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Holtz, Cassia

2026

University of the Witwatersrand, Johannesburg

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Holtz, Cassia. (2026). Exploring shifts in the threshold for reporting on extreme temperature events over the past century in South Africa [Master's dissertation, University of the Witwatersrand, Johannesburg]. WIReDSpace. https://hdl.handle.net/10539/50286

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Exploring shifts in the threshold for reporting on extreme temperature events over the past century in South Africa

Cassia Holtz

Student No. 2357355

Dissertation

Submitted in fulfilment of the requirements for the degree

Master of Science

In

Geography

Faculty of Science, University of the Witwatersrand,

Johannesburg, South Africa

Supervisor: Professor Jennifer M. Fitchett

February 2026

Declaration

I declare that this dissertation is my own, unaided work. It is being submitted for the Degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at the University of the Witwatersrand or any other University.



(Signature of Candidate)

09/02/2026

(Date)

Abstract

This research aims to better understand how the heat wave threshold has changed in South Africa over the past century. Based in practices of historical climatology, a mixed methods approach was used to explore both purely quantitative meteorological data and more documentary evidence from archival newspapers, namely the Rand Daily Mail and the Business Day between the years 1903-2023. By exploring both sides of heat waves, the meteorological data as well as human perception around heat waves, this study aimed to explore how heat waves and their perception by people in South Africa have changed over time. This study identified 235 heat waves across 12 locations throughout South Africa that were reported in newspapers and had coinciding SAWS meteorological data. The newspaper reports were used to explore how people and journalists perceive high temperatures and write and talk about heat waves. Over the course of the last century, newspaper reported heat wave thresholds have not changed in any statistically significant way. This has implications as climate change causes a shift towards warmer mean annual temperatures and an increase in extremely hot days, meaning that there will be more days above this perceived threshold where people in South Africa will be more vulnerable to thermal stress. A total of 395 heat waves that align with the SAWS heat wave definition were also explored, also showing no statistically significant change over time. This exploratory study of historical heat waves across a range of locations in South Africa demonstrates the richness of documentary evidence of climate and weather changes through newspaper reporting. It also explores the ways in which people have always had an interest in the weather and climatic changes and why they are happening. In a warming world where heat waves will increase in intensity, understanding how they are changing and whether human understanding of them is changing too will be crucial to public health preparedness in South Africa.

Dedication

In loving memory of my grandfather

Ernst Joachim Holtz

November 1933 – November 2024

Acknowledgements

This project would not have been possible without the help and support of my supervisor, Prof Jennifer Fitchett. Thank you for your endless support, encouragement, and many small ways you help your students to reach their potential. I want to give a big shoutout to Dr Ariel Prinsloo who was one of my biggest cheerleaders throughout this process, thanks for letting me lean on you. I would like to acknowledge the support of my parents throughout my academic journey. Friends and fellow students also made the writing of this thesis possible, Emma, Michelle, Alexi, Nic, and Kayleigh.

I would like to acknowledge the funding awarded to this project by the National Research Foundation with partial funding provided by the Postgraduate Merit Award at Wits. This project would not have been possible without the archivists and historians who preserve history in the form of newspapers on platforms such as Readex, and the University of the Witwatersrand Library for investing in a large Readex licence. I would also like to thank the South African Weather Service for providing the meteorological data for this project.

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List of Abbreviations, Acronyms and Scientific Terms

°C – Degrees Celsius

°F – Degrees Fahrenheit

ASHRAE – American Society of Heating, Refrigerating, and Air-Conditioning Engineers

ENSO – El Niño Southern Oscillation

ERA-5 – European Centre for Medium-Range Weather Forecasts Reanalysis Five

ETCCDI – Expert Team on Climate Change Detection and Indices

ETE – Extreme Temperature Event

ET-SCI – Expert Team on Sector-Specific Climate Indices

HIV – Human Immunodeficiency Viruses

IOD – Indian Ocean Dipole

IPCC – Intergovernmental Panel on Climate Change

m.asl – Metres Above Sea Level

PET – Physiological Equivalent Temperature

QBO – Quasi-Biennial Oscillation

RClimDex – R Based Climate Software Package

SABC – South African Broadcasting Corporation

SADC – Southern African Development Community

SAPA – South African Press Association

SAWS – South African Weather Service

SIOD – Subtropical Indian Ocean Dipole

T_{max} – Daily Maximum Temperature

T_{mean} – Daily Mean Temperature

T_{min} – Daily Minimum Temperature

T_w – Wet Bulb Temperature

UHI – Urban Heat Island

US – United States of America

UTCI – Universal Thermal Climate Index

WBGT – Wet Bulb Globe Temperature

WMO – World Meteorological Organisation

WWII – World War II

Chapter 1: Introduction

1.1 Background

Extreme Temperature Events (ETEs) are climatic phenomena marked by a short-lived period when temperatures are significantly warmer or cooler than is normal for that time of the year in a particular region (WMO, 2023). Hot ETEs are often called warm spells, warm events, and in more extreme cases heat waves, which will be the focus of this study (Van der Walt and Fitchett, 2022). Globally, there are no widely agreed upon definitions for heat waves, and definitions range from relative threshold-based, percentile-based, to absolute temperature thresholds (Robinson, 2001; Xu et al., 2016; Perkins-Kirkpatric and Gibson, 2017; Brown, 2020; Diniz et al., 2020; Van der Walt and Fitchett, 2022). Heat waves can have severe impacts on human health, ranging from thermal stress to cardiovascular and respiratory illness and in extreme cases can result in death (Allen and Sheridan, 2018; Campbell et al., 2018; Van der Walt and Fitchett, 2022). Understanding the health effects of heat waves and how thresholds may be changing over time will be crucial to preparing for a warmer world.

While the myriad of scientific definitions of heat waves are useful in accounting for regional variations in climate and defining what constitutes an extreme heat event, human perceptions of temperature are also crucial to have a full understanding of extreme heat (Coccolo et al., 2016). Perceptions of temperature are highly individual and are influenced by the meteorological conditions at that location and time, age, gender, clothing, and level of physical activity of each person affected (Xu et al., 2023). Acclimatisation can also affect how the temperature feels; warmer days in spring are often perceived as hotter than similarly warm days

in summer (Sulewska et al., 2018). Additionally, spending time indoors or outdoors affects human thermal perceptions; people who exercise outdoors regularly adapt more quickly to thermal changes (Kenny and Flouris, 2014). Therefore, a person who is acclimatised to hotter environments and working indoors in temperature-appropriate clothing may not feel the direct effects of a heat wave (Coccolo et al., 2016). Overall, human thermal perception is highly individual and cannot be understood by exploring hospitalisation data during heat waves, which is the primary way of studying the health effects of extreme climate events (Xu et al., 2016; Diniz et al., 2020). Understanding how these thermal perceptions during heat wavs has changed over the past century will be crucial to future preparedness of the public health sector.

1.2 Rationale

Heat waves can cause a myriad of health conditions, mainly influencing the cardiovascular and respiratory systems (Allen and Sheridan, 2018; Campbell et al., 2018). The health risks of heat waves are high in developing nations such as South Africa where an increasingly urban population is heightening both the local climate through the Urban Heat Island (UHI) effect and the chronic disease burden (Cohen, 2000; Mayosi et al., 2009; Van der Walt and Fitchett, 2022). While research into heat waves in South Africa has applied existing thresholds and indices to quantify the occurrence of these events (Van der Walt and Fitchett, 2021a), there is a gap in the research about the perceived threshold of a heat wave and whether this has remained static over the past century. This study explores the human experience of temperature through time to determine whether humans have heightened or dampened their sensitivity to extreme temperatures by exploring newspaper reporting on heat waves and comparing it to South African Weather Service (SAWS) measured daily temperatures. This historical approach will indicate whether climate change has increased the threshold for heat waves or instead made

humans more sensitive to extreme climate which will be a crucial aspect to public health preparedness and future projections of heat waves and their effects. This is important in South Africa as the nation is predicted to warm at twice the rate of global warming trends while the Intergovernmental Panel on Climate Change (IPCC) has made a high confidence prediction in an increase in hot extremes in the region (IPCC, 2022).

1.3 Aim and Objectives

This project explores whether the threshold for heat waves has shifted in 12 locations across South Africa over the past century by investigating newspaper reporting and daily resolution meteorological data. This will be achieved through the following objectives:

1. To identify news articles in the Rand Daily Mail and the Business Day newspapers that report on extreme heat events for the period 1903-2023 by extracting dates, date corrections, locations, and the weather conditions described.

2. To compare these reports on heat waves with concurrent meteorological conditions by exploring T_{min}, T_{max}, T_{mean}, and determine whether these have changed through time.

3. To explore the meteorological conditions preceding any heat waves and determine if the jump in temperature considered to be a heat wave has changed through time.

1.4 Structure of the Dissertation

This dissertation is structured in the following way: this introduction is followed by an extensive literature review on three main topics, namely, heat waves in South Africa, the

physiology of heat in the human body and finally, the human perception of temperature and how this is explored in archival newspaper reporting. The literature review is followed by an exploration of the study site for this study, South Africa, by exploring the geography and climate of the country and then examining the availability of data for this project from newspaper reporting to meteorological recordings in South Africa. This leads on to the methods chapter which explores approaches in historical climatology and then the practicalities of the data collection and analysis of this study. The next section is the results chapter which includes sub-sections on the data compilation for this study, observable climate change in South Africa, the newspaper reporting on weather and heat waves in the newspaper. Further sub-sections of the results include a comparison of heat wave reporting with meteorological data, the weather conditions before and after reported heat waves, mortality, and morbidity in the newspaper reporting, and finally, SAWS classified heat waves and hot days. The discussion chapter of this study explores newspapers as a source of data and how people access information about the weather, an exploration of the shifts in heat wave thresholds and then a deeper look at the heat waves that reported cause mortality and morbidity. The final section of the discussion explores the limitations of this study and is followed by the conclusion chapter which includes a synthesis of the study, the achievement of the aims and objectives and avenues for future research. Finally, there will be a full reference list and all mentioned appendices.

Chapter 2: Literature Review

2.1 Introduction

The thermal comfort to thermal stress continuum is a crucial field of research within human biometeorology (Djongyang et al., 2010; Motlogeloa and Fitchett, 2023), the inter-disciplinary study of the effects of climate on human health and activities such as tourism or sport (McGregor, 2012; Rutty et al., 2021). Biometeorology research considers thermal comfort and stress but also falls into another larger category of human biometeorology which studies the effects of climate on human health (McGregor, 2012; Motlogeloa and Fitchett, 2023). Many different indices have been created to quantify different aspects of human thermal comfort or discomfort using meteorological data (Coccolo et al., 2016). Since the emergence of human thermal comfort research over the past century, over 165 indices have been created (de Freitas and Grigorieva, 2017; Potcher et al., 2018). This literature review critically examines heat wave research globally and in South Africa, how heat affects the human body, and how human perceptions of heat play into heat wave dynamics.

2.2 Heat Waves in South Africa

The number of hot days and nights have been increasing in South Africa at a rate of several days per decade since 1960 due to anthropogenic climate change (Kruger and Shongwe, 2004; MacKellar et al., 2014; Kruger and Nxumalo, 2017; Kruger et al., 2019; Van der Walt and Fitchett, 2021a). Anthropogenic climate change can broadly be attributed to the burning of fossil fuels to create energy, releasing gasses that have a greenhouse, or warming, effect on the earth's atmosphere (Tol, 2009). The IPCC has reported 1.1°C mean air temperature warming

since the industrial revolution, making increasing temperatures the main truly global change (IPCC, 2022). The other effects of climate change vary across different regions of the world (IPCC, 2022). Therefore, this section will review the literature about heat waves in South Africa, how they are changing due to global warming, and the definitions and synoptic drivers of heat waves.

While increased global temperatures have been a widely studied topic in the last two decades, there is a knowledge gap in research on the effects that this will have on Africa (Manyuchi et al., 2022). Most studies that explore the effects of heat waves on people have a focus on North American and Australian cities (Manyuchi et al., 2022). A review by Campbell et al. (2018, 1) found that the impacts of heat waves have been mostly studied in "mid-latitude, high-income countries of low-to-medium population density." This excludes most developing and tropical nations (Campbell et al., 2018), which have a decreased ability to adapt to climatic changes (Nangombe et al., 2019).

The arid regions of Africa are projected to warm faster than the global average temperature (Nangombe et al., 2019), with North and West Africa recorded to have experienced an increase in heat wave days of up to four days per decade since 1980 (Engdaw et al., 2021). As a result of its economically developing status, the African continent has a low adaptive capacity to climate change, and the target limit of 2°C of warming set out by the Paris Agreement may be too high for African healthcare systems to handle (Russo et al., 2016). Even with only 2°C warming, parts of West Africa are projected to have 184 more days of heat wave events annually, while southern Africa is expected to receive once-a-decade extreme heat events almost annually (Nangombe et al., 2019). Southern Africa is projected to warm at 1.5 times the

global average, putting the region at high risk of increased heat stress and heat waves (Perkins-Kilpatrick and Gibson, 2015; Russo et al., 2016; Nangombe et al., 2019).

There have been several studies exploring projections of climate change with a specific focus on southern Africa or sub-Saharan Africa, which include South Africa but do not exclusively focus on it (New et al., 2006; Shackleton et al., 2015; Connolly-Boutin and Smit, 2016; Henderson et al., 2017; Serdeczny et al., 2017; Nhemanchena et al., 2020; Opoku et al., 2021). This may be in part due to the widespread use of large-scale gridded climate data and models (New et al., 2006; Shackleton et al., 2015; Connolly-Boutin and Smit, 2016; Henderson et al., 2017; Serdeczny et al., 2017; Nhemanchena et al., 2020; Opoku et al., 2021). This is arguably a more appropriate approach as climatic change does not adhere to national boundaries, and larger patterns can be found using regional data rather than national (New et al., 2006; Shackleton et al., 2015; Connolly-Boutin and Smit, 2016; Henderson et al., 2017; Serdeczny et al., 2017; Nhemanchena et al., 2020; Opoku et al., 2021). The accuracy of these gridded datasets, however, remains debated, especially in regions with complex topography (Roffe and Van der Walt, 2023). There is also a body of research that has explored heat waves in a broad African context (Nangombe et al., 2019; Engdaw et al., 2021; Manyuchi et al., 2022; Meque et al., 2022) with only a few focusing on South Africa specifically (Van der Walt and Fitchett, 2021a, b, 2022).

Research on heat waves has been steadily increasing over the last decade (Marx et al., 2021). Local to South Africa, several studies on heat waves have been conducted using SAWS weather station data and Expert Team on Climate Change Detection and Indices (ETCCDI) indices and associated software for their computation (Kruger and Shongwe, 2004; New et al., 2006;

Kruger and Nxumalo, 2017; Kruger et al., 2019; Van der Walt and Fitchett, 2022). The ETCCDI is a UN-based panel of experts with the aim to create a universal way to characterise and measure climate change across the world (World Climate Research Programme, 2024). The ETCCDI provides both indices for various measurements of climate change and software such as the widely used RClimDex which allows researchers to compute 27 different extreme climate indices using weather station data (Kruger and Nxumalo, 2017). This method, backed by the World Meteorological Organisation (WMO), has been widely used in research on climate change in South Africa (Kruger and Shongwe, 2004; New et al., 2006; Kruger and Nxumalo, 2017; Kruger et al., 2019; Van der Walt and Fitchett, 2022). However, there are limitations to this research, mainly that much of the data in these studies is homogenised, a process which adjusts data based on changes in reporting and quality control measures to make it as similar as possible, to fit into ETCCDI indices which can result in data being omitted and potentially giving conservative projections (Kruger and Nxumalo, 2017; Kruger et al., 2019). Despite this limitation, studies have demonstrated that South Africa has a clear trend of decreasing cold days and increasing hot days (Kruger and Shongwe, 2004; New et al., 2006; Kruger and Nxumalo, 2017; Kruger et al., 2019; Van der Walt and Fitchett, 2022). Maximum temperatures have increased for all four seasons and daily minimum temperatures have also increased for the whole country besides the central interior plateau, which demonstrated slight cooling (MacKellar et al., 2014). However, the findings of the MacKellar et al. study (2014) have been disputed by a more recent paper by Kruger and Nxumalo (2017) that found no statistically significant trend of cooling over the interior. Despite this, the broad consensus in the literature, based on large amounts of weather station data, demonstrates that South Africa is becoming warmer, both in minimum and maximum daily temperatures, and that the proportion of cold days annually is decreasing (Kruger and Shongwe, 2004; New et al., 2006; Kruger and Nxumalo, 2017; Kruger et al., 2019; Van der Walt and Fitchett, 2022). As a result

of this warming, South Africa is projected to experience an increased frequency of heat haves that are shorter in duration, resulting in an increase of total heat wave days per year and an increased number of discreet heat wave events (Mbokodo et al., 2023). While this kind of research is important for understanding the occurrence of heat waves, it does not provide insight into the specific health effects of heat waves (Chersich et al., 2018) or how heat waves interact with different climate phenomena such as drought (Chikoore and Jury, 2021).

Studies using gridded climate data demonstrate that southern Africa is becoming both warmer and generally drier over the last several decades and is expected to continue on this trajectory until the end of this century (Shackleton et al., 2015; Connolly-Boutin and Smit, 2016; Henderson et al., 2017; Serdecznyn et al., 2017; Nhemanchena et al., 2020; Opoku et al., 2021). A study using gridded climate data and general circulation models found that the eastern areas of South Africa were projected to have a slight increase in rainfall, while the western coast and interior was projected to become drier (Lumsden et al., 2009). Annual rainfall and precipitation have steadily decreased across most of South Africa between 1990-2007, placing several regions in the 'water-scarce' category, which receives less than 350mm of rain annually (Nhemanchena et al., 2020). However, intense rainfall events are also projected to be the main driver of increased precipitation in the eastern areas of South Africa, increasing the potential for flooding (Lumsden et al., 2009). Drier conditions are projected to exacerbate desertification occurring in Sub-Saharan Africa, while increasing the intensity and detrimental effects of precipitation events (Ebi et al., 2021). Inter-annual variability in rainfall is also projected to increase (Lumsden et al., 2009), which may be exacerbated by El Niño Southern Oscillation (ENSO) cycles which have a large effect on rainfall (MacKellar et al., 2014). This is important as droughts and heat waves can exacerbate one another if they occur at the same time. Using ERA-5 reanalysis of 40 years of climate data, a recent study found that extreme heat waves and

drought often occurred concurrently in South Africa (Mbokodo et al., 2023). This co-occurrence can lead to directly to wildfires and more indirectly to exacerbation of the effects of both heat waves and droughts (Mbokodo et al., 2023). Compound drought-heat wave events are predicted to be a large climate stressor in the coming century (Yin et al., 2023), especially in areas already classified as arid to semi-arid with a heavy reliance on rain-fed agriculture, such as South Africa (Serdeczny et al., 2017; Nhemanchena et al., 2020).

Within heat wave and climate change literature there are many points of broad consensus. The primary consensus is that heat waves are increasing both globally and locally (Perkins-Kilpatrick and Gibson, 2017; Van der Walt and Fitchett, 2021a). However, there is one primary lack of consensus in global heat wave literature, which relates to the classification and threshold of heat waves and how they are defined by different organisations (Robinson, 2001). Locally, SAWS (2024, 1) defines a heat wave as "if the maximum temperature at a particular town is expected to meet or exceed 5°C above the average maximum temperature of 'the hottest month' for that particular place, as well as persisting in that mode for 3 days or more". The WMO (2023, 1) defines heat waves as "a period where local excess heat accumulates over a sequence of unusually hot days and nights." This is a broader definition, addressing only to unusual heat. The ETCCDI Climate Change Indices defines a heat wave as daily maximum temperatures above the 90th percentile of average temperatures for a five-day window of the period 1961-1990 for at least six consecutive days (ETCCDI, 2024). The Expert Team on Sector-Specific Climate Indices (ET-SCI) is overseen by the ETCCDI team and thus uses the same definition of heat waves (ClimPACT, 2024). As a result of this inconsistency of definitions for heat waves, many review papers use their own threshold to apply across the papers they review. For instance, a global review by Campbell et al. (2018) simply defines heat waves as warm events that cause excess mortality (death) or morbidity (illness). Another review by Brown et al.

(2022) found that health focused studies define heat waves as three consecutive days where temperatures reached above the 99th percentile (Brown et al., 2022). An even earlier review paper defines heat waves as simply "consecutive days of excessive heat," which is very broad (Perkins-Kilpatrick and Gibson, 2017, 1). This can be seen even in South African research despite the SAWS definition. Some studies use the SAWS threshold (eg. Van der Walt and Fitchett, 2021a, 2022; Fazel-Rastgar and Sivakumar, 2024), while others do not clearly specify the threshold used (eg. Nana et al., 2019). This is the main issue in heat wave literature and is tackled in most papers on the topic as they each clarify which definition they will be using.

Heat waves are caused primarily by high pressure synoptic conditions and have different characteristics depending on where they occur, for example different levels of humidity (Meque et al., 2022). The purpose of threshold-based definitions for heat waves allows for local variation of climate as a heat wave in the Arctic is not the same as a heat wave in the Sahara (Xu et al., 2016). This also allows for smaller regional variations based on altitude or local micro-climates such as the UHI effect but it also requires understanding of local climate norms (Brown, 2022). The high mortality rate of the July 2022 heat wave in London is attributed to high night-time temperatures due to the UHI effect (Simpson et al., 2024).

The synoptic drivers of heat waves in South Africa have not been widely studied (Meque et al., 2022). ERA-5 reanalysis for the period 1981 to 2018 over southern Africa as a whole, ENSO and the Botswana High Pressure were found to be a crucial driver of heat waves in the region with Namibia and Angola having the most heat wave days (Meque et al., 2022). This is supported by a reanalysis of the January 2023 heat wave in South Africa which found that the Botswana High Pressure in an El Niño year was the primary driver of the extreme heat wave

(Fazel-Rastgar and Sivakumar, 2024). Climate modelling also demonstrates that the Indian Ocean Dipole and Subtropical Indian Ocean Dipole had statistically significant association with heat wave occurrence in their negative phases (Meque et al., 2022). A reanalysis by Fazel-Rastgar and Sivakumar (2024) reports that the 2023 heat wave was partially caused by weakening of zonal winds and stretching of Rossby waves over South Africa and demonstrates that upper air anomalies can have an impact on heat waves. Despite these studies, the synoptic drivers of heat waves in Africa are not as well understood as other places in the world (Meque et al., 2022). For example, the synoptic climatology of heat waves in Australia has been widely studied at both regional and national levels (Pezza et al., 2012; Boschat et al., 2015; Parker et al., 2020; Wei et al., 2023).

The effects of climate change have been studied widely at local through to global scales (Haines and Patz, 2004; Serdeczny et al., 2017; Rocque et al., 2021). Broadly, climate change is projected to increase the incidence and severity of heat stress due to surface temperature increases, change in precipitation patterns, and exacerbate extreme weather events (Haines and Patz, 2004). There are projections that there will be a global increase of 30 heat wave days per 1°C of global warming (Perkins-Kirkpatric and Gibson, 2017). While these are the broad effects of climate change, it is also expected to have a profound effect on human health in many different spheres (Rocque et al., 2021). Heat waves and their effects have been studied in a South African context; however, the health effects of these events are not. Heat extremes are the most direct and deadly effect of climate change of human health that can have an eroding effect on health at population levels (Wallace et al., 2007; Raymond et al., 2020). It is therefore crucial to understand how climate change affects heat waves so that South Africans can be prepared for what is coming.

2.3 The Physiology of Heat in the Human Body

The human body is homeothermic, meaning that it works to keep an equilibrium and stable core temperature by shedding excess heat during hot weather (Robinson, 2001; Kenny and Flouris, 2014). There are several different physiological mechanisms to absorb and deal with excess heat (Raymond et al., 2020). The ideal human core temperature is around 37°C (Donaldson, 2003), and under the right conditions, the human body can shed excess heat very effectively (Raymond et al., 2020). When the human body is at an ideal temperature in any given environment this is called thermal comfort; thermal stress is the opposite, where the human body is working hard to compensate for non-optimal thermal conditions (Matzarakis et al., 2011). This section will explore response of the human body to extreme heat up to the point of death and what increasing heat wave activity means for global level public health.

Generally, the body regulates the skin temperature at between 30°C for extremities and 35°C in the head and torso, to keep the flow of excess heat from the core temperature of 37°C to the skin (Sherwood and Huber, 2010; Coccolo et al., 2016). When the human body is exposed to heat, there are two reactions that can occur. The first is an acute reaction to immediate heat stress; the second is a long-term process of acclimatisation (Castellani and Young, 2016). These two reactions are studied in different ways.

The acute reaction to heat is often studied through a lens of heat strain, and uses test subjects exercising under progressively warmer or more humid climate conditions to test at what levels acute heat stress begins (Holmer and Elnäs, 1981; Neilson, 1988; Havenith et al., 1995; White and Cabanac, 1995). Over the past decade there has been a proliferation of meta-analyses and review papers that take the findings of many of the original studies in this field and their modern

counterparts to develop a comprehensive understanding of what is known about the physiology of heat stress (Wilson and Crandall, 2011; Kenny and Flouris, 2014; Coccolo et al., 2016). Through these studies, the acute reaction to heat is found to be is an increase of blood flow to the skin, while sweat glands are activated to release salt and sweat through the skin (Holmer and Elnäs, 1981; Neilson, 1988; Havenith et al., 1995; White and Cabanac, 1995; Kenny and Flouris, 2014; Wilson and Crandall, 2011). The response brings moisture onto the surface of the skin, which leads to the loss of heat through evaporation, called evaporative heat exchange which is the most effective way to cool the body (Wegner, 1972; Holmer and Elas,1981; Gagnon et al., 2013; Kenny and Flouris, 2014).

In addition to exercise tests, observations of people hospitalised with heat stress found that vasodilation and an increase in blood around the body helps transport heat from the core towards the skin and extremities where it can be radiated outwards into the air (Shapiro and Siedman, 1990; White and Cabanac, 1995; Donaldson, 2003). A side effect of this is that vasodilation can cause cardiovascular stress as the increased blood flow requires the heart to work harder (Donaldson et al., 2003; Kenny and Flouris, 2014). Hyperventilation, or breathing rapidly, is also a physical response to heat that removes heat from the brain specifically and acts as a protective mechanism to avoid brain tissue from dying due to excess heat (White and Cabanac, 1990; Beker et al., 2018). When these combined mechanisms of heat loss fail to cool the body enough, heat stress and heat illness will occur (Wallace et al., 2007).

People can also become better acclimatised or adapted to warmer climates, the more long-term effect of heat exposure (Coccolo et al., 2016). There are generally three types of acclimatisation: behavioural, physiological, and psychological (Coccolo et al., 2016).

Behavioural adaptation is the simplest to perform and includes actions such as removing clothing, drinking more water, opening an umbrella to shade from the direct sunlight, opening a window to allow a breeze into a room, or not performing outdoor work in the hottest part of the day (Castellani and Young, 2016; Coccolo et al., 2016; Gifford et al., 2019; Yezli et al., 2023). Psychological adaptation has more to do with the expectations of individuals, how long they are exposed to extreme heat, the perceived level of control they have over their environment and what their personal experience of the heat is (Coccolo et al., 2016). Physiological acclimatisation occurs as the body learns to change its physiological response to certain stimuli such as excess heat (Keim et al., 2002). Acclimatisation manifests differently depending on humidity, with physiological adaptation to dry heat manifests as an increased sweating response, where acclimatisation to humid heat results in less sweating and increased heart function in test (Gonzalez et al., 1974b). Exercising outdoors in warmer conditions was found to speed up acclimatisation in all test subjects (Allan and Wilson, 1971; Adams et al., 1975; Pandolf et al., 1977; Gonzalez et al., 1974b).

Seasonal acclimatisation also plays a role in the physiological adaptation of people (Castellani and Young, 2016). A study by Sheridan and Lin (2014) found that early season heatwaves in spring and the beginning of summer had increased mortality with much shorter lag times in hospitalisation than heat waves later in summer. This spring and autumn hospitalisation trend persists even though heat waves in the middle of summer tended to have more extreme high temperatures (Sheridan and Lin, 2014). A 2022 review (Brown et al., 2022) found that most heat acclimatisation research was conducted on healthy adult males, which may limit the results of this type of research.

In June of 2024, over 1,300 pilgrims in Saudi Arabia died due to heat stroke while making the pilgrimage to Mecca (Mekay and Nereim, 2024). While everyone can be vulnerable to heat stress, more vulnerable populations include athletes who travel a lot and push their bodies to their limits, and tourists who may underestimate the effects of heat in a tourism destination (Ncongwane et al., 2021). A study by Yezli et al. (2023) used distributed lag nonlinear models to estimate the interaction between high temperatures and mortality in Mecca, Saudi Arabia, where there is a relatively low death rate from heat among highly adapted local populations, but tourists and pilgrims travelling into the desert have a higher rate of adverse effects from the heat. This phenomenon has been studied for decades, a 1978 study found similar results by systematically analysing the death reports of pilgrims in Saudi Arabia and comparing them to climate data (Ghazanwi and Ibrahim, 1978).

While there are certain groups of the population that are at higher risk of mortality or morbidity because of heat stress, all people are at risk of heat stress (Campbell et al., 2018; Ncongwane et al., 2021). The first vulnerable group is elderly populations as research has found that they have a reduced capacity for internal thermoregulation due to arterial stiffness and aging (Donaldson et al., 2003; Hess et al., 2009; Kenny and Flouris, 2014; Xu et al., 2016; Brown, 2020). Infants and children also have a reduced capacity for internal thermoregulation, and heat stress from being wrapped too warmly has been linked as a risk factor for sudden infant death syndrome (Fleming et al., 1990; Ponsonboy et al., 1992; Russell and Vink, 2001; Donaldson et al., 2003). Africa and South-East Asia were found to have an increased risk of childhood mortality due to heat stress as compared to more developed regions of the world (Manyuchi et al., 2022).

Similarly to elderly populations, chronically ill people have a narrower tolerance range for ambient air temperature (Li et al., 2022). Urban populations have also been identified as higher risk for heat stress, which is believed to be because of the combination of the UHI effect and the higher instances of chronic illness in urban areas (Xu et al., 2016; Diniz et al., 2020). Awareness of these vulnerable groups can be useful for public health preparedness as precautions can be taken to avoid overexertion of elderly or chronically ill people and to protect school aged children from spending too much time in the sun during extreme heat events (Brown et al., 2022).

Heat is one of the leading causes of weather-related mortality globally, specifically as a direct cause of extreme weather (Azhar et al., 2014; Gifford et al., 2019; Raymond et al., 2019; Sorensen and Hess, 2022). Heat illness is the umbrella term used to describe any heat related illness or heat stress such from heat exhaustion to heat stroke in the worst cases (Gifford et al., 2019). Heat illness is generally a continuum from mild symptom such as heat rashes, heat cramps to more severe cases such as heat syncope, heat exhaustion, hyperthermia, and heat stroke (Gifford et al., 2019). Even the milder cases of heat illness can cause permanent damage to tissue in the heart, liver, and kidneys (Wallace et al., 2007). Identifying heat illness can be complicated as it does not present the same way in all people, for example, heat illness can exacerbate the symptoms of a chronic illness, including many heart issues, respiratory tract infections, asthma, and some psychiatric disorders, or can simply be attributed to dehydration and thus not be diagnosed as heat illness (Gifford et al., 2019; Sorensen and Hess, 2022).

The deadliest form heat stress is heat stroke which results the internal organs and tissue warming beyond their capacity to regulate which causes cell death (Donaldson et al., 2003;

Beker et al., 2018). Heat stroke has a mortality rate of 40-60%, which means that this cannot be studied in control study setting (Walter and Carreretto, 2016). Therefore, most of the data about heat stroke comes from observational studies conducted on patients who are hospitalised for heat stroke (Ferris et al., 1938; Austin and Berry, 1956; Kilbourne et al., 1982; Shapiro and Seidman, 1990; Shimazaki et al., 2020). Heat stroke is classified as a core temperature of over 40.5°C, which is too much heat for all heat dissipation mechanisms to handle which results in a loss of consciousness and disruptions of the central nervous system (Shapiro and Seidman, 1990; Shimazaki et al., 2020). Heat stroke is a systematic inflammatory response when the body fails to dissipate heat and all tissue within the body dies within five minutes of core temperatures elevated above 40.5°C (Beker et al., 2018).

Diurnal temperature ranges are also crucial drivers of heat related mortality and morbidity, as research has found that the human body uses the cooler night-time to lose excess heat stored in the body (Perkins, 2015). This is because the human body can store heat for a few hours until the conditions allow it to be dissipated; however, the longer this heat is stored in the body, the more intense the heat illness it causes (Sherwood and Huber, 2010). Therefore, when heat waves increase night-time temperatures over several days, mortality, and morbidity due to heat increases (Perkins, 2015). Most heat stress related mortality globally has been linked to increased night-time temperatures, suggesting that warm nights may be more dangerous to human health than hot days (Sherwood and Huber, 2010). Additionally, diurnal temperature variations of lower than 16°C during heat waves have been linked to increased adverse birth effects such as stillbirth, low birth weight, and premature birth (McElroy et al., 2022).

Extreme heat events have been found to immediately increase all-cause mortality in US military personal (Wallace et al., 2007), Vietnamese general populations (Phung et al., 2013), Indian general populations (Azhar et al., 2014) and general populations in Johannesburg, Durban, and Cape Town in South Africa (Wichman et al., 2017). A longitudinal study on US military personnel found that prior hospitalisation due to heat stroke specifically has been found to increase risk of all-cause mortality by up to 40% in later life due to tissue damage (Wallace et al., 2007). This suggests that having previous heat illness, more specifically heat stroke, can impact the body's ability to deal with extreme heat in the future, making individuals even more susceptible to heat stress which over time can erode the public health of whole populations in regions that experience more severe global warming (Wallace et al., 2007; Nzvere et al., 2020; Raymond et al., 2020). This means that extreme heat is not only dangerous in the present but has additive effects, making people more susceptible over time despite acclimatisation and behavioural modifications to extreme heat (Cambell et al., 2018; Raymond et al., 2020).

Beyond the impact of extreme heat on the people who survive it, there is also a threshold of survivability of extreme heat (Vecellio et al., 2022; Vanos et al., 2023). There has been much speculation on what this threshold may be for humans which has resulted in the creation of climate modelling frameworks (Sherwood and Huber, 2010; Raymond et al., 2020; Vanos et al., 2023). As air temperature increases, the human body sheds heat through sweating and vasodilation until it reaches a core temperature of 43°C, which causes death in 99.9% of people (Vanos et al., 2023). High humidity negates the cooling effects of sweating and thus, high humidity combined with high heat will force human core temperatures to exceed deadly levels more quickly than dry heat (Sherwood and Huber, 2010). Humid heat can be measured by Wet Bulb Temperature, which measures theoretical air temperature at 100% humidity (Vanos et al., 2023). According to models presented by Sherwood and Huber (2010), exposure to a Wet Bulb

Temperature (T_w) of 35°C for a period of six hours or more will cause death. The air temperature increases as humidity decreases, with 43.3°C being T_w for air at 75% humidity, and 49.9°C at 50% humidity (Vanos et al., 2023). At 100% humidity the sweating response of the body does not result in any significant cooling and the very low temperature differential between the temperature of human skin which is regulated in healthy humans at 35°C, which is why T_w is 35°C (Sherwood and Huber, 2010) and the outside air temperature does not allow for the radiation of heat off the body (Vanos et al., 2023).

Physical thermal comfort is highly subjective and many different indices have been created to quantify it more simply, such as the Universal Thermal Climate Index (UTCI), Physiological Equivalent Temperature (PET), Humidex, and Wet Bulb Globe Temperature (WBGT) among many others (Cocccolo et al., 2016; Diaconescu et al., 2022). A major shift has occurred between the first thermal comfort indices and the more recent ones, namely, that static comfort models have been abandoned in favour or more adaptive indices such as the ASHRAE scale (de Dear et al., 2013). Adaptive indices include a much wider range of comfort to account for personal control over thermal comfort such as taking off clothing or decreasing the level of activity being performed (de Dear et al., 2013). Humidex is one of these adaptive biometeorological indices developed in 1979 to better understand Canadian climates (Masterton and Richardson, 1981). It uses a combination of temperature and humidity to calculate hourly what the climatic conditions on a given day feel like to an average person outdoors and has been implemented widely as a warning system by the Canadian Government (Diaconescu et al., 2023; Canadian Centre of Occupational Health and Safety, 2024). Humidex is an index made specifically to measure the risk of heat stress and thus does not account for extreme cold temperatures, which has been described as one of its main limitations (Coccolo et al., 2016).

