Initiative for Climate Action Transparency - ICAT

ICAT Deliverable 1.1b:

A second set of basic tools and methodologies for South Africa

Review of impacts of weather and climate-related disasters in South Africa and needs assessment

Report prepared for:

UNEP CCC

Prepared by:

Daleen Lötter, Sasha Naidoo, and Juanette John

CSIR Smart Places Cluster, Meiring Naude Rd, Pretoria, 0001

28 February 2023

DISCLAIMER

PREPARED UNDER

The Initiative for Climate Action Transparency (ICAT), supported by Austria, Germany, Italy, the Children's Investment Fund Foundation and the ClimateWorks Foundation.

The ICAT project is managed by the United Nations Office for Project Services (UNOPS).

Contents

1. Introduction

South Africa, like many other developing countries, is vulnerable to the effects of climate change, and has the task of balancing accelerating economic growth and transformation with sustainable use of environmental resources and responding to climate change (DEA, 2017). South Africa is vulnerable to natural disasters such as drought, flooding, extreme storms, and fires and has faced a number of devastating climate-related disasters over the last few decades and their impacts have been varying. The country is projected to face a higher frequency of climate-related disasters that are increasing in intensity, and these events are likely to be associated with impacts that are on par with, if not worse that those already experienced (DEA, 2018a). The impacts of climate-related disasters are wide-ranging and impact multiple sectors, including damage to infrastructure, damage to ecosystems, and contributing to water shortages, rising food insecurity and impacting public health.

The country's Medium-Term Strategic Framework (MTSF) 2019-2024 highlights a need to reduce the impact of climate change disasters on human life; livestock/crop yield; houses/shelter; infrastructure; species. Currently there are no tools, methods, or data collections systems in place that guide how the country should approach the monitoring and evaluation of the impacts of weather and climate-related disasters and thus track the country's progress towards mitigating impacts through adaptation efforts. It is for this reason that the Department of Forestry, Fisheries, and the Environment in partnership with the National Disaster Management Centre and with support from Climate Action Transparency (ICAT) Adaptation project undertook this work with the Council for Scientific and Industrial Research as the implementing partner. The focus for this work is to identify/develop a framework to monitor and evaluate the impacts of weather and climate-related disasters that would support the monitoring and evaluation (M&E) of climate change in South Africa. This framework would support understanding what is needed to monitor and evaluate the impacts of weather and climate-related disasters and what needs to be included for reporting on these impact assessments to the international community in terms of the data that is needed (metrics for what is measured), how the data is stored, who stores it and what is their role. This work aims to support collation of information-related to enhancing understanding, action and support to avert, minimize and address loss and damage and inform South Africa's position under the UNFCCC. This work will also fit into the Global Stocktake that is due in 2023 and 5 yearly thereafter.

This report considers South Africa's climate change policy framework and alignment of national climate change policies with international agendas, including the country's current monitoring and evaluation framework, and policy directives on the impacts of weather and climate disasters in South Africa. A review of the impacts of weather and climate change disasters in South Africa provides an overview of historical hazard events, how these impacts from these events are covered domestically, data challenges, and what are the gaps. An overview of frameworks to assess loss and damage was conducted to better understand elements within available M&E frameworks which deal with loss and damage, e.g. how criteria are measured or defined, the data that is required and the roles and responsibilities of those involved.

1.1. SA Climate priorities and policies that support climate change action.

South Africa has made substantial progress towards becoming a low carbon and climate resilient society and its responses to climate change seek to address both the country's development needs as well as climate change obligations. The country is a signatory of numerous global climate change responses including the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement. This supports the South African government, in partnership with climate change stakeholders and role players, to continue to strengthen their efforts of achieving and stabilizing GHG concentrations in the atmosphere hence reducing carbon footprints and preventing harmful human activity interference in the climate system. South Africa is dedicating significant resources to adapt to the reality of an already changing climate and address consequential loss and damage.

The Paris Agreement is important to the 2030 Agenda for Sustainable Development since climate action influences the achievement of the 17 SDGs of the 2030 Agenda, and climate change is also recognised as one of the 17 goals (Goal 13 - 'Take urgent action to combat climate change and its impacts'). The Sendai Framework for Disaster Risk Reduction is a global framework which acknowledges and emphasises the importance of climate change and sustainable development for disaster risk reduction and vice versa. Preparing for climate-related disaster and building resilience are key priorities in the Sendai Framework. Table 1.1 provides an overview of the Sustainable Development Goals, the Paris Agreement, and the Sendai Framework (OECD, 2020).

South Africa's development pathway, defined by the NDP, is closely aligned to the Sustainable Development Goals. South Africa has made provision in recent legislative amendments, aligned to the Sendai Framework, to expand the existing national institutional structure (the National Disaster Management Advisory Forum) to serve as the SA National Platform for Disaster Risk Reduction (Tau, 2019). This emphasises the multi-sectoral nature of disaster risk reduction and the responsibility of stakeholders to take collaborative action to reduce risk. South Africa has made significant strides in terms of disaster management, specifically, the Disaster Management Act, 2002 (Act 57 of 2002), and the Amended Disaster Management Act (Act No. 16 of 2015), which is a critical piece of legislation that directly responds to climate change adaptation. The Amendment Act assigns responsibility to national, provincial and local spheres of government to invest in disaster risk reduction and climate change adaptation interventions for their respective jurisdictions. Each organ of state is required to develop disaster management plans that include climate change risks and responses.

South Africa has developed overarching policies and frameworks to support climate change responses with its climate change response actions guided by Section 24 of the Constitution of the Republic of South Africa, the National Development Plan (NDP) (NPC, 2011) and the National Climate Change Response Policy (NCCRP) (DEA, 2011a). South Africa's National Climate Change Response Policy (DEA, 2011) called for the establishment of a National Climate Change Response Monitoring and Evaluation (M&E) System, which would "evolve with international measuring, reporting and verification (MRV) requirements". South Africa is developing a comprehensive, integrated National Climate Change Response Monitoring and

Evaluation System which includes the current National Climate Change Response Database (NCCRD) and the National Greenhouse Gas Inventory System (NGHGIS). The NCCRD will serve as a data and information coordination network. The National Climate Change Response Monitoring and Evaluation System Framework (Framework) is aimed at understanding South Africa's progress in moving towards the envisaged climate resilient and lower carbon economy and society. The M&E system includes information on GHG emission reductions achieved, observed, and projected climate change, impacts and vulnerabilities, the impact of adaptation and mitigation actions, financial flows and technology transfer activities. South Africa's approach is premised upon continuous learning and improvement through a phased implementation approach (DEA 2019).

Table 1.1 Overview of the Sustainable Development Goals, the Paris Agreement and the Sendai Framework (OECD, 2020)

	Sustainable Development Goals	**Paris Agreement on climate change**	**Sendai Framework for Disaster Risk Reduction**
Background	Global agenda for action towards sustainable development	Agreement on the global response to climate change; adaptation, mitigation and finance	Global framework to guide multi-hazard management of disaster risk
Climate change adaptation and disaster risk reduction	Climate action and disaster risk reduction are cross-cutting issues, but explicitly mentioned in: – Goal 13 to combat climate change and its impacts, – Goal 11 to make cities inclusive, safe, resilient and sustainable. Climate action also contributes to the achievement of many of the other goals	Articles 7 and 8 explicitly focus on CCA and DRR: – Article 7.1, on enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change – Article 8.1, on averting, minimising and addressing loss and damage associated with the adverse effects of climate change	Paragraph 13 recognises climate change as a driver of disaster risk, and points to the opportunity to reduce disaster risk in a meaningful and coherent manner
Role of development co-operation	Stresses the need for strengthened global solidarity, with the participation of all countries, all stakeholders and all people (Goal 17.16-17.17)	Recognises the "importance of support for and international cooperation on adaptation efforts" (Article 7.6) and the provision of scaled-up financial resources that aims to achieve a balance between adaptation and mitigation (Article 9.4)	Recognises that the ability of developing countries to manage risks may be strengthened through the provision of "adequate, sustainable and timely provision of support, including through finance, technology transfer and capacity building from developed countries and partners" (Paragraph 19)

The concept of Desired Adaptation Outcomes (DAOs) has been developed to complement the building blocks of the monitoring and evaluation framework and to facilitate and focus the M&E of the country's progress towards resilience. Nine generic DAOs have been developed, each of which is cross-cutting, has cross-sectoral relevance and describes, in a general sense, a desired state that will enhance South Africa's transition towards climate resilience. The DAOs provide a means of assessing the capacity of 'at risk' sectors and their stakeholders to adapt to climate change and whether the measures being taken are appropriate. The generic Desired Adaptation Outcomes (DAOs) as well as the international agreement goals, targets, impacts and indicators that will be achieved/met by reporting/tracking under each DAO are shown in Table A1 in Appendix A. Specifically, DAOs G 6-9 consider the impacts of Sendai Targets A-D which are targets to reduce the losses attributed to disasters relating to mortality (A), number of people affected (B), economic loss relative to GDP (C), damage to critical infrastructure and disruption of basic services (D). Each of these targets has several indicators of loss and damage.

Figure 1.1 presents the relationship between international agendas, national commitments to international agendas and operational vehicles to support the achievement of commitments to international agendas in South Africa.

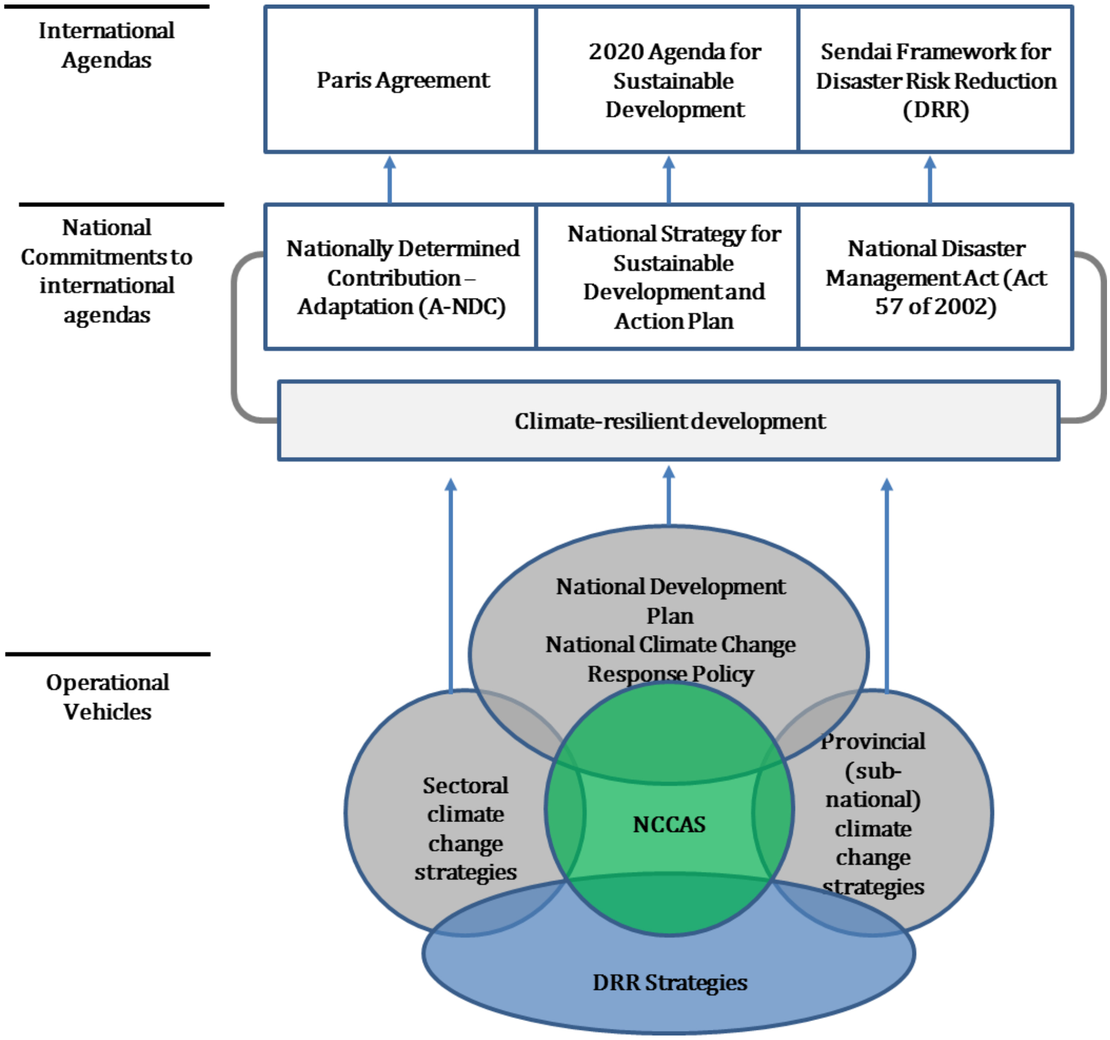

Figure 1.1 Relationship between international agendas and policy processes in South Africa (adapted from Dazé et al. (2019))

1.2. Policy directives on impacts of weather and climate disasters in South Africa

The Government Medium-Term Strategic Framework (MTSF) 2019-2024 indicates that the effects of climate change are increasingly being felt through changes in rainfall patterns (drought and floods), and infrastructure damage. This exacerbates the vulnerability of communities, especially the poor. Environmental management must therefore be embedded across the economy, human settlements, and infrastructure systems to safeguard the water, air and land quality. The MTSF highlights the target of “100% reduction of losses (human life; livestock/crop yield; houses/shelter; infrastructure; species) due to climate change disasters” under the Environmental Management and Climate Change programme. The indicator under this target is ‘Percentage reduction of losses (human life; livestock/crop yield; houses/shelter; infrastructure; species) due to climate change disasters. This work is aimed at developing a framework to inform the baseline for monitoring and evaluating the loss and damage from weather and climate events towards understanding how the country is doing towards achieving the proposed MTSF target.

The National Treasury Budget Review 2020[1] indicates that extreme weather events are becoming more frequent because of climate change. While parts of South Africa continue to grapple with a years-long drought, severe floods, and storms in KwaZulu-Natal during 2019 damaged infrastructure and resulted in the deaths of 50 people. According to the World Economic Forum, extreme weather, natural disasters, and climate action failure are three of the top five global risks in 2020. Since 2016, government has allocated R 6.3 billion for drought relief projects and R 660 million for flood relief. Yet reactive responses to disasters are inefficient and costly. The National Treasury is exploring ways to improve the immediate fiscal response to disasters and the fiscal management of government's response to the long-term effects of climate change.

The United Nations Framework Convention on Climate Change Conference of Parties (COP) also established the Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts (Loss and Damage Mechanism) to address loss and damage associated with impacts of climate change, including extreme events and slow onset events, in developing countries that are particularly vulnerable to the adverse effects of climate change at COP19 (November 2013) in Warsaw, Poland. The mechanism was established with the following three functions:

1. Enhancing knowledge and understanding of comprehensive risk management approaches to address loss and damage associated with the adverse effects of climate change, including slow onset impacts;
2. Strengthening dialogue, coordination, coherence, and synergies among relevant stakeholders; and
3. Enhancing action and support on loss and damage, including in the areas of finance, technology and capacity building.

The Executive Committee of the Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts (ExCom) was established to guide the implementation of the Mechanism through its workplan. ExCom developed the five-year rolling workplan with the following strategic work streams:

1. Enhanced cooperation and facilitation in relation to slow onset events
2. Enhanced cooperation and facilitation in relation to non-economic losses

[1] National Treasury Budget Review 2020
http://www.treasury.gov.za/documents/National%20Budget/2020/review/FullBR.pdf

3. Enhanced cooperation and facilitation in relation to action and support, including finance, technology and capacity-building, to address loss and damage associated with the adverse effects of climate change;
4. Enhanced cooperation and facilitation in relation to human mobility, including migration, displacement and planned relocation ;
5. Comprehensive risk management approaches (including assessment, reduction, transfer, retention), to address and build long term resilience of countries, vulnerable populations and communities to loss and damage, especially in relation to extreme and slow onset events, inter alia, through:
    - Emergency preparedness, including early warning systems;
    - Measures to enhance recovery and rehabilitation and better build back/forward;
    - Social protection instruments including social safety nets; and
    - Transformational approaches

At COP 24 (held in Katowice), transparency-related outcomes that deals with the inclusion of reporting on and consideration of loss and damage in the transparency framework, and in the global stocktake, respectively, were also discussed.

