

The Extent of the Inclusion and Consideration of Extreme Climate Events and Health in South African Policies; The Case of eThekwin

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DECLARATION

I, Charné Amy Meyer (1862115), hereby declare that this is my own original work unless indicated and acknowledged otherwise. This study is being submitted for the Degree of Master of Science in Geography to the University of the Witwatersrand, Johannesburg. This study has not previously been submitted, in part or in full, towards any other degree or examination, at this or any other university.



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ABSTRACT

Climatic changes over southern Africa include the increased frequency and intensification of Extreme Climate Events (ECEs) which exacerbate health risks within vulnerable low- and middle-income countries. Examples of health impacts from ECEs include water-, food-, and vector-borne diseases, morbidity, and mortality. Increased interest in ECEs since the beginning of the 21st century strengthened the recognition of the impact thereof on health. Therefore, it is important to analyse policy documents to determine the extent to which they include and comprehend these themes to prepare for and address negative ramifications. This study aims to explore the scope to which policy documents relevant to eThekweni, mention and deliberate the ECE-health nexus. This exploration of existing policies allows a contribution to the nascent literature around the ECE-health intersection and is indicative of possible areas of corrective strategy. This is conducted through a review of relevant policy documents, interviews with key stakeholders, and the analysis of secondary climate and health interview data. Findings reflect a 50% recognition of the ECE-health intersection in policy documents. Stakeholders acknowledge the importance of policy documents recognizing this interconnection. Notably, stakeholders are not aware of such policy documents that currently exist but identify barriers to these policy documents being updated and upheld. Hence, the Municipality does have adaptation strategies in place however, improvements thereof are necessary. Examples include the need for short-term adaptation planning, improved policy implementation, and community education. The lack of such work would exacerbate health concerns and add significant strains on the health sector.

Keywords: policy, Extreme Climate Events, health, eThekweni, adaptation

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LIST OF ACRONYMS AND ABBREVIATIONS

AR6: IPCC Sixth Assessment Report

CBD: Central Business District

CDC: Centre for Disease Control

CoLs: Cut-off Lows

DCCS: Durban Climate Change Strategy

DMA: Disaster Management Act

DoH: Department of Health

DRM: Disaster Risk Management

ECE: Extreme Climate Event

ENBEL: Enhancing Belmont Research Action

ETE: Extreme Temperature Event

GDP: Gross Domestic Profit

HFA: Hyogo Framework for Action

HiAP: Health in All Policies

HIV/AIDS: Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome

IDP: Integrated Development Plans

IGR: Inter-governmental relations

IPCC: Intergovernmental Panel on Climate Change

IPRR: Investigation Process Research Resources

INDC: Intended Nationally Determined Contribution

ISB: International Society of Biometeorology

KZN: KwaZulu-Natal

MEC: Members of the Executive Council

NAS: National Adaption Strategies

NCCRP: National Climate Change Response White Paper

NDC: Nationally Determined Contribution

NDMF: National Disaster Management Policy Framework

NFCS-SA: National Framework for Climate Services

Policy: Used by a variety of participants (politicians and the public alike) to shape the organization of public life (Colebatch, 2009). The term ‘policies’ throughout this study is used broadly to refer to various documents like legislation, governmental reports, policy documents, strategies, and published guidelines.

SAMRC: South African Medical Research Council

SAWS: South African Weather Service

SDG: Sustainable Development Goal

SLR: Sea Level Rise

TB: Tuberculosis

UNFCCC: United Nations Framework Convention on Climate Change

USA: United States of America

WHO: World Health Organisation

WW2: The Second World War

CHAPTER 1: INTRODUCTION



(eThekweni Highlights, 2023)

1.1 Background

Climate change in southern Africa is likely to exacerbate existing health risks, indicating the need to understand projections and adaptation strategies of vulnerable developing regions (Wright *et al.*, 2021a,b). An increased interest in connections between climate change and ECEs in the 21st century has emphasized the intensification of these events (Kreslake *et al.*, 2018; IPCC, 2023). Climate extremes can be identified as brief and unusual meteorological events characterized by specific consequences (e.g., effects on health) and climatic features (Catalano *et al.*, 2019). These effects on health resulting from ECEs amplify vulnerabilities such as escalating heat stress and communicable diseases among others (Kreslake *et al.*, 2018; Berrang-Ford *et al.*, 2021; IPCC, 2023). If adaptation strategies for developing regions are not adequate there will be unprecedented strains across all aspects of the health sector (Wright *et al.*, 2021b).

The risks and vulnerabilities of climate change and ECEs on health will increase further if important documentation, such as policies, does not include themes of climate change, ECEs, and health (Catalano *et al.*, 2019; Wright *et al.*, 2021b). The right to health (South African Human Rights Commission, 2004) is comprised out of the absence of disease and the state of wholeness mentally, physically, and socially in the 1946 constitution of the World Health Organization (WHO). The WHO reflects the importance of this right through its framework for public health policies, called Health in All Policies (HiAP; WHO, 2014). Considering the human right to health and the threat thereof under intensifying ECEs due to the advancement of climate change, it can be concluded that the state is obligated to recognise, generate, and uphold

policies that protect the right to health (South African Human Rights Commission, 2004).

Considering the projections of climate change in South Africa (Engelbrecht *et al.*, 2015; IPCC, 2023) and the resulting vulnerabilities of health, the intersection between ECEs and human health should be more recognised in the governmental and developmental policy documents of South Africa as part of adaptation efforts. For this reason, it is important to analyse policy documents to determine the scope to which they comprehend, prepare for, and address negative ramifications (Nalau and Verrall, 2021).

1.2 Rationale

There is a critical gap in scientific research that considers the responsibility of policy as a catalyst for climate change adaptation efforts (Catalano *et al.*, 2019). Policies guide the organisation of daily life, assisting with decision-making, management, and compliance with laws and protocols (Colebach, 2009). In this study, the term ‘policies’ is used broadly to refer to legislation, policy documents, governmental reports, and published guidelines. These documents collectively are an important part of adaptation efforts and should be analysed to identify the degree to which climate change, ECEs, and the impacts on health are recognised in policy. Exploring the extent to which policy documents consider the impact on health from climate change can contribute to the nascent literature and assist in corrective strategies (Wright *et al.*, 2021b). KwaZulu-Natal (KZN) is not an exception regarding climate impacts, for example, Cut-off Lows (CoLs) are frequent due to the southern jet stream split into polar and sub-tropical axes (Leuci *et al.*, 2022). These CoLs have devastating impacts

- such as the most recent flooding in 2022 which resulted in approximately 435 deaths and 40,000 people's lives 'severely disrupted' (Gumede, 2022). Policies applicable to vulnerable regions should not only include and consider these themes but should assist in implementing the necessary strategies to limit risk and vulnerabilities. Hence, there is a need to analyse policy documents applicable to KZN to develop an understanding of how many recognise and discuss climate change, ECEs, and health, individually or collectively, before reviewing potential implementation issues.

1.3 Aim and Objectives

This study aims to find the extent to which key concepts (ECEs and their impact on health) are accounted for in policy documents that have a bearing on the eThekweni Municipality. To achieve the aim of this dissertation the following objectives will be used:

- 1) Sourcing and exploring the governmental national, provincial, and municipal policy documents in the broad domains of climate change, ECEs, health, and developmental planning, that are relevant to eThekweni. This is to find the degree to which climate change, ECEs, and impacts on health are included in sourced policy documents, through document analysis. This includes assessing which concepts individual policy documents contain, and the degree to which each concept is included.
- 2) Tabulating the recognition and possible absence of the study's key concepts using the sourced documents and the analysis. This considers 1) General information of relevant policy documents for eThekweni (Titles, implementation dates, statuses, and levels) and 2) Quotations from

throughout the policy that confirm the recognition of this study's key concepts. Thereby creating an opportunity to evaluate how policy could be further developed and assist more comprehensive practice.

- 3) Gather input from key informants with primary and secondary interview data around the relation to policy deficiencies such as the awareness of relevant policy documents, recognition of key concepts, collaboration, capacity (resource and human), and barriers. Thus, reviewing stakeholders' understanding and knowledge of relevant policy documents.

1.4 Structure of Dissertation

This dissertation follows seven chapters; the first, [Chapter 1: Introduction](#) includes the study's background, rationale, and objectives. [Chapter 2: Literature Review](#) reflects on the published literature. To begin, an introduction is given before reflecting on published research and literature that considers: the general ways climate impacts health; climate change impacts under ECEs and the health effects thereof; policy, climate change, ECEs, and health in adaptation efforts; and the South African policy landscape. The review of these aspects of the literature within this dissertation outlines this study's contribution to science. Thereafter, [Chapter 3: Study Site](#) describes the study region; eThekweni, KZN, South Africa. This chapter's introduction reflects on general social aspects of the Municipality including the vulnerability thereof. This is followed by the geographical location and environmental setting of the region before considering the regions populous. Afterward, the eThekweni climate is studied with reference to the ECEs the area experiences. The chapter ends with the recognition of the locale's future climate change projections. [Chapter 4: Methodology](#) begins with an introduction that outlines the study's methods and considers why these methods are

suitable. The chapter then reflects on the study design before explaining the methodologies behind the three sets of data that this study utilized. Lastly, a review of the ethical information of the study and the conclusion. Following, [Chapter 5: Results](#) begins with a brief introduction before delving into the results of each set of data: ENBEL, interview, and policy. The ENBEL data considers participants' reflections on: ECEs and policy, ECEs and health, and general reflections on climate and health. Interview data considers participants' feedback on why this nexus is important in policy, who is responsible therefore, what policy documents are they aware of and the scope of these policies, barriers to this nexus being included in policy, and a reflection of the eThekweni policies. In conclusion, this chapter gives the results of the policy data collected in which the inclusion of this study's themes are considered. The second last chapter, [Chapter 6: Discussion](#), is the coalescence of this study's previous chapters to give a coherent narrative on the results, literature, methods, and study objectives. The chapter has an introduction before reviewing the South African policy framework, the policy coverage of ECEs and health, and the limitations of this study. Finally, [Chapter 7: Conclusion](#) gives a synthesis of this study through the main findings, achievements of the aim and objectives, the implications of this research, and recommendations for future research.

CHAPTER 2: LITERATURE REVIEW



(eThekweni Landscape, 2018)

2.1 Introduction

Comprehending the intricate correlation between ECEs, health, and policy begins with situating this study within the published literature. Firstly, a short reflection on biometeorology gives a historical perspective of the evolution of scientific research that identified the climate and health nexus. This brief recognition of biometeorology creates a foundation to understand that climate impacts health in a variety of ways (Landman *et al.*, 2020; Liu *et al.*, 2021; Motlogeloa and Fitchett, 2023). However, this study does not focus on the way in which long-term ambient climate influences health but a specific sub-section thereof, namely ECEs. It is logical to assume that if the climate affects health, then extreme climates will have a more serious impact thereon. Hence, it is necessary to reflect on the literature that recognises various ECEs impacting human health (Bell *et al.*, 2018; Butsch *et al.*, 2023). Considering that global climates differ, and projected ECEs are also region specific, the chapter focuses on the ECEs experienced in eThekweni alongside the health implications thereof. Thereafter, the chapter focuses on the significance of policies in adaptation efforts (Catalano *et al.*, 2019; Hughes, 2020; Bonnet and Birchall, 2023) and the policy landscape of South Africa. Thereby, creating an opportunity for increased awareness, preparation, and management for associated risks (Burton *et al.*, 2004; Kearl and Vogel, 2023; Khavhagali *et al.*, 2023).

2.2 Climate Impacts on Health

The intersection between the health of living organisms and climate is an archaic concept that can be traced back some 2400 years ago; to ancient Greece and Hippocrates, the father of allopathic medicine (Kevan, 1980; Horowitz, 2002; Curić *et al.*, 2022). Hippocrates argued in his work that climate and seasonal shifts are

important when understanding and treating ailments to health, which led to the expectation that health experts must considering this intersection (Kevan, 1980; Horowitz, 2002; Curić *et al.*, 2022). In the ninth century, a Persian physician named Abu Bakr-al-Rāzī explored the impact of climatic factors on the spread of diseases and the seasonality of disease (Bouma, 1987). During the late 18th and early 19th centuries, several researchers conducted statistical work around health biometeorology (Bouma, 1987). After the Second World War (WW2) research in this field considered more specific meteorological variables like that of high and low temperatures (Bouma, 1987). However, Franz Linke's (1878-1944) work was the beginning of the formal introduction of the subject of medical meteorology in academia, which later led to the concept of biometeorology (Tromp, 1963; Motlogeloa and Fitchett, 2023). In the 1920s meteorologists began to make great strides in interpreting atmospheric movements correlated to the onset of some diseases (Motlogeloa and Fitchett, 2023). The theoretical concept that climatic fluctuations trigger and exacerbate illness was later argued in the scientific work of experts such as de Rudder (1931) and Petersen (1935) amongst others (Motlogeloa and Fitchett, 2023). However, this field of study was officially formalized in 1956 when a Dutch biometeorologist named Solco Walle Tromp (1909-1983) established the International Society of Biometeorology (ISB; Kevan, 1980; Motlogeloa and Fitchett, 2023). The ISB stressed the interdisciplinary quality of biometeorology, and its international positioning encouraged work in various fields that contribute to human biometeorology (Bouma, 1987). Thus, currently, biometeorology is classified as the field of study concerned with the relations between living organisms and their surroundings, with a sub-branch of human biometeorology focused on human health (Tromp, 1977; Curić *et al.*, 2022; Motlogeloa and Fitchett, 2023). Biometeorology and its sub-branches are

continuously growing multidisciplinary fields of study that come from the intersection of different disciplines, for example, that of meteorology and biology (Horowitz, 2002; Folk, 2013).

Having considered the formation of biometeorology and the work of the physicians associated with it, modern biometeorology studies can be explored. For example, a recent study reviewed ISB publications that recognise climatic impacts on health - 14 groups of diseases were recognised: psychiatric, neurological, bacterial, cardiovascular, vector-borne, respiratory, skin, intestinal, rheumatic, genetic, cerebrovascular, renal, metabolic and others like that of measles (Motlogeloa and Fitchett, 2023). Thus, more commonly modern research shows that climate can directly and indirectly impact health in a variety of ways (Wright *et al.*, 2014a; Butsch *et al.*, 2023). To explain further; the 'common cold' or 'flu' is well associated with winter seasons (Motlogeloa *et al.*, 2023), heavy precipitation can increase asthmatic attacks (Rai *et al.*, 2023), the increased pollen in springtime is well associated with increased allergies (Hájková *et al.*, 2023), temperatures cause shifts in blood pressure (Li *et al.*, 2023), and pain can be associated with different types of weather (Gyöngyi *et al.*, 2023). There is a significant quantity of evidence that health is influenced by various characteristics of the climate, specific to different regions (Motlogeloa and Fitchett, 2023).

2.3 Climate Change Impacts – ECEs and Health

It is important to recognize that the climate will continue to change globally due to anthropogenic influences, and thus health impacts will increase (Wright *et al.*, 2014b; IPCC, 2023). These climatic shifts have resulted in the geographical shift, and

increased frequency and intensification of ECEs (Bell *et al.*, 2018; Butsch *et al.*, 2023; IPCC, 2023). ECEs result in direct and indirect health implications (Wright *et al.*, 2014b; Butsch *et al.*, 2023). For example, between 1969 and 2018 there were approximately 10,000 ECEs globally which resulted in over two billion deaths (Tong *et al.*, 2022). ECEs include extreme temperatures (heat waves and cold snaps), droughts, flooding, storm surges, intense precipitation, wildfires, and tornadoes (Bell *et al.*, 2018; IPCC, 2023). The interconnections between ECEs and health are complex and varies across local environmental and societal factors (Bell *et al.*, 2018; IPCC, 2023). This intersection between climate change, ECEs, and health alongside adaptation efforts needs more research, especially when considering regional differences (Davidson *et al.*, 2003; Bell *et al.*, 2018; Wright *et al.*, 2021b). The lack of which will cause an increase in health effects and add strain on the health sectors (Wright *et al.*, 2021b).

When focusing on sub-Saharan Africa there is a lack of information regarding health risks under climate change (Wright and Norval, 2020). The health of the South Africans populace is at risk as climate change threatens the overall well-being of citizens given that the country is a developing nation with a lower adaptive capacity (Chersich *et al.*, 2018; Romanello *et al.*, 2021). Additionally, South Africa is exposed to a wide range of ECEs, including tropical cyclone-related cloud bands, CoL-induced floods, droughts, tornadoes, and an increase in temperatures twice as fast as the global rate (Engelbrecht *et al.*, 2015; Catalano *et al.*, 2019; Tong *et al.*, 2022). These events have been overlooked, creating various health implications like malnutrition, vector-borne diseases, morbidity, and mortality concerns amongst others (Wright *et al.*, 2021). However, as previously noted, ECEs and their influence are particular to specific

regions – therefore, considering the ECEs of South Africa overlook the impacts on local regions.

Hence, it is beneficial to consider the ECEs within the eThekweni region specifically. eThekweni experiences a range of ECEs as a feature of its geographic position (Tyson and Preston-Whyte, 2000; Tong *et al.*, 2022). Flood events have occurred because of both warm-cored tropical depressions and storms, and cold-cored CoLs (Mashao *et al.*, 2022). Coastal flooding has also occurred because of seawater inundation during storm surge events (Mather and Stretch, 2012). The region is exposed to drought events resulting in water shortages for the Municipality (Cole, 2016; Papayya, 2022). Both extreme heat and extreme cold events have been recorded for eThekweni (Jagarnath *et al.*, 2020; Mashao *et al.*, 2022). Finally, while less common, tornadoes have also been recorded within the region (D'Abreton, 1991).

Climate change model output projections for eThekweni reveal a range of implications including increases in frequency and intensity of droughts and floods, vector-borne diseases, changes in geographical distribution, extinction, infrastructural damage, coastal erosion, decreased water availability and food security, and increased heat stress (Friedrich and Kretzinger, 2012; eThekweni Municipality, 2019; eThekweni Municipality, 2022). These climate change concerns must be rooted in local realities that are focused on limiting and avoiding impacts from a range of issues like heavy precipitation, storm surges, heat waves, and Sea Level Rise (SLR; Lutz, 2018). The ECEs for eThekweni are defined and discussed below.

2.3.1 Floods

Flooding refers to an excess amount of water released from normal confines because of natural or anthropogenic modifications (Carter, 2012). A globally agreed definition strives to address confusion about the parameters of flood coverage to assist various stakeholders such as insurance companies, governments, and the public (Carter, 2012). Previous flood events in eThekweni have had catastrophic effects that impacted both the society and the economy (Figure 2.1).



Figure 2.1: eThekweni flood damage in April 2022 (Magidimisha-Chipungu, 2022).

For eThekweni, there are three primary causes of flooding. Firstly, eThekweni experiences CoLs which are low-pressure systems that develop over the southern region of South Africa from the westerly trough of cold air. These systems are characterised by the associated deep moisture convection which can lead to significant rainfall within short periods and flood risks (Singleton and Reason, 2007).

These have been evident along the coast of South Africa. For example, in September of 1987 there were severe floods in KZN when a CoL tracking east over the Northwest and Northern Cape Provinces induced precipitation in excess of 900mm within three days (Singleton and Reason, 2007; Extreme Events, 2019). More recently, on 11-12 April 2022 intense precipitation in KZN caused severe flooding and landslides resulting in 400 deaths, 12,000 homes destroyed, and 40,000 people displaced (Tandon, 2022).

Tropical storms and depressions are also causes of flooding in the region. A tropical depression is a warm low-pressure system with a maximum wind speed of 34 knots (NASA, 2023). In January 2021, the South African Weather Service (SAWS) warned of tropical cyclone Eloise possibly moving into the north-eastern lowveld of South Africa, in which the eThekweni Municipality warned community members to prepare for heavy downpours if the storm made landfall (Singh, 2021). This did not occur and the impacts of Eloise were largely restricted to Mozambique. The region does not currently experience the landfall of tropical cyclones, but with a poleward expansion and intensification of South Indian Ocean tropical cyclones (Fitchett, 2018), this is a concern under future climate change.

Sea level inundation from storm surges is a third cause of flooding for the Municipality (Friedrich and Kretzinger, 2012). Coastal inundation is defined as the covering of what would normally be dry land with water, a result of SLR, and storm surge flooding (NOAA Climate Program, 2020). eThekweni has 17 estuaries, 18 catchments, and 4000km of rivers, each vulnerable to coastal inundation (Friedrich and Kretzinger, 2012). Moreover, the Municipality has 407,500 sewer connections and 8790km's of wastewater pipeline networks which can be damaged by these flooding events

(Friedrich and Kretzinger, 2012). On 19-20 March 2007 KZN experienced storm swells of ~8.5m associated with a CoL which significantly increased coastal erosion and coastal property damage estimated at approximately R1 Billion (Figure 2.2; Smith *et al.*, 2007; Extreme Events, 2019).



Figure 2.2: 2022 landslide damage in KZN after floods (MacRobert, 2022).

The health implications of floods include but are not limited to; water and vector-borne diseases (e.g., cholera, malaria, typhoid), psychological issues, malnutrition, injury, water contamination, morbidity, animal bites, communicable diseases and mortality (Hajat *et al.*, 2005; Du *et al.*, 2010; Lee *et al.*, 2020).

2.3.2 Drought

On the other end of the hydro-climate spectrum, the region is also prone to droughts (Figure 2.3). There are different types of drought including: hydrological (van Loon, 2015), socioeconomic (Mehran *et al.*, 2015), meteorological (Palmer, 1965), and

agricultural (Liu *et al.*, 2016). Droughts are considered ‘creeping events’ as they develop slowly often unnoticed, with primary and secondary consequences (van Loon, 2015).



Figure 2.3: eThekwini and iLembe water source; Hazelmere Dam (Dlamini, 2015).

Commercial and subsistence farmers in eThekwini have already noticed drought conditions in their farming practices and the impact thereof on providing sufficient food (Diga, 2017; Knegtel and Naidoo, 2014). Multiple regions globally have water scarcity and availability issues due to increasing water demand, deteriorating water quality, and the impacts of climate change and variability on total rainfall (Mehran *et al.*, 2015). With the growth in population and industry increasing, socioeconomic drought is becoming a larger concern (Mehran *et al.*, 2015). Rainfall variability projections are uncertain however, an increase is expected in the frequency of extreme rainfall events (eThekwini Municipality, 2022). To prevent the socio-economic effects of these

droughts the region hopes to increase alternative water supply by 2050 and reduce water demand by 50% to protect against the risks of drought, as dry years will increase (eThekweni Municipality, 2019). In 2015, the eThekweni Municipality experienced drought conditions that led to numerous water awareness campaigns to educate community members on water conservation (Naidoo, 2015). In 2017 campaigns increased awareness of the importance of water socially and economically (Baillache, 2017).

Drought can indirectly influence respiratory and cardiovascular health concerns, malnutrition, water quality and quantity concerns, water and vector-borne diseases, skin infestations, diarrheal diseases, asthma, psychological concerns, heat-related illness (e.g., heat stroke), and dust-related illnesses (Sugg *et al.*, 2020; Weinhhammer *et al.*, 2021; Ayugi *et al.*, 2022). The increased duration and frequency of droughts in eThekweni will also have direct effects on food production and food access, thereby exacerbating existing food insecurity (eThekweni Municipality, 2019).

2.3.3 Heat Waves and Cold Snaps

Regarding temperature, eThekweni has experienced both extreme heat events (heatwaves) and extreme cold events (cold snaps) (Malinga, 2021; Simpson, 2021). Extreme Temperature Events (ETEs) include cold spells, cold waves, heatwaves, and warm spells which can have major implications on ecosystems and human health (van der Walt and Fitchett, 2021b). Under climate change, these events duration, frequency, and intensity are projected to increase (van der Walt and Fitchett, 2021a). Research regarding ETEs in South Africa can still significantly increase and fill gaps within the literature - such as examining and identifying trends (van der Walt and

Fitchett, 2021b). According to SAWS, a heatwave is a climatological event with temperatures at least 5°C warmer than the recorded mean of the hottest month for longer than three days within a specific location (van der Walt and Fitchett, 2021b). A cold snap (cold wave) is defined as a short period of colder-than-usual weather occurring when a cold front intrudes northwards occasionally producing snowfall (Archer *et al.*, 2010; van der Walt and Fitchett, 2020).

Cold waves can have devastating impacts on human health and ecosystems, and even under increasing mean temperatures these events will still occur (van der Walt and Fitchett, 2020). These events can constitute a significant threat because of urgent development needs, low adaptive capacity, and inadequate infrastructure, particularly in low- and middle-income regions like South Africa where little research on extreme cold events exists (van der Walt and Fitchett, 2020). KZN has experienced numerous cold snaps such as on 22 July 2002 which resulted in snowfall that caused deaths of people and livestock, and on 27 June 2007 there were numerous road closures, flight delays, and power outages due to heavy snowfall (van der Walt and Fitchett, 2020). Furthermore, in 2014 KZN experienced snowfall that posed a threat to property, road accessibility, and life, as temperatures dropped below 0°C (Smit, 2017; Malinga, 2021). More recently in 2021, KZN experienced another cold snap that resulted in snow and power outages (Xulu, 2021; IOL, 2021). Extreme cold conditions and temperatures have prominent impacts on tourism, recreational activities, phenological shifts, energy demand and infrastructure, ecosystems, agriculture, and human health (specifically in poor regions; van der Walt and Fitchett, 2020).

Cold snaps can result in a range of health outcomes including hypothermia which can result in respiratory and cardiovascular diseases and mortality (van der Walt and Fitchett, 2020; Weinhhammer *et al.*, 2021). Circulatory concerns, pneumonia, asthma, cerebrovascular issues, and mortality are also associated with the health risks of extreme cold (Ma *et al.*, 2021).

In the 21st century, extreme heat events (warm spells) are anticipated to increase in magnitude and frequency (Matooane, 2009). These conditions affect numerous organisms including animals. For example, on 8 November 2020 temperatures reached 40°C by 10 am, increasing to 45°C by that afternoon (Bega, 2020). These conditions resulted in the first heat-related mortality event that involved bats and birds in southern Africa, as at least 110 songbirds and fruit bats were found dead (Bega, 2020). More recently, SAWS had announced heatwave conditions in KZN with temperatures reaching above 40°C on 14th October 2021 when conditions further contributed to power outages in the area (Simpson, 2021), during which fans and air conditioning cannot be used to reduce temperatures.

If the worst-case scenarios occur, eThekweni will have a triple increase in average heatwaves by 2050 (Lutz, 2018). A further increase in humidity would aggravate people's perception of increased temperatures (Lutz, 2018). Everyone is vulnerable to temperature-related mortality however, measures are enhanced by various factors such as socioeconomic status, latitude, population composition, urbanisation, and pollution (Matooane, 2009). Notably, people with mental illnesses, manual labourers, immobile people, the elderly (>65), people with pre-existing diseases, and children are among those who are particularly vulnerable (Matooane, 2009). In this way, it is

important to understand projected temperature changes, as specific locations morbidity and mortality will be affected (Matooane, 2009). eThekweni is already giving guidance to policymakers to make informed decisions regarding climate change response (Matooane, 2009; eThekweni Municipality, 2020; Olanrewaju and Reddy, 2022).

The health impacts of extreme heat events include increases in morbidity, and respiratory and cardiovascular mortality (Matooane, 2009). Other health concerns incorporate adverse pregnancy and birth outcomes, decreased productivity and motor-cognitive abilities, mental health issues, dehydration, heat stress and stroke, and organ damage amongst others (Ebi *et al.*, 2021b).

2.3.4 Tornadoes

Tornadoes are violent rotating air columns that extend from the base of thunderstorms to the earth's surface, capable of destroying infrastructure, hurling objects in the air, and uprooting trees (de Coning and Adam, 2000; NOAA, 2019). Until the middle of 1998, a public perception prevailed that tornadoes do not occur in South Africa but occur exclusively in the United States of America (USA; de Coning and Adam, 2000). This perception changed during the 1998-1999 summer season, with tornadoes accompanying several severe storms over the eastern escarpment generating widespread interest through extensive news media coverage (de Coning and Adam, 2000). In 2021, The Citizen newspaper reported the loss of two lives and more than 20 injured after a tornado happened in KZN (The Citizen, 2021). The health implications of tornadoes include psychological impacts, chronic and acute stressors, and infectious diseases like acute respiratory infections, diarrheal diseases, dengue

fever, malaria, measles, viral hepatitis, tetanus, meningitis, typhoid fever, morbidity, and mortality (Kouadio *et al.*, 2012; Cong and Liang, 2022).

Identifying the ECEs that continue to impact the health of eThekweni citizens is also useful in revealing other vulnerabilities that place more risk on the region. Much like the rest of southern Africa, eThekweni has greater vulnerability considering the weakening health systems capacity and resilience, vulnerability factors including corruption, the heavy burden of disease, social inequality, poor leadership, and exposure pathways (Coovadia *et al.*, 2009; de Villiers, 2021; Ndebele *et al.*, 2021). For example, increased exposure to floods may put strains on the already weak health system's capacity and resilience by decreasing service delivery, thereby contributing to inequalities in healthcare distribution which in turn could contribute to an increase in climate-sensitive health risks such as increased morbidity and mortality rates (Figure 2.4).

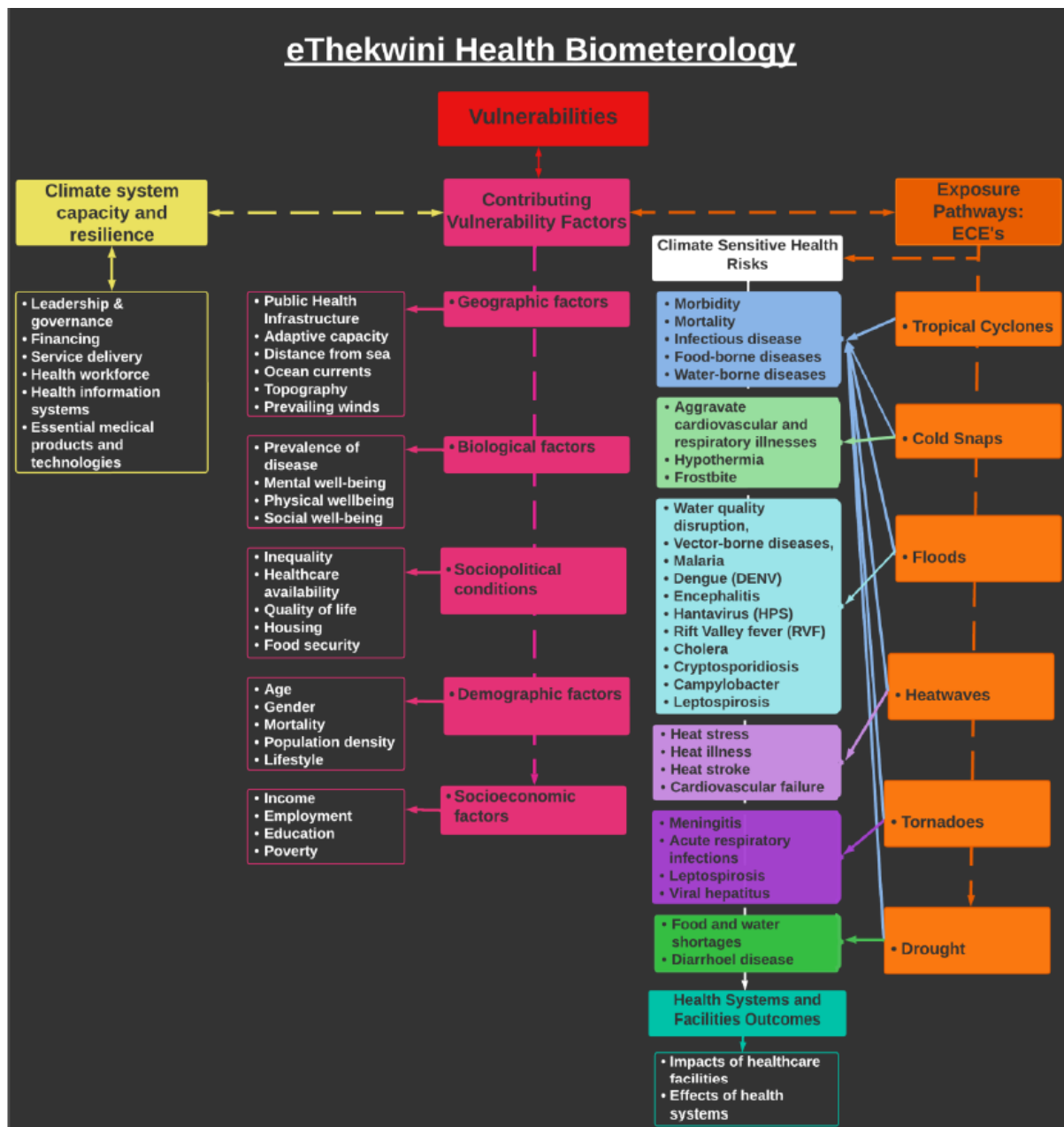


Figure 2.4: Health biometerology in eThekweni demonstrating health impacts of ECEs (after WHO, 2021).

Hence, the health sector alongside Disaster Risk Management (DRM) and other interconnected sectors plays a crucial role in leading the efforts to protect public health, for example through policy adaptation and increased recognition of climate change (Chersich *et al.*, 2018; Luke *et al.*, 2022; Tong *et al.*, 2022). Moreover, by specifically researching ECEs impact on health in South Africa, role-players such as

governments and policymakers are given evidence-based research to inform policy and decision-making (Kreslake *et al.*, 2018; Berrang-Ford *et al.*, 2021; Wright *et al.*, 2021).

2.4 Policies, Climate Change, ECEs, and Health

Proactive efforts to protect humanity are uncommon - for example, the global political agenda has only recently begun to include climate change after the increase in climate change evidence globally (e.g., increased ECEs; Biesbroek *et al.*, 2010; Khan *et al.*, 2016; Berrang-Ford *et al.*, 2021). The gaps in existing policies such as that of the ECE-health nexus increase the risks and vulnerabilities of health (Catalano *et al.*, 2019; Wright *et al.*, 2021b). A brief synopsis of the significance of this research is evident when reflecting on; 1) Global efforts of climate change recognition and inclusion in policy, 2) Sub-Saharan efforts to include and consider climate change in policy, and 3) South African policy reflection and inclusion of climate change. In other words, although the policy recognition of climate change and ECEs have been slow, the current progress thereof gives rise to the seriousness thereof. An active role of national governments can assist with the integration and coherence of climate-sensitive policy which is vital for information and awareness for timely support, action, and tools in adaptation strategies (Biesbroek *et al.*, 2010). Furthermore, research on these policy documents contributes to the global recognition of policies as a tool in climate change sustainability (Catalano *et al.*, 2019).

Policy has rapidly become a tool to adapt and prepare for the effects of climate change (Catalano *et al.*, 2019; Hughes, 2020). International efforts including the Intergovernmental Panel on Climate Change (IPCC; IPCC, 2023), the Kyoto protocol

(Franco *et al.*, 2008; Biesbroek *et al.*, 2010; Khan *et al.*, 2016), and Europe's National Adaption Strategies (NAS) amongst others, have assisted in policy recognising climate change (Biesbroek *et al.*, 2010). The NAS for example commits to the improvement of policies by recognizing climate change and the preparations thereof, however human health as a vulnerable sector has not been prioritised (Biesbroek *et al.*, 2010). The lack of policy documents inclusion of health as a central concern has led some NAS to suggest a revision of policy (Biesbroek *et al.*, 2010). Additionally, Pakistan has developed an action plan after considering their vulnerability to ECEs including heat increases, floods, droughts, and tropical cyclones that pose a heightened risk to health (Pakistan National Adaptation Plan, 2023). However, this would need to be multifaceted to include numerous sectors that crosscut one another, such as the impact of ECEs on health (Khan *et al.*, 2016). California has been praised for strong climate policy that is strengthened by national policies and climate science, nevertheless, these policies do not specifically give recognition to health too (Franco *et al.*, 2008). Generally, policy globally seems to still lack adequate recognition of climate change impacts and more specifically the intersection between ECEs and health (Biesbroek *et al.*, 2010; Khan *et al.*, 2016; Catalano *et al.*, 2019).

Keeping in mind the ECEs that South Africa and particularly eThekweni face, there is considerable need for relevant policy to address vulnerabilities (Engelbrecht *et al.*, 2015; Catalano *et al.*, 2019; Tong *et al.*, 2022). Examples of policy documents South Africa uses to guide climate change adaptation strategies include the National Climate Change Response White Paper (NCCRP), Climate Change Bill, National Framework for Climate Services (NFCS-SA), National Climate Change Adaptation Strategy, Presidential Climate Change Coordinating Commission and more locally the

eThekwini Integrated Development Plans (IDPs; Garland, 2014; eThekwini Municipality, 2020). However, the volume and quantity of research in South Africa is disproportionate to the threat posed by ECEs (Chersich and Wright, 2019). Notably, the health sector must take more responsibility not only as an integral sector in this nexus but in having the expertise for policy advocacy, implementing capabilities for systems-based approaches, and ability to identify effective interventions (Chersich and Wright, 2019). The cross-cutting nature of health biometeorology should consequently be reflected in policy to assist with adequate adaptation strategies (Khan *et al.*, 2016). Local (micro) efforts are vital in catalysing climate literacy at a provincial and national (macro) level (Roberts, 2008; Keskitalo and Preston, 2019). Health in policy can also benefit poverty alleviation and economic opportunities especially when encouraging governmental accountability for improved health and a reduction in health inequalities (Rispel *et al.*, 2009). In this way, research that considers health and climate within local policy documents may encourage greater-scale policy recognition too (Biesbroek *et al.*, 2010).

