Understanding Climate Change in South Africa: An Analysis of the Perceptions of Affected Communities

by

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Contents

Declaration

I, Octavia Nombulelo Ndlovu,(1268678) declare that this research project, Understanding Climate Change in South Africa: An Analysis of Perceptions of Affected Communities, is my work. It is submitted in partial fulfillment of the requirements for the MA e-Science. All sources of information and material used in this project have been acknowledged and cited. I affirm that this work has not been submitted previously for any academic award and is not the result of plagiarism. I understand that any act of plagiarism, including reproduction of someone else's work without proper citation, will result in penalties as outlined by the university policies.

Acknowledgments

I want to show my gratitude to those who assisted and contributed to this research project and made it what it is. To my supervisor, Professor Rod Alence, my sincerest gratitude for your guidance and expertise through the research process. I am grateful.

Abstract

Climate change is a pressing global issue, yet public perception varies significantly across regions and demographics. This study investigates the factors influencing climate change awareness and concern in South Africa, utilizing Afrobarometer survey data. Through statistical analysis, the research examines the role of socioeconomic status, education, and media exposure in shaping public attitudes. Findings will contribute to understanding regional disparities in climate perception, informing targeted awareness campaigns and policy interventions. By addressing gaps in climate communication, this study aims to enhance public engagement and foster proactive responses to climate challenges.

Introduction

Climate change is a critical global issue, impacting ecosystems, economies, and human development. South Africa, in particular, faces rising temperatures and increased extreme weather events (Adedeji, 2014). Climate refers to the long-term weather patterns in a region, and climate change signifies a sustained alteration in these patterns over time (Santos and Bakhshoodeh, 2021). Industrialization and human activities have significantly contributed to recent temperature increases (Santos and Bakhshoodeh, 2021).

The adverse effects of climate change include rising sea levels, frequent flooding, and prolonged droughts (Santos and Bakhshoodeh, 2021; Hisano et al., 2018). The Intergovernmental Panel on Climate Change (IPCC) describes it as a persistent shift in weather variability and mean conditions (Santos and Bakhshoodeh, 2021). South Africa is particularly vulnerable due to its carbon-intensive economy and high greenhouse gas emissions (Rowlands, 1996; De Wit and CSIR, 2001).

Climate change is closely linked to increased atmospheric greenhouse gases, trapping heat and leading to global temperature rises of 2°C to 4°C (van der Bank and Karsten, 2020; Kundzewicz et al., 2008). Its effects include extreme weather events, biodiversity loss, and threats to water security (Elum et al., 2017; van der Bank and Karsten, 2020). In South Africa, sectors such as water resources, agriculture, and biodiversity are at significant risk (Elum et al., 2017; van der Bank and Karsten, 2020).

Over the past five decades, South Africa's annual temperatures have risen 1.5 times the global average increase of 0.65°C (Elum et al., 2017; Murphy et al., 2016). These rising temperatures threaten biodiversity, food security, and infrastructure (Crespo et al., 2011; Elum et al., 2017; Niles et al., 2016; Kundzewicz et al., 2008). The major sectors affected are:

Biodiversity: Rising temperatures and CO_2 levels may lead to increased encroachment of woody vegetation into grasslands (Elum et al., 2017; Khumalo, 2021).
Human development: Changes in rainfall patterns will increase the demand for water management, impacting livelihoods reliant on consistent rainfall (Khumalo, 2021; Benhin, 2006).
Water resources: More frequent floods and droughts will strain water availability, crucial for social and economic stability (De Wit and CSIR, 2001; Crespo et al.,

2011; Akanbi et al., 2021; Elum et al., 2017).

Climate change manifests through prolonged droughts, extreme weather, and ocean warming, significantly impacting human development (Khumalo, 2021; Deressa et al., 2011). Experts highlight that climate change is a global crisis already disrupting South African agriculture. The National Climate Change Adaptation Strategy confirms the country has experienced significant warming, with increasing heatwaves, prolonged dry spells, and intensified rainfall (Benhin, 2006; De Wit and CSIR, 2001; Masson-Delmotte et al., 2018). Empirical data indicate that the past decade has recorded the highest global temperatures (Daze et al., 2009; Benhin, 2006).

Rural communities play a crucial role in understanding climate change. Research suggests that they recognize shifting temperatures and rainfall patterns, correlating these changes with declining agricultural productivity and resource depletion (Rankoana, 2016). Impacts such as malnutrition, water scarcity, disease outbreaks, soil erosion, and biodiversity loss are well-documented (Rankoana, 2016). This understanding is essential for developing adaptation strategies to mitigate the adverse effects of rising temperatures and decreasing rainfall, ensuring long-term sustainability (Rankoana, 2016).
The effects of climate change are evident in South Africa, with severe floods recorded in the Eastern Cape in 2022, causing significant property damage and loss of life despite warnings from the South African Weather Service (Singh et al., 2022). Similarly, KwaZulu-Natal has experienced annual floods over the past five years, highlighting shifts in weather patterns (Ndlovu et al., 2021). These events demonstrate that climate change impacts both rural and urban areas, as seen in the destruction of infrastructure in Durban's central business district.

This study examines the multifaceted effects of climate change on South African livelihoods and well-being. Rather than attributing all environmental challenges solely to climate change, the research seeks to understand public perceptions of its tangible consequences. The link between climate change and human development depends on how individuals interpret environmental changes and the assumptions they hold about South Africa's future. These perspectives are crucial in shaping discussions on climate adaptation and resilience.

This study is structured into two main components:

1. An analysis of climate data that sets the context for South Africa's environmental trends.
2. A quantitative analysis of Afrobarometer survey data, which is the primary focus, to assess how demographic and socioeconomic factors shape public awareness and concern about climate change.

Research Questions

The methodological framework employed in this research project involves a quantitative approach that utilizes descriptive statistical analysis. This approach aims to provide structure and coherence to this paper by employing a hypothesis as a guiding question. The central hypothesis under investigation posits that people's perspectives, particularly among the citizens of South Africa, are fundamentally shaped by their perception of the effects of climate change. The main research questions are :

1. What demographic and social factors (e.g., gender, education, media exposure) influence public attitudes and awareness toward climate change in South Africa?
2. How do individuals perceive the climate change's impact on their lives, and how does this perception vary by region and demographic characteristics?
3. What is the relationship between climate exposure fluctuations and public awareness or concern about climate change?

Aims

This study aims to investigate the impact of climate change in South Africa by examining public perceptions and climate exposure trends at both the provincial and demographic levels. Specifically, the study seeks to:

1. Describe variances in climate-related exposure across South Africa's provinces.
2. Explore the demographic and social factors (e.g., gender, education, media consumption) that influence public attitudes and awareness regarding climate change.
3. Assess how individuals perceive climate change and identify variations in these perceptions based on region and demographic characteristics.

4. Describe variances in climate-related exposure across South Africa to discover the potential interactions between climate exposure fluctuations and public awareness about climate change.

Rationale

The changing climate is a critical issue that affects both global and local environments. In South Africa, the effects are seen in rising temperatures and extreme weather , vary significantly across regions. Understanding public perceptions and awareness is crucial for designing effective policies and interventions.

This study is important for the following reasons:

- Climate change does not affect all areas equally, and there are notable sub-national differences in climate-related exposure, which require a detailed investigation to inform localized policy responses.
- Demographic and social aspects, such as gender, education, and media exposure, have been shown to influence climate awareness, and this research will explore how these aspects shape attitudes toward climate change.
- Public perceptions about the changing climate are influential in determining support for climate policies and adaptation efforts, and it is crucial we comprehend how individuals perceive climate impacts on their daily lives.
- By analyzing the interactions between climate exposure fluctuations and public awareness, this study can provide insights into the effectiveness of current awareness campaigns and identify gaps in public understanding of the effects of climate change.

Literature Review

Climate change is a complex global challenge with significant social and environmental impacts. As its effects intensify, understanding public perceptions has become essential for shaping effective mitigation and adaptation strategies. Factors such as demographics, media exposure, and perceived personal vulnerability influence attitudes toward climate change. This is particularly relevant in South

Africa, where climate risks, such as extreme temperature fluctuations, vary across regions and social groups.

Studies have explored how individuals perceive climate change and the factors shaping these perceptions. Visschers (2018) found that ambiguity in climate research increases public concern, emphasizing the need for clear communication and trust in scientific sources. Their findings are especially relevant for South Africa, where awareness and concern differ across demographic and regional lines. Research also suggests that gender, education, and media consumption influence climate awareness. While media exposure, particularly print newspapers, enhances understanding, many remain unaware of climate change's local impacts.

This study aims to examine climate awareness in South Africa, focusing on regional differences, demographic influences, and the link between climate exposure and public perception. Identifying gaps in awareness can inform targeted communication strategies and support policies addressing both environmental and social dimensions of climate change.

The South African government has taken steps to combat climate change through initiatives like the Climate Change Response Fund, which promotes public-private collaboration to build resilience. President Cyril Ramaphosa has highlighted the importance of this initiative in mitigating climate risks, reflecting South Africa's commitment to sustainability (South African Government News, 2024).

Climate change also exacerbates poverty, affecting vulnerable populations reliant on climate-sensitive resources (Khine and Langkulsen, 2023). With 79% of the world's poor living in rural areas, the impacts of climate change further strain livelihoods. The COVID-19 pandemic has worsened poverty alleviation efforts, while institutional barriers and limited data hinder effective adaptation strategies. Integrating climate resilience into poverty reduction policies is essential to addressing these challenges (Khine and Langkulsen, 2023).

Semenza et al. (2008) examined public perceptions of climate change, focusing on awareness, concern, and barriers to behavioral change. While most respondents expressed concern, socioeconomic disparities emerged, with higher-income and more educated individuals displaying greater awareness. The study found that individuals are more likely to take action when they perceive climate change as a

direct threat. However, barriers such as limited knowledge of effective actions and lack of access to resources hinder behavioral change.

Surveys conducted in Hamburg between 2008 and 2011 revealed a decline in public concern for climate change, suggesting an intermittent trend rather than a long-term shift (Ratter et al., 2012). This decline contrasts with rising scientific confidence and increased media coverage. Similar trends have been observed globally, with surveys across Western countries showing a reduced sense of urgency regarding climate change compared to previous years.

In developed countries, despite widespread awareness, uncertainty often affects the willingness to take action (Papoulis et al., 2015). Climate change is frequently deprioritized in favor of immediate concerns, and cultural beliefs, alongside limited personal experiences, shape public attitudes. Sociological ambivalence contributes to declining concern, despite the necessity for immediate mitigation to prevent shifting the burden onto future generations. A study in Athens highlighted the importance of state policies on forests, water, and energy, alongside individual efforts such as recycling and resource conservation (Papoulis et al., 2015).

Cvetković and Grbić (2021) found that education level significantly influences climate change awareness, with higher educational attainment linked to greater understanding. Employment status affected perceptions of vulnerability, while age correlated with differences in climate change perception. These demographic factors highlight the need for tailored awareness campaigns targeting different population segments. The study, based on face-to-face interviews in urban centers, may introduce urban bias, suggesting the need for future research incorporating diverse locations and participants. Integrating behavioral insights into climate policies can enhance public engagement and contribute to mitigation efforts.

The agricultural and water sectors play a critical role in economic transformation and livelihood sustainability, particularly in emerging economies (Nhemachena et al., 2020). The African Union's 2014 Malabo Declaration emphasizes agricultural productivity as a driver of inclusive economic growth, employment, and food security. However, climate change poses significant threats to these development goals by undermining water and food security, exacerbating poverty, and disrupting economic stability. Empirical evidence suggests that extreme heat and prolonged droughts negatively affect agricultural performance across Africa, reinforc-

ing the need for adaptation measures.

Nyahunda and Tirivangasi (2020) examined the impact of climate change on rural women in the Makhado municipality, highlighting their disproportionate burden due to dependence on natural resources and caregiving roles. Using qualitative methods such as interviews and focus groups, the study illustrated how climate change exacerbates existing gender inequalities in agriculture, health, energy, water, and livestock production. Climate variability leads to resource scarcity and environmental degradation, further threatening rural livelihoods and well-being.

The findings underscore the urgent need to address systemic gender discrimination that heightens women's vulnerability to climate change. The study advocates for robust support systems to mitigate these impacts, emphasizing equitable access to resources, education, and participation in decision-making. Empowering women not only enhances resilience but also strengthens climate adaptation strategies. Ultimately, safeguarding women's interests is essential for both social justice and effective climate change mitigation (Nyahunda and Tirivangasi, 2020).

Masipa (2017) highlights the significant impact of climate change on South Africa's food security, emphasizing its multifaceted nature. Global warming disrupts food systems by affecting production, availability, accessibility, utilization, and affordability. The study calls for a comprehensive policy framework to protect arable land, stressing that effective adaptation depends on understanding the specific vulnerabilities of different food items.

South Africa's challenges mirror broader issues in developing nations, including institutional weaknesses and technological deficits that hinder responses to climate-induced food insecurity (Masipa, 2017). The financial burden of adaptation is a key obstacle, exacerbated by a gap between adaptation costs and government support. Bridging this gap requires investment in resilient technologies to strengthen food systems against climate threats.