In light of these events, this study focuses on the following:

- how impacts of weather and climate-related impacts are reported domestically,
- where there could be possible gaps,
- the various systems and/or repository systems available to provide information-related to loss and damage in the country, and
- improved understanding, action, and support to avert, minimise and address loss and damage and inform South Africa's position under the UNFCCC.

This work will also fit into the Global Stocktake that is due in 2023 and 5-yearly thereafter.

The Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) was adopted at the 3rd UN World Conference held in Sendai, Japan on 18 March 2015. The expected outcome of the SFDRR is the substantial reduction of disaster risks and losses in lives, livelihoods, and health and in the economic, physical, social, cultural and environmental assets of people, businesses, communities and countries. The goal of the SFDRR is to prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures. These measures should prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience.

South Africa is one of the driest countries in Africa and is currently suffering from the effects of another drought. Vulnerability to drought and the resilience due to coping mechanisms depend on many factors, including the availability of water reserves, alternate livelihoods and income streams, advanced warning and the ability to react to it. Drought has devastating economic, environmental, and social impacts in terms of loss of human life, food insecurity, reduced agricultural productivity, and degradation of natural resources. Drought is therefore a major disaster in South Africa in terms of total economic loss and the number of people affected.

Due to climate change, droughts are becoming more frequent followed by flash floods and forest fires which have negative impacts on soils and land. In South Africa, millions of people are directly affected by natural resource degradation and many of them live below the poverty line. These communities often depend on natural resources to sustain their livelihoods. Yet the capacity of our country's land, water, and biological resources to sustain its people is degrading. In addition, nighty one percent (91%) of the country falls within the category of drylands, making it susceptible to desertification, land degradation and drought which are intricately linked to food and water insecurity, poverty, urbanization, climate change, and biodiversity loss. The United Nations Convention to Combat Desertification (UNCCD) 10-year strategic framework adopted a standalone strategic objective on drought for implementation by parties which is "to mitigate, adapt to, and manage the effects of drought in order to enhance resilience of vulnerable populations and ecosystems". This strategic objective is also guided by the two expected impacts which are that ecosystems vulnerability to drought is reduced, including through sustainable land and water management practices, and community resilience to drought is increased.

The Disaster Management Act, 2002 provides for an integrated and coordinated disaster management policy that focuses on preventing or reducing the risk of disasters, mitigating the severity of disasters, and improving emergency preparedness, rapid and effective response to disasters and post-disaster recovery, including climate-related disasters. South Africa also developed the National Framework on Climate Services (NFCS) which strives to enable society to better manage the risks and opportunities arising from climate variability and change, especially for those who are most vulnerable to climate-related hazards. The NFCS will mainstream and enhance climate observations and monitoring information, forecasting and prediction and transform these into sector-specific products and applications that can be disseminated widely, and further develop user capacity to manage risks of climate variability and change at all levels. This will be done through developing and incorporating science-based climate information into planning, policy and practice. To be effective, the NFCS will be user driven, and will address the entire value chain for the production, processing and application of climate services through local, regional and global collaborative efforts. The NFCS will be one of the enabling tools for South Africa, in the transition towards building a climate resilient country.

The NFCS has five overarching goals, namely:

- Reducing the vulnerability of society to climate-related hazards through better provision of climate information;
- Advancing the key national development goals through better provision of climate information;
- Mainstreaming the use of climate information in decision-making;

- Strengthening the engagement of providers and users of climate services; and
- Maximising the utility of existing climate service infrastructure.

The NFCS mission and vision has also been clearly articulated in the draft National Adaptation Strategy (NAS). Outcome 2.1.6 of the NAS specifically requires the development and support for a climate change early warning and vulnerability network. This network, which will be set up together with relevant stakeholders, will promote collaboration and sharing of information on preparing for different climate-related risks. Role players will include government and research institutions, as well as community organisations and neighbouring states.

This need assessment will therefore provide a framework to contribute towards the development of a baseline as the first step towards realising the requirements of the Disaster Management Act, international reporting requirements under impacts of weather and climate disasters, the Sendai Framework for Disaster Risk Reduction, UNCCD and the Sustainable Development Goals, NAS outcomes, and the mission and vision of the NFCS. A key element of this framework is the establishment of a platform that connect all partners involved in weather and climate disaster-related work to understand and manage respective roles and ensure effective coordination and tracking of priorities specified in the MTSF.

Reliable data will also support sustainable reporting on the global frameworks such as the SFDRR and the Sustainable Development Goals (SDGs). For example, the data need to form part of a relational database, must be sustainably collected, credible, freely accessible and validated.

2. Impacts of weather and climate change disasters in SA

The second focus area for the ICAT project, selected in consultation with the Department of Forestry, Fisheries, and the Environment (DFFE), is to develop a framework to monitor and evaluate the impacts of weather and climate-related disasters that will support the monitoring and evaluation (M&E) of climate change in South Africa. The review of the impacts of weather and climate change disasters in South Africa intends to support an understanding of how these impacts are covered domestically and what the gaps are. This includes:

- Understanding definitions, distribution and types of weather and climate-related hazards and disasters in South Africa,
- Data collection and databases consulted,
- Historical hazard events and timelines for disaster types,

2.1. Definitions, distribution and types of weather and climate-related hazards and disasters in South Africa

South Africa is prone to several weather-related natural disasters such as devastating floods, violent hailstorms, veld fires, droughts, and tropical cyclones. The South African Weather Service (SAWS) keeps record of the location, extent, and impact of these events through input from various sources. The South Africa Weather Service (SAWS) maintains the CAELUM (CAELUM, 1991) weather events database, a restricted commercial product, that provides a description of historical extreme weather events that dates back to as far as the early 1900's and up to the present day. CAELUM is compiled from various sources including newspaper reports and articles, as well as field observations to report on the spatial occurrence and impacts of severe weather events across South Africa. Given the lack of verified and consistent data collection in CAELUM, a need was identified by the SAWS to improve the capturing of severe weather impact information to be more consistent with international requirements and streamline data sharing and integration with other data custodians or sources. In partnership with the Central University of Technology (Free State) SAWS have started on a project to update and improve the existing CAELUM database. The Severe Weather Impact Database (SWID) was proposed to replace the CAELUM database. The draft data architecture proposes the collection of information on the actual weather forecast leading up to the event, the name, actual coordinates, and other relevant spatial information of the event (to be aggregated at local municipal level), data sources and direct and indirect impacts on lives and infrastructure.

The National Disaster Management Centre (NDMC) of South Africa also records major disaster events to mobilise resources and funding to affected areas. The CAELUM database of SAWS and the declared disasters database of the NDMC differ in their definition and description of weather-related disasters. For example, the CAELUM database has fourteen categories (weather-related) with significantly contrasting categories compared to those defined by the NDMC. There is therefore a need to standardise the categories and definitions by the NDMC and the SAWS as a step towards developing the monitoring and evaluation framework on impacts of weather and climate disasters.

Other national government departments such as the Department of Water and Sanitation (DWS), Department of Forestry, Fisheries and Environment (DFFE), Department of Agriculture, Land Reform and Rural Development (DALRRD) and Department of Health manages programs and projects to deal with consequences associated with extreme weather events. These sector departments collect disaster-related data in spreadsheet format for monitoring and reporting purposes (Davis-Reddy and Hilgart, 2021). Statistics South Africa (StatsSA) releases information on mortality and causes of death, which includes those attributed to natural disasters. However, these statistics on mortalities are not assigned to a specific weather-related event but rather refers to general descriptions such as e.g., drowning, and as such were not included in the compilation of data.

Some research organizations have also embarked on projects to develop an interoperable national hazards events database for South Africa. Although basic frameworks were developed, the projects have not made any progress, due to limited or discontinued funding.

Other potential data sources of the costs associated with weather and climate-related disasters are the South African Insurance Association (SAIA). Private insurance companies keep record of the costs of recovery from disasters.

Internationally, the EM-DAT database is a global database maintained by the Centre for Research on the Epidemiology of Disasters (CRED) at the School of Public Health of the Université catholique de Louvain located in Brussels, Belgium. EM-DAT reports on the occurrence and effects of natural and technological disasters, across the world, from 1900 to present.

According to the CAELUM database of SAWS (Table 2.1) the main type of extreme weather event that were most often recorded in South Africa during the period from 2005-2021 is storms. Storms fall under the *meteorological* hazard group and includes convective and tropical storms. Convective storms include hail, tornadoes, strong wind, lightning, storm surges, dust storms and heavy rain.

Floods were the second most recorded extreme weather event over South Africa. Floods fall under the *hydrological* disaster group and includes flash floods, coastal floods and riverine floods. After storms and floods, extreme temperature (that includes cold and heat wave conditions) was the most recorded extreme weather event over South Africa. Extreme temperature also falls under the *meteorological* hazard group. Wildfire and drought which falls under the *climatological* disaster group were respectively the 4th and 5th most recorded extreme weather events over South Africa.

Although drought is not mentioned or described very often in the CAELUM database, it is the extreme weather event that is declared a disaster in South Africa most often. Drought is a slow onset disaster and therefore not as acutely observed by media reports as sudden onset disasters such as floods and fires. However, the NDMC data showed that meteorological drought has been declared a disaster most often across South Africa. Floods was the disaster type that was the 2nd most declared as a disaster, and thereafter it was storms, wildfires and extreme temperature. A total of 290 new climate, hydrological or meteorological-related disasters were declared across South Africa between 2007 and 2021 (Figure 2.1).

Table 2.1 Count of main extreme/disaster types recorded in South Africa by the South African Weather Services CAELUM database for the time-period 2005 – 2021.

Extreme Event Type	Number of event occurrences
Storm	2072
Flood	640
Extreme temperature	348
Wildfire	314
Drought	84
Fog	45
Other	29
Landslide	1

*Only main disaster types are given as there was not a consistent classification of sub-types in the CAELUM database. For a complete description of the classification of meteorological, hydrological and climatological disaster types, please refer to https://www.emdat.be/classification.

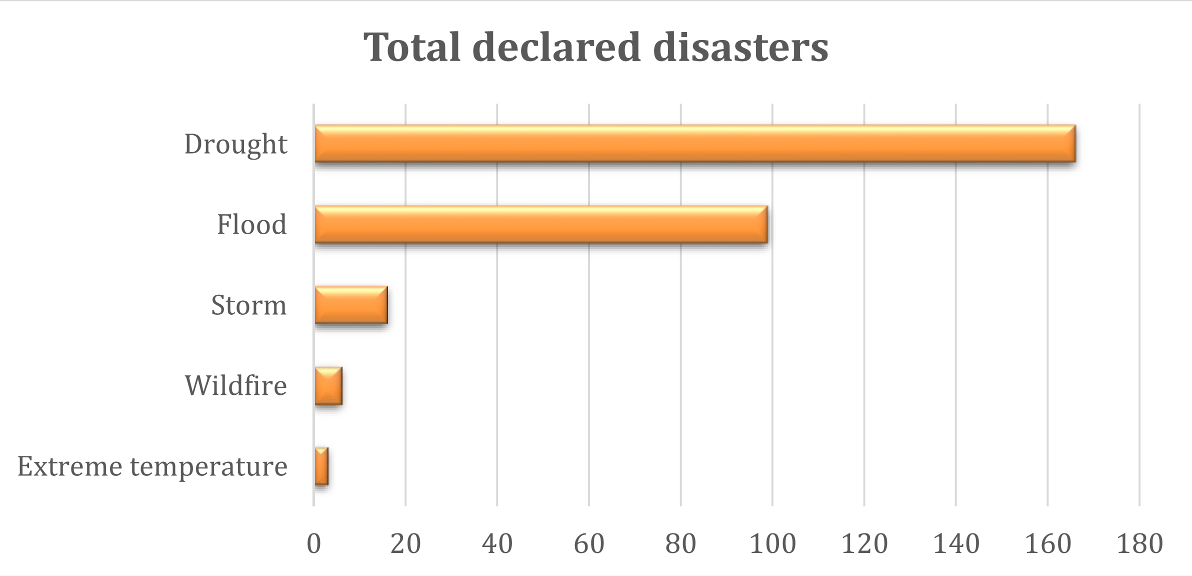

Figure 2.1 Count of new climate, hydrological or meteorological-related disasters declared in South Africa according to the National Disaster Management database for the time-period 2007 – 2021.

The CAELUM data were further broken down to a provincial level to understand which extreme weather events were more evident in different provinces. According to Table 2.2, the provinces of Gauteng, KZN and the Western Cape were most imperilled by storm events. The province with least occurrences of storm events was the Northern Cape. Similar to the storm event analysis, the Western Cape, Gauteng and KZN were the provinces most often subjected to floods. The Eastern Cape was the province where extreme temperatures were observed most often.

Wildfires were most widely and often reported in the Western Cape and is a significant hazard in the province, with wide-ranging impacts. In terms of droughts, the KZN province, followed by Northwest and the Western Cape had the most reported incidents thereof. Fog was most often recorded in Gauteng and the Western Cape.

Table 2.2 Count of main extreme/disaster types recorded per province in South Africa by the South African Weather Services' Caelum database for the time-period 2005 – 2021.

Province	Drought	Extreme temp	Flood	Fog	Land-slide	Other	Storm	Wildfire	Total
Western Cape	13	77	192	16		14	413	131	856
KwaZulu-Natal	23	91	121	3	1	3	457	59	758
Gauteng		11	163	14		4	469	18	679
Eastern Cape	6	105	33	3		4	198	19	368
Mpumalanga	4	11	42	9			159	24	249
Free State	8	19	28	3		1	148	33	240
Limpopo	9	5	37			1	153	27	232
Northwest	16	7	35			1	129	12	200
Northern Cape	7	19	10			1	61	6	104

KwaZulu-Natal was the province where the highest number of new disasters (85) were declared for the period 2007-2021 (Table 2.3). This is followed by the Eastern Cape (54), Free State (48), Mpumalanga (33) and Gauteng (23). The disaster types with the highest occurrence in Kwazulu-Natal was drought and floods. Droughts were most often declared a disaster in KwaZulu-Natal and 2nd most in the Free State. Floods were most often declared a disaster in KwaZulu-Natal and 2nd most in Gauteng. The Eastern Cape had the most incidences of storms being declared a disaster. The only province where extreme temperature was declared a disaster was in the Northern Cape. Wildfire was most often declared a disaster in the Free Sate.

From the NDMC analysis, KwaZulu-Natal is the province where most new disasters were declared and where both droughts and floods have been declared a disaster most often. In the CAELUM database of extreme events, the Western Cape is however indicated as the province where the most extreme events occur (Table 2.3). This is contrary to the NDMC data that shows Western Cape as a province where disasters have not been declared that often. This is indicative of the differences between the two databases and illustrates the importance of also taking local extreme events into account and not only declared disasters.

Table 2.3 Count of new climate, hydrological or meteorological-related disasters declared in South Africa and per province according to the National Disaster Management database for the time-period 2007 – 2021.

Province	Drought	Extreme temp	Flood	Storm	Wildfire	Grand Total
Kwa-Zulu Natal	44		40		1	85
Eastern Cape	29		14	10	1	54
Free State	41		4		3	48
Mpumalanga	26		7			33
Gauteng	1		20	2		23
Limpopo	6		4	4		14
Western Cape	10		3		1	14
Northwest	7		3			10
Northern Cape	2	3	4			9
Grand Total	166	3	99	16	6	290

Impacts of extreme weather events can include monetary losses (such as damage to buildings and infrastructure) as well as non-monetary losses such as loss of life, health impacts, and irreversible damages such as coastal erosion, ecosystem impacts and societal impacts (Bouwer, 2019). It is against this background that several historical high impact disaster types in South Africa will be discussed in the following section.