2.5 The South African Policy Landscape

South Africa is a constitutional democracy with a three-tier government system: national, provincial, and local (Mlambo and Maserumule, 2023; Education and Training Unit, 2023a; Western Cape Government, 2023). These three levels of government have executive and legislative authority in their spheres (South African Government, 2023). The South African constitution defines them as interrelated, interdependent, and distinctive, and further outlines each of the spheres' responsibilities (Simeon and Murray, 2001; Mlambo and Maserumule, 2023; South African Government, 2023; Western Cape Government, 2023). Each of these

branches of government has both an administrative and political arm – the administrative arm is the portion of the government that provides services and puts into effect policies and laws. The political arm generates the policies and laws (Western Cape Government, 2023).

Each of the tiers has a specific mandate relating to its formation and responsibilities. For example, the national government has three branches: Legislature, Executive, and Judiciary (Western Cape Government, 2023). The Executive sector includes the President, Deputy President, Cabinet ministers at the national level, the Premier, Members of the Executive Councils (MECs) at a provincial level, government departments, and lastly civil servants (Parliamentary Monitoring Group, 2023). Their responsibilities include developing, implementing, and upholding policy (Parliamentary Monitoring Group, 2023). Each of the nine provinces also has its legislature which can make provincial laws (Education and Training Unit, 2023a; Western Cape Government, 2023). Although they have these capabilities, neither provincial or local governments can do anything in contravention to the policies and laws of the national government (Education and Training Unit, 2023a). Part of the primary provincial role in the system is to deliver nationally determined policies and programs. South Africa is also divided into local municipalities which each has a council where decisions are made. Municipal staff and officials implement the municipal work (Education and Training Unit, 2023a). There is a Council developed out of elected members who are responsible for the approval of policies and by-laws for the specified region, and for passing the municipal budget yearly (Education and Training Unit, 2023a). Provincial governments and local governments depend on money, grants, and loans

received from the National Treasury (Madumo, 2015; Tau, 2015; Education and Training Unit, 2023a).

There are three different types of municipalities in South Africa: metropolitan, district and local - eThekweni falls under the first type (Education and Training Unit, 2023a; Mlambo and Maserumule 2023; Western Cape Government, 2023). In South Africa there are 278 municipalities, of which eight are metropolitan municipalities (Thornhill, 2014; Western Cape Government, 2023). Each Municipality is further divided into wards (Thornhill, 2014; Education and Training Unit, 2023a). The responsibility of each Municipality is to provide basic service delivery such as water and health, and promote community development and, safe and healthy environments (Thornhill, 2014; Mlambo and Maserumule, 2023; Western Cape Government, 2023). Local governments are subject to regulation by both national and provincial governments, as in many instances local responsibilities are closely related to provincial and national functions (Maluleke, 2019). Local governments can pass ordinances with the same legal force as provincial and national governments (Maluleke, 2019; Education and Training Unit, 2023b). All three spheres of government have limited capacity and resources to uphold responsibilities – this is especially the case for local and provincial governments, however, also happens at a national level (Simeon and Murray, 2001). These hindrances are budgetary as well as skill-based, as there are not enough skilled policymakers, administrators, and professionals which impedes effective development (Mlambo and Maserumule, 2023). Local government plays a critical role in South Africa's constitutional vision, especially in delivering governmental services and promoting development (Madumo, 2015; Mlambo and Maserumule, 2023). For

example, metropolitans have considerable capacity and have achieved a high level of autonomy from the national government.

It is therefore clear that the South African government is dependent on effective intergovernmental relations that feeds into the formation of policy documents. The Constitution in this way calls on cooperation rather than competition within intergovernmental relations (Maluleke, 2019). Additionally, making laws and policy documents is a slow process with numerous stages involved (Education and Training Unit, 2023b). Key issues are negotiated and debated before finalization and this process can take years before being implemented and its impact felt (Education and Training Unit, 2023b). It is thereby also important to clarify what a policy is; an outline of what the government hopes to achieve alongside the methods and principles to achieve them, while continuously subject to environmental influences and changes (Roux, 2002; Education and Training Unit, 2023b). A policy document is not the same as a law however, policy documents will often identify new laws needed to assist in achieving goals (Education and Training Unit, 2023b). It is also useful to note that the public cannot pass or create policies but can participate in the processes (Moosa, 2021). For example, after public hearings where relevant stakeholders have shared their opinions, a policy is drafted, reviewed, and sent to the national assembly and council of provinces (Thornhill, 2014; Moosa, 2021).

2.6 Conclusion

The ECE-health nexus is a sub-section of a much older field called biometeorology. Biometeorology has reflected on the impact's climate can have on health with current research still recognising this intersection (Motlogeloa and Fitchett, 2023). Notably,

under climate change the impacts on health will become more common as there will be an increase in the frequency and intensity of ECEs (IPCC, 2023). eThekweni is expected to have a range of ECEs that will impact health differently. These vulnerabilities need to be recognised and addressed to protect the right to health. One method is adaptation – more specifically the preparation to handle the ECEs impact on health through proactive preparation such as updating policy. This policy would assist in various aspects like increasing education, awareness, and timely support (Biesbroek *et al.*, 2010). To apply this adaptation strategy, it is first necessary to note the scope that policy currently recognizes this intersection (Nalau and Verrall, 2021).

CHAPTER 3: STUDY SITE



(Bhikha, 2016)

3.1 Introduction

This study focuses on the eThekweni Municipality, a major urban and economic centre in South Africa (ASSAF, 2011; Turpie *et al.*, 2021). The vulnerability and contribution to climate change of this metropolitan due to social, cultural, and economic capital include a large population (Donner and Rodriguez, 2008; ASSAF, 2011; eThekweni Municipality, 2022). The study site was selected due to the proactive efforts of the eThekweni Municipality in planning for and adapting to climate change (Roberts, 2010; Glavovic and Smith, 2014; Olanrewaju and Reddy, 2022). The local context shapes interventions and their implementations, however, the Municipality faces numerous challenges including a lack of transparency, finance and accountability, weak administrative capacity, fraud and corruption, poor governance structures and ineffective implementation strategies (ASSAF, 2011; Pillay and Mutereko, 2022). Therefore, it is necessary to outline the socioeconomic, institutional, spatial, and environmental characteristics of the Municipality (Pillay and Mutereko, 2022).

The Municipality has a heightened vulnerability to climate change as a coastal region that is already experiencing a wide range of ECEs, each of which are projected to intensify under climate change (eThekweni Municipality, 2014; Olanrewaju and Reddy, 2022; Tong *et al.*, 2022). From a health perspective, as for the rest of South Africa, the Municipality has a public healthcare sector operating in parallel to a private health sector, with policy pertinent to both and each of these (Meyer *et al.*, 2017). This chapter covers the environmental setting, human population, climate, and climate change projections in eThekweni. Therefore, providing a comprehensive approach to the environmental and social aspects of the Municipality.

3.2 Environmental Setting

The eThekweni Municipality is situated on the east coast of South Africa (La Guardia *et al.*, 2013; Olanrewaju and Reddy, 2022), ranging from 30° 96' 98" - 31° 22' 51" E and 29°08' 64" - 30°69' 50" S. The Municipality covers a land area of 2,292km², of which a 100 kilometres represents the busiest coastline in sub-Saharan Africa bordering the Indian Ocean (Corbella and Stretch, 2012; Olanrewaju and Reddy, 2022). The Municipality has a slightly undulating topography with an average elevation of 10.36m.asl, ranging from 0m.asl at the coast to 907m.asl at the top of Cameni Mountain (Ngie *et al.*, 2016; Sandham *et al.*, 2022).

The Municipality is divided into 103 wards, each of which are managed by a ward councillor. eThekweni has numerous private and public hospitals of which the majority sit along the eastern edge of the Municipality (Figure 3.1). Considering the social influences on the natural environment, the Municipality's spatial configuration is shaped by the consolidation of local authorities, apartheid ideology, modernism, national housing policy, and the power of major developers and local capital (Meth and Buthelezi, 2017; Sibiya *et al.*, 2018).

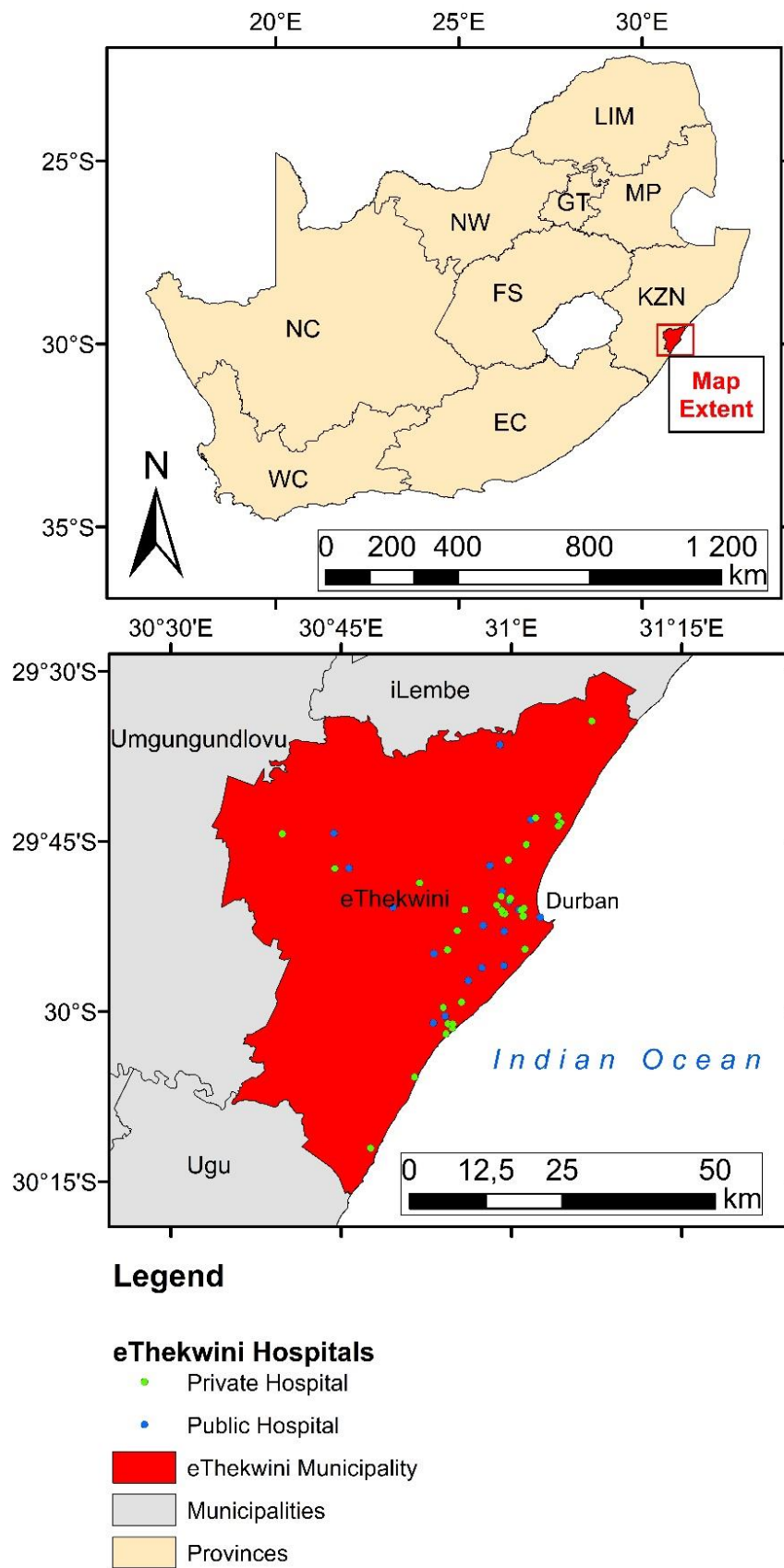


Figure 3.1: eThekweni Municipalities private and public hospitals.

As a result of Apartheid land planning, poorer groups are located on the Municipality's periphery (Figure 3.2; Mbatha and Mchunu, 2016; Sibiya *et al.*, 2018). The eThekweni neighbourhood has an outer rural region surrounding an inner upper/middle class, lower class, and township area (Figure 3.2; Hellberg, 2014; Sim *et al.*, 2016). In terms of land use, the region has a large rural periphery and a central urban core (Sibiya *et al.*, 2018). This portrays the impact of apartheid on the existing municipal layout and configuration.

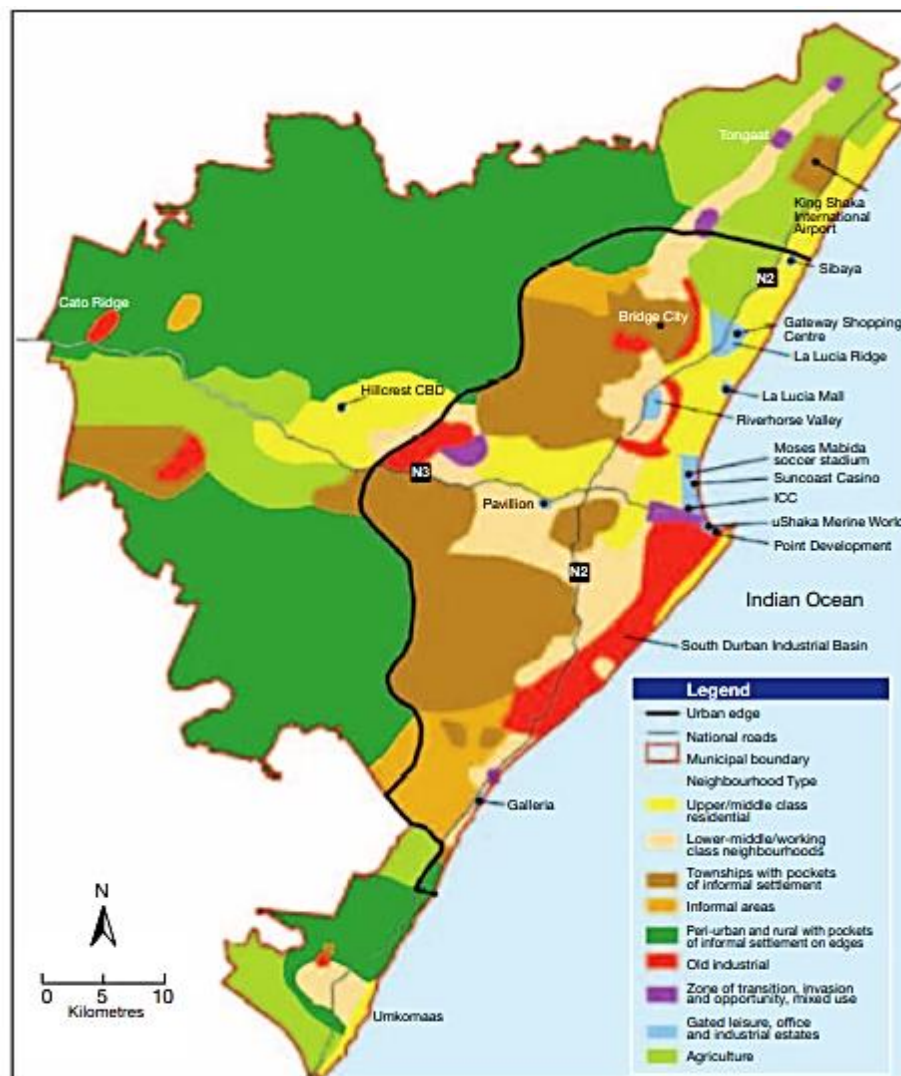


Figure 3.2: eThekweni land use (ASSAF, 2011: 101).

3.3 Human Population of eThekwini

In South Africa, the highest concentration of people are located in the Gauteng province, and in the coastal Municipalities of eThekwini and Cape Town (Archer *et al.*, 2010). Metropolitan areas such as eThekwini have had the largest growth in human population (Archer *et al.*, 2010). eThekwini has approximately 3.4 million people, increasing annually at a rate of 0.8% (Hellberg, 2014; Pillay and Mutereko, 2022). There are high levels of unemployment and poverty, with 18,7% unemployment rate and approximately over half of the Municipality's people living below the upper boundary poverty line (eThekwini Municipality, 2022).

In 2012, the municipal area had 289,251 (~8%) of its citizens considered illiterate (EPCPD, 2014). The IDP for the Municipality indicated the Gross Domestic Product (GDP) to be R210 Billion in 2012 which was 10.7% of the National GDP (EPCPD, 2014). In 2022 the Gini coefficient was at 0.62 (eThekwini Municipality, 2022). Within the Central Business District (CBD) there are high densities of people unlike the middle- and upper-income sections with low densities before the periphery populous, in which the human population density spikes within the townships (Musvoto *et al.*, 2016; Figure 3.3). eThekwini has a young community, in which in 2011 it was estimated that 25% of the total residents were under 15 years and over 64 years accounted for under 5% of the total populace (eThekwini Municipality, 2022). The region is characterised by low life expectancy, high infant mortality, and high dependency rates (Ashokcoomar and Naidoo, 2016). To further highlight the vulnerability of the citizens, approximately 41% of the Municipality's people live lower than the poverty line, 18.7% of this Municipalities citizens are unemployed, and there are 8,802 child headed households (CoGTA and eThekwini Municipality, 2020).

Additionally, in the indigent populace, there are backlogs in the service provisions and inadequate housing (Narsai *et al.*, 2013; Pillay and Mutereko, 2022).

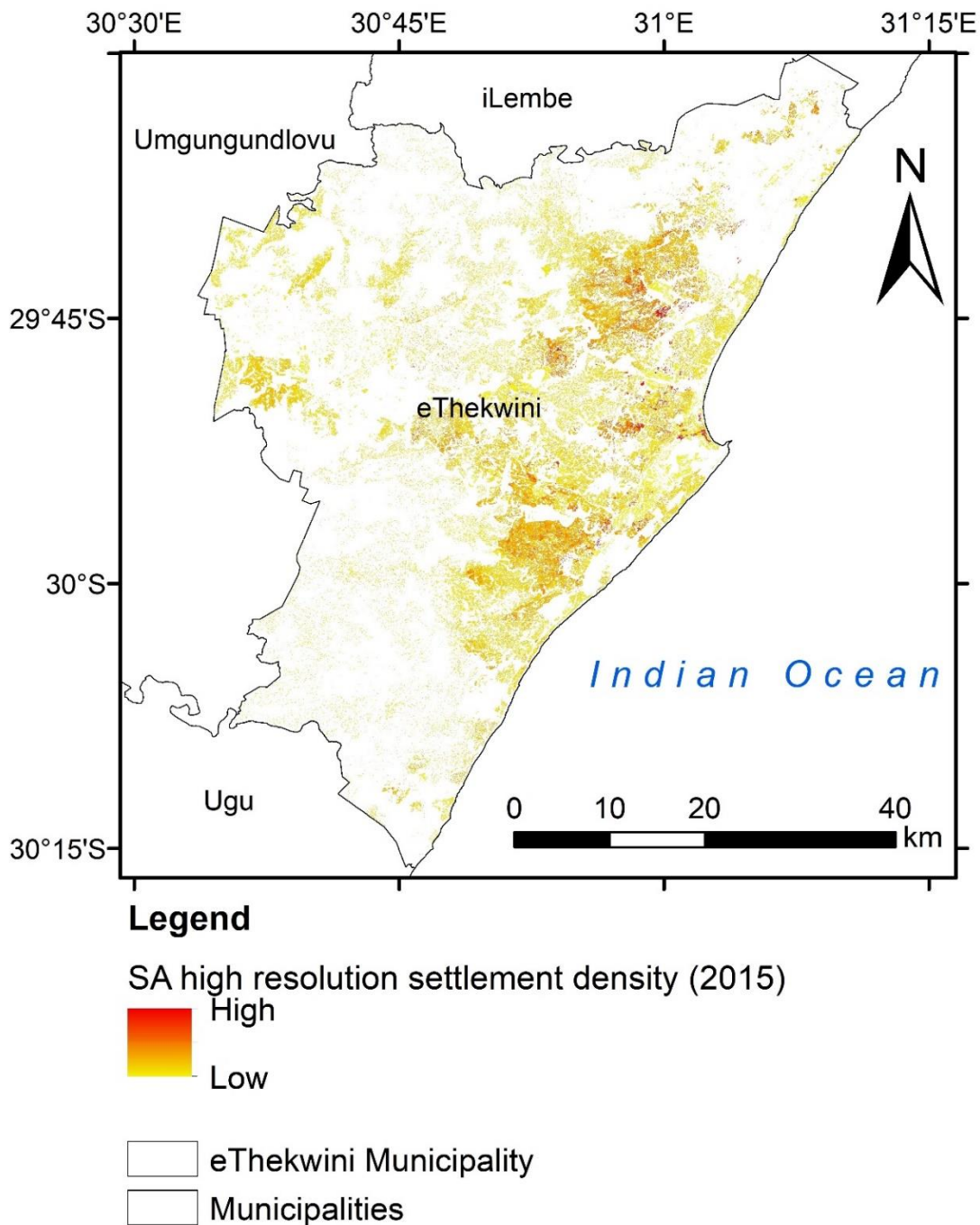


Figure 3.3: Settlement density in eThekweni.

3.4 Climate of eThekwini

eThekwini is characterised with a warm and moist subtropical climate (Koppen Geiger zone: Cfa) because of the latitude, low altitude, and proximity to the warm Indian Ocean (NOAA, 2013; Wavomba, 2019; Arnfield, 2022). Temperatures range from a highest $T_{\max}$ of 28°C and lowest $T_{\min}$ of 14°C with a mean annual temperature of 22°C (Jury and Buthelezi, 2022). The Municipality receives a mean annual rainfall of 850mm/yr, the majority of which falls in the summer months of November to March (Geographical Location and Climate, 2020; Durban Weather, 2022).

June is the driest month, with an average of 30mm of precipitation (Durban Climate, undated). In the eThekwini Municipality, the annual average wind speed and direction is south-easterly at 9 knots; there are strong winds from the southerly direction between March and December which shift to an easterly direction from December to March (Durban Summer Weather, undated; Windfinder, 2022). The southerly winds peak in November at 42% and the easterly peaks in January at 39% (Durban Summer Weather, undated). The windiest month is October with average wind speeds of 11 knots, however, from the end of January to August conditions are calmer - May being the calmest month with an average of 9 knots (Durban Summer Weather, undated).

eThekwini has variations in mean climate between locations, such as the effects of the urban heat island as well as wind differences when comparing the coastal and inland regions. The Durban metropolitan region experiences a major heat island over the centre of the city and smaller impacts around the region (Ngie *et al.*, 2016). In surrounding rural areas, there is more transpiration and water evaporation from the soil, alongside less heat retention and absorption, and increased water absorption

through the soil leading to a cooler effect compared to that of the urban area (Phillips, 2021). In the urban centre there is more heat retention, less water penetration in the ground, less plant transpiration, and water evaporation from soil, which leads to a 3-10°C increase in temperature over the urban sector (Phillips, 2021). Considering wind speed differences, wind speed increases as latitude increases within coastal regions, with an increase between 4.14 to 6.01 m/s (Rehman *et al.*, 2021). Much of the time, winds blow from north and north-westerly directions (Rehman *et al.*, 2021).

3.5 Climate Change Projections for eThekwini

The eThekwini Municipality climate change projections show impacts on temperature, water availability, SLR, agriculture, economy, rainfall, biodiversity, and health (Malinga, 2021; Lutz, 2018; Chari and Ngcamu, 2022). Depending on greenhouse gas emission reductions globally, the severity of the projected climate impacts in eThekwini varies (eThekwini Municipality, 2022). eThekwini is projected to face more flooding and intense storms, SLR, increased periods of drought, and increased temperatures (eThekwini Municipality, 2022). For example, climate models project under the lowest and highest emission scenarios that the average temperature of the region will increase between 0.8°C and 1.6°C respectively by 2050 (eThekwini Municipality, 2022). Projected average temperature increases will also result in increased evaporation rates which would create numerous risks such as reduced water quality, storage and irrigation, water supply insecurity, increased heat stress, increased frequency of droughts and floods, increased water and vector-borne diseases, consequences on food production and other negative ramifications (Friedrich and Kretzinger, 2012; Gumbi and Rangongo, 2018; eThekwini Municipality, 2022; Papayya, 2022). A 0.5m increase of the sea level would impact tourism and erode

beaches, yet SLR may range from 0,3-1m by 2100 depending on greenhouse gas emission scenarios (Mather and Stretch, 2012; eThekwini Municipality, 2022). In terms of agriculture, food production is expected to have critical challenges due to changes in rainfall, water availability, and temperature (Singleton and Reason, 2007; Matooane, 2009; Chari and Ngcamu, 2022). Lastly, the projected shifts of rainfall and temperatures will negatively influence health where for example, malaria areas will spread (ASSAF, 2011; eThekwini Municipality, 2022). These results indicate several risks in the future for the region.

The warmer and wetter conditions projected for Durban could result in more health impacts such as heat stress, heat-related and vector-borne diseases (e.g., malaria), and water-borne diseases (e.g., cholera): for example, people living in damp conditions may develop respiratory illness (Ingham *et al.*, 2019; eThekwini Municipality, 2022). Increased temperatures will also increase the rate and risk of food-borne illness as food may spoil faster (Brubacher *et al.*, 2020). With the increased frequency of ECEs, human well-being and safety will be influenced, particularly for the poor in informal settlements (Ziervogel and Frayne, 2011; Pasquini *et al.*, 2020).

3.6 Conclusion

eThekwini was chosen as a suitable study site for various reasons such as the proactive efforts of the Municipality around climate change and the regions current and projected ECEs. Much like the rest of South Africa, this region has various vulnerabilities around social and economic factors (eThekwini Municipality, 2022). The large human population and significant poverty levels add to the region's vulnerabilities when attempting to address and prepare for the impacts of ECEs. Although the region

has specific climate features in different areas, overall the climatic projections of the area are concerning. Some projections include increased temperatures and dry periods amongst others – of which all of these will have health impacts that will place further risk on the eThekweni Municipality (eThekweni Municipality, 2022).

CHAPTER 4: METHODOLOGY



(Saad, 2017)

4.1 Introduction

Previous studies have shown the need for further research in the field of health policy analysis (Araújo and Maciel, 2001). When policy documents are implemented, they need to be monitored and evaluated to inform the continuation or modification thereof, and to highlight valuable information for similar proposed policies (Patton *et al.*, 2016). The primary aim of this study is to determine the extent to which climate change, specifically ECEs, and their impact on health are accounted for in relevant policy documents for the eThekweni Municipality in the KZN province. The goal of policy analysis is to inform decision-makers and encourage enlightened discussion of public policy in the field of health and climate change, to assist in better policy adoption (Patton *et al.*, 2016). The content of this study contributes to the literature on the impact of ECEs on health, and to policy analysis in low- and middle-income countries (Walt and Gilson, 1994). This study uses qualitative information and various stakeholder perspectives within relevant sectors. This created a holistic understanding of relevant policy documents as well as the themes these included and excluded, as has previously been suggested in similar work (Yanow, 2007; Patton *et al.*, 2016).

This chapter outlines the methods used to obtain primary, secondary, and policy data used for the study. The chapter first considers the secondary data (ENBEL data) before the primary interview data and lastly the policy data. Methods are later discussed and presented in the same order as the results in the results chapter. Each of the three data sets are reflected upon, and data collection, processing, and analysis are reviewed. Lastly, ethical considerations for the study are detailed.

4.2 Study Design

The design of this study was informed by the work of Collins (2005), Owen (2014), Wagenaar (2015), and Baldwin *et al.* (2022), which integrated policy analysis data, secondary data, and primary data through interviews with stakeholders to understand the policymaking and policy application framework. As such, this study uses three separate sets of data; namely the ENBEL data, interview data, and policy data. The ENBEL data provided valuable information on experts' awareness of ECE policy documents in the field as well as useful questions and discussion topics around policy. Although these secondary data gave a good foundation to work from, it was necessary to obtain further information that was more specific to this study's aim and objectives. For example, the primary interview data were useful in obtaining policy documents around ECEs impacting health in South Africa and more specifically eThekweni. Furthermore, both sets of data together give a holistic understanding of policy documents within the field, thereby substituting the shortfalls of each set of data. Lastly, the policy data gives a direct evaluation of policy documents mentioned by both the secondary and primary data sets and allows for the review of the extent to which policy documents include the study's themes, thereby achieving the study's aim and objectives. The three data sets were generated to provide an accurate understanding and review of policy documents in the field.

4.3 ENBEL Data

The ENBEL data refers to a collection of semi-structured interviews, used as secondary data from the Horizon 2020 project (ENBEL, 2021). This study contributed to EU policymaking for health and climate change which coordinated a system of climate and health research internationally and was funded by the EU and Belmont

Forum (ENBEL, 2021). ENBEL aimed to assist with policy advice in the climate and health nexus to support resilience and adaptation through knowledge generation (ENBEL, 2021). The significance of these data lies in the reflection it gives on the importance of relevant policies related to the climate and health nexus alongside the opinions of policy experts within the field.

ENBEL used semi-structured interviews conducted between 7 December 2021 to 9 February 2022 with key informants that were health decision-makers at provincial and national levels of government. Before interviews, a list of persons to interview was established based on current networks available. Participants included an activist lawyer, city-level specialist, presidential climate commission spokesperson, adaptation specialist, governmental department representative, governmental health researcher, legal researcher, and NGO delegate. Participants were chosen to create a reasonable representation of key informants in policy for the health sector. Participants were sent a participant information sheet and consent form (*Appendix E*) before the interviews which conveyed details of the interview and information processes. Email and telephone correspondence took place to set up and schedule interviews. Additionally, if supplementary information was needed a Microsoft Teams meeting was set up before the interview to set up a time and explain details for the interview. The interviews were conducted online using Microsoft Teams. Interviews were recorded and transcribed first with Microsoft Teams; however, this was insufficient and was later transcribed by a team in London. Interviews were limited to an hour long. The interviews were semi-structured and questions were categorized into seven topics which included: interest in climate and health, influencing capacity, current policy gaps, collaboration network, current evidence gaps, COVID-19, and

policy alignment (*Appendix G*). The semi-structured nature of the interviews allowed the key informants to share information beyond what the questions asked which broadened the information received.

The secondary data obtained from the ENBEL interviews were used to formulate the primary data interview schedules as well as additional information for this study that creates a comprehensive view of stakeholder perceptions and opinions of policy around adaptation, climate change, ECEs, and health.

4.3.1 Data Acquisition and Processing

The ENBEL data was received on the 28th of February 2023 in Word format as individual interview transcripts for each participant. Each participant had their interview fully transcribed which was made available as secondary data for this study. None of the data received was redacted. To ensure these data were sufficient for this study, each transcription was read to ensure there was information that could be useful to this study.

4.3.2 Data Analysis

Thematic content analysis was used for the ENBEL interview data analysis. Thematic content analysis is used widely for qualitative data analysis and allows the arranging and communication of data in detail, alongside reflecting an in-depth understanding thereof (Braun and Clarke, 2006). Additionally, this type of analysis identifies and examines themes found within the data, specifically identifying significant themes to the research questions posed (Harper and Thompson, 2011; Maguire and Delahunt, 2017). The six-stage processes suggested by Braun and Clarke (2006) for thematic

analysis were used in this study to ensure methodological acceptability (Figure 4.1; Maguire and Delahunt, 2017).

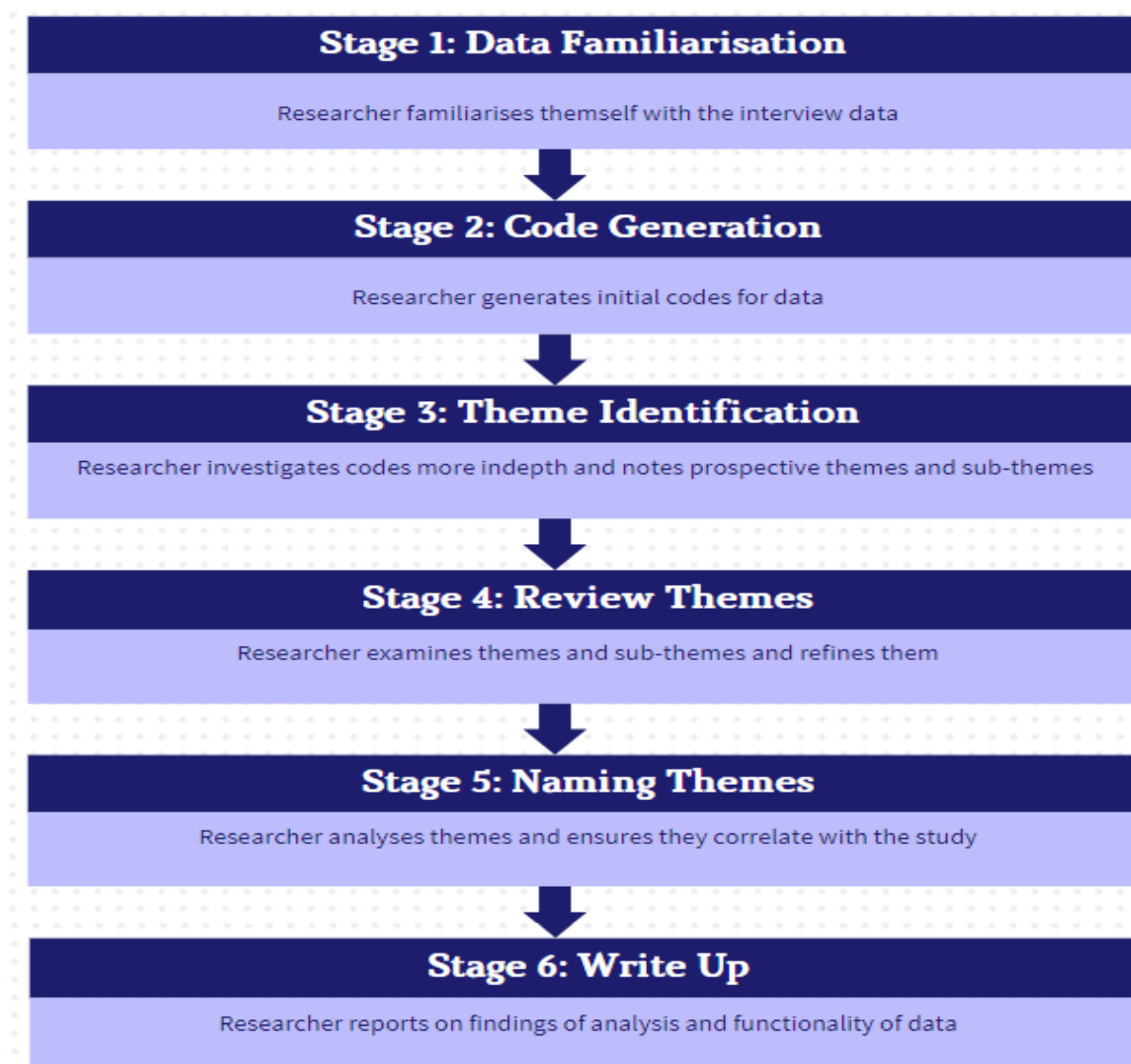


Figure 4.1: Braun and Clarke (2006) thematic analysis stages.

In the first stage the transcripts were read objectively, the second reading of each included the researcher highlighting topics of interest (Braun and Clarke, 2006). This was done manually as the preferred method for the researcher. Once topics of interest had been highlighted and a good comprehension of the transcripts was obtained, key themes were written down in the fields of climate, health, and interlinkages. Because

this was secondary data it was critical to distinguish the valuable and useful information early on so as not to confuse it with additional information that was not related to this study. After this stage, the highlighted sections were read again to get an in-depth understanding of the themes that had been identified as well as to find quotes to use.

ENBEL data was presented in various forms; the first of which is a table that reflects on the participants' pseudonyms, sectors, and roles – this allows the researcher to uphold anonymity and assist in easier reflections of participant responses. When a particular quote was identified that supported the reflection made by a participant, this was then included. Infographics were also used to assist with list-intensive data and to allow easier reflections on the themes found.

4.4 Interview Data

The ENBEL data provided valuable input on considerations of ECEs when discussing climate and health policy however, these interviews were conducted before this study and therefore do not specifically focus on ECEs or the eThekweni region. Thus, a series of further interviews were conducted for this study to address the research aim and objectives. These interviews were used to identify stakeholder awareness of policy documents relevant to eThekweni in relation to the themes of this study. The primary data used for the study was obtained through semi-structured interviews conducted online using Microsoft Teams, with several KZN stakeholders between the 28th of November 2022 and the 3rd of May 2023. A total of 16 stakeholders were approached, among whom 12 agreed to be interviewed. Interviews were guided by an interview schedule that was comprised of 16 questions that covered topics of policy generally,

health and ECEs, eThekwini policy, and global and national policy (*Appendix D*). The semi-structured nature of the interviews allowed the researcher to obtain additional information through the natural progression of the conversation during the interviews. In turn, this allowed the collection of a wide range of information about each participant's perception and understanding of policy documents for the region.

4.4.1 Data Processing

With the consent of the participant, each interview was recorded on a recording device. After the interview, the recordings were used to create transcripts of the interviews for thematic analysis. Transcripts were created by playing back the recordings and typing out the interview discussion on a Word document for each participant. Transcripts were checked twice thereafter for errors, and corrections were made by simultaneously reading and listening to the recordings.

4.4.2 Data Collection

To identify participants to interview a snowball approach was used (Farquharson, 2005; Noy, 2008). The process began by obtaining contact details for stakeholders within policy, climate change, and health who had an affiliation with eThekwini and KZN who could then refer other possible participants. In this way, the participants included postgraduate students, Municipality representatives, NGO representatives, academics, and a volunteer. These participants were chosen as a good representation and wide-ranging view of the KZN stakeholders who would need policy documentation to guide them in the event of extreme events. Possible participants were sent an email explaining the research aim and objectives as well as any other additional information the participant asked for. Once it had been confirmed that the individual was willing to

participate, they were sent a consent form to sign. An interview date and time were then discussed, and a Microsoft Teams meeting was scheduled. A reminder for the interview was sent out to participants the day before and the day of the meeting. Interviews were ideally limited to an hour long but ranged between 30-90 minutes depending on the level of engagement with the participant. The interviews began with general opening questions for the researcher to explore the participants' background, such as the name of the stakeholder, their job title, and description. Thereafter, delving into the predetermined questions. These questions sought to find what policy documents the stakeholder might be aware of at various levels of government, barriers they were aware of that prohibited such policy development or implementation, and the importance of such policy documents.