2.4 Human Perception of Temperature

While the physiological effects of heat are universal and based on the laws of thermodynamics, thermal comfort is a much more subjective measure of extreme temperature (de Dear et al., 2013). Human thermal comfort is a highly subjective measure that is linked to a combination of activity level, clothing, age, gender, and meteorological conditions, which influence metabolic responses to heat, and psychological effects that could make one feel warmer or cooler in an environment of fixed temperature at any given point of time (Xu et al., 2023). Studies of thermal comfort usually employ a mixed methods approach to understanding how comfortable people feel given the current climatic conditions (de Dear et al., 2013). These studies use a mix of qualitative methods such as interviews or questionnaires and quantitative methods such as daily climatic data to assess human perception in relation to ambient air temperatures (Andrade et al., 2010; Schlader et al., 2011; Wei et al., 2022; Xu et al., 2023). They are also broadly split into indoor versus outdoor thermal comfort studies as changing the conditions in indoor environments is possible, and not as easy or possible in outdoor environments (de Dear et al., 2013). Moreover, human perception of ambient air temperature is known to be inaccurate as the perception of temperature is also dependant on other factors such as humidity and wind speed (Andrade et al., 2010; Sulewska et al., 2018). In the simplest terms, thermal comfort is when meteorological conditions are most optimal for the human body and most subjectively favourable to an individual (Matzarakis et al., 2011). This section will explore thermal comfort and perceptions of heat and extreme temperature.

Studies exploring perceived thermal comfort and work and productivity are run similarly to heat stress tests, where subjects are asked to work on a climate-controlled chamber for a certain

amount of time (Cui et al., 2013; Sulewska et al., 2018). In these studies, office work is completed and an element of subjective perception is considered through a survey or questionnaire (Cui et al., 2013). This subjective element has raised some questions as wording of survey questions may change the outcome of questionnaires. For example, a study by Dubois et al. (2016) on French tourists found that a survey asked participants if it was "too hot" had different results to a survey asking if it was "unbearably hot." This may also vary across languages and cultural landscapes and may make it difficult to compare across all studies (Lee and Tochihara, 2010).

Thermal comfort is studied much more broadly by exploring neutral temperature ranges, by interviewing people and passers-by in different settings (Lin et al., 2011; Cui et al., 2013; Li et al., 2022; Wei et al., 2022; Xiong et al., 2022; Carter et al., 2023). These ranges change based on the demographic being studied, the season, and the setting such as indoor or outdoor (Li et al., 2022). Perceptions of outdoor neutral ranges tend to be broader than indoor ones because of sunshine, wind speed and shade options that can change thermal perception (Wei et al., 2022). A study in Shanghai, China, neutral ranges for outdoor comfort were 14.2-32.6°C for three seasons, Spring, Summer, and Autumn (Wei et al., 2022). Indoors, neutral ranges are much smaller, between 22-26°C (Cui et al., 2013). However, these ranges vary greatly based individual characteristics as discussed before. For example, older people, young children, and chronically ill people have the narrowest range of neutral temperatures that they perceived as comfortable (Li et al., 2022). Menopausal people also have lower neutral temperature ranges (Xiong et al., 2022; Carter et al., 2023). Acclimatisation can change neutral temperature ranges, as places with smaller temperature ranges between summer and winter have narrower neutral ranges over the course of a calendar year (Lin et al., 2011). People's seasonal expectations can also change what is considered comfortable or neutral, where neutral temperature ranges

dropped by 10°C from summer to winter in the UK and 20°C in Australia (Nikolopoulou et al., 2001; Spagnolo and de Dear, 2003), while in Taiwan, a tropical and subtropical island, the neutral range only had a 3°C difference between the summer and winter (Lin et al., 2011). This suggests that people acclimatised to different regions' specific climate, have neutral ranges of tolerance based on their home region, with more tropical regions supporting narrower neutral ranges.

Another branch of temperature perception literature tests the variables that may increase or decrease perceived thermal comfort. For example, different surfaces may promote thermal comfort. Wooden wall panelling was found to increase thermal comfort in a climate-controlled chamber than white walls (Blackenberger et al., 2019). Colour also plays a role in thermal perception, people seem to prefer cooler temperatures when exposed to extreme red light (Fanger et al., 1977). A later study in China (Wang et al., 2018) found that warm colours were more satisfactory to study subjects in warm environments as cool colours were preferred in warmer environments. These studies all use a mix of physiological data such as measuring heart rate and blood pressure, in addition to meteorological data from the climate-controlled chamber and more subjective data from participants (Fanger et al., 1977; Wang et al., 2018; Blackenberger et al., 2019; Tsunetsugu and Sugiyama, 2021).

Understanding which meteorological conditions impact thermal perception is also important. Many studies of this nature use methods such as heat stress studies, where study participants are subjected to range of conditions while noting their physical reactions such as skin temperature and heart rate and asking for thermal sensation votes or survey questions (Xu et al., 1995; Shimazaki et al., 2015). Wind speed did not seem to greatly affect core temperature;

however, it was found to change thermal comfort perceptions through thermal sensation votes (Shimazaki et al., 2015; Yu et al., 2021). Seasonal changes also affect what variables have the most impact on the thermal comfort of individuals (Sulewska et al., 2018). Windspeed demonstrated the greatest effect on outdoor thermal comfort in the summer or warmer seasons while ambient air temperature was the most important variable in winter thermal comfort votes (Wei et al., 2022). This is mainly because wind can reduce the feeling of heat on the skin by supporting sweat evaporation in summer to make people feel cooler while low temperatures impact internal temperature the most (Wei et al., 2022). However, another study suggested that women, generally, preferred lower wind speeds regardless of season (Andrade et al., 2010). Sunlight is also critical for perceptions of thermal comfort. Sunlight being visible in indoor spaces has also been found to increase thermal comfort, regardless of temperature (Chinazzo et al., 2019). Therefore, the design of buildings or urban areas can have a great impact on the amount of sunlight experienced through windows and the visibility of sunlight to increase or decrease thermal comfort (Chinazzo et al., 2019).

Visible trees, urban green spaces, and water features were found to significantly increase perceived thermal comfort in outdoor spaces in cities (Li et al., 2022). Broadly, studies suggest that people perceive heat waves or warmer temperatures to be more thermally comfortable in the summer months, while colder temperatures were deemed more comfortable and acceptable in winter because of seasonal acclimatisation and expectations (Andrade et al., 2010; Sulewska et al., 2018; Asif et al., 2022). This suggests that psychological adaptation plays a large role in thermal comfort as this shapes the expectations of temperature for the season, the perceived level of control over the environment and how long people are exposed to more extreme temperatures (Coccolo et al., 2016).

Thermal comfort or discomfort also depends on the perceived level of control over the thermal environment of any given individual at that moment (Coccolo et al., 2016; Xu et al., 2023). This is because pure air temperature does not translate directly to a level of thermal comfort. A study by Fitchett (2025) found that people struggle to accurately gauge ambient air temperature and sometimes guessed temperatures to be up to 6°C above or below the measured value. There are many individual factors that influence human perceptions of temperature. High skin temperature in the face results in significant thermal discomfort so cooling just the face of people exercising has been found to have a significant effect on their perceived thermal comfort, without directly lowering their core body temperature (Schlader et al., 2011).

While human perception of climate is widely studied today, this has not always been the case (Carey, 2012). Additionally, if people find it difficult to gauge ambient air temperature in the moment (Fitchett, 2025), it may be impossible to do historical perception studies about climatic events like heat waves. There are studies being done in Africa on small-scale farmers' perceptions about climatic change and variability in the past few decades and how they compare to the meteorological data for that time (Moyo et al., 2012; Amadou et al., 2015; Cherinet et al., 2019). These studies are often done by interviewing farmers on the past and what climate change they have witnessed and comparing this to meteorological recordings of the area (Moyo et al., 2012; Amadou et al., 2015; Cherinet et al., 2019). However, this kind of research has not yet extended broadly to the public, and none has been done on heat waves in particular. An exploratory 2022 study by Vilá et al. was done to explore the possibility of using a more social science-based approach to record normal people's perception of climate change in Canada. The study found that when people recount impactful climate events that they have lived through, they often 'jump around' in the timeline and speak to the personal effects of natural disasters, rather than being able to systematically recount their region's climatic

changes (Vilá et al., 2022). The study also found an interesting effect whereby people had clearer memories of more recent climatic events and events that occurred in their formative, childhood years, with big gaps in memory in between, which the researchers called 'blackout years,' even when there were large disasters in that time (Vilá et al., 2022). People's use of words for the timing of events was also reported to be very vague, using words such as 'recently' or 'now' and 'then' (Vilá et al., 2022). People's memories can also be overshadowed by more recent or extreme disasters. This demonstrates some of the difficulties with doing historical research about human perception retrospectively.

This is where approaches in historical climatology may provide insight. Historical climatology is a rapidly growing field where researchers explore the historiography of climate change (Carey, 2012). Historical climatology often uses a mixed method approach of using both documentary evidence like archival newspapers, letters and journals and more official government or bank records in addition to meteorological records to reconstruct climate history (Vogel, 1989; Kelso and Vogel, 2007; Grab and Nash, 2010; Nash et al., 2015, 2019). Southern African climatic history is among some of the more studied regions using these methods (Carey, 2012). Many of these studies in South Africa, and neighbouring countries like Lesotho, focuses on the 1800s, a time when widespread meteorological recordings were only beginning (Vogel, 1989; Kelso and Vogel, 2007; Grab and Nash, 2010; Nash et al., 2015, 2019). A paper by Carey (2012) argues that much of this research on periods prior to 1900 includes a lot of discussion about the cultural attitudes around climate and climate variability, while more current historical climatology leaves out cultural discussions as it is deemed to be recent enough that the cultural aspects are understood by readers. In places like South Africa, where long-running national newspapers have been archived, these are often used as sources of

historical data (Vogel, 1989; Fitchett and Raik, 2021; Snyman and Fitchett, 2022; Fitchett et al., 2022; Ndebele et al., 2019, 2022; Holtz and Fitchett, 2024).

This is where the research gap for this project appears, historical climatology research about heat waves, using archival newspapers as a source to explore human perception of temperature through time. The 2012 paper by Carey argues that climate histories must engage with the social histories and narratives of the period being studied. This study engages with heat waves that are reported in the archival newspapers to gauge human perception of extreme heat in South Africa over the last century. The newspaper reports are also a rich documentary text that allow small glimpses into the ways in which people spoke about climate and weather over time.

2.4 Synthesis

While there is an existing body of literature on heat waves (both globally and locally), it deals with heat waves in meteorological terms only and thus cannot give a full picture of the way in which heat waves are perceived and the effects of extreme temperature events on health. The human body has several mechanisms to radiate the excess heat it absorbs, from sweating to increased cardiovascular function (Donaldson et al., 2003; Kenny and Flouris, 2014; Wilson and Crandall, 2011). When these functions are impaired due to either too high a temperature or humidity, the body goes into a state of heat stress (Gifford et al., 2019). The effects of extreme heat on the body are additive and increasing heat wave activity is a global concern as it can erode population level health over time (Wallace et al., 2007; Raymond et al., 2020). There is also a point at which the human body can no longer function, which is believed to be at or below a T_w of 35°C (Sherwood and Huber, 2010; Raymond et al., 2020; Vecellio et al., 2022;

Vanos et al., 2023). While certain climate conditions such as wind speed, visible sunlight, and colours can increase or decrease thermal comfort votes (Andrade et al., 2010; Sulewska et al., 2018), the perceived level of control of the environment can also influence the individual perception of temperature (Coccolo et al., 2016; Xu et al., 2023).

Chapter 3: Study Site

3.1 Introduction

South Africa is the study site for this project. This study focuses on 12 locations across a range of climatic zones in South Africa. The locations were chosen because they each had more than five reported heat waves and the selection will be explored in further detail in the methodology. Located at the southern tip of the African continent, South Africa spans the tropics to mid-latitudes, and consequently experiences both heat waves and cold snaps (Van der Walt and Fitchett, 2022). However, heat waves have been found to be increasing in occurrence while cold events have been decreasing in frequency since 1960, meaning that understanding heat waves in this region will be of great importance for the future under anthropogenic climate change (Van der Walt and Fitchett, 2021a, b). As a developing nation with limited healthcare access, South Africa is both particularly vulnerable to heat waves and a severely understudied region (Chambers, 2019). This chapter will explore the geography and climate of South Africa, and the risk of heatwaves in different parts of the country. After this, the chapter will give an overview on newspapers in South Africa and the collection and recording of meteorological data across the nation over the past century.

3.2 Geography of South Africa

South Africa is located between 22-35°S and 16-33°E (Figure 3.1). The topography of the country is characterised by a long coastline of over 3,000km (South African Government, 2024), and a large inland plateau that reaches a maximum height of 3,400m.asl (Grab and Knight, 2018; Lennard, 2019). This central plateau increases the probability of extreme cold

events across the inland area of South Africa during the winter (Grab and Knight, 2018). The great escarpment, which separates the inland plateau and low-lying coastal regions, features the Drakensberg Mountain Range which can receive snowfall in the winter months (Lennard, 201 9). The high elevation of these mountains also influences the inland climate by acting as a physical barrier that prevents moisture from reaching the plateau in winter (Botai et al., 2018). This results in a drier winter season and a rainy summer season for most of the interior of South Africa (Roffe and Van der Walt, 2023). Overall, the interior plateau has more severe winters than the coast due to its high altitude (Landman et al., 2017), while the lowveld or low-lying interior of northern South Africa is the warmest area in the country and thus the most prone to heat waves (Landman et al., 2017).

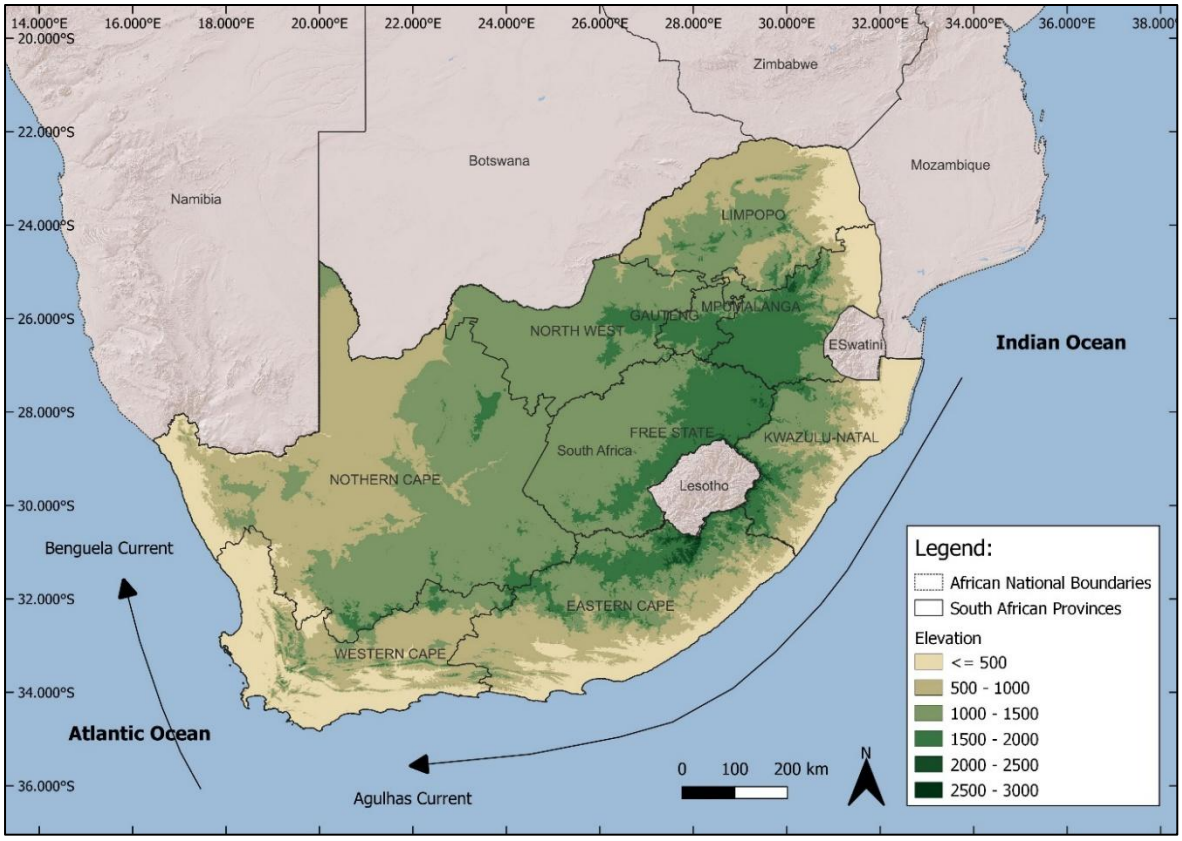


Figure 3.1: South Africa and neighbouring countries showing elevation and ocean currents.

3.3 Climate of South Africa

South Africa is influenced by the subtropical easterly wind belt in the north and temperate westerly wind belt in the south (Lennard, 2019). The climate of the country is further influenced by the two main ocean currents to the east and west of the continent, the warm Agulhas Current on the east coast and the cool Benguela Current on the west coast (Figure 3.1; Jury, 2013; Landman et al., 2017). Due to the moisture brought to the east coast by the easterly winds blowing over the warm Indian Ocean, the east coast of South Africa experiences more rainfall with rainfall decreasing towards the west coast (Figure 3.1; Jury, 2013; Landman et al., 2017). South Africa receives an average annual total rainfall of 464mm, with the western parts of the country being drier and the eastern coast receiving the most rainfall (South African Government, 2024). The wettest place in South Africa is Matiwa, Limpopo, which receives over 2,000mm of rain annually, while the driest place is Alexander Bay in the Northern Cape with an average annual rainfall of only 46mm (South African Government, 2024). There is great variation in rainfall across South Africa, but regions are also separated into rainfall regions based on when they receive their annual rainfall (South African Government, 2024). The south-western coast of South Africa receives winter rainfall, the southern coast receives year-round rainfall and most of central regions the country is a summer-rainfall zone (Roffe et al., 2021). The winter rainfall zone on the south-western coast mainly receives rainfall from mid-latitude cyclones also called cold fronts, while the rest of the southern coast receives rainfall year-round (Roffe et al., 2019). The central summer rainfall zone covers the largest surface area of the country and receives its rainfall from convection thunderstorms and tropical cyclones on the eastern side of the country (Roffe et al., 2019; Xulu et al., 2020). There is some variability in where the boundaries of these regions are drawn in the scientific literature,

however, it is well documented that these three rainfall zones have distinct patterns of precipitation (Roffe et al., 2019).

South Africa has an average annual temperature of 16℃ with average summer temperatures in the range of 12-30℃ and winter temperatures in the range of -2-26 ℃ (Landman et al., 2017; Roffe and Van der Walt, 2023). The western and south-western coast of South Africa exhibits a mild Mediterranean temperature range, while the eastern coast gets warmer towards the north, exhibiting a more subtropical temperature range (Kruger and Sekele, 2013). Buffelsfontein on the south coast of the Eastern Cape, has the lowest mean temperature in the whole country at 11.5°C (SAWS 2024b). The western interior of the country is characterised by extreme temperatures, with hot summers and cold winters and has some of the driest regions in the nation (Kruger and Sekele, 2013; South African Government, 2024). The eastern interior, especially on the plateau is also prone to high temperature ranges between summer and winter, although not as extreme as the Northern Cape region (Kruger and Sekele, 2013). The warmest region of the country is in the north-east, with Letaba in the Limpopo Province recording the highest mean annual temperature at 23.3°C (South African Government, 2024). This region is called the lowveld and is both at low altitude and closest to the equator, making is warmer than the rest of the nation (Kruger and Sekele, 2013).

South Africa is prone to both extreme heat and extreme cold events, although heat waves are becoming a larger share of ETEs each year (Van der Walt and Fitchett, 2022). The climate of South Africa is also affected by large scale climate phenomena such as the Southern Annular Mode (SAM), the Indian Ocean Dipole (IOD), and ENSO (Mason, 2001; Gillett et al., 2006; Gaughan et al., 2016). These phenomena all play a role in seasonal temperature changes, ETEs

and moisture availability over Southern Africa (Mason, 2001; Gillett et al., 2006; Gaughan et al., 2016; Baudoin et al., 2017). The South African seasons have been statistically classified as follows: summer falls between October-March, autumn between April-May, winter in July-August, and spring in September (Van der Walt and Fitchett, 2020). Extreme warm temperature events such as heat waves mainly occur during the summer in South Africa due to the latitudinal shift of the Intertropical Convergence Zone and the Kalahari High pressure cell (Tyson and Preston-Whyte, 2000; Lennard, 2019).

There are several regions of South Africa that are more vulnerable to heat, the Kalahari Desert and the Limpopo River basin have the highest heat wave temperatures in South Africa (Meque et al., 2022). Low-altitude north-western parts in the Northern Cape and Kalahari of South Africa also have the highest threshold for heat wave classifications according to SAWS (Figure 3.2; Ncongwane et al., 2021; SAWS, 2024). The north-western regions of South Africa are also projected to have the highest increase in heat wave days in the coming decades (Mbokodo et al., 2020). The map in Figure 3.2 uses the SAWS heat wave definition: “if the maximum temperature at a particular town is expected to meet or exceed 5°C above the average maximum temperature of ‘the hottest month’ for that particular place, as well as persisting in that mode for 3 days or more” (SAWS, 2024, 1).

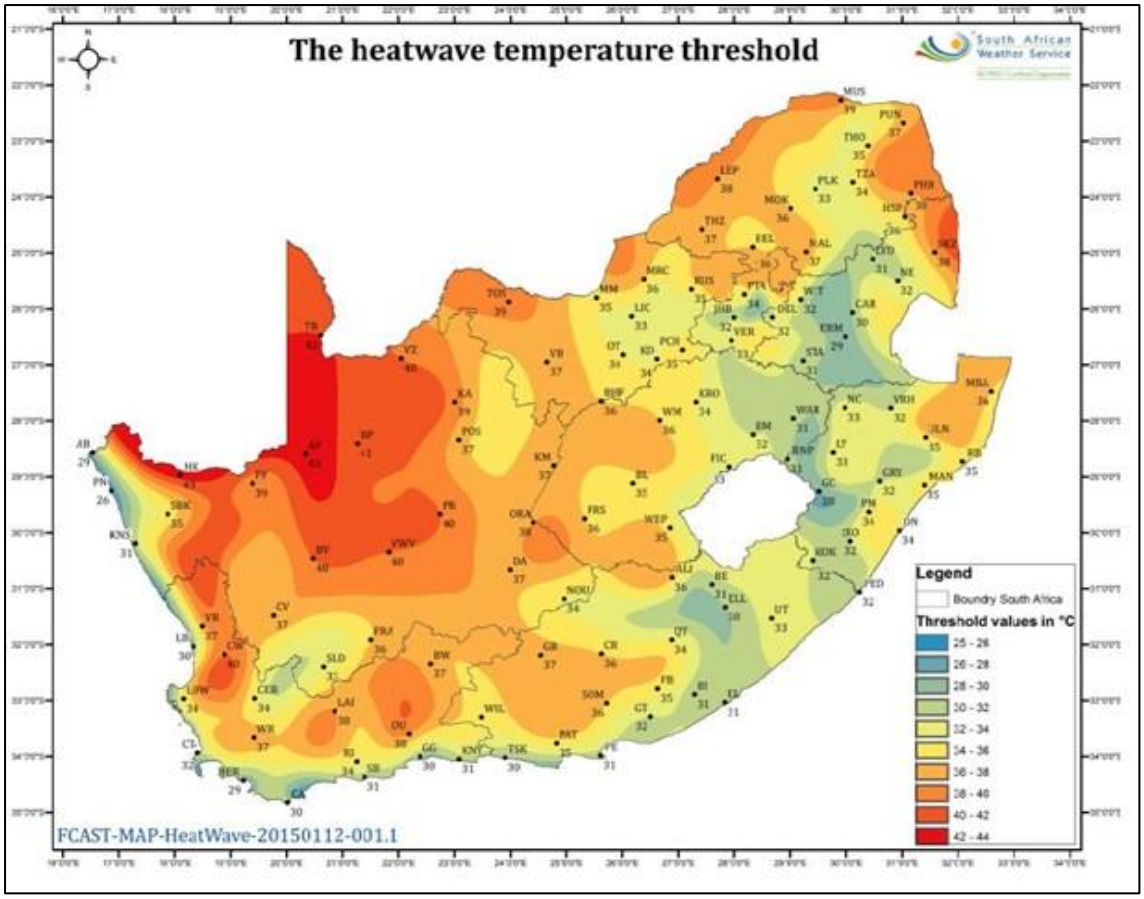


Figure 3.2: Map of heat wave temperature thresholds across South Africa (SAWS, 2024).

The west coast of South Africa is unique to the rest of the country as it has the fewest cold nights of the year and has most of its heat wave days in the winter season when the heat wave threshold is at its lowest (Mbokodo et al., 2023). The rest of the country is affected by heat wave events mainly during the summer season (Meque et al., 2021; Mbokodo et al., 2023). Several locations in South Africa have been identified by Ncongwane et al. (2021) as being at risk of long-term heat stress (Table 3.1). While long-term heat stress may be a risk in some places, heat waves thresholds vary based on local climate and thus every part of South Africa is at risk of experiencing heat waves and their related impacts.

Table 3.1: Locations in South Africa with the highest risk of long-term heat stress (Ncongwane et al., 2021) and their Köppen-Geiger zone (Conradie, 2012), with the population of each town (StatsSA, 2024).

Town	Province	Köppen-Geiger Zone	Population
Patensie	Eastern Cape	Arid	5263
Pietermaritzburg	KwaZulu-Natal	Temperate	618,536
Pongola		Temperate	1403
Knysna	Western Cape	Arid	68,569
Hoedspruit	Limpopo	Arid	94,857
Skukuza	Mpumalanga	Arid	1599
Komatidraai		Arid	393,030

Extreme heat wave events have been found to be exacerbated by drought conditions (Megue et al., 2022; Rogers et al., 2022; Mbokodo et al., 2023). This is partly because of soil moisture. Moist soil can help regulate terrestrial air temperature, and in turn, dry soil increases air temperature above it, which can create a feedback loop that dries out soil further thereby increasing air temperatures and causing heat waves to co-occur with drought, however, the mechanism of evaporative heat transfer can increase relative humidity in the air, which can also increase risk of heat stress (Benson and Dirmeyer, 2021; Mbokodo et al. 2023). These findings have been contentious as several studies have found that soil moisture deficit was crucial to prolonged heat waves across Europe while the same was not true across different areas of Australia (Perkins et al., 2015). However, in South Africa, the most severe heat wave summers have co-occurred with widespread drought in the years 1982/83, 1997/98 and 2015/2016 with 2016 being the hottest year in South Africa since records began between 1840-1860 (Mbokodo et al., 2023). This extreme drought/ heat wave summer in 2015/16 was triggered by an extreme high-pressure system over Botswana, Namibia, and the northern parts of South Africa (Mbokodo et al., 2023). Both globally and more specifically in South Africa, El Niño events have also been found to exacerbate heat waves (Meque et al., 2022; Mbokodo et al., 2023). In South Africa, most extreme drought events and heat waves have occurred during El Niño

events, which generally bring dry conditions to South Africa (Megue et al., 2021; Mbokodo et al., 2023). El Niño cycles have caused the strongest heat wave action over the northern interior of South Africa (Mbokodo et al., 2023). Additionally, the IOD, Subtropical Indian Ocean Dipole (SIOD), Quasi-Biennial Oscillation (QBO) have been found to have a statistically significant compounding effects heat wave events in South Africa, although not as severely as ENSO (Megue et al., 2021; Mbokodo et al., 2023). This relationship has not been widely studied or understood in South Africa but there have been several studies demonstrating that strong El Niño and positive IOD phases in Australia were statistically associated with more extreme compounded heat wave and drought events (Papari, 2022; Reddy et al., 2022). Climatic variation such as the Benguela Niño has been found to have no association to heat wave conditions in South Africa (Meque et al., 2022). The Mascarene High has also been found to have very little impact on heat waves (Meque et al., 2022).

3.4 Newspaper Reporting in South Africa

Print newspapers in South Africa have complex and multilingual history, with the first printing press being imported and set up in Cape Town in 1794 (Kolbe, 2005). The Cape Town Gazette and African Advertiser was the first newspaper and government gazette in the country, and on the African continent, opening in 1800 and publishing for only two years (Kolbe, 2005). This is a common trend throughout the 1800s, short lived newspapers dominated mainly by government gazettes and religious and missionary presses (Kolbe, 2005). In the early 1900s independent black-owned newspapers began printing more widely (Couzens, 1984). During this time, daily newspapers also began printing more widely starting with the Rand Daily Mail (1902), The Sunday Times (1906) and the Afrikaans paper Die Burger (1915; Kolbe, 2005). As Apartheid became the law of South Africa, more and more restrictions were placed on free

speech which broadly affected newspaper publishing (Ginwala, 1973). Apartheid laws such as the Official Secrets Act of 1956 and the Prisons Act of 1959 restricted what could be published by any source, however, newspapers were not required to have a government censor in their offices but were expected to self-police their reporting, which resulted in very timid reporting on any topic that could potentially be deemed illegal by the Apartheid government (Progrund, 1976). Print media and newspapers were largely divided by language between English and Afrikaans and smaller papers publishing in African languages such as isiZulu (Kolbe, 2005). However, a truly free press could not exist in South Africa under the oppression of the Apartheid Government (Ginwala, 1973). Despite this, the Rand Daily Mail, the most influential and widely circulated English daily newspaper professed to be a liberal publication that was against National Party politics and marketed towards an urban black readership in Johannesburg (Keogh, 2006). In 1978, about one quarter of journalists working for the Rand Daily Mail were black, which was unusual in the largely white-owned national newspapers (Keogh, 2006). In 1983, the national government severely restricted advertising in the Rand Daily Mail which lead to a crisis within the newspaper and eventually lead to its closure due to financial hardship and government pressure in 1985 (Owen, 1986). This restricted advertising is broadly thought to be due to the less than favourable reporting on Apartheid government activity and the fact that the Rand Daily Mail had gained an international reputation and awards for reporting more liberally on the national government (Owen, 1986; Kolbe, 2005). Moreover, the Apartheid government declared a state of emergency between 1985-1990 which allowed it to further restrict all news reporting (Kolbe, 2005).

At the same time as the Rand Daily Mail was failing, a new kind of daily newspaper was being established in Africa, namely, business, and financial journalism (Mare and Brand, 2010). The financial crisis across Africa in the 1970s and 1980s gave rise to several business focused

newspapers across the continent, with the Business Day beginning publication in Johannesburg in 1985 (Mare and Brand, 2010). At its height, the Business Day circulated about 350,000 newspaper copies daily across South Africa (Kolbe, 2005). The Business Day is still publishing today and has withstood both Apartheid press restrictions and the post-Apartheid transition to a more free press (Kolbe, 2005).

It is important to understand what can and cannot be reported on accurately in South Africa throughout history, so as not to draw from sensitive data that may have been censored. Moore (2010) argues that sensitive topics cannot be studied through news reporting because of the lack of reporting on certain subjects. However, this study uses data from some of the most consistent and non-controversial reporting in any newspaper: the weather. Reporting on weather is both extremely consistent and widely distributed daily in the Rand Daily Mail during its entire publication. Newspapers have been used widely to reconstruct both pre-meteorological monitoring climate histories and in combination with meteorological data (Kelso and Vogel; 2007; Grab and Nash, 2010; Nash et al., 2019). Most of these studies use newspaper data to identify extreme climate events and explore how climate was reported on which aligns with the methodology of this project (Kelso and Vogel; 2007; Grab and Nash, 2010; Nash et al., 2019). Therefore, despite the restrictions on press freedom in South Africa over the last century, meteorological and weather reporting does not contain sensitive or restricted data, making newspapers a good source for identifying extreme events in weather patterns (Kelso and Vogel; 2007; Grab and Nash, 2010; Nash et al., 2019).

3.5 Meteorological Data in South Africa

The SAWS is the most advanced weather service in the Southern African Development Community (SADC), and provides climate data to all 16 member nations (Banitz, 2001; de Coning and Poolman, 2011; Landman et al., 2013; Hess et al., 2021). SAWS operates 243 Automatic Weather Stations, 1,180 rainfall stations, 14 meteorological radar stations, 11 upper air stations, and 25 lightning detection stations and several more specific weather detection and prediction stations (Figure 3.3; Hess et al., 2021; SAWS, 2025b). SAWS also has the highest bandwidth internet which is crucial to access real-time meteorological data to make predictions and warn people of potential extreme weather conditions (Hess et al., 2021). With extreme weather events, the larger or more extreme an event, the more likely that SAWS reports accurately on it, meaning that smaller extreme events are more likely to be falsely reported or not reported at all (Landman et al., 2013). Weather forecasting and warning systems are crucial to better decision making both individually and nationally (Banitz, 2001). SAWS weather forecasting has been found to be accurate to within 2.3°C of actual temperatures and be more accurate in morning forecasts than evening forecasts (Banitz, 2001). However, like most SADC nations, SAWS has faced issues such as poor maintenance of weather stations, financial constraints, lack of qualified staff, and general issues with service delivery such as electricity to its weather stations (Hess et al., 2021).

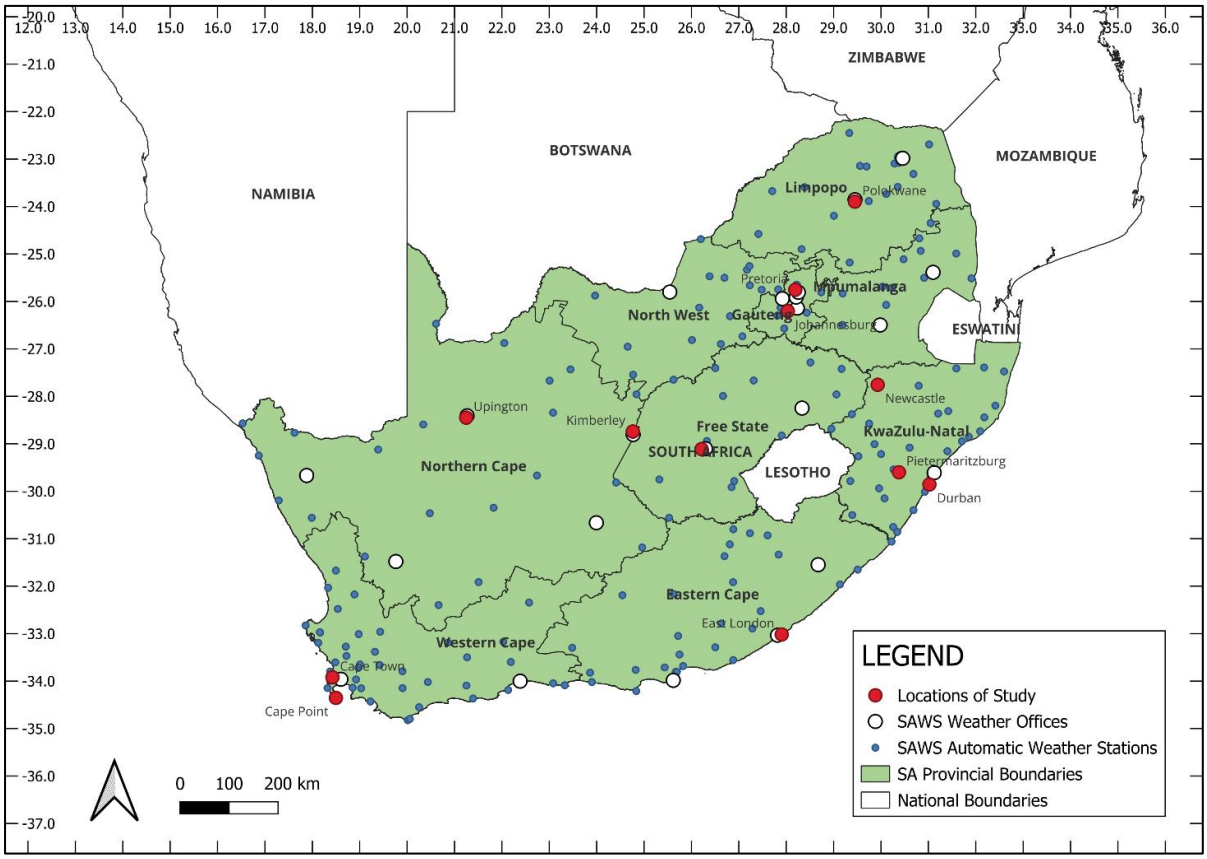


Figure 3.3: South Africa with all SAWS Automatic Weather Stations and Weather Offices as well as the 12 locations explored in this study (SAWS, 2025b).

While these stations may seem like they cover the nation in a comprehensive net, issues with continuous electricity supply, colloquially called load-shedding, financial constraints, and the fact that many of these stations have not been operational for longer than a decade or two, means that there is no comprehensive long-term dataset on climate in South Africa. SAWS may have the most comprehensive monitoring system in Africa, however, this does not mean that it has nearly as much or as long-term data as more developed nations such as the United Kingdom (Hess et al., 2021). Moreover, collecting raw meteorological data cannot accurately describe how weather extremes such as heat waves are experienced by people.

3.6 Synthesis

South Africa, located at the tip of the African continent, is becoming more vulnerable to increased heat waves (Van der Walt and Fitchett, 2021a). South Africa contains a broad range of climatic zones, however, broadly, heat wave occurrence has been increasing while cold spells have been decreasing in frequency across the country (Van der Walt and Fitchett, 2021a, b). With a rich history of print media across many different topics, and the strongest weather service in southern Africa, it also has some of the most comprehensive weather data on the continent (Hess et al., 2021). Therefore, by combining the more subjective reporting on extreme weather with objective or qualitative data from SAWS, this project will explore heat waves and how they have been perceived in South Africa over the last century.