Addressing food insecurity amid climate change necessitates a multi-faceted approach, including policy reform, institutional strengthening, technological innovation, and increased financial investment (Masipa, 2017). Only through such an integrated strategy can nations like South Africa mitigate climate-related threats

and ensure long-term food security.

Capstick et al. (2015) reviewed empirical research on public perceptions of climate change, revealing a complex and evolving landscape. Since the 1980s, diverse methodologies—including surveys, statistical analyses, and qualitative longitudinal studies—have tracked public sentiment. A notable trend is the rise of skepticism in some developed countries in the late 2000s, influenced by economic and sociopolitical factors, contrasting with growing global concern about climate change.

The review by Capstick et al. (2015) highlights a significant bias in climate perception research, with an overemphasis on polling data from Western nations, particularly the United States. Capstick et al. advocate for broader research employing inferential statistical methods to decode perception trends and suggest qualitative longitudinal approaches to better understand cultural influences shaping public attitudes.

Masson-Delmotte et al. (2018) argues that climate change poses a major societal risk, particularly in Africa, where vulnerability is disproportionately high. However, despite widespread acknowledgment of these risks, perceived threats vary significantly across individuals and communities.

South African citizens have reported notable environmental shifts, often attributing them to rising global temperatures (Trust, 2010). Documented changes include weather pattern fluctuations, food security concerns, biodiversity loss, and desertification. Coastal residents have observed alterations in sea levels, coastlines, and marine wildlife behavior, while urban dwellers have noted rising pollution and industrialization, recognizing their adverse effects on community well-being.

Shi et al. (2015) examined the interplay between cultural worldviews, climate-related knowledge, and public concern about climate change in the German-speaking region of Switzerland. The study found strong correlations between cultural beliefs, climate knowledge, and concern levels. Additionally, causal knowledge about climate change heightened public concern and fostered support for climate policies, highlighting the importance of effective risk communication in

promoting climate action.

Kutywayo et al. (2022) emphasized the need to enhance climate change awareness and promote environmental protection, particularly across Africa. A survey by Mpako and Govindasamy (2023) revealed that only 46% of South Africans had encountered the term ”climate change,” with awareness lowest among women. Similarly, a 2019 survey by the Royal Institute of International Affairs found that just over 10% of young Africans (aged 18-35) viewed climate change as an urgent issue (Mpako and Govindasamy, 2023; Kutywayo et al., 2022).

Mpako and Govindasamy (2023) further highlighted that climate change in South Africa impacts ecosystems, economies, and livelihoods, yet competing priorities—such as poverty, inequality, violence, and employment—often overshadow climate action (De Wet-Billings, 2022). Additionally, Trust (2010) noted concerns regarding access to clean water, food security, and the broader socioeconomic effects of climate change on local communities.

Hagen (2015) critically examined the disconnect between scientific climate evidence and corresponding public and policy responses. The study underscored failures in media and scientific communication, which have limited policy action. By analyzing international case studies, Hagen (2015) explored how social and cultural factors influence climate perception, emphasizing the need to build public trust in scientific institutions to drive climate action.

Whitmarsh and Capstick (2018) analyzed the complexities of climate change perception, advocating for a nuanced approach to inform policy and technological innovation. While awareness of climate change is widespread, concern levels vary across regions and time periods. The rise of skepticism, particularly among right-leaning groups in Western countries during the late 2000s, demonstrates the influence of sociopolitical alignment on climate attitudes.

Factors shaping public views include immediate weather experiences, economic considerations, media narratives, and personal ideologies. Whitmarsh and Capstick (2018) argue that survey-based research should be complemented with ethnographic and neuroscientific approaches to better understand climate perception. Such interdisciplinary efforts could enhance public engagement strategies and pol-

icy development.

Knight (2016) analyzed global awareness of climate change using Gallup World Poll data from 2007-2010, identifying wealth and education as primary drivers of climate knowledge. Higher affluence and education levels were linked to greater climate awareness, while political orientation and a country's vulnerability to climate change had less influence. Interestingly, wealthier, politically left-leaning nations perceived greater climate risks, though unemployment rates showed no significant effect.

The study highlighted inconsistencies in how education affects risk perception and awareness, emphasizing the need for targeted communication strategies that consider the socioeconomic and political contexts of each country when shaping climate policies (Knight, 2016).

Moore et al. (2019) explored the 'boiling frog' effect, which suggests that individuals gradually acclimate to changing weather conditions, diminishing the perceived significance of extreme temperature shifts. Social media analysis indicated that, despite increasing climate anomalies, public discourse on extreme weather events has declined over time, suggesting a normalization of extreme conditions.

Moore et al. (2019) further highlighted a disconnect between the public's shifting perception of "normal" weather and the reality of climate change projections. This discrepancy may hinder climate action, as individuals fail to recognize long-term environmental threats. The study suggests that climate communication strategies should address perceptual biases to foster proactive engagement and drive meaningful policy interventions.

The literature collectively underscores the complexity of public perceptions of climate change, shaped by socio-economic, political, cultural, and psychological factors. Wealth and education emerge as key determinants of climate awareness, while political orientation and a country's vulnerability to climate impacts exhibit more nuanced effects (Knight, 2016; Hagen, 2015). Media representation also plays a pivotal role in shaping public discourse, with a tendency to emphasize extreme weather events over proactive mitigation measures, potentially skewing public perceptions and responses (Pasquaré and Oppizzi, 2012). Additionally, personal experiences with climate variability can contribute to the normalization of

extreme conditions, diminishing the perceived urgency of long-term climate risks (Moore et al., 2019).

Despite the breadth of research on climate change perceptions, significant gaps remain. Existing studies largely focus on global or national trends, with limited attention to South Africa's unique socio-economic and environmental context. Regional disparities, demographic variations, and localized factors influencing climate perceptions are often overlooked. Furthermore, the interplay between media exposure, climate-related experiences, and public attitudes in South Africa remains underexplored. Addressing these gaps is critical for developing targeted communication strategies that resonate with different segments of the population.

This study aims to bridge this gap by analyzing South African citizens' awareness, concern, and understanding of climate change using Afrobarometer survey data. By examining demographic influences, media exposure, and personal experiences, the research will contribute to a more nuanced understanding of climate perceptions in South Africa. The findings will inform tailored communication strategies and policy development, ultimately fostering broader public engagement in climate action.

Research Design and Methodology

Climate Change Problem

Johnston et al. (2024) addresses the climate change issue in a 2024 report, outlining the significant threats South Africa faces due to rising temperatures. As a country rich in biodiversity and reliant on agriculture and tourism, South Africa is particularly vulnerable to climate change. Extreme weather conditions, shifting ecosystems, and rising temperatures are increasingly threatening water security, biodiversity, crop production, and infrastructure. In KwaZulu-Natal, for example, floods have caused extensive destruction, not only damaging infrastructure but also resulting in irreversible harm to farmlands.

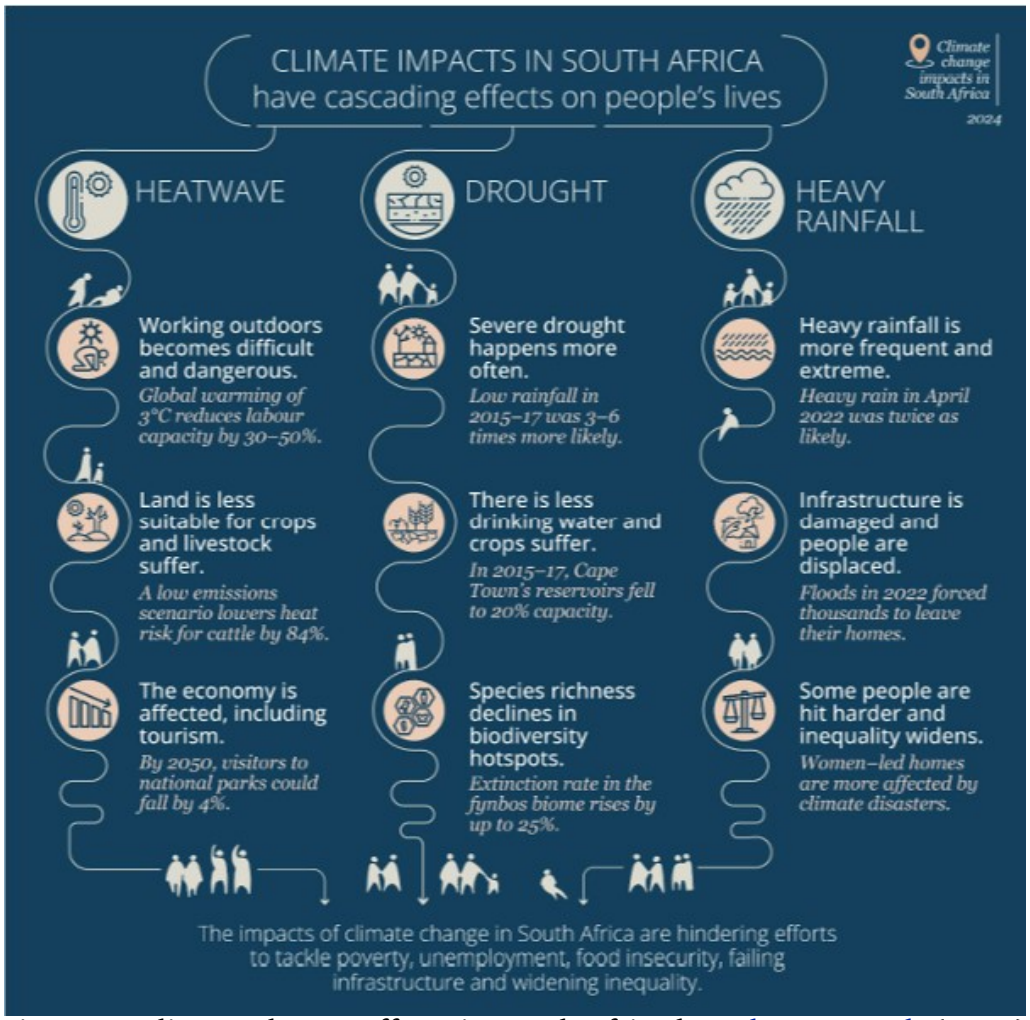

Figure 1: Climate change effects in South Africa by Johnston et al. (2024)

The graphic illustrates the significant challenges posed by climate change. The literature review highlights both the severity of the issue and the existing knowledge and responses. Consequently, it is essential to examine public perceptions of climate change and the factors influencing these perceptions. This study seeks to identify patterns and relationships between climate change and its perception within the South African context.

Climate Data: Context for the Study

Understanding South Africans' perceptions of climate change requires an examination of historical climate trends. South Africa has experienced significant climatic shifts over the past decades, with notable increases in temperature, shifts in precipitation patterns, and an increase in extreme weather events. These changes have far-reaching implications for ecosystems, agriculture, water resources, and public health, ultimately shaping public awareness and perceptions of climate change.

The study analyzes historical temperature records and rainfall variability, focusing on long-term patterns and extreme weather occurrences. The increasing frequency of heatwaves, droughts, and unpredictable rainfall patterns are key indicators of climate change in South Africa. These climatic shifts have led to significant consequences for agriculture, biodiversity, and water availability, affecting local economies and food security.

The analysis of climate data serves as a foundation for understanding public perceptions of climate change. By contextualizing survey data within observed climate trends, this study explores how South Africans perceive and respond to these environmental changes. The following sections integrate climate data with survey findings to assess awareness levels, regional variations, and demographic influences on climate change perception.

Data Requirements and Collection

To examine the relationship between climate change and public perception in South Africa, this study employs a combination of climate data and survey data. These datasets are critical in assessing how climate change awareness is shaped

by demographic, geographic, and behavioral characteristics.

Data Sources and Justification

The study utilizes two primary data sources:

- Survey data from Afrobarometer Round 7, which captures South Africans' perceptions of climate change as well as socio-economic and demographic attributes. Afrobarometer provides nationally representative samples, ensuring a proportional distribution across different geographic and socio-economic groups.
- Climate change data from the Climate Change Knowledge Portal, which includes temperature and precipitation trends to quantify climate variability and its potential impact on public awareness.

Additional control variables are included to ensure a robust analysis:

- Education level, which captures how formal education influences climate change awareness.
- Media exposure, which examines how frequently individuals engage with climate-related news sources.
- Urban versus rural location, which assesses differences in climate perception between urban and rural residents.
- Lived poverty index, which controls for economic conditions that may influence perception and concern about climate change.

Sampling Strategy

The Afrobarometer survey employs a stratified, multi-stage, random sampling approach to ensure national representativeness. The sample includes both urban and rural populations, with stratification based on province, gender, and socio-economic status. A minimum sample size of 1,200 respondents is typically used per country, yielding a 95 percent confidence level with a plus or minus 3 percent margin of error.

Causal Framework

The conceptual framework of this study is represented by the causal diagram below, illustrating the relationship between climate change, socio-economic conditions, and public perceptions.