The open-ended nature of the interviews allowed participants to share thoughts on the topics discussed beyond what the question specifically sought to identify, creating a broad image of their understanding and ideas of policy. Thereby assisting them in understanding the processes of policy (Weller *et al.*, 2018). The semi-structured nature of the interviews was advantageous in allowing the researcher to ask additional questions about unanticipated remarks made by participants in response to the formulated questions (Mitchell and Jolley, 2013). In turn, these follow-up questions allowed the researcher to gain further insight into the participants' perceptions of climate change and health impacts in policy (Hill *et al.*, 2005). Participants had the opportunity at the end of the interview to add any additional comments and were then asked to suggest two further possible participants.

Using the data obtained from the interviews, it was possible to determine to what extent the stakeholders understand eThekweni policy documents and their inclusion of the impact of ECEs on health. This provides insight into the role that policy documentation can have on stakeholders' understanding and knowledge around these issues, alongside the current efficiency of policy documents in preparing for the impacts of ECEs on health in eThekweni.

4.4.3 Data Analysis

As with the ENBEL data, the primary interview data was thematically analysed using Braun and Clarke's (2006) six steps (Figure 4.1). However, there were some differences between the analysis of the ENBEL data and that of the primary interview data. The primary data were first read thoroughly and then read again to identify patterns and writing notes. These patterns were not predetermined as with the ENBEL data but rather formulated depending on the stakeholders' answers to the questions. It was also in this step that the similarities and differences in the responses were identified. The second step used open coding to group the responses and themes identified. Thirdly, the codes given to the data were considered more thoroughly to identify primary and secondary codes and outlying comments and statements. The fourth step confirmed codes and checked for themes identified more than once. The fifth stage confirmed the themes correlation to the study's aim and objectives and allowed the researcher to explore them in more depth. Finally, the last step involved the write-up. All stages except the final one were conducted manually as the preferred style for the researcher.

The primary interview data was presented first similarly to that of the ENBEL data where participants were given pseudonyms in a table to assist with anonymity and easier recognition of participants' responses. A conceptual diagram was also used to assist in the visualization of the nexus between climate change and health. Participants were quoted when necessary to support the data analyses and review. Lastly, infographics were used where data was list intensive.

4.5 Policy Data

This project also included the collation and review of policy documents that considered health and climate, to identify the coverage of considerations on ECEs and health within policy. To a considerable extent, this relates to the policy's ability to protect health when ECEs occur and to review what plans are in place to prepare. By collecting quotes from each policy document that related to each of the keywords, the researcher could identify the extent to which each policy document reflected on these themes as well as recognize plans of action and preparedness.

4.5.1 Data Collection

A comprehensive search for policy documents that might include climate and health was done on various online platforms such as the eThekweni Municipalities website and South African policy document portals. Policy documents needed to have a bearing on eThekweni to be selected for review. Policy documents were also identified on recommendations from the ENBEL data and primary interview data. For example, interview participants were asked various questions to identify policy documents. Participants were asked if they were aware of: any tools that should guide or assist policy development, South African policy documents that are concerned with the

impact of climate on human health, South African governmental policy documents that consider climate change, South African governmental policy documents that cover concerns of ECEs, any documents that only consider ECEs and human health, any eThekweni policy documents that mentioned the themes of climate change, human health, and ECEs, and any national or international policy documents that included themes of climate change, human health, and ECEs. A collection of policy documents could be accumulated from the responses to these questions that could then also be used for collecting policy documents for the policy data collection.

Approximately 120 policy documents were identified, of which 94 were included in the final sample. Policy documents were excluded if they did not mention any of the themes that were searched for or did not have a bearing on eThekweni. All policy documents were downloaded before being checked for the inclusion of themes and then saved or deleted based on their inclusion or exclusion.

4.5.2 Data Processing

Each policy document had various information confirmed before it was tabularized. For example, the table included: policy title, year of publication, URL, policy type and status, policy level, overview, the inclusion of weather, weather quotes, climate, climate quotes, climate change, climate change quotes, ECEs, ECE quotes, health, health quotes, the intersection between ECEs and health, the intersection between ECEs and health quotes, figures and tables, and reference. The policy document was then checked to determine whether it obtained any mentions of weather, climate, climate change, ECEs (which included keywords such as severe, disaster, flood, drought, tropical cyclone, cold snap, heat, tornadoes, and temperature), health

(including keywords like vector-borne, disease, mortality, and morbidity) and lastly, the intersection between ECEs and health. All except the last concept was searched using the word search function in Adobe Acrobat (text-mining; van der Geest and Warner, 2019). The last concept of the intersection between ECEs and health involved taking what had been found for both ECEs and health and seeing if the policy document made any interlinkages between them. The policy documents tables and figures were also checked to see for any correlation to the study's themes. All data were tabulated in Microsoft Excel to maintain a structured manner for the analysis.

4.5.3 Data Analysis

This study used both descriptive and prospective policy analysis since a wide variety of policy documents both finalized and in draft form were collected for analysis (Patton *et al.*, 2016). When all policy documents had been tabularized, thematic content analyses were conducted. There were slight differences in the process compared to that of the primary interview data and secondary ENBEL data.

The first step involved reviewing what themes the policy documents did and did not include, which involved quantitatively assessing those that did and did not include individual and grouped codes. This step allowed the researcher to become familiar with the table of policy documents collected (Braun and Clarke, 2006). The second step involved reading over the quotations tabularized. This is different from the second step in Braun and Clarke's (2006) thematic analysis as codes had already been generated to create the table headings. The third stage included highlighting suitable quotes to use in the research study, reading and comparing descriptive information to the codes that the policy document had and had not reflected upon (Figure 4.2). The

third step was the same as the original method from Braun and Clarke (2006) as codes were explored deeper and potential themes and sub-themes were identified from the descriptive information collected (Figure 4.2). The fourth step included reading the quotes selected to decide on more refined themes and sub-themes (Braun and Clarke, 2006).

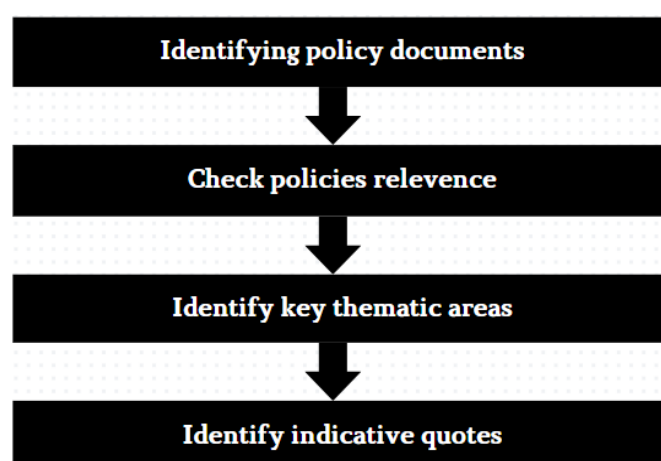


Figure 4.2: Flow diagram of policy data analysis.

Fifth, the themes derived from the codes and selected quotes were analysed and the researcher checked their relation to the study (Braun and Clarke, 2006). Lastly, the report was written up to reflect the findings and assist in achieving the study's aim and objectives.

A flow diagram was used to present policy identification, screening, eligibility, and inclusion in this study. The entire table of collected policy documents was also presented (*Appendix H*) however, a simplified version was included in the results that shows only the names of the policy documents, the year, and the inclusion or exclusion of each of the six themes. Graphs were used to reflect on various aspects of the policy

documents such as the percentage of themes included in the policy documents and how many included more than one theme. Policy documents that included the intersection between ECEs and health were tabularized too and given a reference to assist in listing multiple policy documents. Again, quotations were used to give better evidence for the thematic analysis of the policy documents. Infographics were also used here when considering policy documents reflecting on impacts from ECEs and necessary changes suggested by policy documents.

4.6 Ethics

As per the regulations of the University of Witwatersrand, ethical clearance was obtained from the University of Witwatersrand's Human Non-Medical Ethics Committee after the research proposal had been accepted and before interviews were conducted. Ethics clearance was given for this study (*Appendix A*; Ethics Clearance Protocol Reference: H22/08/16). ENBEL data also received ethics clearance in June 2021 from the Research Ethics Committee in LSHTM [Ref 25707].

During data collection anonymity and confidentiality were prioritized and ethical considerations were maintained both for the collection of the primary and secondary data. For the primary and secondary data collection, participants were informed in detail of all components of this study including the aim and objectives, purpose of the study, how data will be used during and after the study, as well as possible publication. Participants were reminded that the data would be kept confidential, and participants' identities kept anonymous. Additionally, for the primary and secondary data collection participants were given a participation information sheet (*Appendix B* and *Appendix E*) which explained the details concerning the study. Furthermore, participants were

asked to read and sign a formal letter of consent (*Appendix C* and *Appendix F*), which denoted their agreement to partake in the study. All participants were over the age of 18 years and were not classified as vulnerable.

4.7 Conclusion

ECEs are an expression of climate variability influenced by climate change that is likely to increase in frequency and intensity which cause significant adverse impacts on human health like morbidity and mortality (Ebi *et al.*, 2021a,b). It is therefore necessary for immediate policy action specifically within the field of adaptation (Galarraga *et al.*, 2011). Regional policies are particularly important for effective and successful policy implementation as well as the fact that it is at the local level that most of the impacts will be felt (Galarraga *et al.*, 2011). Without continued policy progress, it will become increasingly difficult in the future to address possible serious health consequences of climate change (Ganesh and Smith, 2018). To ascertain a deeper understanding of ECEs, health, and policy, specific methodologies needed to be followed. This study used a mixed-method approach that depended on various aspects of secondary, primary, and policy data. The secondary ENBEL data allowed the researcher to prepare relevant questions for the open-ended semi-structured interviews. The primary interviews enabled stakeholders to share popular policy documents to be reviewed in the study, alongside barriers that prohibit relevant policy development. The primary, secondary, and policy data collected from the interviews were analysed using thematic content analysis. The use of this method allowed the identification and analysis of themes within the data to be explored and revealed pertinent themes for achieving the aim and objectives of the study.

CHAPTER 5: RESULTS



(Mahlangu, 2022)

5.1 Introduction

To assist in policy awareness, improvement, and overall adaptation strategies, the aim of this dissertation is to reflect on the extent to which South African policy documents include and consider the impacts of ECEs on health. This is accomplished via the exploration of themes from experts in the field compared to themes identified in current policy documents. The following chapter presents the analysis of three sets of data namely primary interview transcripts, secondary interview transcripts, and a reflection of policy documents. The first segment considers ENBEL data, a secondary set of data from a previous study that interviewed various professionals within the climate, health, and policy nexus. The secondary data has been placed first in this chapter as it was obtained before the study began as well as the thematic analysis thereof having provided context for the primary data gathered and the analysis of the policy documents. The second set of material is primary data, obtained through semi-structured interviews with professionals in various sectors relevant to the climate and health nexus. Lastly, this chapter discusses the results of the tabularized policy documents from various sectors relating to the dissertation. Consequently, key themes identified by experts in relevant fields of this study are displayed and contrasted with key themes policy documents hold.

5.2 ENBEL Data

The ENBEL data derives from a set of interviews conducted by the Environment and Health Research Unit of the South African Medical Research Council (SAMRC) in which experts were not explicitly asked about ECEs and health impacts in policy documents. However, due to the open-ended nature of these interviews, and their thematic focus on climate, health, and policy, it is valuable to identify the experts'

reflections on these themes as it reveals the level of engagement around this policy space. Nine interviews were conducted with experts from various regions in South Africa with varying levels of experience in the climate, health, and policy nexus. The experts included an adaptation specialist, activist lawyer, presidential climate commission spokesperson, governmental health researcher, city-level specialist, legal researcher, professor, NGO delegate, and governmental department representative. Four scientists conducted the interviews on a rotational basis each leading an interview or being on the call to administer the recording and transcription. Participants were each assigned a letter as a pseudonym in substitution of their name to uphold anonymity – the letter I was excluded in this processes to prevent readability issues (Table 5.1). The rest of this segment considers various reflections and responses of these experts within the intersection of ECEs and policy, ECEs and health, and broader comments on climate and health.

Table 5.1: ENBEL participants' pseudonyms, sectors, and roles.

Participant Pseudonym:	Participant Sector:	Participant Role:
A	Government	Deputy Director
B	Law	Lawyer
C	Government	Senior Advisor
D	Research	Senior Manager
E	Academia	Professor
F	Government	Director
G	Law	Legal Researcher
H	NGO	Campaign Coordinator
J	Government	Director

5.2.1 Participants' Reflections on ECEs and Policy

ENBEL interview participants alluded to the nexus between ECEs and policy by reviewing two topics: types of ECEs and DRM (Table 5.2). The table below gives an overview of what types of ECEs participants recognised as well as comments on DRM (Table 5.2).

Table 5.2: ENBEL participants reflections on ECEs and Policy

ECES		
Participants:	Observations:	
A, C, F	Extreme heat events	
A, E, F	Floods	
A	Extreme storm events	
E	Droughts	
F	Fires	
None	Tropical cyclones, Tornadoes, Cold snaps	
Disaster Risk Management (DRM)		
A	• DRM is what guides South Africa's response to ECEs "... I'll make reference to [the] Disaster Management Act, because it covers a whole lot of things in terms of extreme weather, in terms of how do we then respond when such happens in excess."	
A and B	• There is DRM in SA for extreme events. • Participant B noted it as a generic response, explaining: "...there's the general generic disaster response mechanisms... But again, I'm not sure that the monitoring systems are in place [for] extreme weather events, that the linkages with climate change have been adequately mapped. And I don't think that the kind of proactive preparedness that we need to have really has been adequately mapped or put into place as well... I mean, I think at policy levels, it's a bit general."	
D	"National adaptation ... do highlight extreme weather events that are particularly, affecting South Africa... as well as the health-related risks that have been identified."	
D and J	• National adaptation, for example the NCCRP, does give direction and policy guidance regarding ECEs and the health impacts thereof.	
F	• Concerned for DRM in South Africa. • DRM has general interest in ECEs, like assistance offered by NGOs and churches. • Sensitivity around the topic. "...in the disaster management space, there's so many NGOs and churches that want to work... to improve our disaster management function...I do get the sense that there's a lot of sensitivity around health and disaster management."	
H	"And then as far as extreme weather is concerned, that is how... most people understand climate...they understand climate as weather."	
J	• No awareness of ECEs in policies generally. • Risks for South Africa due to ECEs.	

	“...extreme risk might be there, but like I... indicated, subsequent to the national climate change white paper, we just provided an overarching policy and direction...”
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5.2.2 Participants’ Reflections on ECEs and Health

Participants alluded to the intersection of ECEs and health by reflecting on the impacts and risks that the South Africa health sector would face under a changing climate. Participant G for example described:

“...understanding that climate change is going to be an intensifier of many existing social problems and health problems, and we needed to find a way to ensure that our systems are able to adapt.”

Similarly, participant H added:

” But I don't think the National Department of Health has done enough to articulate extreme weather in the context of public health. So extreme weather as a risk for infectious diseases...”

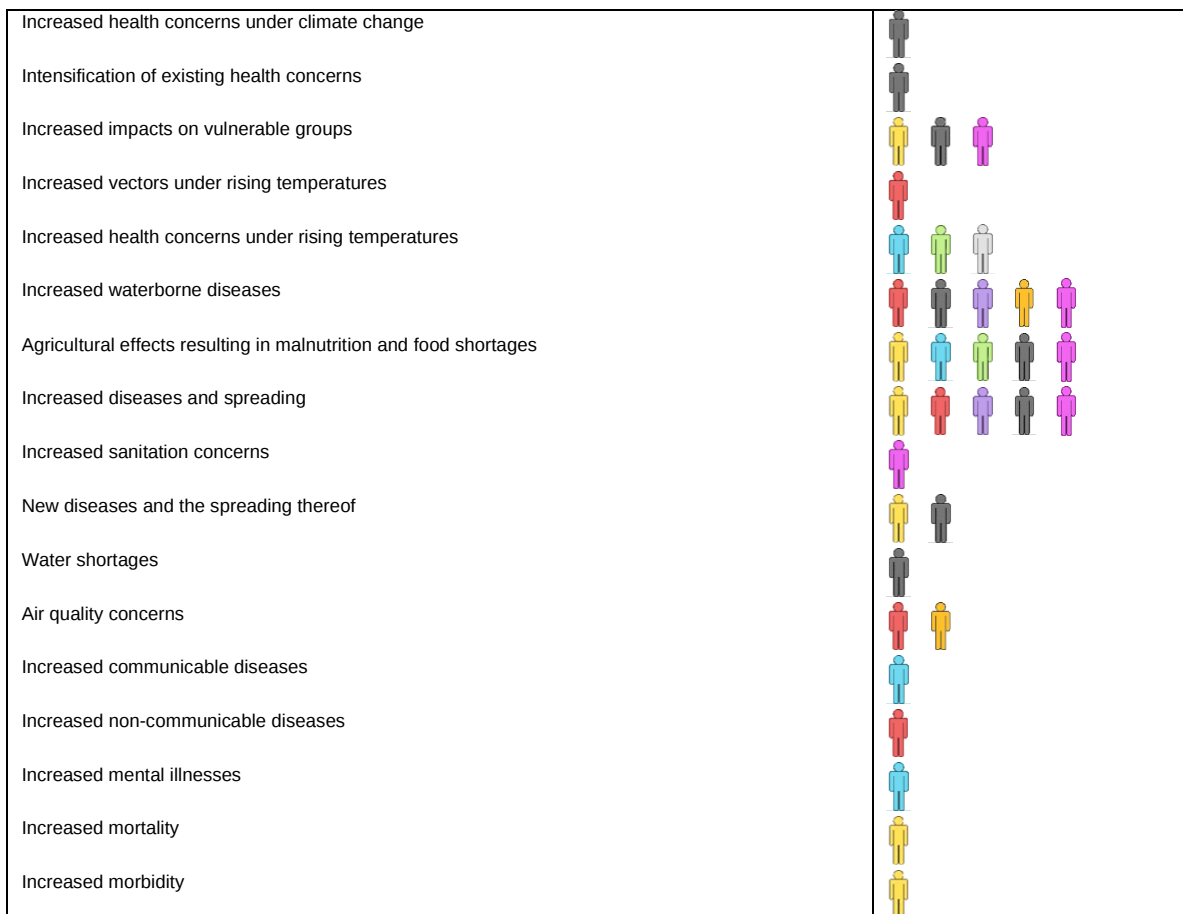
Additionally, participants also identified the intersection between ECEs and health when observing the information they need to further develop and assist adaptation efforts. Participant G emphasised the overall concern in this regard by explaining:

“...and generally, I think they're quite aware that the health care system is just not ready.”

While participant B noted the need for increased adaptation on a local scale when they described:

“... I don't know if a local clinic even knows about the potential climate change health impact that we might be seeing already, and that we certainly will see more of in future.”

Considering the risks and impacts that the South African health sector would face under a changing climate, participants identified 28 different risks and impacts (Figure 5.1). The three most noted ones included increased waterborne diseases, agricultural impacts that would lead to malnutrition and food shortages as well as an increase in diseases and the spreading thereof – each mentioned by five participants. Three different participants each then mentioned the increased impact on vulnerable groups, increased stress around patients with Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS) and increased stress around malaria patients. The next most common impacts and risks were identified by two different sets of the participants and include increased diseases and the spread thereof, air quality concerns, and the decrease of the health sector budget. All other risks and impacts were only identified by one participant each.



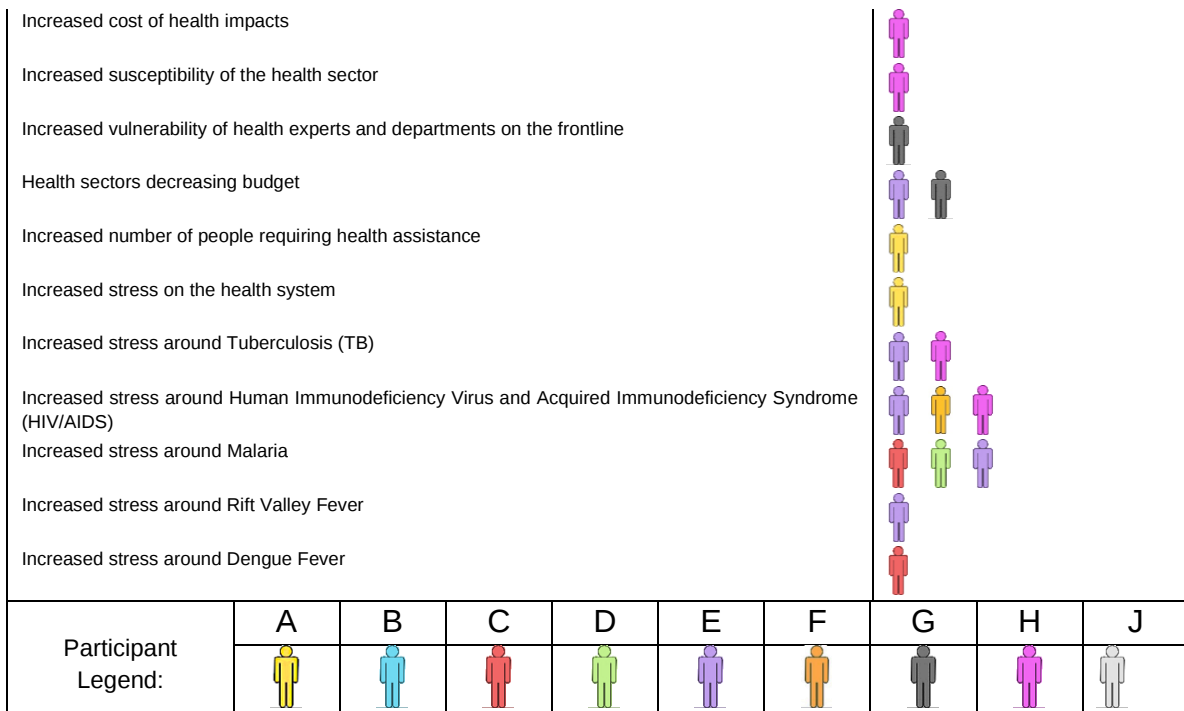


Figure 5.1: South African health sector risks and vulnerabilities.

When participants expressed the scientific health and climate evidence they both wanted and needed for their professions, they indirectly noted the importance of this interconnection within policy. Their responses reveal that more knowledge must be formulated about the impacts expected under a changing climate and the vulnerability of the health sector to the effects of ECEs. The participants' responses to data that would assist their work was broad. The most common response was the need for data on health – for example, health indicators, data on the intersection between climate and health, and what impacts on people and infrastructure look like which was mentioned by participants B, F, and G. Participants B and H identified that they needed information on agriculture and the food industry. Additionally, participants F and G noted that disaster management and extreme events data would be valuable information. Participant G explained:

"I would like to know after extreme weather events... what kind of people go to the doctor or to the clinics or to the hospitals and what do they complain about?... I'd like

to know if there's a correlation and what it looks like. I also would like to know just after an event, what has happened to the infrastructure of a clinical hospital, what's the impact on people and what's the impact on structures. And I think that would enable us also then to make some kind of analysis on the impact on health systems as a result."

Participant C wanted information specifically about increased temperatures including what the future healthcare system would need to look like and the spread of diseases under increasing temperatures. Participant C also wanted to seek data on air quality and lower greenhouse gas impacts. Participant B wanted to look for information from the water and education sectors. Participant H identified three other sources of data they would want including the climate change experiences of vulnerable communities, up-to-date costs of climate change in South Africa, and drivers of climate change. Lastly, each of the following were mentioned once by various participants; what South Africa faces under climate change (participant J), published research (participant A), and resilience measurements (participant F).

5.2.3 Participants' General Reflections on Climate and Health

When participants reflected on climate and health throughout the ENBEL interviews two main themes could be established: vulnerabilities from climate change and necessities for the health sector. These categories will be used in this order to view the participants' reflections on the nexus between climate and health.

Considering the country's vulnerabilities from climate change, various participants had explanations thereof. For example, participant A noted that climate change is seen as only an environmental concern which limits understanding. Similarly, participant G noted that there was already difficulty navigating the understanding that exists around

climate change - thereby explaining that climate change is considered a separate problem to multiple interconnecting sectors. Participant B identified that climate change is weighed up against developmental and economic well-being which decreases the focus and seriousness thereof having said:

“...often climate change response is kind of played off against development and economic wellbeing. And that's understandable because climate change response is going to be economically difficult...ultimately, responding well to climate change is going to have benefits for both the economy and society, ... we could end up with a more equitable society just by responding to climate change properly... So that the population really understands the issues and can also put the right pressure on politicians and... get involved in the fight against climate change.”

Participant F added to this by explaining that climate change is not considered a funded mandate, in other words, it is not guided by the constitution where functions of local government can be identified and given. Participant E identified that climate change is a neglected field. Likewise, participant G emphasized that climate change calls on the critical need for more adaptation efforts. Additionally, participant H found that ministries and policies that cover concerns about climate change do not have a major influence. All these responses identify the gaps in the climate industry that increase our vulnerabilities if we do not change the way climate is considered. These vulnerabilities amplify risks as participants identified nine of these (Figure 5.2). The most common response identified by two participants (E and H) was in identifying that infectious diseases would increase. Furthermore, participant H identified that climate change impacts will be felt disproportionately whereas participants B and J noted that women and children will be particularly vulnerable.

Lack of understanding impacts

Lack of understanding responses needed



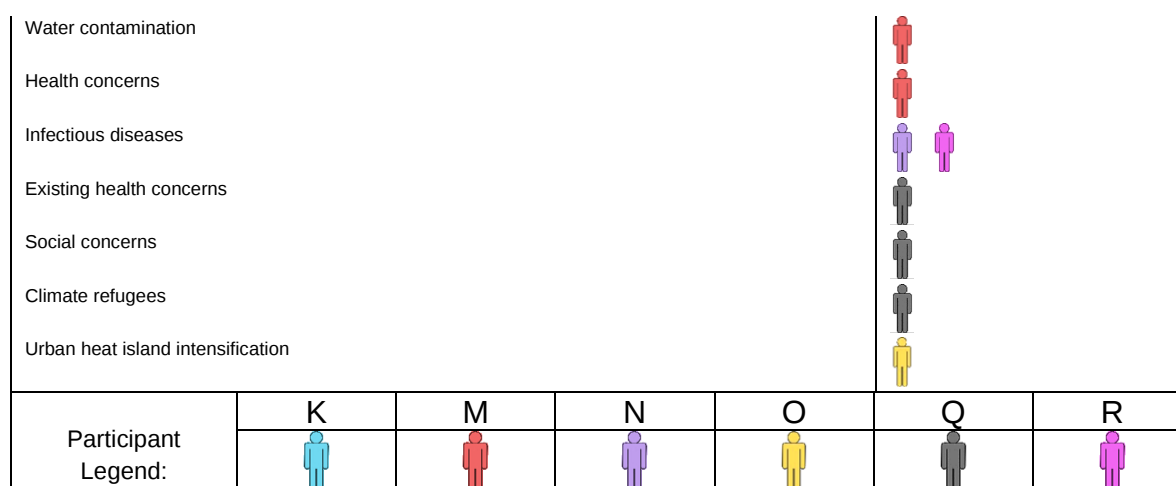


Figure 5.2: Vulnerabilities amplifying risk.

Although participants' recognitions of vulnerabilities and risks gives an overall understanding of experts' observations regarding the climate and health nexus, it is beneficial to also consider their reflections on necessary changes for the health system under a changing climate. Participant A noted that there is increased awareness amongst health experts on the impacts of climate change, and in this way, it would be helpful for them to acknowledge and understand their impact and contributions within the climate-health nexus. Participant H also reflected on the health sector personnel and mentioned that because people trust health practitioners they should be obliged to talk about these impacts. Other issues identified include what participant B reflected on, which was that health clinics are not aware of climate change impacts and how it will get worse under a changing climate. Whereas participant H noted that ministries are not taking health seriously in that they exclude the health minister in important processes of planning. Participant G pointed out that there is an awareness that the health sector is not prepared. Participant H also noted that the health sector has the most trusted voice in society which strengthens the sector's ability to create changes in the country. Overall participant G reminded us of why health is such a critical field

in the climate health nexus, in that everyone has a right to health and this right must be upheld.

5.3 Interview Data

The primary data for this study was collected via semi-structured interviews with stakeholders from or involved in research about climate, policy, and urban planning in KZN. The interviews were structured around 16 predetermined questions around the topics of policy generally, health and ECEs, eThekweni policy, and global and national policy. Twelve interviews were conducted. Stakeholders included postgraduate students, lecturers, municipality representatives, NGO representatives, a volunteer, researchers, and academics. To uphold anonymity, as for the ENBEL data, each stakeholder was allocated a letter as a pseudonym to substitute their name (Table 5.3).

Table 5.3: Interview participants' pseudonyms, sectors, and roles.

<u>Participant Pseudonym:</u>	<u>Participant Sector:</u>	<u>Participant Role:</u>
K	Academia	Senior Lecturer
L	Academia	Researcher
M	Government	Senior Manager
N	NGO	Research Manager
O	NGO	Volunteer
P	Academia and Health	Researcher & Physician
Q	Academia	Lecturer
R	NGO	Senior Manager
S	NGO	Director
T	Governmental Research Organisation	Principle Researcher
U	NGO	Impact Manager
V	Governmental Research Organisation	Researcher

The open-ended nature of the interviews allowed stakeholders to share additional thoughts and comments on these topics. The following sections consider the six codes established from the primary data collected which include policy necessity, policy accountability, policy identification, scope of policies, barriers, and eThekweni policies (Figure 5.3).

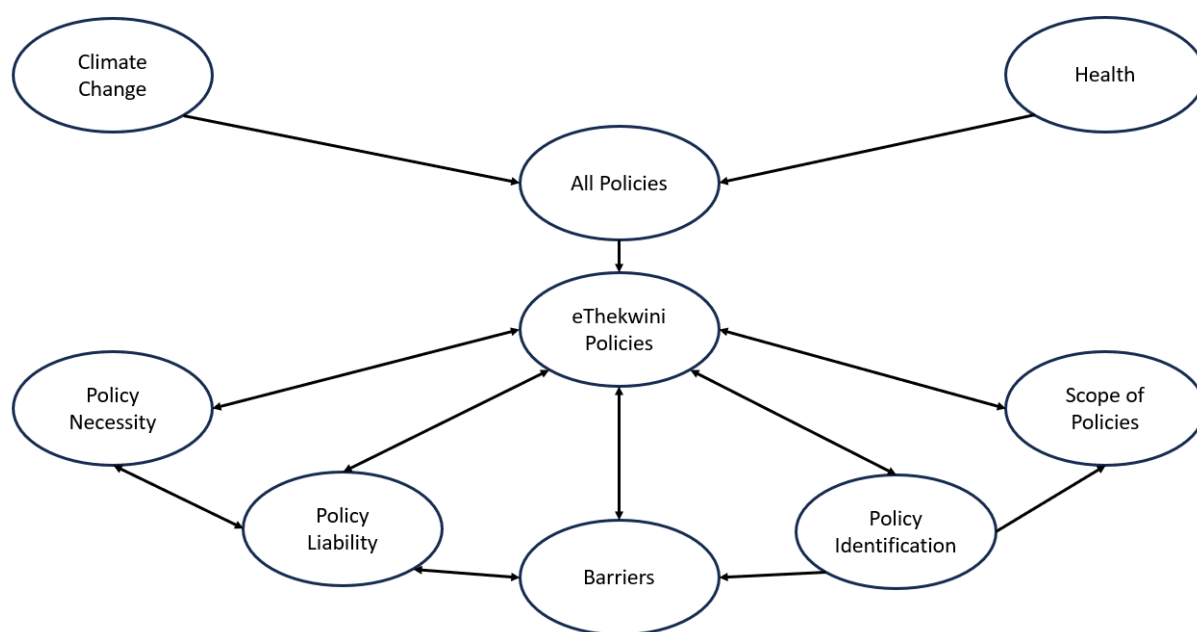


Figure 5.3: Conceptual diagram of the climate change and health nexus.

5.3.1 Participants' Reflections on the Necessity of Policy

During the interviews for this study, one question asked participants whether the policy documents of eThekweni Municipality should reflect the interrelationship between ECEs and health. The response to this question is considered first as it sets the foundation of the stakeholder's understanding of the necessity for this study. Therefore, this section reflects on the stakeholders' replies in which all respondents replied that it was necessary to include this interconnection, providing several reasons in justification.

Participants K, N, Q, R, T, and U mentioned the risks and impacts of climate change and ECEs as the reason for policy documents needing to include this interconnection. Participant K mentioned that without these policies, health is undermined. Participant N explained that the lack of policies recognizing this nexus (between health and ECEs) results in the backlog of services and provisions of the health sector due to an increase in waterborne diseases, inaccessible medications, and increased migration. Participant U echoed the last sentiment and added that the recognition of this nexus in policy documents would decrease impacts and hospitalizations. Additionally, participant U added that there would be an increase in hospital capacity as hospitals would be more aware of the preparation necessary for these impacts, while risks like cholera and infrastructural issues would also decrease. Participant U summarized this statement by explaining that there would be a decrease in lives at risk as well as impacts. This statement was also reverberated by participant Q who mentioned that lives would be saved with policies that included ECEs and health impacts. Additionally, participant Q explained:

“... definitely yes, there is a need... for eThekweni Municipality climate change strategy to include the relationship between these two disciplines...climate change as well as human health...is important in the sense that I will say a lot of people...do not understand the relationship between these two.”

Lastly, participant R mentioned that the inclusion of these themes in policy would assist with the risk of funds being siloed.

The next most popular reasons given for the necessity of including these themes in policy were to encourage proactive efforts, increase awareness and education, and due to the recent experience of ECEs in the eThekweni region. Each of these was mentioned by three participants. For example, participants K, T, and U mentioned that

ECEs (specifically flooding) have been experienced in the eThekweni region, and participant K explained that it was urgent that policies, therefore, include these themes to better prepare for these events. Participants Q, R, and U each mentioned that by including these themes in policy we increase planning, preparation, participation, and preparedness. Participant Q specifically highlighted the need to increase local participation in these concerns. Finally, participants Q, R, and S recognized the need to include these themes in policy to increase awareness and education. Participant Q explained that it was important to increase the understanding of the nexus between ECEs and health. Participants O, P, and V mentioned that it was necessary to include these themes of health and ECEs in policy but did not specify why.

5.3.2 Participants' Considerations of the Accountability of Policy

Considering that participants identified the importance of policy documents recognizing ECEs impact on health, it was fitting to identify which sphere of government should be responsible for these policies. Therefore, one of the interview questions asked participants if ideal policy documents (policy documents that recognize health impacts from ECEs and suggest methods of reducing risk) should be enacted at national or regional level. Participants responses and reasoning have been tabularised (Table 5.4).

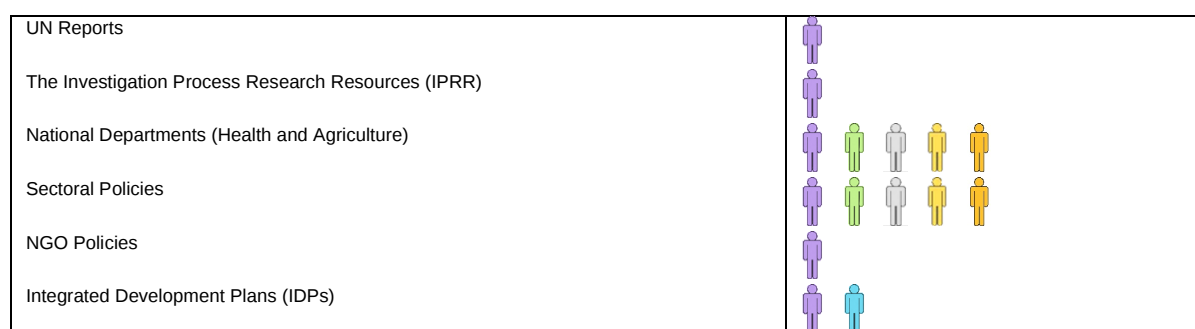
Table 5.4: Interview Participants' Responses for Policy Accountability

Participants:	Municipal	Provincial	National	Reasoning:
K	X	X	X	• Regional context
L	X	X	X	No explanations given.
M		X	X	• Increase the interconnection between governmental spheres and share responsibility: "... the literature is very clear around everyone having a role to play with

				climate change and so maybe the nature of that responsibility and how we share responsibility across the different spheres are a much more useful conversation to have, because it is absolutely certain that we need to do this through partnerships.”
N		X	X	• Regional context
O	X			• Regional context
P			X	• National government capable of reflecting on current affairs, advocate for this policy and supply resources and finances.
Q			X	• Regional context: “...local strategies...should be informed by a national strategy because the national strategy will be holistic... and then from then on we can develop our own... localized strategy that actually addresses issues... of the community that is specific to that particular region.” • National government capable of reflecting on current affairs, advocate for this policy and supply resources and finances.
R		X	X	No explanations given.
S	X	X	X	• National government capable of reflecting on current affairs, advocate for this policy and supply resources and finances.
T		X	X	• Regional context
U		X	X	• Regional context
V	X	X	X	• National government capable of reflecting on current affairs, advocate for this policy and supply resources and finances.

