C, humidity, atmospheric instability to ensure the formation of thunderstorms, and significant Coriolis force (Vitart et al., 2003). Although Malawi and Zimbabwe are landlocked they were also affected due to the intensity of the cyclones. Although not directly affected by the cyclones, South Africa was affected by some floods during 2019 and assisted affected nations in dealing with the impacts of the cyclones. Figure 16.1 presents the aforementioned countries.

Based on the four identified countries, a desktop study involving the search of online newspaper reports was conducted. The first stage of the literature search involved the search of mainstream newspapers from each country using the keywords "Cyclone Idai", "Cyclone Kenneth" and "Floods in Southern Africa 2019". The search engine Google was utilised to search for online news across the four different countries using the keywords indicated above. The rationale behind selecting the mainstream papers in each country was the voluminous number of reports on the cyclones from various sources. To narrow down the sources, the mainstream newspapers from each affected country were deemed suitable to analyse the media discourses. To this end, background research was conducted to identify the mainstream newspapers of each country. Eventually, four mainstream newspapers with a

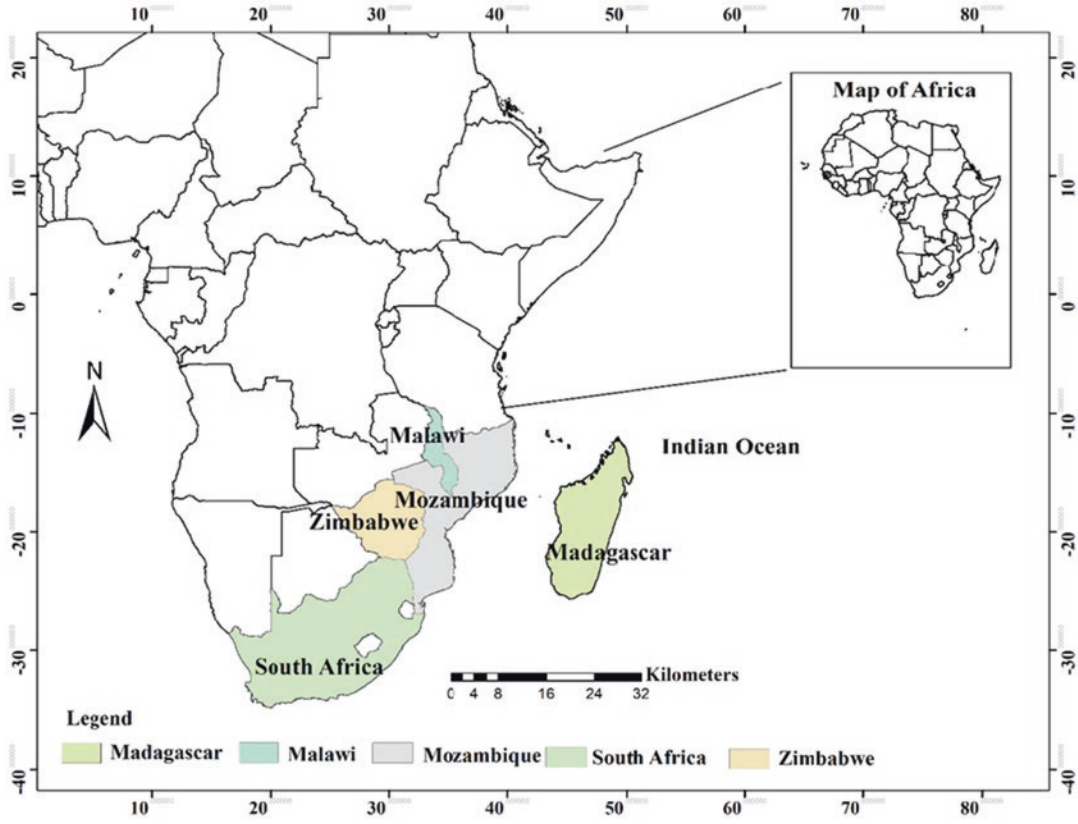

Fig. 16.1 Location of study sites

higher number of articles on the cyclones and floods from each country were chosen. The selected newspapers were The Herald Zimbabwe (HZ); The Nyasa Times, (NTs) a Malawian newspaper; Noticias, a Portuguese newspaper from Mozambique; and the Mail and Guardian for South Africa (SAM&G). The Google Translate option was used to translate the content of the Noticias newspapers from Portuguese to English. The Guardian International Edition (GIE), the international paper, was chosen to explore how the news was presented by a newspaper outside the affected countries. A search for publications related to the cyclones on the identified online newspapers was carried out. The search was limited to articles published between March and June 2019. The content analysis attempted to capture articles published before, during and after the identified disasters. A total of 103 online articles focusing on the headlines and images were used in this chapter as data. Content analysis was chosen as the appropriate method to analyse the media discourse.

16.4 Findings and Discussion

Reports on alertness and preparedness, casualties, mitigation and management, and weather updates were some of the main issues reported in the newspapers. The difference in choices of semiotics used to construct social realities of the disasters shows different ideologies and inequalities the media houses carry when reporting on disasters. All newspapers highlighted the different stakeholder efforts made in trying to assist affected countries with aid. The spirit of donating was spread across all newspapers, showing how the global community

was coming together to assist affected victims. The selected newspapers adopted different styles and values of reporting, various semiotics and headline constructions to inform the audience. They used several newsworthiness values such as sensationalism, eliteness and proximity. Starting with The HZ, the first few headlines captured the reports on Mozambique as the Cyclone Idai rapidly eroded. Headlines 1–9 captured warnings and early casualties of the cyclone in both Mozambique and Zimbabwe[1] (Table 16.1).

Table 16.1 The HZ

1. Floods kill 10 in Mozambique as Cyclone Idai lashes heavy rains	18. Idai: UN, partners join forces
2. Cyclone Idai: Mozambique on high alert	19. UAE, SADC add to donations haul
3. Cyclone Idai set to make hard landfall inMozambique tonight	20. Idai: Bikita victims get humanitarian assistance
4. Cyclone Idai Zim-bound	21. How Cyclone Idai tore into Moza, Zim & Malawi
5. Nation braces for Cyclone Idai	22. Donations pour in for Idai victims
6. Deadly Cyclone Idai makes damaging strike on central Mozambique	23. China offers to rebuild infrastructure
7. Cyclone Idai lashes Mozambican port, hits communications	24. Idai: Two days of mourning declared
8. Cyclone Idai hits Manicaland	25. …search on for missing persons
9. Cyclone Idai wreaks havoc	26. UN avails helicopter for food distribution
10. BREAKING: ED cuts short UAE trip to respond to Cyclone Idai back home	27. Midlands raises $500k for Cyclone Idai
11. Cyclone Idai: First Lady consoles families	28. Govt to investigate further into Cyclone Idai
12. Zanu-PF mourns Cyclone Idai victims	29. Religious groups join hands in national mourning
13. Zim's disaster preparedness in focus as Cyclone Idai moves inland	30. School accommodates Idai-affected pupils
14. Cyclone Idai wreaks havoc	31. 82 Idai victims buried in Moza
15. Idai to subside	32. Zim sends formal Cyclone Idai SOS
16. EDITORIAL COMMENT: Cyclone Idai: Wake-up call to climate change	33. Idai: Woman gives birth in mango tree
17. Macheso, Jah Prayzah join relief efforts for Cyclone Idai	34. More help for Idai victims

The sensationalism is evident in most of the headlines in which the cyclone is positioned as the subject. The verbs used show the gravity of the destructive nature of the cyclone. Examples are seen in the headlines 3, 4, 6, 7, 8, 9, 14 and 15. Behavioural processes are used to articulate this gravity of the dangerous cyclone or flood activities seemingly causing deliberate harm. The newspaper selectively used emotive language through the use of behavioural processes to reveal the cyclone's occurrence and impact. The processes are "kill" in 1, "makes" in 6, "lashes" and "hits" in 7 and 8 and "wreaks" in 9 and 14. The choice of such processes as semiotics in the meaning-making process of disseminating the news on the disaster undoubtedly makes readers want to read more and possibly respond as well-wishers. The headlines carry a serious tone and are constructed using more content words and less functional words; they are more informational statements than the other moods such as commands and questions. This kind of reporting signals indirect advocacy by offering or declaring that information unquestionably would both grab the readers' attention and invoke fear and proactive responses in various stakeholders.

