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THE ROLE OF NATURAL DISASTERS IN SHAPING INDIVIDUAL PERCEPTIONS OF CLIMATE CHANGE IN AFRICA



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A research report submitted to the Faculty of Humanities, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Arts in International Relations

Supervised by: Rod Alence

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Abstract

This paper explores the relationship between individual perceptions of climate change and natural disasters in African states. This paper uses both qualitative and quantitative research methodology to explore 33 African states by observing the climate change perceptions as well as climate risk experienced by individuals through natural disasters. By using subnational Afrobarometer survey data and corresponding subnational natural disaster data, this paper finds individuals who have experienced natural disasters are less likely to express concerns for climate change.

University of the Witwatersrand, Johannesburg

School of Social Sciences

SENATE PLAGIARISM POLICY

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Signature:  **Date: 13 November 2023**

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1. Background

Climate change is defined as long-term shifts in weather patterns and average temperatures across the globe (United Nations 2022), which since the 1800s has been intensified by human activity such as the burning of fossil fuels. Consequently, 700 million people are projected to be displaced, with 250 million Africans at risk of water-related stresses (Raulerson, 2022). In addition, the IPCC (2022, 5) maintains that average annual greenhouse gas emissions in the 2010-2019 period were higher than any previous decade, emphasising the fact that human activity will continue to cause harm to the environment if this trend is not quickly and effectively undone. In addition, 96% of mammal biomass on Earth is comprised of humans and livestock, showcasing the extent to which biodiversity has plummeted (Laurance, 2019, R954).

In the field of International Relations, climate change presents a relevant and contested issue in terms of global diplomacy and international policy, most notably through international institutions such as the 'United Nations Framework Convention on Climate Change' and the 'Intergovernmental Panel on Climate Change', as well as international policies such as the 1997 *Kyoto Protocol* and the 2015 *Paris Agreement* (Bodansky, 2001; United Nations, 2015). The *Paris Agreement* emphasises the importance of limiting global average temperature increase beyond 2°C, with a strong focus on a limit of 1,5°C (United Nations, 2015). The *Paris Agreement* likewise makes specific reference to the vulnerability of African states to the effects of climate change, as it risks economic development, food security, and worsening poverty (United Nations, 2015). In addition, the 2018 'United Nations Annual Climate Report' asserts that existing emissions will continuously affect the climate, worsening as emissions increase (United Nations, 2018).

The United Nations (2018, 19) also contend that some unforeseen or unaddressed effects of climate change will create a convergence of issues due to technical, political, cultural, societal, or economic factors. This suggests that states with limited capacity for climate adaptation will face expected challenges in conjunction with those unplanned for, further limiting the ability to cope with the climate crisis – this is especially problematic for the most vulnerable states in the developing world. However, as more research is done on African states and their responses to climate change, this will ultimately aid in adaptation and mitigation across the continent.

2. Problem Statement

The critical issue to be addressed is the way to increase adaptability to the climate crisis within African states. To achieve this understanding, much literature has attempted to understand the many facets of climate change, particularly in vulnerable areas. One aspect which has been addressed in global research is the effect that public perceptions of climate change have on increasing support for climate movements and climate-related policies, therefore improving overall climate-related action. There are several potential variables which have shown to affect these perceptions, such as access to information, and gender. However, as natural disasters increase due to the changing climate, the role of these natural disasters holds much explanatory potential. Likewise, where individuals both experience natural disasters and express concern for climate change, it is becoming increasingly relevant to study the manifestation of environmental movements as a response to these factors.

3. Research Question

How do natural disasters in African states impact individual perceptions of climate change? Where states are exposed to a high frequency of natural disasters, what are the implications of these natural disasters, as well as individuals' perceptions, for the interests and actions of grassroots environmental movements?

4. Hypothesis

The proposed hypothesis is that states with higher levels of natural disasters will have increased levels of concern for climate change amongst individuals. Where states have increased levels of concern for climate change, it is hypothesised that this will influence the interests and actions of environmental grassroots movements.

5. Literature Review

5.1 Theoretical background

There is a myriad of theoretical foundations used to approach the climate crisis, each finding validity in varying degrees. Likewise, the theoretical underpinnings for the importance of understanding individual perceptions will be presented. For example, democratic eco-socialism emphasises the importance of equitable resource sharing and environmental sustainability (Baer, 2016, 5). By approaching a study centred on climate change within this theoretical paradigm, one acknowledges the innate desire of individuals to reverse the climate crisis in sustainable and just ways. This remains relevant when environmentally vulnerable states face further issues such as economic development and poverty.