5.3.3 Participants' Identification of Policy Documents

During the interviews, seven questions asked participants to identify various relevant policy documents. Participants identified 29 policy documents of which the most recognized included the Paris Agreement (including Sustainable Development Goals (SDGs)), Intended Nationally Determined Contributions (INDCs), and Nationally Determined Contributions (NDCs)) - mentioned by eight participants (M, O, Q, R, S, T, U, V). The National Climate Change and Health Adaptation Plan 2014-2019 was identified by six participants (M, N, Q, S, T, V; Figure 5.4). National departments (e.g., Health and Agriculture) and sectoral policy documents were the next most identified policy documents given by participants K, M, S, T, and U. IPCC documents and World Health Organisation policy documents were identified by four participants each, namely; M, O, Q, V and N, R, S, V. The Durban Climate Change Strategy (DCCS; M, Q, S), Durban Climate Action Plan 2019 (M, S, T), NCCRP 2011 (M, R, T), National Climate Change Adaptation Strategy 2017 (M, S, T), South Africa's National Climate Change Response Strategy 2011 (Q, S, T), and the National Heat Health Action Guidelines 2020 (S, T, V) were identified by three participants each. The IDPs (K and Q) and Disaster Management Act (DMA) 57 of 2002 (M and N) were mentioned by two participants each. Various participants only once mentioned the remaining 15 policy documents. Participants L and P did not know any policies to suggest to any of the questions.



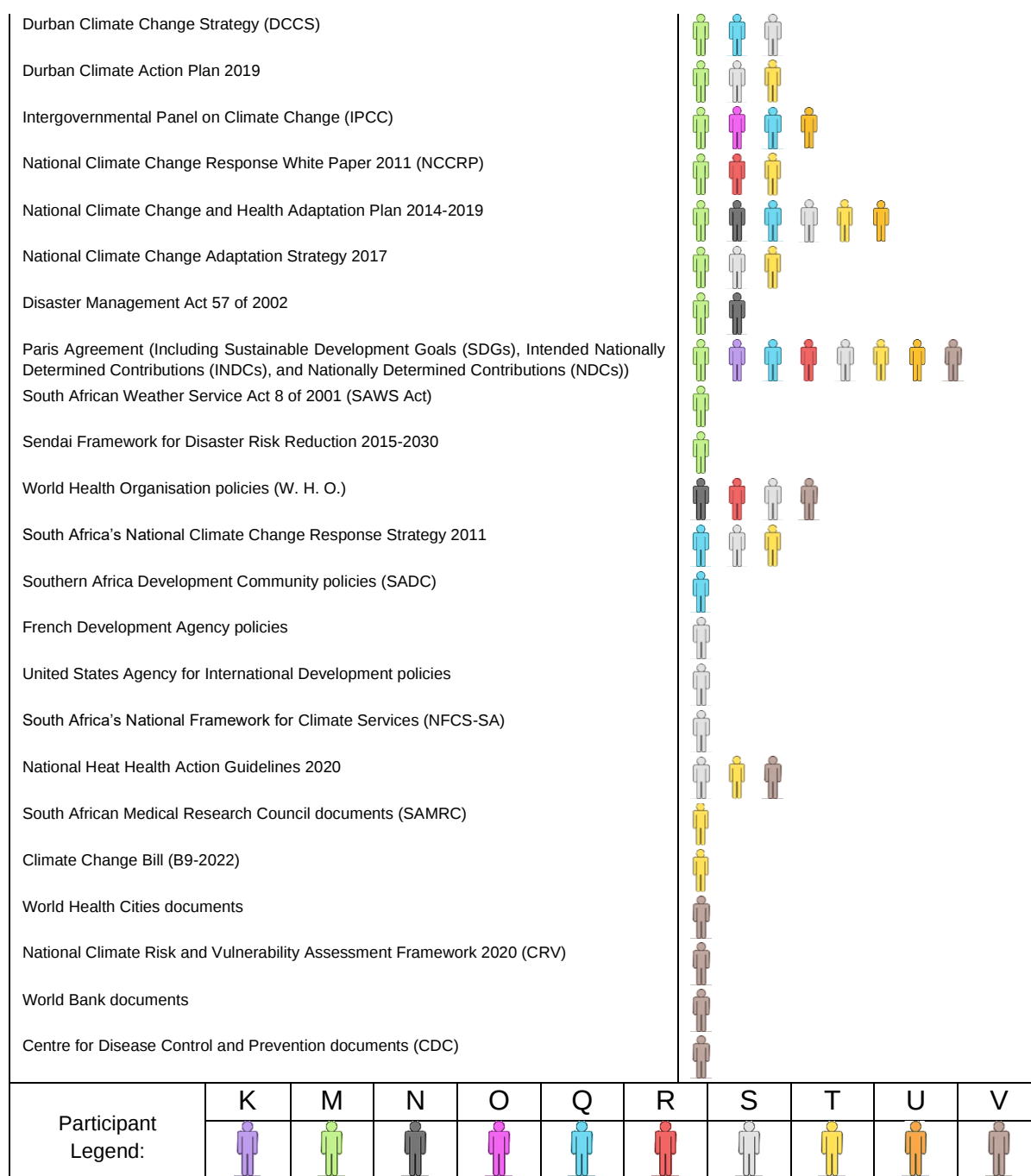


Figure 5.4: Infographic of policy documents identified by participants.

5.3.4 Participants' Contemplation on the Scope of Policy Documents

Participants were asked four questions about the extent to which policy documents include climate change, human health under climate change, ECEs, and health impacted by ECEs. Participants L, O, P, and U did not know policies or did not know policies well enough to comment. The table below reviews the other participants'

responses to these four questions and gives a brief overview of the positive and negative extent to which policy documents include the themes of this study (Table 5.5).

Table 5.5: Scope of study's themes in policy documents according to participants:

Positive:	Negative:
Participants K and S • Policies have an 'active inclusion' of themes. Participant M • Policy can be commended. Participant Q • Policy documents are detailed and highlight stakeholder responsibilities and management contributions. Participants R, S, and V • Policy documents are adequate. Participant R argued: "I remember the policies being pretty good...and like quiet progressive in like our department of environmental affairs at the time..." Participant T • Policy documents are: detailed and comprehensive, sufficiently based on scientific evidence, and mention the necessary key points, (e.g., potential health impacts, key risks, and interventions at individual and sectoral levels). Participant V • Inclusion of mental implications and negative impacts. Participants K, M and T • Recognition of health implications (e.g., cholera, infectious disease, drought, flooding, lack of resources and vector-borne diseases). Participant Q, T and V	Participants K and N • Themes are not meaningfully included and considered, creating a superficial review. Participant N explained: "So, do these policies...take into account all of those things? I don't think so, I don't think they do, at a...really meaningful level." Participant K • Policy documents need to use more scientific evidence, to assist persuasion. Participant N • Policies do not consider: the psychological impacts of climate change, enough proactive efforts rather than reactive efforts, and definitions of ECEs. • Policy for ECEs need to be reviewed - are they adequate for building resistance and, testing resilience and preparedness. Participant M • Gaps in policy documents – e.g., how to deal with climate change. • Policy documents including ECEs need more sufficient warnings. Participant R • Policy documents need local adaptation strategies. Participant T • Policy documents are not long and detailed. • Policy documents for ECEs other than extreme heat events needed.

Helpful policies include the DCCS and the Heat Health Plan.	Participant V Policies only give a general idea of climate risks and vulnerability.
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5.3.5 Participants' Explanations for Policy Barriers

During the interviews, participants were asked if they knew of any barriers that prohibit the inclusion of the intersection between human health and ECEs in policy. All respondents had a response to this question and a total of 13 themes could be established. These themes include interdisciplinarity, lack of education and understanding, policy and procedure, data, immediate concerns, implementation, complexities, challenges faced by the eThekweni Municipality, resources, unavailability, ECEs, vulnerability of the impoverished, and DRM (Table 5.6). The table below gives an overview of what respondents mentioned under these themes concerning the barriers of policy including the ECE-health nexus.

Table 5.6: Participants' recognized policy barriers

1) Lack of Education and Understanding
Lack of education Participants: N, O, P, Q, R, S, T, U, V Participant N - Need to build expertise in government at all levels. - School curriculum should include adaptive capacity which would then increase resilience, the lack of which would result in a dysfunctional society. Participants O and R - Education is necessary at a local level to guide awareness of relevant policy documents that can then guide action. Participants S and U - Lack of knowledge – alludes to necessary educational endeavours. Participant P

- Need for improved education.

Participant Q

- Some people do not know and believe in climate change.
- The government is responsible for creating more awareness of the nexus between health and ECEs.
- South Africa needs more people studying climate change.

Participant T

- People do not relate ECEs to climate change.

Participant U

- People do not generally think of health under climate change.

Participant V

- Need to know examples of ECEs impacting health.

Lack of Understanding

Participants: K, M, N, P, Q, R, S, U, V

- There is a lack of understanding around the effects of ECEs at various levels, and the need to improve this.

Participants M, Q, U, V, N

- Need for more understanding of the effects of climate change and what to do about it.

Participant N

- Necessary to know about the impacts like the displacement of people, migration, and pressure on health services:

“I don’t think policymakers really understand what is... going to happen.”

- People do not know the association between health and ECEs and the extent of the impact.
- Departments outsource people due to a lack of sufficient understanding of the topic and a lack of ability to interpret information, which argues that government is incapable.
- Health is not added to policy because of this lack of understanding of how an overarching framework could work.
- The lack of understanding leads to a lack of capacity to translate science into policy and policy into action.
- Policy itself must consider this lack of knowledge and understanding.
- Policymakers do not understand what will happen to health under ECEs.

Participant P and N

- Need to improve the understanding of ECEs caused by climate change, especially at a local level.

Participant S

- Lack of understanding of how health is impacted by climate change in which more focus is given to sectors like agriculture and resources.

Participant M

- There is a lack of people interested in the health sector even though it is central to well-being, arguably because the connection between climate change and health is not well understood.

2) The Call for Interdisciplinary Funding, Jargon, and Cooperation

Participants: K, L, M, N, O, Q, R, U

Participant K

- There are clear disciplinary boundaries which leads to a lack of interdisciplinarity in policy.
- There needs to be interdisciplinarity between departments to assist policy development, in which jargon specific to disciplines needs to be shared to create jargon that is suitable across disciplines.
- The relevant departments work in silos which weakens an interdisciplinarity perspective and creates a superiority complex amongst disciplines.

Participant L

- Identified a lack of cooperation between the disciplines of health, climate change, and ECEs.

Participant M

- A lack of interdisciplinarity due to undefined boundaries lead departments to overstep mandates.

Participant N

- Lack of interdisciplinarity between the health and environment departments.
- There is a de-link between ministries and mandates specifically around the health department, leading to dysfunctionality in the legislative system.
- The health department does not position itself in environmental governance.

Participant O

- A need for interconnectedness that works on knowledge transfer issues.

Participant Q

- Silos between departments create a lack of collaboration.
- A more holistic approach is necessary.

Participant R

- Siloing influences around funding.
- Climate change is siloed from other social and economic issues.

Participant U

- Government as a whole works in silos

3) Policy and Procedure Interconnections and Involvements

Participants: K, M, N, O, Q, T, U, V

Participant K

- Policy documents as words rather than actual pronouncements.
- Academics and local communities need to be allowed to assist with the policy processes.
- Everyone is responsible for these concerns however there are not singular people or departments that vigorously defend the cause.

Participant M

- Policy documents do not always influence decision-making as they should.
- Need to increase the capacity of all stakeholders and the public around policy, which includes identifying roles and how to address these issues.

- Policy must be interconnected across government with shared responsibility thereof.
- Mandates are differential between national, provincial, and local government.
- Recalled that policy documents exist to inform decision-making, planning, and catalytic projects.
- People do not see climate change as their problem, explaining:
“People not... seeing climate change as their responsibility but as, the responsibility of another sphere of government and maybe that needs to be clarified a little bit...”

Participant N

- Inefficiency of government, specifically the Department of Health (DoH) - to be more associated with climate change concerns.

Participant O

- Policy documents that include themes of climate change, ECEs, and health are separate, making it difficult to find the nexus between these themes.
- Need for improved communication between policies and policy representatives.
- Nobody wants the responsibility of uniting policy documents and themes around climate change - leaving these policy documents open to individual interpretation.

Participant Q

- Identified a lack of stakeholder involvement and commitment in which the private sector and civil society need to take responsibility for driving policy.
- Recognized that ignorance perpetuates climate change concerns.
- Government does not feel the need to respond to these concerns immediately.

Participant T

- Plans remain in draft form.

Participant U

- Evoked that one is not familiar with the policy until it applies to you.

Participant V

- Continuity of issues across government persons, for example, when there are elections, past work does not continue with the new government members.

4) Data Availability, Sharing, and Funding

Participants: K, M, O, P, T, U, V

Participant K

- Need to mainstream data via sources like research and news feeds.

Participant M

- Noted that data needs to be globally recognised and funded.

Participants O and V

- Identified concerns around data access, collection, quality, resolution, and continuity.

Participants P and V

- Identified the importance of having data that is well-known amongst societies, freely accessible, grouped together, and openly shared.

Participant T

- Argued that there is a data limitation regarding health as it is not well detailed.

Participant U

- Issue around data, a barrier to policy due to the novelty of the nexus.

Participant V

- Generally, not enough data.

5) The Prioritization of More Immediate Concerns

Participants: K, L, M, N, P, Q, R

Participants K, L, and Q

- Poverty was particularly a concern that continues to take the focus away from policy concerns.

Participant K

- Gender and environmental issues are more immediate concerns.

Participant L

- Housing is an immediate concern that takes precedence over policy concerns.

Participant N

- Identified infrastructural failure, broken sewerage lines, closed beaches, and focus on energy, financial crisis, HIV/AIDS, Tuberculosis (TB), and Malaria.

Participant Q:

“...the reason why climate change is not as... important as it should be, [is] because we are dealing with so many social issues in the country which again makes climate change... not so significant [an] issue... for example,... you look at the issue of demonstrations, you look at the issue of crime, you look at the issue of corruption, you look at the issue of poverty..., lack of infrastructure...”

- Immediate concerns take focus away from other concerns like policy, in which the best way to work on all these concerns as well as those of policy is if the country prioritizes these issues better.

Participant R

- Unemployment as an immediate concern.

6) The Need to Focus on Implementation Strategies

Participants: N, O, Q, U, V

Participants N and V

- Improve recognition of policy documents that can then feed into policy implementation and additionally ensure policy documents are suitable for implementation and the ability to translate policy into action.

Participants N and U

- Policies in South Africa are good, but implementation falls short.

Participant O

- Policy processes are slow which creates a decrease in immediate action.

Participants Q and V

- Lack of implementation.

Participant Q

- Implementation issues due to policies that are created for administrative purposes only.

7) The Complexities of the ECE-Health Nexus

Participants: K, L, P, T

Participants K, L, and T

- Climate change and ECEs influencing health is complex and conceptually tricky.
- The causal pathways are difficult to directly relate to climate change.

Participants L and P

- The topic is difficult to distinguish between broader causes and proximate causes to an extent that they can then be included in the policy, and it is especially difficult to relate it to health.

8) Challenges Faced by eThekweni Municipality

Participants: K, L, U, V

Participants K, U, and V

- The eThekweni government is failing to achieve its commitments and is difficult to work with.

Participant K

- The Municipality has lost direction.

Participant L

- Described the level of preparation of the Municipality as inadequate, as seen after the flooding events in 2022.
- The Municipality needs to increase efforts to assist in decreasing the impacts of ECEs, especially regarding informal settlements.

9) The Restraints of a Lack of Resources

Participants: K, N, O, Q

- General lack of resources shared within municipalities.

Participant K

- Resource constraints include budget limitations.

Participant Q

- Lack of resources prevents a full understanding of the impacts of climate change and the response thereof.
- Improving resource allocation will assist in addressing climate change concerns.

Participant O

- Improved resource allocation is necessary.

10) City Officials lack Availability, Capacity, and Incentives

Participants: M, S, V

Participants M and V

- City officials and people tasked to deal with these concerns are busy.
- Participant M described:
“So quite often city officials are already sort of really busy and... dealing with immediate problems that they have.”

Participants S and V

- Lack of incentives, willingness, and capacity.

Participant S

• Staff are not actively involved.
11) Expanding and Improving the Preparation of ECEs
Participants: K, S, V Participant K • South Africa can respond to ECEs and provide aid however, it is curative and not preventative. • Some people believe that ECEs do not happen. Participants K and S • ECE policy should exist. Participant V • Identified the need for policy documents beyond that of heat, for example, a policy for ECEs like flooding.
12) Vulnerability of the Impoverished
Participants: L and N • Focus must be placed on local-level vulnerability because of high levels of vulnerability and risks. Participant N • Must build capacity for resilience as public health resilience depends on basic health services such as water, infrastructure, and sanitation.
13) The Need to Improve Disaster Risk Management
Participants: K and O Participant K • DRM should be part of policy and thus part of municipal mandates. • DRM seems separate from the environmental department, especially at a local level and thus it needs to be updated, tested, and considered in regional contexts. • Lack of civil society's inclusion in DRM. Participant O • There is a general need for better DRM.

5.3.6 Participants' Perceptions of eThekwini Policies

During the interviews, two questions asked participants to reflect on eThekwini policies. The first question asked whether the participant felt that the themes of climate change, ECEs, and health are currently adequately reflected upon in the eThekwini policy documents. Seven participants (K, L, M, O, S, U, and V) did not know the extent to which these themes are reflected in policy. Notably participant K noted that they suspect not, although they are not entirely sure. Participant M said they are not sure

specifically about the theme of health. Participant O did not know a response to the question but did explain that policy is vital in recovering from ECEs. Participants N, P, Q, R, and T had various responses. For example, participant N explained that due to the lack of bylaws that are updated, policy documents are not inclusive of the theme of ECEs. Adversely, participant Q noted that eThekweni policy documents are not inclusive of health effects but are inclusive of climate change and ECEs. Participant P identified a lack of recognition of these themes and participant R also noted that it is likely that these themes are not adequately reflected upon because nationally there is not much recognition in policy documents and generally it is even less so for regional policy documents. Participant T differed from other responses in that they explained that policy documents adequately reflect upon topics of risks, adaptation, and resilience, stating:

“I mean they are there, they know what the risks are and what needs to be done to adapt and build resilience.”

The second question asked if participants feel that eThekweni adequately has efforts of action to address climate impacts on health and to give examples if so. Only participants M, N, O, and P had a response. Participant M reflected on the strategic response of eThekweni, explaining that it is good in terms of vector and water-borne disease preparations however, it is not adequate when regarding indirect impacts like agricultural impacts. Moreover, operational efficiency and performance are eroded by capacity and reduction of service delivery. Participant M also added that implementation is a large concern when regarding the response to this question. Participant N noted that bylaws exist, but they are outdated and not reflective of ECEs. Participants O and P both explained that the actions of the eThekweni Municipality are inadequate and do not have enough work done on them.

5.4 Policy Data

The last set of data used for this study was a collection and analysis of various policy documents with a bearing on eThekwin, collected through a process of online document identification, and on recommendation from the respondents in the ENBEL study and of the interviews that yielded the primary data for this study. Policy documents were tabularised with various sections of information collected (*Appendix H*). Approximately 120 policy documents were reviewed but a total of 94 were tabularised based on relevance, inclusion of themes, and connection to eThekwin (Figure 5.5).

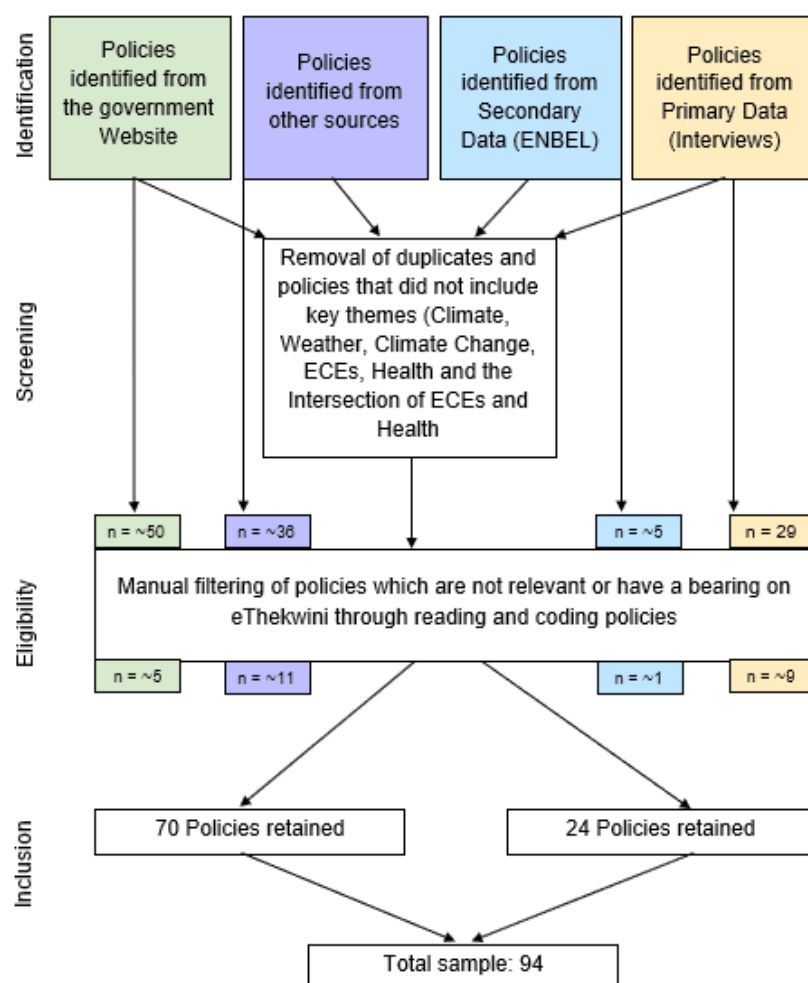


Figure 5.5: Flow diagram of policy identification, screening, eligibility, and inclusion in this study.

If the themes were included in the policy the table received a tick mark and a green colouring, alongside a quotation from the policy (Table 5.7). If the theme was not found within the policy, a cross mark would be placed in the table and marked orange (Table 5.7). The years of the policy documents ranged from 1996 to 2023 with the majority (12 policies) having been released in 2015. Policy document levels varied from municipal, national, and international. Policy types included acts, guidelines, the South African constitution, declarations, summaries, documents, reports, plans, green and white papers, charters, analysis tools, strategies, frameworks, reviews, action plans, IDPs, Bills and contributions. The first section of the results is the policies' inclusions of themes. Within this section the first two sub-headings separate policy documents that alluded to versus specified this intersection. Thereafter, the four themes established from the thematic analysis of the policy documents are discussed: ECEs, ECE impacts, vulnerable groups, and suggested changes.

Table 5.7: Inclusion of themes within each of the policy documents.

Policy Name	Year	Weather	Climate	Climate Change	ECEs	Health	ECEs/Health Intersection
South African Constitution, Chapter 2: Bill of Rights	1996	X	X	X	✓	✓	X
White Paper on Environmental Management Policy	1997	X	✓	✓	X	✓	X
No. 107 of 1998: National Environmental Management Act	1998	X	X	X	X	✓	X
Climate Change and Human Health: Impact and Adaptation	2000	✓	✓	✓	✓	✓	✓
No. 8 of 2001: South African Weather Service Act	2001	✓	✓	X	✓	X	X
Disaster Management Act	2002	X	X	X	✓	✓	X
No. 46 of 2003: National Environmental Management Amendment Act	2003	X	X	X	X	X	X
No. 61 of 2003: National Health Act	2004	X	X	X	X	X	X
No. 8 of 2004: National Environmental Management Amendment Act	2004	X	X	X	X	X	X
Minister for Provincial and Local Government Disaster Management Act, 2002 (ACT NO. 57 OF 2002)	2005	✓	✓	X	✓	X	X
Using climate to predict infectious disease epidemics	2005	✓	✓	✓	✓	✓	✓
Health and Climate Change: the "now and how" A policy action guide	2005	✓	✓	✓	✓	✓	✓
No. 13 of 2005: Intergovernmental Relations Framework Act	2005	X	X	X	X	X	X
Air Quality Management Plan for eThekweni Municipality, Kwa-Zulu Natal, South Africa	2007	X	X	X	X	✓	X
Climate Change: What does it mean for eThekweni Municipality?	2007	✓	✓	✓	✓	✓	✓
Libreville Declaration on Health and Environment in Africa	2008	X	X	✓	✓	✓	✓
Climate Change and Health	2008	X	✓	✓	✓	✓	✓
No. 24 of 2008: National Environmental Management: Integrated Coastal Management Act	2008	X	X	✓	✓	✓	X
Climate change and health Report by the Secretariat	2008	X	X	✓	✓	✓	✓

Euroheat; Improving Public Health Responses to Extreme Weather/ Heat-waves	2009	✓	X	✓	✓	✓	✓
No. 14 of 2009: National Environmental Laws Amendment Act	2009	X	X	X	X	✓	X
KwaZulu-Natal Health Act	2009	X	X	X	X	✓	X
Climate Change and Health	2009	✓	✓	✓	✓	✓	✓
Protecting Health from climate change; Global Research Priorities	2009	✓	X	✓	✓	✓	X
Municipal Adaptation Plan; Health and Water	2009	✓	✓	✓	✓	✓	✓
National Climate Change Response Green Paper	2010	✓	X	✓	✓	✓	X
South African Risk and Vulnerability Atlas	2010	✓	✓	✓	✓	✓	✓
Department of Environmental Affairs Annual Report	2011	✓	✓	✓	✓	✓	X
Community-based Adaptation to Climate Change in Durban	2011	✓	✓	✓	✓	✓	✓
National Climate Change Response White Paper	2011	✓	✓	✓	✓	✓	✓
Durban's Municipal Climate Protection Programme: Climate Change Adaptation Planning for a Resilient City	2011	✓	✓	✓	✓	✓	✓
Department of Environmental Affairs Annual Report	2012	✓	✓	✓	✓	✓	X
Durban Adaption Charter	2012	X	✓	✓	X	X	X
Durban Adaption Charter	2013	X	X	✓	✓	X	✓
Climate Change and Health: A Tool to Estimate Health and Adaptation Costs	2013	✓	✓	✓	✓	✓	✓
National Environmental Health Policy	2013	X	X	✓	✓	✓	✓
Protecting Health from Climate Change; Vulnerability and Adaptation Assessment	2013	✓	X	✓	✓	✓	✓
KZN Department of Public Works, Risk Management Strategy	2014	X	X	X	X	X	X
WHO guidance to protect health from climate change through health adaptation planning	2014	✓	X	✓	✓	✓	✓
Durban Adaption Charter Annual Report	2014	X	✓	✓	✓	X	X
Health in All Policies (HiAP) Framework for Country Action	2014	X	X	✓	X	✓	X
National Climate Change and Health Adaptation Plan	2014	✓	✓	✓	✓	✓	✓
Act No. 25 of 2014: National Environmental Management Laws Amendment Act	2014	X	X	X	X	✓	X
Durban Climate Change Strategy	2014	X	✓	✓	✓	✓	✓
South African Development Community; Climate Change Strategy and Action Plan	2015	✓	✓	✓	✓	✓	✓
Department of Health Notice 1229 OF 2015	2015	✓	X	X	✓	✓	✓
Climate and Health Country Profile - South Africa	2015	✓	✓	✓	✓	✓	✓
Operational Framework for Building Climate Resilient Health Systems	2015	✓	✓	✓	✓	✓	✓
Sendai Framework for Disaster Risk Reduction	2015	X	✓	✓	✓	✓	✓
Act No. 16 of 2015: Disaster Management Amendment Act	2015	X	✓	✓	✓	X	X
South Africa's Intended Nationally Determined Contribution (INDC)	2015	✓	✓	✓	✓	✓	X
National Department of Health Strategic Plan 2015-2020	2015	X	X	✓	X	✓	X
Department of Health Strategic Plan	2015	X	X	X	X	✓	X
The Millennium Development Goals Report	2015	X	✓	✓	✓	✓	X
Durban Adaption Charter Report	2015	X	✓	✓	✓	X	X
eThekweni Municipality Integrated Development Plan	2015	X	X	✓	✓	✓	✓
Evidence and policy in South Africa's Department of Environmental Affairs	2016	X	X	✓	X	X	X
Annual Climate Change Report	2016	✓	X	✓	✓	✓	X
Health and Climate Change	2016	X	X	✓	✓	✓	✓
Durban Adaption Charter Report	2016	X	✓	✓	✓	✓	✓
eThekweni Municipality Integrated Development Plan	2016	✓	✓	✓	✓	✓	✓
Durban Resilience Strategy	2017	X	✓	✓	✓	✓	✓
eThekweni Municipality Integrated Development Plan	2017	X	X	✓	✓	✓	✓
The Libreville Declaration on Health and Environment in Africa	2018	X	✓	X	X	✓	X
Draft National Climate Change Adaptation Strategy	2018	X	✓	✓	✓	✓	✓
Updated Climate Change Projections for eThekweni Municipality	2018	X	✓	✓	✓	✓	X
Durban Adaption Charter	2018	✓	✓	✓	✓	✓	✓
COP24 special report: health and climate change	2018	✓	X	✓	✓	✓	✓
Port of Durban Strategic Environmental Assessment; Strategic Impact Assessment & Strategic Environmental Management Plan Draft	2019	X	X	✓	X	X	X
National Climate Change Adaptation Strategy	2019	X	X	✓	✓	✓	✓
Durban Climate Action Plan	2019	✓	✓	✓	✓	✓	✓
Durban Adaption charter	2019	X	✓	✓	✓	✓	X
eThekweni Municipality Integrated Development Plan Review	2019	X	✓	✓	✓	✓	X
eThekweni Municipality Integrated Development Plan	2019	X	✓	✓	✓	✓	X
DCCS Annual Report	2019	✓	✓	✓	✓	✓	X
Department of Health Strategic Plan	2020	X	X	X	X	✓	X
South Africa's Low-emission Development Strategy 2050	2020	✓	✓	✓	✓	✓	✓
National Heat Health Action Guidelines	2020	✓	✓	✓	✓	✓	✓
Durban Adaptation Charter Report	2020	X	✓	✓	✓	X	X
KwaZulu-Natal Department of Health Strategic Plan	2020	X	X	X	X	✓	X
National Climate Change Adaptation Strategy	2020	✓	✓	✓	✓	✓	✓

eThekweni Integrated Resource Plan Draft	2020	✓	X	✓	✓	X	X
eThekweni Municipality Integrated Development Plan	2020	X	X	✓	✓	✓	X
eThekweni Municipality Integrated Development Plan Review	2021	X	X	✓	✓	✓	✓
National Health Research Strategy: Research Priorities For South Africa 2021-2024	2021	X	X	✓	X	✓	X
Draft National Climate Change and Health Adaptation Plan 2020 - 2024	2021	✓	✓	✓	✓	✓	✓
First Nationally Determined Contribution under the Paris Agreement	2021	✓	✓	✓	✓	✓	X
Trading Services eThekweni Water Policy	2021	X	X	X	X	✓	X
Climate Change and Health Research: Current Trends, Gaps and Perspectives for the Future	2021	✓	X	✓	✓	✓	X
eThekweni Municipality Integrated Development Plan Review	2021	X	✓	✓	✓	✓	✓
Climate Change Bill	2022	✓	✓	✓	✓	✓	✓
eThekweni Municipality Integrated Development Plan Review	2022	X	X	✓	✓	✓	✓
Synthesis Report of the IPCC Sixth Assessment Report (AR6) Summary for Policymakers	2023	✓	X	✓	✓	✓	✓
eThekweni Municipality Integrated Development Plan	2023	✓	✓	✓	✓	✓	✓

5.4.1 Policy Documents Inclusions of Themes

Out of the 94 policy documents tabularized, 42 included the weather theme, 50 included the theme of climate, 74 included the climate change theme, 72 included the ECE theme, 78 included the health theme and lastly, 47 included the theme for the interconnection between health and ECEs (Figure 5.6).

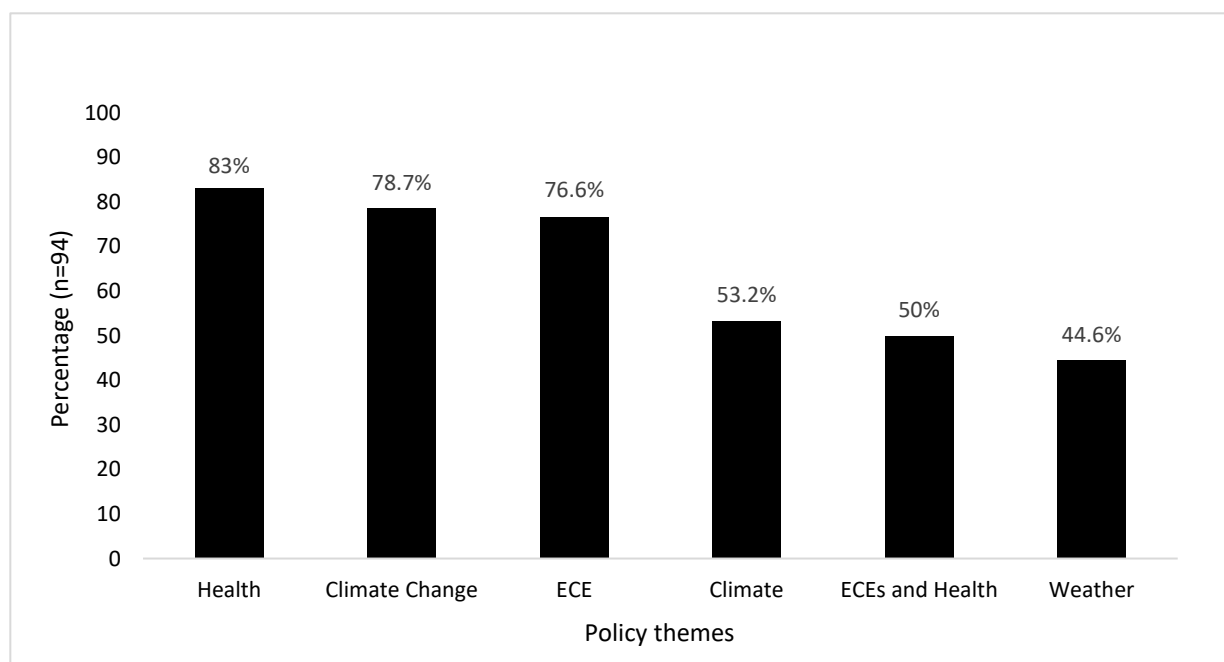


Figure 5.6: Percentage of themes included in policy documents.

When considering the overall inclusion of themes, five policy documents included none of the themes, 11 included one theme, seven included two themes, 11 included three themes, 19 included four themes, 17 included five themes and 24 included all six themes (Figure 5.7).

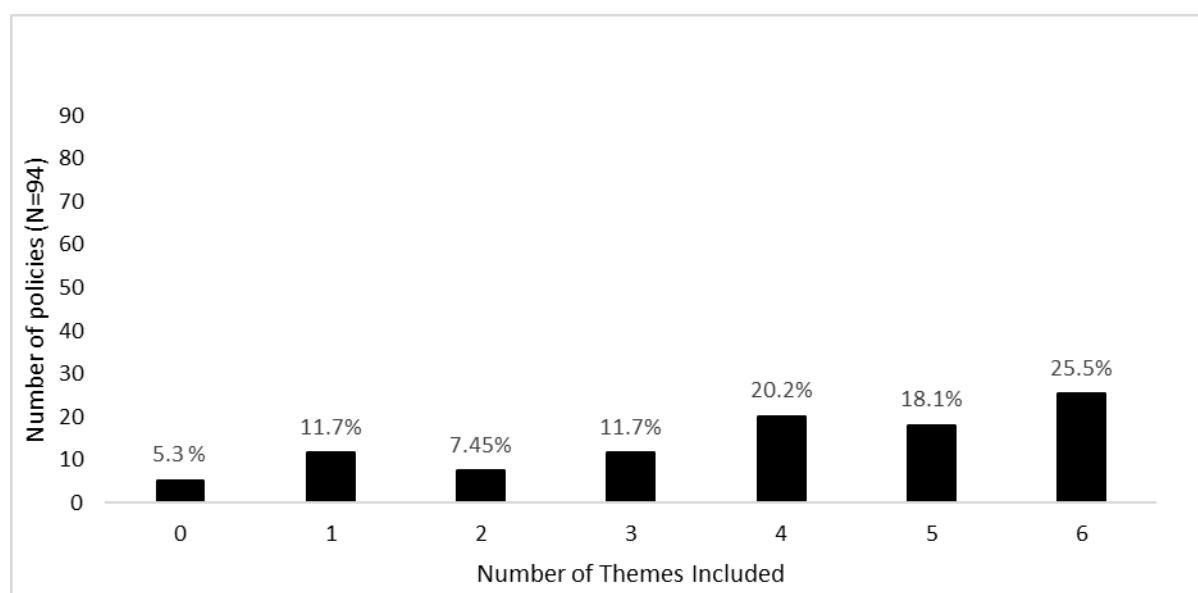


Figure 5.7: Policy documents' inclusions of themes.

5.4.2 Policy Coverage of ECEs and Health

Out of the 94 policy documents collected, 47 included the intersection between ECEs and health which equates to 50% (Table 5.8). When considering how many of these policy documents were created within one year, two batches stand out, the first is six of the policy documents created in 2015 and the second is four policy documents created in 2013. The policy types and statuses included nine reports, seven strategies, six IDPs, five guidelines and five plans, two frameworks and one of each of the following: document, declaration, summary, atlas, white paper, charter, analysis tool, policy, act, profile, review, and bill. Considering the policy documents' levels, there was an equal number of international and municipal policy documents as both had 17

policy documents, while national policies only included 13 policy documents. When policy documents were reviewed to determine whether they included the intersection between ECEs and health, two categories could be established; policy documents that alluded to the intersection and policy documents that explicitly stated the intersection. The following sections will review these categories and further delve into themes found within the data. Each policy was given a policy reference to assist in easier reference thereof (Table 5.8).

Table 5.8: Table of policy documents reflecting on ECEs and health, and policy references.