2.2. Historical hazard events and timelines for disaster types

2.2.1. Drought

The vulnerability of South Africa to climate change and variability, including periods of drought, is well documented and acknowledged by policymakers, farmers and natural resource managers (Vogel et al, 2009). Drought is a slow-onset disaster and although not occurring as frequently, may cause greater financial losses due its extent, intensity and duration (García-Acosta 2002). Due to its geographic location, steep topography, and the influence of the warm Indian and cold Atlantic Ocean currents, South Africa is naturally prone to droughts. The El Niño Southern Oscillation (ENSO), a quasi-periodic invasion of warm sea surface waters into the central and eastern tropical Pacific Ocean contribute to South Africa also experiencing extreme droughts that persist over several years (Baudoin et al., 2017). Droughts have become more commonplace in South Africa in recent years. In the past two decades since 1990, 12 of those years were defined as drier years compared to only seven years in the previous 20 years. Table 2.4 gives a timeline on the location of significant droughts in South Africa from 1964 until 2019.

Drought has several impacts which are complex and dynamic in nature (Vogel 1994, White et al, 2007). The impacts of drought can be classified as environmental, economic, and social (Heim, 2002). The impact of drought also depends on vulnerability and social inequalities and varies with the coping mechanism of the affected communities (Dai, 2011b).

Historically, droughts across most sub-Saharan countries including South Africa, has been associated with famine, mortality, agricultural loss and economic setbacks. For example, during the 1992-93 drought, South Africa saw a significant decline of 40% in its crop production (Holway, 2000). During this drought period, South Africa had to import maize amounting to R 1,725 million (US$ 604 million) between the months of April and December 1992 (Benson and Clay, 1998). These resulted in maize export earnings declining by an estimated R365 million, with other agricultural-related exports estimated to have dropped by R335 million (Benson and Clay, 1998). The 1992-93 drought resulted in a layoff of an estimated 50 000 workers within the agricultural sector, with a further 20 000 in related sectors (Mniki, 2009). At the time, the drought in 1992-93 was regarded as the most severe drought to ever occur in South Africa (Vogel and Drummond, 1993), only to be surpassed by the 2015/16 drought event. Food security in most of the rural areas of South Africa was affected, e.g., in the then Venda homeland, just about all dryland crops failed and in the then Gazankulu former homeland, food shortages increased three-fold.

More recently, during the period 2010 - 2020, South Africa has experienced a series of multi-year droughts, exacerbated by increasing temperatures as well as the long-term effects of El Niño. Average temperature over South Africa were the hottest on record during this same period. Most recently, in 2018, an El Niño event developed over South Africa, and drought conditions started to affect large areas of the country's summer rainfall regions. The drought increased in severity and continued throughout 2019 with multiple regions in South Africa seeing significantly reduced levels of rainfall. This drought was twice declared as national emergency in South Africa.

In 2017, the winter rainfall region of South Africa suffered one of the area's worst droughts in decades. Over the period from 2015 to 2017, Cape Town received below-normal rainfall. All three these years were considered drought years of increasing severity - with 2017 being the driest year in the Western Cape (Otto et al, 2019; Taing et al, 2019). During this drought it was expected that the Western Cape agricultural sector could lose an estimated R5.9 billion in the 2017/18 season. The drought also had significant implications for the labour sector, with around 30 000 jobs being lost in the process.

Table 2.4 Timeline on location of significant droughts in South Africa since the year 1964. CAELUM database

Year	Type	Location
1964	Drought	Ciskei, Transkei
1980	Drought	Natal
1981	Drought	Countrywide, Transvaal, Orange Free, Natal state
1986	Drought	Lebowa, Venda (Eastern Transvaal)
1988	Drought	Homelands
1990	Drought	Limpopo, Mpumalanga, central and northern KwaZulu-Natal, North Cape, Eastern Cape
1995	Drought	Nebo District (Northern provinces)
2004	Drought	KwaZulu-Natal, Eastern Cape, Northern Cape, Mpumalanga, North-West, Free state, Limpopo provinces
2015	Drought	KwaZulu-Natal, Free state, Limpopo, Mpumalanga, North-West, Western Cape provinces
2017	Drought	Western Cape, Northern Cape
2019	Drought	KwaZulu-Natal, Eastern Cape, Northern Cape, Mpumalanga, North-West, Free state, Limpopo provinces
2020	Drought	KwaZulu-Natal, Eastern Cape, Northern Cape, Free state provinces

2.2.2. Flooding

The American Meteorological Society (AMS, 2012) defines flood as the overflow of the normal confines of a stream or other body of water, or the accumulation of water over areas that are not normally submerged.

Like many other southern African countries, South Africa has a history of floods ranging from minor, localised events through to national disasters (Le Maitre and Kotze, 2019). In most cases localised flooding is mainly due to heavy rains and thunderstorms whereas regional flooding is mostly caused by cut-off lows and tropical cyclones. The physical factors that contribute to flooding are the nature and intensity of rainfall, topography, vegetation, and soil type and runoff patterns. Floods have been occurring in most parts of South Africa, with KwaZulu-Natal, the Western Cape and Gauteng province the areas most prone to such type of disasters (Figure 2.2).

Timeline of high impact flood events:

- **1981** - In Western Cape, the town of Laingsburg experienced monumental flooding that claimed 104 lives, with 72 bodies never recovered. A flash flood hit the town after heavy rains (about 425 mm in two days) which caused the banks of the nearby Buffalo River to burst, which resulted in the entire town being covered in the deluge.
- **1987** – KZN, September floods– this flood was proclaimed as one of the worst natural disasters to hit South Africa and caused by an intense “cut-off” low pressure system.
- **2007** - Western Cape floods in Cape Town forced up to 40,000 people in informal settlements outside the city from their homes.
- **2010 –** KZN during 2010-11 a series of floods linked to a La Niña event happened across three countries in Southern Africa. Thousands of people were displaced and evacuations of more continued. At least 141 people are known to have been killed, including 88 in KwaZulu-Natal.
- **2019 –** Gauteng floods, more than 200 mm of rain fell in a 48-hour period. Hundreds were evacuated from their homes and were left displaced by the damage caused.
- **2022** - KwaZulu-Natal (KZN) floods, parts of the province received rainfall of between 200 and 400 mm over a 24-hour period. A humanitarian disaster ensued, with over 8,300 homes being damaged, more than 40,000 people displaced, and 489 people losing their lives.

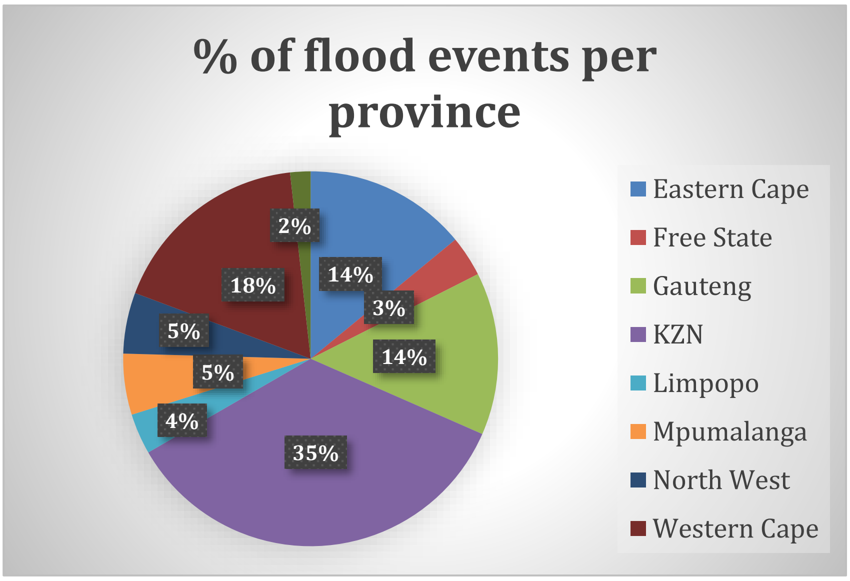

Figure 2.2 The occurrence of flood events per province for the period 1959 to 2020, EM-DAT, the International Disaster Database. **https://public.emdat.be/.**

2.2.3. Tropical cyclone-related flooding

Tropical cyclones are a rare occurrence in South Africa, but when these storms do occur, they can be extremely destructive. Tropical storms originate over warm tropical oceans and are associated with gale-force winds of more than 33 m/s, heavy downpours of rain, and storm surges. One of the global hot spots for cyclone generation is in the Indian Ocean, over the equator, north-east of Madagascar. Only tropical cyclones moving into the Mozambique channel influence South Africa's weather. Out of every ten cyclones that originate in the south-west Indian Ocean, only four, on average, enter the Mozambique Channel. If a tropical cyclone moves into the Mozambique channel, it is mostly the provinces of KwaZulu-Natal, Mpumalanga and Limpopo that are affected by these storms.

The following cyclones have had significant destructive consequences over South Africa:

- Tropical Storm Domoina (1984) - During the 28 of January 1984 tropical cyclone Domoina made landfall in the Southern parts of Mozambique and moved southwards towards South Africa causing heavy rainfalls over the northern parts of Kwazulu-Natal (South Africa) and Swaziland. It is estimated that Domoina caused 10 extensive damages which amounted to $10 billion across the Natal coast of South Africa (Dunn, 1985).
- Tropical storm Irina (2012) - was a large tropical cyclone that brought gale-force winds, very rough seas and torrential rain across Madagascar, Mozambique, and South Africa. Hundreds of families were left homeless and many roads and streets in the coastal area of eThekwini were flooded.

- Tropical cyclone Dineo (2017) - heavy rainfall, flooding and strong winds were recorded over the north-eastern parts of the country.
- Tropical Cyclone Eloise (2021) – this cyclone landed in South Africa on 24 January 2021 and was declared a national disaster. The storm brought heavy rainfall, flooding, destructive winds and lightning over Limpopo, Mpumalanga and far-north of KwaZulu-Natal Province. Four people died, hundreds of homes were either partially or destroyed and the storm uprooted trees, blocked roads, and destroyed buildings in affected areas.

2.2.4. Wildfires

Most of the fires in South Africa are seasonal and they vary across the country. The seasonal variation in veld fires is directly linked to the South African climatic conditions, with most of the interior receiving rainfall in the austral summer and the Cape region mostly having dry summers and receiving its rainfall during the austral winter. These has led to the eastern region of the country, and more specifically provinces such as Mpumalanga and KwaZulu-Natal experiencing a fire maxima peak season during August. The Western Cape mostly experiences its maximum activity during February, which is usually the warmest and driest month of the year. Mpumalanga, KwaZulu-Natal and the Western Cape are the three provinces which experience the most severe fire seasons owing to their indigenous vegetation types, topography and climate (Strydom and Savage, 2016).

Wildfires can occur even outside their peak season, such as the Knysna fires which happened in June 2017. This event is considered the worst wildfire disaster in South African history. A range of meteorological (including drought, low atmospheric humidity, strong winds and abundant fuel), bio-physical and institutional factors came together to create the disaster (Forsyth et al., 2019).

KwaZulu-Natal is the province in South Africa that has the largest area of extreme veldfire risk comprising 84.1% of the province. This is followed by Mpumalanga with 70.9% (Forsyth et al., 2010). The Northern Cape is the province with the lowest veldfire risk (Figure 2.3). According to Strydom and Savage (2016) future increases in average and extreme temperature as well as events such as La Niña may contribute to increased fire activity.

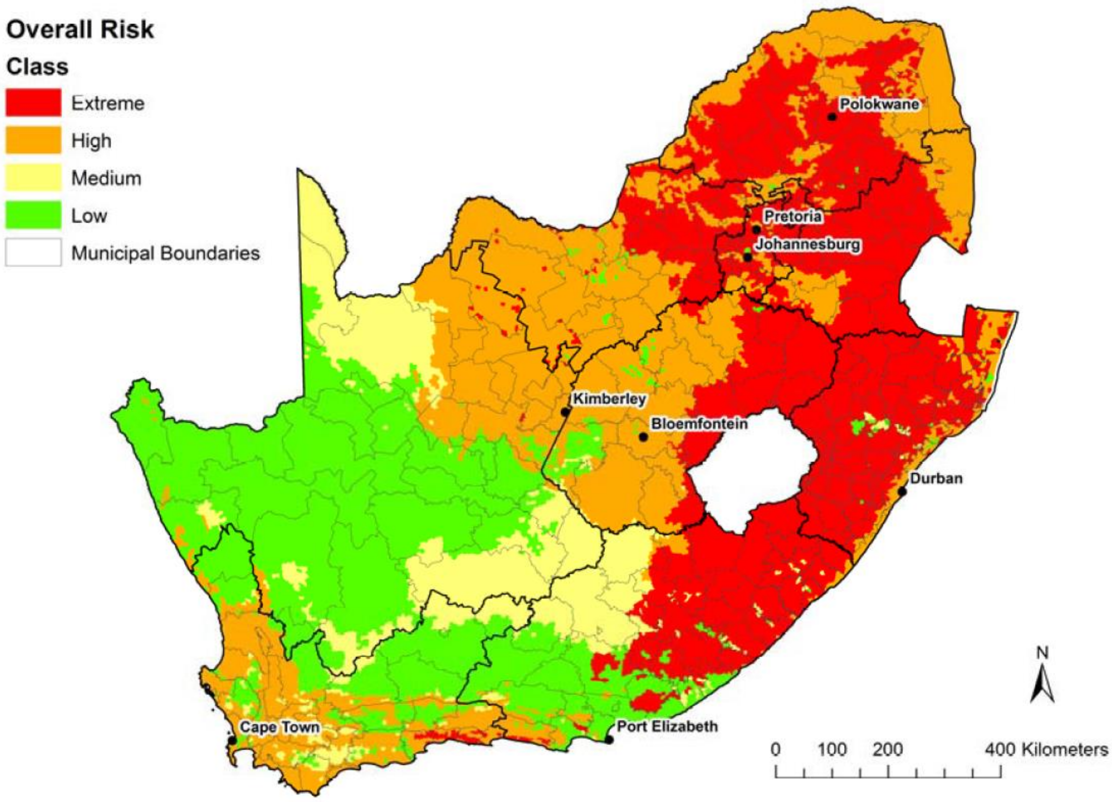

Figure 2.3 Overall assessment of veldfire risk levels in South Africa. Source: (Forsyth et al., 2010).

2.2.5. Storms with associated heavy rain, strong winds, lightning, and hail

Hail, lightning/thunderstorms, heavy rain, tornadoes, and severe winds are all hazards that are associated with convective storms and occur mostly over the summer rainfall regions of South Africa. They are more likely to occur on the Highveld in Gauteng, and in the parts of the Free State and KwaZulu-Natal prone to thunderstorms. The largest tornado ever recorded in the country was when a multi-vortex tornado swept through the suburbs of Welkom in the Free State on March 20, 1990. Up to 4 000 homes were destroyed, causing more than R 230 million worth of structural damage. The number of tornadoes in South Africa is likely to increase as temperatures rise, leading to increased evaporation and more frequent and intense thunderstorms.

South Africa is well known for electrical storms and lightning. Areas in South Africa with the highest density of lightning strikes per square kilometre are the Lowveld and Highveld regions of Mpumalanga. According to Gijben (2012) the average amount of lightning-related deaths in South Africa are between 1.5 and 8.8 per million of the population, which may be four times higher than the global average. Insurance claims in South Africa because of lightning amount to more than R 500 million per year.