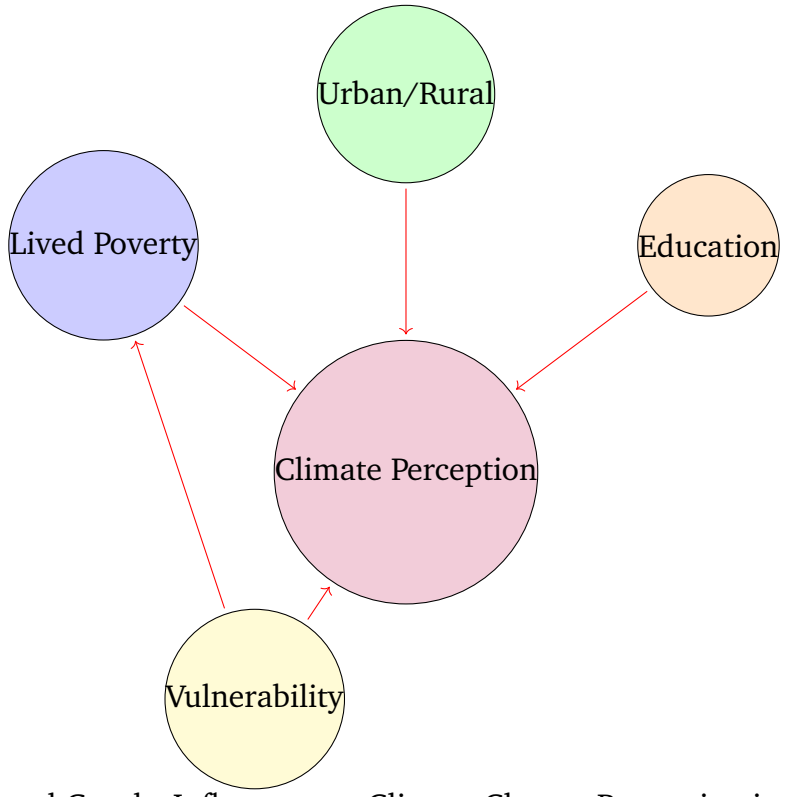

Figure 2: Causal Graph: Influences on Climate Change Perception in South Africa

Analytical Methods

This research employs a quantitative approach to examine the relationship between climate change and public perception in South Africa. The analytical framework consists of three primary techniques:

1. Descriptive statistics to summarize trends in climate awareness, concern, and regional variations.
2. Regression analysis, including:
    - Logistic regression to identify significant predictors of climate concern.

    - Multivariate regression to examine the interaction between socio-economic factors and climate perception.
3. Factor analysis to identify underlying dimensions in climate attitudes and concerns.

Addressing Biases and Limitations

- Response bias, where climate concern may be influenced by social desirability bias. Findings are cross-validated with historical climate perception trends.
- Data gaps, where missing values will be handled using multiple imputation techniques to maintain statistical robustness.
- Generalizability, where Afrobarometer provides nationally representative data, but results may not fully capture localized variations in perception within smaller South African communities.

Quantitative Analysis

The quantitative analysis in this study focuses on statistical examination of South African citizens' perspectives across the nine provinces. Using Afrobarometer survey data, quantitative methods will be employed to analyze structured responses regarding climate change awareness and concern. The study incorporates descriptive statistics to summarize key trends and inferential techniques to establish relationships between demographic factors and climate perceptions.

A key aspect of the analysis involves text-based survey responses. While open-ended responses contain qualitative elements, they will be quantitatively assessed using text mining techniques, such as word frequency analysis and sentiment scoring. This enables the identification of recurring themes and patterns in public perceptions while maintaining a numerical basis for comparison.

The study also tests hypotheses related to the socio-demographic determinants of climate awareness. Descriptive statistics will be used to examine variations in climate concern across different regions, education levels, and media exposure categories. Furthermore, regression analysis will be conducted to explore the influence of independent variables—including education, urbanization, and lived poverty—on climate change perception. These statistical techniques provide

empirical evidence for the relationships between key socio-economic factors and climate change attitudes, ensuring a rigorous and objective evaluation.

Analysis and Results

RStudio is employed for data analysis, utilizing key packages such as ‘tidyverse‘, ‘lubridate‘, and ‘readr‘ for data manipulation and visualization. Five datasets are used to ensure robustness and credibility, minimizing potential biases.

The datasets include annual precipitation records, annual temperature series, monthly temperature (TAS), and separate datasets for maximum and minimum monthly temperatures. Each dataset serves a specific role in assessing long-term climate trends and regional variations across South Africa.

The temperature dataset consists of observations spanning from 1901 to 2021, covering all nine provinces: Free State, Gauteng, Western Cape, Eastern Cape, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape, and North West. This dataset contains 121 yearly entries and 10 feature variables, facilitating both exploratory and inferential analyses.

Data preparation included thorough validation, revealing no missing values across datasets. This ensures the integrity of subsequent statistical analyses. The next phase involves data visualization, where trend plots will be generated to illustrate climate patterns, followed by regression modeling to test hypotheses on climate change perception.

Afrobarometer Data Analysis

This section presents an analysis of Afrobarometer survey data to evaluate public perceptions of climate change in South Africa. The survey data provides insights into climate change awareness, perceived changes in climate conditions over time, and beliefs about the causes of climate change. Additionally, demographic and media engagement data are examined to understand the factors influencing climate change awareness. By quantifying these responses, we gain a clearer understanding of public attitudes and their potential implications for policy and environmental education initiatives.

Climate Change Awareness

One of the primary aspects examined is climate change awareness among respondents.

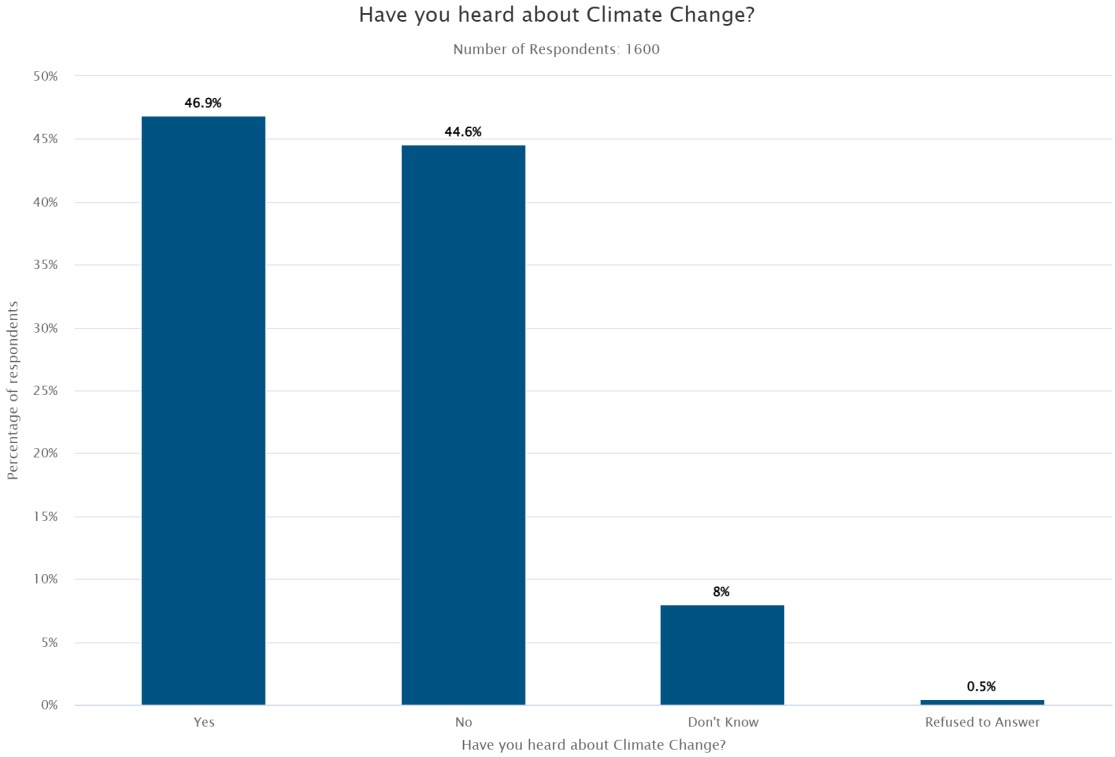

Figure 3: Bar graph of climate change knowledge

Figure 3 presents responses to the question, ”Have you heard about climate change?” The results indicate that 46.94% of respondents in South Africa are aware of climate change, while 44.56% have not heard about it. A small percentage (approx-

imately 0.5%) either did not know or did not provide an answer. This suggests that nearly half of the surveyed population lacks awareness of climate change, highlighting the need for increased public education efforts.

Perceived Climate Change Conditions

Another critical aspect of the analysis involves how respondents perceive climate conditions compared to a decade ago.

Table 1: Perceived Climate Change Conditions Compared to 10 Years Ago

Category	**Frequency**	**% Total**	**% (Excluding No Answer)**
No experience	281	15.3%	15.4%
Much worse	283	15.5%	15.5%
Worse	351	19.2%	19.3%
About the same	388	21.2%	21.3%
Better	268	14.7%	14.7%
Much better	79	4.3%	4.3%
Refused	10	0.5%	-
Don't know	169	9.3%	9.3%

Table 1 illustrates public perceptions of climate change over the past decade. The majority of respondents believe that conditions have either remained the same (21.2%) or worsened (34.7% combined for "Much Worse" and "Worse"). These perceptions may be shaped by experiences with extreme weather events, changing rainfall patterns, or other environmental factors.

Beliefs About the Causes of Climate Change

Public beliefs regarding the causes of climate change were also analyzed.

Table 2: Public Perceptions of the Causes of Climate Change

Category	**Frequency**	**% Total**	**% (Excluding No Answer)**
Human Activity	385	45.7%	45.8%
Natural Processes	239	28.3%	28.4%
Both Human Activity and Natural Processes	138	16.3%	16.4%
None of These	7	0.9%	0.9%
Refused	3	0.3%	0.3%
Don't know	72	8.5%	8.6%

Table 2 indicates that the majority (45.7%) attribute climate change primarily to human activity, while 28.3% believe it is due to natural processes. This highlights

the need for targeted educational campaigns emphasizing the scientific consensus on anthropogenic climate change.

Climate Change Awareness Across Demographics and Media Engagement

To further understand climate change awareness, this study also considers education levels, geographic regions, and media consumption habits.

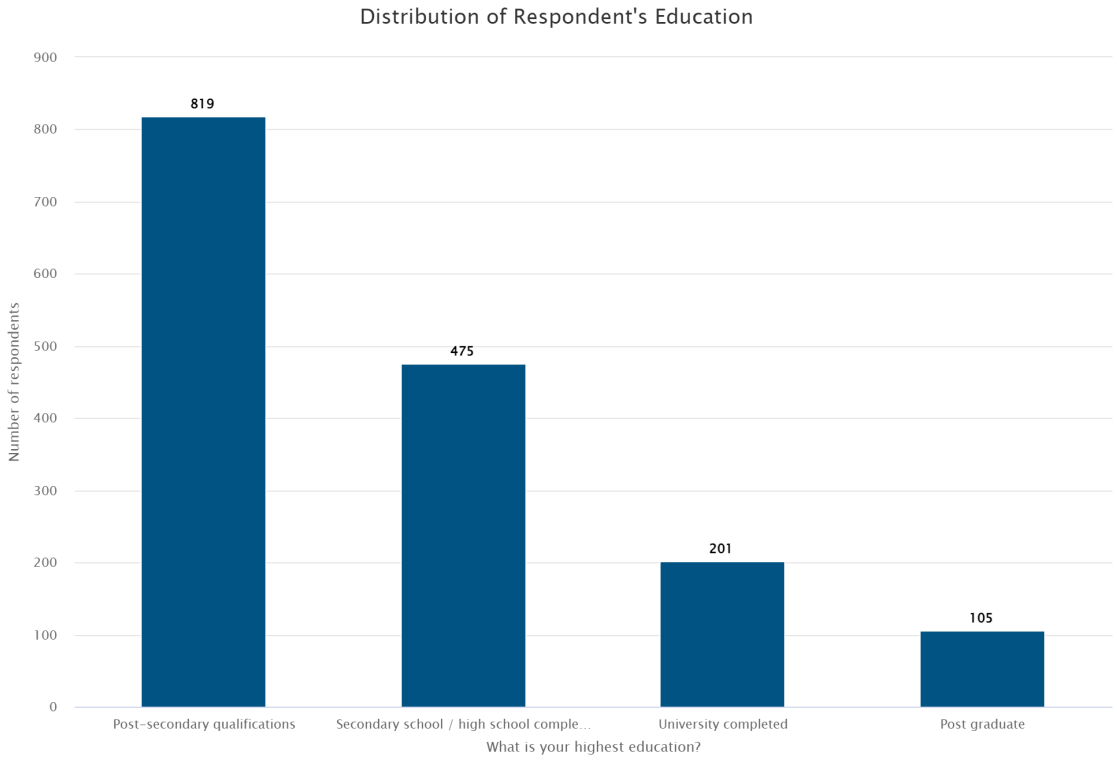

Figure 4: Climate Change Knowledge by Education Level

Figure 4 shows that individuals who have completed first degrees or higher tend to have greater awareness of climate change. Interestingly, post-graduate respondents show slightly lower awareness levels than undergraduates, raising questions about data collection or external factors influencing awareness.
Figure 5 highlights regional disparities in climate change awareness. The Eastern Cape (54.8%), KwaZulu-Natal (53.7%), and Gauteng (52.0%) show the highest awareness, while Free State, North West, and Limpopo exhibit lower awareness levels. This variation may be linked to industrialization and environmental exposure.
Figure 6 illustrates that urban areas exhibit slightly higher awareness levels (47.8%) compared to rural areas (43.7%), aligning with expectations that urban dwellers,