In addition, environmental realism views climate change as a security threat to state sovereignty and consequently, climate policies differ from state to state dependent on national interests (Lieven, 2020). In a study of climate change perceptions in African states, this realist principle holds potential value when determining the national interests of a state, considering factors such as political landscape and the progress of climate policies, ultimately to understand which factors most influence a state's response to the climate crisis. Contrastingly, Baer (2016, 7) highlights the importance of anti-systemic movements, as they "have an important role to play in creating a socio-ecological revolution committed to both social justice and environmental sustainability." This includes grassroots climate movements, indigenous movements, and women's movements, all of which rely on civic engagement to operationalize. Here, Baer highlights the importance of civic engagement in moving towards a democratic eco-socialist world, one which is emancipated from the crisis of contemporary capitalism.

Consequently, democratic eco-socialism - as a theoretical framework - manifests most tangibly through grassroots environmental movements. Death (2014) focuses on grassroots movements in South Africa, noting that land and service delivery movements are unified and thriving, while their 'green' counterparts lack the structure and framing to succeed. This, likewise, indicates the growing need for greater understanding of grassroots movements in Africa, and the ways in which they contribute to social justice and ecological adaptation. For example, Barthel et al. (2013) find that urban social movements focused on food security and the environment leads to a more effective social response to major food crises in urban spaces, thus

protecting food security more effectively. Feola and Nunes (2014) likewise contend that geographical location influences the actions of grassroots environmental movements and suggests that comparative case studies are the most effective approach to understanding these movements. The importance of grassroots environmental movements is emphasized by O'Brien (2012), claiming that these movements often act as incubators for social change. In this way, comparing grassroots environmental movements by geographic, cultural, and other factors may unearth the most effective ways in which these movements perform.

While some scholars (Eden 1996) indicate the initial approach to climate change was in educating the public with scientific information to encourage changes in behaviours and attitudes towards the phenomenon, more recently, it has been argued that contextual factors, personal experience, and societal factors have a larger impact on individuals' response to climate change (Sturgis and Allum, 2004; Irwin and Wynne, 1996). This highlights the necessity to consider climate change perceptions from a more holistic perspective.

Lorenzoni et al. (2007, 446) contends that influencing individual perceptions of climate change, and therefore changing behaviours and actions for sustainable development, is of equal importance as civic engagement in the democratic process. Essentially, the study of public perceptions of climate change is the initial step in creating meaningful change in individual attitudes to climate change, thus allowing for solutions to be implemented, whether through policymaking or through actions on behalf of movements. This notion is supported by Leiserowitz (2006) who argues that public risk perceptions are integral to political, economic, and social action in addressing certain risks; this in turn has a significant influence on the socio-political context of policymaking.

Likewise, Wang and Kim (2018) contend that climate change "skeptics" often do not support climate change policies which encourages research into understanding the factors which cause this low level of concern for climate change. However, often these studies have been done in developed states where majority of the population is aware of climate change due to access to information and education, who then deny the scientific foundation of climate change (Lorenzoni et al., 2007; Wang & Kim, 2018). It is equally, if not more, important to understand the levels of concern for climate change in less developed states, particularly in Africa, as it influences climate adaptation and mitigation policies.

Likewise, Brownlee et al. (2013) explore the notion of cognitive dissonance in shaping individual beliefs concerning climate change, where individuals grapple with the contradictions between their personally held beliefs and the empirical science which is presented to them but which they may not personally experience or be able to contend with given their pre-existing beliefs. Thus, for the purposes of this research, the term 'perception' is used to describe the ways in which individuals observe, regard, and ultimately interpret the specific underpinnings of climate change as a scientific phenomenon. This distinction has been made to differentiate from previous studies which engage with climate change 'beliefs,' in order to measure the extent to which individuals perceive climate change's existence, while taking into account the possible cognitive dissonance and climate *skepticism* which may occur.

On the other hand, Barthel et al. (2013, 8) contend that "an active civil society is necessary for mobilising people and resources to protect urban green space, sustaining the knowledge of how to grow food and re-imagining the city as being a place of food production." Therefore, understanding the levels of concern for climate change in a state will potentially lead to an understanding of the actions of the civil society of that state, which for the purposes of this study will focus primarily on grassroots environmental movements.