Policies Including the intersection between ECEs and Health:		Policy Reference:
Climate Change and Human Health: Impact and Adaptation	2000	1
Using climate to predict infectious disease epidemics	2005	2
Health and Climate Change: the "now and how" A policy action guide	2005	3
Climate Change What does it mean for eThekweni Municipality?	2007	4
Libreville Declaration on Health and Environment in Africa	2008	5
Climate change and health	2008	6
Climate change and health Report by the Secretariat	2008	7
Euroheat; Improving Public Health Responses to Extreme Weather/ Heatwaves	2009	8
Climate change and health	2009	9
Municipal Adaptation Plan; Health and Water	2009	10
South African Risk and Vulnerability Atlas	2010	11
Community-based Adaptation to Climate Change in Durban	2011	12
National Climate Change Response White Paper	2011	13
Durban's Municipal Climate Protection Programme: Climate Change Adaptation Planning for a Resilient City	2011	14
Durban Adaption Charter	2013	15
Climate Change and Health: A Tool to Estimate Health and Adaptation Costs	2013	16
National Environmental Health Policy	2013	17
Protecting Health from Climate Change; Vulnerability and Adaptation Assessment	2013	18
WHO guidance to protect health from climate change through health adaptation planning	2014	19
National Climate Change and Health Adaptation Plan	2014	20
Durban Climate Change Strategy	2014	21
South African Development Community; Climate Change Strategy and Action Plan	2015	22
Department of Health Notice 1229 OF 2015	2015	23
Climate and Health Country Profile - South Africa	2015	24
Operational Framework for Building Climate Resilient Health Systems	2015	25
Sendai Framework for Disaster Risk Reduction	2015	26
eThekweni Municipality Integrated Development Plan	2015	27
Health and Climate Change	2016	28
Durban Adaption Charter Report	2016	29
eThekweni Municipality Integrated Development Plan	2016	30
Durban Resilience Strategy	2017	31
eThekweni Municipality Integrated Development Plan	2017	32
Draft National Climate Change Adaptation Strategy	2018	33
Durban Adaption Charter	2018	34
COP24 special report: health and climate change	2018	35
National Climate Change Adaptation Strategy	2019	36
Durban Climate Action Plan	2019	37
South Africa's Low-emission Development Strategy 2050	2020	38
National Heat Health Action Guidelines	2020	39
National Climate Change Adaptation Strategy	2020	40
eThekweni Municipality Integrated Development Plan Review	2021	41
Draft National Climate Change and Health Adaptation Plan 2020 - 2024	2021	42
eThekweni Municipality Integrated Development Plan Review	2021	43

Climate Change Bill	2022	44
Synthesis Report of the IPCC Sixth Assessment Report (AR6) Summary for Policymakers	2022	45
eThekwini Municipality Integrated Development Plan Review	2022	46
eThekwini Municipality Integrated Development Plan	2023	47

Policy Documents that Alluded to ECEs and Health Intersection

A total of 10 policy documents alluded to the intersection between ECEs and Health (Table 5.9).

Table 5.9: Table of policy documents alluding to the intersection between ECEs and health.

Policies Alluding to the ECEs and Health Intersection:		Policy Reference:
Using climate to predict infectious disease epidemics	2005	2
Libreville Declaration on Health and Environment in Africa	2008	5
Sendai Framework for Disaster Risk Reduction	2015	26
eThekwini Municipality Integrated Development Plan	2015	27
Health and Climate Change	2016	28
Durban Adaption Charter Report	2016	29
eThekwini Municipality Integrated Development Plan	2016	30
eThekwini Municipality Integrated Development Plan	2017	32
Draft National Climate Change Adaptation Strategy	2018	33
eThekwini Municipality Integrated Development Plan Review	2021	41

Two themes could be identified from these policy documents: health threatened by climate change, and positive and negative impacts on health. Considering the first theme - out of the ten policy documents, nine policy documents (2, 5, 26, 27, 28, 29, 32, 33, 41) noted climate change as a threat to health but did not specifically refer to ECEs under climate change. When considering these nine policy documents, three of them noted that health was not the only sector influenced by climate change (26, 27, 33). One policy document (26) further noted that the impacts are specifically felt locally and communally. Additionally, the Health and Climate Change (2016:2) policy document that noted climate change as a threat to health, explained further that health must be prioritised:

“The Secretariat proposes the following strategic priorities in light of the Paris Agreement[:] Expanding the public health response to climate change.”

Policy document 34 noted that health is a key sector under adaptation. Policy 34 additionally identified that in South Africa there is a lack of understanding between health and climate. Policy 30 identified that projects done in the eThekweni Municipality have assisted in the increased inclusion and consideration of the climate and health nexus. Lastly, policy 2 alluded to the intersection by explaining that climate change calls for epidemic preparation such as early warning systems for Rift Valley Fever - the policy however did not specifically identify ECEs as having a direct impact on health. The second theme found in these policy documents was the recognition that the environment can have negative and positive effects on health which was found in two of the ten policy documents (30, 41). The eThekweni Municipality IDP Review (2021:146) stated;

“The environment in which people live has the potential to be promotive of health or to impact negatively on health due to the presence of various environmental health risks.”

Policy Documents that Stated the ECE and Health Intersection

There were 37 policy documents that stated the direct intersection between ECEs and health (Table 5.10). There were six themes established from these policy documents which include: ECEs impact health, heatwaves, rainfall/floods, disease, quantification difficulties, and cold snaps. These themes categorise how policy documents state the interconnection between ECEs and health.

Table 5.10: Policy documents that state the interconnection between ECEs and health.

Policies Including ECEs and Health Intersection:		Policy Reference:
Climate Change and Human Health: Impact and Adaptation	2000	1
Health and Climate Change: the “now and how” A policy action guide	2005	3

Climate Change What does it mean for eThekweni Municipality?	2007	4
Climate Change and Health	2008	6
Climate Change and Health Report by the Secretariat	2008	7
Euroheat; Improving Public Health Responses to Extreme Weather/ Heatwaves	2009	8
Climate Change and Health	2009	9
Municipal Adaptation Plan; Health and Water	2009	10
South African Risk and Vulnerability Atlas	2010	11
Community-based Adaptation to Climate Change in Durban	2011	12
National Climate Change Response White Paper	2011	13
Durban's Municipal Climate Protection Programme: Climate Change Adaptation Planning for a Resilient City	2011	14
Durban Adaption Charter	2013	15
Climate Change and Health: A Tool to Estimate Health and Adaptation Costs	2013	16
National Environmental Health Policy	2013	17
Protecting Health from Climate Change; Vulnerability and Adaptation Assessment	2013	18
WHO guidance to protect health from climate change through health adaptation planning	2014	19
National Climate Change and Health Adaptation Plan	2014	20
Durban Climate Change Strategy	2014	21
South African Development Community; Climate Change Strategy and Action Plan	2015	22
Department of Health Notice 1229 OF 2015	2015	23
Climate and Health Country Profile - South Africa	2015	24
Operational Framework for Building Climate Resilient Health Systems	2015	25
Durban Resilience Strategy	2017	31
Durban Adaption Charter	2018	34
COP24 special report: health and climate change	2018	35
National Climate Change Adaptation Strategy	2019	36
Durban Climate Action Plan	2019	37
South Africa's Low-emission Development Strategy 2050	2020	38
National Heat Health Action Guidelines	2020	39
National Climate Change Adaptation Strategy	2020	40
Draft National Climate Change and Health Adaptation Plan 2020 – 2024	2021	42
eThekweni Municipality Integrated Development Plan Review	2021	43
Climate Change Bill	2022	44
Synthesis Report of the IPCC Sixth Assessment Report (AR6) Summary for Policymakers	2022	45
eThekweni Municipality Integrated Development Plan Review	2022	46
eThekweni Municipality Integrated Development Plan	2023	47

The most popular theme was the recognition of ECEs affecting health, which was identified by 21 policy documents (1, 7, 9, 10, 11, 13, 17, 18, 19, 20, 21, 22, 24, 25, 31, 35, 36, 38, 40, 43, 44). The Climate Change Bill (2022:2) emphasized:

“...climate variability...including the increased frequency and intensity of extreme weather events, will affect, amongst other things, human health...”

Out of these policy documents, 14 (7, 10, 11, 13, 18, 19, 20, 22, 24, 31, 35, 36, 38, 44) made the direct statement that ECEs affect health. Additionally, seven of the 21 policy documents (10, 11, 17, 21, 36, 40, 43) gave a specific location in which the ECEs affect health; eThekweni (10, 21, 43) and South Africa (11, 17, 36, 40). The Municipal Adaptation Plan; Health and Water (2009:14) explained:

“Water...and health...have been identified as potentially being critically affected by climate change in Durban.”

The National Environmental Health Policy document (2013:31) mentioned:

“Human beings are directly and indirectly exposed to climate change...Consequently, many South Africans are vulnerable...”

Furthermore, four of the 21 policy documents (3, 9, 11, 25) gave additional information on the ECE-health nexus. Policy 3 explained that ECEs reveal the health sector’s preparation and response shortcomings, and the need for mechanisms to protect health and detect the impacts that will be experienced. Climate Change and Health (2009:5) noted that health systems need to be strengthened to cope with ECEs:

“Strengthen health systems to cope with the health threats posed by climate change, including emergencies related to extreme weather events...”

Policy 11 added that generally, the environment determines residents’ health. Lastly, Operational Framework for Building Climate Resilient Health Systems (2015:8) noted that ECEs are increasing in frequency and intensity which will increase health impacts:

“As many of the largest health concerns are strongly influenced by weather and climate conditions, this inevitably presents risks for human health that can be grouped into: Direct impacts, such as those arising from damages and illness due to increased frequency and severity of extreme weather events...”

The next most common theme was heatwaves, in which ten policy documents (1, 4, 6, 8, 12, 23, 37, 39, 45, 46) made the recognition of heatwaves affecting health. Euroheat; Improving Public Health Responses to Extreme Weather/ Heatwaves (2009:3) described:

“Heat threatens health. Hot weather can cause illness and kill.”

Some policy documents gave additional information, like policy document 1 explained that heatwaves impact health via heat-related illness and morbidity. Policy document 12 reflected on heatwaves increasing pressure on healthcare facilities. Lastly, policy

documents (23, 39) noted that heatwaves threaten the health of vulnerable human populations.

When reflecting on disease risks from ECEs, five policy documents (12, 13, 14, 15, 16) recognised this. Durban's Municipal Climate Protection Programme: Climate Change Adaptation Planning for a Resilient City (2011:18) explained:

“Contingency plans should be developed for each response unit including...: Early warning of disease outbreaks and extreme weather...”

Out of the five policy documents, only one policy document (12) adds that eThekwin is particularly at-risk regarding vector- and water-borne diseases.

Only four policy documents (1, 34, 42, 47) reflect on rainfall/ flood events. For example, eThekwin Municipality IDP (2023:272) explains:

“Key risks posed by these extreme rainfall events include threats to lives and livelihoods, damage to and loss of property (public and private) and decreased water quality...”

When regarding the documents under the theme of rainfall/flooding, two policy documents (42, 47) reflected on locations specifically threatened by floods and rainfall which were KZN and eThekwin. Policy document 34 mentioned that flood risk reduction will increase health benefits. The Climate Change and Human Health: Impact and Adaptation (2000:18) reflected on extreme rainfall events causing mosquito-borne diseases, floods, water contamination, and increased hospital admission:

“...rainfall events triggering mosquito-borne disease outbreaks...flood disaster...contamination of the water supply with human or animal waste...thunderstorms and high humidity leading to short-term increases in hospital admissions for respiratory and cardiovascular diseases...”

The last theme from the policy documents that state the interconnection between ECEs and health, is the recognition of the difficulty in quantifying the impacts of ECEs on health. Policy documents 11 and 42 made this recognition. South African Risk and Vulnerability Atlas (2010:41) added to this statement by explaining that health impacts are sometimes indirect which makes quantification thereof difficult:

“Determining how environmental conditions at different scales change, and how they influence or determine human health is a challenge...Effects of climate change on human health are particularly critical, since climate change itself is a gradual process and its effects on human health are mostly indirect, not easily quantified and their manifestation is complex.”

5.4.3 Common Themes in Policy Documents that Reflected on ECEs and Health

Having considered the policy documents that allude to and state the interconnection between ECEs and health, the sections below consider four themes that all these policies identified. These themes include ECEs, impacts, vulnerable groups, and suggested changes.

ECEs Named in Policy Documents

Out of the 47 policy documents that recognised the intersection between ECEs and health, 20 policy documents identified specific ECEs that impact health. The most popular ECE recognised in these policy documents was heatwaves, identified by 15 policy documents (1, 4, 6, 7, 11, 12, 16, 19, 22, 31, 33, 35, 37, 40, 43). Climate Change and Health (2008:2) explained:

“Higher temperatures will change the distribution, and increase the burden, of various vector-borne, foodborne, and water-related infectious diseases...Greater frequency and intensity of heat waves will increase mortality and the incidence of heat stress and heat stroke. Evidence shows that this is already occurring.”

The next most common ECE identified was rainfall and flood events in which 13 policy documents (1, 10, 11, 13, 19, 22, 24, 31, 35, 39, 40, 42, 43) noted this. From these policy documents, ten of these policy documents (1, 5, 10, 11, 19, 31, 35, 39, 40, 43) specifically noted extreme precipitation while eight policy documents (11, 13, 22, 24, 35, 39, 40, 42) noted flooding. The third most common ECE identified was droughts which were recognized in 11 policy documents (10, 11, 13, 16, 19, 22, 35, 39, 40, 42, 43). There were three ECEs named by two policy documents each: tropical cyclones (5, 22), wildfires (35, 42), and tornadoes (39, 42). Lastly, only policy document (19) identified cold snaps. When reviewing the policy recognition of ECEs it is helpful to note that seven policy documents identified one ECE, five policy documents identified two and four different ECEs, and five policy documents each identified three, five and six ECEs (Figure 5.8).

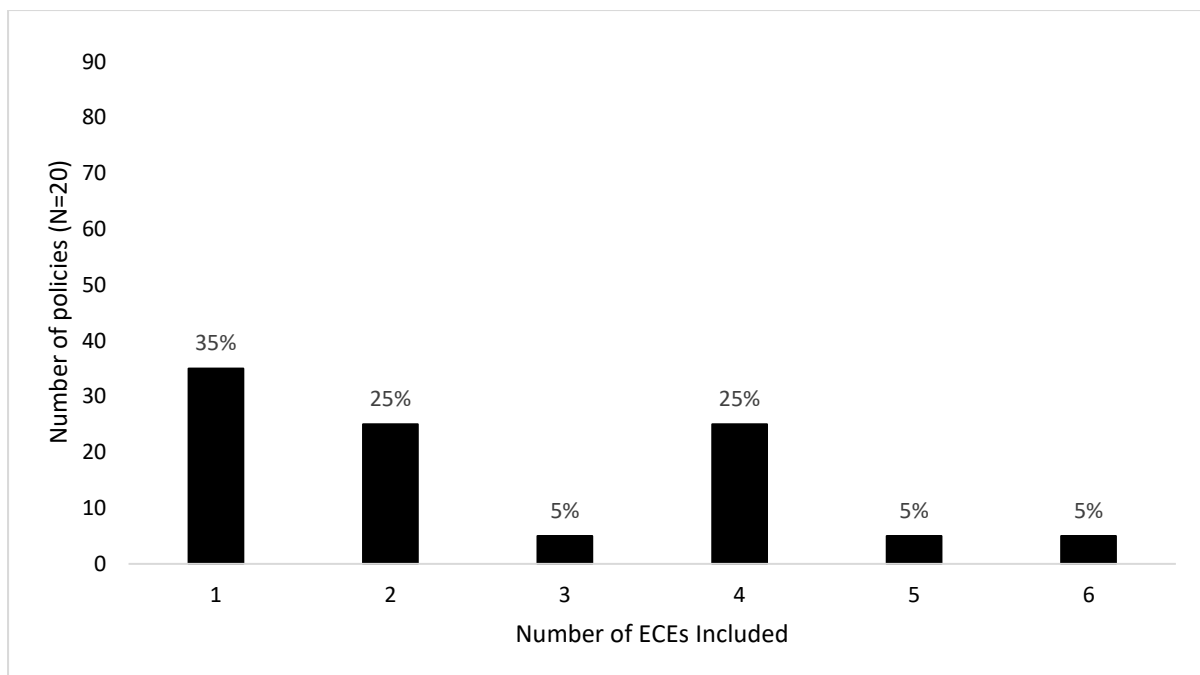


Figure 5.8: Policy documents mention of ECEs.

ECE Impacts Reviewed in Policy Documents

Out of the 47 policy documents, 26 of them gave examples of health impacts under ECEs (Figure 5.10). Most of the policy documents reflected on the general impacts of ECEs as well as heatwave impacts. The South African Risk and Vulnerability Atlas (2010) gave various impacts of ECEs and the health implications thereof (Figure 5.9):

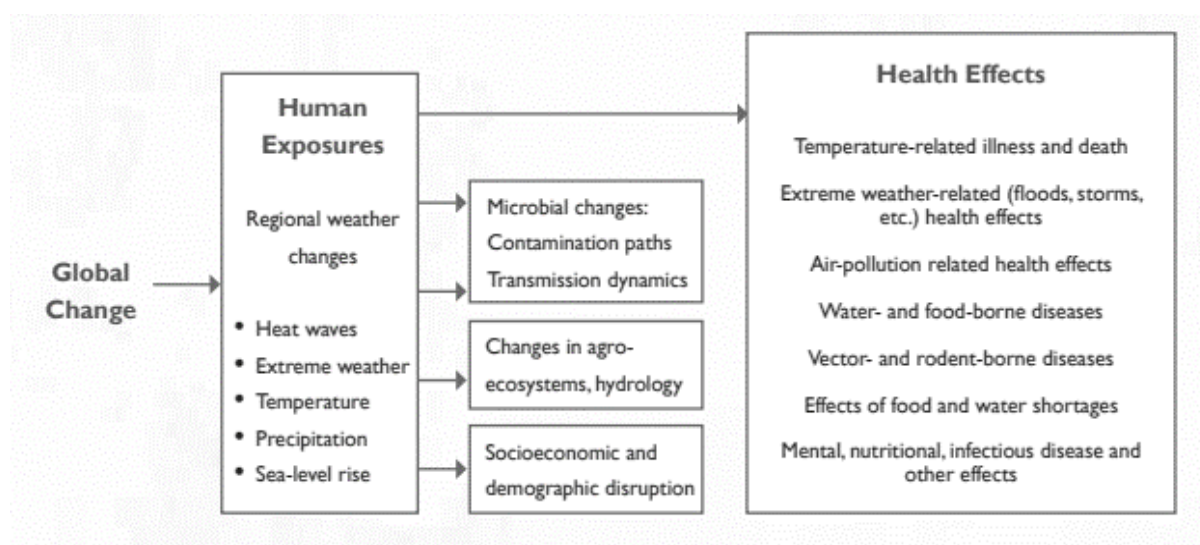


Figure 5.9: South African Risk and Vulnerability Atlas (2010;42) health effects of climate change.

Fewer policy documents detected the impacts experienced under extreme rainfall/flood events and the least reflected on drought impacts. For example, eThekweni Municipality IDP (2023:949) explained:

“The Municipality has identified several climate change risks which may include: An increase in heat-related vector-borne (e.g., malaria) and water-borne (e.g., cholera) illnesses; An increase in heat stress, leading to dehydration, particularly for those that reside in the Municipality, as well as children and the elderly...”

Additionally, 19 policy documents (1, 4, 6, 7, 10, 13, 16, 20, 21, 22, 24, 25, 33, 35, 36, 38, 42, 43, 45) considered the impacts generally. Furthermore, 14 policy documents (1, 6, 7, 8, 12, 22, 33, 35, 37, 39, 40, 45, 46, 47) noted the impacts of heatwaves, nine policy documents identified the impacts of excessive precipitation (1, 10, 42, 47) and

floods (13, 24, 35, 40, 42), and only two policy documents (10, 13) noted those of droughts. Policy documents that noted the general impacts of ECEs had eight main impacts; water-borne diseases were identified by nine out of the 26 documents, vector-borne diseases were noted by eight policy documents, malaria risks were distinguished by seven policy documents, infectious diseases and food-borne disease/pathogens were each recognised by six policy documents, five policy documents each documented psychological impacts, decreased food production/supply and mortality. COP24 special report: Health and Climate Change (2018:20) considered pathogens because of different ECEs:

“Rising temperatures, floods and droughts also affect food safety; for example, rising temps can increase the levels of pathogens in food sources...and flooding increases the risk that pathogens will spread from livestock.”

Considering the psychological impacts, the COP24 special report: Health and Climate Change (2018:20) for example noted:

“For example...mental illness after extreme weather events, climate-related displacement, immigration and loss of culture, can be lifelong.”

Of these 19 policy documents that identified general impacts of ECEs there were also four policy documents that each accounted for water supply disruptions, population displacement, and respiratory illness, disease, and infection. Out of the 14 policy documents that reflected on heatwave impacts; 7 policy documents acknowledged mortality, and four policy documents each recognized heatstroke and water-borne diseases. For example, Climate Change and Health Report by the Secretariat (2008:2) explained:

“Greater frequency and intensity of heat waves will increase mortality and the incidence of heat stress and heat stroke.”

In connection with these policy documents, five policy documents associated health impacts of floods in which vector-borne diseases, water supply disruption, and population displacement were each identified in two policy documents. COP24 special report: Health and Climate Change (2018:20) reflected on this:

“Climate change has indirect effects on health due to ecological changes, such as food and water insecurity and the spread of climate-sensitive infectious diseases, and also to societal responses to climate change, such as population displacement and reduced access to health services.”

For the policy documents that recalled the impacts of excessive precipitation, there were four policy documents; of which morbidity, infrastructural damage and water contamination/decreased water supply were each also identified by two policy documents. For example, the Synthesis Report of the IPCC Sixth Assessment Report (AR6) Summary for Policymakers (2022:6) considered infrastructural damages saying:

“Individual livelihoods have been affected through, for example, destruction of homes and infrastructure, and loss of property and income...”

Lastly, a minority of policy documents reflected on drought impacts, however out of the two policy documents that did, both were conscious of heat stress. By way of illustration, Climate Change and Health: A Tool to Estimate Health and Adaptation Costs (2013:21) describes:

“Droughts...direct and indirect health effects, through reduced crop productivity, more animal deaths, pests, relocation, fires...risk for infectious diseases, inadequate water supply and sanitation services, acute respiratory infections...”

ECEs Impacts:	Droughts	Heatwaves	Floods	Extreme Precipitation	General ECE impacts
Heat stress	 	 			 
Increased stress on the health sector					 
Increased costs on health facilities					
Waterborne diseases (e.g., Cholera)		   			        
Psychological effects (e.g., Depression, Post-traumatic stress, Insomnia)					    
Morbidity		  		 	 
Infectious disease					     
Sanitation concerns					
Infrastructural damage				 	  
Vector-borne diseases/breeding		  	 		       
Water supply disruption			 		   
Population displacement			 		   
Decreased food production/supply					    
Decreased water availability					
Increased disease distribution					
Increased pathogens between livestock					
Floods					
Mosquito-borne disease (e.g., Chikungunya)					
Increased insurance costs					
Increased hospital admissions					
Water contamination/decreased water quality				 	
Illness					
Mortality		      			    
Malaria risk		  			      
Heat cramps					

Heat exhaustion					
Heat related illness					
Increased infections					
Impact on resources					
Physiological effects					
Decreased air quality					
Increased dehydration		 			
Cardiovascular disease					
Increased asthma cases					
Increased disease distribution					
Respiratory disease, illness, and infections		 			   
Foodborne diseases and pathogens		   			     
Injury					  
Malnutrition					  
Diarrhoeal disease					
Rodent-borne disease					
Yellow fever					 
Decreased occupational health					 
Decreased life expectancy					
Decreased maternal and child mortality					
Hepatitis A and E					
Decreased immunity					
Increased susceptibility to infectious disease					
Overcrowding					
Spreading of Meningitis					
Spreading of influenza					
Damage to water facilities					
Increased municipality and state costs					 

Impact on water, waste, transport, and sanitation sectors													
Magnify health challenges													
Dengue fever													
Increased communicable diseases (e.g., HIV/AIDs and TB)													
Decreased economic growth													
Increased poverty aggravation													
Increased non-communicable diseases													
Gender and social equity concerns													
Airborne diseases													
Increased susceptibility to health risks													
Increased vulnerability of health facilities													
Increased migration													
Policy Legend	1	4	6	7	8	10	12	13	16	20	21	22	24
	25	33	35	36	37	38	39	40	42	43	45	46	47

Figure 5.10: Policy documents reflection of ECEs impacts.

Reflection of Vulnerable Groups within Policy Documents

Of the 47 policy documents, 16 noted vulnerable groups including: the elderly, the young, socio-economically disadvantaged, those with pre-existing health conditions, women, and lastly, outdoor workers and urban and rural areas (Figure 5.11). Of the 16 that mentioned vulnerable groups seven just mentioned that there are vulnerable groups but did not specify any. The most popular vulnerable group was identified by

nine policy documents (2, 4, 12, 13, 22, 35, 39, 43, 47) which was the elderly. The young were noted by eight policy documents (2, 4, 12, 13, 23, 39, 43, 47). Socio-economically disadvantaged groups were mentioned in four policy documents (2, 13, 30, 39). Those with pre-existing health conditions were referred to within three policy documents (2, 12, 39) as a vulnerable group. Only two policy documents (13, 19) brought up women as a vulnerable group. The NCCRP (2011:19) explained numerous vulnerable groups:

“Furthermore, direct physical temperature stresses pose particular risks for children, the elderly and socio-economically vulnerable communities. Women, as primary caregivers, are put under additional strain looking after sick and elderly household members whilst maintaining a household.”

Lastly, one policy document noted outdoor workers (4), urban (20) and rural (42) areas as vulnerable groups.

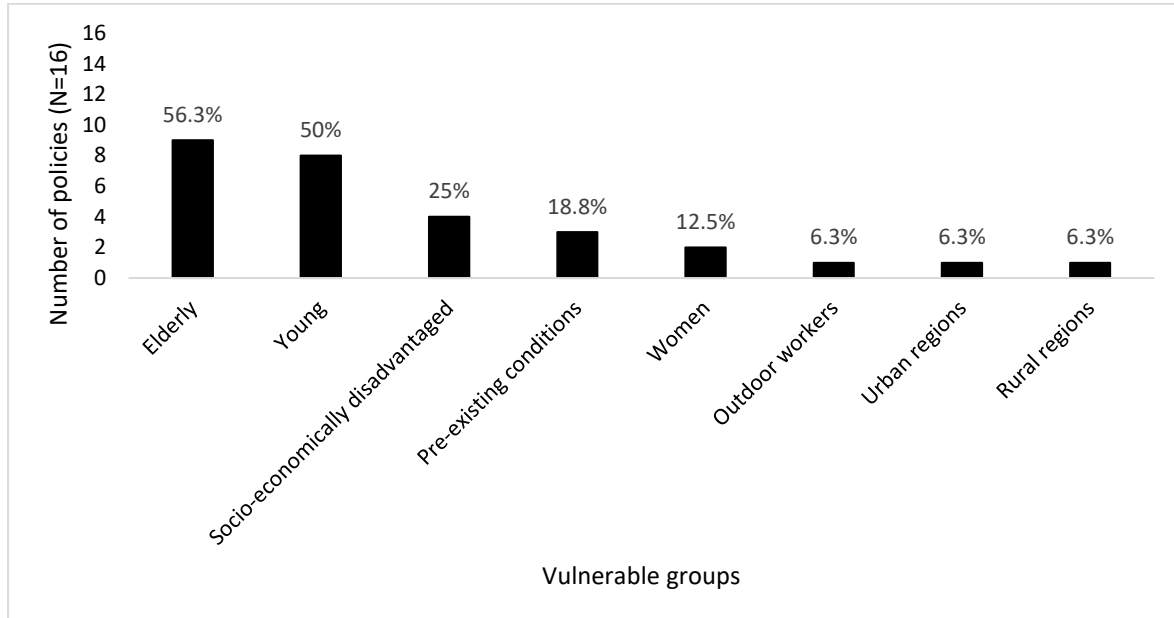


Figure 5.11: Policy documents identification of vulnerable groups.

Policy Documents Suggested Changes

From of the 47 policy documents that identified the intersection between ECEs and health, 29 also identified necessary changes and strategies to strengthen this intersection (Figure 5.12). These suggested changes can be categorized into seven themes: needed increases in aspects of preparation for ECEs, cooperation, health facilities and sectoral changes, disaster/emergencies/ECEs, information/data, education, and health personnel. Furthermore, 18 policy documents (6, 8, 9, 10, 11, 12, 14, 16, 19, 21, 25, 26, 33, 34, 35, 36, 41, 42) identified the theme of necessary increases in methods of adaptation and preparation for ECEs. There were 31 increases identified by these 18 policy documents of which the three most common were identified by two policy documents each and included: the need for increased understanding (e.g., understanding between climate change and health impacts), strengthening healthcare delivery and climate resilience, and increased early warning systems and surveillance. One example of this can be taken from the Draft National Climate Change Adaptation Strategy (2018:13):

“There is a lack of understanding of the linkages between climate and health in South Africa (e.g., quantitative link between high temperatures and mortality).”

Of the 29 policy documents, 13 policy documents (7, 8, 10, 19, 22, 25, 26, 30, 33, 35, 37, 41, 42) identified necessary co-operation between various sectors, levels, and stakeholders. Out of these, 22 needs were identified of which the most popular was cooperation, coordination, and collaboration between key sectors (e.g., health and water), which was identified by three policy documents. The WHO Guidance to Protect Health from Climate Change through Health Adaptation Planning (2014:26) identified this need for cooperation, coordination, and collaboration:

“...intersectoral coordination and collaboration are often required to address health impacts.”

Additionally, 12 policy documents (12, 20, 21, 25, 26, 28, 33, 35, 36, 39, 40, 45) noted necessary changes in the health sector as well as health facilities. These 12 policy documents identified 21 key changes regarding health facilities and the health sector, none were mentioned by more than one policy each. Health and Climate Change (2016:2) clarified:

“...to strengthen the climate resilience of their health systems, for example through improved disease surveillance and preparedness for extreme weather events, ensuring climate-resilient health facilities, with access to essential services such as energy, water and sanitation...”

Moreover, 11 policy documents (7, 8, 9, 10, 21, 25, 26, 34, 36, 39, 41) found changes that would be beneficial regarding disasters, emergencies and ECEs. The 11 policy documents highlighted 15 key needs when considering disasters, emergencies, and ECEs. Of these, two were most popular namely, strengthening and promoting emergency management and preparation services, and planning and decreasing disaster risk – both of which were mentioned by two policy documents each. Changes that are necessary when considering information and data was identified by six policy documents (19, 25, 35, 39, 40, 42). COP24 special report: Health and Climate Change (2018:58) explained the following for data:

“Continued, effective progress in protecting health from climate change requires coordination among the many stakeholders acting at various levels. Their priorities, decisions and assessment of progress must, however, be based on reliable, relevant data.”

There were fifteen suggestions under this theme of which none were mentioned by more than one policy. Notably, five policy documents (12, 15, 16, 19, 35) identified educational changes. There were five suggestions given, of which, increasing education (e.g., educating the community on ways to respond to events) was the most

popular as two policy documents mentioned this. The Community-based Adaptation to Climate Change in Durban (2011:40) reflected on how education can assist:

“... [A] public education campaign is recommended for the Department of Public Health that focuses on how communities should respond to various climate change-related health impacts.”

Lastly, four policy documents (2, 7, 26, 35) identified the theme of health personnel changes needed. There was no suggestion identified by more than one policy.

Necessary Changes:	Increases:	Cooperation:	Health Facilities and Sector:	Disasters, Emergencies and ECEs:	Information and Data:	Education:	Health personnel:
Polymakers need to increase system effectiveness and positive impact on disease control							
Increase health system mobility in response to ECEs impacting health							
Strengthen health systems' ability to deal with ECEs							
Health professionals need to contribute to the increasing of understanding of adaptation and mitigation to decrease and prevent climate-related disease, injury, and death							
Health sectors at all levels are responsible for leverage and skilled staff to assist in protecting the public from ECEs							
Increase heat-health action plans							
Prevent impacts where possible							
National and regional plans to protect health							
Increased awareness							
Increased understanding (e.g., understanding of climate change and health intersection)	 						
Increased behavioural change							
Assess health emergency effectiveness to decrease health impacts from ECEs							
Cooperation, coordination, and collaboration between key sectors (e.g., Health and water)		  					
Keep existing surveillance and monitoring for disease detection under climate change							
Revise plans to increase awareness							
Planning and disaster management are needed to decrease pressure during ECEs							
Amend and support strategies and policies to increase resilience							
The health sector must adapt							
Review primary healthcare system finding interventions to increase capacity							
Create a health department emergency plan for disaster response to increase capability and prioritization							
Increase education (e.g., educate communities about how to respond)						 	

Increase health system response to disease outbreaks	◆						
Show decision-maker cost of inaction on the health sector						■	
Policymakers must increase cases for early adaptation	■						
Find the current burden and distribution of climate-sensitive health outcomes					●		
Find how effective current health sector policies and programs are in managing climate-sensitive health outcomes					●		
Find long-term health impacts					●		
Create additional public health policies and programs					●		
Educate individuals, communities, responders, and health workers for appropriate responses						●	
Increase health sector infrastructural resilience	●		●				
Tailor health policies to consider climate conditions					●		
Actors need to focus on core system components such as governance, information management, finances, workforce management, and health service delivery		●					
Capacity building			◆				
Continue to promote health under climate change			▲				
Increase municipality adaptability, recovery plans, and health service improvement, especially for vulnerable groups	▲						
Strengthen and promote emergency management and preparation services				▲ □			
Develop community emergency plans				▲			
Equip local health facilities for ECEs				▲			
Strengthen healthcare delivery and increase climate resilience	□ ◆						
Improve management of environmental determinants (e.g., Water and sanitation)		□					
Need up-to-date information on high-risk regions, staff, and supplies, concerns for vulnerable groups, and health facilities					□		
Consider essential environmental services to health facilities			□				
Plan and decrease disaster risk				○ □			
Address existing challenges and prepare for future ones				○			
Focus on monitoring, assessing, and understanding disaster risk governance				○			
Relevant stakeholders at all levels must meaningfully participate							○

Invest in resilience, response, recovery, rehabilitation, and reconstruction							
Prevent and decrease existing disaster risk through collaboration between sectors							
Adopt and implement disaster risk reduction at local and national levels							
Foster global collaboration and regional mechanisms for implementing relevant tools							
Public and private investment in disaster risk prevention							
Enhance national health systems' resilience							
Strengthen the design and implementation of inclusive policy							
Enhance cooperation between the health sector, authorities, and stakeholders							
North and South cooperation and partnership							
Prioritise public health response							
Use Paris Agreement to strengthen climate resilience for health sector							
Make disaster management everyone's business							
Cooperation between internal and external departments							
Increase understanding of interconnections							
Improve healthcare by increasing the resilience of the community							
Equip and capacitate healthcare facilities to manage climate change effects							
Local government disaster risk and health sectors to capacitate healthcare facilities to manage climate change-related health effects							
Increase river management							
Decrease flood risk and health implications							
Increase early warning systems and surveillance							
Make use of easy and cheap methods							
Make healthcare the centre of service delivery							
Healthcare facilities to increase quality, population coverage, and resilience							
Allow the health sector to play a central role in health adaptation							
Health sector to prioritize increasing public support from civil and health societies							
Note that health professionals are the most trusted in society							

Remember health professionals have a commitment to protect and improve health and witness and respond to health effects							●
Health professionals need to increase awareness	●						
Keep climate change central in health work			●				
Keep increasing scientific evidence and papers	●						
Health professionals, institutions, organizations, and sectors need to increase education on health and climate change and increase political engagement	●						
Health professionals need to increasingly interact with politicians and policymakers	●						
Need more formal education on the interconnection between health and ECEs						●	
Increase funding	●						
Invest in adaptation for sectors like disaster risk management		●					
Coordinate stakeholders at all levels		●					
Prioritise and assess progress and ensure decisions are supported by reliable data					●		
Use major international agreements for ideas on monitoring targets					●		
Coordinate approaches to monitoring and interconnecting policies		●					
Efficient data collection and reporting					●		
Better data quality and consistency					●		
A coalition of data and annual updates					●		
Support from health and climate financing mechanisms		●					
Invest in climate-resilient health systems, and facilities and determining sectors			●				
Efficient collaboration among health ministries		●					
Increase investment and partnerships	●						
Facilitate and promote engagement of the health community as trusted advocates for climate action							●
Increase health and community resilience			◆				
Equip and capacitate emergency response departments				◆			
Equip and capacitate healthcare facilities to manage climate change impacts			◆				
Improve interconnection between water and health		▲					
Create an operational plan for facilities during ECEs				◆			

Timely health data																
Prevent possible negative health consequences																
Find how people understand health risks																
Ensure sound information and data																
Health system adaptation																
Healthcare representatives should know they are key in disaster risk management both pre- and post-disaster																
Increase community health and decrease vulnerability																
Stakeholders need to share responsibility for decreasing disaster risk																
Strengthen reporting and information systems of the health sector																
Increase health services and adequate responses																
The health system must evaluate and strengthen itself to remain operational during ECEs																
Municipality and provincial levels should contribute towards disaster management plans																
Urgent mitigation and adaptation actions																
Policy Legend	2	6	7	8	9	10	11	12	14	15	16	19	20	21	22	
	25	26	28	30	33	34	35	36	37	39	40	41	42	45		

Figure 5.12: Policy documents reflection of necessary change

5.5 Conclusion

This chapter considered the data collected from experts and policy documents to increase policy awareness and enhancement. Three sets of data were contemplated: ENBEL interview data, primary data, and policy data. The ENBEL data reflected on participants' recognitions of ECEs and policy, ECEs and health, and general reflections on climate and health. The primary data displayed six codes created which included policy necessity, policy accountability, policy identification, scope of policy documents, barriers, and eThekwin policies. Lastly, the policy data first reflected on the themes the policy documents were searched for. Half of the policy documents included the intersections of ECEs and health. Some of these policy documents either alluded to or explicitly stated the interconnection. Considering all the policy documents that identified the ECE-health nexus, 20 policy documents named ECEs, 26 policy documents noted health impacts from ECEs, 16 mentioned vulnerable groups, and 29 gave suggestions for improvement.