Eliteness is also adopted as a newsworthiness stance elevating the government's visibility, especially in how the newspaper drew on various semiotics in both the choice of words in the headlines and the accompanying iconic images. From the examples above, numbers 10–12 have the focus on the president portrayed as responsible by cutting short his UAE official trip to "respond to Cyclone Idai back home". In 11, the first lady is another semiotic used to capture the event's seriousness, which has caused grief among affected Zimbabweans. Applying of both moral legitimation and rationalisation (Fairclough, 2003) on government level shows ownership of dutiful activities the government was in charge of. By positioning her as reacting responsibly and emotively, it portrays the level of the calamity

[1]Headlines can be accessed at https://www.herald.co.zw/?s=cyclone+idai
https://www.herald.co.zw/?s=cyclone+kenneth

which the government has to dutifully intervene. The focus is also on the ruling party as clearly captured by the headline 12 which also reinforces 11, and later 24 where the president's face is used to accompany the declaration of a mourning period in Zimbabwe.

The authorisation of government and exclusion of other non-government officials or parties are explicit and reinforce the way readers are meant to read the Government of Zimbabwe as the one proactively responding to disaster management. Even when donations were pouring in to support the victims of the disasters in Zimbabwe, influential governmental figures such as the Namibian official were captured as representing SADC donating to Zimbabwe, Malawi and Mozambique. Officials who used semiotics to construct the news text show a positive positioning that directly relates to ensuring the SDGs' implementation even in mitigation processes during and after the disasters. However, this kind of reporting can also influence how well-wishers and victims would respond to the calamity in a country facing economic and political problems.

UN is grouped with other partners, as in headline 18; the accompanying image is that of Cyclone Idai, hence making the UN and those partners faceless. The focus is placed on the actual cause of their interactions in mitigating the effects of the disaster. The UN's positioning and participation as a global organisation increase participation or intervention of the global community reaching out to the affected community. This could have positive results in rebuilding and trying to implement the SDGs. As indicated in 17 and 27, strategically reporting on different bodies is a mobilising approach that yields positive results for mitigation at a local level. Just as the disaster striking verbs used, the mitigating verbs are also bordering between material and behavioural processes ranging across "join" in 17 and 29, accommodates (30), buried, sends (32) search (25), pour 22, and offers 23 and 34 and are used as the strategic choice of semiotics to signal a continuation of responses or how people helped, thereby creating urgency in readers as well-wishers or victims. In 33, the headline subtly signals new birth coming out of such a dire situation again to show health-related problems on top of displacement and hunger, thereby constructing a social narrative of advocating for intervention covering some of the SDGs.

The Cyclone Idai meteorological related image, food parcels and influential figures were used as part of the visual journalism. The construction of the news on these disasters focused more on the local responses than the international ones painting a picture that the government was managing the problem well and was not necessarily calling out for help but just informing readers what was happening. The HZ's stance of advocacy in such a disaster was quite limited to the functional role of informing. However, the newspaper was instrumental in news related to whistle-blowing to alert both the local and international communities. Among all the newspapers under study, The HZ was the one that repeatedly used the images of the depicted cyclones to inform readers. Figure 16.2 shows some of the images.

It concentrated on the reports on alertness, preparedness and occurrence of the cyclones. The repurposed meteorological images show weather focus activities and updates on the approaching disaster. The meteorological discourses are carried out in the images of the cyclone that were circulated and recirculated in different headlines. This makes readers responsive as they identify the images with what is breaking news. The most circulated image was the meteorological disastrous cyclone and less on the affected, and this indicated that the reporters were not always on the ground and were monitoring the situation from a distance. The images could also signal the country's helplessness, which was in the proximity of the danger but could not record the actual casualties as the international newspaper below.

16.4.1 The Noticias

Mozambique newspapers are unique as most of them are written in Portuguese. Although this language is one of the country's official languages, many people in the world use English as

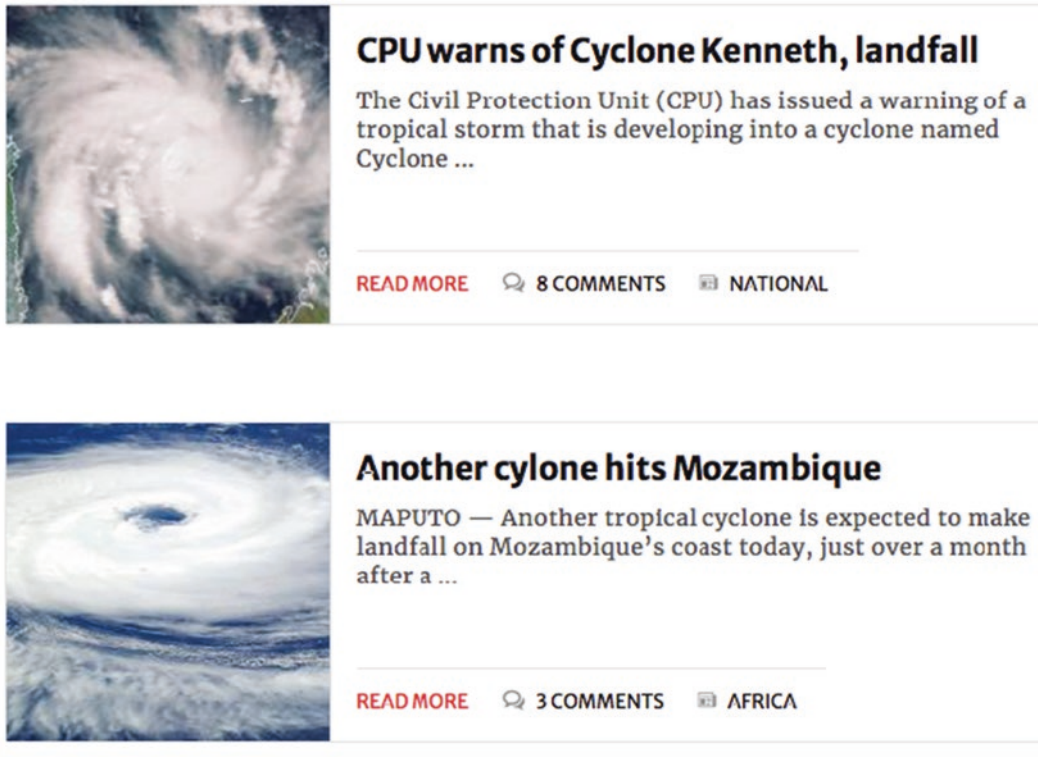

Fig. 16.2 Meteorological reports on Cyclone Kenneth (The Herald Zimbabwe)

a common language. At a glance, the news is not easily accessible to an audience who are not literate in the language. However, the inclusion of other semiotics such as the audio and the interactive videos as part of the texts made it easier for the audience to see what was happening. For instance, the audios help the audience who may not be able to read the language but could make sense of it through listening to the voice while the unedited video clips of the actual floods, affected people and conferencing audience helped a lot in disseminating information to the audience who are not literate in the language. Table 16.2a shows some of the headlines from the Portuguese newspaper called Noticias. Table 16.2b shows the English translated version of the headlines[2] in Table 16.2a.