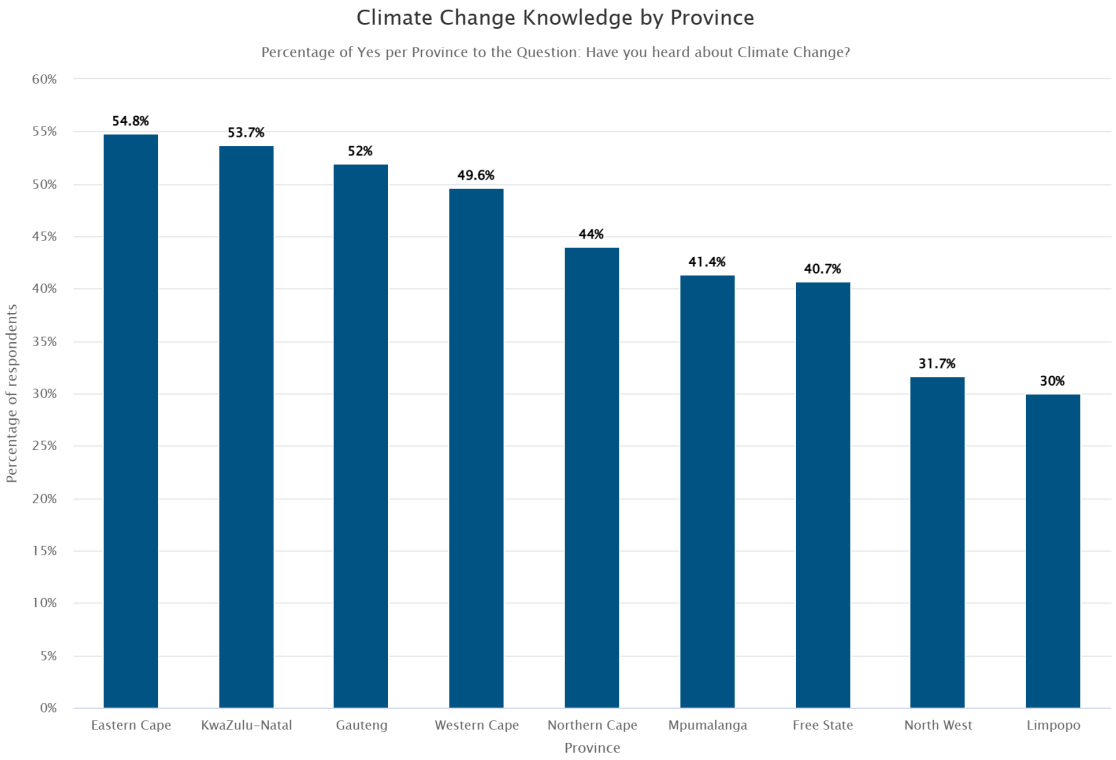

Figure 5: Climate Change Knowledge per Province

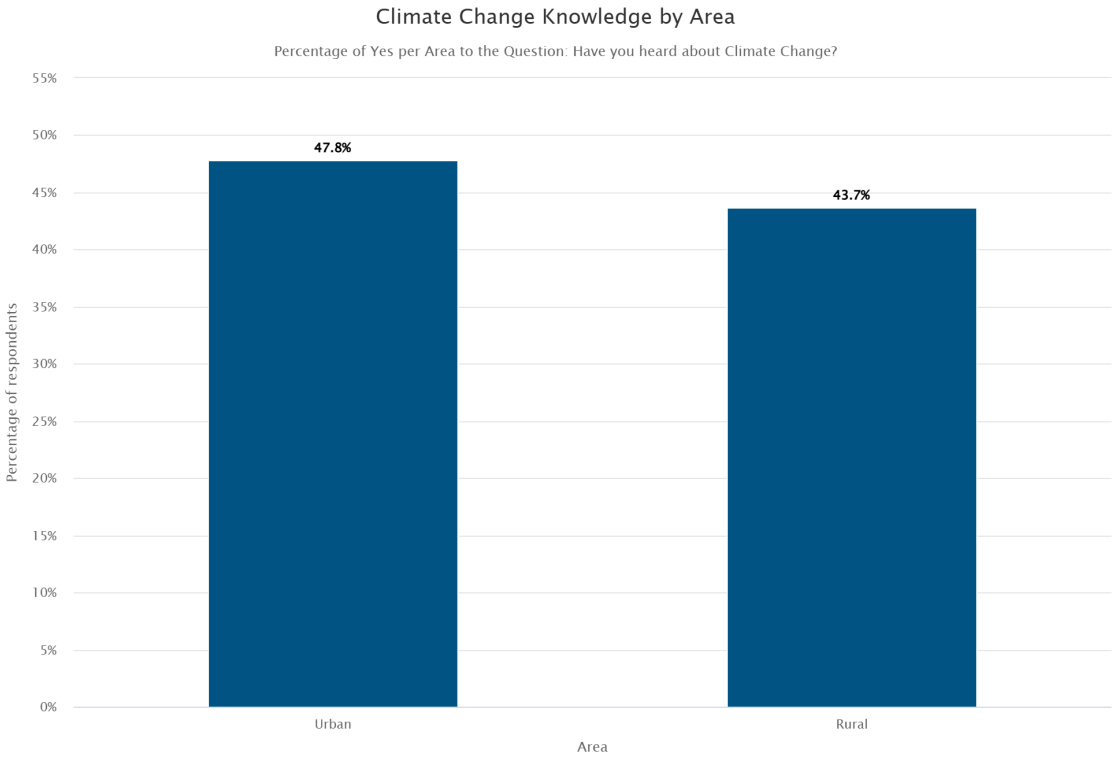

Figure 6: Climate Change Knowledge by Area

with greater access to information and education, are more aware of climate change.

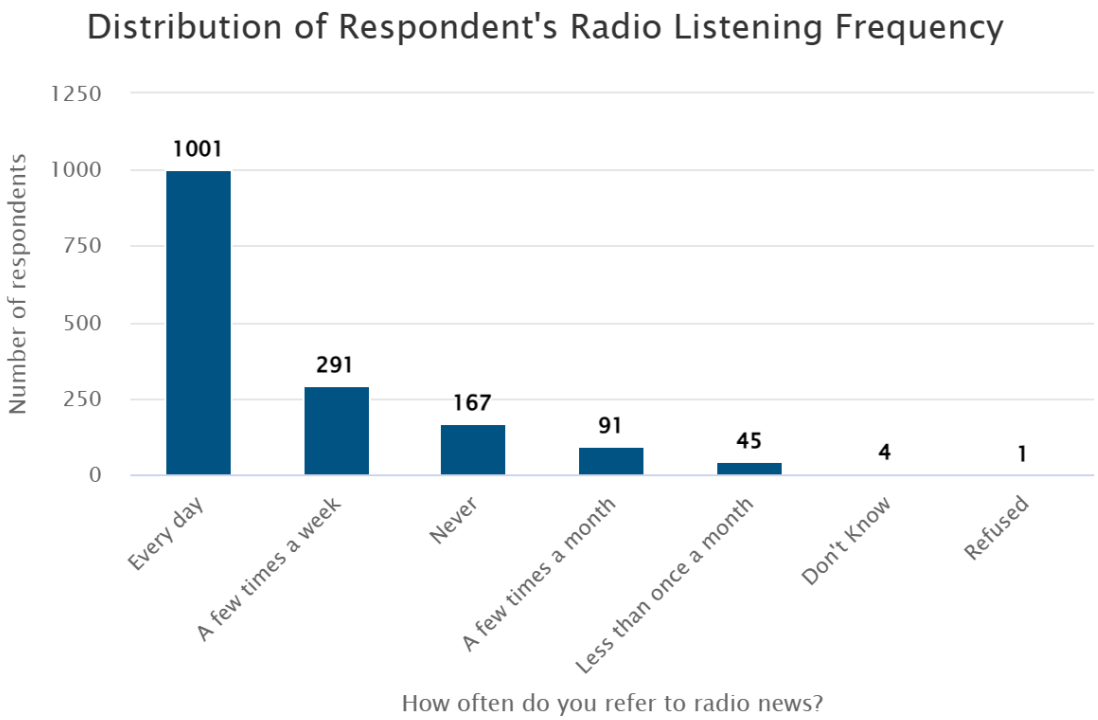

Figure 7: Climate Change Awareness by Radio Listening Frequency

Figure 7 demonstrates that individuals who listen to the radio more frequently tend to have higher awareness of climate change. This emphasizes radio's role as an important medium for disseminating climate change-related information.

Climate Change: Community Perception vs Reality (Climate Data)

This section examines whether significant differences exist between public perceptions of climate trends and actual climate data across South Africa's provinces.

- Assess whether observed climate trends align with public perceptions or are anecdotal.
- Investigate whether perceptions of adverse climate trends are supported by objective temperature data.
- Identify discrepancies between public perception and recorded climate trends.

Figure (9) illustrates public perceptions of climate change's impact on the country. A total of 69.2% of respondents believe climate change has worsened conditions—34.1% categorize it as "much worse" and 35.1% as "somewhat worse."