In addition, Lorenzoni et al. (2007) emphasises that 'engagement' with the climate change issue is not merely an awareness for climate change and its causes, but process wherein individuals care about climate change and are motivated to take action in solving it. Likewise, it is argued that climate policies are at risk of rejection or ineffectiveness within a public which lacks an understanding of climate change (Lorenzoni et al., 2007). This is fundamental in approaching climate change solutions in African states, as climate policies and public engagement through environmental movements may not be as successful in states where individuals are not only unconcerned for climate change, but equally lack an awareness for the phenomenon at large.

5.2 Empirical background

Scholars from a variety of disciplines have sought to understand climate change and the ways in which it affects individual-, group-, as well as state behaviour. Shifting from a theoretical framework to a more empirical foundation, it is prudent to look at individual perceptions of climate change to more closely understand the observed experiences which shape this field of study, particularly, the ways in which the global North differs from the global South.

Perceptions of climate change worldwide:

Adger et al. (2005) contends that a community's resilience to natural disasters can be explained by the structure and progress of its 'social infrastructure'. These observations indicate the importance of civic engagement and social commitment in creating community resilience. Adger et al. (2005) observes the relevance of social structure, including civic engagement, in building community resilience against natural disasters. Therefore, grassroots environmental movements potentially lead to increased climate adaptation.

Moreover, McGeer (2004) notes the importance of hope in climate activism as it stimulates action, while Kleres and Wettergren (2017) discuss the difference between climate activists in the global North compared with the global South; while climate fear in the global North is based on hypothetical disasters of the future, those in the global South are already affected by climate-related disasters and are personally experiencing the lack of adaptability in their regions. Consequently, Lee et al. (2015, 1014), find that perceptions of local temperature change is often the strongest indicator of climate change risk perception in Africa, whereas understanding anthropogenic causes of climate change is more often the cause of perceptions of climate change risk in other regions of the world such as Europe and Latin America.

In addition, Kleres and Wettergren (2017, 516) contend that, for the global South, climate activism is often rooted in hope and fear, comingled with anger and desperation, which accounts for the engagement in climate justice movements. Therefore, it may be postulated that, as these climate-related disasters increase, so does civic engagement with climate activism. Furthermore, this study recognizes the link between fear in the global South, and the attribution of guilt placed on those in the global North, where hope for collective action is a means of survival (Kleres & Wettergren, 2017). This indicates the value of studying perceptions of climate change as it improves understanding of individual responses to climate

change. Yet, to build on this research foundation, it will be useful to study the levels of concern across a range of states to determine more substantially whether a state's population views climate change negatively - as a phenomenon to be concerned with.

Scholars maintain that studying perceptions of climate change is important as it impacts climate adaptation and mitigation by influencing decision-making and climate action (Krkoška Lorencová et al., 2019). However, many scientifically supported, long-term consequences of climate change, such as deforestation and desertification, impact individuals in a substantially minimal, indirect way at present, with climate change effects presenting more clearly over many years (Sloggy et al., 2021, 25). Contrastingly, natural disasters have a more salient and direct impact on individuals (Sloggy et al. 2021), and thus provides the potential for research on the effects of these natural disasters on individual perceptions of climate change.

In terms of international study, Lee et al. (2015) claims that current research on climate change risk perception is predominantly focused on the United States, Australia, and Europe. However, as aforementioned, the factors which influence these perceptions differ across regions, and thus runs the risk of universality as well as falsely generalizing claims across economic, geographic, and cultural lines. The Gallup World Poll with data from 2007 and 2008, which surveyed participants representing 90% of the world population, has been used to determine these factors. Lee et al. (2015) find that the developed world has significantly higher levels of climate change awareness, while studies focused on the US find that long-term temperature changes do not have a significant impact on perceptions of climate change (Brody et al., 2008,14).