Like the newspaper above, Noticias also positioned cyclones as subjects acting against humanity. Headlines 5, 7, 9, 12, 13, 14 and 15 show the foregrounded noun phrases of the cyclones Idai and Kenneth interchangeably wreaking havoc on the people of Mozambique. Among the six headlines, five carry behavioural processes in which the construction of the cyclones as enemies to humanity is captured. The verbs *puts, took, betrayed, killed* and *threatens* show menacing cyclones. Even the material process *arrives* in headline 13 signals arrival of an unwelcome actor in Mozambique. The social construction of the meanings around the cyclone activities would immediately capture the readers' attention. The newspaper chose a stance of an onlooker informing the public about the cyclones' activities. It depicts helpless victims and this creates discourses of the people on the margins affected by natural disaster likened to victims of injustices who need intervention. It socially constructed a reality that invokes the readers to morally respond to the helpless victims in Mozambique. The reproduction of discourses of invaders and the invaded is

[2] https://www.voaportugues.com/s?k=cyclone%20idai&tab=all&pi=1&r=any&pp=10

Table 16.2 (a) Noticias in Portuguese (https://www.voa-portugues.com/a/4886567.html). (b) Noticias (Portuguese to English translation)

(a) Noticias in Portuguese	
1. Conferência de doadores da Beira pode não atingir os seus objectivos	11. Secretário-Geral da ONU apela a mais ajuda a Moçambique
2. PMA procura fundos Para apoiar vítimas de ciclones em Moçambique	12. Ciclone Kenneth matou cinco pessoas no norte de Moçambique
3. Aumenta Para 38 número de mortes devido ao ciclone Kenneth	13. Ciclone Kenneth chega a Moçambique
4. África em posição privilegiada Para combater as mudanças climáticas	14. Washington fora d'horas 25 Abril: Ciclone Kenneth já atingiu Moçambique
5. Ciclone Kenneth coloca norte de Moçambique em alerta	15. Kenneth "ameaça" norte de Moçambique com mais destruição
6. Mais de 350 postos sem energia Para recensear eleitores em Sofala	16. Autoridades moçambicanas reiteram que Zimbabwe não abriu barragens nas inundações de Março
7. Moçambique: Mulheres resilientes depois do Idai	17. Moçambicanos começam a sentir o peso do ciclone Idai no custo de Vida
8. Deslocados de Nhamatanda tentam reconstruir a Vida depois do Idai	18. Mia Couto diz ter ficado surpreso de forma negativa com a resposta do Brasil ao ciclone Idai
9. Exclusivo ciclone Idai: A natureza desta vez traiu-nos, diz Daviz Simango	19. A Beira começa a tenttaar recuperar após o ciclone Idai ter devastado a cidade a 14 de Março
10. Número de mortos do ciclone Idai em Moçambique sobe Para mais de 400	

(continued)

Table 16.2 (continued)

(b) Noticias (Portuguese to English translation)	
1. Beira donor conference may not achieve its objectives	11. UN Secretary-General calls for more aid to Mozambique cyclone
2. WFP seeks funds to support cyclone victims in Mozambique	12. Kenneth killed five people in northern Mozambique
3. Increases to 38 deaths due to Cyclone Kenneth	13. Cyclone Kenneth arrives in Mozambique
4. Africa in a privileged position to fight climate change	14. Washington out of hours April 25: Cyclone Kenneth has already hit Mozambique
5. Cyclone Kenneth puts northern Mozambique on alert	15. Kenneth "threatens" northern Mozambique with further destruction
6. More than 350 power stations to register voters in Sofala Mozambique: Resilient women after Idai	16. Mozambican authorities reiterate that Zimbabwe did not open dams in the March floods
7. Idai took everything [from people] who had nothing	17. Mozambicans begin to feel the weight of Cyclone Idai in the cost of living
8. IDPs from Nhamatanda try to rebuild life after Idai	18. Mia Couto says he was negatively surprised by Brazil's response to Cyclone Idai
9. Exclusive Cyclone Idai: Nature this time betrayed us, says Daviz Simango	19. Beira begins to try to recover after Cyclone Idai devastated the city on March 14
10. Death toll from Cyclone Idai in Mozambique rises to over 400	

strategically intertextualised and recirculated in media to disseminate information on the cyclone's effects. For example, the headline 6 that reads "Idai took everything … who had nothing" reveals a personification stance of the cyclones' negative activities as being consciously acted rather than a natural occurrence on the people. That calls for immediate intervention for well-wishers to holistically restore the implementation of the SDGs.

Continuously using the newsworthiness of negativity in headlines 6, 10 and 17 still shows the cyclones' disastrous impact on the people of Mozambique. Unlike the Herald above, the Noticias concentrated on reporting on the local events. This could be because the country was the most affected but a closer look at the other headlines shows that the newspaper adopted an ideological stance in reporting using proximity that worked both on local and global levels. In terms of news related to readers' responses or calling out for well-wishers, the selected headlines indirectly show that more help is needed by casting doubt on some of the activities as in 1 shown by the verb phrases "may not achieve" and "was [negatively] surprised" in 18 to indicate a donor conference that was predicted as a fiasco and the inadequate response of Brazil to the crisis.

Headlines 2 and 11 indicate two powerful organisations calling for help on behalf of Mozambique in "WFP seeks funds to support cyclone victims …" and "UN Secretary-General calls for more aid". Using such lexical chains constructing a social reality of the powerful organisation not being able to fight alone and callout for helping hands would make well-wishers respond quickly. Therefore, different semiotics used to disseminate the socially constructed realities pushing particular ideologies make unique contributions of mass media in sharing information and advocating for the needy. This kind of reporting positions the country to get a lot of attention from all over the world and puts it on a road to speedy recovery—a stance that could be influential too for the country to have resources to implement the SDGs continuously.

16.4.2 The Nyasa Times (NTs)

The NTs slanted towards reporting on the well-wishers' responses to the floods that were rampaging Malawi. The choice of the words used in the headlines is quite clear and more informative than directly advocating for action from the well-wishers. The NTs' selected headlines in Table 16.3 are centred around reporting on how helpers responded to the crisis.