Chapter 4: Methods

4.1 Introduction

The methods for this project are based on previous studies in historical climatology and geography (Vogel, 1989; Kelso and Vogel, 2007; Grab and Nash, 2010; Nash et al., 2015, 2019; Holtz and Fitchett, 2024). Archival newspapers were used to identify the occurrence of heat waves over the past century across South Africa in a similar way to many historical climatology studies using documentary sources (Vogel, 1989; Kelso and Vogel, 2007; Grab and Nash, 2010; Nash et al., 2015, 2019). The heat waves identified from the newspaper reporting were then compared to quantitative meteorological recordings where they were available (Ndebele et al., 2019; Fitchett and Raik, 2021; Ndebele et al., 2022; Snyman and Fitchett, 2022; Fitchett et al., 2022). The combination of data sources allows for a more nuanced exploration of heat waves and their effect on the people in South Africa, than either source on their own, using the words of newspaper reporters throughout the last 100 years.

4.2 Approaches in Historical Climatology

Historical geography and historical climatology have long been used to compile information that can give insight into long term changes in the environment when conventional modern-day records are not consistent or well-preserved (Harris, 1991; Moore, 2010). This method primarily uses several sources of documentary evidence, ranging from letters, journals, newspapers, bank records, and meteorological records where they are available (Vogel, 1989; Kelso and Vogel, 2007; Grab and Nash, 2010; Nash et al., 2015, 2019). Where early meteorological data is available, it is used in conjunction with documentary records to verify

the accuracy of the information recorded in newspaper reports, journals and personal records (Vogel, 1989; Nash et al., 2015). Much of this historical climatology research in southern Africa focuses on the 1800s, before meteorological stations were recording weather at a national scale (Vogel, 1989; Kelso and Vogel, 2007; Grab and Nash, 2010; Nash et al., 2015, 2019). In 1841, the first meteorological station in South Africa, recording rainfall, air temperature and air pressure, was established in Observatory, Cape Town (Vogel, 1989; Ndebele et al., 2019, 2022). Newspapers as a source of documentary evidence and data has also been widely used in historical geography (Vogel, 1989; Fitchett and Raik, 2021; Snyman and Fitchett, 2022; Fitchett et al., 2022; Ndebele et al., 2019, 2022). The methods for this project have been derived from the approach of historical climatology in using both archival data and meteorological records (Vogel, 1989; Kelso and Vogel, 2007; Grab and Nash, 2010; Nash et al., 2015, 2019). This project also integrates historical geographical methods of using a mix of data sources to create a historical record of events and explore their shift over time (Fitchett and Raik, 2021; Snyman and Fitchett, 2022; Fitchett et al., 2022).

4.3 Data Collection

The data collection for this project comprised of two stages. The first part of the data collection followed the methods of historical geography research (Kelso and Vogel, 2007; Grab and Nash, 2010; Nash et al., 2015, 2019; Fitchett and Raik, 2021; Snyman and Fitchett, 2022; Fitchett et al., 2022). This process utilised the online repository of digitized newspapers, Readex. Two newspapers were identified that span the entire study period of 1903-2023, namely the Rand Daily Mail and the Business Day. The Rand Daily Mail published its first issue in 1903 and shut its doors due to political pressure in 1985. The Business Day was established in 1985 and continues to publish daily newspapers. Both newspapers were daily publications,

headquartered in Johannesburg, minimising inconsistency between locations or frequency of reporting. The beginning of the study period was therefore determined to be the first publication of the Rand Daily Mail in 1903. The data collection for the newspaper data took place in early 2024, therefore, the end of the study period is December 31st 2023. As of the writing of this thesis in 2025, there are no heat waves reported in the Business Day in all of 2024, therefore, the 31st of December 2023 remains the end of the study period. There may have been unreported heat waves during 2024-2025 that are not included in this study due to a lack of direct meteorological reporting in the Business Day, but this does not limit the value of this long-term archive of data. Therefore, the final study length is 1903-2023, 120 years of South African heatwave history.

The keyword search function on Readex was used to identify extreme heat through the Boolean search term of 'heat+wave.' While other search terms could have been used, these keywords yielded 1,484 results across both newspapers, resulting in a large amount of data to be explored, therefore, reducing the need to explore different search terms (Figure 4.1). The resultant newspaper articles were manually read to identify when a recent or ongoing heat wave was being reported on. This screening process included carefully reading the qualitative reports and each article that fit the criteria inputting the details of heat waves into a database on Microsoft Excel. The inclusion criteria were: reporting on a recent or ongoing heat wave in some part of South Africa. The following information was captured in the database: date, date corrections like a heat wave occurring yesterday, location, the type of weather described, and the section of the newspaper the report came from. Illustrative quotes were also entered into the database to use as examples in the analysis of ways in which people spoke about and reported on extreme heat events. This method of data collection retained both quantitative data about heat waves and their location and reported temperatures and qualitative data on media representation of

extreme events as well as how the news media representation of heat waves has changed over time. Here careful attention was paid to the date corrections mentioned in the newspaper reporting, for example, if a newspaper report mentioned a heat wave occurring "last Tuesday," the previous Tuesday was identified by date and highlighted in the meteorological data. Through these steps, the total number of heat waves (1,484) was screened to a total number of 670 heat waves reported across South Africa in the selected newspapers in the last 100 years (Figure 4.1). While some historical climatology research using this method, namely Holtz and Fitchett (2024), required more extreme screening where a large majority of results on Readex were excluded because of a large amount of advertising and random reporting relating to influenza, weather reporting, and particularly heatwaves, was a very steady and non-controversial type of newspaper reporting and thus a higher proportion of reports were included.

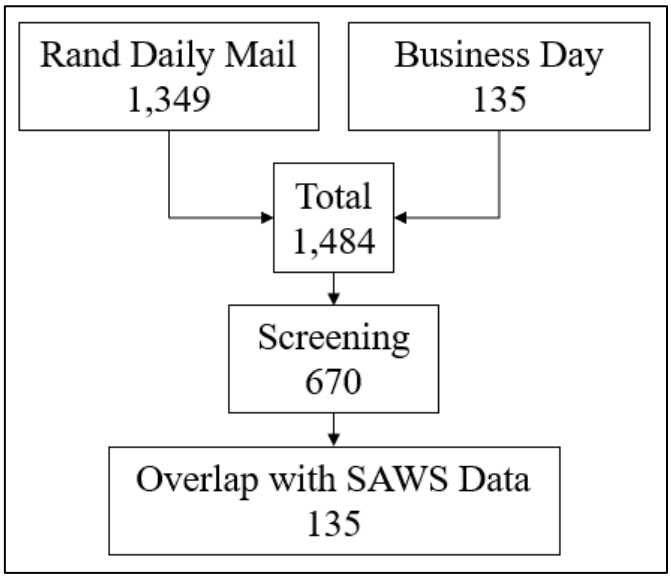


Figure 4.1: Number of newspaper articles screened from the Rand Daily Mail and Business Day newspapers.

The second stage of data collection incorporated historical climatology methods that compare documentary evidence, gathered from newspapers to meteorological records (Vogel, 1989; Grab and Nash, 2010; Snyman and Fitchett, 2022). As both of the newspapers were headquartered in Johannesburg, there was an expectation that most of the reported heat waves would likely focus on urban areas around Gauteng such as Johannesburg and Pretoria or even Cape Town which has some of the longest meteorological records in the nation (Vogel, 1989; Ndebele et al., 2019, 2022). The heat waves were counted according to location and the 13 locations with more than five heat waves were included in this study. The reason for this threshold of five was that over 125 unique locations were reported on by the newspapers, most with only one to four reports each. However, all 13 locations with more than five heat waves represented a majority of heat wave reports and were also the most likely to have a local weather station. Daily resolution weather data for weather stations in the following 13 locations was requested, Johannesburg, Irene/Pretoria, Cape Town, Pietermaritzburg, Durban, Kimberley, Cape Point, Polokwane formerly Pietersburg, East London, Newcastle, Upington, Bloemfontein, and Kenhardt. Only Kenhardt, a small town in the Northern Cape Province, did not have a SAWS weather station or weather office within a 60km range, and was excluded due to lack of data. Relative humidity data was initially also requested from SAWS for the other 12 stations, however, there was not enough consistent humidity data across many of the stations to analyse more in depth, therefore, the focus of this study shifted to temperature alone. This also fits within the scope of the SAWS definition of a heat wave and is thus not a large limitation of this study. For the meteorological data required for the data analysis, daily resolution temperature data (T_{min}, T_{max}, T_{mean}) were obtained from SAWS. The longest possible record for all 12 locations was obtained from SAWS and was screened for outliers, gaps and erroneous entries before being entered into a new database for each location.

4.4 Data Analysis

The data analysis of this project used a mixed methods approach with both quantitative and qualitative analysis methods. The quantitative part of the data analysis used the various newspaper and weather station databases created in the data collection phase of this project. First, the weather data were separated by month of the year to explore monthly climate means. SAWS uses a 30-year climate normal of 1961-1990 to set the heat wave threshold for each location, thus these climate normals and meteorological thresholds were also calculated for each location (SAWS, 2025c). The weather data was then combined for each location where more than one weather station existed in a 50km radius and used to calculate the length of the records and the percentage of data missing from each record. Next, the years with one or more heat wave reports for each location were plotted against the years with coinciding weather data, to understand where the majority of reports lay and visually demonstrate the start of each weather station recording climate data. Long-term change in temperature for each location was calculated using linear regression, or y=mx+c. The Pearson correlation coefficient was used to explore the changes in temperature over time. In this equation, the r-value represents the Pearson correlation coefficient, which measures both the direction and the strength of correlation between two variables (Harris and Taylor, 2003; Wilks, 2011). The Pearson correlation coefficient for the time trends in this study were calculated using *GraphPad Prism 10* using the following equation:

$$r_{xy} = \frac{1}{n-1}\sum_{i=1}^{n}\left[\frac{(x_i-\bar{x})}{s_x}\frac{(y_i-\bar{y})}{s_y}\right] \quad \text{(Wilks, 2011)}$$

The p-value can be calculated from the Pearson correlation coefficient and measures the probability that an observed effect is random chance (Harris and Taylor, 2003). A low p-value (<0.05) indicates that the correlation between the two variables is not due to coincidence or random noise but rather that a clear relationship exists between them (Harris and Taylor, 2003). This was followed by a more qualitative analysis of the newspaper heat wave reports, starting with the newspaper section each report came from and showing illustrative examples of reporting from general weather to photographs made during heat waves. The newspaper reports were also analysed by year of reporting to explore where increased or decreased heat wave reporting was occurring. This information was also plotted on a monthly basis to demonstrate seasonality of reporting.

Next, the dates of extreme heat events were identified from the newspaper reporting and highlighted in the database of weather recordings for that location on that day. These heat waves were recorded in a database. T_{max}, T_{min}, and T_{mean} from the SAWS data were recorded for each of the events identified from newspaper reporting. The three temperatures (T_{max}, T_{min}, T_{mean}) of the newspaper reported heat waves were plotted on a graph through time to explore changes over the past century using linear regression, or y=mx+c. A calculation was also made for the mean T_{max}, T_{min}, and T_{mean} for the seven days prior to and the seven days after any reported heat wave event. This was used to explore if the weather before and after the event was characterised by a marked rise or drop in temperatures. This was followed by another, more qualitative analysis of the newspaper reports where morbidity and mortality were reported on. The number and content of reports on morbidity and mortality were counted and analysed to explore the ways in which newspapers reported on heat illness both in South Africa and contextualised by exploring international reporting on heat wave deaths within the Rand Daily Mail and Business Day.

For the SAWS data, the 30-year climate normals (SAWS, 2025c) for each location were calculated to understand the SAWS heat wave threshold across the study area. With this information, an analysis of SAWS heat waves across all the available data for all 12 locations was made. This was done independent of all newspaper reported heat waves, exploring monthly distribution, changes in SAWS heat waves through time using linear regression and finally, the overlap between the SAWS heat waves and newspaper reported heat waves was calculated. A comparison to the temperatures reported in the newspaper was also made to explore the accuracy of the newspaper journalists in reporting temperature. This was followed by an exploration of hot days, or days above the heat wave threshold that did not meet the three-day requirement for being classified as a heat wave. The overlap between hot days and newspaper heat waves was also calculated.

The more qualitative element of the analysis for this project was related to the newspapers and their wealth of historical data. This was a much smaller component of the research as the large volume of SAWS data allowed for more extensive statistical analysis. The qualitative information gleaned from the newspapers gave much more depth to the data as it allowed for an exploration of the difference between civilian and expert climate knowledge and understanding and how this has changed over the past century.

4.5 Synthesis

This methodology of this study was grounded in a more exploratory basis rather than in the application of any specific index or threshold as many studies on heat waves do. While extreme temperature indices such as Humidex exist and can give more insight into the data, they are

only applicable in historical research where the data such as daily humidity recordings are available, which is difficult in long-term historical research. This study used methods based in historical climatology and geography which have been widely used to reconstruct historical climate records across South Africa (Vogel, 1989; Kelso and Vogel, 2007; Grab and Nash, 2010; Nash et al., 2015, 2019; Holtz and Fitchett, 2024). The two types of data used in this study can give insight into different aspects of heat waves, from purely statistical analyses to a more qualitative view of the ways in which people spoke about extreme weather in the past. Expanding upon this rich history of historical climatology in South Africa, this study explored one type of ETE, heat waves, to help expand the basis for the understanding of climate change in South Africa.

Chapter 5: Results

5.1 Introduction

To compile a record of heatwaves across South Africa and explore the threshold temperatures for media reporting on heatwaves, the data for this research comes from two sources: archival newspapers and the South African Weather Service. This data does not always coincide, meaning that there are many heat waves reported in the newspaper that cannot be explored in more depth with SAWS data to validate their accuracy. However, where there is data, there seems to be no change in the human perception threshold for heat waves. Both heat waves reported in newspapers and SAWS heat waves do not demonstrate a nationwide change over time. This will be explored in further detail throughout this chapter.

The first part of this chapter will explore where the datasets coincide with each other, then heat waves in the newspaper will be contrasted with heat waves according to the South African Weather Service. This will be followed by a deeper exploration of the ways in which newspapers reported on heat waves and where mortality and morbidity was reported. Finally, an exploration of days of extreme heat across South Africa will be made to examine other ways of assessing extreme heat.

5.2 Data Compilation

The combined newspaper records archived on Readex, span the period 1903-1985 (The Rand Daily Mail) and 1985-2023 (The Business Day), with a gap in reporting from 1985-1995 as Readex has not yet made the Business Day archives fully available. This data used in this study

ends in 2023 as data requests to SAWS were made throughout 2024 and there were no more reported heat waves in the Business Day.

The second dataset is daily-resolution meteorological air temperature records from SAWS. Here, there are many differences in the available length of datasets for different cities across South Africa, ranging from 123 years for Johannesburg to 29 years for Newcastle (Table 5.1). Additionally, there are days, months, and years for which individual weather stations do not have recorded data. The percentage of missing data for each location varies with East London and Newcastle missing 22.68% and 22.32% of days, respectively, within the period of data coverage, and Bloemfontein with the least missing data at only 0.36% of the days for the period recorded (Table 5.1). All locations besides East London and Newcastle are missing less than 10% of the data for the whole study period. These 12 locations were chosen as they each reported five or more heat waves throughout the study period in the archival newspapers. The locations are listed in order of most newspaper reported heat waves in Johannesburg to least in Pietermaritzburg for the duration of this study.

Table 5.1: Duration of weather station records by location.

Location	Start of Records	End of Records	Length of Records	Missing Data
Johannesburg	1900	2023	123 years	9.73%
Cape Town	1933	2023	90 years	2.40%
Pretoria	1925	2023	98 years	8.04%
Durban	1956	2023	67 years	2.62%
Kimberley	1932	2023	91 years	0.70%
Cape Point	1917	2023	106 years	4.54%
Bloemfontein	1970	2023	53 years	0.36%
Upington	1928	2023	95 years	22.68%
Polokwane	1952	2023	71 years	3.98%
East London	1970	2023	53 years	0.80%
Newcastle	1994	2023	29 years	22.34%
Pietermaritzburg	1993	2023	30 years	4.21%

The newspaper-reported heat waves range from the earliest in reported in the Rand Daily Mail 1904 up to the most recent reported in The Business Day in 2016 (112 years), comprising a total of 652 articles. Only a portion (36%) of this period coincides with SAWS meteorological data with 236 heat waves coinciding with weather station records for the relevant locations (Figure 5.1). As a result of this, 416 (64%) of the 652 heat waves reported by the newspapers cannot be explored in any further detail than what was reported by journalists. However, where the heat waves reported coincide both in place and time with recorded weather station data, the meteorological characteristics of the heatwave can be independently explored and confirmed. Johannesburg is the only location with weather station data spanning the entire period, and thus 132 of 174 (75%) of the reported heat waves for this city can be explored in relation to weather station data (Figure 5.1). Three locations, Polokwane, Newcastle, and Pietermaritzburg, have no overlap between reported heat waves and weather station data (Figure 5.1). Upington only has one heat wave coinciding with available SAWS data and all other locations have two or more heat waves that coincide with weather station data (Figure 5.1).

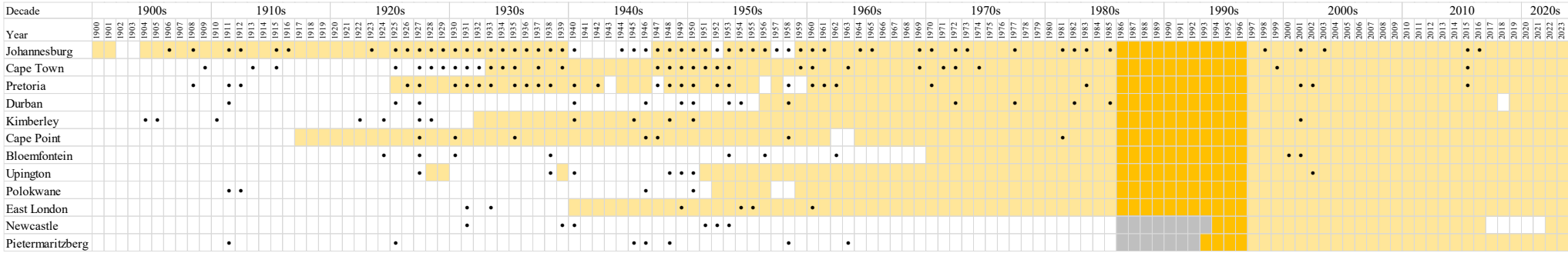


Figure 5.1: Comparison of years with reported heat waves (dots) to length of weather station data (yellow) demonstrating the gap in newspapers (dark yellow and grey) and years with no weather station data (no fill).

5.3 Climate Change in South Africa

All 12 locations in this study have 29 or more years of data. Although 30 years is generally used as the minimum threshold of time to explore long-term climatic changes outside of normal weather fluctuations, often called a climate normal for that region (WMO, 2000), these 29 or more years can give a good understanding the nature of climatic changes in South Africa, against which potential shifts in heat wave occurrence or thresholds for heat wave reporting can be understood. The long-term SAWS data was plotted using annual mean temperatures to explore climate change. All three temperature measurements (T_{max}, T_{min}, and T_{mean}) demonstrate increases for most locations. All 12 locations also demonstrate statistically significant increases in temperature for at least one of the three variables (T_{max}, T_{min}, and T_{mean}). Pretoria, Durban, Polokwane, and East London all display statistically significant increases of all three variables (Table 5.2; Appendix A). For $T_{min,}$ statistically significant changes are calculated for only seven locations, with five locations having no statistically significant change in this variable, however, T_{min} has the second highest rate of change at 0.4°C/decade in both Pretoria and Pietermaritzburg (Table 5.2; Appendix A). Newcastle has the highest rate of warming for T_{max} at 0.7°C/decade over the 29 years of data explored (Table 5.2; Appendix A). T_{max} has the largest range for statistically significant rates of change, ranging from 0.1-0.7°C/decade (Table 5.2). Statistically significant changes in T_{min} range from ~0-0.4°C/decade and T_{mean} ranges from ~0 to 0.3°C/decade (Table 5.2). Changes in T_{mean} demonstrate significant p-values at <0.0001 in seven of the 12 locations, which indicates a broad increase in mean temperatures across these locations (Table 5.2). The slowest rate of warming that is still statistically significant is ~0 for T_{min} in East London and T_{mean} in Newcastle (Table 5.2). Each of the 12 locations is demonstrating some degree of warming in at least one variable with a wide array of rates of change.

Table 5.2: Statistical analysis of climate change trends over time for each location.

Location	Variable	r-value	p-value	Rate of Change (°C/decade)
Johannesburg	T_{max}	0.15	0.1182	~0
	T_{min}	0.67	<0.0001	+0.2
	T_{mean}	0.52	<0.0001	+0.1
Cape Town	T_{max}	0.32	0.0018	+0.1
	T_{min}	-0.18	0.0917	~0
	T_{mean}	0.09	0.4169	~0
Pretoria	T_{max}	0.32	0.0013	+0.2
	T_{min}	0.73	<0.0001	+0.4
	T_{mean}	0.53	<0.0001	+0.3
Durban	T_{max}	0.44	0.0002	+0.1
	T_{min}	0.60	<0,0001	+0.2
	T_{mean}	0.60	<0.0001	+0.2
Kimberley	T_{max}	0.54	<0.0001	+0.2
	T_{min}	-0.38	0.0002	+.1
	T_{mean}	0.14	0.1871	~0
Cape Point	T_{max}	0.79	<0.0001	+0.2
	T_{min}	0.18	0.0608	~0
	T_{mean}	0.66	<0.0001	+0.1
Bloemfontein	T_{max}	0.58	<0.0001	+0.3
	T_{min}	-0.00	0.9743	~0
	T_{mean}	0.38	0.0049	+0.2
Upington	T_{max}	0.55	<0.0001	+0.3
	T_{min}	0.22	0.0555	+0.2
	T_{mean}	0.42	0.0001	+0.3
Polokwane	T_{max}	0.58	<0.0001	+0.2
	T_{min}	0.35	0.0030	+0.1
	T_{mean}	0.56	<0.0001	+0.1
East London	T_{max}	0.60	<0.0001	+0.1
	T_{min}	0.24	0.0312	~0
	T_{mean}	0.50	<0.0001	+0.1
Newcastle	T_{max}	0.57	0.0025	+0.7
	T_{min}	0.34	0.0916	+0.2
	T_{mean}	0.49	0.0102	+~0
Pietermaritzburg	T_{max}	0.12	0.5366	+0.1
	T_{min}	-0.6214	0.0002	+0.4
	T_{mean}	-0.2709	0.1404	+0.1

5.4 Newspaper Reporting on Weather

The newspaper reports on heat waves spanned a range of 22 separate sections of the two newspapers from general weather reporting all the way to fashion and letters to the editor. The largest proportion of reports came from general reporting on the weather at 491 (76%; n=652) with the second largest proportion being only 38 (6%; n=652) in agricultural reporting (Figure 5.2). The category of 'all other' newspaper reports consist of at least 12 unique sections of the newspaper, each of which had less than five (<1%) reports and include: gardening, theatre, church reports, and crime reporting among others (Figure 5.2).

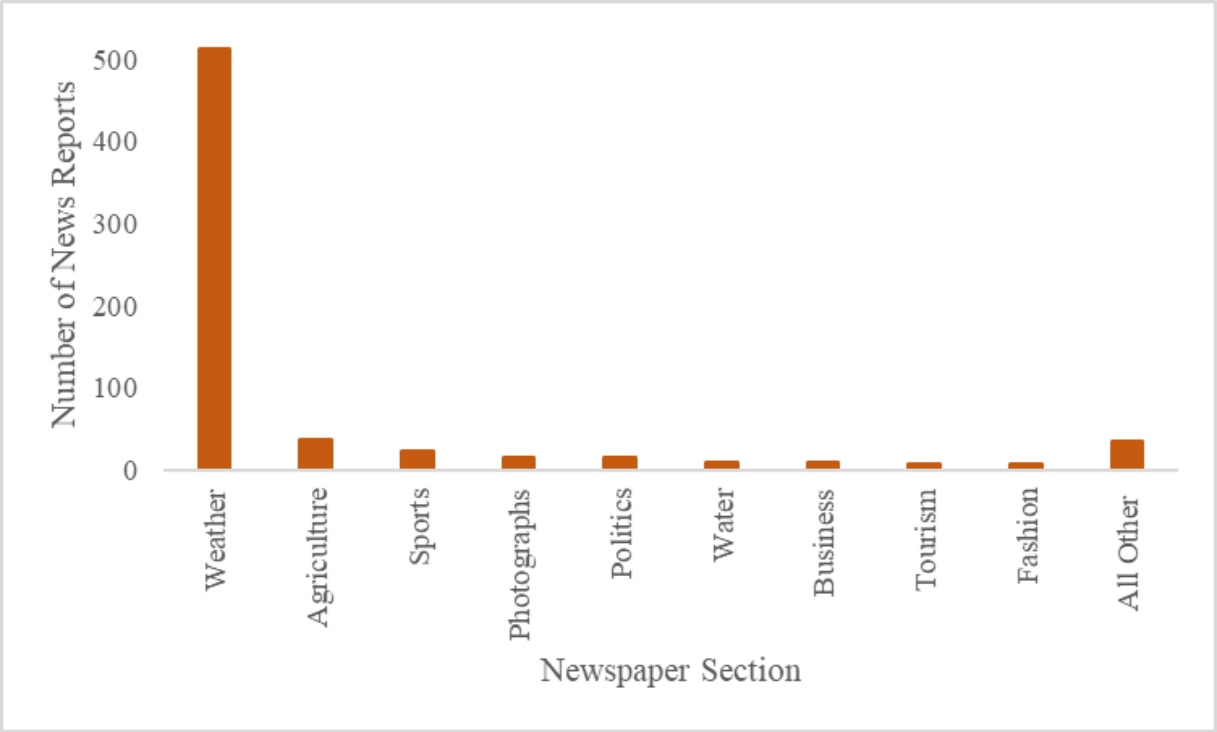


Figure 5.2: The origin of newspaper reports of heat waves between 1903-2023.

In the fashion section (Figure 5.2), for example, an ongoing heat wave is discussed in relation to how people are wearing more scandalous clothes because of the heat. Church reports (Figure

5.2) generally sent out prayers for the ongoing heat wave to pass without harming any people. The crime reporting warns people about sleeping with open windows during the ongoing heat wave as it could tempt burglars to break in. Throughout the study period there were seven human interest stories that discuss the human and economic consequences of heat waves (Figure 5.3a). Agricultural reporting often spoke to the loss of crops or livestock (Figures 5.3b, c). These incongruous sections of the newspaper were only included in the database for this study if they spoke to an ongoing heat wave at that time, and not general heat wave advice or other irrelevant information.



Figure 5.3: Examples of heat wave reports from various sections of the newspaper from a) a human-interest story from the 28th of December 1925 b) agriculture on the 14th of December 1960 c) another agriculture report from the 7th of February 1947 and d) a sports story from the 4th of September 1962.

Weather reporting was the most consistent source of heat wave related reporting throughout the study period (Figure 5.4). Only reporting that spoke to ongoing or recently occurring heatwaves (for example, “last week’s heat wave”) were included in the database. Some weather reporting mentioned specific temperatures at specific times and most of them mention specific locations, for example 5.4e mentions “Jansenville (Cape) – Friday,” which gives a very clear indication of place and time of the reported heat wave (Figure 5.4). Some reports spoke to heat waves “across the Union” or mentioned entire provinces, sometimes historical provinces such as the Transvaal. Some report on heatwaves across two or more different towns or cities. For example, Figure 5.4a reports on a heat wave in King Williams Town. Articles in print media often have a lag-time between when an extreme temperature event such as a heat wave occurs and when it is reported, and many articles capture this explicitly. The most common lag time is between one day (“yesterday” – occurring at 29% or 193 of 652) and over the past week (Appendix B). As both newspapers used in this study printed daily editions, where a specific weekday is mentioned (eg. “Friday”) this usually meant either two or three days before publication to give time for printing.



Figure 5.4: Examples of weather reporting on heat waves from a) the 12th of January 1912, b) the 30th of November 1935, c) the 12th of December 1939, d) the 2nd of February 1951 and e) the 30th of January 1954.

Photographs were occasionally used, appearing in 15 heat wave reports (2%; n=652) of all reports (Figure 5.5). Photographs were often standalone and not part of any larger news story, they usually have their own headline and caption and may compliment other heat wave stories in the newspaper on the same day but not be directly linked. Examples of this reporting include tennis outfits worn during a heat wave with no accompanying news story other than a headline (Figure 5.5).



Figure 5.5: Examples of the use of photographs in weather reporting from a) the 6th of January 1936 and b) the 23rd of January 1956.

5.5 Heat Waves in the Newspaper

Of the 652 reported heat waves 354 (54%; n=652) news articles stated a temperature, and 52 (7%; n=652) days even recorded relative humidity levels. The reported temperature was sometimes explicitly obtained from SAWS or its predecessor organisations: The Weather Service in the Union of South Africa (1912-1940), The Meteorological Service (1940-1949), The South African Weather Bureaux (1949-2001) The South African Weather Service (2001-present; SAWS, 2025). However, temperature was more often recorded simply from the thermometer of the newspaper office or *in situ* recordings by journalists, as stated in a few individual articles (Figure 5.6). Figure 5.6a reports on a "Melville resident states that his thermometer, shortly before 2 p.m., recorded 100 degrees". Another example simply reports the "mercury rising" to a certain temperature (Figure 5.6b), and implies that this was witnessed by the journalists, perhaps by looking at a thermometer in the newspaper offices. Figure 5.6c

lists SAPA (South African Press Association) as a reporter which implies that the temperature readings came through SAPA to the journalist. The final example (Figure 5.6d) cites the weather bureau as the source for climate predictions. This demonstrates the range of types of weather recordings used in the newspaper.



Figure 5.6: Sources of weather data in heat wave reporting from a) the 16th of October 1916, b) the 19th of October 1937, c) the 1st of November 1960 and d) the 25th of December 1954.

The year 1911 recorded the largest number of heat waves reported in the Rand Daily Mail at 36 (5.5% of the total 652 reports; Figure 5.7). There is a decrease in newspaper reporting on heat waves in the first half of the 1940s, likely because of the media focus on World War II (WWII; Figure 5.7). After 1970, there are also fewer newspaper reports on the weather than in previous decades. There is a large gap in the archives on Readex where the first decade of Business Day reporting has not yet been made available to the Readex platform, which

accounts for the gap in reporting between 1985 and 1995 (Figure 5.7). There are very few reports of heat waves after 2005, with all subsequent newspaper reports on heat waves being a combination of reporting on drought and heat together, most notably around the Day Zero drought in Cape Town, which represents the final peak in reporting in 2015/16. There are no reports after 2015/16 in The Business Day (Figure 5.7). Here it is important to acknowledge that there could very well be reports of heat waves in other forms of media that were not consulted in this study, however, the two newspapers chosen span the entire study period, were headquartered in the same city, and published daily to have the most continuous data for this research.

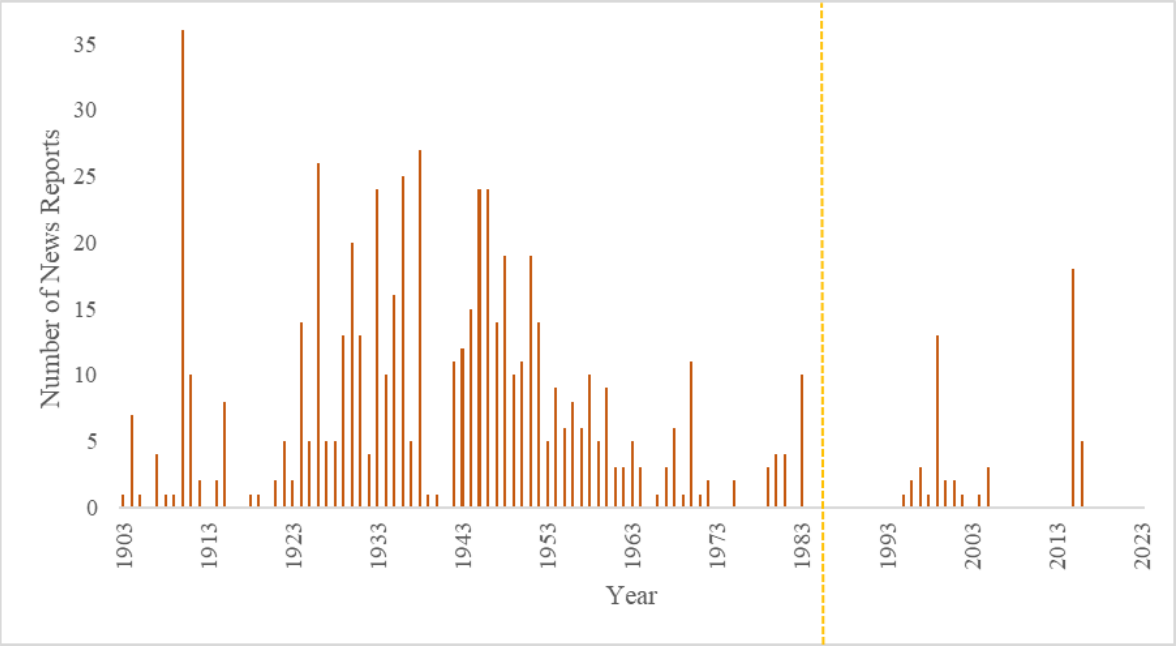


Figure 5.7: Number of heat waves reported in newspapers by year of the study period.

In the heat wave literature, a heat wave study by Mbokodo et al. (2023), reported that the most severe heat wave summers in South Africa have co-occurred with widespread drought. These drought/ heat wave summers were 1982/83, 1997/98 and 2015/2016 with 2016 being the hottest

year in South Africa since records began in the 1840s (Mbokodo et al., 2023). In the years 1982/83, 10 heat waves were reported, in 1997/98 four heat waves were reported and in 2015/16 23 heat waves were reported (Figure 5.7). There are clear peaks in reporting for the 1982/83 and the 2015/16 drought/ heat wave years (Figure 5.7), while the 1997/98 years have fewer reported heat waves than 1999 (13) although this may be a function of the lack of early records of the Business Day being public on Readex. This indicates that the newspaper reporting does peak in years with a higher number of recorded heat waves in meteorological literature.

The summer season in South Africa spans October through March (Van der Walt and Fitchett, 2020). The heat waves reported in the archival newspapers follow this seasonality, with October, November, December, and January demonstrating the highest number of reports (Figure 5.8). Despite this broad seasonality, heat waves reported on by news media appear in all months of the year, January has the largest proportion of all reported heat waves at 219 reports (33%; n=652) with December having the second most reports at 129 of heat waves (19%, n=652; Figure 5.8). This aligns with the summer season across South Africa and when the hottest month of the year is recorded for most of the country.

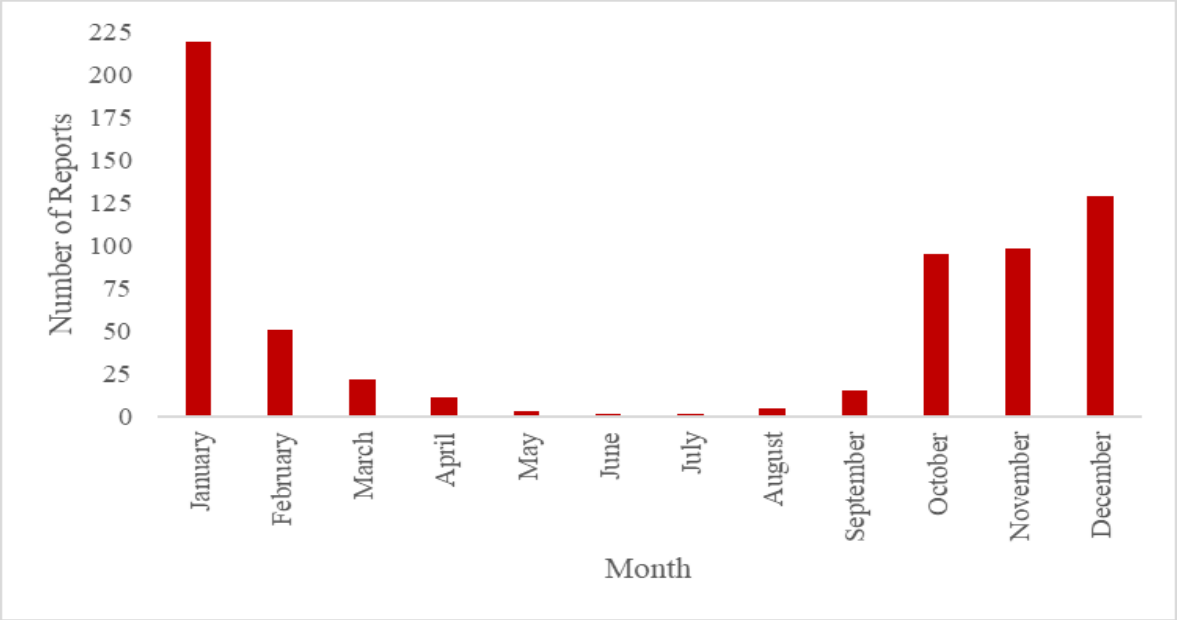


Figure 5.8: Number of all heat waves reported in newspapers by month of the year.