Hailstorms are associated with strong thunderstorm activities or occur if wind and moisture move up against mountains or mountain ranges. The high-risk hail areas in South Africa are the high-lying areas of the summer rainfall region such as the eastern Free State, central and western parts of KwaZulu-Natal, the northern parts of the Eastern Cape, as well as parts of Mpumalanga. Hail formation is usually caused by convective clouds with strong updrafts, associated with thunderstorms. Hail stones vary in size from 3 mm up to the size of tennis balls. Hail may cause significant damage to grain, fruit, and vegetable crops, but it can also injure livestock and damage other farming assets and infrastructure. Although the agricultural sector suffers severe consequences from hailstorms, hail disasters can have serious consequences over built-up areas. During the late afternoon of 28 November 2013 devastating hailstorms moved through the Gauteng province, resulting in reports of golf ball to tennis ball size hailstones. More than R2 billion in claims were paid out following the massive hailstorm which sent hail the size of golf balls pelting down onto Gauteng cars and homes.

2.3. Climate change and disasters

Already under present-day climate conditions, South Africa is a country prone to extreme weather events such as droughts, floods, intense thunderstorms (with associated hail, damaging winds and lightning), heat waves and high fire danger days (resulting in veld and forest fires) (Bruwer et al., 2017). In a changing climate during the 21st century, South Africa is projected to be impacted drastically under low mitigation futures (Niang et al., 2014). It is projected that temperatures will rise rapidly, at 1.5 to 2 times the global rate of temperature increase (James and Washington, 2013; Engelbrecht et al., 2015). South Africa is projected to become generally drier under enhanced anthropogenic forcing (Christensen et al., 2007; Engelbrecht et al., 2009; James and Washington, 2013; Niang et al., 2014, Maure et al, 2018). The effect of drastically rising temperatures in combination with decreasing rainfall (in some areas) may result in more severe and prolonged droughts. However, in some areas, it is likely that the design rainfall will increase and that the volumes of storm runoff will increase, leading to increased occurrence of floods (Le Maitre et al., 2017). As temperatures are on the increase globally, the frequency of occurrence of tropical cyclones are also projected to increase. These storms are projected to be more intense, resulting in more destructive flooding events in parts of Limpopo, Mpumalanga, and Kwazulu-Natal (Malherbe et al, 2013; Muthige et al, 2018).

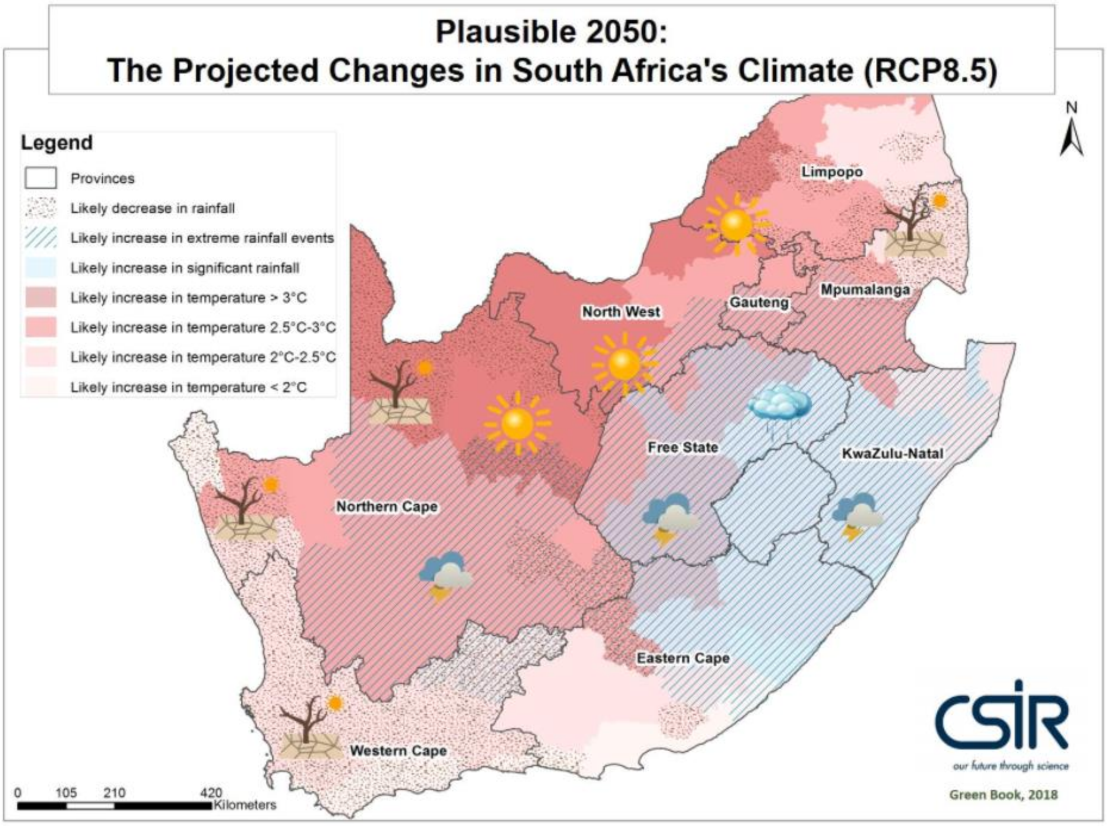

Figure 2.4 Projected climate changes in South Africa's climate for the near future (2050). CSIR, Green Book, 2018.

3. Reporting of loss and damage data in South Africa

Loss and damage reporting after weather-related disasters plays a crucial role in informing decisions and setting priorities for climate change mitigation and adaptation. The responsibility to conduct assessments to verify the impact of a disaster incident is legislated in the Disaster Management Act of South Africa. These assessments are done to ascertain the damages and losses incurred to infrastructure (municipal or sector departments) and in the case of the agricultural sector, losses with respect to cattle and grazing areas. However, insurance companies also do economic evaluation after the occurrence of disasters using a cost benefit analysis, typically only accounting for direct damages. It is therefore important to do a comprehensive assessment of NDMC assessment reports and evaluation reports from insurance companies to inform the monitoring and evaluation framework of impacts of weather and climate disasters. Assessing the true economic costs of disasters is central to addressing their impacts, allocating adequate resources for monitoring and preparedness, assessing their changes over time, and building resilient communities.

Worldwide, economic losses from natural disasters were estimated at $ 268 billion in 2020 (AON, 2021). Locally, natural disasters in South Africa also come at a staggering cost to the economy and the insurance industry. Since 2016, government has allocated R 6.3 billion for drought relief projects and R 660 million for flood relief (National Treasury, 2020). In 2017 alone, catastrophe-insured losses during that year were the highest ever recorded, driven by the disastrous Knysna fires and floods in Durban and Gauteng. Santam alone paid in excess of R 2 billion in claims related to these. Again, in 2019 multiple catastrophe events raised the total insurance claims paid by Santam (Santam, 2020). Fires, floods and drought devastated various parts of the country during 2019, with Gauteng, KwaZulu-Natal and the Northern Cape taking a particular toll. Santam paid more than R 800 million in agricultural-related claims during the period under review.

The impact of weather and climate-related disasters on people depend on various interlinked factors including the type of hazard, its location and duration, as well as the vulnerability of communities subject to the hazard. Impacts are mainly characterised as direct losses and costs and quantified by:

1. assessing the number of people affected and killed in a disaster;
2. the economic costs of damage to assets and infrastructure.

Other losses such as the damage to ecosystem services, costs to rehabilitate biodiversity, loss of productivity, disruption of businesses, repairing damaged goods etc., are referred to as indirect losses and are more difficult to quantify.

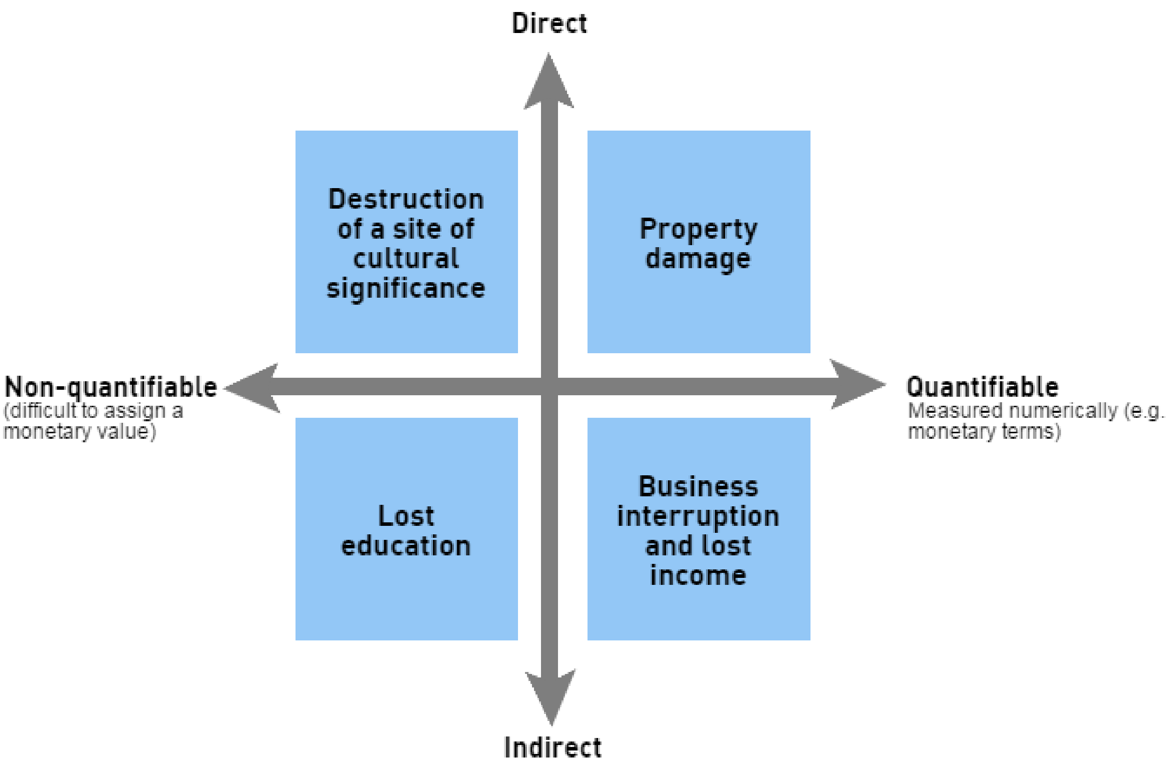

Figure 3.1 Visual representation of direct/indirect and quantifiable/non-quantifiable losses. (Source: UNDRR).

3.1. Why should we quantify loss and damage?

Understanding and quantifying disaster losses is an important step towards taking responsibility and tracking progress of implementing measures and investments to reduce risk (UNDRR, 2013). By evaluating trends and statistics of historical losses, decision makers can better address the following: (University of South Carolina, 2014):

- Determine financial needs of recovery and reconstruction;
- Assess the risks of future disasters;
- Estimate the economic viability and progress of investments made to reduce losses;
- Monitor and evaluate the patterns and trends of human impacts and disasters to achieve the international goals set in disaster risk reduction;
- Perform thematic analysis (e.g., gender differences in mortality rates and damage assessment in specific sectors).

South Africa, however, lacks comprehensive, accurate and updated information on disaster loss. Databases tend to be incomplete, inconsistent or under-reporting (Gall et al., 2013). Furthermore, disaster losses tend to account for only direct losses.

3.2. Social and economic impacts of the four major categories of weather-related disasters in South Africa

There is no central appraisal source available of the human and economic consequences of all disaster events in South Africa, but a partial analysis is possible using various sources.

3.2.1. Social impacts

Consequences to human lives are mostly recorded through metrics of fatalities, missing people, and injuries. CAELUM did not specifically record this type of data, but in many cases event descriptions included expressions like 'died', or 'drowned', or 'killed'. According to the database the total number of fatalities associated with extreme weather events over the period from 2005 until 2021 was approximately 1 311 people (Figure 3.2). This is likely to be a gross underestimation of true deaths associated with weather and climate-related extreme events, as not all events were correctly and consistently captured across the country. Most deaths were associated with storm and flood events.

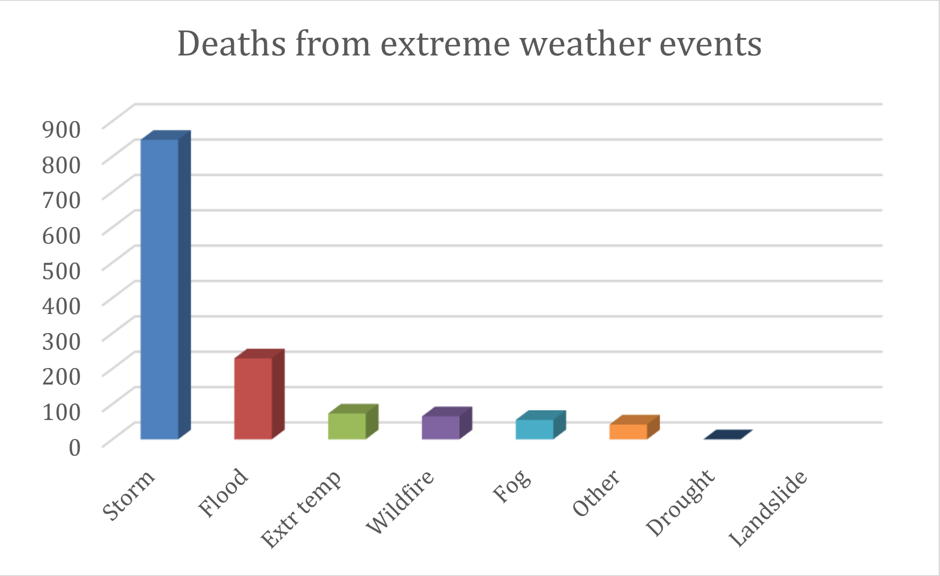

Figure 3.2 The number of deaths associated with main extreme/disaster types recorded in South Africa by the South African Weather Services CAELUM database for the time-period 2005 – 2021.

According to the CRED database (Figure 3.3) a total of 1 403 human fatalities were associated with weather-related disasters over the period from 2005 to 2021. Most of these fatalities were associated with flood (1 184) and storm events (117), while wildfire and extreme temperatures collectively caused the deaths of 102 people.

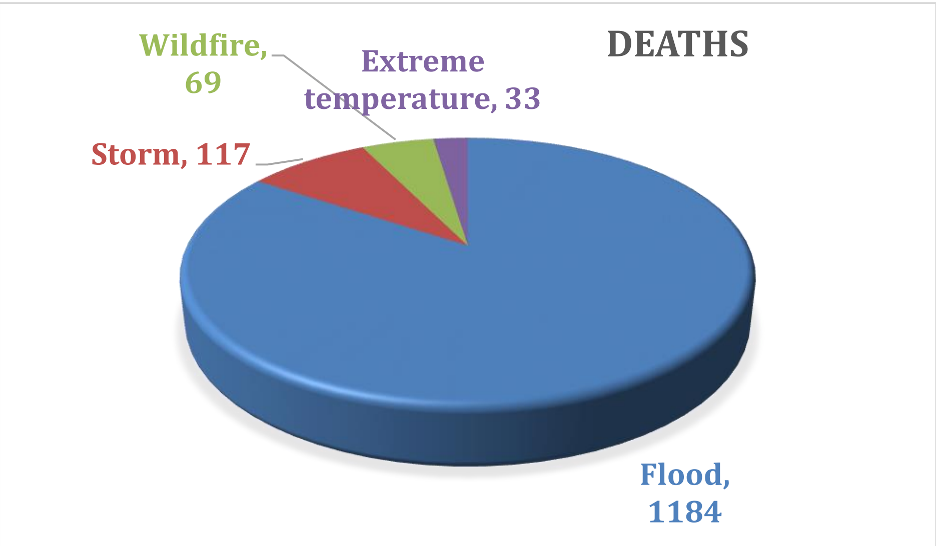

Figure 3.3 Total number of deaths associated with different types of disasters in South Africa according to the International Disaster Database, CRED for the time-period 2005 – 2021.