From headlines 7 up to 15 the behavioural processes of giving are repeatedly used. Except for headline 7 which has the verb "sends" "donate/s" is repeated in 8, 11, 13 and 14 while "bailout" is repeated in 9 and 10 and "sets aside/up" is used in 12 and 15, respectively. The named well-wishers are mainly from the country and Africa, but the unnamed collective donors offered substantial amounts of money. The two prominent figures—the Malawian President and the Pope—are reported as both commiserating with the victims and calling for help. This kind of reporting, through focusing on the positive responses of the social actors helping out and the social construction on the moral discourses of giving and responding to the need, is also influen-

Table 16.3 The NTs (https://www.nyasatimes.com/tag/cyclone/)

1. Malawi safe from Cyclone Kenneth
2. Weather experts warn heavy rains flooding to hit Centre north regions Malawi declares disaster zones
3. Cyclone Kenneth looms with fresh floods Malawi weather experts warn
4. Cyclone Kenneth effects hit Nkhata Bay
5. Flood hit Mozambicans flee to Malawi Makhanga remains cut off
6. Floods displace 256 people in Salima, destroy 60 hectares of crops in Ntchisi
7. South Africa sends rescue teams relief items to help Malawi flood devastation
8. Tobacco Processors Association donates K43 million items to flood victims
9. Donors bail out Malawi on K17bn flood victims resettlement deficit
10. Chilima bails out flood victims in Nsanje Malawi VP urges people to move to upland
11. Tanzania donates to Malawi maize, medical supplies after Cyclone Idai
12. Malawi mission in South Africa sets up disaster task force
13. Ma Blacks to perfom in aid in of Malawi flood disaster partners Blantyre Press Club
14. Mutharika visists Thyolo flood victims Govt extends social services to cater for disaster victims
15. South African Prophet Radebe of revelation church donates Malawi flood victims
16. Chikwawa Cyclone Idai victims to get relief
17. FDH bank sets aside K3 million for cyclone
18. NICO, Sanlam donate to neglected victims of cyclone
19. Malawi President visits flood victims and distributes relief goods
20. Malawi govt hails Pope Francis partners for donations to relieve flood victims
21. Pope expresses grief for victims of Cyclone Idai urges support for Malawi Mozambique and Zimbabwe
22. Chakwera urges MCP members to help disaster victims as floods kill 26
23. Hailstorm victims ask govt for relocation before Cyclone Kenneth hits
24. MEC assures Nsanje flood victims to allow voters who lost voter ids
25. UNHCR asks Malawi Govt to acquire land for flood hit victims support their return home
26. Why Malawi is failing to protect people from floods and what needs to be done
27. Army soldiers deployed in flood hit areas mad over unpaid lunch allowances

tial in invoking readers to collectively respond. Positioning of the country at the receiving end of the support in its dire need equally portrays the magnitude of its vulnerability.

This reproduction of social life activities still recreated the country's poor status amidst the floods caused by the cyclones. Unlike the Zimbabwean newspaper which extensively published several reports on the cyclones, the NTs hardly reported on the casualties but selectively reported on the effects of the Cyclone Kenneth in selected areas in the country using material processes "hits" and "looms" signalling the sudden occurrence of the cyclone (see headlines 3 and 4) and again personifying the cyclone. What follows after this disastrous impact are stories signalling interventions by several organisations in response to the cyclones' casualties. The choice of words used in the headlines shows a lack of seriousness in intervention from the government, as can be seen from headline 22 where victims ask for the government to relocate them and in 24, where the government is asked to "acquire land for the victims". Therefore, the socially constructed narratives of the activities still show the discrepancies in how the government was handling the disaster. That kind of reporting shows gaps in handling disasters because from the reports, it is evident that the well-wishers responded to the immediate needs of the victims but other crucial needs around rebuilding are not quickly addressed to put the affected country back on addressing the developmental goals.

16.4.3 The South African Mail and Guardian

The SAM&G reported on a few cases as depicted in Table 16.4. The semiotics used to create the headlines and the accompanying images depict a few forecast reports of the aftermath of the cyclones, including showing the damages shown in Table 16.4 and Fig. 16.3. This includes reflecting stories on the surviving victims. This newspaper focused on reports related to the alertness and aftermath. Although South Africa was not affected by the cyclones, from the newspaper, it can be understood that the reporters were in Mozambique capturing the actual devastating aftermath and the affected victims on the ground. The behavioural process "braces" is repeatedly used to depict how Mozambique was helplessly preparing for the Cyclone Kenneth. The cyclone is described as "violent" making "landfall" and named an "apocalypse". These lexical sets portray a disastrous cyclone and the image in Fig. 16.3 serves as evidence to show readers an overview of the casualties. The headlines and the image give a clear picture of what is on the ground and the angle from which the image was captured. The newspaper sources were actually well equipped to capture the casualties compared to the other newspapers of the affected countries. This newspaper was also able to evidently provide information on the destroyed infrastructure that needed to be rebuilt. Well-wishers are likely to respond to address such casualties, making it easier to rebuild and implement the SDGs. Another interesting headline portrays South African Defence Force as "in critical decline" after it had problems with one of its helicopters while offering help in Mozambique. This also reveals poor mitigation conditions and resources in Southern Africa and an indirect call for more help of that kind or improvement of disaster management resources. These newspapers hardly reported the floods in South Africa as more focus was on the most affected countries, which are Mozambique and Zimbabwe in this case.

16.4.4 The Guardian International Edition

Some of the headlines from GIE included headlines that captured the casualties. The headlines' verbs and adjectives used depicted a dire situation that needed prompt action from the world. The images accompanying the words as meaning-making semiotics signal to discourses related to both disaster reporting and call for mitigation. Examples of the semiotics are shown in Table 16.5.

The choice of semiotics used in constructing the headlines' multimodal texts and accompanying images depicts a bad situation in the affected country and would make well-wishers respond

Table 16.4 SAM&G

1. Cyclone Idai shows the deadly reality of climate change in Africa 2. Mozambique and Comoros brace for cyclone Kenneth 3. Mozambique braces for violent floods after Cyclone Kenneth 4. Cyclone Kenneth makes landfall in Mozambique	5. Tropical cyclone Idai: The storm that knew no boundaries 6. Mozambique, Zimbabwe cyclone deaths exceed 300 as UN boosts aid 7. Beira, one week after the apocalypse 8. SA defence in 'critical decline' 9. Foresight and quick thinking: How one village survived the floods

(https://mg.co.za/)

quickly. In contrast to The HZ that used the government officials' and celebrities' images on the ground receiving help on behalf of the victims or joining forces with other well-wishers, this particular newspaper concentrated on a socially constructed narrative depicting a country in dire need of help. The choice of lexical sets used in recording the casualties can be likened to discourses of war, as shown in the first, second and fourth captions below. The third caption, however, shows mobilising for "another huge aid effort" and this kind of reporting can increase aid and increase better chances of improving the SDGs. Examples of amplified statements include the following: "… more than 1000 feared dead in Mozambique death toll rises as rain continues … … Mozambique may need another huge aid effort Five dead and homes flattened after cyclone hits Mozambique …".

The choice of images also shows the affected people and the environment rather than the officials in the Herald Zimbabwe. The affected people are also pictured from a distance in full view to depict their victimhood and helplessness in the situation they found themselves in. Such a strategic positioning of semiotics is informational and works as a whistle-blower's proof for readers to react. The semiotics are also repurposed and recirculated in different media and form. For instance, instead of just having a still image, the GIE created video clips showing the actual reported cases for viewers to have a first-hand experience virtually, as shown in Fig. 16.4.

The angle at which the images were captured shows the reporters' presence on the ground. Using the victims' actual bodies and activities to construct a social reality of events positions the newspaper as a powerful organ telling stories of the affected on the one hand and mobilising well-wishers on another. The images are used as evidence to show the dire situation in this country and the evidence of destroyed infrastructure, homeless and hungry victims. This was a good presentation of the needs that should be addressed under the SDGs in response to the affected countries.

16.4.5 Implications: Gaps in Media Reports and Disaster Management

The South African and international newspapers revealed the semiotics of what was actually on the ground which signals a lack of resources of the local newspapers to capture the events. The semiotics difference shows that news carries ideological discourses and representations of events by media houses. There were few reports on what was happening during early mitigation to save lives before the disastrous cyclones struck. Government-run media camps seem to present their news to positively portray responsible government/s. This, unfortunately, may significantly affect disaster response, especially in cases where the government is portrayed as managing the situation without much help, and complicates the implementation of the SDGs.