Contrastingly, studies find that individuals who have awareness of climate change in developing parts of the world view climate change as a bigger threat to themselves and their families than the developed world's counterparts (Lee et al., 2015). Consequently, this study highlights the need for closer study of regions in the developing world, as perceptions of climate change vary dependent on regions (Lee et al. 2015). Research shows that gender, age, and previous experience with climate-related shocks significantly impacts perceptions of climate change in the Czech Republic, where personal experience with climate disasters is most likely to encourage the implementation of climate adaptation and mitigation (Krkoška Lorencová et al., 2019). In addition, Dabla-Norris, et al. (2023) find that, particularly in "advanced and emerging market economies," climate risk perceptions in conjunction with

perceptions of co-benefits in policy attributes contribute to public support for climate-related policies such as carbon pricing.

Perceptions of climate change in African states:

In terms of Africa's response to climate change, Afrobarometer survey data has been used to show African's perceptions of the climate crisis. Ifegbesan et al. (2021) have conducted a study to determine the relationship between access to information and awareness of climate change, using Afrobarometer round 7 data in Nigeria. The study's findings show that women tend to have more awareness of climate change than their male counterparts, and individuals from a rural living area tend to be more aware of climate change than their urban counterparts (Ifegbesan et al., 2021, 233). This is significant as it empirically highlights the role of women and the rural population in addressing climate change, as this case study indicates these demographic groups in Nigeria are more environmentally conscious. Overall, the findings of this study indicate that socio-demographic factors affect climate change awareness. Contrastingly, Nonjinge (2018) states that rural residents and women in South Africa have lower rates of awareness of climate change in the same round of Afrobarometer data. This highlights the possibility of underlying causes which allow for this variance.

On the other hand, Afrobarometer data indicates that only one in three Mozambicans have heard of climate change, indicating a very low awareness of climate change, despite Mozambique being at a "very high" risk to climate change (Patel & Patel, 2022). Similarly, over half of South Africans have a lack of awareness of climate change, despite the higher risk South Africans face to climate-related disasters (Nonjinge, 2018). However, the latest data provided by the Afrobarometer indicates that 58% of Africans have heard of climate change, whereas 71% of Africans agree that climate change needs to be stopped (Afrobarometer, 2021). This shows a significant determination amongst Africans to address climate change, showing the potential need in understanding how this belief that climate change needs to be stopped tangibly manifests.

Asrat and Simane (2018) find that perceptions of climate change specific to farmers in North-West Ethiopia depend on geographic factors. For example, farmers in wet lowlands are affected by changes in precipitation and temperature, among other factors, which influence perceptions of climate change significantly, while farmers in dry lowlands are influenced by climate information and food shortages (Asrat & Simane, 2018). This indicates the importance of

considering geographic and demographic factors such as ecological changes and access to information in shaping perceptions of climate change. However, these factors suggest that climate shocks, in varying forms, have an impact on perceptions of climate change.

In a global study of climate change perceptions, Kenyan respondents were more likely to agree to protect the environment at the expense of job creation and slower economic growth than Nigerian respondents (Brechin & Bhandari, 2011), which indicates a variance in perceptions of climate change across African states. Likewise, Brechin and Bhandari (2011, 882), in their study of perceptions of climate change worldwide, recommend that future studies focus on the context of specific countries to explain the varied response across the globe, as their study shows that geographic, socioeconomic, and political factors have a state-by-state effect on climate change views.

6. Research gap

As evidenced, much research has been done on a select number of states' perceptions of climate change, particularly in the global North. It has likewise been established that public perception of climate change influences the process of adapting to and mitigating the climate crisis. However, this research area is severely overlooked in the global South, particularly Africa as it faces extreme vulnerability to climate change in the face of increased climate-related disasters. It is possible that, due to the significant differences in access to information, governance, economic activity, and civic engagement, that public perception of climate change, and therefore the overall level of engagement with climate change on a policy-level, may present in vastly different ways to that of the global North. More specifically, it is possible that public concern for climate change is much lower in the global South, as a result of overall lower levels of development as compared to the global North. Moreover, African states desperately need to gain momentum in adapting to climate change, and it is essential to understand which factors most successfully support this process. Likewise, studies on African states have focused on the emotional aspect of climate change beliefs while overlooking levels of concern for climate change.

7. Rationale

This study on climate change perceptions has the potential to contribute to International Relations literature by providing insight into the effects of natural disasters on individual-level perceptions across Africa. Likewise, this study is important in characterizing individual understandings of the causes and effects of climate change, thus providing information on individual adaptation techniques such as support for climate-related policies and involvement in environmental movements. This study has been conducted in the global North, yet Africa's vulnerability to climate change encourages further study on the continent to improve Africa's adaptation capabilities.