3.2.2. Economic impacts

Droughts

Droughts in South Africa is considered the disaster type that has the most significant impact and consequences in terms of the economy and people affected. Up until 2022 the total estimated economic impacts of the most severe droughts in South Africa were almost R 30 billion (Figure 3.4). Droughts are a slow onset disaster, which cause damage over a greater period with long-lasting effects. Drought not only affects agricultural production, but it has a wider impact on society and the environment. The impacts of drought depend on its intensity, duration, frequency, and geographical extent. Drought impacts on the different sectors of the economy vary and is reliant on the extent to which the sector depends on water resources. In South Africa, the agricultural sector is the biggest user of water (accounting for 60% of water demand), followed by the municipal sector (27%), power generation (4.3%), mining (3.3%), and industrial demand (+/-3%).

For the agricultural sector, drought may lead to substantial production decreases which, if it spirals down, leads to substantial price increases, and gives rise to increased food insecurity. Due to the drought of 2019, agricultural production fell by 9.1% in the first three quarters of that year, compared with the same period in 2018 (National Treasury, 2020). These transpire into job losses, poverty and increasing inequality which may slow down the country's economic growth. In 2007/2008 the South African government spent R 285 million on drought relief of which R 20 million and R 25 million were allocated to the Eastern Cape and Free State provinces respectively (Ngaka, 2012).

In 2015, South Africa suffered its driest year on record since 1904 with an average rainfall of 403 mm, about one-third less than the 608 mm annual average. The 2015 drought led to an increase in imports of wheat, from 1.8 million tons in 2014/15 to 2 million tons in 2015/16, at a cost of approximately R 5.5 to R 6 billion. According to BFAP (2016), reduced domestic production of maize cause substantial price increases and significant quantities of maize had to be imported. At the time BFAP (2016) estimated that because of the drought, food prices would increase by 15% to 20% and 7.4 million tons of maize would need to be imported. AgriSA also indicated that about R 12.5 billion, including R 4 billion in government guarantees will be needed over the next three years to assist farmers, specifically those who produce maize. The drought will inevitably have a significant impact on maize yields which will affect more than 1.2 million individuals, and this will give rise to increased food insecurity. Government said that the droughts has affected more than 2.7 million households facing water shortages across the country. The drought, concentrated in provinces of Free State and KwaZulu-Natal, started to impact the livelihoods, and drain the economy. Cane production decreased in all cane-growing areas and estimates of sugar cane production were estimated to decline from an annual norm of 19 million tons to 14 million tons, and the South African Cane Growers Association estimated that more than 6500 seasonal jobs would be lost because of decreased cane production. In the livestock sector, drought resulted in natural grazing areas becoming seriously depleted leading to the forced slaughtering of livestock, and livestock deaths due to fodder unavailability. Increases in red meat slaughter rates of 23% (cattle), 37% (sheep) and 12% (pigs) were reported for November 2015 to December 2015.

In the Free State, Hlalele et al. (2016) found that about 80% of businesses lost more than 50% of their employees due to the drought in the Free State. Moreover, about 87% of these businesses lost over 50% of their revenue. In terms of both employee and revenue losses, the economic losses were above 50%.

The 2015-2017 drought in the Western Cape had a significant impact on the agricultural sector which was predicted to lose an estimated R5.9 billion in the 2017/18 season. This has implications for the rest of the country, as the Western Cape contributes 22% to national agricultural GDP. High value crops produced in the Western Cape such as the deciduous fruit, wine and citrus industries are key exports and contribute significantly to South Africa's overall agri-economy. For the period 2017 to 2019, National Treasury estimated that, a total amount of R 1.342 billion national disaster grant funding was allocated for disaster recovery and rehabilitation projects in the Western Cape (WC PDMC, 2018). These funding went mainly towards disasters such as drought, storms, and fires.

Flood and storm damage and losses

Flood and storm events are the disaster types that has the second- and third-highest cost to the economy of South Africa. According to the EM-DAT database the total estimated economic impacts of the most significant floods in South Africa up until 2022 were around 25 billion rands, while storm impacts are estimated at almost R 15 billion (Figure 3.4). Floods and storms may cause direct economic damage, such as the destruction of physical assets, property and the interruption of business activities that were in contact with the flood or storm. Indirect economic losses include losses that are not provoked by the flood or storm itself, but by its consequences long after the event and over a wider geographical area (Meyer et al., 2013). Indirect economic losses from floods are much more difficult to quantify. Floods and storms being sudden onset disasters cause damage that is most pronounced in urban areas, where high densities of people, assets and vulnerable infrastructure occur.

The worst flood to have ever occurred in South Africa took place on 11 and 12 April 2022, when a weather system triggered floods in the KwaZulu-Natal (KZN) province causing a major humanitarian disaster. Parts of the province received rainfall of between 200 and 400 mm over a 24-hour period. This caused extensive damage to houses, businesses, roads, bridges and water, electricity, rail and telecommunications infrastructure. The flooding also disrupted fuel and food supplies. Nearly 4,000 homes were completely destroyed and over 8,300 homes partially damaged. It is estimated that more than 40,000 people have been displaced by these floods, and 489 people lost their lives. Wide-ranging indirect losses of informal homes, assets and other livelihood assets are undercounted and often uncompensated.

Another significant flood also took place in in 2019 over KwaZulu-Natal. The estimated cost of infrastructural damage from the 2019 KwaZulu-Natal floods was around R 1.2 billion. The damage in eThekwini alone amounted to more than R 685 million. The total death toll was 70, with 64 of those coming from eThekwini Municipality.

Previously, in 1987 in KwaZulu-Natal (BELL, 1994) the low-lying and coastal areas of KwaZulu-Natal, South Africa, were subjected to exceptionally heavy rainfall that exceeded 600 mm over four days. Floods and landslides caused damage estimated at over R 600 million, and 380 lives were lost (BELL, 1994).

Elsewhere in South Africa, a cut-off low weather system (2007) severely affected the Overberg, Cape Winelands, Eden and Central Karoo District Municipal areas. A total of 512 mm rain was measured in George over a 24-hour period with dam levels that exceeded 100% in most instances. This extreme weather event resulted in severe damage and losses to dams, municipal infrastructure, formal and informal housing, roads as well as agricultural land, equipment, and crops. The total verified losses over these areas amounted to R 1 181 436 762.

Wildfire loss and damages

Veld fires have serious consequences for the economy, social-wellbeing, and the environment. Veld fires lead to loss of livelihoods and reduce environmental quality. The sectors of the economy most adversely affected by veld fires include agriculture, forestry, tourism and wildlife (Nyamadzawo et al., 2013). The economic damages associated with the most severe wildfire events in South Africa as described in (Figure 3.4) are estimated at R 3 billion.

Loss of life and injury owing to veldfires is a significant factor in the health profile of rural communities with deaths that may run to hundreds in bad years. These are often accompanied by social losses, involving at least the loss of homes and livelihoods ((Forsyth et al., 2010). The forest sector is particularly vulnerable to fire disasters and usually suffer severe economic losses during these events. In 2007, fire disasters caused losses of more than R 1.6 million in total for the forest sector in South Africa. The Mpumalanga province suffered the most damage, followed by KZN and the Eastern and Western Cape. The forward effects of wildfire disaster are even worse with impacts on wood flows, especially sawlogs for construction timber, closure of manufacturing capacity, loss of rural jobs, and many other adverse effects.

Other examples of the economic consequences of wildfires are:

- Damage to and loss of powerlines
- Damage to agricultural infrastructure
- Livestock losses and losses of grazing veld
- Loss of wood and edible resources for rural livelihoods (Forsyth et al., 2010).

As a result, the industry has invested billions of rands in fire prevention and management.

The Knysna fires in the Western Cape of South Africa were the worst wildfire disaster in South African history The fire caused a lot of damage in the region, burning 15 000 ha around the town of Knysna and 5000 ha of forest plantations, destroying at least 800 buildings and claiming the lives of 7 people. The disaster caused more than R 2 billion worth of damage in these areas.

Other serious wildfires in the eastern parts of the country occurred in industrial forests and in surrounding grassland in the Mpumalanga and Kwazulu-Natal Provinces. Towards October 1994, three major plantation wildfires raged in the Sabie District, destroying more than 1 000 ha in each case. During one fire in a SAFCOL plantation in the area, ten firefighters lost their lives when the fire spotted around the team inside *Pinus* and *Eucalyptus* stands. Two firefighting vehicles were also burned out in the process, and combined losses for the district in terms of timber losses exceeded US $1 million.

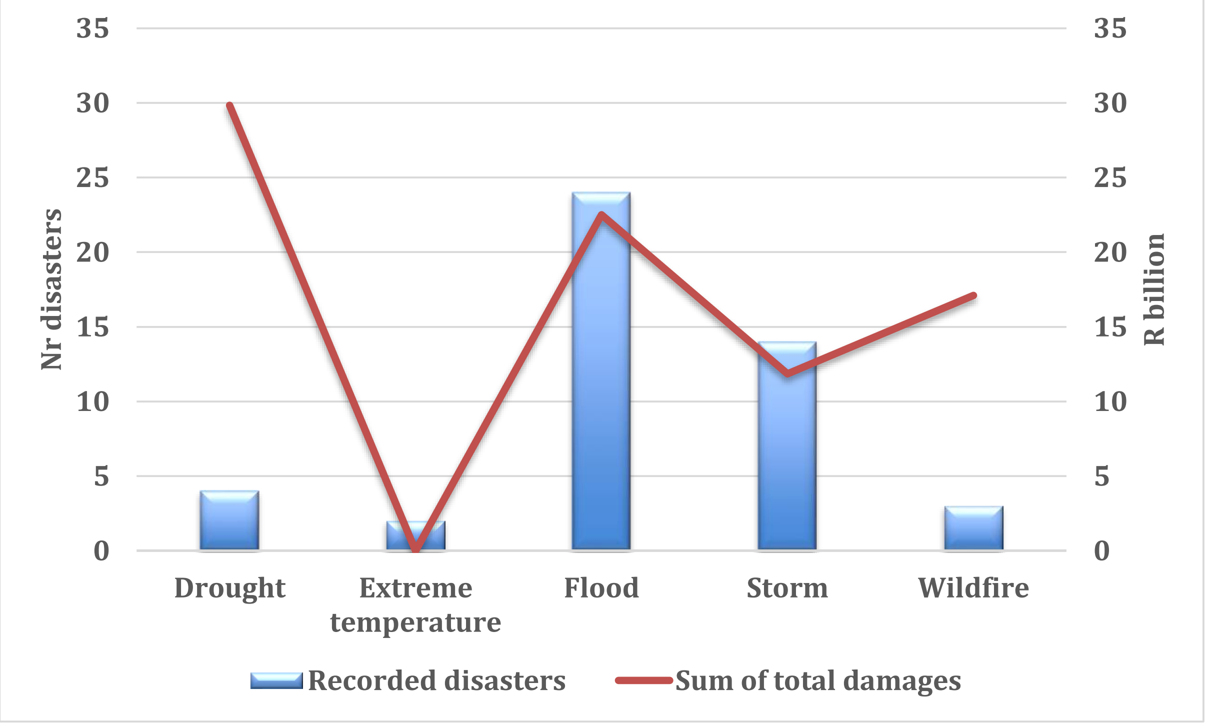

Figure 3.4 Summary of the relative cost of the four major categories of weather-related events; droughts, floods, storms and fires in South Africa between 1900 and 2022. Source: EM-DAT

Table 3.1 The economic impact of the top 10 disasters in South Africa from 1900 to 2022 Source: EM-DAT

Year	Disaster Type	Location	Total Damages ('000 US$)
2022	Flood	KZN	1 470 588 235
2017	Drought	WC, NC	1 200 000
1990	Drought	Limpopo, Mpumalanga, KZN, EC and NC	1 000 000
1987	Flood	KZN	765 305
2008	Wildfire	KZN, FS	430 000
2017	Wildfire	Knysna (WC)	420 000
1990	Storm	KZN	393 000
2017	Storm	KZN and Gauteng	320 000
2017	Storm	WC, NC	283 000
2015	Drought	KZN, FS, Limpopo, Mpumalanga, NW,WC	250 000
2011	Flood	EC, FS and Gauteng	211 000
2012	Flood	EC	200 000

Disaster-relief funding

The Limpopo province received most of the funding over the period from 2010 until 2021 and this funding was mostly used for flood disaster recovery and relief (Table 3.2). The Limpopo province was affected by severe flooding during January 2013 and again in March 2014, which required substantial post-disaster assistance and recovery.

Second-most funding for disaster aid was awarded to KwaZulu-Natal and most of that funding was for drought relief, followed by floods and storms. However, after the most recent April 2022 floods, funding amounts towards disaster aid in KwaZulu-Natal will likely be substantially adjusted upwards. The Eastern Cape province received the third-most of the funding over the period from 2010 until 2021 and this funding was mostly used for flood disaster recovery and relief. Disaster relief and funding for wildfires was mostly awarded to the Western Cape and this illustrates this province's vulnerability towards large-scale wildfire disasters as was witnessed during the Knysna fire disaster in 2017. KwaZulu-Natal, Western and Eastern Cape were the provinces that received most disaster aid aimed at drought relief. The provinces that received the least amount of funding was Northwest and Gauteng.

*Table 3.2 Funding allocated by National Treasury to the nine provinces in South Africa for disaster relief according to flooding, storm, drought or wildfire disasters between 2010 and 2021 in SA Rands (obtained from annual reports from the NDMC). (Source: NDMC). *Actual Funding allocated by National (Emergency, Rehabilitation & Reconstruction)*

Province	Drought	Flooding	Storm	Wildfire	Total
Limpopo	R242 515 000	R4 665 486 510			R4 908 001 510
KwaZulu-Natal	R1 971 331 360	R1 406 643 025	R412 859 000		R3 790 833 385
Eastern Cape	R1 309 116 000	R1 997 494 603	R41 558 648		R3 348 169 251
Northern Cape	R274 161 000	R1 429 978 000			R1 704 139 000
Western Cape	R1 068 767 000	R358 517 125		R75 000 000	R1 502 284 125
Free State	R369 734 000	R378 166 041		R15 790 824	R763 690 865
Mpumalanga	R192 177 952	R150 856 043	R365 903 117		R708 937 112
Northwest	R508 979 000	R128 988 000			R637 967 000
Gauteng		R11 672 590	R152 620 727		R164 293 317
Grand Total	R5 936 781 312	R10 527 801 937	R972 941 492	R90 790 824	R17 528 315 565

3.3. Data gaps and challenges

South Africa faces significant challenges in terms of disaster incidence reporting and there is a lack of loss and damage reporting. These relate to data fragmentation, biased reporting, unavailability and/or poor data. Several private and government entities collate data and maintain databases that report on extreme weather events as well as the location and impact of these events. These databases are distributed between the National Disaster Management Centre (NDMC), South African Weather Services (SAWS), StatsSA, municipalities, government sector departments and the insurance industry. At present the CAELUM database is the only national database which documents the occurrence, location, and impact of all hazard types, whereas the National Disaster Management Centre documents the location, timeline and incidence of all declared disasters across the country. Internationally, the global disaster loss databases, EM-DAT (Centre for Research on the Epidemiology of Disasters), provides access to records about disaster occurrence, damages, losses, and impacts, compliant with the Sendai Framework for Disaster Risk Reduction. There are several inconsistencies between these databases, ranging from the classification of the hazard or disaster type to the manner in which losses and economic damages are reported or calculated. Hence, a need was identified to consolidate existing information of extreme weather events into one central database and standardize on the way data collection and reporting are done to adhere to international standards. This was reiterated at a meeting of the SADC Committee of Ministers Responsible for Disaster Risk Management held in 2020 in Tanzania. It was recommended that South Africa should improve on post-disaster reviews and data management for loss and damage reporting. There is a specific need to establish a central National Disaster Loss Database which obtains the relevant information through a defined National Disaster Loss Architecture (NDMC 2020).

Another challenge that would need to be addressed in the long term is to consider the indirect impacts of extreme weather events. Post-event surveys most often give estimates of the economic impacts of natural hazards and tend to undervalue the full cost of disasters to societies and the environment. They often only account for direct impacts, while only giving partial or incomplete consideration to indirect, wider and macroeconomic effects (Carrera et al., 2013). However, the assessment of indirect impacts is essential for a full understanding of the economic outcomes of natural disasters.