Furthermore, international newspapers had more informative pictorial information than local newspapers as seen in semiotics such as videos and images. The quality of images presented by local newspapers, except the South

Fig. 16.3 SAM&G cyclone aftermath image

Table 16.5 The GIE (https://www.theguardian.com/international)

1. Cyclone Kenneth death toll in Mozambique rises as rain continues	7. Cyclone Idai caused $2bn of damage and affected millions says World Bank
2. Five dead and homes flattened after cyclone hits Mozambique	8. Why were people affected by Cyclone Idai so badly?
3. Cyclone Kenneth: At least five dead as heavy rain lashes Mozambique	9. Mayor in Mozambique says negligence led to cyclone deaths
4. Cyclone Kenneth: UN says Mozambique may need another huge aid effort	10. Cyclone Idai has devastated people's lives. They need your help
5. Cyclone Idai: "My family needs to eat, I don't know how we will survive"	11. Cyclone Idai crisis deepens as first cases of cholera confirmed in Mozambique
6. Cyclone Idai: More than 1000 feared dead in Mozambique	12. Hundreds dead or missing in devastation of Cyclone Idai—in pictures

African one, is strikingly different. The local images are of poor quality and fail to depict a clear picture of the impacts of the disaster. Images presented in the IGE and SAM&G had good quality and were captured at angles providing a better appreciation of the state of the communities during the occurrence and the aftermath of these disasters. Therefore, inequalities in access and resources seem to affect the quality of news. The international community zoomed on the most critical parts of the crisis, including videos showing evidence of affected people and call for well-wishers. In this light, it is notable that such disadvantages can be obstacles in implementing the SGDs during disastrous events. At the same time, the platforms reported few efforts of governments' mitigation efforts on the affected communities. For example, the NTs chose to concentrate on humanitar-

Fig. 16.4 Devastating effects of the Cyclone Idai (GIE)

ian discourses. Noticias reproduced the actual events around Mozambique's affected victims, showing efforts to widen readership by using video and audio clip substitution of the Portuguese text.

The findings show gaps on other related useful information of accounting for the scale of the disasters and what was needed to rebuild the affected communities besides informing the public about the disasters. This could lead to poor disaster management responses that would also stifle the implementation of the SDGs holistically. The selected reports mobilised people to respond to immediate needs than the long-term needs, such as rebuilding permanent structures and addressing education and health issues. The news focused mainly on what was happening and failed to directly inform well-wishers to respond on rebuilding infrastructure among other important areas to both rehabilitate the affected areas and community and keep a conducive environment for the development goals to be successfully implemented. Some also portray incompetence of the governments' responses to disasters which could increase well-wishers' responses but can have a crippling impact on implementing the SDGs. There is a need for media to take holistic approaches in reporting the disaster activities from the warning, forecasts, casualties and mitigation efforts, including indicating gaps in mitigation to promote better disaster management responses and strategies.

Informing the public and advocating for the people on the margins are necessary news media functions in disaster management that should be adequately fulfilled. Hence, reporting hard news in disasters could also add answering the question: What could be done to mitigate rather than concentrating on answering what happened, why and how it happened questions?

16.5 Conclusion

This chapter has revealed the different functions of the media in reporting disasters and the mitigation efforts through a critical multisemiotic discourse analysis of the newspaper headlines and accompanying images. It highlighted the positive and negative strategies used to construct effective or ineffective socially constructed narratives on the disasters. The chapter highlighted diverse media outlets and choices of semiotics in creating social realities of disasters as they occur and their impacts. However, these platforms usually possess different agendas that militate against or meaningful coverage of the cyclones. This affects how the affected countries receive aid beyond basic needs such as food and temporary shelters and effective implementation of the SDGs.

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Part V

The Policy Space

Concluding Remarks: De-risking Tropical Cyclones in the Era of Climate Change Emergency

17

Kaitano Dube and Godwell Nhamo

Abstract

Tropical cyclones are a global challenge, and climate change is adding to the complexity of their impact on development and occurrence, particularly in developing countries. While there is a marked improvement in the forecasting of track and intensity of tropical cyclones across the world, such improvements have not translated into improved disaster risk reduction (DRR). This has been mainly due to communication challenges, which remain highly technical. DRR and management information remain largely inaccessible to risky communities at appropriate times. Even where DRR communication reaches the intended communities, early evacuation has been a challenge owing to various factors including perceptions, religious beliefs, understanding and absence of community evacuation plans in times of tropical cyclones. We note the critical role played by early warning systems, community response, understanding of DRR and management, use of systems thinking, role of the media, use of indigenous knowledge systems and involvement of faith-based organisations in tropical cyclone emergency response. Several initiatives are recommended that can be used in disaster response in southern Africa, among them appropriate communication and synergising of indigenous knowledge systems and current scientific knowledge in disaster management. There is also a need to build back better (BBB) post-cyclone to de-risk future cyclones. Tropical cyclone disaster response has to be timeous, inclusive and done with a view to building stronger to ensure community resilience. Climate change adaptation is also identified as an important component of BBB through private and public sector partnership for resource pooling. Investment in research and forecasting improvement and communication of tropical cyclones is further recommend to be central to the regional climate-smart future.

Keywords

Tropical cyclones · Resilience · Adaptation · Climate change · Disaster communication

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17.1 Introduction

All signs point to a world that has entered an era of climate change emergency. There is clear evidence that extreme weather events are a real threat to the global developmental discourse agenda that has now been epitomised by the 2030 Agenda for Sustainable Development and the interwoven 17 Sustainable Development Goals (SDGs) (United Nations, 2015). With climate change footprints too visible across the global economy, there has never been a more perfect time in human history to foster and advance the dictates of climate resilience and climate change adaptation. A recent report by the World Economic Forum (2021) demonstrates how the global economy is connected to the environment and the centrality of climate (Fig. 17.1) as a global risk. From Fig. 17.1 it is clear how failure in climate action, which is identified as the top global risk and a disaster, will create a catastrophe and chaos for the global economy and society. The world, which is already battling poverty, inequality and exclusion, is battling in many respects to deal with the additional burden created by extreme weather events induced by climate change such as tropical cyclones.

We sought to identify vulnerabilities and emerging disasters from the tropical cyclones and ways of reducing risk. We provide the relevant policy framework that can ensure community resilience amidst the observed increased intensification of tropical cyclones. This chapter highlights the critical findings and potential recommendations for policy and practice.

17.2 A Recap of Foundational and Fundamental Issues

Developing countries with little capacity to adapt and build resilience directly and indirectly pays for the cost of climate change events, such as tropical cyclones. This happens mainly when these countries want to incur sovereign debts with banks and other international financial institutions. There is evidence indicating that the level of a country's development often determines its vulnerability and adaptation capacity to disaster, including tropical cyclones. According to Cevik and Jalles (2020), a country's vulnerability and/or its resilience to climate change has a bearing on the cost of borrowing and its creditworthiness. It has been found that climate change tends to affect the ability of a country to repay loans. Consequently, such actions promote the deepening of poverty and continued vulnerability of developing states as most are likely to fail to escape the trap and cycle of debt and poverty. Apart from high borrowing costs, developing countries also have to contend with high premium costs of insurance (Mechler et al., 2010), which either discourage or inhibit the uptake of such products, further exposing the countries to additional uninsured risks at a time when they need risk protection.