Overall, the seasonality of newspaper reporting indicates a very clear summer season peak, however, each of the 12 locations in this study have more unique seasonal distributions. All but one location (East London) are characterised by a summer peak in heat wave reporting (Figure 5.9). East London has a bimodal distribution, with the most heat waves reported in July and November (Figure 5.9). In Johannesburg, Kimberley, Cape Point, Bloemfontein, and Upington, the highest number of reported heat waves were in the month of January (Figure 5.9). Only in Cape Town are the most reported heat waves occurring in February (Figure 5.9). In Durban and Polokwane, the highest number of reported heat waves was in December, and for Pretoria, Newcastle, and Pietermaritzburg the largest number of heatwave reports was in October (Figure 5.9).

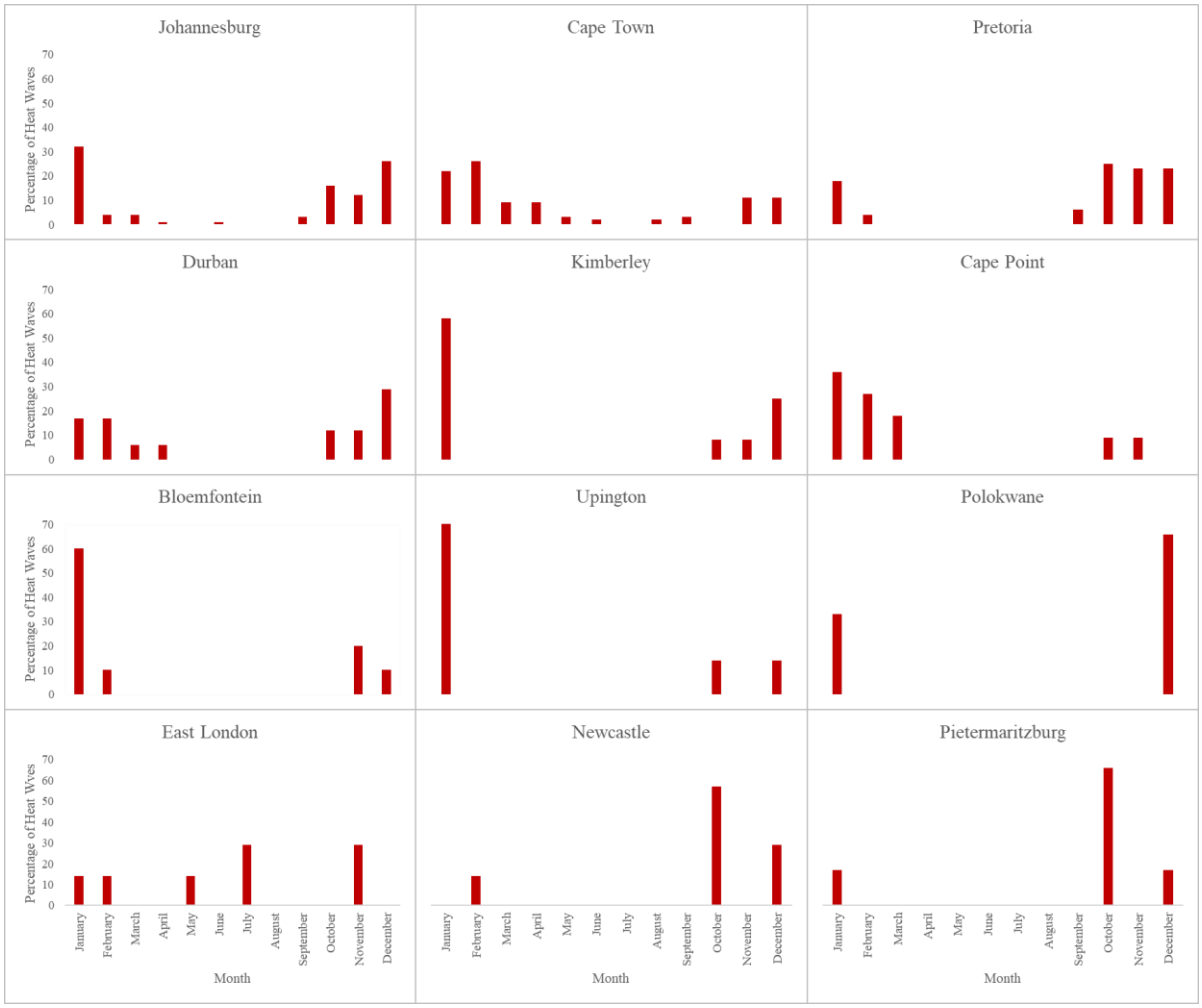


Figure 5.9: Monthly distribution of newspaper reported heat waves between 1903-2023 by location of the study.

5.6 Comparing Heat Wave Reporting with Meteorological Data

Of the heat waves reported in the archival newspapers, only seven of the 12 locations had more than two heat waves that occurred for the period of SAWS weather station data. For those locations, the meteorological conditions during the time of the reported heatwave could be explored. 236 heat waves correspond with weather station data (Table 5.3). The SAWS temperatures (T_{max}, T_{min}, T_{mean}) for multi-day heat waves were averaged across the duration of each event (Table 5.3).

Table 5.3: All 235 heat waves which correspond with weather station data.

Year	Date	Location	Reported Temperature	Reported Temperature in °C	SAWS Temperature in °C for Date of Measurement (T_{max},	T_{min},	T_{mean})
1906	21 Jan	Johannesburg	87.6°F	30.8	30.7	17.4	24.1
1911	18-20 Oct	Joubert Park	91.5°F	33	31.2	16.4	23.8
1911	20-26 Dec	Joubert Park	T_{max}: 94°F T_{min}: 64.3°F	T_{max}: 34.4 T_{min}: 17.9	33.7	17.8	25.8
1912	03 Dec	Johannesburg	T_{max}: 76°F T_{min}: 52°F	T_{max}: 24.4 T_{min}: 11	27.1	14.7	20.9
1915	10 Nov	The Rand	103°F and 90°F in the shade	39.4° and 32.2 in the shade	30.3	14.6	22.5
1916	14 Jan	The Rand			27.2	15	21.1
1916	02 Oct	Johannesburg	82°F in the shade	27.7	29.4	2.8	16.1
1916	15-16 Oct	Johannesburg	91°F in the shade	32.7	32.05	19.1	25.6
1923	07 Nov	Joubert Park	89.4°F	31.9	26.7	11.4	19.1
1923	01 Dec	Johannesburg	83.9°F	28.8	26.1	17.9	22
1923	06 Dec	Joubert Park	T_{max}: 88°F T_{min}: 60°F	T_{max}: 31.1 T_{min}:15.5	29.7	14.2	22
1925	30 Oct	The Rand			30.7	12.2	21.5
1925	02 Nov	The Rand			27.3	11.7	19.5
1925	20-28 Dec	Johannesburg			32.1	18	25.1
1926	13 Jan	Joubert Park	T_{max}: 88°F T_{min}: 67°F	T_{max}: 31.1 T_{min}: 19.4	31	17.4	24.2
1926	20-25 Jan	Johannesburg			28.5	14.43	21.5
1926	19 Oct	Pretoria	T_{max}: 95.9°F T_{min}: 49.2°F	T_{max}: 35.3 T_{min}: 9.55	32.5	4.4	18.5
1927	14 Jan	Johannesburg	94.2°F at 3pm	34.5	34.7	15.4	25.1
1927	15 Jan	Cape Point			20.0	17.2	18.6
1927	15 Jan	Pretoria	97°F	36.1	34.9	14.2	24.6
1928	21 Dec	Joubert Park			30.1	15.8	23
1929	06 Jan	Joubert Park	125°F in the sun	51 in the sun	33.3	17.5	25.4
1929	06 Nov	The Rand	95.3°F 24°F up since Tuesday	35 up 7 degrees since Tuesday	30.6	14.6	22.6
1929	25 Dec	Johannesburg			29.6	12.4	21
1930	24 Jan	Cape Peninsula			20.6	15.6	18.1
1930	29 Aug	The Rand			20	4.7	12.4
1930	29 Oct	Joubert Park	T_{max}: 68.1°F T_{min}: 40.5°F the previous night	T_{max}: 20 T_{min}: 4.7	32.2	16.8	24.5
1930	16 Dec	Johannesburg			21.4	17.8	19.6
1930	25 Dec	Johannesburg	Over 90°F	over 32.2	28.8	14.2	21.5
1930	31 Dec	Pretoria			26.3	12.6	19.5
1931	25 Sep	Johannesburg	mercury over 90°F over two days	Over 32.2	31.1	11.6	21.4
1931	21 Oct	Pretoria	94°F	34.4	30.7	18	24.4
1931	28 Oct	Pretoria			29.1	12.8	21
1932	11-12 Jan	Johannesburg	over 90°F	over 32.2	32.9	16.6	24.8
1932	13 Jan	Pretoria	96°F over 2 days	35.5	33.7	17.8	25.8
1932	8-12 Oct	Johannesburg	84°F in the shade	28.9	30.1	14.42	22.3
1932	16-19 Oct	Johannesburg	88.3°F on hottest day with T_{min}:56°F	T_{max}: 31.2 T_{min}: 13.3	29.6	14.6	22.2
1932	30 Nov	Johannesburg			32.9	17.3	25.1

1932	02 Nov	Cape Town	88.6°F	31.4	31.4	15.5	23.5
1932	07 Nov	Cape Town			25.3	15	20.2
1932	30 Nov	Johannesburg	91.2°F	32.9	32.9	17.3	25.1
1932	11-12 Dec	Johannesburg			31.6	14.9	23.1
1933	09 Jan	Johannesburg	88.7°F on Saturday	31.5	28.9	13.3	21.1
1933	25 Jan-2 Feb	Cape Town			25.6	17.8	21.7
1933	25 Jan-02 Feb	Johannesburg	89.6°F	32	29.4	14.3	21.9
1933	09 Feb	Cape Town	105°F in the shade	40.5	19.6	16.3	18
1933	27 Mar	Johannesburg	Normal average for march is T_{max}:72.7°F and T_{min}:53.9°F - but it has been over 80°F all week	Normal T_{max}: 22.6 T_{min}: 12.2 but it has been over 26.6	26	13.6	19.8
1933	03 Oct	Pretoria			28.1	10	19.1
1933	11 Oct	Johannesburg			28.1	12.3	20.2
1933	01 Nov	Johannesburg			23.8	16.7	20.3
1934	12 Feb	Johannesburg	nearly 83°F	nearly 28.3	29.4	15.6	22.5
1934	17-18 Apr	Cape Town	80°F	26.7	39.75	14.4	27.1
1934	13 Oct	Benoni			27.8	11.8	19.8
1935	06-08 Jan	Johannesburg	1 Jan: 88.3°F - Wed: 82.5°F - Thurs: 81.8°F - Fri: 84°F - Sat: 85°F	1 Jan: 31 - Wed: 27.7 - Thurs: 27.6 - Fri: 28.8 - Sat: 29.4	28.6	15	21.9
1935	11-12 Jan	Johannesburg			27.2	13.9	20.6
1935	16 Jan	Zoo Lake			26.7	11.1	18.9
1935	17 Jan	Cape Town			27.1	21.1	14.4
1935	18 Jan	Cape Point			20.7	15.6	17.8
1935	03 Oct	Pretoria	over 90°F	over 32.2	31.1	10.4	21.1
1935	10-12 Oct	Johannesburg	hottest day in last 2 days		31	15.3	23.2
1935	15 Oct	Pretoria	88°F	31.1	31.6	12.3	22
1935	15 Oct	Joubert Park	90°F in the shade	32.2 in the shade	28.4	11.2	19.8
1935	25 Oct	Pretoria			16.6	11.8	14.2
1935	23-26 Oct	The Rand			22.1	10.8	16.5
1935	30 Nov	Cape Town	over 100°F	over 37.7	37.3	16.4	26.9
1936	05-10 Jan	The Rand			28.9	15.7	22.3
1936	09 Nov	Benoni	over 80°F	over 26.6	18.3	12.9	15.6
1936	07-08 Dec	The Rand			28.2	16.2	22.2
1936	25 Dec	Pretoria			26.2	16.7	21.5
1937	21 Jan	The Rand	88.5°F at 8pm last night	31.4	24.7	16.2	20.5
1937	01 Mar	Cape Town			32.8	17	24.9
1937	10 Mar	Germiston			27.4	12.7	20.1
1937	28 Sep	Johannesburg	15-20°F rise in temperatures	8-11 rise	28.2	12.9	20.6
1937	19 Oct	Johannesburg	86°F in the mercury	30	28.1	13.9	21
1937	12 Nov	Pretoria			35.7	15	25.4
1937	13-16 Nov	Johannesburg	a few days over 90°F in the mercury	32.2	24.1	13.6	18.9

1937	01 Dec	Pretoria			25.6	17.3	21.5
1937	04 Dec	Johannesburg	temperatures dropped 40°F within 24 hours - over 90°F last week now under 60°F	over 32.2 now under 15.5	22.2	9.2	15.7
1938	22-Jan	Johannesburg	83°F	28.3	23.6	16.6	20.1
1938	22-24 Nov	Pretoria	90°F	32.2	31.9	16.2	24.1
1938	22-24 Nov	Johannesburg	87°F	30.5	30.3	17.1	23.9
1939	10 Feb	Cape Town			28.3	15.2	22.4
1939	20 Oct	Johannesburg			12.8	10.2	11.5
1940	09 Jan	Polokwane			33.1	16.9	25.0
1940	09 Jan	Kimberley	101°F	38.3	35.1	15.6	25.4
1940	15 Jan	The Reef	over 80°F	over 26.6	25.6	14.4	20
1940	16 Jan	Pretoria			25.9	13.6	19.8
1940	16 Jan	Johannesburg			31.3	16.2	23.8
1942	05 Feb	Pretoria			31.1	16.7	23.9
1945	08 Jan	Kimberley			29.4	13.3	21.6
1946	07 Mar	Johannesburg			28.4	14.2	21.3
1946	29 Mar	Cape Point	30°F drop after violent storm after 101°F in the shade	16 drop after 38.3	19.4	16.1	17.8
1946	04 Dec	Johannesburg	90°F - hottest day since Dec 1941	32.2	31.8	17.2	24.5
1946	05 Dec	Johannesburg			31.8	17.2	24.5
1946	06 Dec	Joubert Park			31.8	17.2	24.5
1947	01 Jan	Joubert Park	89.6°F	32	29.9	13.9	21.9
1947	02 Jan	Johannesburg			28.1	15.1	21.6
1947	03 Jan	Joubert Park	84°F	28.8	28.1	15.1	21.6
1947	08 Jan	Joubert Park	84°F	28.8	26.9	15.3	21.1
1947	06-07 Feb	Cape Town			28.3	20.5	23.7
1947	07 Feb	Cape Point			20.6	20	20.3
1947	10 Feb	Cape			20.6	17.2	18.9
1947	18 Mar	Cape Town	99°F	37.2	31.2	15.3	23.3
1947	9 Oct	Johannesburg	85.4°F	29.6	29.4	13.2	21.3
1947	13 Oct	The Rand			28.5	13.9	21.2
1947	14 Oct	Johannesburg	85°F	29.4	28.5	13.9	21.2
1947	03 Nov	Joubert Park	85°F up from 61°F on Sunday	29.4 from 16.1	30.6	13.4	22
1947	03 Nov	Pretoria			30.8	16.9	23.8
1947	03 Nov	Joubert Park	88°F	31.1	32.3	15.7	24
1947	04 Nov	Pretoria	93-93.8°F	33.8-34.3	30.8	16.9	23.8
1947	27 Nov	The Rand			22.7	11.4	21.8
1947	28 Nov	Cape Town	92-100°F - 63% humidity	33.3-37.7	25.7	17.8	22
1948	09-12 Jan	Johannesburg	88-90°F	31-32.2	29.7	13.3	21.5
1948	13-14 Jan	Pretoria	91.3°F	32.9	31.5	16.9	24.2
1948	22 Jan	Cape Town			26.3	15.3	20.8
1948	18 Feb	Cape Town	over 100°F in the sun at noon	over 37.7	38.8	18.7	27.3
1948	03 Apr	Cape Town	101°F	38.3	39.3	16.4	27.9
1948	07 Dec	Kimberley	99°F in the shade	37.2	36.9	19.9	28.4
1948	12 Dec	Johannesburg	88°F	31.1	29.4	15.1	22.3
1948	14 Dec	Johannesburg	not below 85°F for several days	not below 29.4	29.7	16.6	23.2

1948	16-17 Dec	Pretoria			31.2	17.6	24.4
1948	16 Dec	Johannesburg	72°F at midnight. 82°F at 3pm	22.2-27.7	28.2	15.5	22.2
1948	17 Dec	Joubert Park			27.3	13.3	20.0
1948	28 Dec	Pretoria			35.8	16.7	26.3
1949	10-12 Jan	The Rand	90°F	32.2	32.7	16.3	24.5
1949	10 Jan	Johannesburg			28.5	17.1	22.8
1949	11 Jan	Joubert Park			31.2	13.8	22.5
1949	15 Jan	Cape Town			30.7	12.9	21.8
1949	03-04 Feb	Cape Town	92°F	33.3	31.1	19.2	25.1
1949	16 Dec	Pretoria			30.5	30.5	30.5
1950	05 Jan	Cape Town	92°F	33.3	34.1	19.2	35.2
1950	12 Jan	Johannesburg			31,2	13,8	22,5
1950	01 Feb	Rand	85°F for three days in a row	29.4	28.6	14.4	21.5
1950	02 Feb	Cape District	112°F	44.4	22.8	16.1	19.5
1950	07 Mar	Johannesburg			24.9	14.6	19.
1950	28 Jul	East London			16.3	2.8	9.55
1950	18 Oct	Kimberley	90°F	32.2	33.9	10.2	22.1
1950	18 Oct	Pretoria	85°F	29.4	31.4	13.6	22.5
1950	18 Oct	Germiston	83°F	28.3	28.6	10	19.3
1951	11 Jan	Joubert Park	34°F to 61°F rise in 24 hours up to 70°F the next day	1-16 up to 21.1	27.6	16.8	21.2
1951	09 Feb	Cape Town			24.4	17.6	21
1951	10 Oct	Johannesburg	80°F	26.6	31.7	14.6	23.2
1951	21 Nov	Johannesburg			27.5	12.3	19.9
1951	01 Dec	Johannesburg	86.8°F	30.4	21.7	17.3	23.5
1952	01 Jan	Johannesburg			31.1		
1952	18 Jan	Johannesburg	86°F	30	29.7	15	22.3
1952	18 Jan	Pretoria	89°F	31.6	31.7	16.1	23.9
1952	05 Feb	Cape Town	81-90°F in 6 hours	27.2-32.2	32.2	21.5	26.9
1952	24 Oct	Pretoria			33.7	14.2	24
1953	27 Jan	Cape Town			32.2	21.5	26.9
1953	14 Sep	Johannesburg	76.8	24.8	21.6	10	15.8
1953	02 Nov	Pretoria			28	12.6	20.3
1953	30 Dec	Johannesburg	80°F	26.6	29.3	17.9	23.6
1953	31 Dec	Pretoria				18.1	
1954	16 Jul	East London			17.8	14.8	16.3
1954	07 Oct	Johannesburg	85°F	29.4	27.9	15	21.5
1954	15 Oct	Johannesburg			29.3	15.1	22.2
1954	27 Oct	Johannesburg			28.3	10.4	19.3
1954	25 Dec	Johannesburg			21.1	16.2	18.7
1954	30 Dec	Johannesburg			25.8	14.8	20.3
1955	18 Feb	East London			23.0	18.3	20.7
1955	18 Nov	Johannesburg			26.7	10.1	18.4
1956	23-25 Jan	Johannesburg	78°F	25.5	28.8	13.3	21.1
1956	01 Feb	Johannesburg			28.6	13.9	21.3
1957	10 Jan	Cape			21.3	16.6	19
1957	21 Jan	Cape Town			25.2	17.8	21.5
1958	06 Oct	Durban	105.4°F	40.8	20.5	14.2	17.4
1958	07 Oct	Cape Town			31.3	13.3	22.3
1959	03 Apr	Johannesburg	60°F in am to 80°F in pm	15.5-26.6	27.2	13.8	20.5
1959	30 Sep	Cape Town	98°F	36.6	34.7	11.2	23
1960	04 Jan	East London			21.6	13.3	17.5

1960	30 Oct-10 Nov	Pretoria	90°F	32.2	29.0	15.5	22.3
1960	01 Nov	Johannesburg			27.3	13.5	20.4
1960	08 Nov				20.9	13.3	18.1
1960	14 Dec	Cape Town	100°F	37.7	37.5	23.6	30.6
1961	14 Jan	Germiston			28.7	17.8	23.3
1961	26 Oct	Pretoria			31.2	14.4	22.8
1962	04 Sep	Pretoria			23.7	7.5	15.6
1963	17 Jan	Cape Town	83°F	28.3	28.9	20.4	24.7
1964	20 Mar	Johannesburg			26	13.4	19.7
1965	01 Nov	The Reef	90-100°F	32.2-37.7	30	17.8	23.9
1965	01 Nov	Pretoria	98°F	36.7	36.5	20	28.3
1969	17 Jan	Cape Town			29	18.9	24
1969	11 Feb	Johannesburg			29.3	15.6	22.5
1970	05 Jan	Johannesburg			29.3	15.5	22.4
1970	23 Jan	Johannesburg	86-100°F	30-37.7	26.4	15.2	20.8
1970	07 Mar	Kyalami			26.7	15.4	21.1
1970	08 Sep	Johannesburg			24.2	9	16.6
1970	08 Sep	Pretoria			27.4	9.8	18.6
1971	28 Dec	Cape Town			28.5	20.1	24.3
1972	04 Dec	Johannesburg			32	17.8	24.9
1972	07 Dec	Cape Town			25.2	16.4	20.8
1972	07 Dec	Johannesburg			32	17.8	24.9
1972	16 Dec	Johannesburg			28.9	17.4	23.2
1972	19 Dec	Johannesburg			25.2	10	17.6
1973	13 Jan	Johannesburg	88°F	31.1	28.1	16.8	22.5
1974	22 Feb	Durban	83°F	28.8	30.4	20.9	25.3
1974	05 Jun	Cape Town			23.6	24.4	19
1977	13 Dec	Kyalami			26.6	15.4	21
1977	31 Dec	Durban			26.7	18.9	22.8
1981	13 Nov	Johannesburg			28.3	14	21.2
1981	20 Nov	Cape Town			29.7	7.9	18.8
1982	23 Jun	Johannesburg			19.7	7.5	13.6
1982	21 Oct	Johannesburg			23.2	11.9	17.6
1982	12 Nov	Johannesburg			25.6	17.6	21.6
1982	30 Dec	Durban			28.2	23.8	26
1983	13 Jan	Johannesburg			29.1	17.6	23.4
1938	14 Jan	Johannesburg			25.2	14.2	19.7
1983	29 Sep	Pretoria			33.1	12.5	22.8
1985	04 Jan	Durban			27.1	21.6	24.4
1985	04 Jan	Johannesburg			31.7	18.7	25.2
1998	05 Jan	Johannesburg			27.8	15.9	21.9
1998	12 Feb	Johannesburg			24.2	13.9	19.1
1999	01 Apr	Cape Town			31.8	15.2	23.5
1999	13 Dec	Cape Town			34	17.8	25.9
2000	17 Nov	Bloemfontein			36.5	10.1	23.2
2001	11 Jan	Pretoria			34.6	13.7	24.2
2001	11 Jan	Kimberley			37.7	14.2	25.6
2001	11 Jan	Bloemfontein			29.7	15	22.4
2001	15 Jan	Pretoria			31.2	16	23.6
2001	21 Jan	Johannesburg			27.6	13.3	20.5
2002	03 Jan	Pretoria			31.8	15.6	23.7
2002	03 Jan	Upington			40.4	18.6	29.5
2003	18 Feb	Johannesburg			20.2	14.9	17.5
2006	01 Nov	Johannesburg			22.3	14.9	18.6
2007	10 Mar	Johannesburg			25	10.4	17.7
2015	05 Mar	Cape Town			23.3	16.1	19.7

2015	30 Sep	Tshwane/Pretoria			32.2	19.1	25.7
2015	12 Nov	Johannesburg			32.2	19.2	25.7
2015	13 Nov	Johannesburg			32.2	19.2	25.7
2015	16 Nov	Johannesburg			25.8	11.6	18.7
2015	19 Nov	Johannesburg			24.5	9.7	17.1
2015	13 Nov	Pretoria			33.3	22.5	27.9
2015	08 Dec	Cape Town			26.8	18.5	22.7
2016	03 Nov	Johannesburg			26.4	13.6	20

KEY	
Accuracy between Newspapers and SAWS	**Colour**
Within 1°C Difference	
1-3°C Difference	
3-5°C Difference	
5-10°C Difference	
>10°C Difference	

The seven locations with more than two heat waves that coincide with weather station data were analysed for time trends in the threshold temperature for reporting. Johannesburg has the largest heat waves coinciding with meteorological data at 135 (Figure 5.10). Cape Town and Pretoria both have 37. This is likely due to the higher population and therefore more reporting in larger metropolitan areas of South Africa. Durban and Kimberley both have five heat waves. Cape Point has eight and East London has four (Figure 5.10). What is evident even when the heat waves are separated by location are the trends in reporting. For example, there is a clear gap in reporting of heat waves during the early 1940s (WWII) in Johannesburg, Cape Town, and Pretoria (Figure 5.10). There are no reports at all for Durban, Cape Point, and East London after the mid-1980s which may address a change in where people sourced their weather reporting (Figure 5.10).

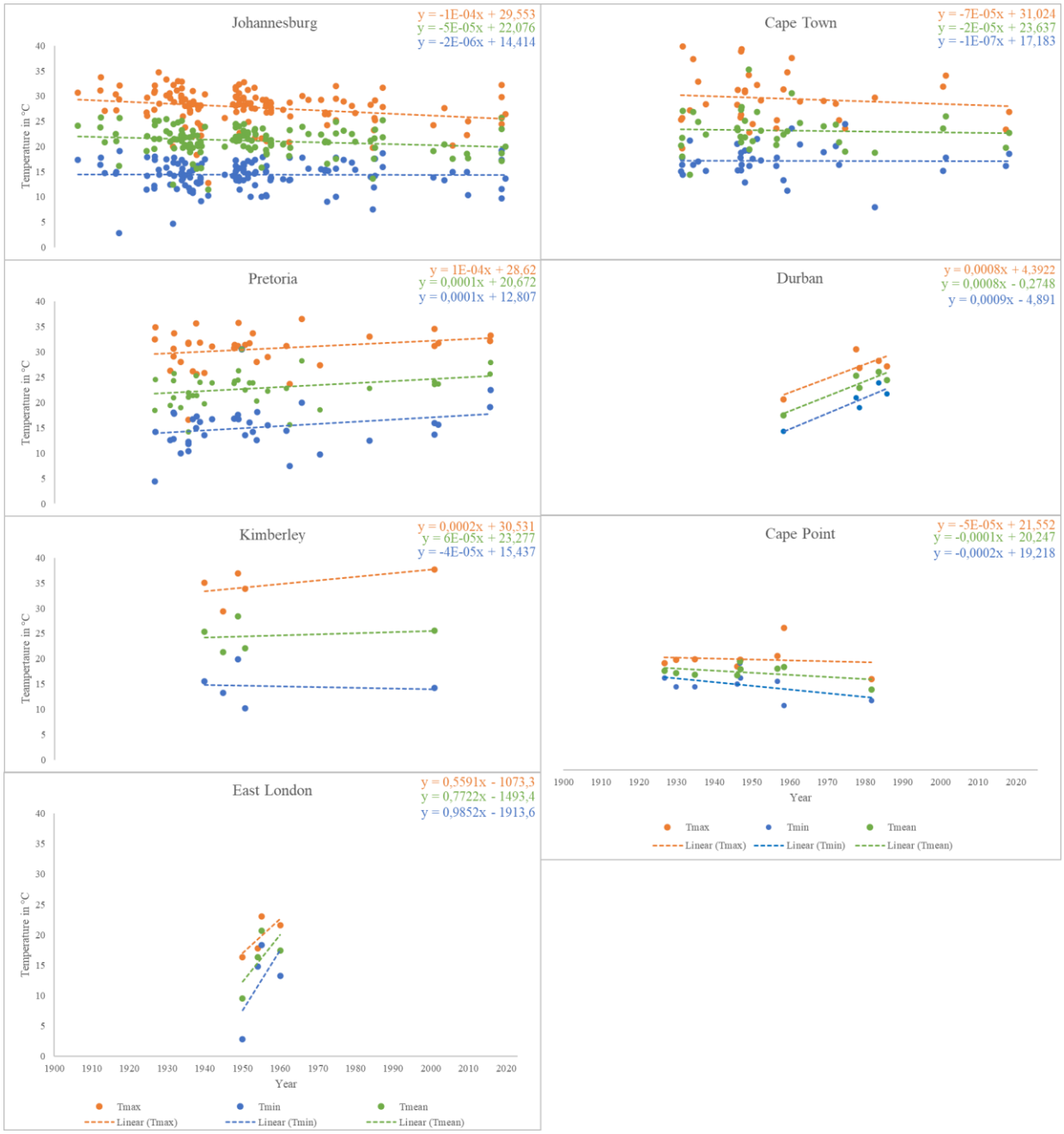


Figure 5.10: Time-trend analysis of the measured temperatures during newspaper reported heat waves.

Of these seven stations with more than two heat waves, only two demonstrate statistically significant trendlines changes in the temperatures at which newspapers reported heatwaves, Johannesburg and Durban. For Johannesburg, the T_{max} and T_{mean} at which the media reports on heat wave events both demonstrate a statistically significantly decline, at rates of -0.01°C per

decade for T_{max} and T_{mean} over the period 1900-2016 (T_{max}: r=-0.24, p=0.01; T_{mean} r=-0.17, p=0.05; Table 5.4), equating to an approximate 0.12°C change in the threshold temperature at which heat waves are reported throughout the study period. This is the more notable result of the two as Johannesburg has the largest number of datapoints (135), whereas Durban only has five. The T_{min} and T_{mean} in Durban for the dates for which heatwaves are reported in the media are both increasing at an equal rate of change of 0.1°C per decade (r=0.93, p=0.02; Table 5.4) over the period 1955-1985.

Table 5.4: Statistical analysis of the trendlines of newspaper reported heat waves.

Location	Temp	r-Value	p-Value	Rate of Change (°C/Decade)
Johannesburg	T_{max}	-0.24	0.01	-0.01
	T_{min}	-0.02	0.85	~0
	T_{mean}	-0.17	0.05	-0.01
Cape Town	T_{max}	-0.15	0.41	~0
	T_{min}	0.01	0.96	~0
	T_{mean}	-0.06	0.72	~0
Pretoria	T_{max}	0.22	0.19	~0
	T_{min}	0.21	0.22	~0
	T_{mean}	0.27	0.11	~0
Durban	T_{max}	0.83	0.08	~0
	T_{min}	0.93	0.02	+0.1
	T_{mean}	0.93	0.02	+0.1
Kimberley	T_{max}	0.53	0.35	~0
	T_{min}	-0.10	0.87	~0
	T_{mean}	0.19	0.76	~0
Cape Point	T_{max}	-0.11	0.77	~0
	T_{min}	-0.49	0.19	~0
	T_{mean}	-0.46	0.21	~0
East London	T_{max}	0.73	0.27	5.6
	T_{min}	0.61	0.39	7.7
	T_{mean}	0.68	0.32	9.9

5.7 Weather Conditions Before and After Reported Heat Waves

The third objective of this study is to explore the temperatures of the week preceding and following each newspaper-reported heat wave. While this can demonstrate the change in temperature surrounding a reported heat wave event, and in turn the degree to which the weather felt markedly different, the mean T_{max} of the weeks preceding and following a heat wave were most commonly less than 5°C lower than the actual heat waves (Figure 5.11). If this phenomenon was only present in the week before a heat wave, it could be an issue of lag-time in news reporting. However, this is also the case for the week after the heat wave (Figure 5.11). For the weeks before a heat wave event, 123 (52%; n=235) of weeks fall within 5°C below the T_{max} of the days of the heat wave, and for the weeks after a heat wave 132 (55%; n=235) of weeks were within 5°C cooler than the T_{max} of the days of the heat wave events. However, 66 and 42 (28% and 18%; n=235) of these weeks before and after respectively record temperatures between 0 and 5°C above the heat wave.

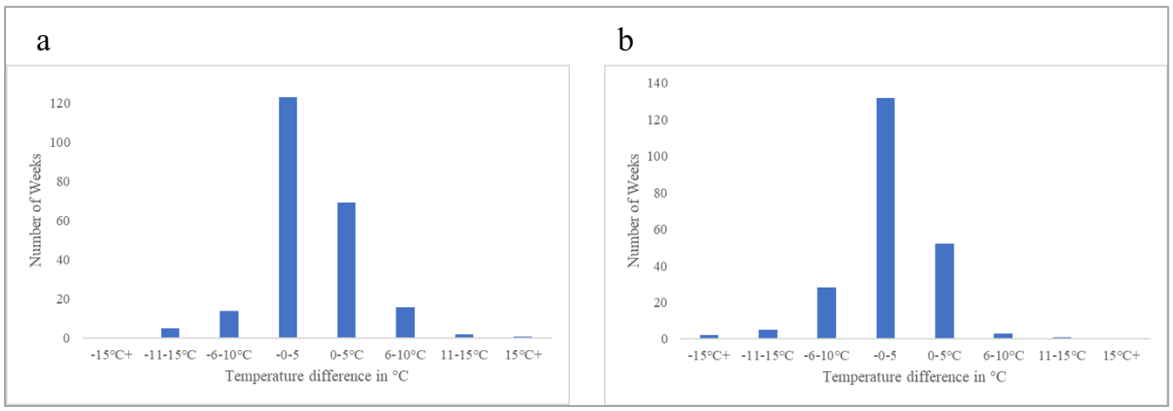


Figure 5.11: Mean T_{max} of the a) week prior to and the b) week after heat waves in the newspaper.

5.8 Mortality and Morbidity

Of the total 652 newspaper articles used in this study, three (<1%) report morbidity or illness and four (<1%) report deaths or mortality in relation to heat waves. The three morbidity reports are reported as follows: on the 19th of November 1925 three people collapsed of heat in Durban (Figure 5.12). On the 6th of January 1929, a man fell unconscious on a street in Johannesburg and finally, on the 15th of January 2001 a man was treated for heat exhaustion in Pretoria (Figure 5.12). While heat syncope (fainting) and exhaustion may be less dire than death, they are as discussed in the literature review part of a spectrum of heat stress that leads to death if untreated. This kind of reporting also gives much more information than purely meteorological data, not only on heat wave conditions but their effects on the local population and how the public spoke about heat waves at the time. This demonstrates the great value of archival newspaper reporting in understanding historical attitudes to certain events or topics.

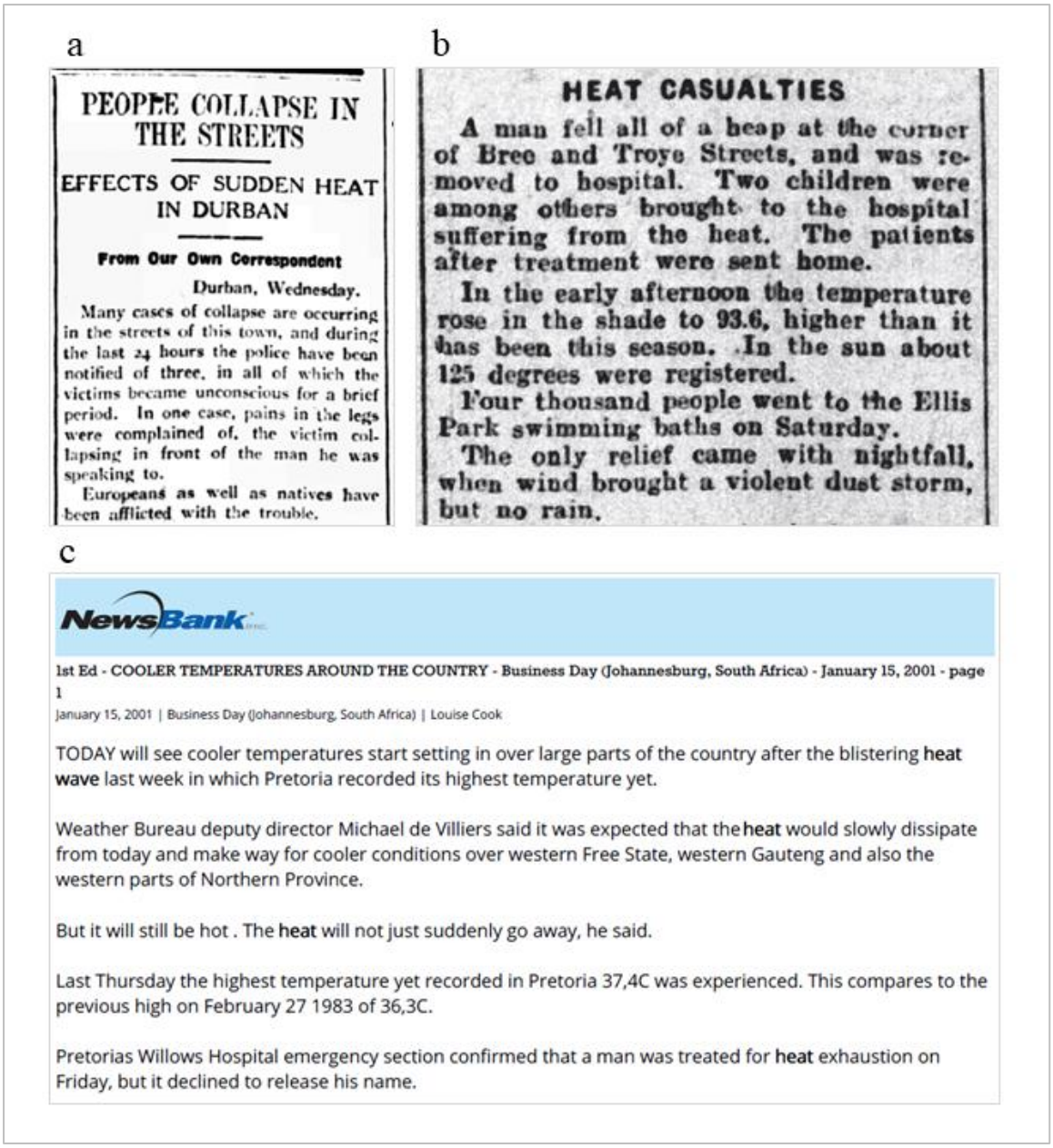


Figure 5.12: Morbidity due to heat waves from a) the 19th of November 1925, b) the 6th of January 1929 and c) the 15th of January 2001.