Most notably, Dabla-Norris, et al. (2023) have recently concluded a study titled: "Public Perceptions of Climate Mitigation Policies: Evidence from Cross-Country Surveys" which highlights the relevance of using survey data to determine individual perceptions concerning topics around climate change. Likewise, an additional study finds that low levels of concern

for climate change delay climate adaptation and policy implementation, thus hindering a state's response to climate change (Lorenzoni et al., 2007).

8. Research Design

The research design has followed a mixed methods approach, firstly through a quantitative study of 33 African states as well as a large-*n* study of individuals from each African state, followed by a qualitative case study of two African states - as determined according to results from the quantitative study. This nested design will first establish an empirical relationship between public perception of climate change and natural disasters, thereafter, using content analysis to explore the context within which these perceptions of climate change are informed.

For the purposes of this study, the dependent variable will be labelled as 'Public perception of climate change' in a series of African states. This term will be used to refer to the level at which individuals express an understanding and concern for climate change. Data provided by the Afrobarometer has been used - Afrobarometer is a pan-African, nonpartisan survey research network, which conducts face-to-face research in the language of the respondent's choice (Afrobarometer, 2021). The responses to several climate-related survey questions have been analysed, describing perceptions of climate change. This dependent variable aims to measure how individuals personally recognize the climate crisis, as it is theorized that if individuals feel more strongly about climate change, they will be encouraged to adapt their behaviour accordingly. Geocoded Afrobarometer data has been used to establish the effect of geographic regions within each African state on concern for climate change. While previous studies have looked at the emotional perspective of climate change beliefs (Kleres and Wettergren, 2017), this research rather looks at levels of concern for climate change, ultimately to understand whether individuals understand the reality of climate change and consequently perceive it to be a negative phenomenon.

The independent variable of the study is the frequency of natural disasters across African states. This data is provided by the International Disaster Database (EM-DAT), which combines data from the United Nations, national governments, the World Bank, and several other sources, thus creating a comprehensive database of worldwide disasters. This database classifies disasters as either natural, technological, or complex, but for the purposes of this research, only data focusing on natural disasters will be used as it relates to the environment, and any other suitable subnational and national climate data sources that may be identified has been used to allow for a larger range of study. Moreover, within the database of natural disasters, those concerning biological disasters such as fungal diseases or insect infestations have been

excluded. Rather, data on meteorological, climatological, and hydrological disasters has been used to create an index of natural disasters in the pool of African. Moreover, data has been drawn from 1998 to 2018 to provide a 20-year indication of the progression of natural disasters in Africa, and disasters occurring within the survey period of Afrobarometer data has been excluded to avoid an overlap in data, wherein disasters occur after a survey has been conducted.

A quantitative study, conducted in R, aims to determine the impact of the independent variable on the dependent variable (R Core Team, 2021). This is done through linear regression models to determine the role of individual experiences with natural disasters, controlling for individual education levels and access to information. Thereafter, two cases have been drawn from the data to allow for a comparative case study analysis of the role of environmental movements within each case. These case studies follow a deductive, most similar approach, selected according to a specified framework, where both cases experience similar perceptions of climate change to determine whether any particular country-level variables contribute to shaping climate change understanding, with specific attention paid to natural disaster vulnerability.

This includes a qualitative analysis of each country case study, examining the country-level demographic data to explore the context within which the individual climate change perceptions are shaped. The comparative case study design has likewise been operationalized through content and discourse analysis of both primary and secondary information provided through the climate and environmental policies of each of the two states, determining which factors motivate the climate action of each state, as well as which factors provide challenges and limitations for the progression of climate action.

The case study analysis similarly looks at the relationship between local and national environmentalism, to determine whether the interests of environmental movements are reflected in national climate policies. Likewise, the qualitative analysis aims to determine whether any 'place meaning' is attached to climate action, such as cultural, linguistic, or ethnic identity, *as well as* geographic factors -including natural disasters. Ultimately, this aims to determine whether individual perceptions on climate change issues impact collective action, whether on a systemic or grassroots level.