Climate change-related extreme events such as tropical cyclones have been blamed for perpetuating poverty and inequality across the world, with the developing countries suffering the most due to incapacity to adapt and build resilience. The impact of extreme weather events on the environment is threatening environmental failure in what some have now called a climate emergency (Paudyal et al., 2018). Biodiversity is facing collapse and extinction due to the global environmental change blamed largely on the impact of climate change. The deterioration of the environment is also threatening ecosystem services, which could further entrench poverty and inequality, as the poor are largely dependent on such critical services for livelihood security (Chaigneau et al., 2019). There is, however, consensus that anthropogenic climate change poses a considerable threat to the all-inclusive global SDGs as shown in Fig. 17.2. The figure shows the downstream impact of increased carbon emissions, which then trigger a chain of feedback loops that give rise to extreme weather events such as tropical cyclones with catastrophic implications on global economic and social development. High-impact events that pose the most significant threats on SDGs include heatwaves, cold waves, fires, droughts, flooding, marine heatwaves, coastal erosion and, indeed, tropical cyclones.

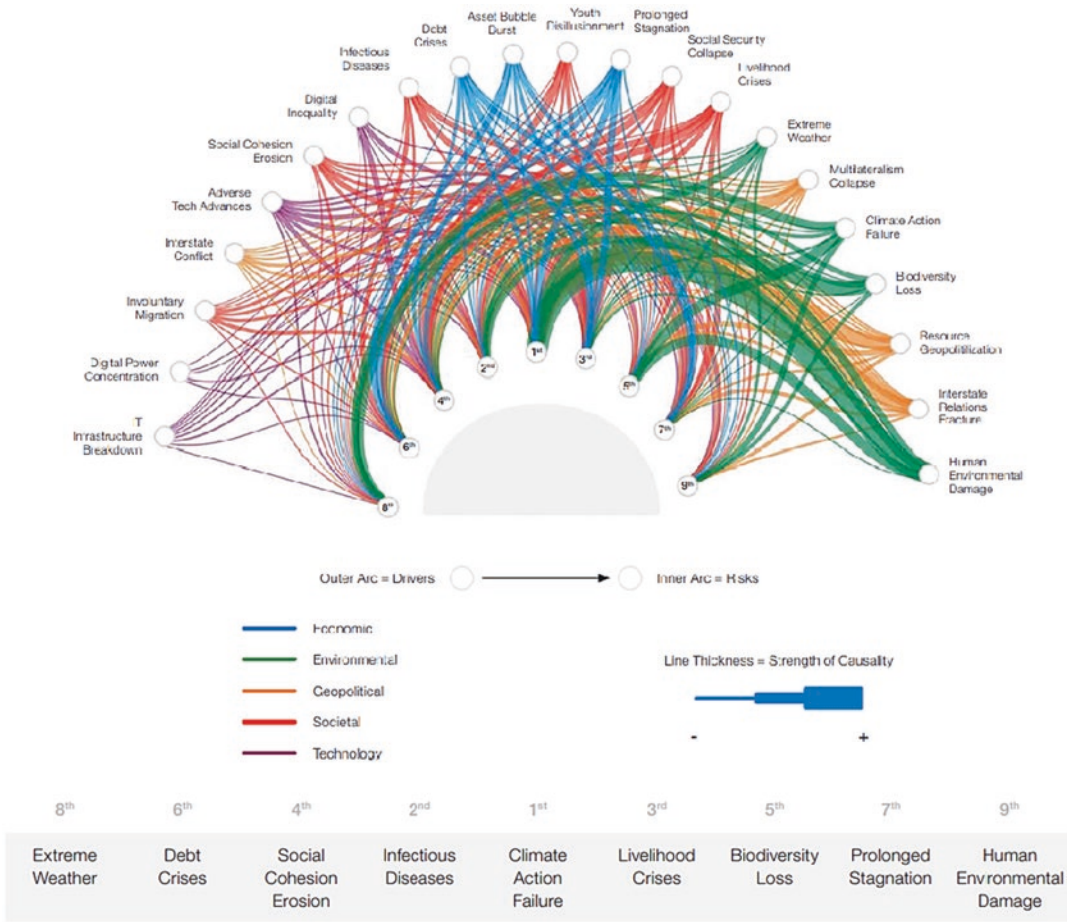

Fig. 17.1 Top global risks and their link to the environment and climate change. Source: Adapted from the World Economic Forum (2021)

As shown in Fig. 17.2, the extreme weather events induced by climate change pose a significant threat to poverty reduction, food security, attainment of global health, water security, infrastructure and loss of biodiversity. These events perpetuate rising inequalities, and human displacement triggers ecosystem imbalances and poses a potential threat to the global, regional and national political order. Progressive economic development is therefore centred on societies' and economies' building capacity to adapt and build sufficient resilience. A disaster reduction approach can be central to ensuring sustainability. This can be achieved by putting in place structures that can withstand the most ferocious tropical cyclones, such as the increasingly more intense tropical cyclones we have witnessed in the recent past (Liu and Chan, 2020). Where this cannot be achieved, ensuring adequate insurance cover can be an approach to avert the worst-case scenario in terms of the impact of tropical cyclones.

The past decades have made a serious case for a de-risked approach to global development, especially regarding tropical cyclones and other extreme weather events. 2020 was not only momentous for the devastating impacts of the COVID-19 pandemic (Nhamo et al., 2020), but it is the same year that witnessed multiple climate threats of what lies ahead of the global community. Some of the climatic events that dominated the climatic calendar globally include the drought

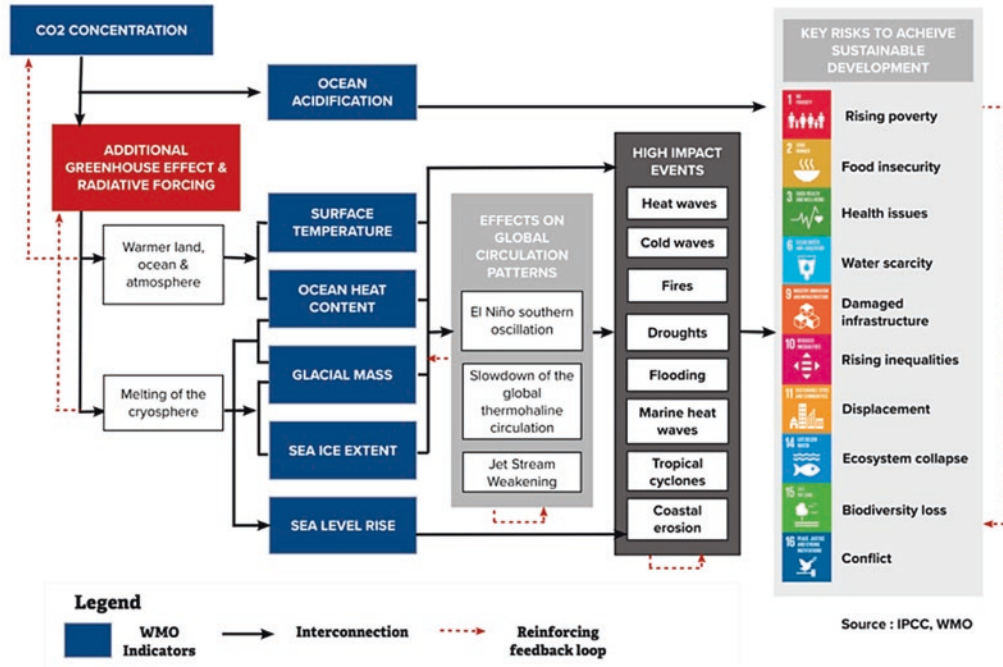

Fig. 17.2 Some climate risks to the SDGs. Source: World Meteorological Organization (WMO) (2021)

that affected South American countries such as Argentina, Paraguay and Uruguay, with the cost of the drought estimated at about US$3 billion in Brazil alone (WMO, 2021).