3.4. Key messages from review of impacts of climate and weather-related hazards

1.1.1. *Historical hazards*

- Floods and storms are the most widely recorded meteorological-related hazards in South Africa.
- Drought, however, is the meteorological-related hazard that has been declared a disaster most often, even more than flood disasters in South Africa.
- KwaZulu-Natal is the province where flooding has been declared a disaster most often, followed by Gauteng and the Eastern Cape.
- KwaZulu-Natal is also the province where droughts have been declared a disaster most frequently, followed by the Free State and Eastern Cape provinces.
- KwaZulu-Natal is therefore the province where both droughts and floods have been declared disasters most often.
- The 2018-2020 drought event over the summer rainfall areas of SA is considered to be one of the worst droughts experienced over Southern Africa. This drought started affecting the Eastern Cape region in 2015 and is now considered the worst drought in the region's history.
- The highest frequency of veld fires occurs in the north-eastern and eastern regions of the country.
- Tropical cyclones are scarce over South Africa. If these storms do develop, it can have devastating impacts, mostly over the provinces of KwaZulu-Natal, Mpumalanga and Limpopo.
- Thunderstorms are associated with tornadoes, strong winds, hail, lightning and flash flooding. As temperatures increase, South Africa may experience bigger and more frequent thunderstorms.

- The Highveld region of Mpumalanga and the Drakensberg escarpment of KwaZulu-Natal are the areas with the highest rates of occurrences of thunderstorms.
- South Africa has the 3rd highest incidence of lightning-related injuries and deaths in the world (more than 260 people each year).
- From available data it seems as if the frequency of weather and climate-related disasters has increased over the years. Reasons for this could be that people and businesses have more physical assets in vulnerable locations such as coastal areas and in river floodplains than previously. However, climate change is also making the occurrence of drought, wildfires, and extreme rainfall more common than in decades past.

1.1.2. *Impacts*

- The KwaZulu-Natal flood of 2022 was South Africa's most devastating flood disaster to date. Damage was estimated at over R24 billion, and 489 lives were lost.
- It is estimated that veld and forest fires cost the South African economy more than R 4.3 billion a year, of which R 3.7 billion are “indirect losses”.
- Studies have found an increased risk for mega-wildfires (burn bigger and hotter, over large areas of land) due to warmer and drier conditions that dry out the ecosystem.
- The Knysna great fire of 2017 is considered the worst wildfire disaster in South Africa, causing loss of lives, damage of billions of Rands to properties and infrastructure and destroying thousands of hectares of plantation forestry.
- In terms of economic losses, droughts in South Africa are considered the disaster type that has the most significant long-term impact and consequences for the economy. This is followed by floods, storms and wildfires.
- Since 2015, the economic damages related to droughts in SA were valued US$ 1 585 000 000.

1.1.3. *Needs/ gaps*

- A lack of awareness, skill, and capacity at local government level to capture and report on losses and damages associated with weather-related extreme events.
- A lack of capacity at NDMC and Treasury to organize, extract and disseminate disaster-related loss and damage data.
- A need for more consistent classification and data collection methodology among data custodians and data sources in reporting on meteorological, climate and hydrological extreme events.
- Better coordination and integration of disaster-related data collection and sharing among data custodians, data sources and various other role players in the government sphere and insurance industry.
- Poor understanding of insured damages caused by meteorological, climate and hydrological extreme events (insurance companies are not inclined to share this information).
- Media reports, insurance companies and other institutions that assess economic loss related to disaster events, mostly only account for direct economic impacts. Assessment

of indirect impacts is essential for a full understanding of the economic outcomes of natural disasters.

Table 3.3 Table of challenges experienced in reporting on loss and damages related to climate extremes in South Africa, with potential interventions to address these challenges.

Challenge	Intervention
Data gaps, scale inconsistencies, data currency, lack of meta-data	Best practice on data collection methods and preparation as a step towards developing the monitoring and evaluation framework on impacts of weather and climate disasters.
Lack of reporting on localized extreme events vs declared disasters	L&D framework to provide for, and include extreme events
Lack of consistent classification of disaster and extreme events	Use guidelines on classification and categories as informed by Sendai Framework
Poor coordination between government departments and other role players, reluctance to share data among custodians	Clearly defining roles, responsibilities, and how the flow of information should work. One department to take the lead and facilitate information collection. SA M&E system for reporting
Poor understanding of insured damages	Engage and involve SAIA in government forums, meetings. Facilitate public-private partnerships
Lack of awareness, skill, and capacity at local government level	Integrate L&D framework into existing data collection and reporting structures to avoid duplication
	Simplify data collection, start out with collecting essential information and scaling up in steps to more complicated information.

Challenge	Intervention
Disparity between the true cost of damages and the actual funding allocated for disaster relief and recovery	Identify reasons for disparity and instill a process of continuous improvement as part of M&E.
Lack of funding to collect, transfer and organize existing databases into a centralized database	Identify and prioritise databases and start integrating through a tiered approach

4. Existing frameworks to evaluate the impacts of climate disasters in SA

There is a need for tools, methods, or data collections systems to guide how the country should approach the monitoring and evaluation of the impacts of weather and climate-related disasters and thus track the country's progress towards mitigating impacts through adaptation efforts. The M&E framework used to guide the evaluation of impacts of weather and climate-related disasters in SA is expected to provide broad, high-level elements and principles that align the country's framework with existing M&E systems which monitor climate change information thus minimizing duplication and ensuring optimal utilisation by end-users.

Developing a comprehensive approach to loss and damage does not require the wholesale invention of new approaches; rather the integration of an existing, but often fragmented, and often competing, set of tools. An assessment of international frameworks was conducted to assess loss and damage aimed to support this work in terms of understanding how these impacts are considered within the framework, high level aims of the framework, evaluation criteria and roles and responsibilities of those involved. Table 4.1 provides selected examples of recent frameworks which includes elements of loss and damage.

Table 4.1 Overview of frameworks which includes elements of loss and damage

Institutional framework to address residual loss and damage (Roberts et al., 2014)	• The framework should be guided by UNFCCC principles; recognise the urgency of developing and implementing robust and practical approaches to address loss and damage; address the needs of vulnerable countries; transform the scale of mitigation and adaptation ambition; be facilitative instead of punitive; and be based on the best available science and national circumstances. • As loss and damage is ultimately incurred at the local level, the institutional framework on loss and damage should also provide guidance and mobilise support to help developing countries implement institutional arrangements to address loss and damage comprehensively.
Sendai Framework for Disaster Risk Reduction (2015)	• The Sendai Framework for Disaster Risk Reduction 2015-2030 outlines seven clear targets and four priorities for action to reduce existing and prevent new disaster risks. • Targets A, B, C and D are targets to reduce the losses attributed to disasters relating to mortality (A), number of people affected (B), economic loss relative to GDP (C) and damage to critical infrastructure and disruption of basic services (D). Each of these targets has several indicators of loss and damage. • It aims to achieve a substantial reduction in disaster risk and loss of life, livelihoods and health, and of the cultural, economic, environmental, physical and social assets of people, businesses, communities and countries over a 15-year period. UNISDR is tasked with the implementation, follow-up, and review of the Sendai Framework • The Sendai Framework Online Monitoring tool has as an important sub-system, the Disaster Loss Data Collection tool (called “DesInventar Sendai”), which permits the creation and maintenance of fully-compliant Loss Databases that can be used to gather the data required for Global Targets A, B, C and D.

Comprehensive Risk Management Framework Approach (Roberts and Pelling, 2018)	• Proposes a Comprehensive Risk Management Framework approach as a practical framing for national and local policies to address loss and damage which could lead to addressing both the underlying and accumulating development failures and risk management capacities that shape loss and damage outcomes. • Expands Loss and Damage view from a technical agenda towards one more attuned to existing policy and mechanisms at the local and national levels and emphasises the underlying developmental potential of Loss and Damage. • Moves Loss and Damage from a reactive to a proactive responsibility and enables action now – not only once attribution and the limits to adaptation are derived. • The Comprehensive Risk Management Framework is a series of tools and measures that come together to reduce vulnerability and build resilience of households at the micro-level and countries at the macro-level. • The need to develop comprehensive risk management frameworks to avoid, minimize and address loss and damage is not novel; however, a focus on reducing vulnerability, centred on sustainable development is a new way of framing the response to Loss and Damage.
The Principled Framework for Loss and Damage (Schinko et al., 2018)	• This policy framework that builds on recent IPCC framing and evidence on climate-related risk. • Applies recent insights from climate risk management (CRM), an approach that strives to link disaster risk reduction (DRR) and climate change adaptation (CCA) agendas under one umbrella to loss and damage. • Rationale: better understanding of climate-related disaster risk and risk management can inform effective action on CCA and point a way forward for L&D policy as well as practice.

FAO's damage and loss (D&L) assessment methodology (FAO, 2021)	• The FAO D&L methodology provides a set of procedural and computational steps for calculating damage and loss from disasters in the agriculture sectors. It is used to calculate Sendai Target C2 at the national level. • FAO's D&L methodology distinguishes between damage, i.e., the total or partial destruction of physical assets, and loss, i.e., changes in economic flows arising from a disaster. • It can be applied to a wide range of disaster events, including climate-related events, from large-scale shocks to small-scale events. It can be used in different national and regional contexts: and at various time scales. • The methodology's five components cover direct damage and loss to crops, livestock, forestry, aquaculture, and fisheries. Together, they capture the total effect of disasters on agriculture.

5. Moving towards a framework for centralizing loss and damage data collection

At present loss and damage data are collected by the National Disaster Management Centre after declared disasters via post-disaster assessments and verification procedures at local municipality level. However, several other institutions also gather loss and damage data at different spatial and temporal scales, using various indicators and methodologies. There is a need to consolidate this data collection and reporting process to allow for a standardized central loss and damage database. The proposed framework in this report will support this process in South Africa and align with international frameworks (such as the Sendai framework) to measure progress made on disaster risk reduction by the year 2030.

It is necessary to identify, measure and characterise losses and damages experienced in the country. South Africa does not have a central National Disaster Loss Database, as such available databases need to be consulted to extract historical weather and climate impacts data for a defined period in a similar file format and on the same platform to support comparative analysis in line with the targets of the Sendai Framework and Sustainable Development Goals. This will inform our understanding of what data on losses and damages is recorded domestically and at what scale (to inform a baseline database of disaster impacts and their costs), whether the data is collected in line with Targets 1 to 4 of the SFDRR and associated SDGs, and whether it supports the country in meeting its reporting requirements to the international community. Understanding data gaps will also facilitate the development of guidance on what data needs to be collected going forward and by whom.

South Africa's Medium-Term Strategic framework includes a target on '100% reduction of losses (human life; livestock/crop yield; houses/shelter; infrastructure; species) due to climate change disasters' under the Environmental Management and Climate Change programme. The indicator under this target is 'Percentage reduction of losses (human life; livestock/crop yield; houses/shelter; infrastructure; species) due to climate change disasters. This work is aimed at developing a framework to inform the baseline for monitoring and evaluating the loss and damage from weather and climate events towards understanding how the country is doing towards achieving the proposed MTSF target (refer to Section 2.1).

5.1. Framework objectives

- **i.** To serve as a guiding tool for local government to systematically record human loss and economic loss data arising from meteorological, hydrological, and climatological-related disasters (declared disasters and local hazard events).
- ii. To improve the monitoring and evaluation of the impacts of meteorological, hydrological, and climatological-related disasters
- **iii.** To support and inform adaptation and mitigation initiatives aimed at reducing disaster impacts.
- iv. To supply South African loss data to international initiatives aiming at providing global loss trends and fulfil its international reporting requirements.

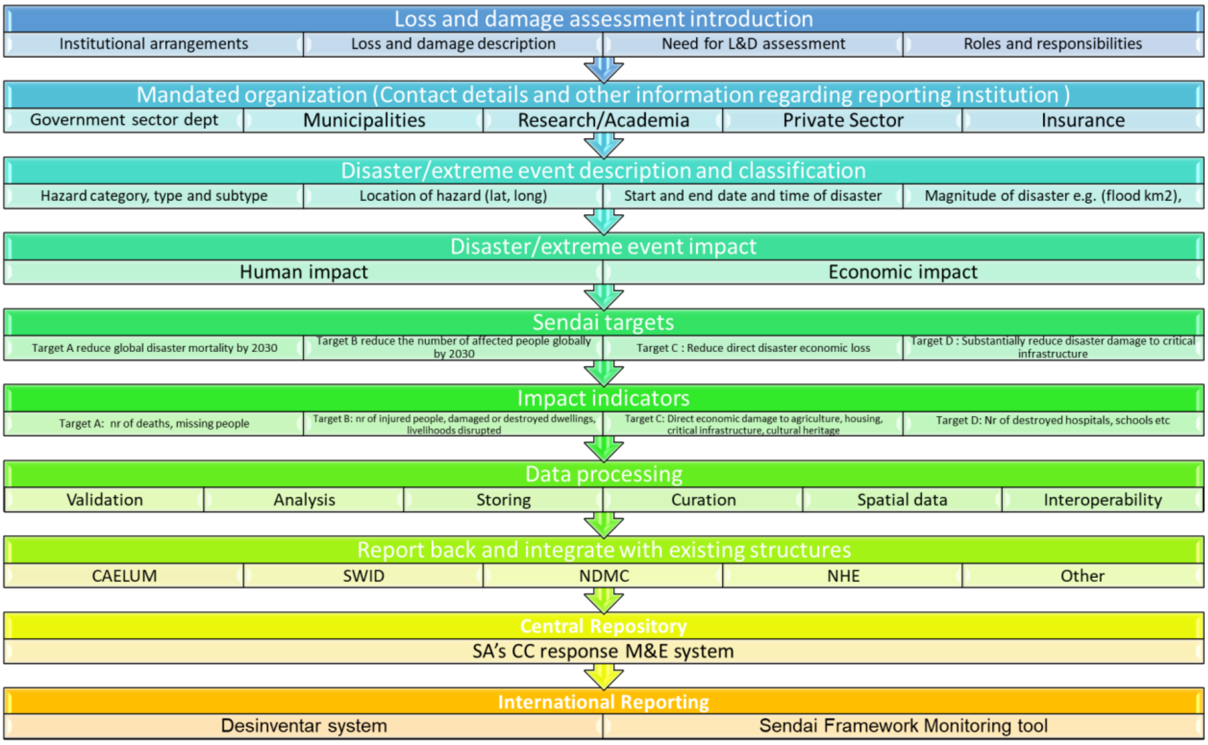

Figure 5.1 Outline of the framework developed for local, provincial and national government to guide loss and damage data collection and reporting.

5.2. Framework elements

Figure 5.1 indicates the key elements of the framework to inform the baseline for monitoring and evaluating loss and damage from weather and climate events.

5.2.1. Disaster loss and damage assessment introduction

A. Institutional arrangements for DRR in South Africa

The Disaster Management Act (DMA) and the National Disaster Management Framework (NDMF) are the main policy instruments used in addressing disaster risk reduction well as disaster response at local government level. Each level of government (national, provincial and local) is required to establish structures to ensure that DRR, response and recovery are coordinated and implemented. These complex multi-level processes are coordinated through the National Disaster Management Centre (NDMC), whose functions include monitoring of disasters, mobilisation of resources, coordination and response to disasters, and maintenance of a repository of information relating to disasters, as well as a database of relevant stakeholders (Department of Environmental Affairs 2014).