In terms of mortality or death from heat waves, only four cases were reported across all 652 newspaper reports. On 8 January 1947, two people, a man and woman were reported as having died on the street due to a heat wave in Port Elizabeth (Figure 5.13). On the 10th of January 1949, a man who collapsed on the sidewalk was reported to have died in Johannesburg amid reporting on a range of accidents and assaults on the same day. On the 7th of October 1954 there

is a report about three children in Alexandra township in Johannesburg dying of "apricot sickness" and children's less efficient heat-regulating mechanism (Figure 5.13). "Apricot sickness" refers to a general gastro-intestinal illness suffered by children during the summer or apricot season which is often also linked to extreme heat (DSAE, 2025). "Apricot sickness" is no longer used as a medical term and it is unclear in the reporting whether the deaths were gastro-intestinal or from the heat (Figure 5.13c). The final mortality case is the opposite of a heat wave death which occurred on the 3rd of December 1937, where a 10°C or 50°F drop in temperatures caused the death of a man. This is reported as a death of exposure to the cold but is useful in pointing to the fact that large drops or rises in temperature over short periods of time can cause adverse health effects.


a

Two Die in Union Heat Wave

TWO people died in Port Elizabeth, and a number of others collapsed during a heat wave which began to ease late yesterday afternoon after a week of high temperatures, accompanied by exceptional humidity, says a SAPA message.

The death of a coloured man who collapsed while off-loading goods from a lorry, was followed by the sudden death through heart failure of a native woman in the street. A number of cases

b

Seven Die in Rand Heat Wave, Accidents and Assaults; Many Hurt

SEVEN people died and many were injured in assaults and accidents, and because of the heat wave on the Rand during the week-end. Six members of a party of 12 were admitted to hospital suffering from food poisoning after they had attended a picnic.

The dead are: Mr. G. W. A. L. Kinnear, an 86-year-old retired accountant, of Fuller Street, Bertrams, who collapsed and died while walking in the sun; Mr. Adam Johannes Dirker, a miner, of Marievale Mine, Nigel; Gert de Beer, aged 10, of Ninth Avenue, Mayfair.

the Pretoria General Hospital were each was found to have sustained a fractured leg.

Mr. and Mrs. Fouche's two sons, who were in the car at the time, escaped injury.

One Native was stabbed to death by another in the Germis-

c

JOHANNESBURG WILTS IN SECOND DAY OF HEAT WAVE

Too Hot for the Judge

BECAUSE of the "stifling heat" in No. 3 courtroom of the Supreme Court in Johannesburg yesterday, Mr. Justice Ramsbottom, who was presiding at a murder trial, ordered a five-minute adjournment during the afternoon.

It is not usual for an afternoon adjournment to be taken while a case is proceeding.

He ordered the court to be cleared, and the doors and windows opened and the fans turned on during the five-minute break.

Meanwhile, in the gardens outside the courtrooms, the hoses were turned on for the benefit of the pigeons, which were also badly affected by the heat.

Water Consumption a Record: Children Die at Alexandra

FOR two days Johannesburg has wilted in an October heat wave, and water consumption has soared to 49,000,000 gallons a day—in previous summers the highest figure was 44,500,000.

At Alexandra there has been an early start to the annual summer epidemic of so-called "apricot sickness" among Native children, three of whom have already died. It is believed that the disease is directly connected with the heat.

The heat-regulating mechanism of some of the babies, especially the malnourished ones, did not seem able to cope with the rise in temperature, said doctors of the Alexandra Health Committee and the University Clinic.

d

HEAT WAVE CHANGES IN A DAY TO WINTRY CHILL

Native Dies, Stock Weakened

THE WEATHER

FREAK weather is being experienced in the Transvaal and Natal. Within 36 hours temperatures dropped nearly 50 degrees in some parts, and tropical warmth was suddenly replaced by the chill of winter.

In Johannesburg yesterday a bitterly cold wind swept the city. The maximum temperature registered was 18 degrees less than that on Wednesday and 36 degrees less than Tuesday's figure, when people wilted in a heat wave. Rain fell intermittently, nearly an inch being recorded since Wednesday.

One native died of exposure at Bramley. With only a ragged shirt and trousers as his protection against the cold he sought shelter under some bushes in an open space. He was found dead yesterday morning, having died in his sleep.

Figure 5.13: Mortality due to heat waves from a) the 8th of January 1847, b) the 10th of January 1949, c) the 27th of October 1954 and a death of cold after a heat wave in d) the 3rd of December 1937.

5.9 Heat Waves Classified according to the South African Weather Service Definitions

Human perception of temperature is crucial to the newspaper reported heat waves; however, this is not the only way to classify extreme heat. Purely quantitative definitions can also be useful. The SAWS definition of a heatwave currently is: “if the maximum temperature at a particular town is expected to meet or exceed 5 degrees Celsius above the average maximum temperature of ‘the hottest month’ for that particular place, as well as persisting in that mode for 3 days or more, a heat wave may be declared” (SAWS, 2024, 1). Two types of extreme heat will be explored in this section: first, SAWS definition heat waves, and second, how many days are above the SAWS threshold T_{max} without taking the three-day duration into account.

Given the SAWS definition, it is important to identify the hottest month of year for each location (SAWS, 2024). The hottest month of the year among the twelve locations studied averages between January and February with the six inland locations having January as the hottest month of the year, while the six coastal locations record February as their hottest month of the year (Table 5.5). Newcastle and Pietermaritzburg are the only of these locations not located at the ocean, and which are located below the Great Escarpment and the plateau that dominates central South Africa. All but one of the SAWS heat wave thresholds are above 30°C, with only Cape Point being below this at 27°C. Upington has the highest heat wave threshold at 40°C (Table 5.5).

Table 5.5: The T_{max} of the Hottest Month and the SAWS Heat Wave Definition for each of the 12 locations.

Location	Hottest Month	Mean T_{max} of Hottest Month	SAWS Heat Wave T_{max} Threshold (for at least 3 consecutive days)
Johannesburg	January	25.6°C	31°C
Cape Town	February	26.8°C	32°C
Pretoria	January	28.1°C	33°C
Durban	February	28.1°C	33°C
Kimberley	January	32.9°C	38°C
Cape Point	February	22.0°C	27°C
Bloemfontein	January	30.6°C	36°C
Upington	January	35.5°C	40°C
Polokwane	January	28.1°C	33°C
East London	February	25.7°C	31°C
Newcastle	February	28.4°C	33°C
Pietermaritzburg	February	28.8°C	34°C

Using this threshold and applying it to the SAWS datasets for each of the 12 locations yielded a total of 392 heat waves, over 150 more than the number of newspaper-reported heat waves that coincide with period for which meteorological data are available. While exploring the hottest month, the seasonal distribution of SAWS heat waves is also important. As the threshold is clearly defined, there are no heat waves identified in winter as temperatures in June or July are very unlikely to reach 5°C above the hottest month of the year. The monthly distribution of SAWS heat waves for all locations displays a bimodal shoulder distribution with only East London demonstrating a mid-year peak (Figure 5.14). Durban, Kimberley, Bloemfontein, Upington and Pietermaritzburg all exhibit the highest number of heat waves in January (Figure 5.14). Cape Town was the only location with the greatest number of heat waves in February (Figure 5.14). Cape Point exhibits the greatest number of heat waves in April and East London in May (Figure 5.14). In Pretoria and Polokwane, the heat waves were primarily occurring in

October with Johannesburg and Newcastle experiencing the most heat waves in November (Figure 5.14). Unlike the newspaper reported heat waves, no location experienced the majority of their calculated heat waves in December.



Figure 5.14: Monthly distribution of SAWS heat waves for all available data in each location.

5.10 Accuracy of News Reporting on Temperature

Of the 235 newspaper reported heat waves that correspond with SAWS data, only 99 (41%; n=235) state what temperature this heat wave was. Of the news reports that mention

temperature all 99 mention the highest temperature on a given day (some state T_{min} on that day, none state T_{mean} at all), therefore, only T_{max} was considered for this exploration of accuracy. Broadly, the newspaper temperatures align with what SAWS recorded for that day, with newspapers skewing slightly higher with a few high outliers. The newspapers do sometimes report where their readings came from, for example, from the thermometer in the news office or in a nearby suburban garden measured by a reporter. Additionally, some T_{max} readings are reported as temperature in the sun, whereas SAWS air temperature measurements are taken in the shade. This is potentially where the difference in readings come from. However, while the readings may not be accurate to the SAWS data, very few are extremely far off. There are no temperatures stated in heat wave reporting after 1974 (Table 5.3; Appendix B), which could point to other methods of weather reporting, for example, through the radio or television, The South African Broadcasting Corporation (SABC) cites 1976 as the first year of its widespread broadcasting which may be the reason for this change in reporting (SABC, 2025).

Ideally, the newspaper would report temperatures (T_{max} only) within the yellow area of the graph in Figure 5.15, indicating perfect accuracy with the recorded temperatures on any given day. The line in the chart is the true intercept, or a 1:1 relationship between measured SAWS temperature and newspaper reported temperature. The yellow section indicates a good alignment between both temperatures. However, at lower temperatures, particularly between 20-35°C, there is a much greater spread in newspaper reported heat wave temperatures (Figure 5.15). Around and above 35°C, the spread is generally closer but with newspaper reported temperatures higher than SAWS, but still not correct. Generally, the newspapers seem to be inflating the temperatures of heat waves, which may be a function of non-standard climate recordings for example, by measuring temperature in the sun rather than the shade as is the norm for SAWS recordings (Figure 5.15).

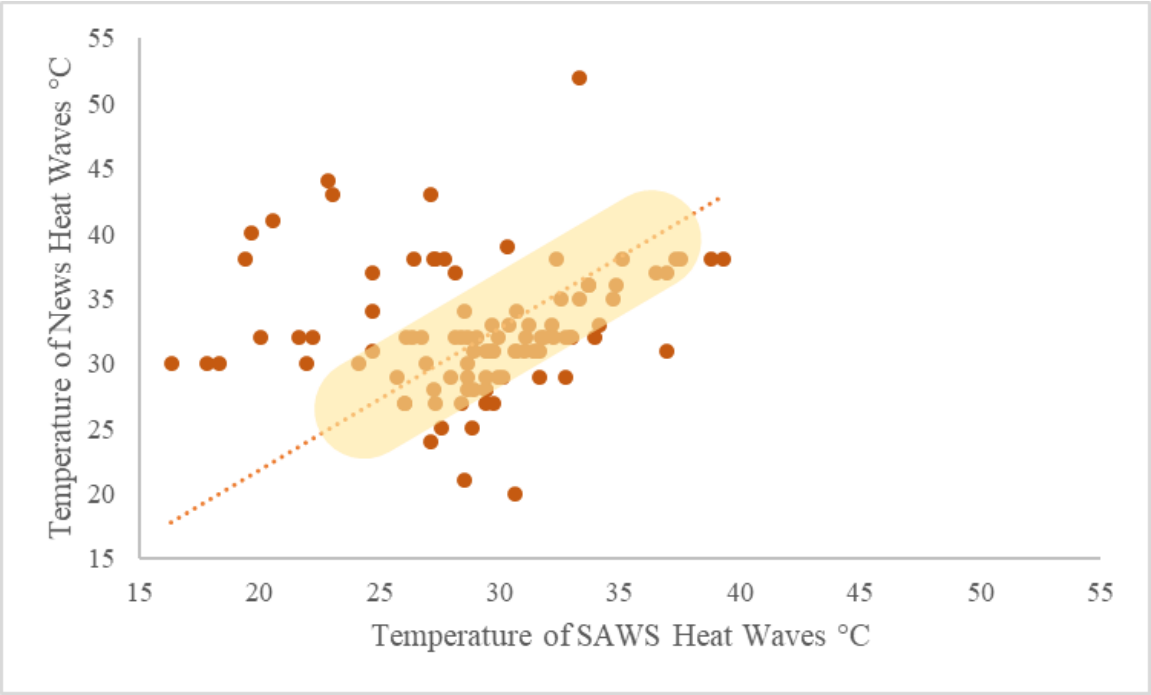


Figure 5.15: Temperature stated by the newspaper vs temperature of SAWS recordings on that day.

Of the 392 SAWS heat waves, only 18 heat waves coincide with the newspaper reported heat waves (Table 5.6). These coinciding heat waves comprise those that were reported and recorded on the same day or previous day, to allow for lag time in reporting in the news. Only three of the 12 locations had any coinciding heat waves, namely, Johannesburg, Cape Town, and Pretoria (Table 5.6). All other locations had between 0-9 heat waves and thus their lack of coinciding records may be due to a small amount of data rather than complete incongruity with the records (Table 5.6). Pretoria had the newspaper most heat waves that coincided with SAWS-defined heat waves at 19% (n=45; Table 5.6). This result is not completely unexpected as the ways in which individuals or even teams of journalists experience the weather may not align completely with raw meteorological numbers.

Table 5.6: Heat waves reported in the newspapers that coincide with SAWS heat waves.

Location	News Heat Waves	News Heat Waves coinciding with SAWS Data	SAWS Heat Waves	Overlap SAWS and Newspaper Heat Waves	Overlap %
Johannesburg	174	132	57	10	7%
Cape Town	45	37	30	1	2%
Pretoria	45	37	64	7	19%
Durban	15	5	3	0	0%
Kimberley	11	5	24	0	0%
Cape Point	9	9	24	0	0%
Bloemfontein	7	2	25	0	0%
Upington	6	0	48	0	0%
Polokwane	6	0	37	0	0%
East London	6	4	7	0	0%
Newcastle	6	0	55	0	0%
Pietermaritzburg	10	0	18	0	0%

Of the 392 heat waves identified, there was more than one heat wave for each of the 12 locations with only Durban having three heat waves and all other locations having between in East London and 64 in Pretoria. These heat waves were analysed in the same way as the newspaper heat waves, with one crucial difference: only T_{max} was used in the analysis. The heat waves were plotted on a graph through time and the T_{max} trendline was analysed for statistical significance (Figure 5.16). Broadly, the time trends do not demonstrate any clear increases or decreases in the mean T_{max} for heat waves, however, Pretoria has the most SAWS heat waves which differs from the newspaper dataset where Johannesburg reported the highest number of heat waves (Figure 5.16).

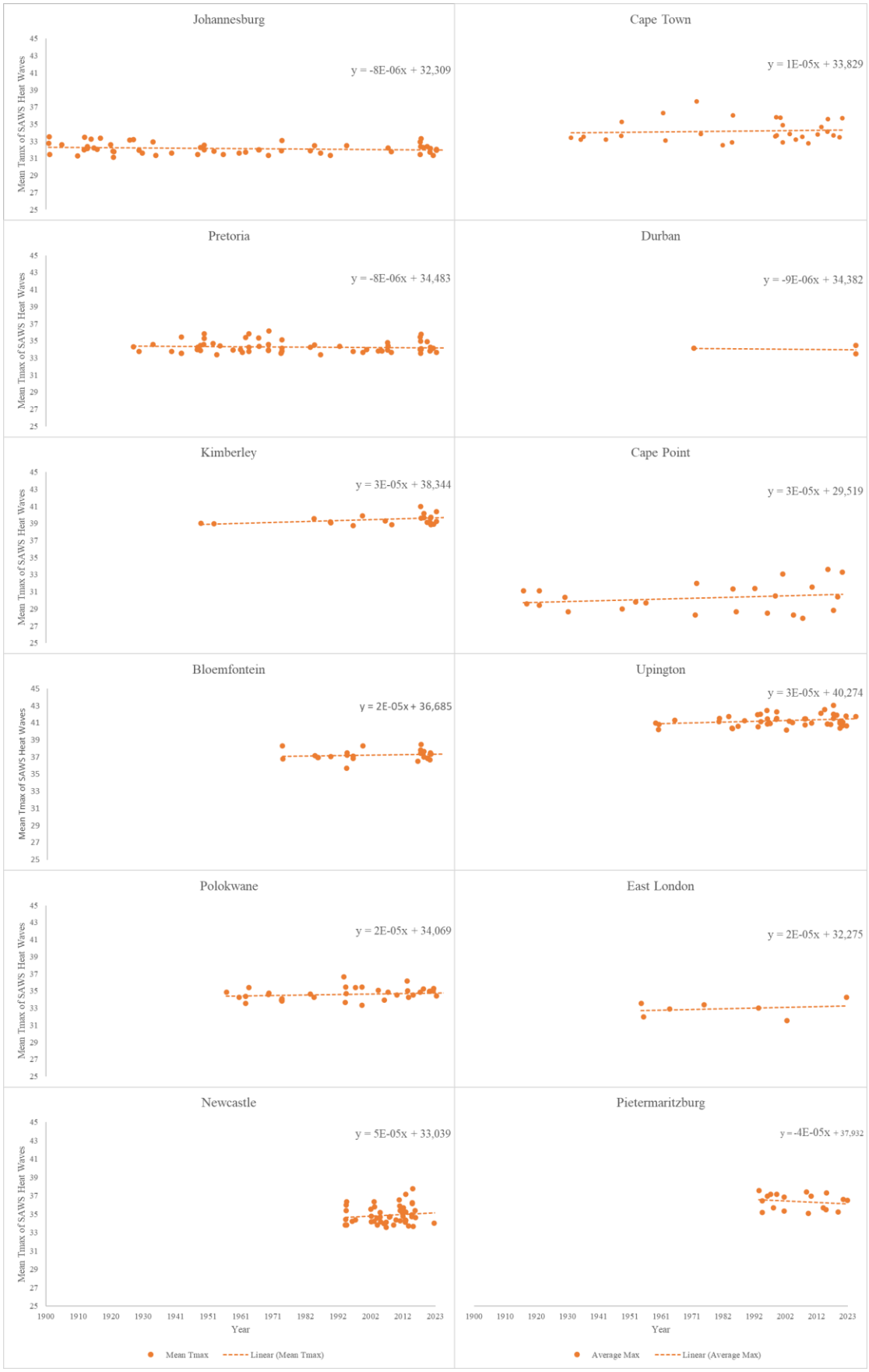


Figure 5.16: Time-trend of SAWS definition heat waves across all 12 locations.

There was no statistically significant change in T_{max} calculated for any of the SAWS-defined heat waves across any location during heat wave events over the entire study period (Figure 5.16; Table 5.7). This contrasts with the mean annual climatic change which demonstrates statistically significant increases in one or more temperature variables for all locations. Therefore, while mean annual temperatures are getting hotter, heat waves are not. While the temperature is increasing for all study locations, the mean T_{max} of heat waves has stayed relatively stable. This is potentially a simple function of using the modern SAWS heat wave threshold across the historical records, as temperatures were lower 100 years ago.

Table 5.7: Statistical analysis of SAWS heat wave trends.

Location	Variable	r-value	p-value	Rate of Change (°C/Decade)
Johannesburg	T_{max}	-0.19	0.15	~0
Cape Town	T_{max}	0.09	0.65	~0
Pretoria	T_{max}	-0.12	0.36	~0
Durban	T_{max}	-0.21	0.87	~0
Kimberley	T_{max}	0.26	0.21	~0
Cape Point	T_{max}	0.21	0.32	~0
Bloemfontein	T_{max}	0.15	0.48	~0
Upington	T_{max}	0.26	0.08	~0
Polokwane	T_{max}	0.17	0.31	~0
East London	T_{max}	0.22	0.64	~0
Newcastle	T_{max}	0.16	0.24	~0
Pietermaritzburg	T_{max}	-0.19	0.45	~0

With the variable length of SAWS datasets for each location, the annual number of heat waves was plotted to explore how SAWS heat waves fluctuate over time (Figure 5.17). The number of locations with data increase over time while the number of heat waves also increases with the highest number of heat waves occurring in the 2015 (19), 2016 (22), and 2018 (21; Figure 5.17). The increasing amount of data over time is also clearly visible in Figure 5.17, with large

increases roughly every decade from 1970 onwards. While there were many individual days above the SAWS threshold for a heat wave in each location, only clusters of three days or more were counted towards the SAWS-defined heat waves. Thus, this is not a complete overview of all the heat waves for all locations since 1900 as they do not all have the same length of data availability.

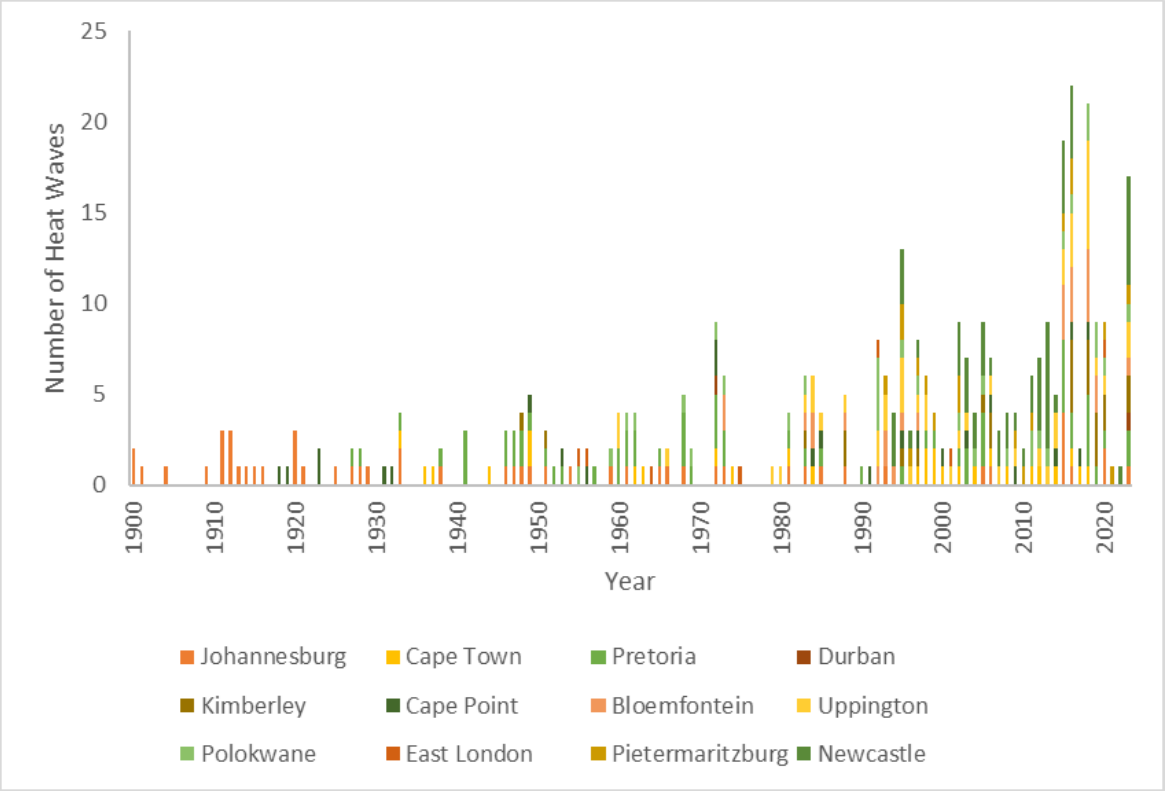


Figure 5.17: Annual distribution of SAWS definition heat waves across the study period.

5.11 Differentiating Hot Days and Heat Wave Events

Discreet heat wave events are one way to explore heat waves; however, the pattern of extreme heat can also be examined by investigating at the number of days above the heat wave threshold to explore the seasonality of extreme heat outside of officially classified heat waves. These are days with a T_{max} above the threshold given for each location in Table 5.5, however, they do not

meet the three-day duration criteria of a SAWS heat wave. These can be individual days or clusters of days where one day in the middle is just below the threshold and means that they do not all meet the three-day duration criteria and can give a different indication of the patterns of extreme heat in South Africa. These days above the threshold also broadly follow a bi-modal shoulder pattern with Durban demonstrating year-round extreme heat days and East London having peaks of hot days in May and August (Figure 5.18).

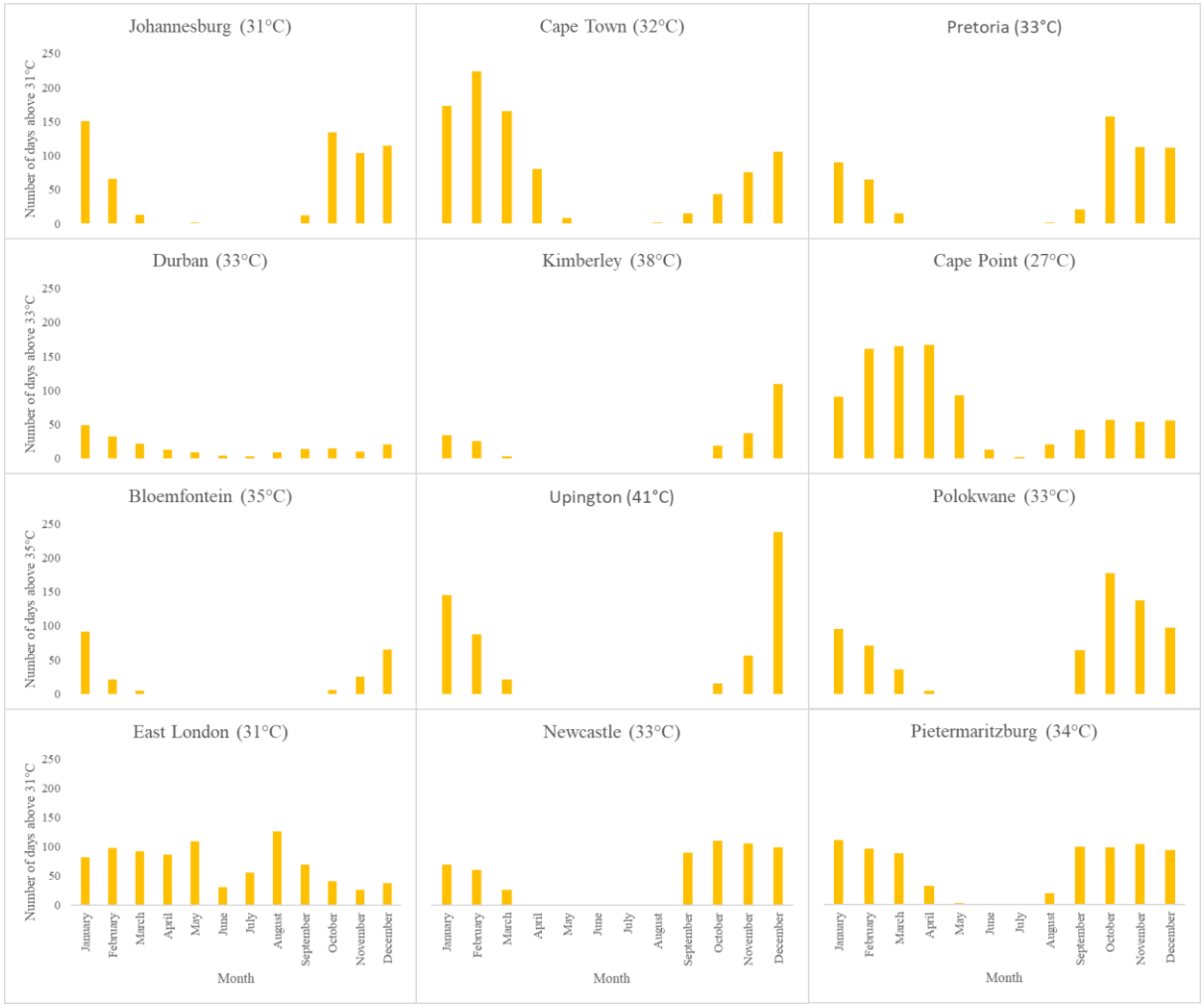


Figure 5.18: Monthly distribution of days above the SAWS threshold for all 12 locations.

While the SAWS heat waves align at most with 19% of newspaper reported heat waves, individual hot days coincide more often with newspaper heat waves. The highest coincidence

occurs in Pretoria and Cape Town at 16 heat waves (35%; n=45) that overlap with one or more days above the SAWS threshold (Table 5.8). Similarly to the SAWS heat wave table, an overlap was counted if it was the previous day to the reported heat wave to allow for lag time inn reporting. The locations recorded between 201 and 1,000 days above the SAWS threshold throughout the dataset, with Cape Town recording 1000, followed by Cape Point at 922 with Durban recording the fewest at 201 (Table 5.8). The 201 days above the threshold in Durban may be because of shorter records (Table 5.8) or because the heat wave threshold is not calibrated equally in each location.

Table 5.8: Heat waves reported in the newspapers that coincide with individual days above SAWS threshold.

Location	News Heat Waves	News Heat Waves with SAWS Data	Days above SAWS Threshold	Overlap	% of Heat Waves Overlap
Johannesburg	174	132	596	35	27%
Cape Town	45	37	1,000	16	35%
Pretoria	45	37	579	16	35%
Durban	15	5	201	1	9%
Kimberley	11	5	229	0	0%
Cape Point	9	9	922	0	0%
Bloemfontein	7	2	214	1	14%
Upington	6	0	603	0	0%
Polokwane	6	0	682	0	0%
East London	6	4	858	1	16%
Newcastle	6	0	566	0	0%
Pietermaritzburg	10	0	745	0	0%

Of the 236 heat waves reported in the media that could be explored in relation to local meteorological data, only 53 (22%) heat waves coincided with days above the SAWS heatwave threshold for their individual location. A further 58 (24%, n=236) heat waves reported in the media coincided SAWS heat wave threshold days in the week preceding the events, and 22 (9%) coincided with SAWS heatwave threshold days in the week after. These heat waves were most commonly discrete events with the heat only lasting a few days.

5.12 Synthesis

Across the study period of 112 years at maximum (Johannesburg) there has not been a nationwide shift in heat wave thresholds. Johannesburg saw a statistically significant 1.2°C decrease in reported heat waves in T_{max} and T_{mean} across the past century. Durban demonstrated a statistically significant increase in T_{min} and T_{mean}, however, with only five heat waves comprising this statistic, it may be less meaningful than the Johannesburg one. With the weeks surrounding a heat wave generally being within a 5°C difference of the actual event, the relatively low mortality and morbidity reported makes sense as large jumps in temperature (over 15°C) are more closely associated with adverse health events. Newspaper heat waves, SAWS heat waves and number of days above the SAWS threshold display similar annual distribution with summer months having the most heat waves across South Africa. In conclusion, archival newspapers contain a large amount of weather data and can be especially helpful in reconstructing heat wave events where there is no meteorological data to explore. However, where newspaper data and meteorological data do coincide, more depth can be drawn out. Both datasets are critical to this study and can demonstrate much about the changing climate of South Africa.

Chapter 6: Discussion

6.1 Introduction

As the climate in South Africa, and indeed globally, is clearly shifting to warmer temperatures (IPCC, 2022), one would expect the perceived heat wave threshold to have similarly changed significantly through time. This chapter begins with an exploration the sources of data, namely the newspaper sources, considering their accuracy and ability expose the human perception of extreme heat in the form of heat waves through time and where people access weather data. The second section examines the unchanged threshold for reporting on heatwaves that emerges from this data, followed by a discussion of heat wave thresholds and the differences between what the public think about heat waves and what experts know and write about. The third discussion point explores the reported heat waves that cause death or disease. The final part will conclude with limitations of this study.

6.2 Newspapers as a Source of Weather Data

Throughout the 20th century there is a notable increase in the amount of meteorological recording stations and their reliability across different parts of the world (Munro and Fowler, 2014). However, the coverage of such meteorological records may not span entire nations, nor is it consistent throughout the century, as evidenced by the data obtained by this study. This is where archival newspapers can be a valuable source of high-resolution climate data (Munro and Fowler, 2014; Nash et al., 2019). However, newspapers, as with any source of data have advantages and disadvantages that need to be discussed.

One of the larger disadvantages of newspaper reporting through the last century is that there is often no dedicated environmental section of the newspaper. Until recent years, when major publications have begun to hire specialist reporters for topics on climate change, much extreme weather reporting was and us still done by general journalists (Hopke, 2020). The general, daily weather forecasting section of the newspaper may be an exception to this issue, as this is one of the few reliable and consistent reports on weather by meteorologists or weather journalists. This is also one of the least controversial sections of the newspaper for most of the study period, with the current politization of climate change reporting having the potential of disrupting the accurate reporting on climate and extreme events.

In exploring newspaper reporting on heat waves, there is a chance of false negatives, whereby heat waves may have occurred somewhere in South Africa but were not reported on at all due to more pressing news items at that time. An example of this is the clear drop off in reporting on heat waves during the years of WWII, where war reporting likely took over much of the newspaper (Figure 5.7). This means it is likely that there were more than the 1,484 heat waves gathered in the data collection process for this study. There is also a potential for false positive reporting, where journalists wrote about a heat wave when there was not one occurring. This is documented to be a common occurrence in the results of this study. Of the 235 newspaper reported heat waves that were validated by weather station data, only 18 coincided with SAWS definition heat waves, meaning only 7.6% of the news reported heat waves aligned with SAWS heat waves. However, with 392 heat waves according to the SAWS classification over the same period with the same weather data, it is unlikely that there was a huge amount of overreporting on heat waves in the newspaper. This points to the potential of false newspaper reporting. A study by Mushawemhuka et al. (2021) explored false news reporting that claimed that Victoria Falls was drying up due to extreme drought. These false reports used misleading images from

one side of the falls that showed a dry waterfall, ignoring the other side still flowing, and was perpetuated by reporters from large overseas publications that had never visited the falls or spoken to people in the area (Mushawemhuka et al., 2021). False climate reporting like this can occur in any newspaper, especially where climate data and information is outsourced from newswire services such as ClimateWire which may give lend credibility to their data while the reporters have never been to the areas they are reporting on (Hopke, 2020). Newswire services such as ClimateWire are important to newspapers that have no dedicated climate reporters (Hopke, 2020).

However, classifying heat wave reports that do not align with SAWS heat waves as false reporting completely ignores the human perception or thermal comfort side of weather conditions. As explored in detail in the literature review, thermal comfort studies explore the much more subjective side of the weather (de Dear et al., 2013). Thermal comfort is also complicated by the fact that humans feel a combination of temperature, humidity, direct radiation, and wind chill (Andrade et al., 2010; Sulewska et al., 2018). Studies on thermal comfort often employ a mixed methods approach, usually combining the meteorological data with questionnaires (Andrade et al., 2010; Schlader et al., 2011; Wei et al., 2022; Xu et al., 2023). Questionnaires can be useful in understanding human perception, however, Fitchett (2025) argues that people are generally unable to quantify meteorological conditions like temperature accurately. This has implications for historical research because if people cannot accurately quantify the temperature today, they may not be able to recall any historical extreme events with useful accuracy. This is where the archival newspapers with so much written discussion around the weather, why extreme weather exists, and meteorologist's interpretation of the weather at the time can give insight into ongoing perceptions of the weather. One of the reasons that exploring human perception of heat waves is important, is that there can be period

of extreme heat in the middle of winter which were often reported in the newspapers but would not meet the SAWS heat wave threshold. The SAWS heat wave threshold is a useful classification to have, but if it discounts any heat anomalies that do not occur during the summer it gives an incomplete picture of extreme heat in South Africa. Therefore, this study does not classify newspaper reported heat waves that do not align with SAWS-defined heat waves as false reporting, but rather explores them as a measure of human perception of temperature through time. However, with the newspapers decreasing weather reporting in the last two decades of the study, and reporting mentioning ambient air temperatures dropping off around the mid-1970s (Figure 5.7), it is important to explore why this shift in reporting is occurring and where the information about the weather has gone.