The floods in East Africa caused a major headache as they resulted in more than 290 fatalities and swept away a significant hectarage of crops in that region (WMO, 2020). Some of the countries worst affected by that disaster included Kenya, Uganda, Somalia, Ethiopia and Rwanda. Some of these countries already suffer other vulnerabilities. What makes it even more tragic is that the floods came at a time when the region was battling the worst locust invasion in history, which greatly undermined food security in the region. Of greater significance and relevance to this chapter, however, was the record-shattering North Atlantic hurricane season. The season recorded 30 named storms, making it one of the most active hurricane seasons. The hurricane season was also a prolonged one, which extended well into November, which was rather unusual. The 2020 season came at the back of one of the most devastating tropical cyclone seasons in southern Africa in 2019 where two of the most devastating cyclones, Idai and Kenneth, eclipsed the region.

Record-high global sea ice melting was witnessed in 2020 owing to increased global average temperatures. 2020 is considered to have been one of the three warmest years on record and it tied with 2016 as the warmest year on record (WMO, 2021). This was despite the cooling effect of La Niña which began at the end of 2020. The warming precipitated the continued decline in sea ice extent which has been blamed for worsening the sea-level rising and coastal flooding. A combination of thermal ocean expansion and melting of sea ice, coupled with other extreme weather events such as tropical cyclones, has been blamed for the increased cost of natural disasters in small island developing states (SIDS) and coastal communities. Rising sea levels have amplified global storm surges from tropical cyclones, increasing the destructive impact of coastal flooding induced by tropical cyclones.

2020 saw a record number of tropical cyclones, particularly in the Atlantic, with 30 named hurricane storms, 12 of them making landfall in the continental USA. Of the 12 that made landfall, 6

were major hurricanes. Hurricane Iota, which occurred late into the hurricane season on 16 November 2020, intensified to become a category 5 hurricane and later made landfall in Nicaragua as a category 4 hurricane. The higher than usual number of hurricanes was attributed to the warm phase of the Atlantic Multi-Decadal Oscillation (AMO). Tropical cyclones are dangerous systems that often result in the dumping of a huge amount of rainfall, wind destruction and storm surges which trigger flooding, particularly in coastal areas.

The issue of flooding, which is also precipitated by tropical cyclones, is a global concern as about 2.2 billion people live in areas that experience once-in-100-year flood events (World Bank, 2021a, b). At least 1.47 billion people live under the persistent risk of flooding. Figure 17.3 shows the number of people at risk of floods in various parts of the world. The figure shows that most of the at-risk flood population is located in some of the regions where the poorest of the poor are located in particular East Asia, South Asia and sub-Saharan Africa. These regions have the highest number of vulnerable people globally.

A focus on sub-Saharan Africa reveals several vulnerabilities to flooding, with countries such as Mozambique, Madagascar and South Africa (Cape Town) being some of the most vulnerable regions in the context of flooding. Mozambique and Madagascar are some of the countries worst affected by tropical cyclones.

The perpetuation of flooding by tropical cyclones has been quite evident in the recent occurrence of tropical cyclones in southern Africa. Muthige et al. (2018) identified flood areas prone to tropical cyclones in southern Africa, namely parts of Mozambique, South Africa and Zimbabwe. It is estimated that between 1950 and 2019 at least 27,000 people died from flooding in western and southern Africa where tropical cyclones have been a persistent feature over the years (Tramblay et al., 2020). Evidence from previous studies indicates the devastating impacts of some of these floods induced by tropical cyclones (Paerl et al., 2019; Dellapenna et al., 2020; Chen et al., 2020).

In March 2000 Tropical Cyclone Dera was responsible for causing floods in Mozambique (Reason, 2007). Douglas et al. (2008) observe that there has been some urban flooding, localised flooding particularly due to poor urban drainage and flooding as a result of water build-up in streams and rivers that often follow tropical

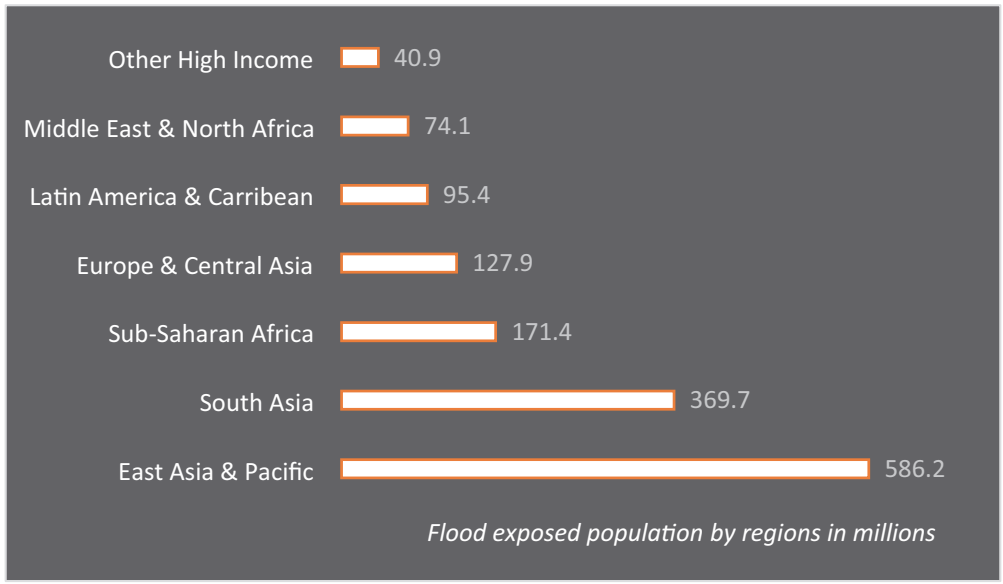

Fig. 17.3 Global flood-exposed population. Data from Rentschler and Salhab (2020)

cyclone occurrence in areas such as Mozambique. In an account of Tropical Cyclone Elita in 2004, Fitchett and Grab (2014) noted the devastating impact of the tropical cyclone which resulted in the flooding of rice fields, rendering about 56,000 people homeless and causing 33 deaths and 129 injuries. A number of other tropical cyclones are known to have caused flooding in the Southern African Development Community (SADC) member states such as Tropical Cyclone Chedza (Rapolaki and Reason, 2018), Cyclone Favio (Douglas, 2017) and Tropical Cyclone Eline (Muthige et al., 2018), to mention but a few.

Two of the most devastating cyclones in recent history, which have been described as some of the most costly natural disasters, are Tropical Cyclones Idai and Kenneth (Dube, 2019; Charrua et al., 2021). Mavhura (2020) states that Tropical Cyclone Idai was the most devastating cyclone ever to affect Zimbabwe. This book volume is born out of the need to document the climatological and meteorological occurrence and impact of the two cyclones that occurred in March and April 2019.

17.3 Emerging Key Findings and Recommendations

17.3.1 Characterisation of Tropical Cyclones

The study found that the Southwest Indian Ocean is an active region in the context of the occurrence of tropical cyclones. It also emerged that while there is debate on the trajectory taken by tropical cyclones in the context of climate change, by and large, there is a decline in the number of cyclones in the region. However, there is a statistically significant increase in the number of higher category tropical cyclones in southern Africa. The findings confirm observations from other studies that climate change will cause an increase in high-impact tropical cyclones in the region and there is a general reduction in the frequency of lower category tropical cyclones (Gupta et al., 2019; Lee et al., 2020; Xiao, 2021).