CHAPTER 6: DISCUSSION



(Baloyi, 2022).

6.1 Introduction

The study aimed to assess the extent to which policy documents relevant to eThekweni include the intersection between ECEs and health. Furthermore, this study aimed to find the interlinkages and differences between stakeholders' opinions on relevant policy documents and the policy data. This chapter gives an assessment, critical evaluation, and interpretation of the main findings. It is useful to note the functionality and practicality of the three sets of data which is to assist in policy decision making and interventions to assist adaptation efforts. Thus, this chapter considers the South African policy framework, policy coverage, and the way forward under future climate change. Lastly, the chapter identifies the limitations of the study.

6.2 Participants' Reflection of the South African Policy Framework

Considering the South African policy landscape as discussed in the literature review, it is beneficial to consider interview participants' feedback on who is perceived to be responsible for these policy documents. Interview participants gave a variety of feedback in this regard as discussed in the previous chapter. There were arguments for national, provincial, and municipal responsibility of policies that all identify the usefulness of each tiers involvement. Participants gave various reasons for their responses, each of which apply currently to the policy documents this study considers. For example, six participants argued that each region has specific circumstances to work around, hence the importance of municipal governance. The importance of local governance responsibility for adaptation to ECEs has been well-recognized (Giordono *et al.*, 2020; Lesnikowski *et al.*, 2021). This has also been highlighted by the IPCC (2023), which has clarified that regional contextualisation of extreme events is as

important as global shifts thereof. Four participants argued that the national government is also responsible as they are most aware and capable of current affairs, supplying resources and finances, and advocate policy. Again, this is not new in the scientific literature that acknowledges the importance of national-level adaptation (Fuldauer *et al.*, 2022; Lee *et al.*, 2022). Having reflected on the synergy between all three spheres of government in South Africa, it is clear that although regional climate extremes occur, and local government is the first response, there is still a dependence on higher tiers of government in a multitude of aspects as indicated by these participants. It can be argued that the most influential way to establish, improve and implement these policies is to share responsibility - participant M was the only respondent to have suggested this in order to also increase cooperative governance. This has also been a well-discussed topic in climate change governance even within South Africa. It has been argued that as with many other countries, South Africa's climate change governance depends on a complex interconnection between various stakeholders including private and NGO sectors, law, and policy around adaptation and mitigation, international connections, and the government – specifically all three spheres of government and its actors thereof (Pietrapertosa *et al.*, 2021; de Visser and du Plessis, 2023). Comparing this data to the secondary ENBEL data and the policy data – there was no recognition on this topic within the ENBEL interviews however, there were policies within the policy data from all three spheres of government.

Bearing in mind the three spheres of government in which each has its policies, and the reflection of participants whereby various governmental spheres are responsible, it is beneficial to deliberate how existing policy documents from different tiers of

government differ from one another when considering extreme climates and health. From this study's policy data, there were 18 international policy documents, 17 municipal policy documents, and 12 national policy documents. South Africa has also integrated itself within international, continental, and regional climate change efforts by signing multiple frameworks, protocols, and treaties such as South Africa's commitments to the United Nations Framework Convention on Climate Change (UNFCCC) including the Kyoto Protocol (van der Bank and Karsten, 2020; Department of Energy, 2023). However, the fact that there are nearly as many municipal policy documents as international ones arguably identifies an intersection between international relations and public governance, specifically regarding eThekweni (Ruffin, 2013). This argues that local governments are becoming actors in global affairs, a recognized characteristic of the eThekweni Municipality (Roberts and O'Donoghue, 2013; Ruffin, 2013; Lesnikowski *et al.*, 2021). The extent of policy documents for eThekweni and resulting adaptation efforts under climate change have also had other welcoming impacts such as the reusability of policy documents in other South African contexts or regions, as well as assisting in poverty alleviation (Diga *et al.*, 2016; Okem and Bracking, 2019). Although it is generally assumed that local action is based on international and national policies, in the case of eThekweni there have been primary drivers that have been local champions who have formed their climate skills and knowledge through personal interest, commitment, and opportunity to then influence institutional local-level planning (Roberts and O'Donoghue, 2013).

Focus will now be placed on the stakeholder reflections against the discussion around the policy documents. The ENBEL stakeholders did not directly comment on policy development in terms of ECEs and health, however, the broad feedback given to questions asked alongside the open nature of the interviews, allowed feedback that is

useful to reflect on. When ENBEL participants reflected on policy development the main area of concern was DRM - five out of the nine participants reflected thereon. Effective DRM decreases vulnerability and exposure however, risks can never be fully eliminated (IPCC, 2012). This recognizes the value of DRM policy when considering the intersection between ECEs, health, and policy - because DRM can enhance resilience to extreme events at all levels but with proven success when done at a local level (IPCC, 2012; Gibson *et al.*, 2016). Moreover, DRM is directly associated with the design, evaluation, and implementation of policy documents among other strategies to aid in well-being, resilience, quality of life, and sustainable development (IPCC, 2012). Participant B identified DRM policy in South Africa as 'general' whereas participant J reflected that they are not even aware of the recognition of ECEs in DRM policy documents. Both arguments identify possible shortfalls in our DRM strategies in South Africa. However, DRM is thoroughly embedded in disaster awareness in South Africa – for example, the South African national government has identified droughts, wildfires, floods, and heatwaves as some of the significant disasters (Culwick, 2019). Participant J's lack of knowledge of extreme events within disaster risk policy rather notes a lack of knowledge of DRM policy documents amongst experts. Additionally, South Africa began the journey of DRM as far back as 1994 when they included DRM in the legislation. This resulted in the DMA 57 of 2002 and the National Disaster Management Policy Framework (NDMF) in 2005, of which the responsibility thereof falls heavily on municipalities (Botha and van Niekerk, 2013). This local risk governance in South Africa is one area where improvements are necessary for better DRM which is also heavily entwined in the connections between civil society, experts, and government (Botha and van Niekerk, 2013). Participant F identified this need for interconnection too, highlighting the willingness of organizations

like NGOs and churches in wanting to be involved in DRM processes when extreme events occur.

DRM was also briefly noted by two of this study's interview participants. Participant K identified the importance of DRM in policy that recognizes the intersection between ECEs and health, as well as general municipal mandates. Participant K identified a problem in this regard as DRM seems to be separated from environmental departments, especially at a local level which calls for necessary updates, testing, and checking on regional contexts. Although it would be generally considered important to ensure DRM is connected to all departments this has also caused issues regarding South African DRM personnel. For example, Wentink and van Niekerk (2017) found that staff members involved in DRM often lacked focus as they were also involved in other departments. Moreover, participant K also pointed out the fact that civil society is not well included in DRM. This has been found in the literature and is arguably an important area to improve DRM (Räsänen *et al.*, 2020). Participant O identified the need to improve DRM in South Africa. It is not surprising that DRM was identified as an important factor by both sets of participants as the interconnection of DRM alongside other elements of extreme weather and government action is critical in decreasing the impacts of these events alongside improving sustainability (Sperling and Szekely, 2005; Imperiale and Vanclay, 2021). Particularly of importance are the synergies between practical methods of DRM and policy frameworks alongside recent scientific arguments for climate change adaptation (Sperling and Szekely, 2005; Unger *et al.*, 2020).

Furthermore, the study's interview participants also identified other factors of importance, such as all the participants noting the need for relevant South African policy documents to reflect the intersection between ECEs and health. Half of the participants specifically identified that the lack of policy documents reflecting on this intersection would increase risks and impacts. Extreme events cannot be avoided entirely, yet health risks can be prevented through strategies like enhancing the health system's climate resilience through improved preparation, recovery, risk reduction, and response – which included adaptation efforts like DRM (Ebi *et al.*, 2021a). Therefore, the lack of action would result in the opposite, the increase of risk, as was highlighted by participants. Participant K explained that without policy that covers this intersection health aspects are undermined. This is similar to a variety of studies that show health is generally undermined during and after disasters (e.g., the right to health or mental health impacts; Burkle, 2006; Silove and Steel, 2006; Herrman, 2012). Three participants also argued the benefits to policy documents including the intersection between ECEs and health. The literature suggests that policy documents could assist with preventing further adverse health impacts and implementing disease control strategies, amongst others (Noji, 2000). Another possible positive influence is via improved infrastructure, which had also been identified in previous research and by participant U (Spence, 2004). Participant R noted possible improvement of siloed funds – also identified in relevant political strategies assisting with financial concerns and efforts for disasters (Wamsler and Johannessen, 2020). Participants gave further reasons for this intersection being important in policy; to encouraging proactive effort, increase awareness and education, and continuous ECEs occurring currently within eThekweni. The literature supports these reasons, for example, it has been identified that policy documents that are proactive in disaster management are highly successful

and comply with international agreements such as the Paris Agreement and the Hyogo Framework for Action (HFA) (Choudhury and Haque, 2024). Additionally, the *Sendai Framework for Disaster Risk Reduction 2015-2030* (2015) is one example of a political strategy that encourages education and awareness for the reduction of disaster vulnerability and risk. The importance of education in these efforts have further been identified in various literature (Sakurai and Sato, 2016; Baytiyeh, 2017; Tsai *et al.*, 2020). Lastly, the participants are correct in noting that there have been disasters occurring in eThekweni such as the 2022 floods, yet more importantly, these will become more threatening as they will occur more frequently and intensely in the future (eThekweni Municipality, 2022).

This section of the chapter has reflected on the South African Policy Framework. Firstly, secondary interview data reflects on who is responsible for the policy documents this study considers. The majority of participants argued that the national and provincial tiers of government are responsible however, participants gave a multitude of reasons for why individual or multiple tiers are responsible. Therefore, this data particularly reveals an uncertainty of who in South Africa is responsible for the policy documents that should consider the interconnection between ECEs and the health impacts thereof. Notably, the literature argues for each of the tiers being important, but no obvious literature considers the interconnections thereof. Although the South African constitution gives a suggested framework for inter-governmental relations (IGR) and cooperative governance, there are shortcomings in the practical way the South African governmental system functions that create uncertainty about the responsibilities of each tier of government (Lukasiewicz *et al.*, 2017; Averchenkova *et al.*, 2019; Michel *et al.*, 2019). Hence, the replies of respondents in this study in

being uncertain of the policy responsibilities of the three tiers of government are not uncommon.

Second, the policy data shows South Africa has climate change policies across all three tiers of government. Notably, policy documents specific to eThekweni indicate a strong municipal presence within policy around climate change. The study site is well recognized in South Africa and globally for its proactive efforts in adapting and planning for climate change (Roberts, 2010; Glavovic and Smith, 2014; Olanrewaju and Reddy, 2022). The efforts of this region are documented in various ways, for example in published literature, the website of the Municipality, and reports (Roberts and O'Donoghue, 2013; Roberts and O'Donoghue, 2016).

Thirdly, primary and secondary participants' reflections on the importance of DRM are discussed. ENBEL participants identified the importance of DRM within climate change policy development. Specifically, the need to increase the awareness of DRM in policy alongside the inclusion of various stakeholders in DRM efforts. Both sets of participants reflections on this front were similar. Published literature recognizes the need for relevant policy to include aspects of DRM, with reflections on the intersection between extreme climates, impacts on health, and DRM in policy (Albris *et al.*, 2020; Ebi *et al.*, 2021a). Additionally, the inclusion of stakeholders in DRM processes is also recognized (Aldunce *et al.*, 2016; Albris *et al.*, 2020; Rajabi *et al.*, 2022).

Lastly, interview participants identified the critical need to increase the recognition of the intersection between ECEs and health in policy. Participants identified positives in doing this alongside negatives if it was not. For example, a positive would be

increasing the preparation of ECEs through disease control strategies versus the negative if it were not done which would be the increase of health risks overall. This section therefore identifies that the South African policy framework is heavily interconnected with the government tiers but there are high levels of uncertainty about the responsibilities of climate change adaptation efforts that consider ECEs and the impacts thereof on health. Moreover, there is recognition of climate change efforts in policy (especially regarding eThekweni) and the importance of DRM therein. Finally, the importance of the South African policy framework having relevant policy identify the intersection between ECEs and health for the benefit of South African adaptive efforts.

6.3 Policy Coverage

This section of the chapter reflects on the recognition of the intersection between ECEs and health in policy, specifically the level of coverage thereof. Firstly, the ECEs mentioned in all three sets of data are considered. Second, all the health aspects identified by the various sets of data are reviewed. Lastly, the intersection between ECEs and health within the three sets of data are discussed.

6.3.1 Policy Document Coverage on ECEs

Out of the total 94 policy documents collected for the study, 72 included the ECE theme. This was the third most popular theme within these policy documents out of the six themes they were reviewed for. However, a more thorough review was established from the 47 policy documents that identified the intersection between ECEs and health. The ECEs noted in these policy documents in descending order are heatwaves (15 policy documents), drought (11), extreme precipitation (10), flooding

(8), tropical cyclones (2), tornadoes (2), wildfires (2), and cold snaps (1). This shows that there are no ECEs that are excluded between all these policy documents yet a large difference in how many policy documents recognize each ECE. This could reflect varying perceptions of different ECEs under climate change, such as the seriousness thereof (Cutler, 2015; Salam *et al.*, 2021; Ratwatte *et al.*, 2022) and the ECEs currently observed – for example, there have been increasingly new records of temperature increases compared to other ECEs (Ripple *et al.*, 2022; Grab and Nash, 2023). When considering the participants' reflections on ECEs, a similar trend can be observed in which some ECEs are more frequently mentioned than others. For example, in the ENBEL data, only four of the nine participants mentioned ECEs they are aware of. Three participants each identified heatwaves and floods. Thereafter, only one participant each identified droughts, extreme precipitation, and wildfires. None of the participants had mentioned tropical cyclones, tornadoes, or cold snaps. Additionally, in the interview data all 12 participants mentioned floods, eight mentioned heatwaves, six mentioned drought, five identified extreme precipitation, two noted tropical cyclones, two distinguished wildfires, one identified cold snaps and none mentioned tornadoes. Thus, from the three sets of data collected, the most frequently identified ECEs in descending order were heatwaves, floods, drought, extreme precipitation, wildfires, tropical cyclones, and then both cold snaps and tornadoes. These results are not surprising as the literature and policy documents have both mentioned the large increase in temperatures globally but also specifically expected over the region of eThekweni within the next few years (Jagarnath *et al.*, 2020). Additionally, shifts in rainfall will lead to increased extreme precipitation as well as drought periods, and lastly, the reflection of ECEs that have already occurred such as the recent storms and floods within eThekweni (Roberts and O'Donoghue, 2013; Jagarnath *et al.*, 2020).

The recognition of ECEs between all three sets of data is encouraging as it reveals that policy documents and stakeholders are aware of these events and the importance of preparing for them.

6.3.2 Policy Document Coverage on Health

Having considered the coverage of ECEs in the various sets of data, it is then important to reflect on the health coverage therein. When reflecting on all 94 policy documents, health as a theme was included in 78 of them. Health was the most recognized theme out of the six themes that the policy documents were searched for. This is wonderful when reflecting on HiAP to which South Africa is a signatory (WHO, 2014). This highlights that policy documents in South Africa have begun to include health in a variety of policy documents, as has been proven effective in other global spaces (Baum *et al.*, 2014; Department of Health, 2021; Williams *et al.*, 2023). Policy documents are then divided into policy documents that allude to the intersection between health and ECEs, versus stating it directly. When considering the ten policy documents that alluded to the intersection, two themes emerged regarding health. The themes included the environment's positive and negative impacts on health and health threatened by climate change, both themes having literature around them when considering health more generally (Wright *et al.*, 2014a; Pinter-Wollman *et al.*, 2018; Butsch *et al.*, 2023). Out of these two themes, the more prominent one was health threatened by climate change, where these policy documents acknowledged various factors around health: health as one of various sectors threatened by climate change, health impacts felt locally, the need to prioritize health, health as a key sector of adaptation, a lack of understanding between the intersection of climate change and health, and the need for preparation such as early warning systems for epidemics. The

rest of the recognition of health from the policy documents collected are not separate from ECEs. Health was also a theme within the responses from participants. For example, throughout the ENBEL interviews, participants noted two health themes, vulnerabilities from climate change and necessities for the health sector. Participants noted that vulnerabilities from climate change amplify risks, one example is the increase in infectious diseases – an increasingly popular correlation identified in the literature (Motlogeloa and Fitchett, 2023). The ENBEL participants identified necessary changes within the health sector such as increasing health experts' understanding of their impact and contribution within the climate-health nexus, the obligation these experts have to be part of the climate-health nexus, and the lack of awareness and preparation of the health sectors personnel and facilities. Suggestions like these can also be found in the literature (Kotcher *et al.*, 2021). Past literature has also identified the importance of reflecting on experts understanding of the climate-health nexus to find areas of improvement to strengthen interdisciplinary spaces of health (dos Santos *et al.*, 2022). Unlike the general feedback the ENBEL participants gave on these themes, the interview participants were asked more specific questions about health. For example, these participants were asked to give their overview of the scope of policy documents including the themes of this study. The participants in this regard identified key health implications that policy documents consider; infectious diseases, a lack of resources, vector-borne diseases, and cholera. Three participants also identified two specific policy documents that cover health particularly well which were the Heat Health Plan and the DCCS. The recognition of these policy documents is also unsurprising when considering the extreme temperature increases expected for southern Africa at large, as well as the consistent development of the eThekweni

DCCS in committing to prepare for climate effects (Engelbrecht *et al.*, 2015; O'Donoghue *et al.*, 2022; IPCC, 2023).

6.3.3 Policy Document Coverage on the ECE-health nexus

Although these results reflect on policy coverage of ECEs and health, this study specifically focuses on the intersection or the nexus between these. Hence, it is necessary to review where the policy documents and participants considered the themes together. Beginning with the policy documents collected, there were 47 policy documents out of the 94 that included the nexus between ECEs and health. These policy documents were of various types and statuses including: IDPs, frameworks, and strategies amongst others. These policy documents could be separated by government tiers in which there were 17 international and municipal policy documents and 13 national ones. The policy documents commenced between the years of 2000 and 2023, in which majority of the policy documents came in the year 2015. There is no literature on the significance of relevant policy documents increasing in 2015 however, it could be possible that perhaps this was influenced by the signing and adoption of the Paris Agreement at the end of 2015 (Pauw *et al.*, 2020). When considering all 47 policy documents some themes could be identified between them, which included the ECEs they identified, the impacts of ECEs, suggested changes for improved preparation, and vulnerable groups recognized. The policies' identifications of ECEs and their impacts directly reveal how ECEs affect health as recognized in some of the literature (Lee *et al.*, 2020; Ayugi *et al.*, 2022). The first theme has been reiterated above under the theme of ECEs in this section, the suggested change's theme is reflected in the next section of the chapter that considers concerns under future climate change. This leaves only two of the themes that emerged from all 47

policy documents which are impacts from ECEs and vulnerable groups. Out of the 47 policy documents only 26 identified health impacts under ECEs, the majority considered general impacts and impacts under heatwaves, and a few identified impacts under extreme rainfall, flood events, and drought. Considering the general impacts, nine distinct impacts were mentioned; water-borne diseases, vector-borne diseases, malaria risks, infectious diseases, food-borne diseases/pathogens, psychological effects, decreased food production and supply, and mortality. The literature explains that these health risks are not new but rather common concerns globally, within South Africa and in eThekweni (Cissé, 2019; Mkhize and Sibanda, 2022; Lucero-Prisno *et al.*, 2023).

Policy documents that reflected on the impacts of ECEs identified various impacts similar and unique between ECEs. These impacts are reflective of the literatures findings as reviewed in previous chapters. The intersection between ECEs and health was also identified in other ways, for example within the policy documents that directly stated this nexus. Although all 47 policy documents did in some way identify the nexus between climate change and health, only the 37 policy documents that directly stated the intersection between ECEs and health are considered from here on. These policy documents had six themes emerge between them that reveal how they state the intersection, namely: ECEs impact health, quantification difficulties, heatwaves, cold snaps, rainfall/floods, and disease. A brief review of these themes is therefore given. The most popular theme is the recognition that ECEs affect health, identified by 21 policy documents. Some of these policy documents further explained certain aspects of this nexus such as the need for mechanisms that will better protect health and detect impacts, the need to strengthen the health system, and the increased risks as ECEs

become more frequent and intense. Heatwaves were recognized by ten policy documents as an ECE that affects health with references to heat-related illness and morbidity, and increased pressure on healthcare facilities and vulnerable human populations. The risk of disease was noted in five policy documents concerning water and vector-borne diseases in eThekweni – also supported synergies identified in the literature (Olanrewaju and Reddy, 2022; Carbonell *et al.*, 2023). There were four policy documents that reflected on rainfall/flooding events with health risks around water contamination and increasing hospital admissions. Lastly, two policy documents recognized the difficulty in quantifying the impacts of ECEs on health. These difficulties have been explained in the literature, for example, the indirect health impacts of ECEs cannot be measured precisely for reasons like not all harmed patients go to a health facility or the period over which they occur could cause them to be considered separate from the extreme event (Bell *et al.*, 2018). From this data we can establish that there is a recognition within a good quantity of policy documents of the nexus between health and ECEs. Notably this nexus is not always at the forefront of what policy documents explain and hence sometimes the nexus is only indirectly identified, but there is still a need to delve into these issues more. For example, perhaps identifying the intersection and even noting effects are not enough, in that the policy documents are there to guide decision-making and state intentions and we therefore need to identify clear strategies of action.

The data from this study does not only consider the recognition of the nexus within the policy documents, hence the participants' feedback are also considered. ENBEL participants alluded to the nexus between ECEs and health when reviewing the risks and impacts of the South African health sector under a changing climate. In this regard,

participants pointed out 28 risks and impacts. The most commonly recognized ones mentioned by five participants each included water-borne diseases, agricultural impacts (including malnutrition and food shortages), the increase of diseases, and the spreading thereof. Again, these are verified in the literature as prominent health concerns of ECEs (Hasegawa *et al.*, 2021; Nosrat *et al.*, 2021; Rayan *et al.*, 2021). Three participants each noted the vulnerability of people with pre-existing health issues such as HIV/AIDs and malaria patients. There is similar literature that supports this in which it is explained that patients with pre-existing health concerns are at higher risk of additional health implications, which increases their vulnerability (Mathebula *et al.*, 2020; Kuran *et al.*, 2020). Some of the risks and impacts are well associated with ECEs generally and even some specific ECEs, for example, ‘increased health risks under rising temperatures’ indirectly indicates the health impacts of heatwaves. Notably, the ENBEL participants do not consider the policy coverage of the nexus but do show the awareness of the intersection amongst stakeholders, even if not directly stated.

Unlike the ENBEL participants, the interview participants had multiple ways in which they stated the intersection between ECEs and health. Firstly, participants responded to whether they believed policy documents relevant to eThekwin should reflect on this intersection. Arguably, directly reflecting on the experts’ opinions on the necessity of a study such as this one – in which all participants responded that this interconnection was necessary and justified this response. Participants also identified the need for policy documents to reflect on this nexus for reasons such as preventing health from being undermined and the backlog of health facilities, the increased risk of diseases spreading, inaccessibility of medicines, or the increase of hospitalizations. Participants

Q and U both summarized the overall perspective by explaining that this recognition in policy documents would allow for better preparation and therefore a decrease in lives at risk as well as impacts overall. Participants also explained that policy documents' inclusion of this nexus allowed for increased awareness and education, and encouraging proactive efforts. Current experiences of the effects ECEs can have on health in eThekweni were noted (with recognition given to the recent flood events in the region). Thus, by policy recognizing the intersection and the current reality thereof, there is increased planning, preparation, and participation (Biesbroek *et al.*, 2010; Catalano *et al.*, 2019; Hughes, 2020). It is also worth mentioning that three of the participants did mention this was an important part of policy but did not explain why, which could show that experts can identify why this change could be important and useful but might not fully understand the intricate details thereof.

6.4 The Way Forward

Climate change will continue to impact health in a multitude of ways on international, national, and local levels (Kotcher *et al.*, 2021; Wright *et al.*, 2021a,b; IPCC, 2023). This calls on the need for interdisciplinary adaptation strategies to protect health, especially when considering vulnerable regions and people – one possible area of adaptation that can assist these efforts is policy (Catalano *et al.*, 2019; Wright *et al.*, 2021a,b). This is especially critical when considering that health will be impacted further by the increased number and intensity of ECEs (Kreslake *et al.*, 2018; Berrang-Ford *et al.*, 2021; IPCC, 2023). Each ECE has various direct and indirect health impacts that range in severity (Lee *et al.*, 2020; van der Walt and Fitchett, 2020; Ebi *et al.*, 2021; Ayugi *et al.*, 2022; Cong and Liang, 2022). The policy does not entirely reflect on the complex nature of the ECE-health intersection even if there is generally

reasonable coverage thereof in policy – this can be found within the data collected, as reviewed below.

The 47 policy documents that noted the ECE-health nexus had 29 policy documents that identified tactics to strengthen this intersection (see Figure 5.12 in the Results chapter). These suggestions can be placed into seven themes: data, increasing aspects of preparation for ECEs, health facilities and sectoral changes, health personnel, cooperation, disasters/ECEs, and education. The necessary preparation for ECEs were to increase understanding, early warning systems and surveillance, and to strengthen the healthcare sector's delivery and climate resilience. Early warning systems and health sector resilience are recommendations in preparing for climatic projections (Ebi *et al.*, 2021a; Hermans *et al.*, 2022). Policy documents noted cooperation and collaboration between various sectors, levels, and stakeholders. As identified previously in the chapter, the success of the governmental tiers that govern South Africa are not separable, especially when considering intersectoral concerns such as ECEs and health impacts (Maluleke, 2019). Policy documents reviewed possible changes for the health sector and facilities and various changes for health personnel. Considering the direct involvement of the health sector and its personnel it has a large responsibility to uphold its role, especially considering the expertise for policy advocacy, identifying effective interventions, and implementing systems (Chersich and Wright, 2019). Considering ECEs and emergencies, policy documents specified strengthening and promoting emergency management and preparation services, and planning and decreasing disaster risk. Educational shifts included increasing education, such as educating the community on ways to respond to events. The value of data and education is well understood when considering the use thereof

to create a foundation of knowledge to then inform decision-making (Laplante *et al.*, 2010; Cerri *et al.*, 2021).

The policy documents give great details into possible improvements for ECE-health knowledge however, participants from both the primary and secondary sets of interview data also identified concerns. The interview participants were asked about barriers they perceived that prohibited policy recognizing the ECE-health nexus. Their responses were very detailed and are therefore not entirely reflected upon here but can be found in the Results chapter under interview data sub-section 5.3.5. In summary themes included: interdisciplinarity, lack of education and understanding, policy and procedure, data, immediate concerns, implementation, complexities, challenges faced by the eThekweni Municipality, resources, unavailability, ECEs, vulnerability of the impoverished, and DRM. Similarly, ENBEL participants reflected on changes to assist the health system under climate risks. Participant A argued that health experts must acknowledge and understand their impact and contributions within the climate-health nexus. Participant H pointed to the trust people have with health practitioners which gives them an obligation to talk about these impacts because they have a strong influence. Participant B explained health facilities are not aware of climate impacts and the projected changes thereof. Participant G blatantly stated that the health sector is not prepared, yet the right to health must be upheld.

All three sets of data show crosscutting knowledge on how and where the focus can be placed on assisting the development of the ECE-health intersection. Although some of the suggestions are directed at different entities, collectively we can identify trends. For example, there is a focus on the responsibilities of health facilities and personnel,

the necessity of improving interdisciplinarity and cooperation amongst sectors involved, refining DRM efforts, and increasing and expanding the data and education on the ECE-health intersection. These suggestions are reflected in existing literature which argues that they are not new or specific to eThekweni (Laplane *et al.*, 2010; Maluleke, 2019; Ebi *et al.*, 2021a; Imperiale and Vanclay, 2021; IPCC, 2023). These are thus gaps that we can use to focus our concerns about policy progress under climate change to decrease the risks of ECEs and the health vulnerabilities thereof.

6.5 Limitations of the Study

The following limitations should be taken into consideration when analysing the findings of this study. The first area of consideration is within the collection of data. The collection of policy documents was limited by the knowledge of participants and the available access to platforms by the researcher. Additionally, the collection of policy documents was also limited by the period in which the study took place. Thus, although the sample size was adequate a larger sample size would give a better indication of policy inclusion and consideration of the ECE-health nexus. The policy data used is therefore not exhaustive but represents an ensemble of widely recognised policy documents. Thus, an increased sample size could have amplified the validity of the conclusions developed. The primary and secondary data revealed stakeholders' perceptions around the themes of ECEs, health, and policy. Notably, these perceptions can change as they are based on participants' experiences and knowledge. The participants' responses were also specific to South Africa and eThekweni as was the policy data, which could bind the data to the study area making it less comparable to similar studies elsewhere. The sample size of the interview participants was also restricted. The primary interview participants were limited to the

people who were willing and able to participate. These participants are also not all involved in policy implementation and development - meaning their perceptions are not as directly informed. The ENBEL participants were also limited, possibly by the challenges faced during data collection. Additionally, all interviews had been conducted online and not always based on both verbal and non-verbal cues; however, those that were based on verbal content alone do not necessarily affect the interpretation of the data.

The analysis of data also presents possible limitations. Thematic and content analysis were used - largely based on the researcher's interpretation of themes and codes within the dataset. To assist in ensuring the interpretation of the data was as objective as possible, reflexivity was utilized. The study depended on qualitative data gathering and analysis, which might be well supported by quantitative methods. Lastly, when reflecting on previous literature there were limitations; for example, the researcher did not find previous research on policy including the ECE-health nexus that could then give a tested method to explore this topic.

This study sought to explore the inclusion and consideration of the ECE-health nexus in policy that was relevant to the eThekweni region. Limitations around data collection impacted the quantity of data collected while the use of only qualitative methods of analysis limited the possible strength of findings. The South African policy framework must depend on government tiers that are cooperative in developing policy that assists in protecting the right to health under the projections of ECEs. The current policy coverage shows progress but there is an array of possible improvements. The recognition of policy as a catalyst in adaptation efforts argues that there is potential to

decrease the risks of ECEs impacting health in developing countries, and for policy to better influence the sustainability movement.

CHAPTER 7: CONCLUSION



(Durban Night Lights, 2014)

7.1 Introduction

The climate-health nexus has been a developing area of research for thousands of years (Landman *et al.*, 2020; Liu *et al.*, 2021; Motlogeloa and Fitchett, 2023). However, a sub-section of climate change called ECEs is intensifying and increasing in frequency, and these events are particularly harmful to health (Wright *et al.*, 2021b; Berrang-Ford *et al.*, 2021; IPCC, 2023). eThekweni has a variety of ECEs that threaten the region's health alongside many social and economic vulnerabilities yet have also been at the forefront of adaptation efforts in South Africa (Roberts, 2010; eThekweni Municipality, 2022; Olanrewaju and Reddy, 2022). Notably, adaptation strategies have the potential to prepare vulnerable regions for the impacts of ECEs to protect the health of citizens (Wright *et al.*, 2021b; IPCC, 2023). Policy acts as a part of adaptation in which it guides decision-making, management, and planning (Colebach, 2009; Catalano *et al.*, 2019; Bonnet and Birchall, 2023). Thus, this study has argued the importance of analysing current policy documents to determine the extent to which they include, consider, and prepare for the negative ramifications ECEs will have on health (Nalau and Verrall, 2021). Exploring policy documents' recognition of the ECE-health nexus assists in corrective strategies and contributes to the nascent literature thereof (Wright *et al.*, 2021b).

7.2 Main Findings

The study focused on three themes; ECEs, Health, and policy – specifically the interconnections between them, a novel area of adaptation studies. The focus of these themes was placed on the eThekweni region. Through the lens of stakeholders and the dissemination of policy documents relevant to the study site, a complex understanding of these themes could be reviewed.

The conglomeration of findings suggests that policy has already been a part of adaptation efforts in the region however, there are areas of concern and improvements. For example, the policy data identified a 50% recognition of the ECE-health nexus - a good indication that it is becoming recognized. However, stakeholder data pointed to concerns around implementation and barriers to policy documents including the ECE-health nexus. Thus, together these two perspectives could give a broader understanding of policy documents and identify potential developments.

The results indicate that policy documents have begun to include the ECE-health nexus, although not always directly or in adequate detail. Additionally, stakeholders believe this is an important policy consideration but lack an understanding and knowledge of policy documents and the interconnection of ECEs and health. Participants also give a broad outline of barriers that prohibit policy recognition of the nexus or even the implementation of these policy documents. For example, interview participants identified more immediate concerns (e.g., poverty) prohibiting policy focusing on issues like the ECE-health nexus. Although these are recognisable issues, they do not outweigh those of climate change as these will increasingly further exacerbate all other concerns.

Two unexpected findings were firstly the extent to which stakeholders themselves can recognise the importance of policy including the intersection. There seems to be an overall agreement that policy is indeed a useful catalyst for adaptation methods, and considering the familiarity of the seriousness of climate change amongst experts and stakeholders they can easily see the necessary correlation. This was well established

amongst this study's participants even when some did not initially understand the connection between ECEs and health. Secondly, while not demoting the importance of policy recognising this intersection and whilst not all being directly involved in policy processes the participants could also give extensive feedback on barriers and areas of improvement.

7.3 Achievement of the Study Aim and Objectives

The study aimed to find the extent to which key concepts (ECEs and their impact on health) are accounted for in policy documents that have a bearing on the eThekwini Municipality. This aim was achieved through the collection of primary semi-structured interview data with 12 participants, secondary semi-structured interview data from nine participants, and the tabularization of 94 policy documents relevant to eThekwini. Each objective will be discussed and the extent to which they were achieved will be examined.

7.3.1 Objective 1

Sourcing and exploring the governmental national, provincial, and municipal policy documents in the broad domains of climate change, ECEs, health, and developmental planning that are relevant to eThekwini. This is to find the degree to which climate change, ECEs, and impacts on health are included in sourced policy documents, through document analysis. This includes assessing which concepts individual policy documents contain, and the degree to which each concept is included.

A total of 94 policy documents were identified from both primary and secondary interview participants that mentioned relevant policy documents, alongside additional

policy documents obtained through searching eThekwini, South African, and various other policy portals. These policy documents came from all three tiers of government and were all relevant to eThekwini. Policy analysis was done in which each policy document was searched for mentions and explanations of themes relevant to this study: weather, climate, climate change, ECEs, health, and the ECE-health nexus. The weather theme was identified in 42 policy documents, 50 included the climate theme, 74 recognized climate change, 72 ECEs, 78 noted health, and 47 identified the ECE-health nexus. Policy analysis of the 47 policy documents that included the ECE-health nexus identified that there were two ways in which these policy documents identified the intersection: either by directly stating the interconnection or by indirectly alluding to it. Policy coverage on health was exceptional as a large degree of all the policy documents included this theme while less recognition was given to ECEs and the least to the ECE-health nexus.

7.3.2 Objective 2

Tabulating the recognition and possible absence of the study's key concepts using the sourced documents and the analysis. This considers 1) General information of relevant policy documents of eThekwini (Titles, implementation dates, statuses, and levels) and 2) Quotations from throughout the policy documents that confirm the recognition of this study's key concepts. Thereby creating an opportunity to evaluate how policy could be further developed and assist more comprehensive practice.

All 94 policy documents were tabularized and gave a review of the first objectives themes they did and did not include. The table first identified the general information of policy documents such as the title, year, URL, policy type or status, policy level, and

an overview thereof. The table then reflected a tick or cross if the policy did or did not include each theme before a collection of quotes was given if they were. This table of policy documents assisted in ascertaining that five policy documents included none of the themes, 11 included one theme, seven included two themes, 11 included three themes, 19 included four themes, 17 included five themes and 24 included all six themes. This suggests that only a few policy documents do reflect on all these themes. Popular responses to improving policy and comprehensive practice included increasing the data available and education on the ECE-health intersection, reclarifying responsibilities of health facilities and personnel, improving interdisciplinarity and collaboration amongst sectors, and refining DRM efforts.

7.3.3 Objective 3

Gather input from key informants with primary and secondary interview data around the relation to policy deficiencies such as the awareness of relevant policy documents, recognition of key concepts, collaboration, capacity (resource and human), and barriers. Thus, reviewing stakeholders' understanding and knowledge of relevant policy documents.

The primary and secondary interview data reflected on various aspects of stakeholders' understanding of the ECE-health nexus and policy documents that recognize this nexus. All 12 primary interview participants identified the necessity of policy documents including this nexus to assist in proactive efforts to prepare for ECEs impacting health, to save more lives, increase education and awareness, and because they already recognise that ECEs are currently occurring and affecting health. Secondary interview participants identified the ECE-health nexus by listing a multitude

of impacts the health sector will face under climate change. In this way, most of the participants from both sets of data could understand the importance of the intersection. Approximately six out of the 34 policy documents listed by all participants were used in the table of policy documents. This suggests that stakeholders are not greatly familiar with policy documents that include the ECE-health nexus, which arguably confirms that society at large needs to be more involved in creating these policy documents to increase their awareness thereof, and additionally to better inform policy documents of stakeholder perspectives. Considering key concepts identified by participants these included DRM, intersectoral involvement as well as barriers and areas of improvement.