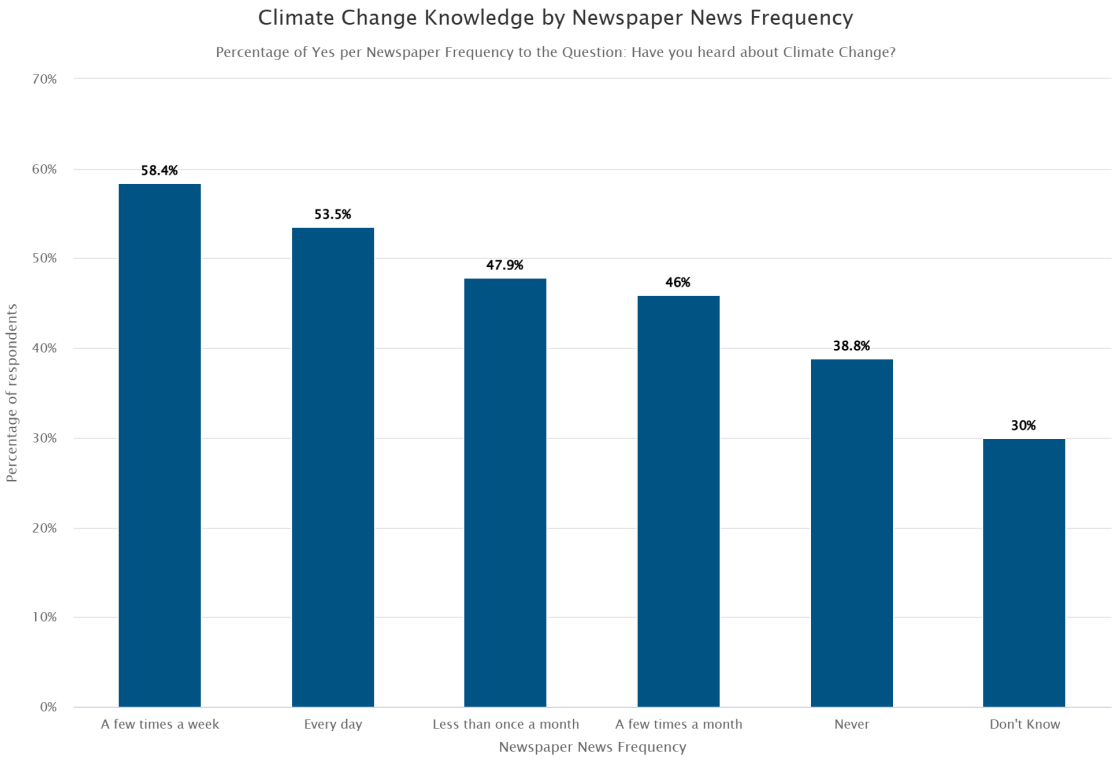

Figure 8: Climate Change Awareness by Newspaper Reading Frequency

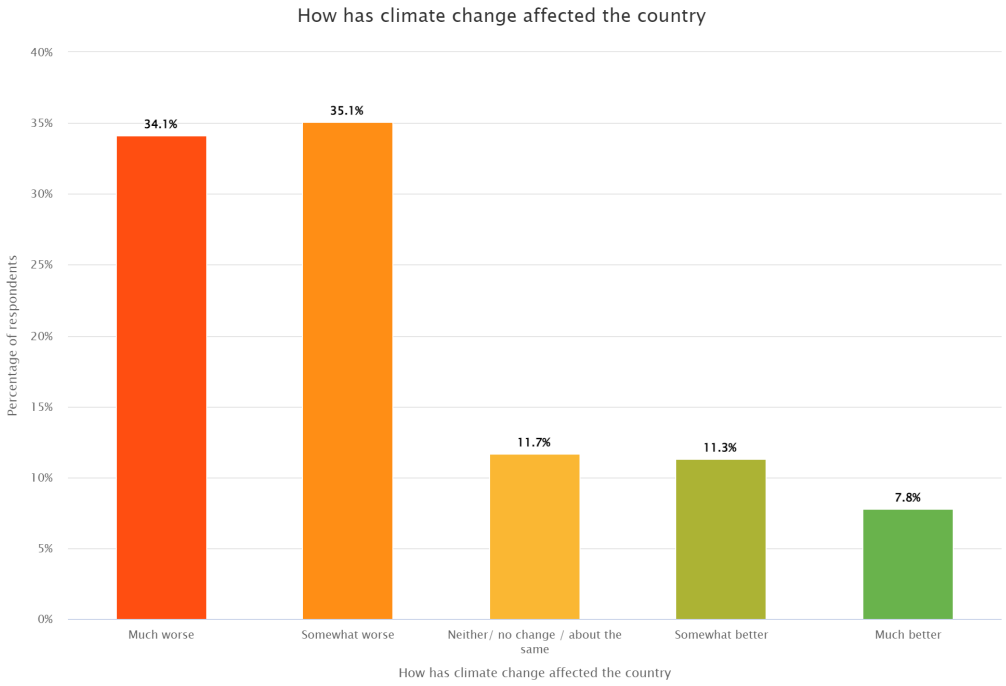

Figure 9: Public Perceptions of Climate Change Impact

Meanwhile, 11.7% remain neutral or perceive no impact. Conversely, 19.1% believe climate change has had a positive effect, with 7.8% considering it ”much better” and 11.3% ”somewhat better.”

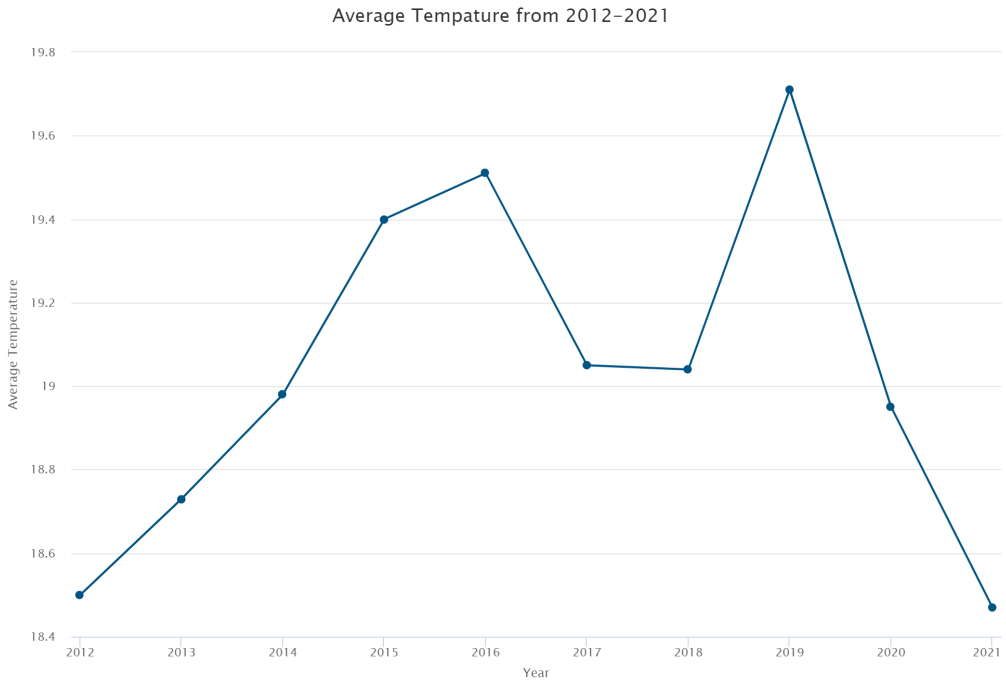

Figure 10: Average Temperature Trends (2012–2021)

Figure (10) presents the average temperature trends over a decade. The data shows that temperatures were at their lowest in 2012, followed by a sharp increase until 2016. A continued rise occurred from 2016 to 2018, peaking before experiencing a decline from 2019 to 2021.

Figure (11) highlights the perceived impact of climate change across selected provinces. The highest proportion of respondents reporting that climate change has made conditions ”much worse” were in Eastern Cape (39.5%), Mpumalanga (39.5%), and Western Cape (36.2%). In contrast, provinces such as Free State, North West, and Gauteng reported lower perceived negative impacts. Meanwhile, North West (20%), Mpumalanga (18.6%), and Limpopo (12.5%) had the highest percentages of respondents perceiving climate change as beneficial.

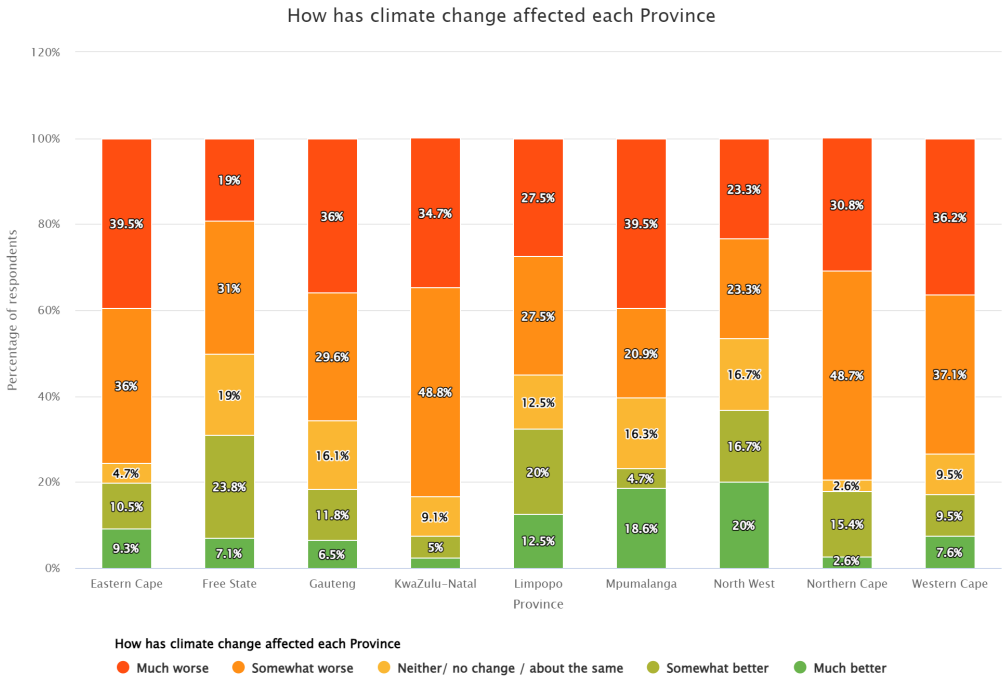

Figure 11: Perceived Impact of Climate Change by Province

Figure (12) shows the average temperature per province from 2000 to 2021. Mpumalanga recorded the highest average temperature, followed by Northern Cape, Limpopo, and Free State.

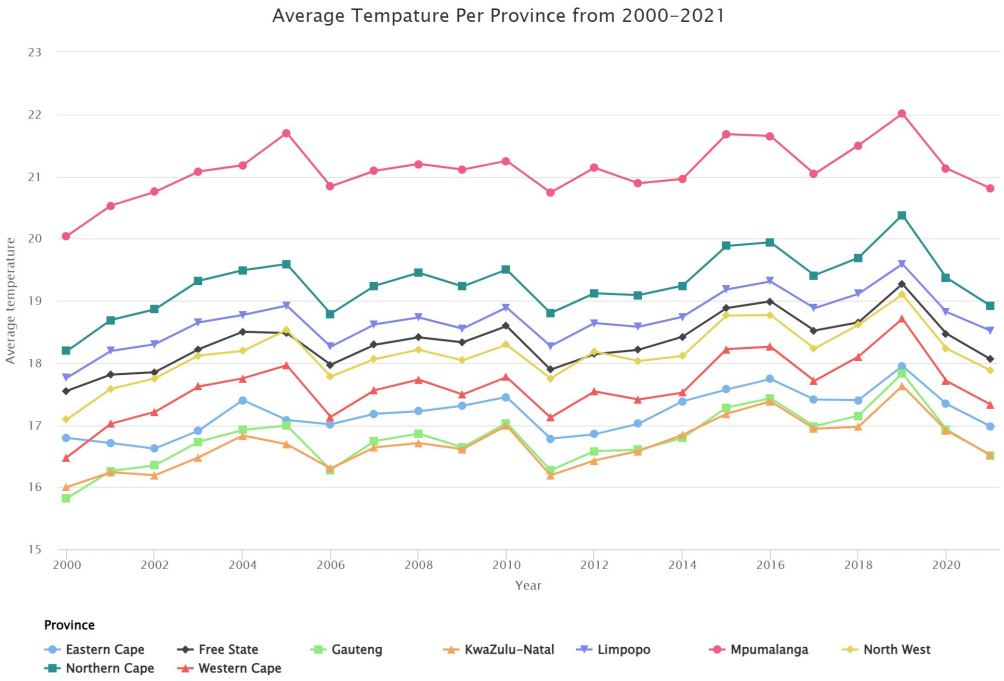

Figure 12: Average Temperature per Province (2000–2021)

Figure (13) depicts annual minimum, maximum, and mean precipitation trends from 2000 to 2021.
Figure (14) presents the annual minimum, maximum, and mean temperatures from 2000 to 2021.

Regression Analysis: Public Perception and Climate Change Awareness

Regression analysis explores the relationship between temperature data and demographic factors, such as education level, climate change awareness, and settlement type. A generalized linear model (GLM) logistic regression was employed to model the probability of perceiving climate change based on these factors.
The dataset used in this study is derived from the Afrobarometer survey, consisting of 5 rows and 417 columns. A subset of variables was selected for analysis based on relevance to the study objectives.
The selected variables include South Africa's nine provinces: Gauteng, Western Cape, Eastern Cape, KwaZulu-Natal, Limpopo, Mpumalanga, North West, and Northern Cape. The primary dependent variables are "Awareness of Climate Change" and "Perceived Climate Change Impact," with explanatory variables including area type (rural/urban), employment status, education level, gender, and media consumption habits.

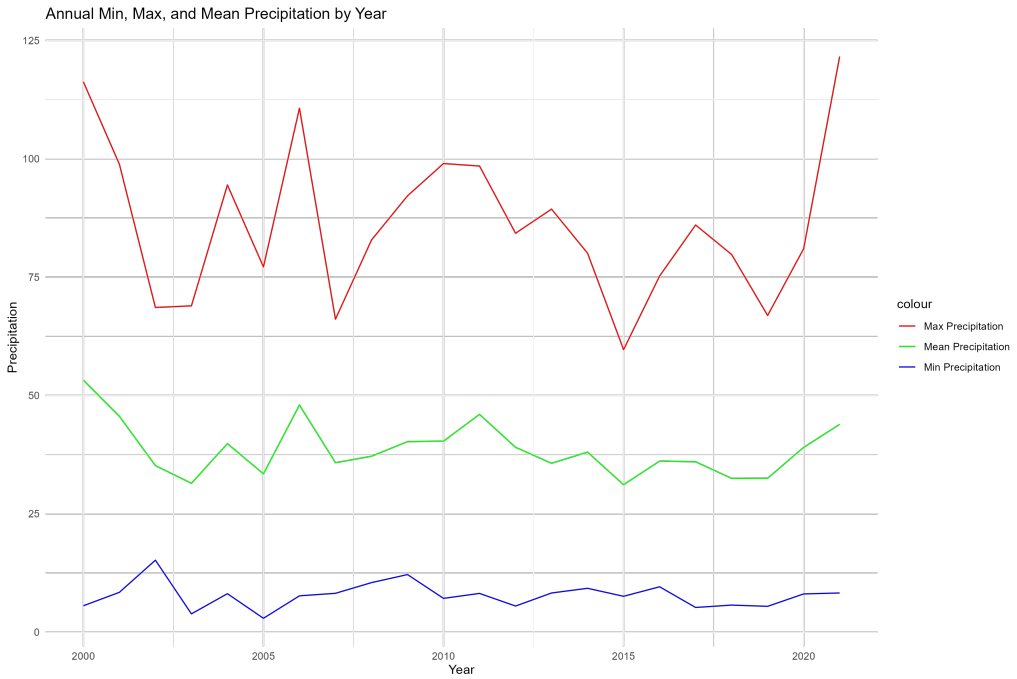

Figure 13: Annual Precipitation (2000–2021)