Alongside the increased intensity of tropical cyclones, it was found that the tropical cyclones result in massive devastation of the infrastructure of urban and peri-urban areas that are on the storm track. This is a result of a combination of factors. It was observed that one of the major causes of destruction is the storm surge. Tropical Cyclone Idai produced a storm surge of between 2.5 m and 6.6 m (source). Storm surge, severe rainfall and wind speeds caused enormous damage and flooding in the affected areas that went on for days. This was quite evident in Beira and could be a contributing factor to the Dondo River in Sofala bursting its banks. Some areas witnessed landslides as a result of heavy soaking from the rains, particularly in the Chimanimani area in Zimbabwe.

The ensuing destruction of property and loss of life and livelihoods are testaments to the vulnerability the region faces from extreme weather events, which are likely to be worsened by climate change. As communities battle with the after-effects of the tropical cyclones, one major recommendation is to BBB by ensuring that the infrastructure that is being replaced by the old destroyed infrastructure is better than the previously existing infrastructure. Design considerations should factor in the strong winds associated with tropical cyclones, intense rainfall activity and amounts of rain. Building codes might need to be revised to ensure that the new realities are factored in.

In some cases, there is clear evidence of neglect where houses and other critical infrastructure were constructed on waterways, which resulted in casualties. In such cases there is a need to conduct hazard mapping of at-risk areas so that people can be settled in areas considered to be favourable, safer zones to reduce the risk and costs of future disasters. In Mozambique, for example, some informal settlements were the biggest casualties of the two cyclones. In that case the need for inclusivity in BBB is imperative by ensuring that these settlements are moved to planned settlements. This will require huge financial investment, and partnership between the private and public sector is a critical element of that BBB process. This calls for proper budget alloca-

tion aimed particularly at ensuring that the reconstruction process takes place faster to allow the affected populations to get back to some form of normalcy post the disaster, with very minimal delay.

One of the issues that came out strongly concerns poor communication and inadequacy of early warning systems (EWSs). It was found that one of the challenges faced by the affected communities is the lack of proper information about the time and intensity of the tropical cyclones. Part of the challenge, particularly in Zimbabwe, was the power outages, resulting in the Zimbabwe Meteorological Services Department failing to provide critical information when it was needed the most. In Mozambique, one of the key meteorological stations in Beira was also destroyed. Data in other stations in remote areas were inaccessible to provide an accurate picture of what was happening. The International Charter "Space and Major Disasters" was activated, which greatly assisted in the mapping and understanding of the extent of the disaster using various satellite missions. This contributed to international awareness and pooling of resources for disaster relief for all the affected countries, although the largest share was received by Mozambique. This came at a time when most areas were cut off as roads were either destroyed or flooded. Buzi and Pungwe Rivers burst their banks and flooding water reached about 5 m, flooding settlements and destroying other economic activities.

The precision in the prediction of tropical cyclones remains a challenge globally, particularly in Africa where research and monitoring of cyclones are not as well developed as in the Global North owing to a lack of skills and resources. Evidence from the National Hurricane Center, which focuses mainly on the Pacific, the Atlantic and other patterns that affect North America, shows that although there has been significant improvement of 70% and 30% in both track and intensity forecasting errors, respectively, it would seem that communities have not benefitted from such improvements. The transmission of crucial information remains a challenge. This is owing to several factors. In particular, French is utilised by Meteo France in the southern hemisphere, but none of the SADC countries uses French as an official language.

Although the development of tropical cyclones was, in many respects, widely covered on social media, this message largely did not translate into actionable response to reduce the disaster risk. This was due to a variety of factors, among them traditional and religious beliefs, and lack of faith in the science of meteorology. There were also many conspiracy theories around the occurrence of Tropical Cyclone Idai, particularly in Zimbabwe. It is not known how such conspiracies affected the disaster response. In some instances, early warming information was not packaged adequately in a manner that would assist the community in taking action. For example, communities were advised to go to higher places, yet it was in such places where the impact of Tropical Cyclone Idai was also severe.

Hydrometeorological communications have often been blamed for being packaged for geographers, which sometimes makes it difficult for consumers to understand and interpret (Morrow et al., 2015). This is confirmed by Otto et al. (2018), who maintain that the traditional meteorological agencies often package information about potential hazards for emergency organisations and community members in a technical manner. Delayed communication was found in some instances to be the stumbling block and lack of information on issues such as safe zones for evacuation made it difficult for some to respond or know exactly where to go. In some cases, those who tried to evacuate moved right into disaster zones, which led to increased fatalities, as was already highlighted in the case of Chimanimani in Zimbabwe. Some communities that decided to act on the warning messages after seeing the disaster realised that it was too late to do so given the extent and intensity of wind and rainfall.

Communication of hydrometeorological information remains a challenge, since a response to the message is often dependent on a person's beliefs, perceptions and understanding. The study recommends a way of communicating hazards to communities at potential risk in a manner that is easily understood by communities. Such mes-

sages have to be conveyed through trusted channels often used by the community. The study also recommends increasing risk education awareness in all potentially risky areas where evacuation routes and safe areas are properly established at all times. Risk education awareness not only should take place during a pending disaster, but must also be a continuous roll-out programme aimed at ensuring that everyone understands both the risks and measures to take should a disaster occur. The study also emphasises the need for continued infrastructure roll-out, particularly access to affordable internet data and communication infrastructure to ensure that people have easy and fair, accessible, credible and accurate information. The building of resilient information communication technology is one step that is critical to ensure reliable access to information. Roll-out of high-speed broadband internet is a critical step in achieving this.

17.3.2 DRR in the Context of Diverse Knowledge Systems

We have examined various ways that were adopted in responding to the two tropical disasters that occurred in 2019, particularly Tropical Cyclone Idai which affected Zimbabwe. We also studied various legislative frameworks that govern disaster management. It emerged that there were gaps in the disaster management policy framework of Zimbabwe, which highlighted the need for urgent revision of the framework. The bureaucracy that is often associated with disaster management in Zimbabwe heightens the suffering of the affected communities. We therefore recommend reducing the red tape during a disaster to allow for the easy flow of aid to reach the affected community.

The study also observed the crucial role played by first responders to disasters, such as community members, pharmacists and traditional healers. The ubuntu concept is vital in times of emergency as communities often pool resources together to assist those worst affected by the often emotional and traumatic experience in providing both resources and emotional support. We recognise the critical role often played by the indigenous knowledge system in both early warning and disaster response. We therefore recommend a hybrid approach in the tropical cyclone knowledge system that interfaces indigenous knowledge with science to assist communities in effective response to tropical cyclones and other disasters.

One of the central issues that received considerable coverage in the book is the need for southern Africa to align disaster management operations with the Sendai Framework to ensure that there is community resilience. Synergy between climate change adaptation is emphasised so as to curtail the increasing cost of natural disasters in the region. However, achieving this is not an easy fit, given budgetary and other resource constraints. Although the SADC heads of state declared climate change a security threat soon after the occurrence of Tropical Cyclones Idai and Kenneth, it remains to be seen if they are going to commit financial resources to deal with this ever-present threat. We therefore encourage leaders to avoid lip service when it comes to issues of climate change adaptation, but to take concrete actions to ensure that sustainable funding is availed within means to foster sustainable regional growth. The role of researchers, technical experts and planners can never be overemphasised in ensuring region-appropriate responses to tropical cyclones as a climate and development threat. Finally, research into forecasting and appropriate disaster communication in the region must be bolstered.

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