In more current times, climate change is broadly understood to be an underreported topic in traditional news media (Hopke, 2020), as attribution science is complex and takes time to attribute extreme weather to climate change (Engelbrecht et al., 2025) which makes reporters hesitant to report extreme weather as being related to climate change in the days following extreme events (Hopke, 2020). There is a concern that this lag in reporting on extreme climate events as attributable to climate change may create a bigger gap in concern about climate change between the climate change scientists and the public (Kirilenko et al., 2015). Moreover, the diminishing importance of television meteorologists, who often act as local climate experts and whose trust with viewers may play a very important role in educating the public about the real effects of climate change in their communities (Bloodhart et al., 2015). This addresses a shift in how people access weather data over time.

Historically, newspapers have been a primary source of information for people, especially in South Africa where television was highly censored and only began broadcasting in 1976 (SABC, 2025). Prior to 1976 in South Africa, newspapers were a primary way of accessing information about the world with weather data being one of the most consistent types of reporting. In the meantime, television as a source of news and weather reporting began to become ubiquitous in other parts of the world such as the United Kingdom. In South Africa, this process was slightly delayed as the SABC only began broadcasting in the country in 1976 and these broadcasts were highly censored and controlled until 1993 (Bevan, 2009). The beginning of nationwide broadcasting marked a large shift in newspaper reporting on weather as many weather reports stopped reporting on the ambient air temperature after 1976 (Table 5.3). The SABC practice of censorship does not directly impact weather reporting as weather is and was not a controversial or political topic, however, it is important to the media landscape and how people were accessing weather data.

The media landscape once again began to change drastically in the 2010s for broad parts of the population, which can be seen in the distinct drop off in reporting on the weather in the newspapers in the 2010s (Figure 5.7). A study in the US found that as of 2011, most people still used the television as a primary source of weather data, but this had changed slightly by 2015 (Phan et al., 2018) with a 2023 study finding that 24% of Americans still relied primarily on television for extreme weather warnings (Vaughn et al., 2023). This is very clear in the data from this study where there we no heat waves reported in the newspapers after 2016 and much of this reporting was writing about the extreme drought and heat waves that occurred together in that year (Figure 5.7). The introduction of streaming services such as Netflix across the world in the 2010s was disrupted for cable television channels and national broadcasting corporations (Vaughn et al., 2023) as people did not need to pay for cable channels or television licences to

access entertainment. Television licences are how cable television fees are collected in South Africa. The increasing use of smartphones led to a rise in the use of weather applications and internet web pages to access meteorological data (Vaughn et al., 2023, 2024). Broadly, the shift through time appears to be from people accessing most of their weather data from one single source, first newspapers and then television, to accessing weather data from many different sources including weather applications, social media, the internet and more (Keul and Holzer, 2013; Vaughn et al 2023). In one survey, Phan et al. (2018) found that young people used a combination of their chosen cell phone-based weather application, family and friends, websites, television, and radio as sources of weather information.

The weather application has taken over as the most used source of weather data in the past decade (Phan et al., 2018; Vaughn et al., 2023). In a 600-person survey in the US, 75% of people accessed weather applications of some kind for weather information and 80% reported receiving severe weather warnings through their phone, although about 40% reported that they still double-checked severe weather warnings against television reporting (Vaughn et al., 2023). While this is not generalisable to South Africa, there is no equivalent literature locally. There is a large body of literature about access to accurate weather data through applications in South Africa in the context of smallholder farmers (Caine et al., 2015; Walker, 2021), however, this is once again not generalisable to the broader population of the country. A study by Bopape et al. (2022) examined SAWS capability of broadcasting weather warnings in light of Tropical Cyclone Idai and found that it had more than quadrupled its reach through local radio stations across South Africa between 2016-2019. This study also found that SAWS used a combination of the SAWS WeatherSmart application, social media such as Facebook and Twitter, now X, and television warnings to broadcast weather warnings to the broader population (Bopape et

al., 2022). What this demonstrates is that the broader global pattern of people accessing weather data from a wider range of sources seems to be true in South Africa too.

There is also a broad range of literature exploring the use of social media as a platform to spread heat wave warnings (Jung et al., 2017; Lambrecht et al., 2021; Olson et al., 2023; Daume, 2024). The mechanism of sharing metrological data on social media is fundamentally different than a print newspaper, where social media can spread misinformation by many users within hours (Daume, 2024). Misinformation spreading on social media is especially acute during extreme climate events and can undermine both short-term emergency response and long-term perceptions of climate change in the public (Daume, 2024). In terms of heat waves, a study by Olson et al. (2023) argues that the use of social media to issue heat wave warnings is ineffective because of four assumptions, one being that warnings lead to behavioural change, two being that at-risk populations will recognise their own vulnerability, three that heat warnings are always taken seriously and four, that caretakers have the knowledge and training to reduce heat stress. This echoes research by Lambrecht et al. (2021) that found that people who view themselves as living in hot places do not undertake any behavioural change in response to heat wave warnings via social media. This is a clear example of what heat stress researchers call psychological adaptation to heat, where people's expectations of regular high temperatures and how much control they have over their environment change their personal experience of high heat (Coccolo et al., 2016). This can be both an advantage and disadvantage, on one hand, if people expect high heat and it is hot they do not feel great discomfort, however, the effects of high heat on the body do not stop just because people expected the heat. The disadvantage is that people and communities that use living in hot places and use it as a marker of community identity do not take heat warnings seriously and thus may put themselves in danger (Lambrecht et al., 2021; Olson et al., 2023). Exploring social media is important as it addresses the fast-

moving nature of climate reporting today and the ways in which this reporting can be manipulated and misreported (Daume, 2024). However, it is also important to recognise that social media is not representative of whole populations and that rural or less literature groups may be left out of social media heat wave warnings completely (Jung et al., 2017).

In the modern age, where people access weather data from many sources, the ability to spread severe weather warnings through multiple channels does allow for the greatest reach (Bopape et al., 2022). However, accessing meteorological data from different sources can have its advantages and disadvantages (Vaughn et al., 2023). The advantage of weather applications and websites is that they can give more location specific information and can be accessed at anytime, anywhere and by anyone (Vaughn et al., 2023). Locally, the development of the SAWS WeatherSmart is aimed at making weather data more accessible via mobile phones (Bopape et al., 2022). A study by Vaughn et al. (2023) argues that there are also disadvantages to this kind of weather information access, namely the transfer or responsibility of interpreting meteorological data from weather reporters or television meteorologists to individual people. This has consequences on the way in which pure meteorological data is interpreted as previous weather reporting, both in newspapers and as television broadcasts, as these forms of reporting were interpreted and explained by the journalist or meteorologist reporting on the meteorological numbers. Weather applications present the meteorological data without interpretation, which studies (Vaughn et al., 2023, 2024) warn could lead to misinterpretation and false expectations as each individual person is expected to interpret the data for themselves.

This shift in weather data access over the study period is important. Perhaps to understand heat waves in the current time of weather applications, these should be included in future research,

although this would present challenges as they do not adhere to the same kind of reporting and interpretation that makes newspaper or even television reports on the weather such rich qualitative resources for historical research. The primary effect of this shift away accessing weather data through one source such as newspapers is that people are all individually interpreting weather data and thus the broader view of climatic changes over time get lost (Vaughn et al., 2023). A global study on English-language news publications also found a bias in reporting, where storms and flooding received a bulk of news reporting on weather, while wildfires and heat waves were reported on less (Brimicombe, 2022). This study argues that this has severe implications for which hazards are addressed by policy makers or even advocated for by the general population (Brimicombe, 2022).

6.3 Has the Heat Wave Threshold Shifted?

The primary question of this study is whether the threshold for a heat wave has shifted in South Africa over the last century and if so, in which direction and what the implications of this could be. In broad terms, the threshold has changed, because the general climate in South Africa is changing and the 30-year climate normals used to calculate the SAWS heat wave threshold have changed due to the 1.1°C of global warming that has occurred since the first industrial revolution (IPCC, 2022). Additionally, there has been a statistically significant shift in the annual temperature means across the whole country at least one temperature variable, either T_{max}, T_{min} or T_{mean}, for each location in this study (Table 5.2). This means that the SAWS heat wave threshold would have been lower in the beginning of the last century than they are now. However, the SAWS threshold as it is used now did not exist at that time and heat wave threshold were not recorded and kept record of in the same way they are today via the internet (SAWS, 2024).

Broadly, the heat waves reported in the newspapers did not demonstrate a shift in threshold (Figure 5.10; Table 5.4). There is no statistically significant change in the threshold from the stormy Cape Point to hot and landlocked Upington and Kimberley to more subtropical and humid Polokwane. There are two locations that did have statistically significant changes over the study period though, Johannesburg, with a decrease in the threshold and Durban with an increase (Figure 5.10; Table 5.4). The results of this study found that newspaper reported heat wave thresholds for the T_{max} and T_{min} in Johannesburg demonstrated a statistically significant decrease over the study period (Figure 5.10; Table 5.4). This lowered threshold indicates an increase in sensitivity to heat waves in Johannesburg. Newspaper reported heat waves in Durban demonstrated the opposite effect, where a statistically significant increase for T_{min} and T_{mean} was found (Figure 5.10; Table 5.4), indicating some kind of acclimatisation or desensitisation to extreme heat. It is not possible to make generalisations from the data at these two locations as the trends oppose each other and are not seen in any other locations, however, they must be explored.

In the case of Johannesburg, increasing sensitivity may be an urban phenomenon of Johannesburg being the most populous city in South Africa (SatsSA, 2024), resulting in both direct heat emission from people, and perceived heat in crowded spaces (Jia et al., 2021). However, its proximity and merging with the greater Johannesburg-Pretoria metropolitan areas, where Pretoria does not have the same trends may negate this idea (Figure 5.10). Durban is also a large metropolitan area also does not display the same trend; in fact, it demonstrates the opposite (Figure 5.10). Indeed, most of the largest cities in South Africa are included as locations in this study and none demonstrate the same trend as Johannesburg.

Durban, while also a large urban settlement, is often perceived to be hotter due to its proximity to the Indian Ocean and warm Agulhas Current and higher humidity levels than western parts of the country (Landman et al., 2017). A 2021 study in the US found that in cities such as Phoenix, Arizona, which are commonly known to be hot, the citizens pride themselves in being able to handle extreme heat and do not take heat wave warnings seriously (Lambrecht et al., 2021). This may be at play in Durban, however, cities such as Upington with the highest heat wave threshold in this study demonstrated no similar effect, despite it being known to be one of the warmer cities in the country.

The hypothesis of this study was that there would be some kind of shift, either towards increased sensitivity or to clear adaptation. The hypothesis was that either: people in the newspapers would be universally reporting heat waves at higher and higher temperatures through time, because against the changing SAWS 30-year climate normals, heat waves are, by SAWS own definition, hotter than they were at the beginning of the last century. This would mean that people have adapted so well to the slowly increasing temperatures that only the more extreme heat waves would be written about. Or alternatively, that people would become much more sensitive to heat waves as a result of living more insulated from the outside temperature. This could be a result of more office and knowledge work, particularly in urban centres, less outdoor work during peak hours of heat and potentially with a growing middle class, people living in more well-insulated houses. This is not broadly true of the entire population of South Africa, however, there is potentially a bias in newspaper reporting to favour the experiences of people in knowledge work jobs and living in cities. However, neither of these seems to be consistently true across all the locations of this study and thus does not explain the lack of change in the threshold.

Despite the clear overall climate change trends, no such change occurred in newspaper reported heat waves. This may relate to the majority of the heat wave reporting occurring earlier in the study period, with the clear reduction in reporting after the introduction of television in 1976 and then the internet in the 2010s (Figure 5.7). There are not as many reports on heat waves in the last 20 years of the study, which may skew these results somewhat. Despite this, an unchanged threshold can be interpreted as a marker of increased sensitivity to extreme heat because of the very clear climatic change happening in South Africa (Table 5.2). The unchanged threshold, contrasted with the increasing mean annual temperatures will result in more days above that threshold. If the reported threshold for heat waves is not shifting with climatic changes, the window of vulnerability gets bigger. This same issue does not persist in the SAWS heat waves because the climate normal calculation will shift the threshold to be higher as more climatic change occurs. Therefore, this is phenomenon of perceived heat waves only.

The implications of a bigger window of vulnerability for heat waves in South Africa are increasing health risks. Drawing on the literature review of this study, the most vulnerable populations to heat illness are children under 18, people over 60, chronically ill people, and people with low cardiovascular health as they have a narrower tolerance range for extreme temperatures (Havenith et al., 1995; Kenny and Flouris, 2014; Manyuchi et al., 2022; Li et al., 2022). Broadly, South Africa has a high chronic disease burden, however, this is often overshadowed by communicable disease research because of the prevalence of HIV and tuberculosis in South Africa (Mayosi et al., 2009). However, as of 2009, there were already warnings about an increasing burden of disease from non-communicable diseases in South Africa such as diabetes, kidney disease, and various cancers (Mayosi et al., 2009). These patterns were being found especially among poor urban populations living in townships in

South African cities (Mayosi et al., 2009). Moreover, lifestyle illnesses such as diabetes have been linked to urban populations and South Africa is rapidly urbanising (Pheiffer et al., 2021). Between 2000 and 2009 the prevalence of diabetes in South Africa rose from 5% to 9%, almost doubling, and this trend is predicted to have continued (Pheiffer et al., 2021). Hypertension or high blood pressure is also commonly referred to as a lifestyle disease. As of 2022, at least 8.2 million South Africans using the public healthcare system suffer from hypertension or high blood pressure, making this a large burden of disease for a country of just over 60 million people, approximately 12% (Kohli-Lynch et al., 2022). Hypertension can lead to heart disease, stroke and other cardiovascular issues that can be greatly exacerbated by extreme heat (Kohli-Lynch et al., 2022). A review by Charumbira et al. (2022) found that there were a notable number of studies done in South Africa on HIV, tuberculosis, stroke, diabetes, which reflected their disease burden in the nation. Above and beyond the chronic disease burden in South Africa, the population is also rapidly urbanising, with up to 69% of the population living in urban areas as of 2024 (World Bank, 2025). In addition to the increase of lifestyle diseases, urban populations are more vulnerable to extreme heat because of the increased temperatures in cities due to the UHI effect (Xu et al., 2016; Diniz et al., 2020). With most of the South African population living in urban areas and the disease burden of chronic illnesses increasing over time, in addition to rising temperatures, there could be serious health implications for the people of South Africa (Kenny and Flouris, 2014). The fact that the reported heat wave threshold has not shifted in parallel to increasing temperatures across the country may in fact point to a slight increase in sensitivity to heat waves across South Africa and may result in more days above what the general public define as a heat wave.

This leads to the final part of this section, which is questioning the gap between experts and the public perception of heat waves and who may be responsible for bridging this gap. Partially,

the gap is probably a result of the contentious nature of heat wave definitions in different parts of the world and by different organisations such as the WMO or more locally, SAWS (Robinson, 2001). The fact that these definitions are not universal and change depending on where a person is at any given time may make be too complex for a non-specialist to calculate the heat wave threshold. Moreover, Chowhury et al. (2012) argue that the public has a much more experiential knowledge of weather and climate change, which means that simply communicating the risks of extreme weather such as heat waves may not result in any adaptions by the public until more extreme heat waves have been experienced.

As discussed in Section 2.2 of the literature review, one of the bigger disagreements in heat wave literature is the definition of a heat wave. This is also the reason that it is difficult to compare different kinds of heat wave research across sectors as there are often sector-specific definitions (Perkins and Alexander, 2012; Smith et al., 2013). A review by Smith et al. (2013) argues that the range if definitions for what constitutes a heat wave is partly because there are many different stakeholders affected by extreme heat, each in their own way, from healthcare workers to agricultural workers, farmers planning crop planting, urban planners, all the way to public health systems. This may mean that there is no way to create a single, universal definition of what a heat wave is that applies to all stakeholders. However, it is still crucial to discuss the merits of different ways in which to classify heat waves.

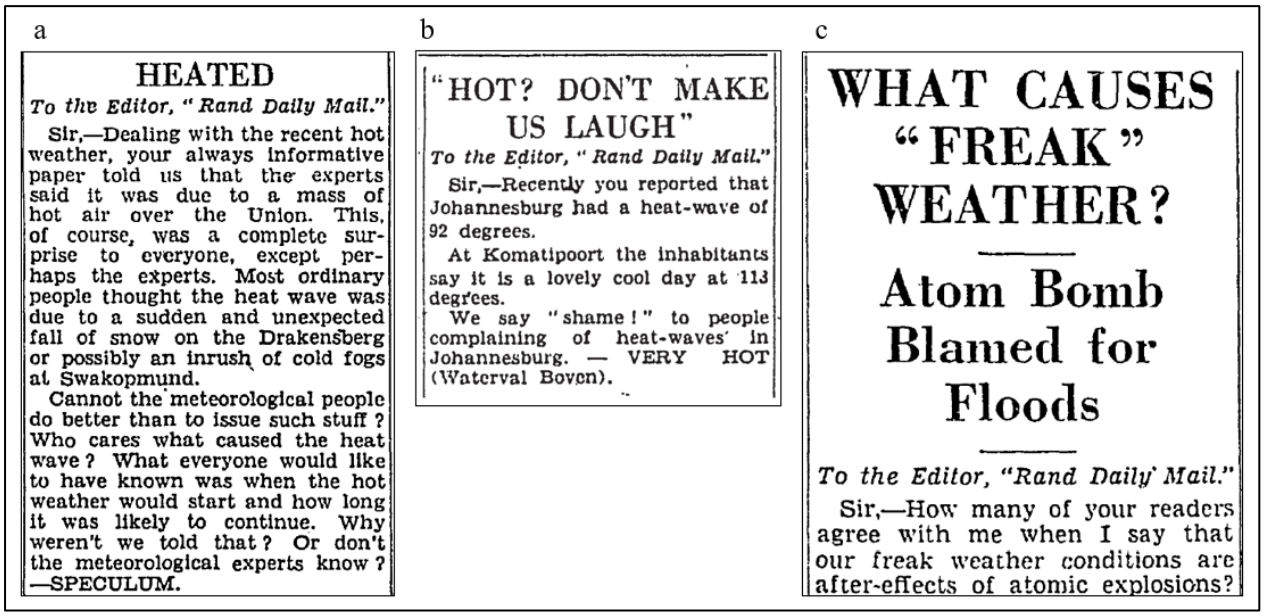
Broadly, heat wave definitions fall into two categories: absolute and relative thresholds (Perkins and Alexander, 2012; Smith et al., 2013). Absolute thresholds for heat waves are usually classified as a given period of time, such as 48 hours, three days, five days above a specific threshold temperature, usually T_{max} or T_{min} (Perkins and Alexander, 2012). The SAWS

definition used in this study uses an absolute threshold, for example, where a heat wave in Johannesburg would be three or more days of T_{max} above 31°C (SAWS, 2024). Relative thresholds are also called "deviations from normal" by Robinson (2001, 764). Relative thresholds are commonly classified by temperatures exceeding a percentile threshold, common ones include 90th percentile, 95th percentile or 99th percentile, or a certain number of standard deviations above the 30-year climate normal for a given location (Robinson, 2001; Smith et al., 2013). WMO and ETCCDI definitions are relative and most commonly use percentiles (Perkins and Alexander, 2012).

What using two data sources has demonstrated through this study is that neither a single definition nor a single source allows for a full picture of extreme heat. By using only the SAWS heat wave definition, no heat waves were identified during the winter months. However, the newspapers reported heat waves in winter, usually reported by a recording how many degrees of temperature change had occurred in a relatively short amount of time. This may point to a need to have more seasonal heat wave definitions that allow climatologists to explore unusual heat for a given season. Perhaps a standardised relative definition should also be applied in the case of South Africa where, for example, a jump of 15°C in a 24-hour period can be part of definition of a heat wave.

The qualitative nature of archival newspaper reporting as a source of historical data allows for the collection of high-resolution data both on the weather and how people spoke and thought about it (Munro and Fowler, 2014). For example, letters to the editor appeared in the Readex search on several occasions and provided insight into what people were thinking about the weather at the time. This includes an angry letter telling meteorologists that regular citizens of

South Africa do not care why the heat waves are happening, they just want forecasts to warn them (Figure 6.1a). In another example, a resident of Komatipoort making fun of the fact that a heat wave was reported in Johannesburg at 92°F (33°C), a temperature above the SAWS threshold for the area, when in Komatipoort they consider it a nice day at 113°F (45°C; Figure 6.1b). This addresses physiological acclimatisation and regional differences in climate that climatologists may know about, but the public may not have knowledge of (Coccolo et al., 2016). Another letter to the editor blames the atomic bomb for "Freak Weather" (Figure 6.1c).



a

HEATED

To the Editor, "Rand Daily Mail."

Sir,—Dealing with the recent hot weather, your always informative paper told us that the experts said it was due to a mass of hot air over the Union. This, of course, was a complete surprise to everyone, except perhaps the experts. Most ordinary people thought the heat wave was due to a sudden and unexpected fall of snow on the Drakensberg or possibly an inrush of cold fogs at Swakopmund.

Cannot the meteorological people do better than to issue such stuff? Who cares what caused the heat wave? What everyone would like to have known was when the hot weather would start and how long it was likely to continue. Why weren't we told that? Or don't the meteorological experts know? —SPECULUM.

b

"HOT? DON'T MAKE US LAUGH"

To the Editor, "Rand Daily Mail."

Sir,—Recently you reported that Johannesburg had a heat-wave of 92 degrees.

At Komatipoort the inhabitants say it is a lovely cool day at 113 degrees.

We say "shame!" to people complaining of heat-waves in Johannesburg. — VERY HOT (Waterval Boven).

c

WHAT CAUSES "FREAK" WEATHER?

Atom Bomb Blamed for Floods

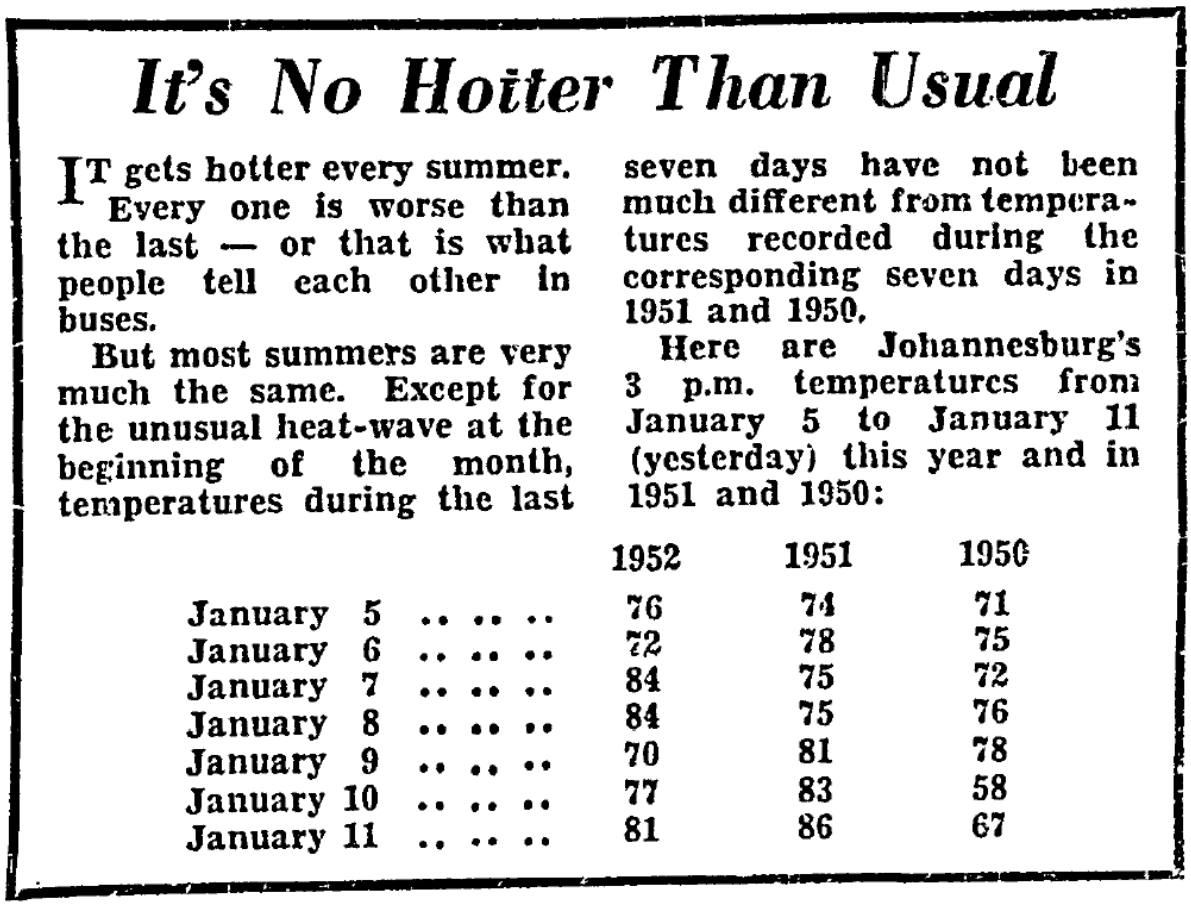
To the Editor, "Rand Daily Mail."

Sir,—How many of your readers agree with me when I say that our freak weather conditions are after-effects of atomic explosions?

Figure 6.1: Letters to the Editor from a) the 20th of January 1949, b) the 20th of December 1949 and, c) from the 2nd of November 1952.

In the newspaper reporting there was one acknowledgement by a weather reporter in 1952 that the public tend to speak about the current weather being the hottest they have felt, regardless of what the meteorological records indicate (Figure 6.2). This report includes the daily temperature at 3pm for six days in January in 1952, 1951 and 1950 to demonstrate that current temperatures are no higher than normal (Figure 6.2). This may be an example of the

psychological effect called immediacy bias, where people perceive current feelings as more intense than those that have occurred in the past (Van Boven et al., 2009). While climate change is a real cause for increasing temperatures, these changes are measured in aggregate across decades and not from year to year, especially not in the 1950s. What this news report demonstrates is that the newspaper weather reporters were aware of public sentiment at the time and as slightly more expert in interpreting climate data, were writing to inform the public and increase their awareness (Figure 6.2).



It's No Hotter Than Usual

IT gets hotter every summer. Every one is worse than the last — or that is what people tell each other in buses.

But most summers are very much the same. Except for the unusual heat-wave at the beginning of the month, temperatures during the last seven days have not been much different from temperatures recorded during the corresponding seven days in 1951 and 1950.

Here are Johannesburg's 3 p.m. temperatures from January 5 to January 11 (yesterday) this year and in 1951 and 1950:

	1952	1951	1950
January 5	76	74	71
January 6	72	78	75
January 7	84	75	72
January 8	84	75	76
January 9	70	81	78
January 10	77	83	58
January 11	81	86	67

Figure 6.2: Reporting from the 12th of January 1952.

Overall, the debates around the definition of a heat wave are productive, but it is not possible to create a single universal definition that will apply to all cases. This is in part the reason for

the use of both the SAWS heat wave definition and the more nebulous newspaper reported definitions of heat waves.

6.4 Heat Waves that Cause Illness and Death

Of the three morbidity cases found reported in the newspapers (Figure 5.12), only one followed two days above the heat wave threshold of 31°C in Johannesburg on 6 January 1929. The other case of collapsing from heat in Durban on 19 November 1925 did not coincide with SAWS data and the final case in Pretoria on 15 Jan 2001 did not coincide with days of extreme heat according to SAWS at all, nor was there a particularly large jump in temperatures in the previous five to seven days. The cases of mortality (Figure 5.13) also only have one notable overlap between a SAWS heat wave of three days, the death of Mr. G.W.A.L. Kinnear who collapsed and died after walking in the sun in Johannesburg on 8 Jan 1949. The other mortality cases either have no weather data such as in the case of a heat wave death in Port Elizabeth on 8 January 1947 or have no notably hot days surrounding the incident in the case of a heat wave death in Johannesburg on 7 October 1954.

This lack of overlap between SAWS definition days of extreme heat and deaths is not surprising. It is likely that many of the health effects of heat waves were under-reported as the only cases actively attributed to heat waves by newspaper reporters were direct collapses of heat in public. However, as explored in the literature review on the physiological effects of heat, extreme heat exposure can manifest in different ways from extreme dehydration, cardiovascular symptoms, or the intensifying of symptoms of illnesses such as diabetes or TB (Perkins, 2015). This means that there could very well be more morbidity or mortality cases

due to heat waves that were not reported in the newspapers as they manifested in hospital cases of heart attacks, dehydration, or worsening chronic illness and thus would be reported as such by doctors and hospitals. Attributing deaths to heat waves is a complex process and is most researched today through attribution models (Mitchell et al., 2016) which would not have been available to newspaper reporters. Additionally, unless family members of people who died of heat stroke approached the newspapers themselves, there would be very few avenues for reporters to accurately report on this. There are examples of people buying personal advertisements in the newspapers to notify friends and family that they were ill or that a family member had died for reporting on influenza that used very similar methods (Holtz and Fitchett, 2024).

Through the reading of the newspaper data in this study, a clear pattern was observed whereby mortality and morbidity were only reported on in newspapers only if a person collapsed of heat in public in South Africa. This is contrasted to heat wave deaths in other parts of the world which were also often reported on and less conservative numbers of heat wave deaths are given such as 40 deaths or an “epidemic of suicide and crime” being reported (Figure 6.3b). This is potentially due to a difference in reporting standards across continents, although all the examples in Figure 6.3 below were reported by Reuters, an international news coverage provider. This could also be amplified by the fact that for much of the study period travel to other continents was limited to the very wealthy and thus inaccurate reporting from abroad could not be easily verified or critiqued in the ways in which the internet and social media allow for today. Additionally, heat waves have gained more public attention over time and an aging global population with a higher chronic disease burden in the later part of the study period are more vulnerable to extreme heat (Sheridan and Allen, 2018). The 2003 European heat wave that is estimated to have caused 32,000 excess deaths and affected crops, forest fires and a big

loss of European glacial mass has been cited as one of the warning signs of the devastating effect increasing heat will have on people and the planet (Amengual et al., 2014; Pinkerton and Rom, 2014). This means that while there was relatively little reporting on heat waves in the last two decades of the study period, heat waves were becoming more deeply researched and understood across the world in light of global climate change.

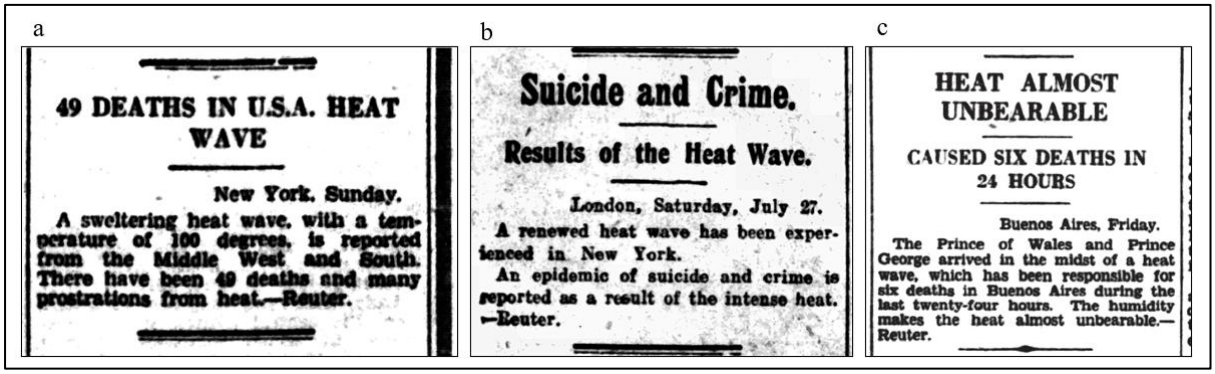


Figure 6.3: Examples of newspaper reporting on deaths in other countries: a and b) USA on the 28th of June 1909, and c) Argentina on the 7th of March 1931.

The less extreme effects of heat illness can still have negative effects on human health, but if treated correctly, long-term effects can be avoided (Gifford et al., 2019). One of the simplest ways to combat heat stress is behavioural adaptation, which includes resting in the hottest parts of the day, opening windows or removing clothing and drinking more water (Castellani and Young, 2016; Coccolo et al., 2016; Gifford et al., 2019; Yezli et al., 2023). These are the kinds of adaptations that are targeted by heat health warnings to reduce the risk of heat stress (Olson et al., 2023). Clothing and fashion reporting was included as heat wave reporting on seven occasions (Figure 5.2). All seven reports were published before 1960 and spoke to scandal around how people were choosing to dress during heat waves (Figure 6.4). In one report, police constables were called to confront a young woman and her parents for wearing a short dress (Figure 6.4a) and in another, young women, referred to as ‘girls,’ formed a new society in East

London to wear shorts together (Figure 6.4c). There were similar reports about men's dress where in one report university hostels suspended formal dress rules for mealtimes (Figure 6.4b), a scandal column about business men in Johannesburg who "even took their coats off," (Figure 6.4d), postmen being allowed to discard ties (Figure 6.4e) and boys in a government school being forced to keep their jackets on at school despite the heat wave (Figure 6.4f). These are fascinating reports that clearly demonstrate the cultural narrative around clothing, fashion, and propriety. While this may seem absurd to modern eyes in a post-pandemic world where people wore sweatpants to remote jobs, the richness of documentary sources such as archival newspapers is demonstrated well here. Furthermore, these behavioural adaptations undertaken in the reports are exactly what is recommended to people today to alleviate heat stress (Coccolo et al., 2016). These reports on what people were and were not wearing do not continue for the entirety of the study period and may indicate that socially, modern people may be better positioned to make behavioural clothing changes during heat waves without fear of being reported to the police or written about in the national newspaper.



Figure 6.4: Examples of fashion reporting from a) the 21st of November 1925, b) the 28th of October 1931, c) the 20th of November 1931, d) 10th of December 1940, e) 10th of December 1946 and f) the 29th of October 1954.

This section explores how the meteorological data from used in this study supports or deviates from the official SAWS heat wave threshold. Broadly, the SAWS heat wave threshold supplied by the map on the SAWS weather portal, and in the study site chapter (Figure 3.2), aligns with the calculations made by this study (Table 6.1). All the locations except Cape Point are within 1°C of the SAWS supplied threshold. There should be no reason for these deviations as the data for this study was provided by SAWS, other than potentially using different weather stations within different cities, for example, using the Irene weather station rather than the Pretoria Proefplaas station as representative of Pretoria. However, despite using the same periods of 1961-1990 to calculate the 30-year climate normal and supposedly, the same data, some of these thresholds were either one degree warmer or cooler than those proposed by SAWS. Additionally, the SAWS map is of a coarse resolution, with thresholds only given for larger urban areas or cities (Figure 3.2; SAWS, 2024). This only allows an indication of the heat wave

threshold across more rural parts of South Africa and thus may not be universally useful in educating the public about what classifies a heat wave in their local area.

Table 6.1: SAWS heat wave threshold calculated by this study and by SAWS.

Location	**SAWS Heat Wave T_{max} Threshold**	**SAWS Heat Wave Map Threshold**
Johannesburg	31°C	32°C
Cape Town	32°C	32°C
Pretoria	33°C	34°C
Durban	33°C	34°C
Kimberley	38°C	37°C
Cape Point	27°C	-
Bloemfontein	36°C	35°C
Upington	40°C	41°C
Polokwane	33°C	33°C
East London	31°C	31°C
Newcastle	33°C	33°C
Pietermaritzburg	34°C	34°C

Newspaper reporting on heat waves was consistent and largely stayed within the scope of weather reporting throughout this study (Figure 5.2). However, one funny and unexpected type of reporting was a string of reports between 1911-1914 in which a racehorse named Heat Wave was recorded in many sports and betting reports in the Rand Daily Mail (Figure 6.5). There were a few other reports screened out, such as a house and home section writing about recipes to make during a heat wave, however, the racehorse was the most memorable.

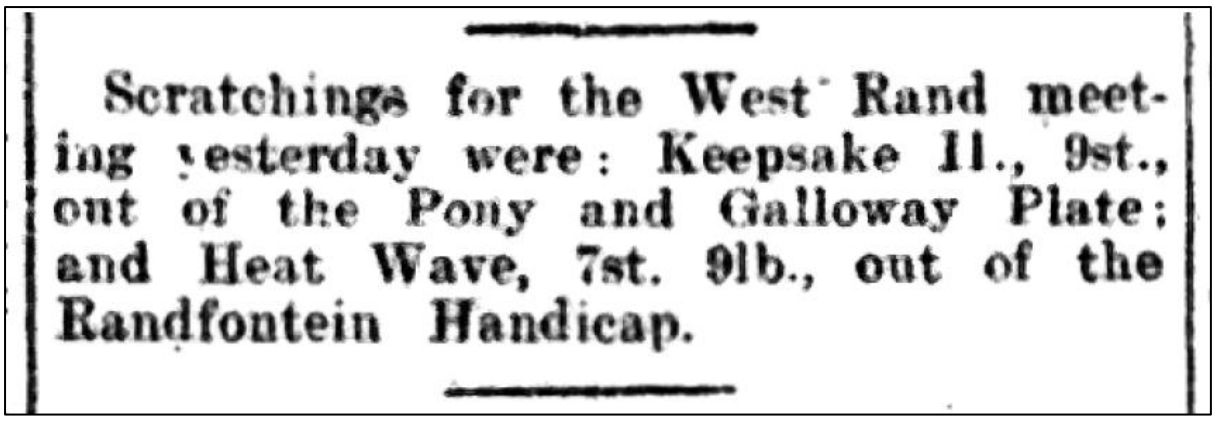

Scratchings for the West Rand meeting yesterday were: Keepsake 11., 9st., out of the Pony and Galloway Plate; and Heat Wave, 7st. 9lb., out of the Randfontein Handicap.