7.4 Implications of Research

In view of the increased frequency and intensification of ECEs and their impact on health, the ECE-health nexus will become increasingly familiar. This study has identified that there is recognition of this nexus within current policy documents that are relevant to the eThekweni region. This recognition is not however always stated directly, implying that policy-makers amongst other key practitioners, might not fully comprehend the value of this intersection.

eThekweni can continue to establish a strong position on climate change interventions by placing more emphasis on preparing to protect health under ECEs. These changes can potentially contribute to sustainability efforts too. Notably, it is important to consistently review policy documents as they are upgraded and adapted, to assist with keeping record of what they lack and where they fall short. The absence thereof will result in continuous policy adaptation that has no focus on current concerns. This has

been a common trend already with South African policies as although these policy documents are well known for including important concepts, they overlook strategies of implementation, sector cooperation, local perspectives, and awareness.

7.5 Recommendations for Future Research

There is significant recognition in the literature that climate impacts health (Motlogeloa and Fitchett, 2023) however, it is recommended that future research puts more focus on the extent to which ECEs affect health on various scales. Additionally, the benefits of future research considering the effects policy can have concerning the ECE-health nexus would possibly advocate for more studies that can then review policy documents and provide avenues for improvement. As this study focused on the eThekweni region, future research in South Africa might consider other provinces' policy recognition of the intersection. Such studies can greatly inform the advancement of policy that proactively protects the right to health under the projections of ECEs. The perceptions and knowledge of stakeholders are also beneficial avenues to continue studying as these will change over time and are useful insights for areas of concern.

7.6 Synthesis

This study is part of a novel field that considers the ECE-health nexus in policy for South Africa, particularly for eThekweni. The ability of policy to improve adaptation efforts and protect health under the climatic changes of ECEs when they reflect this intersection is explained. Policy and interview data revealed that policy has already begun to identify this nexus. However, there are possible improvements; not all policy documents that include the nexus directly state it and not all of them suggest possible

methods to protect health and prepare for ECEs. Stakeholders also reveal shortfalls like the lack of education and awareness of these concerns and the focus placed on other 'higher' prioritised concerns. Nonetheless, policy continues to be a catalyst for adaptation efforts and can bring regions together on all levels to protect the right to health and prepare for the projected ECEs.

References

- Albris, K., Lauta, K.C. and Raju, E. 2020. Disaster Knowledge Gaps: Exploring the Interface Between Science and Policy for Disaster Risk Reduction in Europe. *International Journal of Disaster Risk Science*, 11(1), 1—12.
- Aldunce, P., Beilin, R., Handmer, J. and Howden, M. 2016. Stakeholder Participation in Building Resilience to Disasters in a Changing Climate. *Environmental Hazards*, 15(1), 58—73.
- Araújo Jr, J.L. and Maciel Filho, R. 2001. Developing an Operational Framework for Health Policy Analysis. *Revista Brasileira de Saúde Materno Infantil*, 1(3), 203—221.
- Archer, E.R.M., Engelbrecht, F., Landman, W., Le Roux, A., van Huyssteen, E., Fatti, C., Vogel, C., Akoon, I., Maserumuale, R., Colvin, C., Le Maitre, D.C., Lotter, D., Olwoch, J., Wright, C.Y., Meyer, A.A., Theron, A., Diedricks, G., Maherry, A., Rossouw, M., Midgley, G., Davis, C., Stevens, N., Sinden, L.A., Warburton, M. and Nkambule, C. 2010. *South African risk and vulnerability Atlas*. Department of Science and Technology, Pretoria. Available: <https://researchspace.csir.co.za/dspace/handle/10204/4974> (Accessed: 5 January 2023).
- Arnfield, J. 2022. *Köppen Climate Classification*. Encyclopaedia Britannica. Available: <https://www.britannica.com/science/Koppen-climate-classification> (Accessed: 28 December 2022).
- Ashokcoomar, P. and Naidoo, R. 2016. An Analysis of Inter-healthcare Facility Transfer of Neonates within the eThekweni Health District of KwaZulu-Natal, South Africa. *South African Medical Journal*, 106(5), 514—518.

- ASSAF, 2011. *Towards a Low Carbon City: Focus on Durban*. Pretoria: Academy of Science of South Africa. Available: <https://www.assaf.org.za/files/PDF/LCC.pdf> (Accessed: 23 January 2023)
- Averchenkova, A., Gannon, K.E. and Patrick, C. 2019. *Governance of Climate Change Policy: A Case Study of South Africa*. London: Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy, London School of Economics and Political Science.
- Ayugi, B., Eresanya, E., Onyango, A.O., Ogou, F.K., Okoro, E. C., Okoye, C.O., Anoruo, C.M., Dike, V.N., Ashiru, O.R., Daramola, M.T., Mumo, R. and Ongoma, V. 2022. Review of Meteorological Drought in Africa: Historical Trends, Impacts, Mitigation Measures, and Prospects. *Geophys*, 179, 1365—1386.
- Baillache, E. 2017. *Municipality Mitigates Drought Effects with Intervention Strategies*. South Coast Sun. Available: <https://southcoastsun.co.za/96125/earl-13/> (Accessed: 5 January 2023).
- Baldwin, J.R., Pingault, J., Schoeler, T., Sallis, H.M. and Munafo, M.R. 2022. Protecting Against Researcher Bias in Secondary Data Analysis: Challenges and Potential Solutions. *European Journal of Epidemiology*, 37(1), 1—10.
- Baloyi, T. 2022. *KZN Floods: eThekweni Water Safe to Drink - metro spokesperson*. The South African. Available: <https://www.thesouthafrican.com/news/kzn-floods-ethekweni-water-safe-to-drink-metro-spokesperson/> (Accessed: 10 December 2023).
- Baum, F., Lawless, A., Delany, T., Macdougall, C., Williams, C., Broderick, D., Wildgoose, D., Harris, E., Mcdermott, D., Kickbusch, I., Popay, J. and Marmot,

- M. 2014. Evaluation of Health in All Policies: Concept, Theory, and Application. *Health Promotion International*, 2(1), 130—142.
- Baytiyeh, H. 2017. Can Disaster Risk Education Reduce the Impacts of Recurring Disasters on Developing Societies. *Education and Urban Society*, 50(3), 230—245.
- Bega, S. 2020. *Dozens of Birds and Bats Perish in Extreme Heat in KZN*. The Mail & Guardian. Available: <https://mg.co.za/environment/2020-12-01-dozens-of-birds-and-bats-perish-in-extreme-heat-in-kzn/> (Accessed: 13 January 2023).
- Bell, J.E., Brown, C.L., Conlon, K., Herring, S., Kunkel, K.E., Lawrimore, J., Lubert, G., Schreck, C., Smith, A. and Uejio, C. 2018. Changes in Extreme Events and the Potential Impacts on Human Health. *Journal of the Air & Waste Management Association*, 68(4), 265—287.
- Berrang-Ford, L., Sietsma, A., Callaghan, M., Minx, J., Scheelbeek, P., Haddaway, N., Haines, A. and Dangour, A. 2021. Systematic Mapping of Global Research on Climate and Health: A Machine Learning Review. *The Lancet Planetary Health*, 5(8), 514—525.
- Bhikha, P. 2016. *More Thunderstorms for KZN this Week after Lightning over Durban*. East Coast Radio. Available: <https://www.ecr.co.za/news/news/pics-more-thunderstorms-kzn-week-after-lightning-over-durban/> (Accessed: 15 February 2024).
- Botha, D. and van Niekerk, D. 2013. Views from the Frontline: A Critical Assessment of Local Risk Governance in South Africa. *Journal of Disaster Risk Studies*, 5(2), 1—10.
- Bouma, J.J. 1987. A short history of human biometeorology. *Experientia*, 43(1), 2—6.

- Braun, V. and Clarke, V. 2006. Using Thematic Analysis in Psychology. *Qualitative Research in Psychology*, 3(1), 77—101.
- Brubacher, J., Allen, D.M., Déry, S.J., Parkes, M.W., Chhetri, B., Mak, S., Sobie, S. and Takaro, T.K. 2020. Associations of five Food- and Water-borne Diseases with Ecological Zone, Land Use, and Aquifer Type in a Changing Climate. *Science of The Total Environment*, 728, 138808.
- Burkle, F.M. 2006. Globalization and Disasters: Issues of Public Health, State Capacity and Political Action. *Journal of International Affairs*, 59(2), 241—265.
- Burton, I., Lim, B., Spanger-Siegfried, E., Malone, E.L. and Huq, S. 2004. *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies, and Measures*. Cambridge, UK: Cambridge University Press.
- Butsch, C., Beckers, L.M., Nilson, E., Frassl, M., Brennholt, N., Kwiatkowski, R. and Söder, M. 2023. Health Impacts of Extreme Weather Events - Cascading Risks in a Changing Climate. *Journal of Health Monitoring*, 6(8), 33—56.
- Carbonell, L., Hofmann, P., Srikiissoon, N., Campos, L.C., Mbatha, S., Lakhanpaul, M., Mabeer, V., Steenmans, I. and Parikh, P. 2023. Localisation of Links between Sanitation and the Sustainable Development Goals to Inform Municipal Policy in eThekweni Municipality, South Africa. *World Development Sustainability*, 2(4), 100038.
- Carter, R.A. 2012. Flood Risk, Insurance, and Emergency Management in Australia. *The Australian Journal of Emergency Management*, 27(2), 20—25.
- Catalano, M., Forni, L. and Pezzolla, E. 2019. Climate Change Adaptation: The Role of Fiscal Policy. *Resource and Energy Economics*, 59(C), 1—27.

- Cerri, M., Steinhausen, M., Kreibich, H. and Schröter, K. 2021. Are OpenStreetMap Building Data Useful for Flood Vulnerability Modelling. *Natural Hazards and Earth System Sciences*, 21(2), 643—662.
- Chari, F. and Ngcamu, B.S. 2022. Climate Change and its Impact on Urban Agriculture in Sub-Saharan Africa: A Literature Review. *Environmental and Socio-economic Studies*, 10(3), 22—32.
- Chersich, M.F. and Wright, C.Y. 2019. Climate Change Adaptation in South Africa: A Case Study on the Role of the Health Sector. *Global Health*, 15(22), 1—16.
- Choudhury, M. and Haque, C.E. 2024. Disaster Management Policy Changes in Bangladesh: Drivers and Factors of a Shift from Reactive to Proactive Approach. *Environmental Policy and Governance*, 1—18.
- Cissé, G. 2019. Food-borne and Water-borne Diseases under Climate Change in Low- and Middle-income Countries: Further Efforts Needed for Reducing Environmental Health Exposure Risks. *Acta Tropica*, 194, 181—188.
- CoGTA and eThekweni Municipality, 2020. District Development Model. Available: <https://www.cogta.gov.za/ddm/> (Accessed: 30 August 2023).
- Cole, B. 2016. *eThekweni Prioritises Drought Relief*. Independent Online. Available: <https://www.iol.co.za/news/south-africa/kwazulu-natal/ethekweni-prioritises-drought-relief-1976967> (Accessed: 3 January 2023).
- Colebatch, H.K. 2009. *Policy*. 3rd edn. Maidenhead: Open University Press. Available: <https://search.worldcat.org/title/Policy/oclc/276647867> (Accessed: 15 February 2023).
- Collins, T. 2005. Health Policy Analysis: A Simple Tool for Policy Makers. *Public Health*, 119(3), 192—196.

- Cong, Z. and Liang, D. 2022. Health and Mental Health Impact of Tornadoes: Are Older Adults More Resilient. *International Journal of Mass Emergencies & Disasters*, 40(2), 136—154.
- Coovadia, H., Jewkes, R., Barron, P., Sanders, D. and McIntyre, D. 2009. The Health and Health System of South Africa: Historical Roots of Current Public Health Challenges. *Lancet*, 374 (9692), 817—34.
- Corbella, S. and Stretch, D. 2012. Coastal Defences on the KwaZulu-Natal Coast of South Africa: A Review with Particular Reference to Geotextiles. *Journal of the South African Institution of Civil Engineering*, 54(2), 55—64.
- Culwick, C. 2019. Disasters and Disaster Risk Management in South Africa. In: Knight, J. and Rogerson, C. (eds) *The Geography of South Africa, World Regional Geography Book Series*. Springer: Cham, pp. 295—304.
- Curić, M., Zafirovski, O. and Spiridonov, V. 2022. Human Biometeorology. In: *Essentials of Medical Meteorology*. Springer, Cham, pp. 63—77.
- Cutler, M. J. 2015. Seeing and Believing: The Emergent Nature of Extreme Weather Perceptions. *Environmental Sociology*, 1(4), 293—303.
- D'Abreton, P. 1991. A synoptic Characterization of some South African Tornadoes. *South African Journal of Science*, 87, 56—61.
- de Coning, E. and Adam, B.F. 2000. *The Tornadoic Thunderstorm Events during the 1998-1999 South African Summer*. Water South Africa. Available: https://www.wrc.org.za/wp-content/uploads/mdocs/WaterSA_2000_03_1263.pdf (Accessed: 5 January 2023).
- de Rudder, B. 1931. *Wetter und Jahreszeit als Krankheitsfaktoren: Grundriss einer Meteoropathologie des Menschen*. Berlin: Springer.

- de Villiers, K. 2021. Bridging the Health Inequality Gap: An Examination of South Africa's Social Innovation in Health Landscape. *Infectious Diseases of Poverty*, 10(19), 1—7.
- de Visser, J. and du Plessis, A. 2023. Climate Governance and Federalism in South Africa. In: Fenna, A., Jodoin, S. and Setzer, J. (eds) *Climate Governance and Federalism: A Forum of Federations Comparative Policy Analysis*. Cambridge University Press: Cambridge, UK, pp. 241—262.
- Department of Energy, 2023. *Cop 17: Republic of South Africa*. Department of Energy, South Africa. Available: <https://www.energy.gov.za/cop%2017/default> (Accessed: 5 January 2024).
- Department of Health, 2021. *South African Maternal, Perinatal, and Neonatal Health Policy*. National Department of Health, South Africa. Available: <https://knowledgehub.health.gov.za/system/files/elibdownloads/202304/SA%20520MPNH%2520Policy%25202362021%2520signed%2520Web%2520View%2520v2.pdf> (Accessed: 10 January 2024).
- Diga, K., Mvuselelo, N., Bracking, S., Lombo, M. and Siyabonga, N. 2016. Poverty Reduction Co-benefits through Indigenous Knowledge in Climate Change Adaptation: A study within the eThekweni municipality. *Journal of Social Sciences*, 46(2), 87—97.
- Diga, K. 2017. *Agriculture and Climate Change Impacts in eThekweni Municipality*. Applied Poverty Reduction Assessment. University of KwaZulu-Natal. Available: <https://appliedpovertyreduction.ukzn.ac.za/agriculture-and-climate-change-impacts-in-ethekweni-municipality/> (Accessed: 12 January 2023).

- Dlamini, T. 2015. *Drought-stricken KZN declared Disaster Area*. Times Live. Available: <https://www.timeslive.co.za/news/south-africa/2015-10-30-drought-stricken-kzn-declared-disaster-area/> (Accessed: 3 January 2023).
- Donner, W. and Rodriguez, H. 2008. Population Composition, Migration, and Inequality: The Influence of Demographic Changes on Disaster Risk and Vulnerability. *Social Forces*, 87(2), 1089—1114.
- dos Santos, M., John, J., Garland, R., Palakatsela, R., Banos, A., Martens, P., Nemukula, B., Ramathuba, M., Nkohla, F. and Lenyibi, K. 2022. Climate Change and Health within the South African Context: A Thematic Content Analysis Study of Climate Change and Health Expert Interviews. *African Journal of Primary Health Care and Family Medicine*, 14(1), 1—12.
- Du, W., FitzGerald, G.J., Clark, M. and Hou X.Y. 2010. Health Impacts of Floods. *Prehospital and Disaster Medicine*, 25(3), 265—72.
- Durban Climate, Undated. *Durban Climate*. Climate Data. Available: <https://en.climate-data.org/africa/south-africa/kwazulu-natal/durban-511/> (Accessed: 28 December 2022).
- Durban Night Lights, 2014. *HD wallpaper: Durban Buildings Skyscrapers Night Lights Beach HD, cityscape*. Wallpaper Flare. Available: <https://www.wallpaperflare.com/durban-buildings-skyscrapers-night-lights-beach-hd-cityscape-wallpaper-melbi> (Accessed: 15 February 2024).
- Durban Summer Weather, undated. *Durban Summer Weather*. Weather Spark. Available: https://weatherspark.com/s/96783/1/Average-Summer-Weather-in-Durban-South-Africa#google_vignette (Accessed: 24 November 2022).

- Durban Weather, 2022. *Durban Weather*. Tripadvisor. Available: <https://www.tripadvisor.com/Travel-g312595-s208/Durban:South-Africa:Weather.And.When.To.Go.html> (Accessed: 24 November 2022).
- Ebi, K.L., Vanos, J., Baldwin, J.W., Bell, J.E., Hondula, D.M., Erret, N.A., Hayes, K., Reid, C.E., Saha, S., Spector, J. and Berry, P. 2021a. Extreme Weather and Climate Change: Population Health and Health System Implications. *Annual Review of Public Health*, 42(1), 293—315.
- Ebi, K.L., Capon, A., Berry, P., Broderick, C., de Dear, R., Havenith, G., Honda, Y., Kovats, R.S., Ma, W., Malik, A., Morris, N.B., Nybo, L., Seneviratne, S.I., Vanos, J. and Jay, O. 2021b. Hot Weather and Heat Extremes: Health Risks. *The Lancet*, 398(10301), 698—708.
- Education and Training Unit, 2023a. *The Three Spheres of Government*. Education and Training Unit. Available: <https://www.etu.org.za/toolbox/docs/govern/spheres.html> (Accessed: 18 December 2023).
- Education and Training Unit, 2023b. *The Policy and Law Making Process*. Education and Training Unit. Available: <https://www.etu.org.za/toolbox/docs/govern/policy.html> (Accessed: 18 December 2023).
- ENBEL, 2021. *The Horizon 2020 Project ENBEL*. European Union's Horizon 2020 Research and Innovation Programme. Available: <https://www.ENBEL-project.eu/> (Accessed: 20 June 2023).
- Engelbrecht, F., Adegoke, J., Bopape, M., Naidoo, M., Garland, R., Thatcher, M., McGregor, J., Katzfey, J., Werner, M., Ichoku, C. and Gatebe, C. 2015. Projections of Rapidly Rising Surface Temperatures over Africa under Low Mitigation. *Environmental Research Letters*, 10(8), 1—17.

- Environmental Planning and Climate Protection Department (EPCPD), 2014. *Durban Climate Change Strategy*. Durban, KwaZulu-Natal: eThekweni Municipality. Available: https://www.durban.gov.za/storage/PDF%20Documents/DCCS_Final.pdf (Accessed: 12 January 2023).
- eThekweni Highlights, 2023. *eThekweni Highlights*. SAFLEC. Available: <https://saflec.co.za/ethekweni-highlights/> (Accessed: 15 February 2024).
- eThekweni Landscape, 2018. *eThekweni Landscape*. WWF South Africa. Available: <https://www.wwf.org.za/?25261%2FeThekweni-leads-WWFs-One-Planet-City-Challenge-in-South-Africa> (Accessed: 12 January 2023).
- eThekweni Municipality, 2014. *Durban Climate Change Strategy*. eThekweni, South Africa. Available: <https://www.globalcovenantofmayors.org/wp-content/uploads/2015/06/Durban-Action-Plan.pdf> (Accessed: 13 May 2022).
- eThekweni Municipality, 2019. *DCCS Annual Report 2019/20*. eThekweni, South Africa. Available: https://www.durban.gov.za/storage/Documents/Climate/DCCS%20Annual%20Report%202019_2020.pdf (Accessed: 13 May 2022)
- eThekweni Municipality, 2022. *Durban Climate Change Strategy, 2022*. 7th ed. eThekweni, Durban: eThekweni Municipality.
- Extreme Events, 2019. *Coastal risk and vulnerability: Extreme Events*. Coast KZN. Available: <https://www.coastkzn.co.za/themes/coastal-risk-and-vulnerability/extreme-events/> (Accessed: 12 January 2023).
- Farquharson, K. 2005. A Different Kind of Snowball: Identifying Key Policymakers. *International Journal of Social Research Methodology*, 8(4), 345—353.
- Fitchett, J.M. 2018. Recent Emergence of CAT5 Tropical Cyclones in the South Indian Ocean. *South African Journal of Science*, 114(11/12), 1—6.

- Folk, G.E. 2013. *The International Society of Biometeorology: A Fifty-year History*. University of Wisconsin-Milwaukee. Available: https://uwm.edu/biometeorology/wp-content/uploads/sites/439/2017/06/ISB_50YearHistoryofBiometeorology.pdf (Accessed: 19 February 2023).
- Friedrich, E. and Kretzinger, D. 2012. Vulnerability of wastewater infrastructure of coastal cities to sea level rise: A South African Case Study. *Water SA*, 38(5), 755—764.
- Fuldauer, L.I., Adshead, D., Thacker, S., Gall, S. and Hall, J.W. 2022. Evaluating the Benefits of National Adaptation to Reduce Climate Risks and Contribute to the Sustainable Development Goals. *Global Environmental Change*, 76, 102575.
- Galarraga, I., Gonzalez-Eguino, M. and Markandya, A. 2011. The Role of Regional Governments in Climate Change Policy. *Environmental Policy and Governance*, 21(3), 164—182.
- Ganesh, C. and Smith, J.A. 2018. Climate Change, Public Health, and Policy: A California Case Study. *American Journal of Public Health*, 108(2), 114—119.
- Garland, R.M. 2014. National Policy Response to Climate Change in South Africa. *South African Medical Journal*, 104(8), 584—585.
- Gibson, T.D., Pelling, M., Ghosh, A., Matyas, D., Siddiqi, A., Solecki, W., Johnson, L., Kenney, C., Johnston, D. and Du Plessis, R. 2016. Pathways for Transformation: Disaster Risk Management to Enhance Resilience to Extreme Events. *Journal of Extreme Events*, 3(1), 1—23.
- Giordono, L., Boudet, H. and Gard-Murray, A. 2020. Local Adaptation Policy Responses to Extreme Weather Events. *Policy Sciences*, 53(4), 609—636.
- Glavovic, B.C. and Smith, G.P. 2014. Introduction: Learning from Natural Hazards Experience to Adapt to Climate Change. In: Glavovic, B.C. and Smith, G.P.

- (eds) *Adapting to Climate Change, Lessons from Natural Hazards Planning*. Springer: Heidelberg, New York, London, pp. 18—55.
- Grab, S.W. and Nash, D.J. 2023. A New Flood Chronology for KwaZulu-Natal (1836–2022): The April 2022 Durban Floods in Historical Context. *South African Geographical Journal*, 1—22.
- Gumbi, N. and Rangongo, M.F. 2018. Factors that Hinder Effective Management and the Supply of Clean Potable Water at eThekweni Municipality in KwaZulu-Natal. In: *The 3rd Annual International Conference on Public Administration and Development Alternatives*. Saldhana Bay: University of Limpopo. Available: <http://ulspace.ul.ac.za/handle/10386/2249> (Accessed: 9 February 2023), pp. 622—631.
- Gumede, B. 2022. *Brand New Online Weather Portal is Live: This is what you need to know to use it*. Mail and Guardian. Available: <https://mg.co.za/news/2022-05-11-lexisnexis-launches-online-severe-weather-portal/> (Accessed: 13 May 2022).
- Gyöngyi, H., Nagy, K., Tuboly, G. and Nagy, E. 2023. Pain and Weather Associations – Action mechanisms; personalized profiling. *Brain Research Bulletin*, 200(110710), 110696.
- Hajat, S., Ebi, K.L., Kovats, R.S., Menne, B., Edwards, S. and Haines, A. 2005. The Human Health Consequences of Flooding in Europe: a Review. In: Kirch, W., Bertollini, R. and Menne, B. (eds) *Extreme Weather Events and Public Health Responses*. Springer: New York, pp. 185—196.
- Hájková, L., Možný, M., Oušková, V. and Žalud, Z. 2023. Change in *Carpinus betulus* Flowering in the Czech Republic. *Scandinavian Journal of Forest Research*, 38(7-8), 506—512.

- Harper, D. and Thompson, A.R. 2011. *Qualitative Research Methods in Mental Health and Psychotherapy: A Guide for Students and Practitioners*. Wiley and Sons: Chichester, UK.
- Hasegawa, T., Sakurai, G., Fujimori, S., Takahashi, K., Hijioka, Y. and Masui, T. 2021. Extreme Climate Events Increase Risk of Global Food Insecurity and Adaptation Needs. *Nature Food*, 2, 587—595.
- Hellberg, S. 2014. Water, Life, and Politics: Exploring the Contested Case of eThekweni Municipality through a Governmentality Lens. *Geoforum*, 56, 226—236.
- Hermans, T.D.G., Trogrlić, R.S., van den Homberg, M.J.C., Bailon, H., Sarku, R. and Mosurska, A. 2022. Exploring the Integration of Local and Scientific Knowledge in Early Warning Systems for Disaster Risk Reduction: A Review. *Natural Hazards*, 114(2), 1125—1152.
- Herrman, H. 2012. Promoting Mental Health and Resilience After a Disaster. *Journal of Experimental and Clinical Medicine*, 4(2), 82—87.
- Horowitz, S. 2002. Biometeorology: What it is and How it Affects our Health. *Alternative and Complementary Therapies*, 8(1), 34—39.
- Imperiale, A.J. and Vanclay, F. 2021. Conceptualizing Community Resilience and the Social Dimensions of Risk to Overcome Barriers to Disaster Risk Reduction and Sustainable Development. *Sustainable Development*, 29(5), 891—905.
- Ingham, T., Keall, M., Jones, B., Aldridge, D.R., Dowell, A.C., Davies, C., Crane, J., Draper, J.B., Bailey, L.O., Viggers, H., Stanley, T.V., Leadbitter, P., Latimer, M. and Howden-Chapman, P. 2019. Damp Mouldy Housing and Early Childhood Hospital Admissions for Acute Respiratory Infection: A Case Control Study. *Thorax*, 74(9), 849—857.

- IOL, 2021. *Eskom Warns of Electricity Faults in KwaZulu-Natal Due to Cold Weather*. Independent Online. Available: <https://www.iol.co.za/news/south-africa/kwazulu-natal/eskom-warns-of-electricity-faults-in-kwazulu-natal-due-coldweather-227c8cd3-211b-46ea-8ca1-ce7cb1e4a2a0> (Accessed: 13 January 2023).
- IPCC, 2012. Managing the Risks from Climate Extremes at the Local Level. In: Field, C.B., Barros, V., Stocker, T.F., Qin, D., Dokken, D.J., Ebi, K.L., Mastrandrea, M.D., Mach, K.J., Plattner, K., Allen, S.K., Tignor, M. and Midgley, P.M. (eds) *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. Cambridge University Press: Cambridge, UK and New York, USA, pp. 291—338.
- IPCC, 2023. Summary for Policymakers. In: Lee, H. and Romero, J. (eds) *Climate Change 2023: Synthesis Report*. IPCC: Geneva, Switzerland, pp. 1—34.
- Jagarnath, M., Thambiran, T. and Gebreslasie, M. 2020. Heat stress risk and vulnerability under climate change in Durban Metropolitan, South Africa - Identifying Urban Planning Priorities for Adaptation. *Climatic Change*, 163(2), 807—829.
- Jury, M.R. and Buthelezi, M.S. 2022. Air Pollution Dispersion Over Durban, South Africa. *Atmosphere*, 13(5), 811.
- Kearl, Z. and Vogel, J. 2023. Urban Extreme Heat, Climate Change, and Saving Lives: Lessons from Washington State. *Urban Climate*, 47, 101392.
- Kevan, S. 1980. Medical biometeorology. *Climatological Bulletin*, 11(4), 11—17.
- Khavhagali, V., Reckien, D., Biesbroek, R., Mantlana, B. and Pfeffer, K. 2023. Understanding the Climate Change Adaptation Policy Landscape in South Africa. *Climate Policy*, 24(4) 1—15.

- Knegt, J. and Naidoo, S. 2014. *Climate-smart Urban Agriculture in eThekweni*. Sabinet African Journals. Available: <https://hdl.handle.net/10520/EJC164367> (Accessed: 12 January 2023).
- Kotcher, J., Maibach, E., Miller, J., Campbell, E., Alqodmani, L., Maiero, M. and Wyns, A. 2021. Views of Health Professionals on Climate Change and Health: A Multinational Survey Study. *The Lancet Planetary Health*, 5(5), 316—323.
- Kouadio, I.K., Aljunid, S., Kamigaki, T., Hammad, K. and Oshitani, H. 2012. Infectious Diseases Following Natural Disasters: Prevention and Control Measures. *Expert Review of Anti-infective Therapy*, 10(1), 95—104.
- Kreslake, J.M., Sarfaty, M., Roser-Renouf, C., Leiserowitz, A. A. and Maibach, E. W. 2018. The Critical Roles of Health Professionals in Climate Change Prevention and Preparedness. *American Journal of Public Health*, 108(2), 68—69.
- Kuran, C.H.A., Morsut, C., Kruke, B.I., Krüger, M., Segnestam, L., Orru, K., Nævestad, T.O., Airola, M., Keränen, J., Gabel, F., Hansson, S. and Torpan, S. 2020. Vulnerability and Vulnerable Groups from an Intersectionality Perspective. *International Journal of Disaster Risk Reduction*, 50(101826), 1—8.
- La Guardia, M.J., Hale, R.C. and Newman, B. 2013. Brominated Flame-retardants in Sub-Saharan Africa: Burdens in Inland and Coastal Sediments in the eThekweni Metropolitan Municipality, South Africa. *Environmental Science & Technology*, 47(17), 9643—9650.
- Landman, W.A., Sweijid, N., Masedi, N. and Minakawa, N. 2020. The Development and Prudent Application of Climate-based Forecasts of Seasonal Malaria in the Limpopo Province in South Africa. *Environmental Development*, 35(100562), 1—13.

- Laplanche, B., Dasgupta, S., Wheeler, D. and Blankespoor, B. 2010. Adaptation to Climate Extremes in Developing Countries: The Role of Education. *Policy Research Working Papers No. 5342*, 1—44.
- Lee, J., Perera, D., Glickman, T. and Taing, L. 2020. Water-related Disasters and their Health Impacts: A Global Review. *Progress in Disaster Science*, 8(100123), 1—17.
- Lee, S., Paavola, J. and Dessai, S. 2022. Towards a Deeper Understanding of Barriers to National Climate Change Adaptation Policy: A systematic review. *Climate Risk Management*, 35(100414), 1—12.
- Lesnikowski, A., Biesbroek, R., Ford, J.D. and Berrang-Ford, L. 2021. Policy Implementation Styles and Local Governments: The Case of Climate Change Adaptation. *Environmental Politics*, 30(5), 753—790.
- Leuci, R., Wiles, E., Thackeray, Z. and Vella, G. 2022. Trends in Sandy Beach Variability - eThekweni Municipality, South Africa. *Journal of Sea Research*, 179(102149), 1—14.
- Li, M., Luo, J., Hu, J., Meng, R., Xu, X., He, G., Li, X., Liu, T., X, J., Zeng, W., Wang, Y. and Ma, W. 2023. The Association of Ambient Temperature Variability with Blood Pressure in Southern China. *Blood Pressure Monitoring*, 28(1), 33—41.
- Liu, X., Zhu, X., Pan, Y., Li, S., Liu, Y. and Ma, Y. 2016. Agricultural Drought Monitoring: Progress, Challenges, and Prospects. *Journal of Geographical Sciences*, 26(6), 750—767.
- Liu, J., Varghese, B.M., Hansen, A., Xiang, J., Zhang, Y., Dear, K., Gourley, M., Driscoll, T., Morgan, G., Capon, A. and Bi, P. 2021. Is there an Association between Hot Weather and Poor Mental Health Outcomes; A Systematic Review and Meta-analysis. *Environment International*, 153, 2—18.

- Lucero-Prisno, D.E., Shomuyiwa, D.O., Kouwenhoven, M.B.N., Dorji, T., Odey, G.O., Miranda, A.V., Ogunkola, I.O., Adebisi, Y.A., Huang, J., Xu, L., Obnial, J.C., Huda, A., Thepanondh, S., Dayrit, M.M., Evardone, S.B., Lamawansa, M.D., Ethiopia, S.S., Aziato, L., Adongo, P.B., Samai, M.H., Garcia, F.B., Villaruz, J.F., Karunathilake, I.M., Li, H., Azanza, P.A., Findlay, I. and Wong, M.C.S. 2023. Top 10 Public Health Challenges to Track in 2023: Shifting Focus beyond a Global Pandemic. *Public Health Challenges*, 2(2), 86—94.
- Lukasiewicz, A., Dovers, S. and Eburn, M. 2017. Shared Responsibility: The Who, What and How. *Environmental Hazards*, 16(4), 291—313.
- Luke, J., Franklin, R.C., Dyson, J. and Aitken, P. 2022. Building toward a Disaster Resilient Health System: A Study of Hospital Resilience. *Disaster Medicine and Public Health Preparedness*, 17(219), 1—8.
- Lutz, A. 2018. *Updated Climate Change Projections for eThekweni Municipality*. eThekweni Municipality. Available: https://www.futurewater.nl/wp-content/uploads/2018/11/CC_projections_eThekweni_FW178.pdf (Accessed: 25 February 2023).
- Ma, C., Yang, J., Nakayama, S.F., Iwai-Shimada, M., Jung, C., Sun, X. and Honda, Y. 2021. Cold Spells and Cause-specific Mortality in 47 Japanese Prefectures: A Systematic Evaluation. *Environmental Health Perspectives*, 129(6), 1—10.
- MacRobert, C. 2022. *The Conversation: How Geology puts Durban and other KZN Cities at Risk of Landslides*. Daily Maverick. Available: <https://www.dailymaverick.co.za/article/2022-04-28-how-geology-puts-durban-and-other-kzn-cities-at-risk-of-landslides/> (Accessed: 4 January 2023).
- Madumo, O.S. 2015. Developmental Local Government Challenges and Progress in South Africa. *Administratio Publica*, 23(2), 153—166.

- Magidimisha-Chipungu, H. 2022. *eThekwini Blithely Ignored Annual Flooding*. BizNews. Available: <https://www.biznews.com/global-citizen/2022/04/21/ethekwini-floods-disaster-prone> (Accessed: 3 January 2023).
- Maguire, M. and Delahunt, B. 2017. Doing a Thematic Analysis: A Practical, Step-by-Step Guide for Learning and Teaching Scholars. *AISHE-J*, 8(3), 1—14.
- Mahlangu, I. 2022. *Properties, Roads, and Bridges Swept Away by Floods in Umdloti as KZN Buckles under more Torrential Rains*. Sowetan Live. Available: <https://www.sowetanlive.co.za/news/south-africa/2022-05-22-properties-roads-bridges-swept-away-by-floods-in-umdloti-as-kzn-buckles-under-more-torrential-rains/> (Accessed: 7 November 2023).
- Malinga, G. 2021. *Weekend in KZN Off to a Cold, Wet Start*. East Coast Radio. Available: <https://www.ecr.co.za/news/news/weekend-kzn-cold-wet-start/> (Accessed: 4 January 2023).
- Maluleke, J. 2019. A Paradox of Defined Relationships between the Spheres of Government in South Africa. *Southern African Review of Education*, 25(2), 88—104.
- Mashao, F.M., Mothapo, M.C., Munyai, R.B., Letsoalo, J.M., Mbokodo, I. L., Muofhe, T.P., Matsane. W. and Chikoore, H. 2022. Extreme Rainfall and Flood Risk Prediction Over the East Coast of South Africa. *Water*, 15(1), 50.
- Mathebula, R.L., Maimela, E. and Ntuli, N.S. 2020. The Prevalence of Selected Non-communicable Disease Risk Factors Among HIV Patients on Anti-retroviral Therapy in Bushbuckridge Sub-district, Mpumalanga province. *BMC Public Health*, 20(247), 1—10.

- Mather, A.A. and Stretch, D.D. 2012. A Perspective on Sea Level Rise and Coastal Storm Surge from Southern and Eastern Africa: A Case Study near Durban, South Africa. *Water*, 4(1), 237—259.
- Matooane, M. 2009. *Climate Change and Health: Temperature and Health impacts*. Research Space. CSIR. Available: <https://researchspace.csir.co.za/dspace/handle/10204/5185> (Accessed: 4 January 2023).
- Mbatha, S. and Mchunu, K. 2016. Tracking Peri-urban Changes in eThekweni Municipality – Beyond the “poor–rich” Dichotomy’. *Urban Research and Practice*, 9(3), 275—289.
- Mehran, A., Mazdiasni, O. and Agha-Kouchak, A. 2015. A Hybrid Framework for Assessing Socioeconomic Drought: Linking Climate Variability, Local Resilience, and Demand. *Journal of Geophysical Research: Atmospheres*, 120(15), 7520—7533.
- Meth, P. and Buthelezi, S. 2017. New Housing/New Crime; Changes in Safety, Governance and Everyday Incivilities for Residents Relocated from Informal to Formal Housing at Hammond’s Farm, eThekweni. *Geoforum*, 82, 77—86.
- Michel, J., Chimbindi, N., Mohlakoana, N., Orgill, M., Bärnighausen, T., Obrist, B., Tediosi, F., Evans, D., McIntyre, D., Bressers, H. T. and Tanner, M. 2019. How and Why Policy-practice Gaps Come About: A South African Universal Health Coverage Context. *Journal of Global Health Reports*, 3, 1—32.
- Mitchell, M. and Jolley, J. 2013. *Research Design Explained* (8th Edition). Wadsworth Publishing: United States.
- Mkhize, M. and Sibanda, M. 2022. Food Insecurity in the Informal Settlements of Inanda Households Living with Children under 60 Months in eThekweni Municipality. *Children*, 9(10), 1521.