9. Quantitative Data Analysis

9.1 Public perception data

This paper uses survey data from 33 African countries provided by Afrobarometer Round 7 (2019). The survey data is collected using national probability principles, "designed to generate a sample that is a representative cross-section of all citizens of voting age in a given country" (Afrobarometer, 2023). This is useful for the study as it may provide a reflection of the range of perceptions and observations within each of the sample states. Afrobarometer provides merged datasets which combine the collected data from all countries within a survey round into a single data set. Additionally, for the purposes of this research, geocoded subnational data of each respondent has been included in the study to determine whether the geographic location of an individual influences their responses to the survey questions, overall increasing the robustness of the study. All quantitative analysis was conducted using R programming software (R Core Team, 2021).

The dependent variable of this research is the individual perception of climate change which is measured using a multi-item index comprised of several Afrobarometer survey questions concerning the environment and climate change as a phenomenon. As the available data does not implicitly refer to *perceptions* of climate change, this index has been constructed to provide an aggregate overview of responses to questions which directly relate to climate change, however, the responses to each Afrobarometer survey question which is linked to the environment or climate change will also be explored further to determine any variation.

The aim is to determine the proportion of individuals who understand climate change as a negative impact on the environment caused by human activity, and in turn, show concern for the phenomenon. This index, hereafter referred to as the 'Climate Change Perceptions Index", has been created using responses to questions concerning a) the individual's understanding of the meaning of climate change as negative impacts on the environment, b) the cause of climate change through human activity such as pollution and the burning of fossil fuels, c) the effect climate change has on the respondent's country, and d) the belief that climate change should be stopped. The four Afrobarometer survey questions are shown below, and will be simplified to P1, P2, P3, and P4.

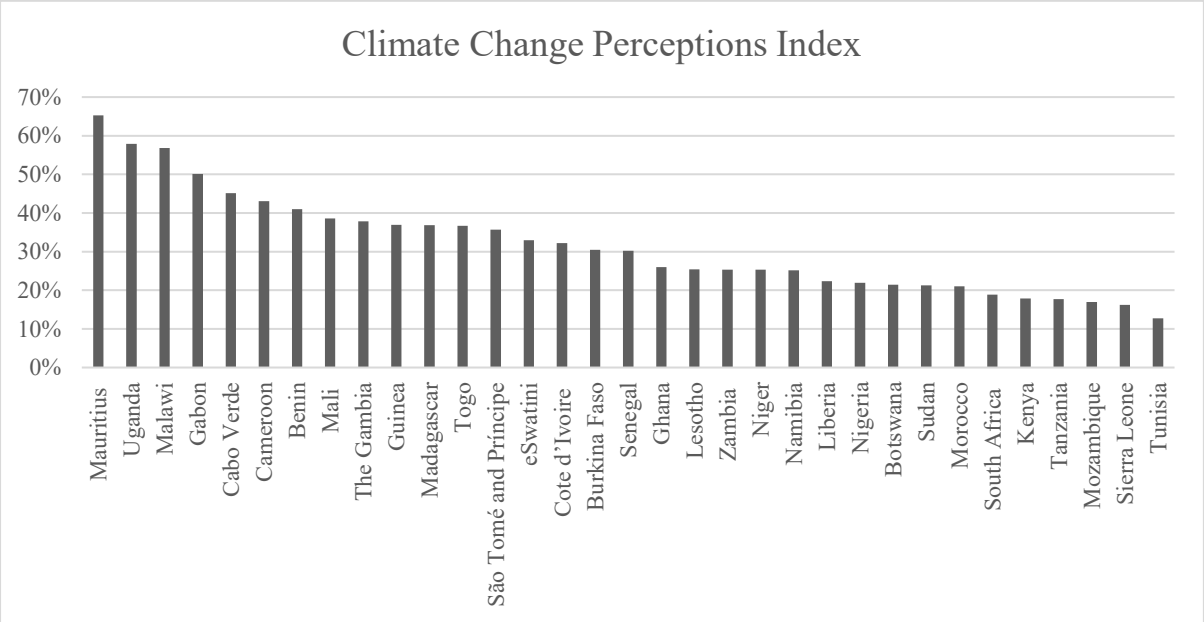
Table:

P1: “What does the phrase “climate change” mean to you? Responses include: negative changes in the weather like more droughts, floods, or extreme heat; positive changes in the weather, like better rainfall patterns or longer growing seasons; or other changes in weather patterns.”
P2: “People have different ideas about what causes climate change. What about you, which of the following do you think is the main cause of climate change, or haven't you heard enough to say? Responses include human activity, like burning fuel and other activities that pollute the atmosphere; natural processes; both human activity and natural processes; or none of these.”
P3: “Do you think climate change is making life in [ENTER COUNTRY] better or worse, or haven’t you heard enough to say?”
P4: “Do you think that climate change needs to be stopped? [If yes] How much do you think that ordinary [ENTER NATIONALITY] can do to stop climate change?”
(Afrobarometer, 2020)

In order to validate the use of this index and the inclusion of the factors within it, several robustness tests have been conducted, which can be found in the annex.