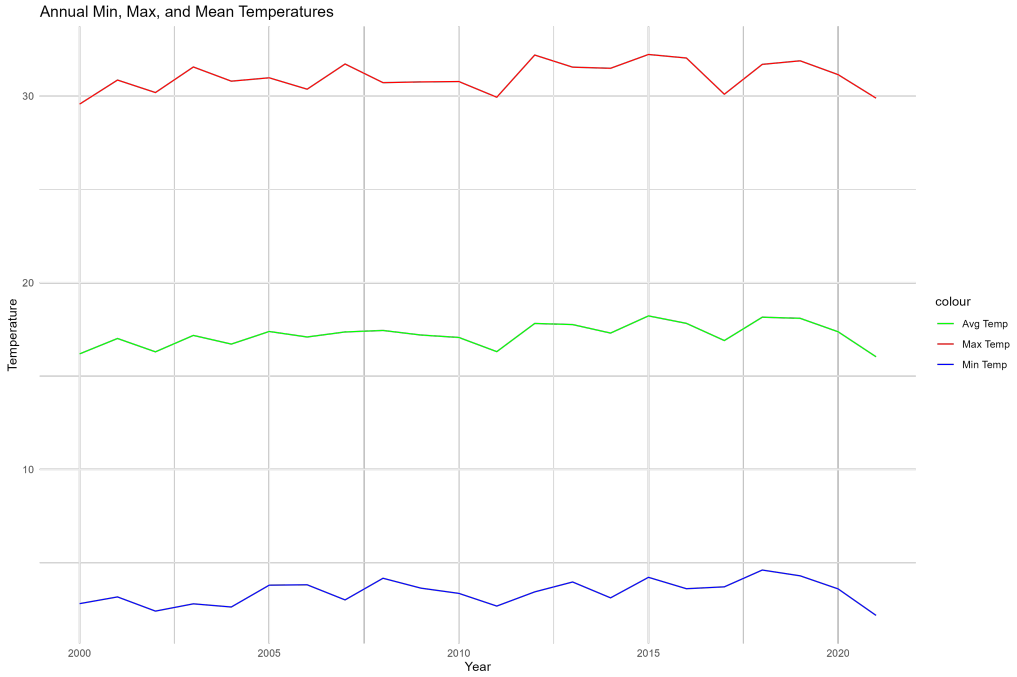

Figure 14: Annual Temperature Trends (2000–2021)

Table 3: Descriptive Statistics of Key Variables (N=1600)

Variable	Mean	Std. Dev
Awareness of Climate Change	1.23	2.40
Perceived Impact of Climate Change	5.67	1.90
Area Type (Urban=1, Rural=0)	0.78	0.41
Education Level (1=Primary, 2=Secondary, 3=Post-Secondary)	1.46	1.31
Gender (1=Male, 2=Female)	1.50	0.50
Radio News Consumption (1=Rare, 5=Frequent)	3.22	1.34
Print Newspaper Consumption (1=Rare, 5=Frequent)	1.72	1.68

Table (3) summarizes the key variables, providing insight into the sample distribution across education levels, media consumption habits, and climate change awareness.

Table 4: Logistic Regression Results: Predicting Climate Change Awareness

Predictor	Estimate	Std. Error	p-value
Urban Area (1=Urban, 0=Rural)	-1.0480	0.2513	<0.001***
Post-Secondary Education	0.3034	0.1300	0.0196**
University Degree	0.5582	0.1969	0.0046***
Female	0.2519	0.1048	0.0162**
Print Newspaper Frequency	0.5173	0.1570	0.0010***
Province: Free State	-1.2070	0.2872	<0.001***
Province: Limpopo	-2.0673	0.3481	<0.001***

Table (4) presents the logistic regression results, highlighting key predictors of climate change awareness.

- Urban vs. Rural: Individuals in rural areas are significantly more likely to be aware of climate change than those in urban areas ($p < 0.001$), possibly due to direct climate exposure.
- Education Level: University graduates exhibit significantly higher climate change awareness ($p = 0.0046$).
- Gender: Females are more likely to report awareness than males ($p = 0.0162$).
- Media Consumption: Print newspaper readership strongly correlates with awareness ($p = 0.0010$), whereas radio news does not show a significant effect.

These findings highlight the importance of education, gender, and media engagement in shaping climate change awareness in South Africa.

ANOVA Testing

Analysis of Variance (ANOVA) is a statistical method used to compare the fit of different models and assess whether additional predictors significantly improve explanatory power. In this study, ANOVA is applied to evaluate whether including province-level predictors enhances the logistic regression model's ability to explain climate change awareness.

Null hypothesis (H_0): The inclusion of province-level predictors does not significantly improve the model's fit; a simpler model without province-level effects explains the data just as well.

Alternative hypothesis (H_1): The inclusion of province-level predictors significantly enhances the model's explanatory power, suggesting that regional differences meaningfully influence climate change awareness, beyond demographic and behavioral factors.

To test this, we compare two nested logistic regression models: one excluding province-level effects and one including them. The results of this comparison are presented in Table 5.

ANOVA Test: Model Comparison

To determine the statistical significance of incorporating province-level fixed effects, an ANOVA test was conducted between two models: one excluding province as a predictor and another including it.

Table 5: ANOVA Model Comparison

Model	Residual Deviance	p-value
Without Province Fixed Effects	2129	-
With Province Fixed Effects	2099	0.0014

The ANOVA results indicate that incorporating province-level effects significantly improves model fit ($p = 0.0014$). This suggests that regional variations play a crucial role in shaping climate change awareness, reinforcing the importance of localized factors in climate-related perceptions.

ANOVA Results for Logistic Regression Models

Table 6: ANOVA Results for Logistic Regression Models

Model	Residual DF	Residual Deviance	p-value
Without Province Fixed Effects	1586	2159	<0.001
With Province Fixed Effects	1578	2099	<0.001

Table 6 presents the ANOVA results comparing the logistic regression models with and without province-level predictors.

- The model including province variables has a lower residual deviance (2099) compared to the model without them (2159), suggesting an improved model fit.
- The chi-square test produces a highly significant p-value ($p < 0.001$), providing strong evidence that province-level factors contribute to explaining climate change awareness.
- This indicates that including province as a predictor improves the explanatory power of the model.

Logistic Regression Results: Climate Change Awareness

Table 7: Logistic Regression Results for Climate Change Awareness

Variable	Coefficient	Std. Error	z-value	p-value
Constant	-0.2114	0.843	-0.251	0.802
Area Type (Rural=0, Urban=1)	0.2144	0.278	0.773	0.439

Table 7 presents the logistic regression results examining the relationship between climate change awareness and area type (rural/urban).

- The model has a final log-likelihood value of 0.692, indicating a weak fit.
- With a pseudo-R-squared value of 0.00001823, the area type variable explains minimal variance in awareness.
- The coefficient for area type (0.2144) is not statistically significant ($p = 0.439$), suggesting no strong evidence that urban or rural residence influences climate change awareness.

The constant term (-0.2114) is also not statistically significant ($p = 0.802$), indicating that the baseline level of awareness does not significantly differ from zero.

Expanded Logistic Regression Model

Table 8: Expanded Logistic Regression Model for Climate Change Awareness

Variable	Coefficient	Std. Error	z-value	p-value
Constant	-0.2356	0.455	-0.517	0.606
Education Level	0.591	0.046	1.277	0.202
Area Type (Rural=0, Urban=1)	-0.1522	1.186	0.264	0.792
Gender (Female=1, Male=0)	-0.2781	0.106	-2.614	0.009
Radio News Consumption	-0.0303	0.042	-0.724	0.469
Newspaper News Consumption	0.1363	0.024	4.024	<0.001

Table 8 presents an expanded logistic regression model examining multiple factors influencing climate change awareness.

- **Gender**: A significant negative association ($p = 0.009$) suggests that females are less likely to report awareness than males.
- **Newspaper Consumption**: A highly significant positive predictor ($p < 0.001$), indicating that frequent newspaper readers are more likely to be aware of climate change.
- **Education Level, Area Type, and Radio News Consumption**: These variables are not statistically significant, implying that they do not independently influence awareness.

Logistic Regression: Regional Differences

Table 9: Logistic Regression Including Regional Predictors

Variable	Coefficient	Std. Error	z-value	p-value
Constant	40.8911	26.525	1.542	0.123
Education Level	0.161	0.083	1.985	0.047
Area Type (Rural=0, Urban=1)	0.0858	0.245	0.351	0.9726
North West Province	-0.0464	0.038	-1.230	0.219
Climate Change Affecting People	-1.5803	0.0085	-18.646	<0.001

Table 9 presents results including regional differences.

- **Climate Change Affecting People**: A strong, highly significant association ($p < 0.001$) suggests that those perceiving climate change effects are more likely to be aware of it.
- **Education Level**: A significant positive association ($p = 0.047$) suggests that individuals with higher education levels have greater awareness.

- **Area Type and North West Province**: These variables are not statistically significant.

Linear Regression: Climate Change Affecting the Country

Table 10: Linear Regression: Climate Change Affecting South Africa

Variable	Estimate	Std. Error	t-value	p-value
(Intercept)	1.3856	0.2115	6.55	<0.001
Urban Area (Rural=0, Urban=1)	-0.5990	0.1535	-3.90	<0.001
University Degree	0.2717	0.1290	2.11	0.035
Female	0.1385	0.0686	2.02	0.044
Newspaper News (Daily)	0.3364	0.1031	3.26	0.001
Free State	-0.3676	0.1777	-2.07	0.039

Table 10 examines factors influencing perceptions of climate change's impact on South Africa.

- **Urban vs. Rural**: Urban residents are less likely to perceive climate change as affecting the country ($p < 0.001$).
- **Education and Gender**: A university degree ($p = 0.035$) and female gender ($p = 0.044$) are associated with stronger perceptions of climate change's impact.
- **Newspaper Consumption**: A strong positive predictor ($p = 0.001$).

The model explains 4.46% of variance (Adjusted R-squared), suggesting other unmeasured factors play a role.

ANOVA test for linear regressions

The analysis of variance (ANOVA) table compares the fit of two linear regression models:
Null Hypothesis (H0): The null hypothesis states that there is no significant difference in model fit between the two models.
Alternative Hypothesis (H1): The alternative hypothesis suggests that there is a significant difference in model fit between the two models.

- Model 1: This model includes predictors related to climate change affecting the country and other demographic variables but excludes the predictor "heard about climatechange."

- Model 2: This model is similar to Model 1 but also excludes additional predictors related to specific provinces (freestate, gauteng, kwazulu natal, limpopo, mpumalanga, northwest, northerncape, westerncape)

Table 11: Model Comparison Results

	Res.Df	RSS	Df	Sum of Sq	Pr(>Chi)
X	1578	2904	-8	-47.83	0.001053
X.1	1580	2916	-8	-47.83	0.001053
X.2	1582	2928	-8	-47.83	0.001053
X.3	1582	2928	-8	-47.83	0.001053
X.4	1584	2939	-8	-47.83	0.001053
X.5	1586	2951	-8	-47.83	0.001053
X.6			NA	NA	NA

The p-value of 0.001053 allows us to reject the null hypothesis, confirming that Model 2 provides a significantly better fit than Model 1. This result suggests that the additional predictors related to specific provinces significantly improve the prediction of climate change effects.

Limitations of the Study

While this study benefits from a large and systematically collected dataset, some limitations must be acknowledged.

First, although the Afrobarometer survey uses probability-based sampling, some degree of sampling error is inevitable. However, standard errors and inferential statistics mitigate this concern.

Second, while the study examines regional variability, future research could explore more granular geographic patterns to assess localized climate perceptions more precisely.

Conclusion

This study examined the impact of climate change in South Africa, focusing on temperature trends and public perceptions. Using logistic regression, we identified significant predictors of climate awareness, including gender, education level, and perceptions of climate impacts on people. Additionally, ordinary least squares regression highlighted the role of education and newspaper exposure in shaping awareness levels. Despite variations across models, both underscored the importance of socio-demographic factors in climate change perceptions.

The findings also revealed significant regional disparities, with respondents from Limpopo and the Northern Cape reporting lower perceived climate change impacts compared to other provinces. In contrast, the Eastern Cape and KwaZulu-Natal exhibited higher climate change awareness. Provinces such as the Eastern Cape, Western Cape, and Mpumalanga experienced the most pronounced weather changes, affecting landscapes and economic activities. While public awareness has evolved over time, it remains insufficient given the growing urgency of climate-related challenges.

Education emerged as a key driver of climate awareness, with more educated individuals demonstrating a greater understanding of climate issues. Media exposure—particularly through newspapers—also played a significant role. However, limited media coverage in rural and remote areas, especially in provinces like the

Eastern Cape, presents a barrier to climate literacy. Enhancing media outreach and educational initiatives could help bridge this gap.

In conclusion, this study underscores the need for targeted climate change education and awareness campaigns, particularly through print media and higher education institutions. Policymakers and educators should integrate these findings into strategies aimed at enhancing public understanding of climate change. Strengthening climate literacy through diverse educational and outreach efforts is crucial for fostering informed decision-making and promoting sustainable environmental practices in South Africa and beyond.