The implementation of this Loss and Damage Framework will align with and link with the following national policies and systems:

i. National Development Plan (NDP)
ii. National Climate Change Response Policy
iii. National Climate Change Response Monitoring and Evaluation (M&E) System

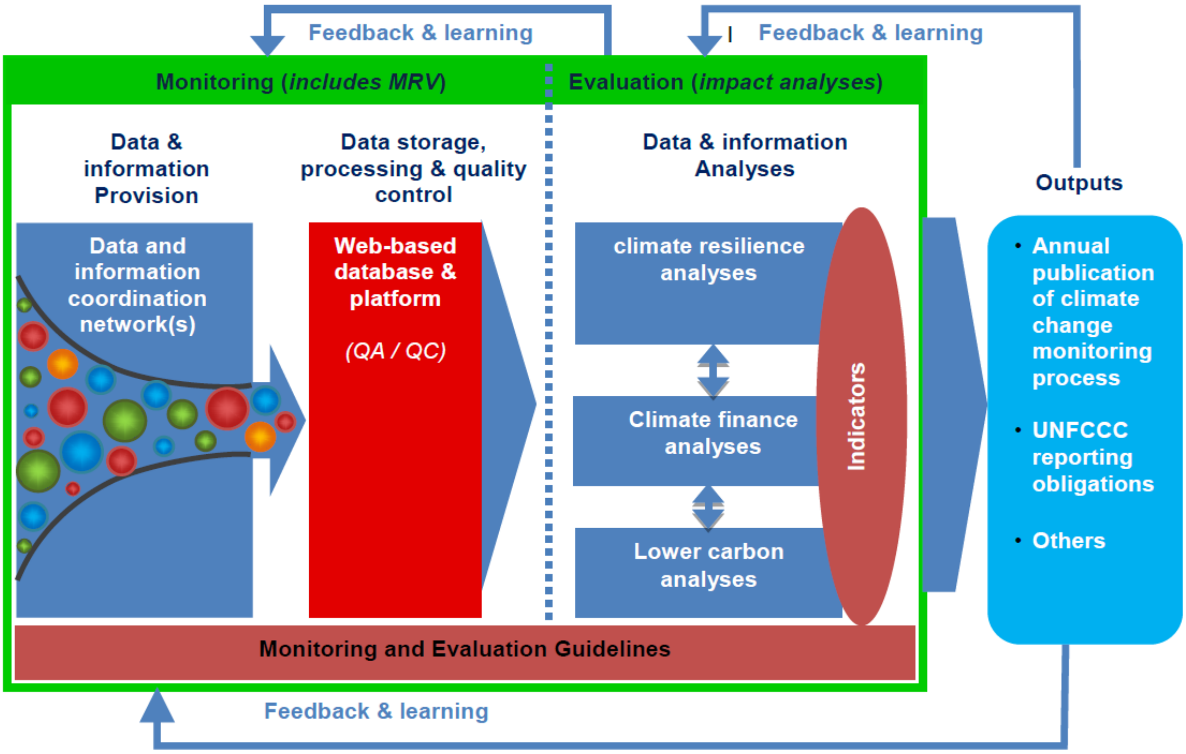

Figure 5.2 South Africa's Climate Change Response M&E system

SA has an M&E system in place that enables the country to assess, analyse and understand the progress that it has made in achieving its climate change commitments and actions. As part of the M&E system a set of Desired Adaptation Outcomes (DAOs) was developed to inform and focus the monitoring and evaluation of the progress of South Africa towards a climate resilient society. This loss and damage framework will be integrated with SA's existing climate change M&E systems and aligned with the specific DAO relevant to assessing loss and damage, thus minimising duplication and ensuring optimal utilisation by end-users.

B. Disaster loss and damage description

Loss refers to things that are lost for ever and cannot be brought back, such as human lives or species loss, while **damages** refer to things that are damaged, but can be repaired or restored, such as roads or embankments. Its monetary value is expressed in terms of replacement costs according to prices prevailing just before the event.

Disaster risk - the potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future period.

Disaster impact - The impact of a disaster represents the overall effects, including positive and negative effects, of the disaster. Refer mostly to market-based impacts (e.g., destruction of property or a reduction in income) and non-market effects (e.g., loss of life, environmental consequences, loss of cultural heritage or psychological effects suffered by individuals).

Affected people - Number of persons that were directly or indirectly affected in some way due to the disaster.

C. Need for loss and damage assessment

Disaster loss data recording is the result of a systematic, (nationally) consistent, coordinated process to collect human, physical, and economic losses as well as social and environmental consequences immediately following an emergency or a disaster. Assessing the human loss and economic costs of disasters is central to addressing their impacts, allocating adequate resources for monitoring and preparedness, assessing their changes over time, and building resilient communities.

D. Roles and responsibilities

Defining roles and responsibilities of key role-players is needed in terms of mapping data custodians and identifying available databases for the historical hazard mapping. This also facilitates the strengthening of institutional arrangements and establishes collaboration with National Sectoral Departments and partnerships with private sector insurance companies to ensure open data sharing. Stakeholders and data custodians involved in disaster risk reduction in South Africa cut across government, research foundations/academia and the private sector.

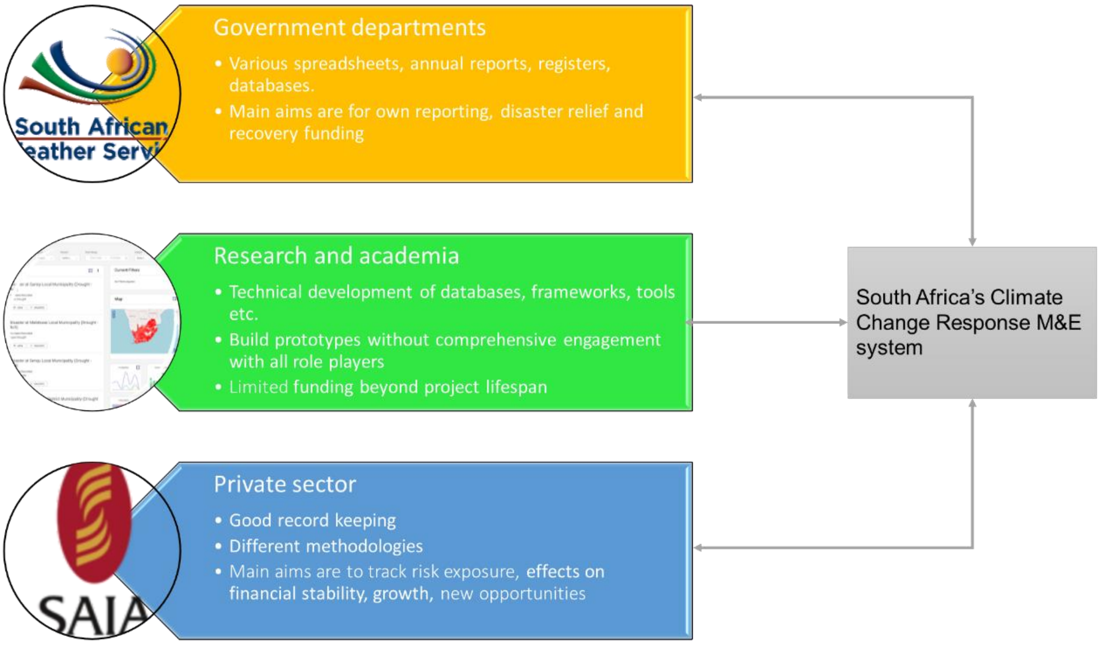

Figure 5.3 Key functions, attributes and responsibilities of the main disaster loss and damage stakeholders and data custodians in South Africa.

Information and data aimed at informing loss and damage of declared disasters are generally collected, managed, and curated by the government sector. Local government (municipalities) reports data to provincial/national disaster management centres for disaster recovery and relief support. National and provincial government sector departments collect disaster-related data for monitoring and reporting purposes. The private sector, civil society and research institutions also engage in collecting similar types of data, although with a different purpose in some instances.

5.2.2. Mandated organisation or institution

The framework is aimed at guiding the collection of information from all stakeholders and custodians across South Africa. The reporting or mandated organisation can be one of several stakeholders in the government, private sector or research space. Figure 5.4, gives an overview of the various organisations or institutions involved in collecting loss and damage data. Although several stakeholders are involved, the implementation of the framework will first be aimed and tested at provincial government department and municipality level.

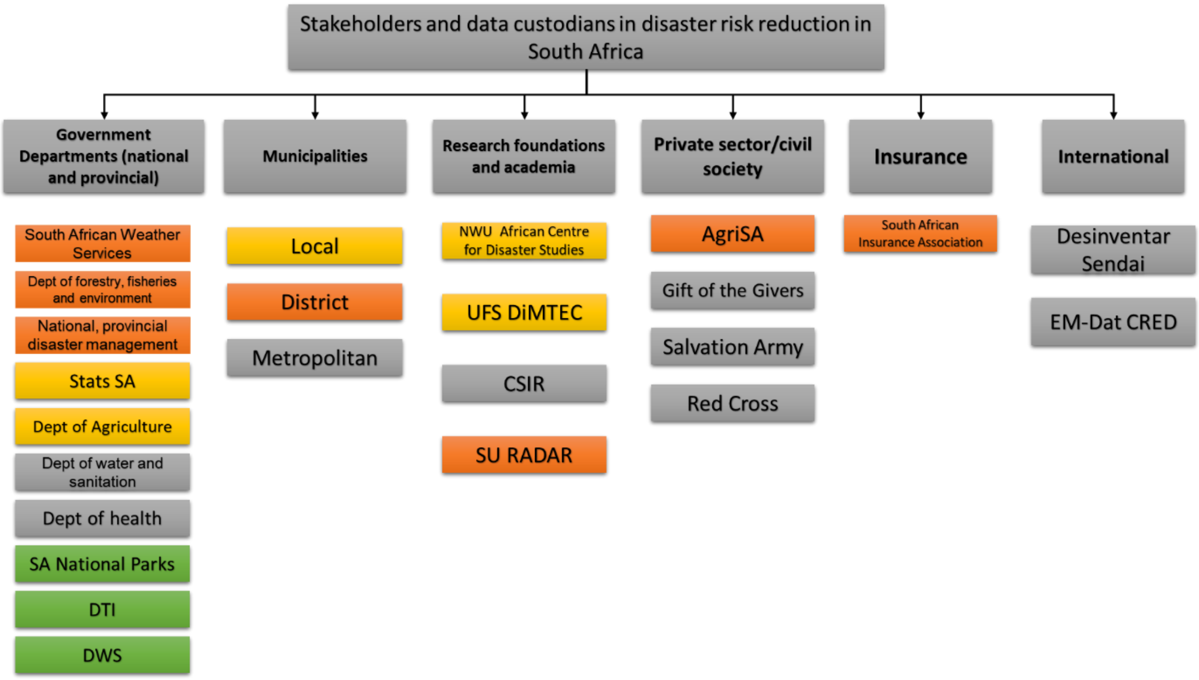

Figure 5.4 Main stakeholders and data custodians in the disaster risk reduction landscape in South Africa. Stakeholders highlighted in orange indicates stakeholders with whom the CSIR have had several direct engagements, yellow indicates some level of engagement and green indicates very little engagement.

5.2.3. Hazard and disaster classification/type

A. Disaster category, type, and sub-type

There is a need to standardise the categories and definitions of disaster/hazard events by the NDMC and the SAWS. For example, the CAELUM database of SAWS and the declared disasters database of the NDMC differ in their definition and description of weather-related disasters. This is relevant for hazard mapping in terms of scale, affected area and impact, and will support consistency of reporting to facilitate comparison across years and regions and the reporting lifecycle. According to the Sendai framework, disasters should be assessed in context of "small-scale and large-scale, frequent and infrequent, sudden and slow-onset disasters caused by natural meteorological, climatological and hydrological hazards". These hazards are further divided into different sub-types, as indicated by EMDAT. These categories align with the classification system used in the SAWS's new severe weather impact database (SWID).

<u>Current classification system according to EMDAT</u>

Meteorological: A hazard caused by short-lived, micro- to meso-scale extreme weather and atmospheric conditions that last from minutes to days.

Main types are:

I. Storm
II. Extreme temperature
III. Fog

Hydrological: A hazard caused by the occurrence, movement, and distribution of surface and subsurface freshwater and saltwater.

Main types are:

i. Flood
ii. Landslide
iii. Wave action

Climatological: A hazard caused by long-lived, meso- to macro-scale atmospheric processes ranging from intra-seasonal to multi-decadal climate variability.

Main types are:

i. Drought
ii. Wildfire

B. Location of hazard

Recording of hazard, might include field work

C. Triggering mechanism: which events are part of the database?

5.2.4. Disaster impact

i. Disaster impacts classification

Disasters are frequently classified according to their impact, measured by number of victims and economic damage. A standard impact classification system needs to be developed for South Africa and adopted by all reporting structures to support consistent reporting on what losses have occurred because of a disaster (Davis-Reddy, C. and Hilgart, 2021).

In South Africa different reporting institutions use different indicators to quantify and define impacts of disaster events. As a point of departure, the Sendai indicators will be used to identify and describe the physical attributes of disaster events as well as the economic and human impact thereof.

These indicators are divided as follow:

i. Human impact:

Number of deaths and missing persons attributed to disasters, per 100,000 population.	
A-2	Number of deaths attributed to disasters, per 100,000 population.
A-3	Number of missing persons attributed to disasters, per 100,000 population.
Number of directly affected people attributed to disasters, per 100,000 population.	
B-2	Number of injured or ill people attributed to disasters, per 100,000 population.
B-3	Number of people whose damaged dwellings were attributed to disasters.
B-4	Number of people whose destroyed dwellings were attributed to disasters.
B-5	Number of people whose livelihoods were disrupted or destroyed, attributed to disasters.

ii Economic

Direct economic loss attributed to disasters in relation to global gross domestic product.	
C-2	Direct agricultural loss attributed to disasters. Agriculture is understood to include the crops, livestock, fisheries, apiculture, aquaculture and forest sectors as well as associated facilities and infrastructure.
C-3	Direct economic loss to all other damaged or destroyed productive assets attributed to disasters.

Direct economic loss attributed to disasters in relation to global gross domestic product.	
	Productive assets would be disaggregated by economic sector, including services, according to standard international classifications.
C-4	Direct economic loss in the housing sector attributed to disasters. Data would be disaggregated according to damaged and destroyed dwellings.
C-5	Direct economic loss resulting from damaged or destroyed critical infrastructure attributed to disasters. Protective infrastructure and green infrastructure should be included where relevant.
C-6	Direct economic loss to cultural heritage damaged or destroyed attributed to disasters.

Damage to critical infrastructure attributed to disasters.	
D-2	Number of destroyed or damaged health facilities attributed to disasters.
D-3	Number of destroyed or damaged educational facilities attributed to disasters.
D-4	Number of other destroyed or damaged critical infrastructure units and facilities attributed to disasters. Protective infrastructure and green infrastructure should be included where relevant.
Number of disruptions to basic services attributed to disasters.	
D-6	Number of disruptions to educational services attributed to disasters.
D-7	Number of disruptions to health services attributed to disasters.
D-8	Number of disruptions to other basic services attributed to disasters.

5.2.5. Data processing

A methodology of recording explains how data should be stored once field data have been collected.

- Data storing: files and documents are recorded digitally and saved in a storage system for future use. Includes creating back-ups of data.
- Data validation: checking the accuracy and quality of source data before using, importing or otherwise processing data.
- Data analysis: processing of the collected data by cleaning, transforming, and modeling data to extract insights that support decision-making.
- Data curation: Data curation is the organization, integration and maintenance of data collected from various sources,
- Spatial data: Information should as far as possible be supported by geographical coordinates and other maps.
- Interoperability: the ability to share data between different components or machines, both via software and hardware, to seamlessly communicate and process data in a way that does not require any involvement from end-users.

5.2.6. Data report-back, sharing and aligning with existing structures

Data collected directly after disasters or extreme events should be quality checked and imported into a central severe weather loss and damage database (repository) for South Africa. Several other databases containing disaster loss and damage data exists and will also need to feed into this central loss and damage database (repository) for South Africa. Ultimately these data collectively will support SA's M&E system and enable the country to report on loss and damage associated with extreme weather events and fulfil its international reporting requirements in terms of the Sendai framework (Desinventar).