Figure 6.5: Heat Wave the horse from the 17th of October 1913.

6.5 Limitations

The limitations of this study come in two types based on the two sets of data that were used. For the newspaper data, the largest limitation if the gap in archiving of the Business Day between 1985-1995. The newspaper was published daily over this period, but Readex has not yet made the full record available. Broadly, this does affect the reporting, however, with over 120 years of data for this is a small gap. There are also limitations on both newspapers and their nationwide reach. While both the Rand Daily Mail and the Business Day were national newspapers and reported on national issues, they were both headquartered in Johannesburg with many of their journalists residing there. This is clear in the reporting as the largest proportion of heat waves were reported in the city of Johannesburg, with Pretoria having the second most and many of the other locations being large metropolitan areas, therefore, leading to the potential for underreported heat waves in more rural areas. Both newspapers are also English language newspapers which may affect the reporting by skewing it towards larger cities or metropolitan areas that use English more than other languages. However, it is not possible to completely mitigate these kinds of limitations without increasing the scope of this project to cover newspapers in multiple languages including small local newspapers covering the whole

country. The best way to ensure more broad and countrywide reporting may in fact be to rely on widely read national newspapers like the Rand Daily Mail.

There could have been heat waves that were not reported on in the newspapers, creating a different kind of gap in reporting. There is a high probability of lack of reporting on less extreme or more rural heat waves, meaning that some heat waves were potentially missed by journalists. However, there is a low probability of false reporting as weather reporting is some of the most common and least controversial reporting in the newspaper. Moreover, as heat wave reporting seems to rest on human perception more than SAWS definitions, it is impossible to discount reporting as false as human perception is unique to each individual person. These limitations were considered in the conceptualisation of this study which is why the SAWS data was added to validate the news reporting. These gaps do no invalidate news reporting on extreme weather events, however, with another source of data they can be compared and discussed in more detail.

There are also limiting gaps in the weather station data. SAWS has only existed as a government entity since 1912; however, weather data had been collected in certain locations from before that time. Additionally, while weather recordings have been made at the Cape Town Observatory since 1841 (Vogel, 1989; Ndebele et al., 2019, 2022), SAWS was only able to provide records from as far back as 1933 for this study. The reason was never really clarified, despite repeated communications on the matter. This may point to the accessibility of relevant data in developing nations rather than a lack of data completely.

Other limitations of the weather station records are that there are no recorded temperatures for some days or weeks of each year. In fact, some locations are missing data from over 22% of days in the record period (Table 5.1). This could be an infrastructural issue, for example, by interrupted power supply to a remote weather station or office. There are also larger gaps of whole months or years where there are records either missing or never recorded. For this study, this meant that in some locations, two weather station's worth of data were combined to create the longest record possible. Pretoria is the primary example of this where two weather stations were combined, the Irene Weather Office and the Pretoria University Proefplaas Station, to allow for the longest record possible of 1925-1974 (Proefplaas) and 1975-2023 (Irene) as the Proefplaas data has several years of data missing as well as several days of every month with no recorded data for earlier parts of the study period.

A final limitation for the meteorological data is that there were locations with many reported heat waves where there was no corresponding weather station in the area or they were too large an area to correlate to a single weather station. For example, there were 40 heat waves reported over the whole of South Africa or the Union as it was historically called by the newspaper. There were 13 reported heat waves in the Free State and 21 in the historic province of the Transvaal. There were also more than five heat waves reported in several small towns, the inclusion threshold for this study, but these towns had no weather stations, such as, Goodhouse, Cradock, Kingwilliamstown, Welkom, Komati Poort and Zeerust. This overlap between places with both more than five heat waves reported and a weather station or office with long-term recorded meteorological data is a crucial limitation of this study. However, with 12 locations included from across the country, the scope of this study has not been severely limited.

6.6 Synthesis

Thermal comfort is a complex issue with topics such as adaptation to unique, local climates playing a large role. Therefore, it is of some concern that the heat wave threshold in South Africa has not shifted in any significant way across more than two cities. The concern is that there is statistically significant climate warming occurring across most of South Africa. Therefore, the gap between a consistent or even decreasing heat wave threshold and increasing temperatures leaves a larger range of temperatures that can put people at risk. There has also been a shift in the ways people access weather information, from primarily one source such as the newspaper or television to many sources like the internet, social media, and weather applications. While this can have a democratising effect, it also places the onus of interpreting raw meteorological data on each individual person.

South Africa is also becoming more urban (World Bank, 2025) and is increasing its chronic disease burden rapidly from communicable diseases like HIV and tuberculosis to non-communicable diseases like cancer and diabetes (Charumbira et al., 2022). This all adds up to a population that is at higher risk of heat illness and the more severe effects of increasing heat waves (Kenny and Flouris, 2014).

Chapter 7: Conclusion

7.1 Synthesis

Heat waves will become a bigger proportion of extreme temperature events in South Africa in the future (Van der Walt and Fitchett, 2021a, b). Moreover, the clear climatic trend towards warmer temperatures across South Africa points to hotter annual temperatures ahead. Heat waves can have severe health effects on people from young children, the elderly, and chronically ill people. Using a mix of quantitative, meteorological data and qualitative newspaper reporting, this study explored the thresholds for heat waves in two ways. The 235 newspaper reported heat waves that coincide with SAWS data were analysed using linear regression and showed no universal shift in either the direction of adaptation or of sensitisation. With the warming effects of climate change clearly detected in the meteorological data, it is concerning that the heat wave threshold in South Africa, based on human perception through newspaper reporting is not changing. If the threshold broadly remains the same, but temperatures are rising, there will be more days above that threshold where people are sensitive to the adverse health outcomes from heat waves. An exploration of the 392 SAWS-defined heat waves also showed no shift towards warmer heat waves through time. The SAWS heat wave definition will change in future, given updated 30-year climate normals that are showing increases in all temperature variables (T_{max}, T_{mean}, and T_{min}). Using historical newspapers to conduct such research rows the richness of documentary data from horses named heat wave to reports on what postmen are wearing to work. The newspaper reporting records human anxieties about climate and a changing climate and how people have always had an interest in the climate and the reasons why it is the way it is. However, changes in the way in which people access weather data are also seen in the newspaper records, where most of the weather reporting

occurred in the early part of the 20th century, with weather reporting dropping off slightly after 1976 when the SABC began widespread television broadcasting and almost dropping off completely after 2010, coinciding with a rise of internet and mobile phone-based weather applications. There are some clear limitations to this study based on the gaps in data in the newspaper archives and gaps in the weather recordings in different parts of the nation, however, with the breadth of data and the length of the study period, these limitations do not hinder the findings of this study. This study achieved the aims and objectives it set out to, and while the hypothesis that there would be some kind of clear shift in the heat wave threshold, either towards adaptation towards higher temperatures or towards increasing sensitivity to heat, was not proven, an interesting result was found. The unchanging threshold will result in more days perceived to be a heat wave for the general population of South Africa, which means we will need to be prepared for the increasing risks of a warmer climate, not just in South Africa, but globally.

7.2 Achievement of Aim and Objectives

The broad aim of this project was to explore shifts in the heat wave threshold, which has not occurred in the newspaper reporting. Newspaper reporting was used as a source of data about human perception of climate, which is a complex area of research as thermal perceptions are highly individual and can change based on how a person is dressed or acclimatised and what level of activity they are undertaking (Xu et al., 2023). However, understanding human perceptions of the thermal environment will be crucial for understanding how South Africans will perceive and react to a warming world. While this study found that the perceived heat wave threshold did not change for most of South Africa since 1903, this can still indicate a slight increase in sensitivity as the IPCC had already a measured a 1.1°C increase in global

mean temperatures by 2022 (IPCC, 2022). The increase in temperatures, combined with an unchanging heat wave threshold in South Africa has the potential for there to be more days above the perceived threshold where people are vulnerable to the effects of extreme heat as perceptions of heat play a role in how individuals are affected.

This aim of the study was to explore whether the threshold for heat waves has shifted in 12 locations throughout South Africa over the past century by investigating newspaper reporting and daily resolution meteorological data.

This was intended to be achieved through the following objectives:

1. *To identify news media reports in the Rand Daily Mail and the Business Day newspapers on extreme heat events for the period 1903-2023 by extracting dates, date corrections, locations, and the weather conditions described.*

A total of 1,484 heat waves were recorded in the newspaper reporting, of which 235 coincided with weather station data to be explored in further detail. Reporting on the weather was the most common type of reporting collected. There were more newspaper weather reports towards the beginning of the century than at the end with the last report being made in 2016. There was also a gap in reporting during WWII, likely due to war reporting taking over much of the newspaper. Prior to the 1970s, the newspaper weather reporting regularly reported on temperatures during heat waves, but with the SABC beginning widespread television broadcasting, including weather channels, in 1976 (SABC, 2025), the newspapers stopped reporting on temperatures. After 1976, newspaper reporting on the weather slowly declined further, with reporting ceasing completely after 2016, likely due to the advances in internet weather reporting and the rise in usage of weather applications for mobile phones. Newspaper

reporting on heat waves in The Rand Daily Mail and the Business Day reported heat waves in 125 unique locations, spanning most of South Africa, however, only 12 of these locations were reported to have more than five heat waves as well as weather stations that could be used to compare to the news reports.

2. *To compare these reports on heat waves with meteorological conditions for those days by exploring T_{min}, T_{max}, T_{mean}, and determine whether these have changed through time.*

The 235 reports that coincided with weather station data for each of the 12 locations were analysed in more detail. Regression analysis of these heat waves over time yielded statistically significant results for only two locations, where T_{max} and T_{mean} in Johannesburg showed statistically significant decreases over the period 1903-2023. In Durban, the recorded T_{min} and T_{mean} of heat waves demonstrated a statistically significant increase over time. The other 10 of the 12 locations used in this study did not demonstrate any statistically significant changes over time, T_{max} is the primary temperature variable used in the SAWS definition of a heat wave and this was used to explore changes in SAWS-defined heat waves which similarly showed no statistically significant change through time. Thus, neither newspaper reported heat waves nor SAWS-defined heat waves show a broad shift across the country. However, mean annual climate, demonstrated a statistically significant increase over time of at least one temperature variable (T_{min}, T_{max}, T_{mean}). The climate change means that while the overall threshold for newspaper reported heat waves and SAWS-defined heat waves may not have changed, there is in fact an increasing sensitivity to heat waves as there will be more days above the threshold simply due to the broader climatic shift.

3. *To explore the meteorological conditions preceding any heat waves and determine if the jump in temperature considered to be a heat wave has changed through time.*

The conditions before and after heat waves were explored and very rarely demonstrated a notable jump in temperatures. Over 50% of weeks before and after heat wave events fell within 0-5°C of the reported heat wave day. This phenomenon was not only seen in the week prior which could have been attributed to lag-times in reporting. However, a lack of notable temperature jumps aligns with literature about heat waves where prolonged periods of high heat cause more health problems than short but intense heat waves that are caused by an extreme jump in temperatures (Perkins, 2015).

7.3 Recommendations for Further Research

Further research recommendations would start by potentially including a larger range of newspapers to explore overlaps between publications and SAWS data, for example, by including the long-running South African newspaper The Star. More recent history could also be explored by including online newspaper publications such as News24 archives. With a broader range of newspapers, the whole study period could be explored in further depth by examining where extreme heat events were reported on by several different newspapers. Perhaps a more thorough search with different search terms such as ‘heat stroke’ in the Readex archives could have demonstrated more mortality and morbidity reporting, which could also expand the scope of further research to more health reporting. Increasing search terms could also potentially yield a further avenue for researching the intensity for extreme heat events by searching for words like ‘hot spell’ or ‘hot weather.’ The intensity of the wording could then be

compared to SAWS meteorological recordings to explore the accuracy of reporting on intensity of heat events in news media.

More in depth weather recordings could also open a new avenue for further research, for example, by including humidity data and calculating Humidex values for the heat waves. Humidity data can give a more nuanced view of extreme heat events as this can severely affect the ways in which humans perceive temperatures. However, SAWS humidity data may be limited for more long-term historical studies as humidity recordings do not go back as far as temperature recordings. Moreover, humidity may not be recorded at all automated weather stations by SAWS and gaps in recording would probably mirror where there are gaps in the meteorological record.

Further research could also explore more locations in South Africa to broaden the understanding of heat waves across the nation. With the potential for more heat wave newspaper reporting from other newspapers, more locations with weather stations could also be explored. Increased coverage over South Africa could also demonstrate more regional trends in heat waves and allow for a more nuanced discussion of extreme heat in general across the country. Overall, this research has been exploratory rather than comprehensive and therefore, more thorough, and extensive research into either set of data used in this project could open avenues for further study.

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Appendices

Appendix A: Climate Change in South Africa.

Mean annual temperatures (T_{max}, T_{min}, T_{mean}) for each of the 12 locations in this study.



Appendix B: Table of all heat waves.

Table of all heat waves recorded in the Rand Daily Mail and the Business Day on Readex (1903-2023), green shaded heat waves coincide with SAWS data.

Year	Date	Date Correction	Location	Temperature (°F)	Temperature (°C)
1904	08-Nov	Yesterday	Kimberley	-	-
1905	18-Jan	-	Bedford	-	-
1905	19-Jan	Yesterday after-on	Graaff Reinet	108-110°F	42-43°C
1905	20-Jan	Yesterday	Cradock	105°F	40°C
1905	20-Jan	-	King Williams Town	-	-
1905	23-Jan	20-Jan	Kimberley	-	-
1905	27-Jan	26-Jan	Cradock	-	-
1905	21-Mar	since Saturday	Cape Town	93°F	34°C
1906	6-Jan	from 1908	Johannesburg	87.6°F	31°C
1908	21-Jan	Yesterday	Johannesburg	84.7°F	29°C
1908	21-Jan	On Sunday	Pretoria	94.5°F	35°C
1908	21-Jan	On Sunday	Komati Port	107°F	41°C
1908	21-Jan	On Sunday	Zeerust	100°F	38°C
1909	26-Nov	On Tuesday	Cape Town	100.7°F	38°C
1910	20-Dec	Monday	Kimberley	-	-
1911	07-Mar	a few weeks ago	Humansdorp	-	-
1911	19-Oct	Yesterday	Joubert Park	91.5°F	33°C
1911	19-Oct	Tuesday	Pretoria	97.5°F	36°C
1911	19-Oct	today	Durban	113°F	45°C
1911	19-Oct	today	Verulam	109-113°F	43-45°C
1911	19-Oct	Yesterday afternoon	Maritzburg	103°F	39°C
1911	20-Oct	-	The Rand	-	-
1911	21-Oct	-	Johannesburg	89.3°F	32°C
1911	21-Dec	Yesterday	Transvaal Observatory	84.1°F	29°C
1911	21-Dec	Yesterday	Joubert Park	87.3°F	31°C
1911	21-Dec	Yesterday	Pietersburg	84°F	29°C
1911	21-Dec	Yesterday	Pretoria	91.3°F	33°C
1911	21-Dec	Yesterday	Standerton	88°F	31°C
1911	21-Dec	Yesterday	Zeerust	96°F	35°C
1911	21-Dec	Wednesday	Vryburg	106°F	41°C
1911	22-Dec	Yesterday	Barberton	99°F	37°C
1911	22-Dec	Yesterday	Christiana	102°F	38°C
1911	22-Dec	Yesterday	Pietersburg	90°F	32°C
1911	22-Dec	Yesterday	Joubert Park	90°F	32°C
1911	22-Dec	Yesterday	Pretoria	93.2°F	34°C
1911	22-Dec	Yesterday	Standerton	92°F	33°C
1911	22-Dec	Yesterday	Zeerust	94°F	34°C
1911	22-Dec	Yesterday	Johannesburg	97.4°F	36°C
1911	22-Dec	Thursday	Maritzburg	105°F	40°C
1911	23-Dec	Thursday	Joubert Park	96°F	35°C
1911	23-Dec	Yesterday	Barberton	T_{max}: 98°F T_{min}: 70°F	T_{max}: 37°C T_{min}: 21°C
1911	23-Dec	Yesterday	Christiana	T_{max}: 96°F T_{min}: 58°F	T_{max}: 35°C T_{min}: 14°C

1911	23-Dec	Yesterday	Joubert Park	T_{max}: 94°F T_{min}: 64.3°F	T_{max}: 34°C T_{min}: 18°C
1911	23-Dec	Yesterday	Pietersburg	T_{max}: 94°F T_{min}: 64.3°F	T_{max}: 34°C T_{min}: 18°C
1911	23-Dec	Yesterday	Standerton	T_{max}: 90°F T_{min}: 54°F	T_{max}: 32°C T_{min}: 12°C
1911	23-Dec	Yesterday	Potchefstroom	98.5°F	37°C
1911	23-Dec	Yesterday	Durban	110°F	43°C
1911	23-Dec	Yesterday	Ladysmith	108°F	42°C
1911	25-Dec	last night	Joubert Park	93°F	34°C
1911	27-Dec	Yesterday	Johannesburg	-	-
1912	05-Jan	Yesterday	Queenstown	over 100°F	over 38°C
1912	12-Jan	Thursday	King Williams Town	111.5°F	44°C
1912	12-Jan	Thursday	Grahamstown	over 100°F	over 38°C
1912	25-Jan	over the last week	Wellington district	105°F	40°C
1912	Dec-03	-	Pretoria, Arcadia	T_{max}: 86°F T_{min}: 56.9°F	T_{max}: 30°C T_{min}: 14°C
1912	Dec-03	Yesterday	Pietersburg	T_{max}: 92°F T_{min}: 62°F	T_{max}: 33°C T_{min}: 16°C
1912	Dec-03	Yesterday	Bloemhof	T_{max}: 92°F T_{min}: 54°F	T_{max}: 33°C T_{min}: 12°C
1912	Dec-03	Yesterday	Zeerust	T_{max}: 94°F T_{min}: 54°F	T_{max}: 34°C T_{min}: 12°C
1912	Dec-03	Yesterday	Johannesburg	T_{max}: 76°F T_{min}: 52°F	T_{max}: 24°C T_{min}: 11°C
1912	Dec-03	Yesterday	Belfast	T_{max}: 76°F T_{min}: 52°F	T_{max}: 24°C T_{min}: 11°C
1913	16-Jan	Yesterday	Cape Town	101.7°F	39°C
1913	30-Jan	past 8 days	Jagersfontein	105°F	40°C
1915	13-Mar	past week	Cape Town	-	-
1915	10-Nov	Yesterday	The Rand	103°F and 90°F in the shade	39°C and 32°C in the shade
1916	14-Jan	-	The Rand	-	-
1916	03-Oct	Yesterday	Johannesburg	82°F in the shade	28°C
1916	03-Oct	Yesterday	Joubert Park	hotter than 82°F	hotter than 28°C
1916	15-Oct	-	Johannesburg	87°F in the shade	30°C in the shade
1916	16-Oct	-	Johannesburg	91°F in the shade	33°C in the shade
1916	16-Oct	On Saturday	Joubert Park	96°F in the shade	35°C in the shade
1916	16-Oct	On Saturday	Melville	100°F in someone's garden	38°C
1916	16-Oct	On Saturday	The Rand	91°F average	33°C
1919	27-Sep	Friday	Port Elizabeth	-	-
1920	16-Oct	-	South Africa	-	-
1922	06-Jan	Wednesday	Kimberley	105°F in the shade	40°C
1922	10-Jan	On Sunday	Komatipoort	113-102°F	45-39°C
1923	13-Jan	Jan-06	Kenhardt	105-110°F	40-43°C
1923	07-Nov	last few days	Joubert Park	89.4°F	32°C
1923	01-Dec	Yesterday	Johannesburg	83.9°F	29°C
1923	01-Dec	Yesterday	Joubert Park	88.9°F	32°C
1923	06-Dec	Yesterday	Joubert Park	T_{max}: 88°F T_{min}: 60°F	T_{max}: 31°C T_{min}: 15°C
1924	19-Jan	Friday	Kimberley	103°F	39°C
1924	19-Jan	Friday	Bloemfontein	101.7°F	39°C
1925	24-Feb	-	Cape Town	115°F in the shade	46°C
1925	24-Feb	-	Zwartkop	122°F	46°C
1925	24-Feb	-	Port Alfred	100°F	50°C
1925	24-Feb	On Sunday	Willowmore	108°F	42°C
1925	24-Feb	-	Grahamstown	104°F in the shade	40°C
1925	26-Feb	Wednesday	Port Elizabeth	-	-
1925	10-Mar	Monday	Durban	-	-
1925	18-Sep	Since Monday	Cape Town	88.5°F up from 67°F since Monday	31°C up from 19°C

1925	30-Oct	-	The Rand	-	-
1925	02-Nov	-	The Rand	-	-
1925	19-Nov	Wednesday	Durban	-	-
1925	21-Nov	Friday	Maritzburg	-	-
1925	23-Dec	last week	Johannesburg	-	-
1925	28-Dec	past week	Johannesburg	around 91°F for the past week	33°C
1926	14-Jan	Yesterday	Johannesburg	-	-
1926	14-Jan	Yesterday	Joubert Park	T_{max}: 88°F T_{min}: 67°F	T_{max}: 31°C T_{min}:19°C
1926	14-Jan	Wednesday	Klerksdorp	-	-
1926	26-Jan	past week	Johannesburg	-	-
1926	19-Oct	On Saturday	Pretoria	T_{max}: 95.9°F T_{min}: 49.2°F	T_{max}: 35°C T_{min}: 9°C
1927	15-Jan	Yesterday	Johannesburg	94.2°F at 3pm	35°C
1927	15-Jan	Yesterday	Cape Province	over 100°F	over 38°C
1927	15-Jan	Yesterday	Kimberley	107°F	42°C
1927	15-Jan	Yesterday	Upington	105°F over last 3-4 days	40°C
1927	15-Jan	Yesterday	Kenhardt	106°F	41°C
1927	15-Jan	Yesterday	Willowmore	102°F	39°C
1927	15-Jan	Yesterday	Vryburg	102°F	39°C
1927	15-Jan	Yesterday	Mafikeng	99°F	37°C
1927	15-Jan	Yesterday	Bloemhof	100°F	38°C
1927	15-Jan	Yesterday	Pretoria	97°F	36°C
1927	15-Jan	Yesterday	Vereeniging	97°F	36°C
1927	15-Jan	Yesterday	Rustenburg	98°F	37°C
1927	15-Jan	Yesterday	Potchefstroom	97°F	36°C
1927	15-Jan	Yesterday	Nylstroom	94°F	34°C
1927	15-Jan	Yesterday	Lichtenburg	95°F	35°C
1927	15-Jan	Yesterday	Heidelberg	91°F	33°C
1927	15-Jan	Yesterday	Middleburg	90°F	32°C
1927	15-Jan	Yesterday	Zeerust	98°F	37°C
1927	15-Jan	Yesterday	Bloemfontein	101°F	38°C
1927	15-Jan	Yesterday	Wepener	97°F	36°C
1927	15-Jan	Yesterday	Kroonstad	96°F	36°C
1927	15-Jan	Yesterday	Durban	87°F	31°C
1927	15-Jan	Monday	Cape Town	94.3°F	35°C
1927	09-Nov	-	Kenhardt	-	-
1927	09-Nov	On Sunday	Wolmaransstad	90°F	32°C
1927	26-Nov	Friday	Cape Town	100.5°F	38°C
1928	14-Aug	Monday	Cape Town	78°F (Saturday) 81°F (Sunday) 77°F (Monday)	25°C (Sat) 27°C (Sun) 25°C (Mon)
1928	20-Dec	Wednesday	Oudtshoorn	105°F in the shade	40°C
1928	20-Dec	Wednesday	Cradock	106°F degrees	41°C
1928	20-Dec	Wednesday	Kimberley	102°F in the shade	39°C
1928	21-Dec	-	Joubert Park	-	-
1929	06-Jan	Saturday	Joubert Park	125°F in the sun	52°C
1929	24-Jan	Wednesday	Cape Town	Mercury registered 100°F yesterday and 105.8°F today	38°C yesterday, 41°C today
1929	01-Feb	-	Cape Town	-	-
1929	18-Feb	Saturday	Brits	102°F, 105°F, 108°F in the shade in the past 3 days	39°C, 41°C, 42°C
1929	07-Nov	Yesterday	The Rand	95.3°F, 24°F up since Tuesday	35°C up 13°C since Tuesday

1929	23-Nov	since Wednesday evening	Brits	102°F for many days	39°C
1929	25-Dec	-	Johannesburg	-	-
1930	24-Jan	Thursday	Cape Peninsula	-	-
1930	25-Jan	Friday	Cape Town	-	-
1930	28-Jan	Monday	Cape Town	-	-
1930	30-Aug	Yesterday	The Rand	-	-
1930	30-Aug	Yesterday	Joubert Park	T_{max}: 68.1°F T_{min}: 40.5°F the previous night	T_{max}: 20°C T_{min}: 5°C
1930	28-Oct	Monday	Maritzburg	over 100°F	over 38°C
1930	04-Nov	Monday	Maritzburg	-	-
1930	06-Nov	Wednesday	Wolmaransstad	-	-
1930	11-Nov	Monday	Bloemfontein	95°F	35°C
1930	16-Dec	-	Johannesburg	-	-
1930	24-Dec	Tuesday	Fort Beaufort	-	-
1930	31-Dec	-	Pretoria	-	-
1930	31-Dec	Tuesday	Cape town	-	-
1931	09-Jan	Thursday	Cape Town	95°F -7 days of over 90°F since September 21 1931	35°C and 7 days over 32°C
1931	19-Feb	-	Brits	between 102-105°F	39-41°C
1931	04-Mar	Tuesday	Cape Town	-	-
1931	25-Sep	Thursday	Nylstroom	99°F in the shade	37°C
1931	26-Sep	Yesterday	Johannesburg	mercury over 90°F over two days	over 32°C
1931	21-Oct	Yesterday	Pretoria	94°F	34°C
1931	22-Oct	-	Newcastle	-	-
1931	28-Oct	-	Pretoria	-	-
1931	18-Nov	Tuesday	East London	97°F	36°C
1931	20-Nov	Thursday	East London	-	-
1932	12-Jan	Yesterday	Johannesburg	over 90°F	over 32°C
1932	12-Jan	Yesterday	Goodhouse	Saturday T_{max}:115°F T_{min}:74°F	T_{max}: 46°C T_{min}: 23°C
1932	13-Jan	Yesterday	Johannesburg	another day over 90°F	over 32°C
1932	13-Jan	Monday	Komatipoort	107°F	42°C
1932	13-Jan	past two days	Pretoria	96°F over 2 days	36°C
1932	10-Feb	Tuesday	Cape Town	101.2°F	38°C
1932	12-Feb	Thursday	Cape Town	109°F	43°C
1932	04-May	Tuesday	Cape Town	-	-
1932	05-May	Wednesday	Cape Town	-	-
1932	10-Oct	Yesterday	Johannesburg	84°F in the shade	29°C
1932	11-Oct	last two days	Johannesburg	85°F degrees in the shade	29°C
1932	13-Oct	5 days of heat	Johannesburg	83°F degrees	28°C
1932	17-Oct	Yesterday	Joubert Park	86.5°F degrees	30°C
1932	18-Oct	Yesterday	Johannesburg	-	-
1932	20-Oct	Monday	Johannesburg	88.3°F on hottest day with T_{min}: 56°F	31°C with T_{min}: 13°C
1932	02-Nov	Tuesday	Cape Town	88.6°F	31°C
1932	07-Nov	Saturday	Cape Town	-	-
1932	01-Dec	Yesterday	Johannesburg	91.2°F	33°C
1932	12-Dec	Yesterday	Johannesburg	-	-
1932	13-Dec	Yesterday	Johannesburg	-	-

1933	09-Jan	second day in a row	Johannesburg	88.7°F on Saturday	31°C
1933	31-Jan	Monday	Riversdale	109°F at 3pm	43°C
1933	01-Feb	Tuesday	Cape Town	-	-
1933	02-Feb	tenth day of heat wave	Johannesburg	89.6°F	32°C
1933	09-Feb	Wednesday	Cape Town	105°F in the shade	40°C
1933	11-Feb	-	Heidelberg	95°F	35°C
1933	27-Mar	-	Johannesburg	Normal average for march is T_{max}: 72.7°F and T_{min}: 53.9°F - but its been over 80°F all week	T_{max}: 23°C and T_{min}: 12°C but its been over 27°C all week
1933	18-Apr	Monday	Cape Town	-	-
1933	12-May	Thursday	East London	73-95°F	23-35°C
1933	03-Oct	-	Pretoria	-	-
1933	11-Oct	-	Johannesburg	-	-
1933	01-Nov	-	Johannesburg	-	-
1933	03-Nov	Monday	Middleburg	-	-
1934	13-Feb	Yesterday	Johannesburg	nearly 83°F	nearly 28°C
1934	19-Apr	Wednesday	Cape Town	80°F	27°C
1934	20-Apr	Yesterday	Cape Town	-	-
1934	13-Oct	-	Benoni	-	-
1935	07-Jan	Yesterday	Johannesburg	1 Jan: 88.3°F - Wed: 82.5°F - Thur: 81.8°F - Fri: 84°F - Sat: 85°F	1 Jan: 31°C – Wed: 28°C – Thurs: 28°C – Fri: 29°C – Sat: 29°C
1935	08-Jan	-	Johannesburg	-	-
1935	11-Jan	-	Johannesburg	-	-
1935	12-Jan	-	Johannesburg	-	-
1935	15-Jan	-	Hoopstad	94°F in the shade	34°C
1935	16-Jan	-	Zoo Lake	-	-
1935	18-Jan	Wednesday	Cape Province	108-109°F	42-43°C
1935	03-Oct	past 2 days	Pretoria	over 90°F	over 90°C
1935	12-Oct	past 2 days	Johannesburg	hottest day in last 2 days	-
1935	15-Oct	Yesterday	Springbok Flats	98°F in the shade	37°C
1935	15-Oct	Yesterday	Farms	104-108°F	40-42°C
1935	15-Oct	Yesterday	Volksrust	90°F	32°C
1935	15-Oct	Yesterday	Rustenburg	98°F in the shade	37°C
1935	15-Oct	Yesterday	Lichtenburg	92°F	33°C
1935	15-Oct	Yesterday	Pretoria	88°F	31°C
1935	16-Oct	Yesterday	Joubert Park	90°F in the shade	32°C
1935	18-Oct	-	Transvaal	-	-
1935	21-Oct	-	Transvaal	-	-
1935	23-Oct	-	The Rand	-	-
1935	24-Oct	this last week	Barberton	-	-
1935	25-Oct	-	Pretoria	-	-
1935	26-Oct	two days ago	The Rand	-	-
1935	29-Nov	Yesterday	Ladysmith	-	-
1935	30-Nov	Yesterday	Cape Town	over 100°F	over 38°C
1936	06-Jan	Yesterday	The Rand	-	-
1936	07-Jan	-	The Rand	-	-
1936	08-Jan	-	The Rand	-	-
1936	09-Jan	-	The Rand	-	-
1936	10-Jan	-	The Rand	-	-
1936	31-Mar	past 10 days	Port Elizabeth	103°F in the shade	39°C

1936	09-Nov	-	Benoni	over 80°F	over 27°C
1936	07-Dec	-	Joubert Park	-	-
1936	08-Dec	-	The Rand	-	-
1936	25-Dec	-	Pretoria	-	-
1937	01-Jan	-	Kenhardt	105°F in the shade	40°C
1937	05-Jan	Monday	Kenhardt	102°F in the shade	39°C
1937	21-Jan	-	The Rand	88.5°F at 8pm last night	31°C
1937	01-Mar	Saturday	Cape Town	-	-
1937	02-Mar	Monday	Grahamstown	97°F in the shade	36°C
1937	02-Mar	-	Carlisle Bridge	103°F in the shade	39°C
1937	10-Mar	-	Germiston	-	-
1937	28-Sep	-	Johannesburg	15-20°F rise in temperatures	8-11°C rise in temps
1937	19-Oct	-	Johannesburg	86°F in the mercury	30°C
1937	22-Oct	-	Messina	105-112°F over the last few days	40-44°C
1937	12-Nov	-	Pretoria	-	-
1937	13-Nov	-	Germiston	94°F in the shade	34°C
1937	16-Nov	-	Johannesburg	a few days over 90°F in the mercury	32°C
1937	01-Dec	-	Pretoria	-	-
1937	03-Dec	-	Transvaal and Natal	temperature dropped 50°F in 36 hours	10°C drop – death of cold
1937	04-Dec	-	Johannesburg	temperatures dropped 40°F within 24 hours - over 90°F last week now under 60°F	Temps dropped 17°C from over 32°C to 15°C
1938	22-Jan	-	Johannesburg	83°F	28°C
1938	22-Jan	-	Grahamstown	106.2°F	41°C
1938	22-Jan	-	Somerset East	over 100°F	over 38°C
1938	22-Jan	-	Graaff Reinet	over 100°F	over 38°C
1938	22-Jan	-	Goodhouse	over 100°F	over 38°C
1938	22-Jan	-	King Williams Town	over 100°F	over 38°C
1938	22-Jan	-	Kenhardt	over 100°F	over 38°C
1938	22-Jan	-	Queenstown	over 100°F	over 38°C
1938	22-Jan	-	Upington	over 100°F	over 38°C
1938	22-Jan	-	Beaufort West	over 100°F	over 38°C
1938	22-Jan	-	Laingsburg	over 100°F	over 38°C
1938	22-Jan	-	Bloemfontein	104°F in the shade	40°C
1938	22-Nov	-	Johannesburg	87°F in the shade	30°C
1938	23-Nov	-	Pretoria	90°F	32°C
1938	23-Nov	-	Zeerust	99°F in the shade	37°C
1938	23-Nov	-	Komatipoort	97°F	36°C
1938	23-Nov	-	Rustenburg	96°F	35°C
1938	23-Nov	-	Nylstroom	95°F	35°C
1938	23-Nov	-	Heidelberg	93°F	39°C
1938	23-Nov	-	Standerton	90°F	32°C
1938	23-Nov	-	Johannesburg	87°F	30°C
1938	24-Nov	-	Pretoria	over 92°F	33°C
1938	24-Nov	-	Johannesburg	-	-
1938	25-Nov	-	Transvaal and Natal	-	-
1939	10-Feb	-	Cape Town	-	-
1939	13-Oct	Thursday	Newcastle	-	-
1939	20-Oct	-	Johannesburg	-	-

1939	21-Nov	Sunday after-on	Cradock	97°F	36°C
1939	12-Dec	last 3 days	Kenhardt	102°F, 103°F, 106°F	39°C, 39°C, 41°C
1939	13-Dec	past 5 days	Goodhouse	106°F, 111°F, 112°F, 107°F, 107°F	41°C, 44°C, 44°C, 42°C, 42°C
1940	05-Jan	-	Free State	-	-
1940	08-Jan	Yesterday	Johannesburg	87°F in the shade	30°C
1940	09-Jan	Yesterday	Goodhouse	107°F	42°C
1940	09-Jan	Yesterday	Graaff Reinet	106°F	41°C
1940	09-Jan	Yesterday	Upington	104°F	40°C
1940	09-Jan	Yesterday	Van Wyksvlei	103°F	39°C
1940	09-Jan	Yesterday	Hopetown	102°F	39°C
1940	09-Jan	Yesterday	Beaufort West	101°F	38°C
1940	09-Jan	Yesterday	Kimberley	101°F	38°C
1940	09-Jan	Yesterday	Somerset East	101°F	38°C
1940	09-Jan	Yesterday	Kenhardt	103°F	39°C
1940	10-Jan	-	Johannesburg	87°F	30°C
1940	11-Jan	-	Transvaal	-	-
1940	12-Jan	-	Johannesburg	-	-
1940	15-Jan	-	The Reef	over 80°F	27°C
1940	16-Jan	-	Johannesburg and Pretoria	-	-
1940	19-Jan	Thursday	Bronkhorstspruit	-	-
1940	23-Jan	last fortnight	Kenhardt	over 90°F	over 32°C
1940	27-Jan	-	Cradock	-	-
1940	01-Feb	-	Transvaal	-	-
1940	03-Feb	-	Cape Town	-	-
1940	07-Feb	-	Free State	-	-
1940	23-Feb	-	Rouxville	-	-
1940	27-Feb	Monday	Newcastle	over 90°F	over 32°C
1940	30-Apr	Yesterday	Durban	94°F	34°C
1940	23-Nov	Friday	Messina	112°F	44°C
1940	25-Nov	last five days	Settlers	-	-
1941	14-Oct	Monday	Messina	106.5°F	41°C
1942	05-Feb	-	Pretoria	-	-
1944	15-Jan	-	Johannesburg	74-82°F	23-28°C
1944	15-Jan	last nine days	Goodhouse	106-111°F	41-44°C
1944	09-Oct	-	Transvaal	-	-
1944	09-Oct	-	Joubert Park	88°F	31°C
1944	10-Oct	-	Johannesburg	-	-
1944	11-Dec	Sunday	Messina	100-109°F	38-43°C
1944	13-Dec	last 11 day	Johannesburg	80-84°F	27-29°C
1944	14-Dec	Yesterday	Duivelskloof	93°F at 7am	34°C
1944	14-Dec	Yesterday	Letsetele	108°F	42°C
1944	19-Dec	-	Johannesburg	-	-
1944	30-Dec	Yesterday	Joubert Park	86°F in the shade	30°C
1945	04-Jan	-	Johannesburg	-	-
1945	08-Jan	-	Kimberley	-	-
1945	15-Jan	past few days	Johannesburg	more than 75°F	over 24°C
1945	16-Jan	-	Joubert Park	85°F at noon and 77°F at 10:30pm	29°C at noon and 25°C
1945	19-Jan	-	Johannesburg	80°F	27°C
1945	04-Oct	last 3 days	Maritzburg	103°F	39°C
1945	08-Dec	last 10 days	Orange River	103-110°F	39-43°C
1945	12-Dec	Yesterday	Johannesburg	80°F	27°C
1945	19-Dec	Yesterday	Johannesburg	86.5°F Tmax	30°C