The Climate Change Perceptions Index shows that respondents from Mauritius have the highest level of concern for climate change with around 65% of respondents displaying an understanding of climate change and its impacts due to human activity. Uganda, Malawi, and Gabon are also shown to reflect high levels of concern for climate change. On the other hand, Tunisian respondents are shown to have the lowest levels of concern for climate change with less than 13% of respondents displaying comprehension of the phenomenon. Likewise, respondents from Sierra Leone, Mozambique, and Tanzania reflect low levels of concern for climate change. The outcomes for each country in the index are reflected below:

Table:


Climate Change Perceptions Index
70%
60%
50%
40%
30%
20%
10%
0%
Mauritius
Uganda
Malawi
Gabon
Cabo Verde
Cameroon
Benin
Mali
The Gambia
Guinea
Madagascar
Togo
São Tomé and Príncipe
eSwatini
Cote d'Ivoire
Burkina Faso
Senegal
Ghana
Lesotho
Zambia
Niger
Namibia
Liberia
Nigeria
Botswana
Sudan
Morocco
South Africa
Kenya
Tanzania
Mozambique
Sierra Leone
Tunisia

Additional environmental Afrobarometer questions

While constructing the Climate Change Perceptions Index, three Afrobarometer survey questions have not been included due to lack of correlation and overall 'lack-of-fit' within the index. Interesting to note is that these three questions relate to the environment but do not explicitly refer to climate *change*, as they refer to the overall environmental conditions within each sample country, as well as the environmental conditions related to droughts and floods. However, these survey questions reveal significant findings when looking at the general perception of respondents' immediate environment. The questions are listed as follows:

Table 1:

Q71: "In your experience, would you say climate conditions for agricultural production in your area have gotten better, gotten worse, or stayed about the same over the last 10 years or haven't you heard enough to say?"
Q72A: "In your experience, over the past 10 years, has there been any change in the severity of the following events in the area where you live? Have they become more severe, less severe, or stayed about the same? Droughts?"
Q72B: "In your experience, over the past 10 years, has there been any change in the severity of the following events in the area where you live? Have they become more severe, less severe, or stayed about the same? Flooding?"
(Afrobarometer, 2020)

The responses to these questions range from "no experience, "much worse," "worse," to "about the same," "better," and "much better." However, for ease of use, the responses have been dichotomized to reflect the 'negative perception' responses, i.e., those who have observed a degradation of their environmental conditions, and the 'positive perception' i.e., those who have observed improved climate conditions. When looking at this dichotomy, it is revealed that respondents perceive more negative changes to their immediate environment.