- Mlambo, D.N. and Maserumule, M.H. 2023. Constitutional and Legislative Frameworks for the Local Sphere of Government in South Africa: Analytical and Interpretive Perspective. *Insight on Africa*, 9, 1—19.
- Moosa, F. 2021. *How are Policies Made in South Africa*. The Daily Vox. Available: <https://www.thedailyvox.co.za/how-are-policies-made-in-south-africa/> (Accessed: 18 December 2023).
- Motlogeloa, O. and Fitchett, J.M. 2023. Climate and Human Health: A Review of Publication Trends in the International Journal of Biometeorology. *International Journal of Biometeorology*, 67(6), 933—955.
- Motlogeloa, O., Fitchett, J.M. and Sweijd, N. 2023. Defining the South African Acute Respiratory Infectious Disease Season. *International Journal of Environmental Research and Public Health*, 20(2), 1074.
- Musvoto, G., Lincoln, G. and Hansmann, R. 2016. The Role of Spatial Development Frameworks in Transformation of the eThekweni Municipality, KwaZulu-Natal, South Africa: Reflecting on 20 years of Planning. *Urban Forum*, 27(2), 187—210.
- Naidoo, E. 2015. *eThekweni Intensifies Drought Awareness Campaign*. North Coast Rising Sun. Available: <https://northcoastrisingsun.co.za/27017/ethekweni-intensifies-drought-awareness-campaign/> (Accessed: 5 January 2023).
- Nalau, J. and Verrall, B. 2021. Mapping the Evolution and Current Trends in Climate Change Adaptation Science. *Climate Risk Management*, 32(100290), 1—22.
- Narsai, P., Taylor, M., Jinabhai, C. and Steven, F. 2013. Variations in Housing Satisfaction and Health Status in Four Lower Socio-economic Housing Typologies in the eThekweni Municipality in KwaZulu-Natal. *Development Southern Africa*, 30(3), 367—385.

- NASA, 2023. *What is the Difference Between a Tropical Storm and a Tropical Depression*. NASA. Available: <https://gpm.nasa.gov/resources/faq/what-difference-between-tropical-storm-and-tropical-depression> (Accessed: 4 January 2023).
- Ndebele, N., Mlambo, V.H., Molepo, J.N. and Sibiyi, L.M. 2021. The South African Health Sector and the World Health Organization, South Africa's Health Sector and its Preparedness for the National Health Insurance (NHI): Challenges and Opportunities. *European Journal of Economics, Law, and Social Sciences*, 334—350.
- Ngie, A., Abutaleb, K., Ahmed, F., Taiwo, O.J., Darwish, A.A. and Ahmed, M. 2016. An Estimation of Land Surface Temperatures from Landsat ETM+ Images for Durban, South Africa. *Rwanda Journal*, 1(1), 1—17.
- NOAA, 2013. *How does the Ocean affect Climate and Weather on Land*. US Department of Commerce. Available: <https://oceanexplorer.noaa.gov/facts/climate.html> (Accessed: 22 December 2022).
- NOAA, 2019. *Tornado Safety*. NOAA's National Weather Service. Available: <https://www.weather.gov/safety/tornado#:~:text=A%20tornado%20is%20a%20violently,the%20air%20like%20deadly%20missiles> (Accessed: 5 January 2023).
- NOAA Climate Program, 2020. *Coastal Inundation, ArcGIS StoryMaps*. Esri. Available: <https://storymaps.arcgis.com/stories/5086cdc8c33b49919648f4142b0f6e1d> (Accessed: 4 January 2023).
- Noji, E.K. 2000. The Public Health Consequences of Disasters. *Prehospital and Disaster Medicine*, 15(4), 21—31.

- Nosrat, C., Altamirano, J., Anyamba, A., Caldwell, J.M., Damoah, R., Mutuku, F., Ndenga, B. and LaBeaud, A. D. 2021. Impact of Recent Climate Extremes on Mosquito-borne Disease Transmission in Kenya. *PLoS Neglected Tropical Diseases*, 15(3), 1—17.
- Noy, C. 2008. Sampling Knowledge: The Hermeneutics of Snowball Sampling in Qualitative Research. *International Journal of Social Research Methodology*, 11(4), 327—344.
- O'Donoghue, S., Morgan, D., Leck, H., Moodley, P. and Haydovogl, K. 2022. The Durban Climate Change Strategy: Lessons learnt from the 2021 Strategy Review and Implementation Plan. *Town and Regional Planning*, 81, 84—96.
- Okem, A.E. and Bracking, S. 2019. The Poverty Reduction Co-benefits of Climate Change-Related Projects in eThekweni Municipality, South Africa. In: Cobbinah, P.B. and Addaney, M. (eds) *The Geography of Climate Change Adaptation in Urban Africa*. Palgrave Macmillan: Cham, pp. 275—304.
- Olanrewaju, C.C. and Reddy, M. 2022. Assessment and Prediction of Flood Hazards using Standardized Precipitation Index – A Case Study of eThekweni Metropolitan Area. *Journal of Flood Risk Management*, 15(2), 1—12.
- Owen, G.T. 2014. Qualitative Methods in Higher Education Policy Analysis: Using Interviews and Document Analysis. *The Qualitative Report*, 19(52), 1—19.
- Pakistan National Adaptation Plan, 2023. *Pakistan National Adaptation Plan*. Ministry of Climate Change and Environmental Coordination. Available: https://unfccc.int/sites/default/files/resource/National_Adaptation_Plan_Pakistan.pdf (Accessed: 13 May 2023).
- Palmer, W.C. 1965. *Meteorological Drought* (Vol. 30). US Department of Commerce, Weather Bureau. Available: <https://books.google.co.za/books?hl=en&lr=&id>

=kyYZgnEk-L8C&oi=fnd&pg=PA6&dq=meteorological+drought&ots=U4fv
hn1Jkl&sig=wqAYcAV-GzE3gt-VzDEE_5Pq7iM&redir_esc=y#v=onepage&
q=meteorological%20drought&f=false. (Accessed: 6 May 2023)

Papayya, M. 2022. *Durban Water Crisis Worsening and No Money Allocated to Deal with it*. Business Live. Available: <https://www.businesslive.co.za/bd/national/2022-09-04-durban-water-crisis-worsening-and-no-money-allocated-to-deal-with-it/> (Accessed: 3 January 2023).

Parliamentary Monitoring Group, 2023. *The Structure of Government*. Parliamentary Monitoring Group. Available: <https://pmg.org.za/page/structure-of-government> (Accessed: 1 January 2024).

Pasquini, L., van Aardenne, L., Godsmark, C.N., Lee, J. and Jack, C. 2020. Emerging Climate Change-related Public Health Challenges in Africa: A Case Study of the Heat-health Vulnerability of Informal Settlement Residents in Dar es Salaam, Tanzania. *Science of The Total Environment*, 747, 141355.

Patton, C.V., Sawicki, D.S. and Clark, J. 2016. *Basic methods of policy analysis and planning*. Routledge: London.

Pauw, W.P., Castro, P., Pickering, J. and Bhasin, S. 2020. Conditional Nationally Determined Contributions in the Paris Agreement: Foothold for Equity or Achilles heel. *Climate Policy*, 20(4), 468—484.

Petersen, W.F. 1935. *The patient and the weather*. Edwards Brothers: Chicago

Phillips, T. 2021. *Durban Tackles Heat Island Effect*. The Mail & Guardian. Available: <https://mg.co.za/environment/2021-07-18-durban-tackles-heat-island-effect/> (Accessed: 3 January 2023).

- Pietrapertosa, F., Salvia, M., De Gregorio Hurtado, S., Geneletti, D., D'Alonzo, V. and Reckien, D. 2021. Multi-level Climate Change Planning: An Analysis of the Italian Case. *Journal of Environmental Management*, 289, 112469.
- Pillay, B. and Mutereko, S. 2022. Caring for the Indigent Urban Population in South Africa: A Case Study of the eThekweni Municipality. *Africa's Public Service Delivery and Performance Review*, 10(1), 2310—2152.
- Pinter-Wollman, N., Jelic', A. and Wells, N.M. 2018. The Impact of the Built Environment on Health Behaviours and Disease Transmission in Social Systems. *Philosophical Transactions*, 373, 1—18.
- Rai, A., Adeyeye, T., Insaf, T. and Muscatiello, N. 2023. Assessing the Effect of Precipitation on Asthma Emergency Department Visits in New York State from 2005 to 2014: A Case-crossover Study. *GeoHealth*, 7(9), 1—12.
- Rajabi, E., Bazayr, J., Delshad, V. and Khankeh, H. R. 2022. The Evolution of Disaster Risk Management: Historical Approach. *Disaster Medicine and Public Health Preparedness*, 16(4), 1623—1627.
- Räsänen, A., Lein, H., Bird, D. and Setten, G. 2020. Conceptualizing Community in Disaster Risk Management. *International Journal of Disaster Risk Reduction*, 45(101485), 1—8.
- Ratwatte, P., Wehling, H., Kovats, S., Landeg, O. and Weston, D. 2022. Factors Associated with Older Adults' Perception of Health Risks of Hot and Cold Weather Event Exposure: A Scoping Review. *Front in Public Health*, 10, 1—10.
- Rayan, R.A., Choudhury, M., Deb, M., Chakravorty, A., Devi, R. M. and Mehta, J. 2021. Climate Change: Impact on Waterborne Infectious Diseases. *Water Conservation in the Era of Global Climate Change*, 15(7), 213—228.

- Rehman, S., Natarajan, N., Mohandes, M.A., Meyer, J.P., Alam, M.M. and Alhems, L.M. 2021. Wind and Wind Power Characteristics of the Eastern and Southern Coastal and Northern Inland Regions, South Africa. *Environmental Science and Pollution Research*, 29(7), 85842—85854.
- Ripple, W. J., Wolf, C., Gregg, J. W., Levin, K., Rockström, J., Newsome, T. M., Betts, M. G., Huq, S., Law, B. E., Kemp, L., Kalmus, P. and Lenton, T. M. 2022. World Scientists' Warning of a Climate Emergency. *BioScience*, 72(12), 1149—1155.
- Roberts, D. 2008. Thinking Globally, Acting Locally - Institutionalizing Climate Change at the Local Government Level in Durban, South Africa. *Environment and Urbanization*, 20(2), 521—537.
- Roberts, D. 2010. Prioritizing Climate Change Adaptation and Local Level Resilience in Durban, South Africa. *Environment and Urbanization*, 22(2), 397—413.
- Roberts, D. and O'Donoghue, S. 2013. Urban Environmental Challenges and Climate Change Action in Durban, South Africa. *Environment and Urbanization*, 25(2), 299—319.
- Roberts, D. and O'Donoghue, S. 2016. *Chapter 18 City View: Durban, South Africa*. In: Mastny, L. (ed). *State of the World: Can a City Be Sustainable*. The Worldwatch Institute, Island Press: Washington, pp. 338—342.
- Roux, N.L. 2002. Public Policy-making and Policy Analysis in South Africa Amidst Transformation, Change, and Globalisation: Views on Participants and Role Players in the Policy Analytic Procedure. *Journal of Public Administration*, 37(4), 418—437.
- Ruffin, F.A. 2013. Municipal International Relations: The South African Case of Metropolitan eThekweni. *Journal of Social Sciences*, 27(1), 119—141.

- Saad, P. 2017. *Moses Mabhida Stadium from the Pier, Durban*. Map Logs. Available: https://sunrise.maplogs.com/durban_north_south_africa.407240.html (Accessed: 14 February 2024).
- Sakurai, A. and Sato, T. 2016. Promoting Education for Disaster Resilience and the Sendai Framework for Disaster Risk Reduction. *Journal of Disaster Research*, 11(3), 402—412.
- Salam, R., Ghose, B., Shill, B.K., Islam, A., Towfiqul Islam, A.R., Sattar, A., Monirul Alam, G. M. and Ahmed, B. 2021. Perceived and Actual Risks of Drought: Household and Expert Views from the Lower Teesta River Basin of Northern Bangladesh. *Natural Hazards*, 108(4), 2569—2587.
- Ndaimani, H., Naidu, M. and Mutanga, O. 2022. Terrain influences on the informal settlements of eThekweni, South Africa. In: Sandham, L., Hansen, C. and Meiklejohn, I. (eds). *Proceedings of the Joint Biennial Conference of the Society of South African Geographers and the Southern African Association of Geomorphologists*. South Africa: Online. Available: <https://www.ssag.co.za/wp-content/uploads/2022/11/SSAG-SAAG-2021-Conference-Proceedings-2022-Final.pdf> (Accessed: 24 May 2023), pp. 192—204.
- Sendai Framework for Disaster Risk Reduction 2015–2030, 2015. United Nations Office for Disaster Risk Reduction. Available: http://www.wcdrr.org/uploads/Sendai_Framework_for_Disaster_Risk_Reduction_2015-2030.pdf. (Accessed: 20 June 2023).
- Sibiya, M.N., Ngxongo, T.S. and Bhengu, T.J. 2018. Access and Utilisation of Antenatal Care Services in a Rural Community of eThekweni District in KwaZulu-Natal. *International Journal of Africa Nursing Sciences*, 8, 1—7.

- Silove, D. and Steel, Z. 2006. Understanding Community Psychosocial Needs after Disasters: Implications for Mental Health Services. *Journal of Postgrad Medicine*, 52(2), 121—125.
- Sim, V., Sutherland, C. and Scott, D. 2016. Pushing the Boundaries – Urban Edge Challenges in eThekweni Municipality. *South African Geographical Journal*, 98(1), 37—60.
- Simeon, R. and Murray, C. 2001. Multi-sphere Governance in South Africa: An Interim Assessment. *Publius: The Journal of Federalism*, 31(4), 65—92.
- Simpson, S. 2021. *Durban Heatwave: High Temperatures Blamed for Blackouts across the City*. The South African. Available: <https://www.thesouthafrican.com/news/weather/durban-heatwave-high-temperatures-blamed-for-blackouts-across-the-city-ethekweni-power-outages-load-shedding-15-october-2021/> (Accessed: 4 January 2023).
- Singh, O. 2021. *Durban on Alert as Tropical Storm Eloise Threatens Weekend Strike*. Times Live. Available: <https://www.timeslive.co.za/news/south-africa/2021-01-21-durban-on-alert-as-tropical-storm-eloise-threatens-weekend-strike/> (Accessed: 5 January 2023).
- Singleton, A.T. and Reason, C.J. 2007. Variability in the Characteristics of Cut-off Low-pressure Systems over Subtropical Southern Africa. *International Journal of Climatology*, 27(3), 295—310.
- Smit, M. 2017. *Snow Falls across KZN*. Highway Mail. Available: <https://highwaymail.co.za/276251/watch-snow-falls-across-kzn/> (Accessed: 13 January 2023).

- Smith, A.M., Guastella, L.A., Bundy, S.C. and Mather, A.A. 2007. Combined Marine Storm and Saros Spring High Tide Erosion Events along the KwaZulu-Natal Coast in March 2007. *South African Journal of Science*, 103(7-8), 274—276.
- South African Government, 2023. *Structure and Functions of the South African Government*. South African Government. Available: <https://www.gov.za/about-government/government-system/structure-and-functions-south-african-government> (Accessed: 18 December 2023).
- South African Human Rights Commission, 2004. *The Right to Health Care: 5th Economic and Social Rights Report Series 2002/2003 Financial*. South African Human Rights Commission. Available: https://www.sahrc.org.za/home/21/files/Reports/5th_esr_health.pdf (Accessed: 14 May 2023).
- Spence, R. 2004. Risk and Regulation: Can Improved Government Action Reduce the Impacts of Natural Disasters. *Building Research and Information*, 32(5), 391—402.
- Sperling, F. and Szekely, F. 2005. Disaster Risk Management in a Changing Climate. In: *World Conference on Disaster Reduction on behalf of the Vulnerability and Adaptation Resource Group (VARG) Discussion Paper*. VARG: Washington, D.C, pp. 1—45.
- Sugg, M., Runkle, J., Leeper, R., Bagli, H., Golden, A., Handwerger, L. H., Magee, T., Moreno, C., Reed-Kelly, R., Taylor, M. and Woolard, S. 2020. A Scoping Review of Drought Impacts on Health and Society in North America. *Climatic Change*, 162(3), 1177—1195.
- Tandon, A. 2022. *Climate Change Made Extreme Rains in 2022 South Africa Floods 'twice as likely'*. Carbon Brief. Available: <https://www.carbonbrief.org/climate->

change-made-extreme-rains-in-2022-south-africa-floods-twice-as-likely/

(Accessed: 4 January 2023).

Tau, M.L. 2015. Intergovernmental Relations and Cooperative Governance in South Africa: Challenges and Prospects. *Journal of Public Administration*, 50(4), 801—823.

Tyson, P.D. and Preston-Whyte, R.A. 2000. *The Weather and Climate of Southern Africa*. Oxford University Press: Southern Africa.

The Citizen, 2021. *Tornado Confirmed to have Claimed Two Lives in KZN*. The Citizen. Available: <https://www.citizen.co.za/news/tornado-confirmed-to-have-claimed-two-lives-in-kzn/> (Accessed: 5 January 2023).

Thornhill, C. 2014. South African Municipalities Prospects and Challenges: An African perspective. *African Journal of Public Affairs*, 7(4), 140—155.

Tong, S., Bambrick, H., Beggs, P., Chen, L., Hu, Y., Ma, W., Steffen, W. and Tan, J. 2022. Current and Future Threats to Human Health in the Anthropocene. *Environment International*, 158(106892), 1—14.

Tromp, S.W. 1963. *Medical biometeorology*. Elsevier: Amsterdam.

Tromp, S.W. 1977. *Progress in Biometeorology, the Effect of Weather and Climate on Man and his Living Environment*. Swets & Zeitlinger: Amsterdam.

Tsai, M., Chang, Y., Shiau, J. and Wang, S. 2020. Exploring the Effects of a Serious Game-based Learning Package for Disaster Prevention Education: The Case of Battle of Flooding Protection. *International Journal of Disaster Risk Reduction*, 43(2), 101393.

Turpie, J.K., Letley, G., Schmidt, K., Weiss, J., O'Farrell, P. and Jewitt, D. 2021. *Towards a Method for Accounting for Ecosystem Services and Asset Value: Pilot Accounts for KwaZulu-Natal, South Africa, 2005-2011*. Available:

- <https://seea.un.org/content/towards-method-accounting-ecosystem-services-and-asset-value-pilot-accounts-kwazulu-natal> (Accessed: 16 January 2023).
- Unger, E., Bennett, R., Lemmen, C., de Zeeuw, K., Zevenbergen, J., Teo, C. and Cromptvoets, J. 2020. Global Policy Transfer for Land Administration and Disaster Risk Management. *Land Use Policy*, 99, 104834.
- van der Bank, M. and Karsten, J. 2020. Climate Change and South Africa: A Critical Analysis of the Earthlife, Africa, Johannesburg. *Air, Soil and Water Research*, 13, 1—11.
- van der Geest, K. and Warner, K. 2019. Loss and Damage in the IPCC Fifth Assessment Report (Working Group II): A text-mining analysis. *Climate Policy*, 20(6), 729—742.
- van der Walt, A.J. and Fitchett, J.M. 2020. Trend Analysis of Cold Extremes in South Africa: 1960–2016. *International Journal of Climatology*, 41(3), 2060—2081.
- van der Walt, A.J. and Fitchett, J.M. 2021a. Exploring Extreme Warm Temperature Trends in South Africa: 1960 – 2016. *Theoretical and Applied Climatology*, 143(3-4), 1341—1360.
- van der Walt, A.J. and Fitchett, J.M. 2021b. Extreme Temperature Events in South Africa: A Review. *South African Geographical Journal*, 104(1), 70—88.
- van Loon, A.F. 2015. Hydrological Drought Explained. *WIREs Water*, 2(4), 359—392.
- Wagenaar, H. 2015. *Meaning in action interpretation and dialogue in policy analysis*. Routledge: New York.
- Walt, G. and Gilson, L. 1994. Reforming the Health Sector in Developing Countries: The Central Role of Policy Analysis. *Health Policy and Planning*, 9(4), 353—370.

- Wamsler, C. and Johannessen, Å. 2020. Meeting at the crossroads; Developing National Strategies for Disaster Risk Reduction and Resilience: Relevance, Scope for, and Challenges to Integration. *International Journal of Disaster Risk Reduction*, 45(101452), 1—8.
- Wavomba, Z. 2019. *How Latitude & Altitude Affect Temperature*. Sciencing. Available: <https://sciencing.com/sun-intensity-vs-angle-23529.html> (Accessed: 22 December 2022).
- Weilnhammer, V., Schmid, J., Mittermeier, I., Schreiber, F., Jiang, L., Pastuhovic, V., Herr, C. and Heinze, S. 2021. Extreme Weather Events in Europe and their Health Consequences - A systematic review. *International Journal of Hygiene and Environmental Health*, 233(113688), 1—11.
- Weller, S.C., Vickers, B., Bernard, H.R., Blackbur, A.M., Borgatti, S., Gravlee, C.C. and Johnson, J.C. 2018. Open-ended Interview Questions and Saturation. *PLoS ONE*, 13(6), 0198606.
- Wentink, G.J. and van Niekerk, D. 2017. The Capacity of Personnel in Disaster Risk Management in South African Municipalities. *The Journal for Transdisciplinary Research in Southern Africa*, 13(1), 427—437.
- Western Cape Government, 2023. *Know your Government*. Western Cape Government. Available: https://www.westerncape.gov.za/your_gov (Accessed: 18 December 2023).
- WHO, 1946. *Constitution of the World Health Organization*. World Health Organization. Available: <https://apps.who.int/gb/bd/PDF/bd47/EN/constitution-en.pdf> (Accessed: 18 January 2023).

- WHO, 2014. *The Helsinki Statement on Health in All Policies*. World Health Organisation. Available: https://iris.who.int/bitstream/handle/10665/112636/9789241506908_eng.pdf?sequence=1 (Accessed: 18 January 2023).
- Williams, C., Smith, J.A., Valentine, N., Baum, F., Friel, S., Williams, J. and Schmitt, D. 2023. The Well-being Economy and Health In all Policies: Fostering Action for Change. *Health Promotion Journal of Australia*, 34(3), 623—625.
- Windfinder, 2022. *Wind and Weather Statistic, Durban Airport*. Windfinder. Available: <https://www.windfinder.com/windstatistics/durban> (Accessed: 10 January 2023).
- Wright, C.Y., Garland, R.M., Norval, M. and Vogel, C. 2014a. Human Health Impacts in a Changing South African Climate. *South African Medical Journal*; 104(8), 579—82.
- Wright, C.Y., Mathee, A. and Garland, R.M. 2014b. Climate Change, Human Health and the Role of Environmental Health Practitioners. *SAMJ*, 104(8), 518—519.
- Wright, C.Y., Kapwata, T., du Preez, D., Wernecke, B., Garland, R., Nkosi, V., Landman, W., Dyson, L. and Norval, M. 2021a. Major Climate Change-induced Risks to Human Health in South Africa. *Environmental Research*, 196, 110973.
- Wright, C.Y., Moore, C., Chersich, M., Hester, R., Nayna Schwerdtle, P., Mbayo, G., Akong, C. and Butler, C. 2021b. A Transdisciplinary Approach to Address Climate Change Adaptation for Human Health and Well-Being in Africa. *International Journal of Environmental Research and Public Health*, 18(8), 4258.
- Xulu, L. 2021. *KZN turns into a Winter Wonderland*. The Witness. Available: <https://www.citizen.co.za/witness/news/watch-kzn-turns-into-a-winter-wonderland-20210828/> (Accessed: 13 January 2023).

Yanow, D. 2007. Interpretation in policy analysis: On Methods and Practice. *Critical Policy Analysis*, 1(1), 110—122.

APPENDICES

APPENDIX A: Ethics Clearance Certificate



Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

R14/49 Meyer

CLEARANCE CERTIFICATE

PROTOCOL NUMBER: H22/08/16

PROJECT TITLE

The Extent of the Inclusion and Consideration of Extreme Climate Events and Health in South African Policies: The case of eThekwin

INVESTIGATOR(S)

Mrs C Meyer

SCHOOL/DEPARTMENT

Geography, Archaeology and Environmental Studies/

DATE CONSIDERED

19 August 2022

DECISION OF THE COMMITTEE

Approved
Risk Level: Minimal

EXPIRY DATE

14 September 2025

DATE

15 September 2022

CHAIRPERSON

(Professor J Watermeyer)

cc: Supervisor : Dr CY Wright and Prof J Fitchett

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and ONE COPY returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to submit an amendment of the protocol to the Committee. I agree to completion of a regular progress report. For Minimal and Low studies, this is due annually on 31 December. For Medium and High Risk studies, this is due twice annually on 30 June and 31 December.

Signature

16 / 09 / 2022
Date

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

APPENDIX B: Participant Information Sheet



UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Hello,

I am Charné Meyer, a Masters student in Geography at the University of the Witwatersrand, Johannesburg. My research is supervised by Dr Caradee Y. Wright and Professor Jennifer Fitchett. The study title is 'The Extent of the Inclusion and Consideration of Extreme Climate Events and Health in South African Policies; The Case of eThekweni'.

I invite you to participate in a once-off interview of approximately 40 minutes. To assist with COVID-19 concerns the interview will take place over an online platform on a day and time that is suited to you in November of 2022. The interview will contribute to the list of policies my research could include.

With your permission, I would like to audio record the interview for data analysis. This data will be stored in a password protected computer for five years and will thereafter be deleted. Only my supervisors and I will have access to the data for the purpose of this study. When I share the results of the research study, I will not include anything that could directly identify you. Each participant will be identified numerically where the first participant will be identified as Participant 1. With your permission, other researchers may use the data collected from this research study, and your name and any personal information will not be used or passed on. You do not have to take part in the interview, if you do, you may stop participation at any point and do not have to answer any questions you prefer not to answer. You will not get any direct benefits if you choose to join the research study and you will not lose any services, benefits or rights you would normally have if you decide not to join. Your participation will not incur any costs, nor will you be paid for your participation. The risks for this research study are no more than what happens in everyday life – however it may be possible that you are identified by the responses you give by colleagues that may recognise your beliefs, opinions, or work style.

This research study will be written up as a dissertation that will be available on the universities library website. If you would like to receive a copy of the dissertation, I will be happy to send it to you.

If you have any questions during or after the research study, feel free to contact me on the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

Yours sincerely,
Charné Meyer

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APPENDIX C: Participant Consent Form



UNIVERSITY OF THE
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The Extent of the Inclusion and Consideration of Extreme Climate Events and Health in South African Policies; The Case of eThekweni

Researcher: Charné Meyer

I _____ agree to participate in this research project.

I agree to the following:

(Please circle the relevant options below)

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study, and that I can stop participation at any point during or after the interview.	YES	NO
I agree that the interview will be audio recorded.	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their dissertation.	YES	NO
I agree that my participation will remain confidential (my name will not be used by the researcher in their dissertation).	YES	NO
I agree that my company and job title will remain confidential (my company and job title will not be used by the researcher in their dissertation).	YES	NO
I agree that other researchers may use the information I provide in my interview (depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on.	YES	NO

Participant:

Name: _____

Signature: _____

Date: _____

Researcher:

Name: Charné Meyer

Signature: _____

Date: _____

APPENDIX D: Study's Semi-Structured Interview Schedule

Interview Schedule:

1) Opening

- A. (Establish Rapport) Hi _____, my name is Charne' Meyer, as per our communications I am currently working on my MSc in Geography at wits. My dissertation considers the extent of the inclusion and reflection of extreme climate events and health in policies that have a bearing on the eThekweni region.
- B. (Purpose) The purpose of the interview with you will assist me with what policies I could add to the collection that will be screened and analysed.
- C. (Motivation) This information will assist me in my research endeavours by giving me a broader selection of policies to consider, as well as what you as an eThekweni expert can bring to light with regards to the themes of my research.
- D. (Time Line) The interview should take about 40 minutes.

(Transition: Let me begin by asking you some questions about policies.)

2) Body

A. Policy

- 1. Are there any tools that you know of that should guide or assist policy development?
For example, the World Health Organisation developed a framework for national level decision-makers called the Health in All Policies: Framework for Country Action. This framework acts as a 'starter kit' for sub-national and national policies, to assist in the inclusion of health in all policies.
- 2. Are there any South African governmental policy documents that are concerned with the impact of climate on human health, of which you may know?
- 3. To what extent would you say these documents include and consider human health from climate change, why do you say so?
- 4. Do you know of any South African governmental policy documents that consider climate change?
- 5. How would you say these documents reflect on climate change?
- 6. To your knowledge are there any South African governmental policies that cover concerns of extreme climate events?
- 7. Do these documents deal with extreme climate events, please explain your reasoning?

(Transition: Now I would like to reflect on the recognition of the nexus between health and extreme climate events in policy.)

B. Health and ECE's

8. Are there any governmental policies that only consider extreme climatic events and human health in a single document?
9. To what extent would you say these documents reflect on health impacted by extreme climates?
10. Do you know of any possible barriers to including this intersectionality between human health and extreme climate events in policy?
11. Should policy that considers this interconnection between human health and extreme climate events be national or regional? Why do you say this?

(Transition: My research is specifically focused on the eThekweni region; the following questions are therefor based on policies relating to eThekweni.)

C. eThekweni policy

12. Have you knowledge of any eThekweni policies, finalized or still in draft form, that mention the themes of climate change, human health and extreme climate events?
13. Should the eThekweni municipality policies include the connection between extreme climate events and health?
14. Do you feel that these themes of climate change, extreme climate events and health are currently adequately reflected upon in policy for eThekweni?
15. Do you feel that eThekweni adequately has efforts of action to address climate impacts on health, and if so, what action do you know is being taken? For example, are there bylaws or guidelines in eThekweni that are concerned with human health impacted by extreme climatic events?

(Transition: The last question considers the inclusion of Extreme Climate Events and health in global and national policy.)

D. The inclusion of themes in global and national policy

16. Have you come across any national or global policies that include themes of climate change, human health and extreme climatic events?

3) Closing

- A. (Thanks) Thank you for taking the time to assist me with my research. Is there anything related to my research you would like to add?
- B. (Action) That concludes the interview, if you would like a copy of my research dissertation please let me know and I will send you a copy once I have completed it.

APPENDIX E: ENBEL Participant Information Sheet



Participant Information Sheet

Stakeholder analysis of policy makers for climate and health adaptation

We would like to invite you to take part in a research study on implementation of adaptation strategies to protect human health in Southern and Eastern Africa.

What is the purpose of the study?

The ENBEL project (Enhancing Belmont) aims to support policy making in the EU and Europe on climate and health. ENBEL brings together leaders in climate change and health research through a network of international research projects funded under the Belmont Forum's Collaborative Research Action (CRA), Societal Challenge 1 and 5 of EU's Horizon 2020. ENBEL will develop evidence syntheses and co-produce with stakeholders targeted knowledge products. We aim to map stakeholders in Africa that work on adaptation in order to understand interlinkages and identify areas for action. ENBEL is funded by the European Commission.

Why have I been asked to take part?

You have been identified as a key decision maker for policies that address adaptation (to reduce the health impacts of climate change).

Do I have to take part?

It is up to you to decide to take part or not. Nothing will happen if you do not take part in this study. You can withdraw from the study at any time.

What will I have to do?

Your participation consists of a single interview that will be recorded and transcribed. All results will be fully anonymised and no quotes will be attributed to you. Your interview will be used to map institutional (unnamed) responses to climate-change adaptation in a stakeholder map. The institution will not be named but identified as a general type. The interview should take about 40 minutes.

What are the possible risks and disadvantages?

We are not aware of any risks or disadvantages of participating in this research.

What are the possible benefits?

We cannot promise the study will help you but the information we get from the study will help our knowledge and understanding of the implementation of adaptation measures on climate and health

adaptation and will also help us to identify research needs in this area. Results will be fed back to decision makers and research funders.

If you have concerns

If you have a concern about any aspect of this study, you can speak to the researchers who will do their best to answer your questions: Caradee Wright 082 677 4037. If you remain unhappy and wish to complain formally, you can do this by contacting our research grants officer at LSHTM: Patricia Henley at rgio@lshtm.ac.uk or +44 (0) 20 7927 2626. The London School of Hygiene and Tropical Medicine holds insurance policies which apply to this study. If you experience harm or injury as a result of taking part in this study, you may be eligible to claim compensation.

What will happen to information collected about me?

We will need to use information from your interview for this research project. All information collected about you will be kept private. Only the study staff and authorities who check that the study is being carried out properly will be allowed to look at the information. Data may be sent to other study staff in ENBEL but this will be anonymised.

Your personal details, meaning your name and other identifiable information, will be kept in a different safe place to the other study information and will be destroyed within 5 years of the end of the study. At the end of the project, the study data will be archived at LSHTM.

Where can you find out more about how your information is used?

You can find out more about how we use your information at <https://www.lshtm.ac.uk/files/research-participant-privacy-notice.pdf> or by asking one of the research team cwright@mrc.ac.za or by sending an email to DPO@lshtm.ac.uk.

What will happen to the results of this study?

The results of this research will be delivered to the European Commission and research funding agencies to inform the future research agenda on climate and health. We will also publish the results in a research journal and disseminate the findings to participants and international agencies with an interest in adaptation (e.g., WHO).

Who is organising and funding this study?

London School of Hygiene & Tropical Medicine is the sponsor for the research and they have full responsibility for the project including the collection, storage and analysis of your data, and will act as the Data Controller for the study. This means that we are responsible for looking after your information and using it properly. The research protocols have been reviewed and given favourable opinion by The London School of Hygiene and Tropical Medicine Research Ethics Committee (Certificate number: 26325).

Thank you

Thank you for taking time to read this information sheet. If you think you will take part in the study, please read and sign the consent form. If you would like any further information, please contact Dr Caradee Wright of the SAMRC, a collaborator on the project, who can answer any questions you may have about the study.

Contact details: Dr Caradee Wright
Caradee.Wright@mrc.ac.za

APPENDIX F: ENBEL Participant Consent Form



Consent Form

Stakeholder analysis of policy makers for climate and health adaptation

Statement	Please initial each box
I confirm that I have read and understood the information sheet for the ENBEL study on climate and health adaptation. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily.	
I understand that my consent is voluntary and that I am free to withdraw this consent at any time without giving any reason.	
I understand that relevant sections of my data collected during the study may be looked at by authorised individuals from the South African Medical Research Council and the London School of Hygiene and Tropical Medicine where it is relevant to my taking part in this research. I give permission for these individuals to have access to these data.	
I understand that data about me may be shared via a public data repository or by sharing directly with other researchers, and that I will not be identifiable from this information	
I agree to me taking part in the above-named study.	
I agree to my interview being audio-recorded and transcribed.	
I understand that disguised extracts from my interview may be quoted in a manuscript.	

Printed name of participant	Signature of participant	Date

Printed name of person obtaining consent	Signature of person obtaining consent	Date

APPENDIX G: ENBEL Semi-Structured Interview Schedule

Stakeholder analysis: climate and health

A gentle introduction from both of you before you begin. Remember to ask if they have any questions from the information sheet. Ask for the signed consent form (if we don't get it in advance) – we cannot do the interview until the form is signed.

Topic	Question
Interest in climate and health	1. What is this department/institution/organisation's mission and primary goal with respect to climate / health adaptation? 2. Are you aware of the policies for climate / health? Which ones? 3. Are you aware of the adaptation policies for climate / health? Which ones? 4. Are you aware of the policies with regard to heat risk management? Which ones? 5. Are you aware of the policies regard to Infectious disease control? Which ones? 6. Are you aware of the policies with regard extreme weather? Which ones? 7. What is the desired outcome of your efforts? / What motivates your work?
Influencing capacity	1. What is your capacity for implementation of these policies you've just mentioned? 2. How strongly does your organisation influence adaptation policy and intervention? <i>Low influence: Stakeholder possesses no legal mandate, resource or mobilisation for policy implementation</i> <i>Medium influence: Stakeholder possesses limited or moderate potential to affect policy implementation</i> <i>High influence: Stakeholder possesses legal mandate, regulatory regime and resources/funding</i> 3. Who do you think is responsible for implementation of the policies you mentioned above? 4. Does your organisation have the necessary resources for implementation of policy and ability to mobilise other groups? 5. Can you describe how (if at all) your organisation influences adaptation policy to improve health in South Africa?
Current policy gaps	1. Are you supportive or critical of current policy on adaptation for health? <i>Strong opponent: Stakeholder uses potential power to strongly act against policy implementation</i> <i>Moderate opponent: Stakeholder uses potential power to moderately act against policy implementation</i> <i>Neutral: Stakeholder does not use potential power and does not act for or against policy implementation</i> <i>Moderate support: Stakeholder uses potential power to moderately act in support of policy implementation</i> <i>Strong support: Stakeholder uses potential power to act strongly in support of policy implementation</i> 2. How / do national policies constrain or support local action?

	3. What are the barriers to addressing adaptation related to climate and health? 4. How does the national policy (policies) support or constrain sub-national action? [Provincial or Municipal level]
Collaboration network	1. Who do you regularly collaborate with in the field of climate adaptation and health? 2. Which international or national organisations support your adaptation planning? 3. Who would like to work with?
Current evidence gaps	1. What research evidence do you use? 1. WHO Reports 2. National vulnerability assessment 3. Measurements 4. Expert advice 5. Journal papers, systematic reviews 6. Other 2. What evidence would help your work? 3. Are you a member of any networks that support adaptation? 4. Are there any science/evidence topics that would be useful for policy briefs or science workshops over the next 18 months?
Covid-19	1. Do you think adaptation in the health sector in South Africa will be hindered or improved by COVID-19 recovery (for example, greater investment in health security)? 2. What are the benefits of COVID-19 recovery, has there been consideration of adaptation and climate in the recovery? E.g., inequalities, health system resilience, emergency planning. 3. How does engagement with other departments/sectors support implementation of policies for adaptation?
Policy alignment	1. Do you think climate-health issues are better addressed in other policies (e.g., Water, Environmental Management, Risk disaster management, One Health)

Thank you for participating in the study. We will share the results of the study with you if you would like us to? (make a note of this).

APPENDIX H: Policy Data Table

[illegible]

[illegible]

[illegible]

190

[illegible]

[illegible]