1945	20-Dec	this week	Ermelo	91-94°F on Monday and 87°F on Tuesday	33-34°C and 30°C
1945	21-Dec	last 13 days	Johannesburg	80-84°F	27-29°C
1945	22-Dec	Yesterday	Johannesburg	85.6°F	30°C
1946	07-Jan	this weekend	Johannesburg	-	-
1946	07-Jan	Yesterday	Joubert Park	82°F in the shade	28°C
1946	07-Mar	Yesterday	Johannesburg	-	-
1946	29-Mar	Wednesday	Cape Peninsula	30°F drop after violent storm after 101°F in the shade	38°C
1946	21-Nov	-	Durban	95°F	35°C
1946	03-Dec	-	Ermelo	72-81°F	22-27°C
1946	04-Dec	Yesterday	Johannesburg	90°F - hottest day since Dec 1941	32°C
1946	05-Dec	Yesterday after-on	Johannesburg	-	-
1946	05-Dec	Yesterday	Kensington	90.8°F	33°C
1946	06-Dec	Yesterday	Johannesburg	89.8°F	32°C
1946	07-Dec	Tuesday	Vryheid	-	-
1946	10-Dec	last week	Johannesburg	-	-
1946	12-Dec	Wednesday	Durban	88°F	31°C
1946	12-Dec	Wednesday	Maritzburg	90°F	32°C
1946	12-Dec	Wednesday	Umkuzi	111°F	44°C
1947	01-Jan	-	Joubert Park	89.6°F	32°C
1947	01-Jan	Yesterday	Wakkerstroom	90°F	32°C
1947	03-Jan	Yesterday	Joubert Park	84°F	29°C
1947	08-Jan	-	Port Elizabeth	-	-
1947	08-Jan	-	Joubert Park	84°F	29°C
1947	06-Feb	-	Cape Town	-	-
1947	07-Feb	-	Cape Province	-	-
1947	10-Feb	-	Cape Peninsula	-	-
1947	18-Mar	-	Cape Town	99°F	37°C
1947	10-Oct	Yesterday	Johannesburg	85.4°F	30°C
1947	14-Oct	Yesterday	Johannesburg	85°F	29°C
1947	14-Nov	-	Joubert Park	85°F up from 61°F on Sunday	29°C up from 16°C
1947	15-Oct	Yesterday	Joubert Park	down slightly at 67°F but still a heat wave	19°C
1947	03-Nov	-	Witwatersrand	-	-
1947	03-Nov	-	Pretoria	-	-
1947	03-Nov	-	Joubert Park	88°F	31°C
1947	04-Nov	past few days	The Rand	70°F at 8pm	21°C
1947	04-Nov	-	Komatipoort	110°F	43°C
1947	04-Nov	Saturday	Pretoria	93-93.8°F	34°C
1947	04-Nov	Yesterday	Klerksdorp	95°F	35°C
1947	20-Nov	several days	South Africa	-	-
1947	22-Nov	-	Potchefstroom	-	-
1947	27-Nov	-	The Rand	-	-
1947	28-Nov	Thursday	Cape Town	92-100°F - 63% humidity	33-38°C – 63%
1948	10-Jan	-	Beaufort West	105°F up to 120°F in the sun	40°C up to 49°C
1948	12-Jan	last 6 days	Maritzburg	SAPA reports hottest day in a long time	
1948	13-Jan	nearly all week	Johannesburg	88-90°F	31-32°C
1948	13-Jan	-	Pretoria	86-88°F	30-31°C
1948	14-Jan	last 4 days	Pretoria	91.3°F	33°C

1948	16-Jan	Thursday	Naboomspruit	-	-
1948	22-Jan	-	Cape Town	-	-
1948	18-Feb	Tuesday	Cape Town	over 100°F in the sun at noon	over 38°C
1948	03-Apr	Friday	Cape Town	101°F	38°C
1948	03-Apr	Saturday	Wingfield	100.7°F	38°C
1948	03-Apr	Sunday	Adderley Street	122°F	50°C
1948	07-Dec	Monday	Kimberley	99°F in the shade	37°C
1948	10-Dec	fifth successive day	Upington	103°F	39°C
1948	13-Dec	Yesterday	Johannesburg	88°F	31°C
1948	14-Dec	last few days	Johannesburg	not below 85°F for several days	29°C
1948	14-Dec	Yesterday	Natal	110°F	43°C
1948	15-Dec	-	Harrismith	-	-
1948	16-Dec	-	Pretoria	-	-
1948	16-Dec	-	Johannesburg	72°F at midnight, 82°F at 3pm	22-28°C
1948	17-Dec	-	Pretoria	-	-
1948	17-Dec	-	Johannesburg	-	-
1948	24-Dec	-	Free state	over 100°F	over 38°C
1948	28-Dec	-	Pretoria	-	-
1948	31-Dec	-	South Africa	-	-
1949	08-Jan	-	Northern Cape	115°F	46°C
1949	08-Jan	Yesterday	Oudedrift	115°F	46°C
1949	08-Jan	Yesterday	Jansenville	114°F	45°C
1949	10-Jan	-	The Rand	-	-
1949	11-Jan	-	Johannesburg	90°F	32°C
1949	11-Jan	-	Upington	125°F	52°C
1949	12-Jan	-	Johannesburg	-	-
1949	15-Jan	-	Cape Town	-	-
1949	03-Feb	Yesterday	Cape Town	90.1°F	32°C
1949	04-Feb	Thursday	Cape Town	92°F	33°C
1949	23-Feb	Yesterday	Durban	83°F - 80% humidity	28°C – 80% humidity
1949	23-Sep	Thursday	Klerksdorp	91°F in the shade 2 days in a row	33°C
1949	24-Sep	Yesterday	Transvaal	-	-
1949	16-Dec	-	Pretoria	-	-
1950	05-Jan	Yesterday	Cape Town	92°F	33°C
1950	01-Feb	Yesterday	Eastern Cape	-	-
1950	01-Feb	Yesterday	Rand	85°F for three days in a row	29°C
1950	01-Feb	Yesterday	Durban	82°F	28°C
1950	02-Feb	Yesterday	Cape District	112°F	44°C
1950	21-Feb	-	Eastern Cape	-	-
1950	07-Mar	Yesterday	Johannesburg	-	-
1950	28-Jul	Wednesday	East London	87°F before a cold snap	30°C
1950	10-Aug	-	South Africa	-	-
1950	14-Oct	-	Transvaal	101°F	38°C
1950	18-Oct	-	South Africa	-	-
1950	18-Oct	Yesterday	Upington	98°F	37°C
1950	18-Oct	Yesterday	Hoopstad	93°F	34°C
1950	18-Oct	Yesterday	Kimberley	90°F	32°C
1950	18-Oct	Yesterday	Mafikeng	90°F	32°C
1950	18-Oct	Yesterday	Beaufort West	90°F	32°C
1950	18-Oct	Yesterday	Pretoria	85°F	29°C

1950	18-Oct	Yesterday	Germiston	83°F	28°C
1950	19-Dec	-	Pietersburg	-	-
1951	11-Jan	-	Joubert Park	34°F to 61°F rise in 24 hours up to 70°F the next day	1°C-16°C-21°C
1951	02-Feb	this week	Grahamstown	temperature rose by a °F every 15 mins until a max of 100.2°F	38°C
1951	09-Feb	-	Cape Town	-	-
1951	10-Oct	Yesterday	Johannesburg	80°F	27°C
1951	10-Oct	Yesterday	Harrismith	92°F	33°C
1951	21-Nov	past few days	Johannesburg	-	-
1951	01-Dec	Yesterday	Johannesburg	86.8°F	30°C
1951	03-Dec	last 10 days	Newcastle	high of 98°F from 56°F today (42°F up in 24 hrs)	37°C from 13°C
1951	04-Dec	-	Newcastle	-	-
1951	19-Dec	Tuesday	Welkom	-	-
1952	01-Jan	-	Johannesburg	-	-
1952	03-Jan	-	South Africa	-	-
1952	18-Jan	midday	Johannesburg	86°F	30°C
1952	18-Jan	-	Pretoria	89°F	32°C
1952	05-Feb	-	Cape Town	81-90°F in 6 hours	27-32°C
1952	21-Oct	Monday	King Williams Town	110°F	38°C
1952	21-Oct	Sunday	Cradock	96°F	35°C
1952	21-Oct	Yesterday	Fort Beaufort	103°F	39°C
1952	24-Oct	-	Pretoria	-	-
1952	25-Oct	last 6 days	Newcastle	-	-
1952	28-Oct	Yesterday	Brits	-	-
1953	10-Jan	Yesterday	Durban	-	-
1953	20-Jan	-	South Africa	-	-
1953	21-Jan	Yesterday	Johannesburg	-	-
1953	24-Jan	Yesterday	Johannesburg	-	-
1953	24-Jan	-	South Africa	-	-
1953	26-Jan	-	Johannesburg	-	-
1953	27-Jan	Yesterday	Bloemfontein	99°F / 37.2°C	37°C
1953	27-Jan	-	Cape Town	-	-
1953	30-Jan	-	Johannesburg	-	-
1953	09-Feb	Yesterday	Klaver	-	-
1953	09-Feb	Yesterday	Cradock	-	-
1953	14-Sep	-	Johannesburg	76.8°F	25°C
1953	12-Oct	-	Welkom	-	-
1953	17-Oct	-	Newcastle	-	-
1953	02-Nov	-	Pretoria	-	-
1953	14-Dec	Sunday	Welkom	90°F	32°C
1953	30-Dec	-	Johannesburg	80°F	27°C
1953	31-Dec	last 6 days	Transvaal	nearly 80°F	nearly 27°C
1953	31-Dec	-	Pretoria	-	-
1954	08-Jan	Thursday	Welkom	90°F	32°C
1954	30-Jan	Friday	Jansenville	up to 107°F	42°C
1954	16-Jul	Thursday	East London	87°F up from 45.5°F in the night	30°C up from 7°C in the night
1954	06-Oct	Yesterday	Transvaal and Free State	90°F	32°C
1954	07-Oct	-	Transvaal	-	-
1954	07-Oct	-	Johannesburg	85°F	29°C

1954	09-Oct	-	Transvaal	82-87°F	28-30°C
1954	15-Oct	-	Johannesburg	-	-
1954	27-Oct	-	Johannesburg	-	-
1954	02-Nov	25-Oct	Tzaneen	114°F	45°C
1954	10-Dec	-	Durban	-	-
1954	25-Dec	-	Johannesburg	-	-
1954	30-Dec	-	Johannesburg	-	-
1955	11-Jan	-	South Africa	-	-
1955	18-Feb	-	East London, Port Alfred, King Williams Town	109°F	43°C
1955	15-Nov	-	Transvaal and Free State	more than 100°F	more than 38°C
1955	16-Nov	-	Natal	-	-
1955	18-Nov	-	Johannesburg	-	-
1956	11-Jan	Tuesday	Beaufort West	98°F	37°C
1956	24-Jan	Yesterday	Johannesburg	78°F	25°C
1956	25-Jan	-	Joubert Park	100°F	38°C
1956	26-Jan	-	Highveld	-	-
1956	26-Jan	-	Kestell	-	-
1956	27-Jan	-	South Africa	-	-
1956	01-Feb	-	Johannesburg	-	-
1956	04-Feb	Friday	Bloemfontein	-	-
1956	28-Nov	Tuesday	Klaver	106.3°F	41°C
1957	10-Jan	Yesterday	Cape	-	-
1957	10-Jan	Yesterday	Transvaal	88°F	31°C
1957	21-Jan	Yesterday	Transvaal and Free State and Cape	-	-
1957	22-Jan	-	Free State	-	-
1957	22-Jan	-	Witwatersrand	-	-
1957	25-Nov	-	The Rand	-	-
1958	06-Oct	-	Durban and Maritzburg	105.4°F	41°C
1958	07-Oct	Yesterday	Witwatersrand	-	-
1958	07-Oct	Yesterday	Pretoria	-	-
1958	07-Oct	Yesterday	Cape Province	-	-
1958	07-Oct	Yesterday	Natal	-	-
1958	21-Nov	-	Pretoria	-	-
1958	21-Nov	Yesterday	Johannesburg	81.7°F	28°C
1958	22-Nov	Friday	Jansenville	111°F	44°C
1959	03-Apr	Yesterday	South Africa	80°F	27°C
1959	03-Apr	Yesterday	Johannesburg	60°F in am to 80°F in pm	15-27°C
1959	03-Apr	Yesterday	Northern Natal	-	-
1959	30-Sep	Tuesday	Cape Town	98°F	37°C
1959	18-Dec	-	Transvaal	-	-
1959	19-Dec	Yesterday	Komatipoort	116.2°F	
1960	04-Jan	-	East London	90°F	32°C
1960	01-Nov	Yesterday	Goodhouse	110°F	
1960	01-Nov	Yesterday	Kenhardt	105.8°F	
1960	01-Nov	Yesterday	Wilgenhoutsdrift	104°F	
1960	01-Nov	Yesterday	Pretoria	90°F	32°C
1960	01-Nov	Yesterday	Jan Smuts Airport	82°F	
1960	08-Nov	Yesterday	Johannesburg	-	-
1960	10-Nov	last 14 days	Pretoria	-	-
1960	14-Dec	Yesterday	Cape Town	100°F	38°C

1960	16-Dec	Wednesday	Somerset East	110°F	43°C
1961	10-Jan	-	Winberg	-	-
1961	14-Jan	-	Germiston	-	-
1961	26-Oct	-	Pretoria	-	-
1961	28-Oct	-	Kruger Park	-	-
1962	06-Jan	-	Bloemfontein	-	-
1962	08-Jan	-	Free state	105°F	40°C
1962	08-Jan	-	Transvaal	-	-
1962	08-Jan	-	Rustenburg	-	-
1962	08-Jan	-	Waterberg	-	-
1962	08-Jan	-	Potgietersrus	-	-
1962	08-Jan	-	Zoutpansberg	-	-
1962	04-Sep	-	Pretoria	-	-
1962	29-Nov	Yesterday	Welkom	in the nineties	32-37°C
1963	17-Jan	Tuesday	Cape Town	83°F	28°C
1963	25-Sep	Yesterday	Transvaal Lowveld	100°F at dozens of reporting stations	38°C
1963	01-Oct	Yesterday	Maritzburg	100°F 14% humidity	38°C 14% humidity
1964	04-Jan	Yesterday	Transvaal	-	-
1964	24-Jan	Yesterday	Kinkelbos	104°F	40°C
1964	20-Mar	-	Johannesburg	-	-
1965	19-Jan	-	South Africa	-	-
1965	01-Nov	Yesterday	The Reef	90-100°F	32-38°C
1965	01-Nov	Yesterday	Pretoria	98°F	37°C
1965	01-Nov	Yesterday	Western Transvaal	100°F	38°C
1965	01-Nov	Yesterday	Johannesburg	-	-
1966	05-Jan	Yesterday	Bothaville	110°F	43°C
1966	01-Feb	Sunday	Alexandria	114°F	45°C
1966	07-Oct	-	South Africa	-	-
1966	29-Nov	-	South Africa	-	-
1968	22-Nov	Tuesday	Underberg	26°C	-
1969	17-Jan	Yesterday	Cape Town	-	-
1969	31-Jan	-	Umtata	-	-
1969	11-Feb	-	Johannesburg	-	-
1970	05-Jan	Yesterday	Johannesburg	-	-
1970	23-Jan	Yesterday	Johannesburg	86-100°F	30-38°C
1970	05-Mar	-	South Africa	-	-
1970	07-Mar	-	Kyalami	-	-
1970	08-Sep	-	Johannesburg	-	-
1970	08-Sep	-	Pretoria	-	-
1971	28-Dec	-	Cape Town	-	-
1972	07-Jan	-	Port Elizabeth	-	-
1972	23-Oct	-	Transvaal	-	-
1972	04-Dec	-	South Africa	-	-
1972	04-Dec	-	Gordonia	-	-
1972	04-Dec	-	Johannesburg	-	-
1972	06-Dec	-	James Town	-	-
1972	07-Dec	-	Cape Town	-	-
1972	07-Dec	-	Johannesburg	-	-
1972	13-Dec	-	Lenasia	-	-
1972	16-Dec	-	Johannesburg	-	-
1972	19-Dec	-	Johannesburg	-	-
1973	13-Jan	-	Johannesburg	88°F	31°C
1974	22-Feb	Yesterday	Durban	83°F	28°C
1974	05-Jun	-	Cape Town	-	-
1977	13-Dec	-	Kyalami	-	-
1977	31-Dec	-	Durban	-	-

1981	13-Nov	-	Johannesburg	-	-
1981	20-Nov	-	Free state	-	-
1981	20-Nov	-	Cape Province	-	-
1982	23-Jun	-	Johannesburg	-	-
1982	21-Oct	-	Johannesburg	-	-
1982	12-Nov	-	Johannesburg	-	-
1982	30-Dec	Yesterday	Durban	-	-
1983	13-Jan	-	Johannesburg	-	-
1983	13-Jan	-	Johannesburg	-	-
1983	14-Jan	-	Johannesburg	-	-
1983	29-Sep	-	Pretoria	-	-
1985	04-Jan	-	Free state	-	-
1985	04-Jan	-	Natal	-	-
1985	04-Jan	-	Transvaal	-	-
1985	04-Jan	-	Western Province	-	-
1985	04-Jan	-	Phalaborwa	-	-
1985	04-Jan	-	Johannesburg	-	-
1985	04-Jan	-	Golden City	-	-
1985	04-Jan	-	Pietersburg	-	-
1985	04-Jan	-	Durban	-	-
1985	05-Jan	-	Johannesburg	-	-
1997	17-Dec	-	Mafikeng	-	-
1998	07-Jan	-	Swartland	-	-
1998	12-Feb	-	Johannesburg	-	-
1999	16-Mar	-	South Africa	-	-
1999	01-Apr	-	Cape Town	-	-
1999	23-Dec	-	Cape Town	-	-
2000	17-Nov	-	Bloemfontein	-	-
2001	11-Jan	-	South Africa	-	-
2001	11-Jan	-	Ellisras	-	-
2001	11-Jan	-	Mafikeng	-	-
2001	11-Jan	-	Pretoria	-	-
2001	11-Jan	-	Klerksdorp	-	-
2001	11-Jan	-	Welkom	-	-
2001	11-Jan	-	Kimberley	-	-
2001	11-Jan	-	Bloemfontein	-	-
2001	11-Jan	-	Tzaneen	-	-
2001	11-Jan	-	Vereeniging	-	-
2001	15-Jan	-	Pretoria	-	-
2001	15-Jan	-	Phalaborwa	-	-
2001	21-Jan	-	Gauteng	-	-
2002	03-Jan	Yesterday	Pretoria	-	-
2002	03-Jan	Yesterday	Upington	-	-
2003	13-Feb	-	South Africa	-	-
2003	18-Feb	-	Johannesburg	-	-
2004	15-Dec	-	Brits	-	-
2006	01-Nov	-	Johannesburg	-	-
2007	10-Mar	-	Johannesburg	-	-
2007	12-Mar	-	South Africa	-	-
2005	05-Aug	-	The Corn Belt	-	-
2015	05-Mar	-	Cape Town	-	-
2015	30-Sep	Yesterday	Tshwane	-	-
2015	07-Oct	-	Mpumalanga	-	-
2015	12-Oct	-	South Africa	-	-
2015	12-Nov	-	Johannesburg	-	-
2015	13-Nov	-	Johannesburg	-	-
2015	13-Nov	-	Pretoria	-	-

2015	13-Nov	-	South Africa	-	-
2015	16-Nov	-	Gauteng	-	-
2015	19-Nov	-	Gauteng	-	-
2015	20-Nov	-	North West	-	-
2015	20-Nov	-	Free State	-	-
2015	20-Nov	-	Mpumalanga	-	-
2015	20-Nov	-	KwaZulu-Natal	-	-
2015	20-Nov	-	Limpopo	-	-
2015	08-Dec	-	Cape Town	-	-
2015	15-Dec	-	South Africa	-	-
2016	13-Jan	-	South Africa	-	-
2016	15-Jan	-	South Africa	-	-
2016	15-Feb	-	South Africa	-	-
2016	19-Feb	-	Hermanus	-	-
2016	03-Nov	-	Johannesburg	-	-

Appendix C: Examples of SAWS Data.

Appendix C.1: Examples of days above the SAWS heat wave threshold (red shading) with a newspaper reported heat wave (black outline) and no actual SAWS heat waves of three days or more for January 1900 to January 1906 in Johannesburg.

	1900			1901			1902			1903			1904			1905			1906		
January	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
1	24,40	10,00	17,20	27,80	16,10	22,00							31,10	15,70	23,40	27,50	11,70	19,60	29,60	15,70	22,70
2	28,30	12,20	20,30	31,70	17,20	24,50							31,70	14,40	23,10	24,20	14,40	19,30	30,00	16,60	23,30
3	31,10	12,20	21,70	28,90	16,10	22,50							28,90	13,30	21,10	25,80	12,20	19,00	27,80	15,20	21,50
4	29,40	11,70	20,60	19,40	15,00	17,20							28,30	15,00	21,70	26,90	13,30	20,10	28,10	16,60	22,40
5	28,90	12,20	20,60	21,10	13,30	17,20							31,10	16,10	23,60	27,50	13,90	20,70	29,40	15,70	22,60
6	27,20	12,20	19,70	22,20	13,30	17,80							30,00	15,60	22,80	31,40	12,80	22,10	30,70	17,40	24,10
7	27,20	13,30	20,30	26,10	14,40	20,30							27,20	13,30	20,30	33,10	15,00	24,10	27,80	16,40	22,10
8	22,80	13,30	18,10	30,60	13,90	22,30							18,30	13,90	16,10	28,90	15,00	22,00	26,20	13,20	19,70
9	20,60	13,30	17,00	25,60	13,30	19,50							22,20	13,90	18,10	28,30	15,00	21,70	26,80	14,20	20,50
10	26,10	11,70	18,90	24,40	13,30	18,90							22,20	14,40	18,30	28,90	13,90	21,40	26,60	15,40	21,00
11	27,20	10,00	18,60	26,70	13,30	20,00							20,60	13,30	17,00	27,20	13,30	20,30	28,10	16,10	22,10
12	27,20	13,30	20,30	27,20	12,20	19,70							26,70	13,30	20,00	29,70	13,30	21,50	25,80	15,10	20,50
13	28,30	13,30	20,80	27,80	13,90	20,90							27,20	16,10	21,70	29,40	15,00	22,20	27,40	15,30	21,40
14	30,60	15,00	22,80	31,10	13,90	22,50							26,10	14,40	20,30	31,70	15,60	23,70	30,20	15,10	22,70
15	21,10	15,60	18,40	27,80	15,60	21,70							27,80	15,00	21,40	31,70	16,10	23,90	25,40	16,90	21,20
16	25,00	16,10	20,60	28,90	15,60	22,30							28,90	15,60	22,30	23,30	13,90	18,60	27,30	16,20	21,80
17	27,80	14,40	21,10	32,20	13,90	23,10							30,60	14,40	22,50	24,40	12,20	18,30	27,80	15,10	21,50
18	26,70	14,40	20,60	32,80	13,30	23,10							26,70	16,10	21,40	22,80	12,20	17,50	25,80	15,70	20,80
19	27,20	14,40	20,80	30,00	13,30	21,70							27,80	15,00	21,40	26,70	13,30	20,00	26,10	14,00	20,10
20	30,60	16,70	23,70	21,70	8,90	15,30							35,60	13,90	24,80	27,20	12,20	19,70	30,90	15,00	23,00
21	30,60	17,20	23,90	21,10	7,20	14,20							27,80	15,00	21,40	29,20	11,70	20,50	31,70	16,70	24,20
22	28,90	14,40	21,70	25,60	7,20	16,40							26,70	18,30	22,50	30,60	13,10	21,90	28,70	15,30	22,00
23	26,70	14,40	20,60	27,80	12,20	20,00							25,60	13,30	19,50	23,90	13,90	18,90	27,80	14,40	21,10
24	25,60	15,00	20,30	28,90	12,20	20,60							20,00	12,20	16,10	31,70	13,60	22,70	27,70	16,10	21,90
25	25,60	12,80	19,20	30,00	13,90	22,00							25,60	13,90	19,80	31,10	15,00	23,10	22,80	14,60	18,70
26	28,30	14,40	21,40	32,20	16,10	24,20							20,60	13,30	17,00	27,80	13,10	20,50	26,30	11,90	19,10
27	23,30	13,90	18,60	26,10	13,30	19,70							24,40	14,40	19,40	29,70	13,90	21,80	27,70	14,20	21,00
28	26,70	15,60	21,20	28,90	13,30	21,10							21,70	13,90	17,80	31,10	14,40	22,80	30,60	15,80	23,20
29	25,00	15,00	20,00	27,20	13,30	20,30							24,40	12,20	18,30	31,70	13,60	22,70	27,80	16,80	22,30
30	22,20	11,70	17,00	28,90	12,80	20,90							24,40	10,60	17,50	28,60	12,80	20,70	26,40	15,30	20,90
31	26,70	8,90	17,80	28,90	12,80	20,90							24,40	10,60	17,50	24,40	12,20	18,30	25,10	14,30	19,70

Appendix C.2: Newspaper reported heat waves (black outlines) that coincide with SAWS heat waves of 3 days or more (red shading) in January between 1926-1930 in Johannesburg.

	1926			1927			1928			1929			1930		
January	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
1	29,30	15,90	22,60	29,70	17,80	23,80	25,80	15,60	20,70	24,80	12,20	18,50	29,60	13,30	21,50
2	26,90	15,20	21,10	30,30	15,10	22,70	28,10	13,70	20,90	30,20	12,70	21,50	26,10	14,70	20,40
3	28,60	15,20	21,90	22,80	14,10	18,50	30,10	15,00	22,60	30,30	15,40	22,90	26,90	14,00	20,50
4	27,10	15,00	21,10	26,00	12,70	19,40	29,60	16,30	23,00	33,30	17,50	25,40	28,20	14,20	21,20
5	27,20	16,00	21,60	26,40	14,10	20,30	26,90	17,60	22,30	34,20	19,20	26,70	24,80	14,70	19,80
6	28,40	13,30	20,90	25,80	15,10	20,50	26,00	14,60	20,30	30,70	16,90	23,80	24,60	11,70	18,20
7	31,30	16,40	23,90	28,90	15,30	22,10	22,20	13,00	17,60	25,30	12,20	18,80	26,90	13,70	20,30
8	31,10	16,70	23,90	23,90	9,00	16,50	24,40	10,20	17,30	26,70	14,10	20,40	27,90	14,10	21,00
9	29,70	17,10	23,40	27,00	8,00	17,50	26,90	12,20	19,60	27,20	14,20	20,70	27,80	14,80	21,30
10	30,30	14,10	22,20	28,60	10,10	19,40	30,70	14,80	22,80	30,60	14,40	22,50	27,10	12,30	19,70
11	30,80	14,00	22,40	31,20	13,40	22,30	25,70	18,40	22,10	22,60	16,80	19,70	28,70	15,10	21,90
12	30,80	15,70	23,30	31,90	16,00	24,00	26,00	13,80	19,90	27,20	14,10	20,70	26,00	13,70	19,90
13	31,00	17,40	24,20	32,80	17,10	25,00	19,40	14,30	16,90	27,60	13,60	20,60	29,80	13,90	21,90
14	28,20	12,50	20,40	34,70	15,40	25,10	24,80	14,40	19,60	25,70	14,80	20,30	29,30	16,20	22,80
15	26,80	15,30	21,10	34,30	17,80	26,10	27,40	14,80	21,10	25,10	12,90	19,00	25,60	16,60	21,10
16	31,60	13,60	22,60	34,20	18,00	26,10	25,10	15,30	20,20	30,00	15,70	22,90	16,30	14,10	15,20
17	30,60	15,10	22,90	29,00	15,90	22,50	22,90	13,30	18,10	20,00	13,20	16,60	17,20	13,80	15,50
18	26,00	15,00	20,50	29,40	15,40	22,40	24,10	14,30	19,20	21,90	13,10	17,50	23,00	10,60	16,80
19	18,80	11,40	15,10	31,40	15,40	23,40	26,40	14,70	20,60	22,40	14,40	18,40	22,20	11,20	16,70
20	25,00	10,60	17,80	31,90	17,40	24,70	27,20	14,30	20,80	25,40	11,20	18,30	22,40	10,20	16,30
21	28,90	14,20	21,60	23,20	15,20	19,20	29,60	15,30	22,50	26,10	12,90	19,50	24,10	9,40	16,80
22	30,00	15,00	22,50	31,10	13,30	22,20	29,00	16,20	22,60	24,40	13,30	18,90	24,40	11,20	17,80
23	29,00	15,00	22,00	28,70	15,60	22,20	29,60	15,60	22,60	21,90	13,30	17,60	23,20	11,10	17,20
24	31,40	16,40	23,90	29,90	14,80	22,40	29,40	14,30	21,90	25,20	13,10	19,20	24,60	10,00	17,30
25	26,70	15,40	21,10	31,10	15,20	23,20	31,70	18,90	25,30	23,90	14,20	19,10	26,90	11,40	19,20
26	29,90	14,40	22,20	23,60	14,80	19,20	23,10	15,70	19,40	25,40	13,70	19,60	24,80	14,40	19,60
27	27,80	15,40	21,60	18,00	14,20	16,10	27,50	13,40	20,50	23,10	12,20	17,70	25,90	13,40	19,70
28	28,90	15,40	22,20	22,60	13,20	17,90	25,00	13,10	19,10	25,80	11,70	18,80	29,80	15,60	22,70
29	23,30	13,30	18,30	26,70	13,60	20,20	27,80	14,60	21,20	29,80	13,70	21,80	26,70	12,60	19,70
30	26,70	15,00	20,90	25,80	14,30	20,10	27,80	13,70	20,80	28,70	15,30	22,00	25,90	12,10	19,00
31	27,30	15,00	21,20	24,40	11,10	17,80	28,70	13,80	21,30	26,90	6,10	16,50	28,10	14,30	21,20

Appendix C.3: Three four-day long heat waves in February between 1994-2000 in Upington.

	1994			1995			1996			1997			1998			1999			2000		
February	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
1	35,80	22,50	29,15	35,90	18,70	27,30	36,60	19,60	28,10	28,50	15,80	22,15	38,70	18,50	28,60	38,10	25,20	31,65	34,60	18,30	26,45
2	31,70	22,30	27,00	39,00	20,60	29,80	35,40	20,80	28,10	33,40	17,00	25,20	33,70	17,80	25,75	36,30	24,70	30,50	33,40	18,20	25,80
3	36,10	24,10	30,10	40,70	22,40	31,55	32,80	16,40	24,60	37,50	19,00	28,25	31,50	17,20	24,35	37,30	20,20	28,75	36,20	15,10	25,65
4	34,70	21,40	28,05	41,50	27,40	34,45	38,30	20,90	29,60	38,10	20,90	29,50	34,90	17,50	26,20	36,10	20,90	28,50	38,40	17,10	27,75
5	31,10	20,80	25,95	42,30	26,70	34,50	38,00	22,90	30,45	38,90	22,10	30,50	41,20	20,50	30,85	37,90	21,70	29,80	37,70	19,90	28,80
6	30,30	18,80	24,55	41,50	29,10	35,30	29,70	22,70	26,20	37,20	25,70	31,45	43,20	23,30	33,25	33,10	18,00	25,55	38,10	19,20	28,65
7	30,80	19,30	25,05	38,20	23,30	30,75	35,80	22,30	29,05	34,20	19,50	26,85	42,50	27,00	34,75	35,60	16,30	25,95	38,60	21,50	30,05
8	34,40	21,30	27,85	36,50	20,80	28,65	32,40	22,00	27,20	38,10	18,80	28,45	39,00	29,20	34,10	38,20	18,40	28,30	38,30	23,30	30,80
9	35,90	21,70	28,80	39,40	23,20	31,30	37,50	23,90	30,70	36,60	23,30	29,95	41,60	24,40	33,00	39,90	20,30	30,10	36,90	23,40	30,15
10	36,00	20,40	28,20	40,90	20,90	30,90	35,80	25,50	30,65	32,90	22,10	27,50	42,10	24,20	33,15	40,40	22,90	31,65	34,30	20,40	27,35
11	33,40	23,00	28,20	40,70	23,20	31,95	36,60	20,40	28,50	35,70	23,70	29,70	41,70	27,80	34,75	35,90	18,00	26,95	37,60	23,00	30,30
12	35,40	21,60	28,50	41,40	25,10	33,25	38,30	19,20	28,75	32,50	20,00	26,25	40,80	24,10	32,45	39,00	18,80	28,90	36,80	21,00	28,90
13	31,40	20,50	25,95	40,40	27,50	33,95	30,80	17,60	24,20	30,40	13,60	22,00	37,30	20,90	29,10	38,90	22,30	30,60	36,00	18,30	27,15
14	33,10	18,90	26,00	38,30	20,80	29,55	25,60	12,10	18,85	32,00	17,10	24,55	38,40	22,30	30,35	40,10	25,60	32,85	36,30	20,20	28,25
15	34,60	20,70	27,65	32,60	21,60	27,10	31,50	16,10	23,80	36,20	16,00	26,10	36,50	23,40	29,95	38,70	24,30	31,50	33,60	19,30	26,45
16	35,50	21,00	28,25	32,20	20,20	26,20	31,90	17,80	24,85	34,40	18,30	26,35	35,70	23,30	29,50	37,60	23,30	30,45	35,80	17,10	26,45
17	35,40	24,40	29,90	37,10	20,70	28,90	36,30	19,60	27,95	36,00	20,90	28,45	31,60	18,80	25,20	39,00	23,90	31,45	30,40	21,80	26,10
18	35,80	24,00	29,90	38,50	25,20	31,85	38,10	23,40	30,75	34,90	19,10	27,00	31,60	20,50	26,05	38,10	21,70	29,90	29,00	18,90	23,95
19	31,40	18,00	24,70	37,50	25,60	31,55	37,40	24,50	30,95	37,50	17,70	27,60	31,50	22,30	26,90	34,30	24,30	29,30	31,20	21,50	26,35
20	30,30	18,10	24,20	37,50	22,90	30,20	35,70	21,20	28,45	39,90	20,90	30,40	34,80	21,20	28,00	36,40	22,80	29,60	26,80	18,80	22,80
21	33,00	16,10	24,55	36,00	19,20	27,60	32,30	20,60	26,45	39,30	21,80	30,55	33,10	20,00	26,55	37,00	23,20	30,10	32,00	18,00	25,00
22	36,70	18,00	27,35	39,60	18,60	29,10	29,70	19,20	24,45	34,90	21,30	28,10	36,00	21,30	28,65	37,70	18,30	28,00	33,10	22,10	27,60
23	36,10	19,30	27,70	38,60	24,30	31,45	28,90	14,10	21,50	33,90	14,90	24,40	35,00	19,30	27,15	39,00	19,80	29,40	34,00	18,90	26,45
24	37,80	22,30	30,05	39,00	28,60	33,80	34,60	15,60	25,10	37,90	16,90	27,40	39,30	19,70	29,50	37,90	23,90	30,90	36,20	19,40	27,80
25	39,50	22,60	31,05	39,40	26,70	33,05	36,30	18,30	27,30	31,90	19,70	25,80	35,10	27,70	31,40	39,70	18,60	29,15	35,50	23,20	29,35
26	40,70	23,80	32,25	39,30	26,30	32,80	35,60	21,00	28,30	33,50	17,50	25,50	33,20	20,00	26,60	38,60	20,40	29,50	35,60	22,50	29,05
27	39,70	22,70	31,20	39,50	24,00	31,75	36,40	21,70	29,05	34,40	17,90	26,15	36,10	20,60	28,35	40,50	20,40	30,45	35,70	20,90	28,30
28	39,20	22,60	30,90	34,20	24,60	29,40	34,20	18,50	26,35	33,60	18,60	26,10	34,40	20,20	27,30	36,60	23,20	29,90	27,80	22,00	24,90
29							35,20	20,90	28,05										32,70	21,10	26,90