Existing disaster-related databases in South Africa:

1. South African Weather Service (SAWS) CAELUM - The CAELUM weather events database is a restricted commercial product and provides a history of notable weather events in South Africa. It is compiled from newspaper reports and articles on weather-related events. The database provides information on weather-related events as far back as the mid-1800s. It includes the location of the event, and in some cases also a description of the impact and severity of the event. Descriptions are not standardized and not consistent across the database. Several events and years are lacking information. The CAELUM database informs the SWID, South African Weather Services: Severe Weather Impacts Database.
2. South African Weather Services: Severe Weather Impacts Database (SWID). A user-friendly and standardized platform of archiving extreme weather systems, events and their impacts which will be easily available to policy makers, and other stakeholders.
3. South African Environmental Observation Network (SAEON): National Hazardous Events Database. A Prototype of a Web-Based National Hazards Events Database for

South Africa to address the gaps in national and international disaster reporting. This database has not been further developed due to a lack of funding.

4. National Disaster Management Center (NDMC) online Disaster Atlas Application. It has not been updated since April 2017.

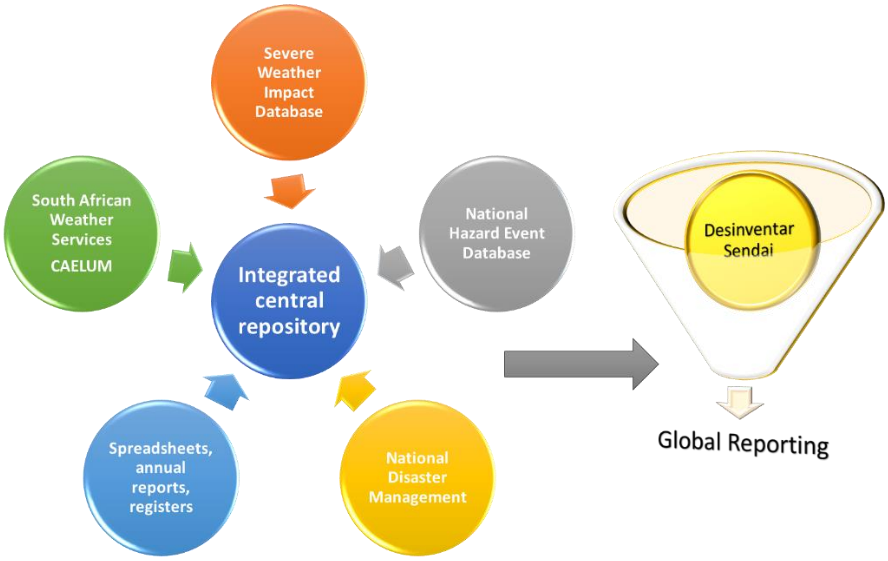

Figure 5.5 Suggested schematic integration of several databases into a central integrated repository for South Africa

5.3. Practical application of the framework

The L&D framework will:

- Ensure that activities of stakeholders involved in loss and damage from weather and climate disasters are well coordinated.
- Ensure that stakeholders understand their role and responsibilities in terms of tracking what has been prioritized in the MTSF.
- Build on existing data collection and databases that are in in place towards informing standardised data collection practices/protocols going forward.
- Raise awareness of the need to collect and report on loss and damage data associated with extreme weather events.
- Promote coordinated and enhanced action across climate change adaptation and disaster risk reduction (DRR).
- Contribute towards understanding how the country is doing in achieving the proposed MTSF target.
- Support government in fulfilling the climate reporting requirements (national and international).

- This work supports transparency in reporting and developing best practice methodologies that can be used both as guidance by other countries, and for capacity building.

6. Summary

Currently, South Africa has limited tools, methods or data collections systems in place to guide the country in terms of the monitoring and evaluation of losses and damages associated with weather and climate-related disasters and thus tracking the country's progress towards mitigating impacts through adaptation efforts. South Africa represents one of many countries where disasters are reported but no national database on loss and damage has been established yet. Data and information related to loss and damage are fragmented across numerous government departments, sector departments and private sector entities in South Africa. Not only are various organizations collecting data, but the formats, hazard classifications, spatial and temporal resolution of the data differ substantially between these data custodians. This complicates the comparison and integration of the various data sources to obtain a realistic picture of the true costs associated with weather-related disasters and how this impacts livelihoods. It also impairs an accurate, timely and high-quality monitoring process.

A Loss and Damage framework for South Africa was therefore developed to guide the country on how it should approach the assessment of impacts from weather and climate-related disasters to ensure an accurate, timely and high-quality monitoring process.

The framework was developed through an iterative process which involved the review of existing international frameworks to better understand how criteria are measured or defined, the data that is required and the roles and responsibilities of key role-players. This also involved consultation with data stakeholders and related databases.

The Loss and Damage framework for South Africa guides the process of collecting loss and damage data related to climate disasters or severe weather events through a systematic process which involves:

1. Describing the Institutional arrangements for DRR in South Africa;

2. Clarifying loss and damage principles/definitions;

3. Explaining the need for loss and damage data;

4. Identifying the main role players as well as their respective roles and responsibilities;

5. Describing various natural disaster categories, types and subtypes;

6. Clarifying the human and economic impacts as well as the type of indicators to measure/assess these.

7. Data capturing, processing, storing and reporting.

8. Integration with other data sources into central data repository or database.

9. International reporting requirements.

A key outcome of the framework was the development of a simple Excel-based loss and damage tool. This tool is aimed at local municipalities and focuses on the most critical elements and data needs in terms of human and economic indicators to perform monitoring and evaluation of impacts. The aim is to simplify data collection, start out with collecting essential information and scale up in steps to more complicated information. The loss and damage tool is therefore designed so that it can be expanded to include more complicated data capture and analyses in future.

7. References

Bruwer, A., Van Staden, M., Le Roux, A and Van Niekerk, CW. 2017. Disaster management and risk reduction in South Africa. South African Risk and Vulnerability Atlas: Understanding the Social &; Environmental Implications of Global Change. 2nd edition, pp 105-111.

Davis-Reddy, C. and Hilgart, A. (2021). Towards improved framework of an interoperable disaster database for South Africa. Frontiers in Climate, 3, 8.

Dazé, A., Terton, A., & Maass, M. (2019). Alignment to advance climate-resilient development – Overview Brief 2: Getting started on alignment. Retrieved from http://napglobalnetwork.org/wp-content/uploads/2019/03/napgn-en-2019-alignment-to-advance-climate-resilient-development.pdf

Department of Environmental Affairs 2014c, Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa: Climate Information and Early Warning Systems for Supporting the Disaster Risk Reduction and Management Sector in South Africa under Future Climates, Department of Environmental Affairs, Pretoria, South Africa.

EM-DAT (Feb. 2015) - The OFDA/CRED - International Disaster Database http://www.emdat.be - Université catholique de Louvain Brussels – Belgium

Fakhruddin et al. Extent and evaluation of vulnerability for disaster risk reduction of urban Nuku'alofa, Tonga, Progress in Disaster Science 2 (2019) 100017

FAO (2021) FAO's damage and loss assessment methodology. Food and Agriculture Organisation. Available at: https://www.fao.org/publications/card/en/c/CB4265EN/

Fire Protection Association of South Africa. 2015 South Africa national fire losses [document on the Internet]. Available from: http://www.fpasa.co.za/images/FireStats/Fire_Stats_2015.pdf.

Forsyth, Greg & Le Maitre, David & van den Dool, Riaan & Firesun, Dool & Walls, Richard & Pharoah, Robyn & Fortune, Gillian. (2019). THE KNYSNA FIRES OF 2017: LEARNING FROM THIS DISASTER.

INFFER™, the Investment Framework for Environmental Resources https://www.inffer.com.au/

Jegede, A. O. (2018). Africa versus Climate Change Loss and Damages: Exploring AU Regional Channels for Influencing National Policy. Journal of African Foreign Affairs, 5(2), 207–226. https://www.jstor.org/stable/26664070

Le Maitre, D., Kotzee, I., Le Roux, A. & Ludick, C. 2019. Green Book. The impact of climate change on flooding in South Africa. Pretoria: CSIR.

Neha Rai, Nick Brooks, Tin Ponlok, Neth Baroda and Erin Nash (2015). Developing a national M&E framework for climate change: Tracking Adaptation and Measuring Development (TAMD) in Cambodia. Research Report, IIED, London.

Ngaka, M.J., 2012, 'Drought preparedness, impact and response: A case of the Eastern Cape and Free State provinces of South Africa', Jàmbá: Journal of Disaster Risk Studies 4(1), Art. #47, 10 pages.

OECD (2020), Common Ground Between the Paris Agreement and the Sendai Framework: Climate Change Adaptation and Disaster Risk Reduction, OECD Publishing, Paris, https://doi.org/10.1787/3edc8d09-en.

Project for Strengthening Institutional and Policy Framework on Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) Integration. https://www.drrandcca.com/

Platt et al. 2010. Monitoring and Evaluating Post-Disaster Recovery Using High-Resolution Satellite Imagery – Towards Standardised Indicators for Post-Disaster Recovery. Conference Proceedings

Republic of South Africa 2005, National Disaster Management Policy Framework, Pretoria, Government Printers.

UNISDR (2015) Sendai framework for disaster risk reduction: 2015–2030. https://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf.

USAID_ATLAS_2019_Best Practices in Urban Climate Adaptation Literature review. https://www.climatelinks.org/projects/atlas van der Geest, K. and Warner, K. (2020) Loss and damage in the IPCC Fifth Assessment Report (Working Group II): a text-mining analysis, Climate Policy, 20:6, 729-742, DOI: 10.1080/14693062.2019.1704678

Williams, A. Options for Results Monitoring and Evaluation for Resilience-building Operations. Scoping Paper. April 2016. World Bank.

Appendix A

Table A.1: Relationships between DAOs and obligations under international climate change adaptation-related agreements.

Generic Desired Adaptation Outcomes (DAOs) ***'Inputs' to enable effective adaptation***		**International agreement goals, targets, impacts and indicators that will be achieved/met by reporting/tracking under each DAO**
G1	Robust/integrated plans, policies, and actions for effective delivery of climate change adaptation, together with monitoring, evaluation and review over the short, medium and longer-term.	**A-INDC goal 1:** Develop a NAS and begin operationalisation as part of implementing the National Climate Change Response Policy for the period 2020 to 2025 and for the period 2025 to 2030. **A-INDC goal 2:** Take into account climate considerations in national development, sub-national and sector policy frameworks for the period 2020 to 2030. **A-INDC goal 4:** Develop an early warning, vulnerability and adaptation monitoring system for key climate vulnerable sectors and geographic areas for the period 2020 to 2030 and reporting in terms of the NAS with rolling five-year implementation periods. **SDG indicator 13.1.1 under target 13.1:** Number of countries with national and local disaster risk reduction strategies. **SDG indicator 13.2.1 under target 13.2:** Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production (including a national adaptation plan, nationally determined contribution, national communication, biennial update report or other). **Sendai target E:** Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.
G2	Appropriate resources (including current and past financial investments), capacity and processes (human, legal and regulatory) and support mechanisms (institutional and governance structures) to facilitate climate change adaptation.	**Financial goal under Paris Agreement**: Direct global finance flows (including private finance) towards low greenhouse gas and climate resilient investment. **A-INDC goal 3:** Build the necessary institutional capacity for climate change response planning and implementation for the period 2020 to 2030. **A-INDC goal 6:** Communication of past investments in adaptation for education and awareness as well as for international recognition. **SDG indicator 13.1.1 under target 13.1:** Number of countries with national and local disaster risk reduction strategies. **Sendai target F:** Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030.
G3	Accurate climate information (e.g. historical trend data, seasonal predictions, future projections, and early warning of	**Temperature goal under Paris Agreement**: Hold global temperature increase below 2ºC above pre-industrial levels while pursuing 1.5ºC target.

	extreme weather and other climate-related events) provided by existing and new monitoring and forecasting facilities/networks (including their maintenance and enhancement) to inform adaptation planning and disaster risk reduction.	**A-INDC goal 4:** Develop an early warning, vulnerability and adaptation monitoring system for key climate vulnerable sectors and geographic areas for the period 2020 to 2030 and reporting in terms of the NAS with rolling five-year implementation periods. **SDG indicator 13.3.1 under target 13.1:** Number of countries that have integrated mitigation, adaptation, impact reduction and early warning into primary, secondary and tertiary curricula. **Sendai target G:** Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.
G4	Capacity development, education, and awareness programmes (formal and informal) for climate change adaptation (e.g., informed by adaptation research and with tools to utilise data/outputs).	**A-INDC goal 3:** Build the necessary institutional capacity for climate change response planning and implementation for the period 2020 to 2030. **A-INDC goal 6:** Communication of past investments in adaptation for education and awareness as well as for international recognition. **SDG indicator 13.3.1 under target 13.1:** Number of countries that have integrated mitigation, adaptation, impact reduction and early warning into primary, secondary and tertiary curricula. **SDG indicator 13.3.2 under target 13.3:** Number of countries that have communicated the strengthening of institutional, systemic and individual capacity-building to implement adaptation, mitigation and technology transfer, and development actions. **Sendai target F:** Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030.
G5	New and adapted technologies/knowledge and other cost-effective measures (e.g. nature-based solutions) used in climate change adaptation.	**A-INDC goal 6:** Communication of past investments in adaptation for education and awareness as well as for international recognition. **SDG indicator 13.3.2 under target 13.3:** Number of countries that have communicated the strengthening of institutional, systemic and individual capacity-building to implement adaptation, mitigation and technology transfer, and development actions. **Sendai target F:** Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030.
G6	Climate change risks, impacts and vulnerabilities identified and addressed.	**A-INDC goal 5:** Development of a vulnerability assessment and adaptation needs framework by 2020 to support a continuous presentation of adaptation needs. **SDG indicator 13.1.2 under target 13.1:** Number of deaths, missing persons and persons affected by disaster per 100,000 people. **Sendai target A:** Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020 and 2030 compared to 2005-2015. **Sendai target B:** Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020 and 2030 compared to 2005-2015. **Sendai target C:** Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030.

‘Impacts’ of adaptation interventions and associated measures		**International agreement goals, targets, impacts and indicators that will be achieved/met by reporting/tracking under each DAO**
G7	Systems, infrastructure, communities and sectors less vulnerable to climate change impacts (e.g., through effectiveness of adaptation interventions/response measures).	**Global adaptation goal under Paris Agreement**: Enhancing adaptive capacity, strengthening resilience/reducing vulnerability to climate change. **Temperature goal under Paris Agreement**: Hold global temperature increase below 2ºC above pre-industrial levels while pursuing 1.5ºC target. **UNCCD indicator S-1 under expected impact 1.1 and 1.2:** Decrease in numbers of people negatively impacted by the processes of desertification, land degradation and drought. **UNCCD indicator S-2 under expected impact 1.1 and 1.2:** Increase in the proportion of households living above the poverty line in affected areas. **UNCCD indicator S-3 under expected impact 1.1 and 1.2:** Reduction in the proportion of the population below the minimum level of dietary energy consumption in affected areas. **UNCCD indicator S-4 under expected impact 2.1 and 2.2:** Reduction in the total area affected by desertification, land degradation and drought. **UNCCD indicator S-5 under expected impact 2.1 and 2.2:** Increase in net primary productivity in affected areas. **UNCCD indicator S-6 under expected impact 3.1:** Increase in carbon stocks (soil and plant biomass) in affected areas. **UNCCD indicator S-7 under expected impact 3.1:** Areas of forest, agricultural and aquaculture ecosystems under sustainable management. **UNCCD indicator S-8 under expected impact 4.1 and 4.2:** Increase in the level and diversity of available funding for combating desertification/land degradation and mitigating the effects of drought. **UNCCD indicator S-9 under expected impact 4.1 and 4.2:** Development policies and measures address desertification/land degradation and mitigation of the effects of drought. **UN Habitat strategic result under the focus area on urban planning and design:** City, regional and national authorities have implemented policies, plans and designs through a participatory process including all different actors, such as civil society and poor people, for more compact, better integrated and connected cities that foster equitable sustainable urban development and are resilient to climate change. **Sendai target D:** Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030.
G8	Non-climate pressures and threats to human and natural systems reduced (particularly where these compound climate change impacts).	
G9	Secure food, water and energy supplies for all citizens (within the context of sustainable development).	