Recommendations for Future Research

Future research should expand the scope of variables to include personal experiences with climate-related events, access to environmental education programs, and cultural influences, as these factors may provide a more nuanced understanding of climate perceptions. Additionally, adopting a mixed-methods approach—integrating quantitative surveys with qualitative interviews—could offer deeper insights into the underlying drivers of climate awareness.

Innovative data collection techniques, such as social media analysis, could help capture real-time perceptions of climate change and reach diverse populations more effectively. Exploring geospatial data and remote sensing applications may also provide valuable insights into the regional impact of climate change.

Furthermore, conducting sensitivity analyses to assess the robustness of model results under different assumptions and specifications would enhance the reliability and validity of findings. Identifying potential sources of bias or instability will ensure that conclusions remain well-supported and generalizable.

By strengthening research methodologies and improving analytical approaches, future studies can contribute to more effective strategies for increasing climate awareness and addressing climate challenges, both in South Africa and globally.

Appendix

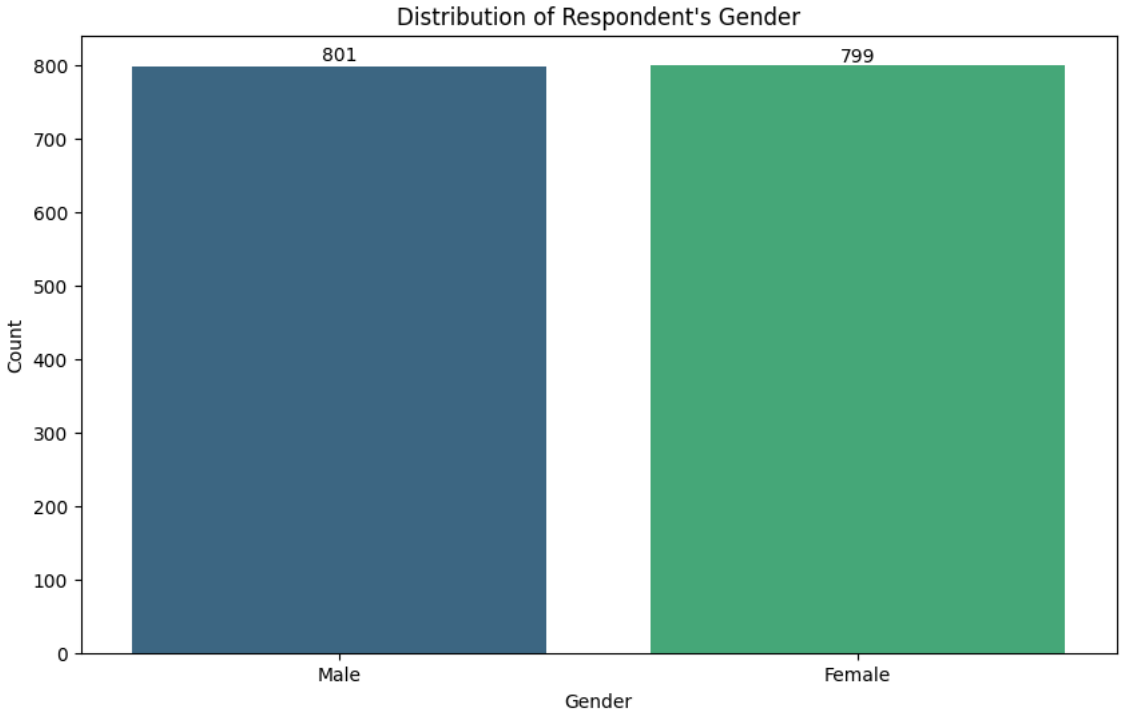

Figure 15: Respondents gender

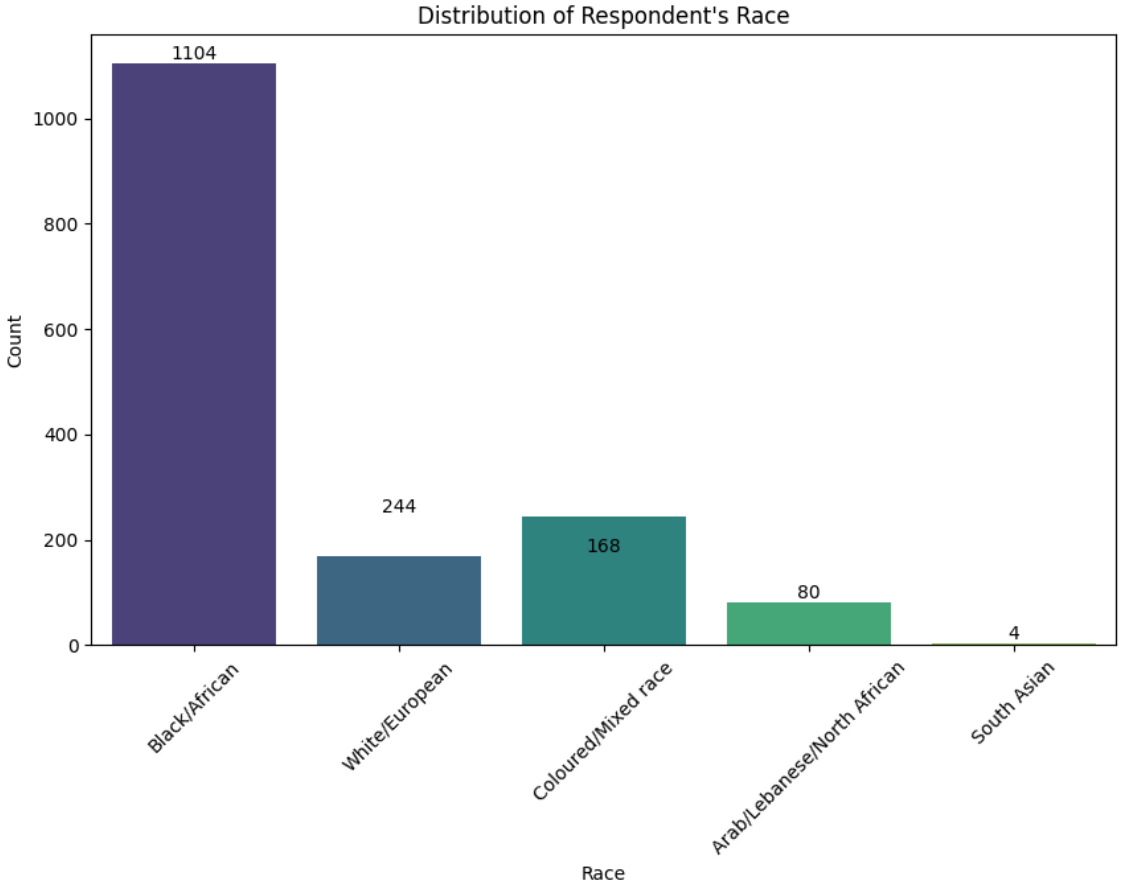

Figure 16: Respondents race

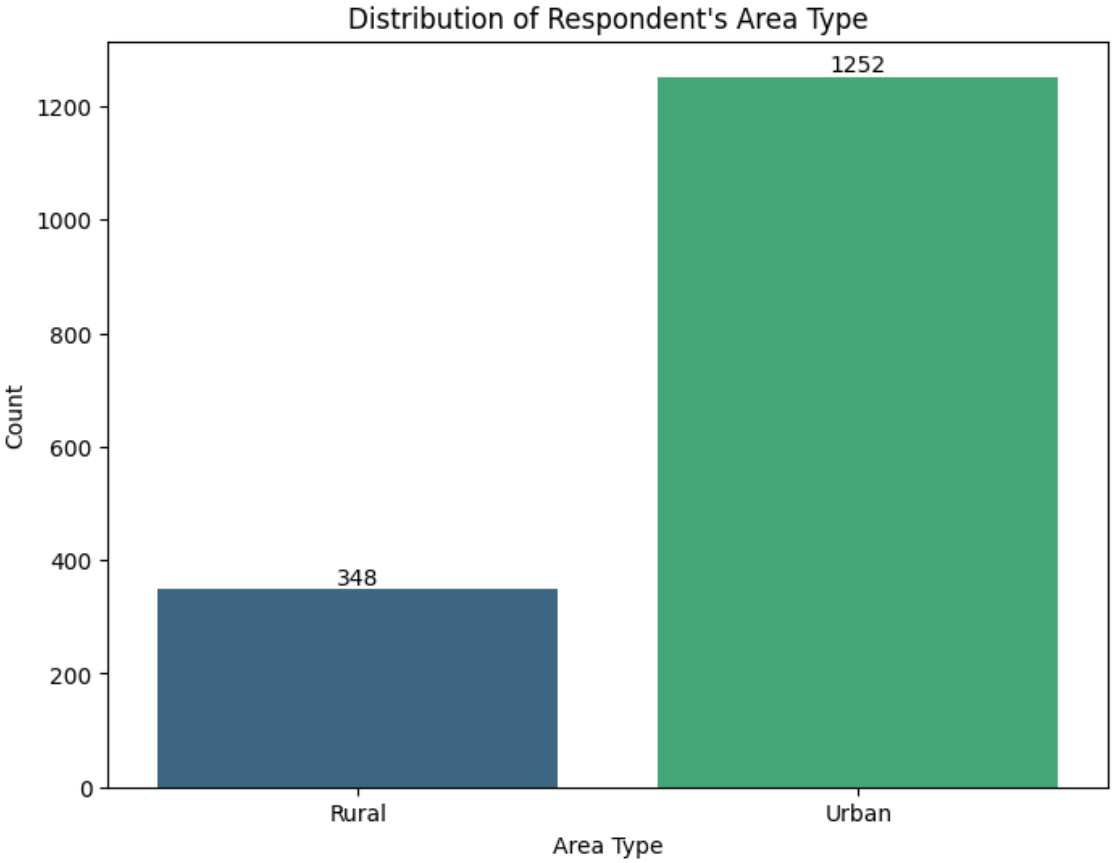

Figure 17: Respondents race

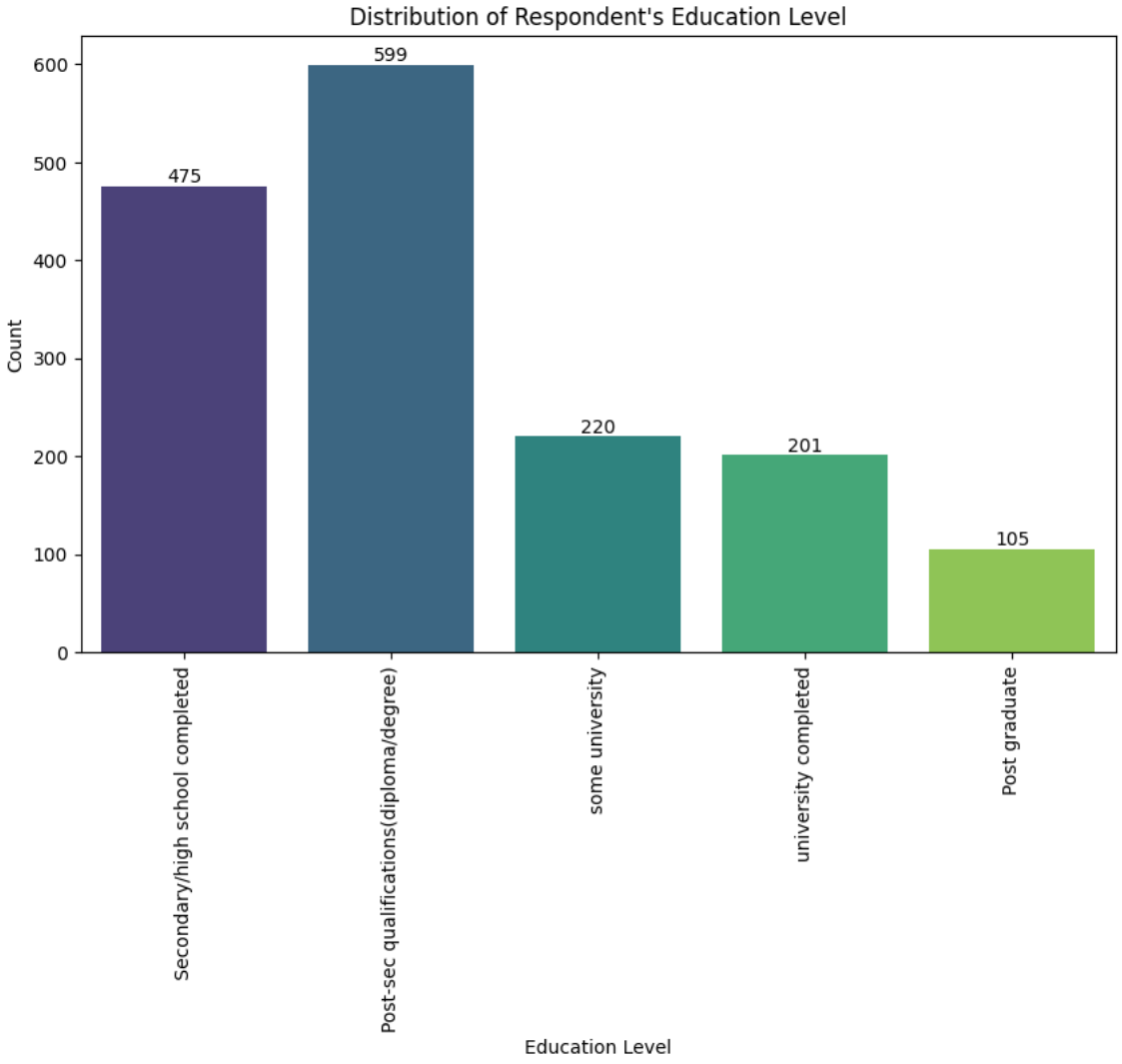

Figure 18: Respondents education level

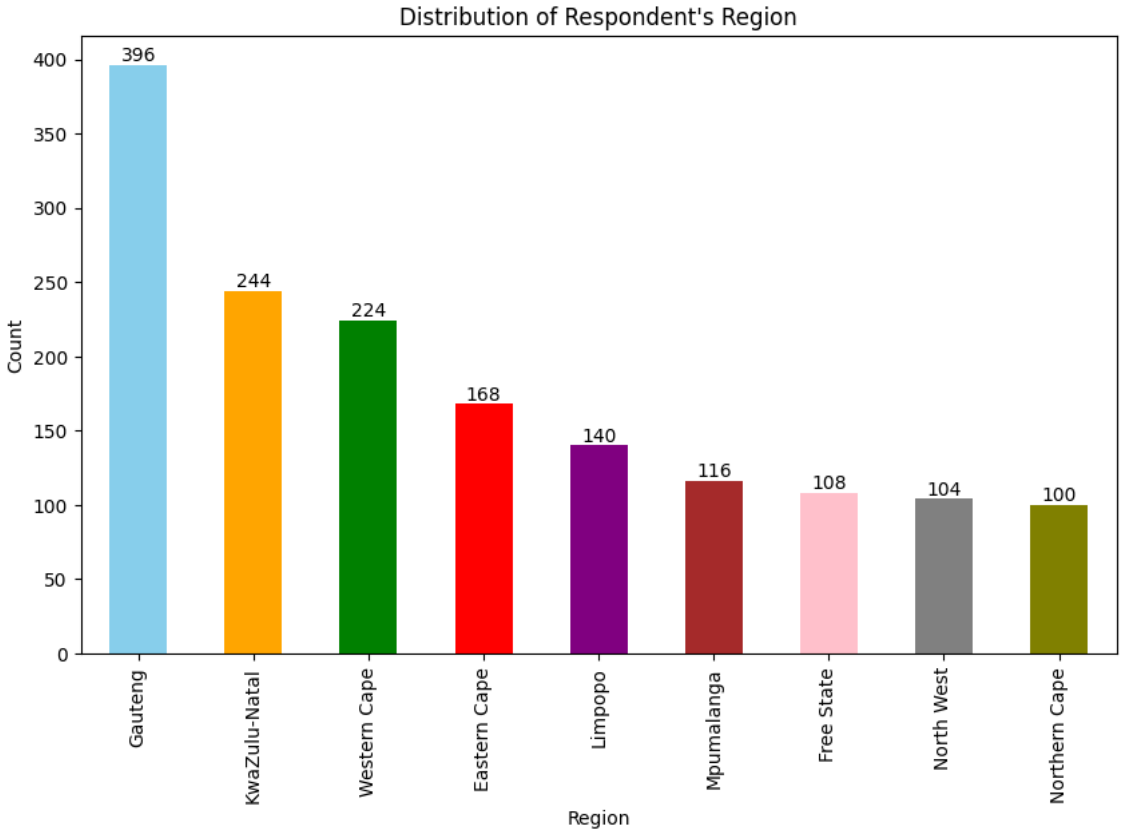

Figure 19: Respondent's region

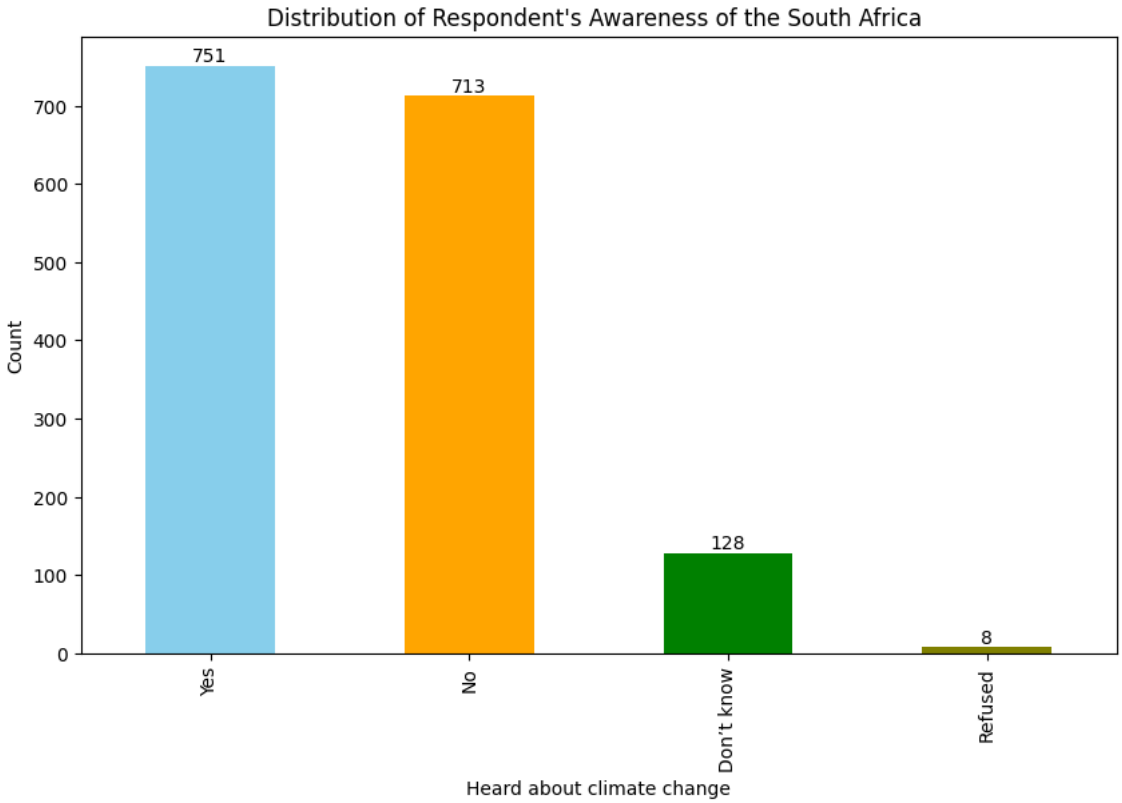

Figure 20: Respondents Awareness

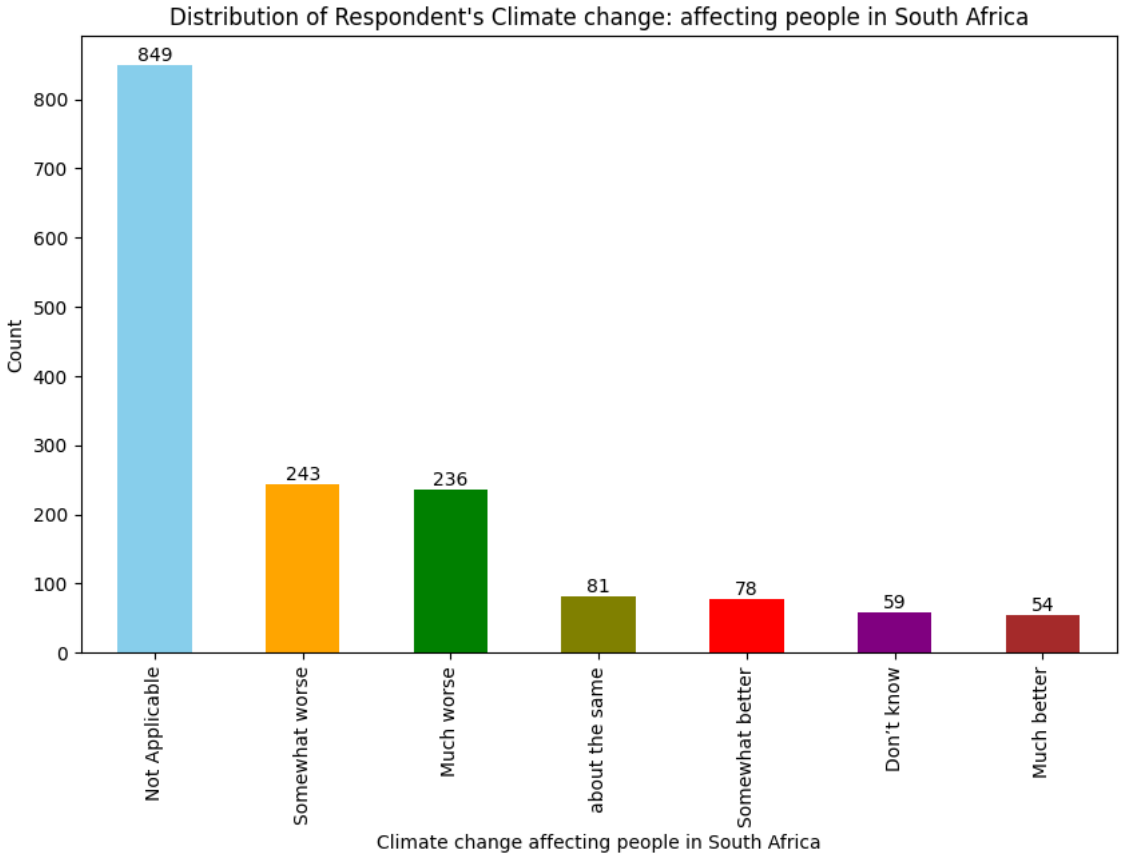

Figure 21: Likelihood of Respondents being affected climate change

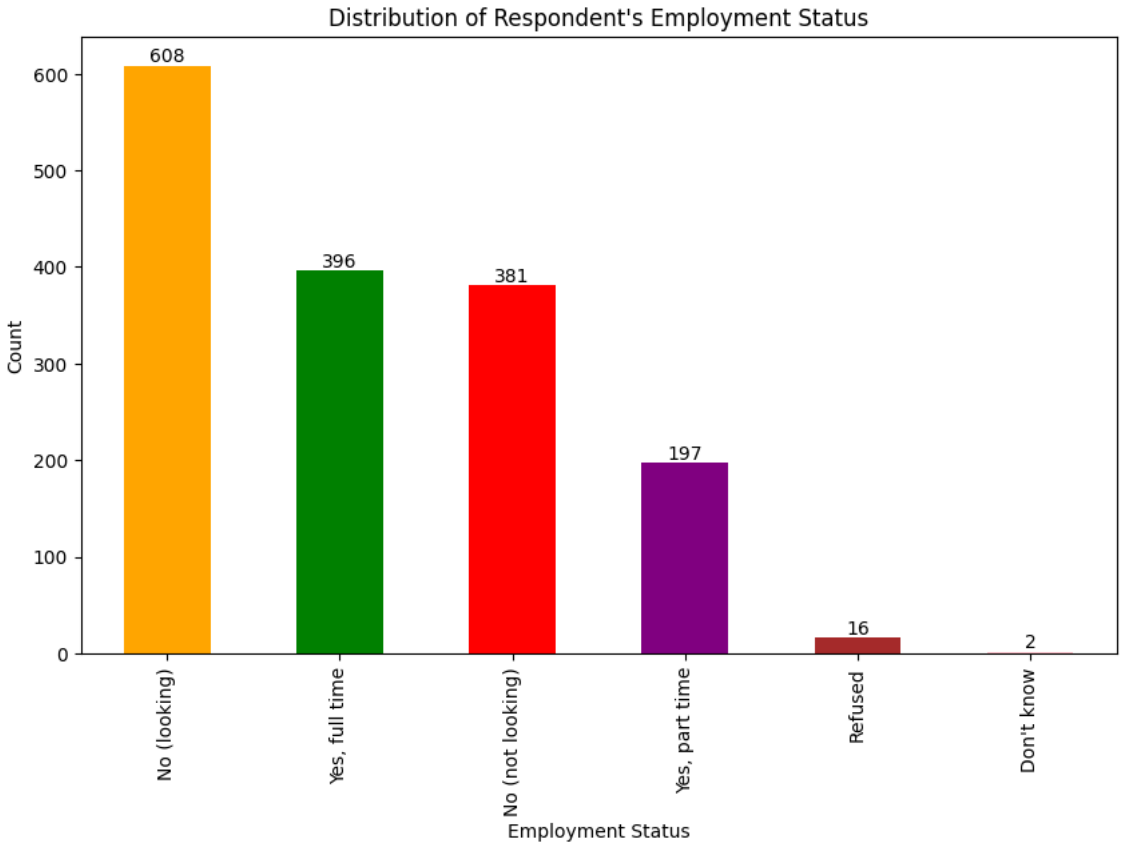

Figure 22: Respondents Employee Level

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