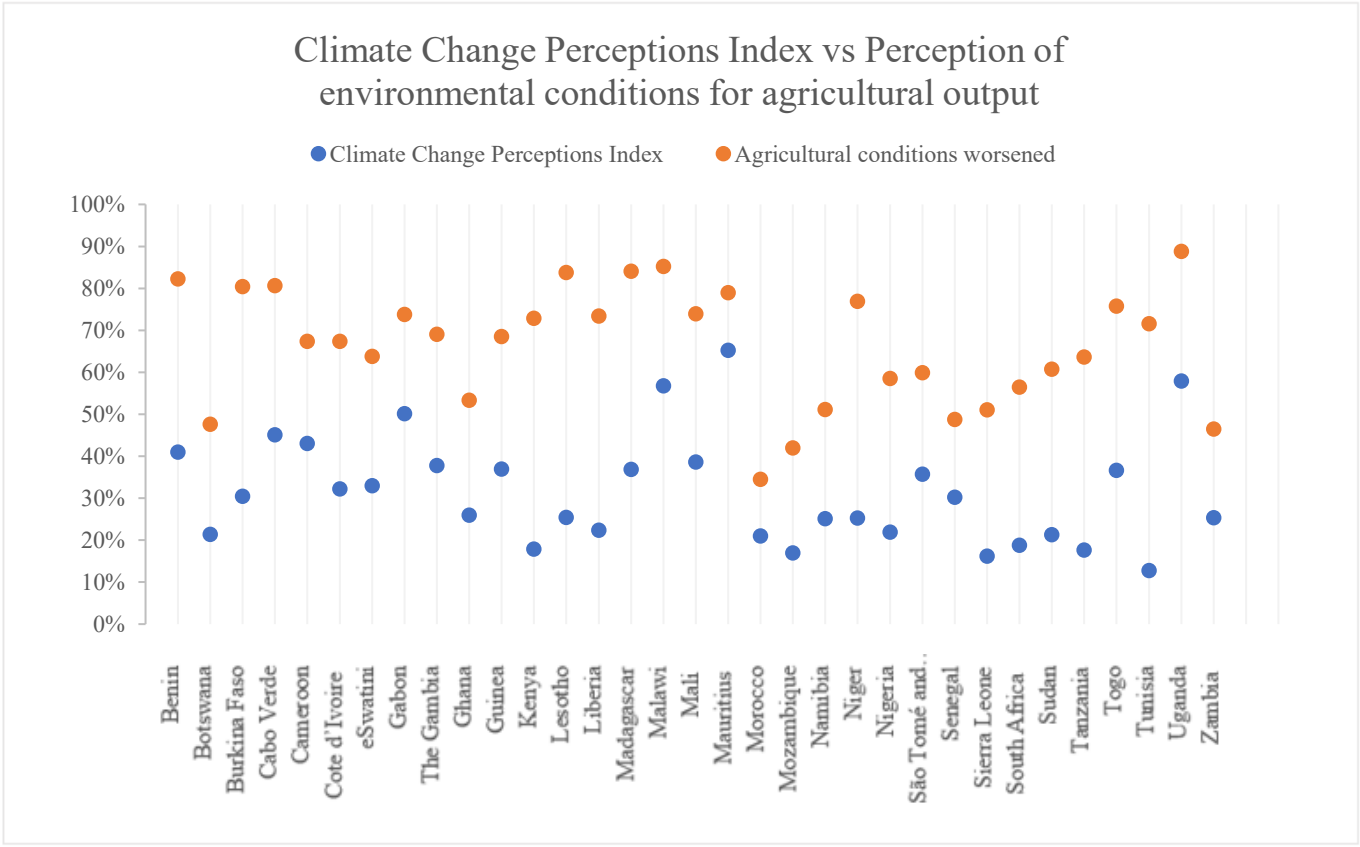
For example, 82% of respondents from Benin responded that climate conditions for agricultural production in their area have gotten worse over the last 10 years, whereas the Climate Change Perceptions Index shows that 41% of respondents from Benin are concerned about climate change as a phenomenon. This trend follows for every sample state, wherein there is a key difference between the concern shown for climate change as a phenomenon within the Climate Change Perceptions Index compared with the perception of changes in climate conditions for agricultural output over the previous ten years. This suggests that respondents may experience and perceive changes to their immediate environment while potentially lacking familiarity with climate change as the cause of these changes.

The difference between the two measurements for climate perception varies across the sample of states, with Tunisia displaying the largest variation. While 72% of Tunisian respondents have shown to experience worsened climate conditions, only 13% of the same respondents show concern for climate change. This is significant as it shows a major gap between experiencing negative climate conditions and an understanding of climate change as a contributor to these changes. As documented, an understanding of climate change often leads to public policy which addresses these issues, therefore it is important to the development of these policies that individuals understand the science behind climate change (Lorenzoni et al., 2007). The variation regarding the aggregated Climate Change Perceptions Index and the question regarding perceptions of climate conditions for agricultural output can be seen in the scatterplot below – which highlights the significant differences for each state.

Table 2: Proportion of responses to each climate related Afrobarometer question for the sample pool of 44623 individuals across all 33 African states

	Negative (climate change is observed as a negative, human-induced phenomenon)	No difference observed	Positive (climate change is observed as a positive, non-human related phenomenon)	Respondents are unsure
Climate conditions for agricultural production have worsened	47.8%	17.5%	19.3%	15.5%
Climate events have worsened: droughts	46.0%	17.8%	27.4%	8.8%
Climate events have worsened: floods	28.9%	20.2%	40.8%	10.1%
Meaning of climate change	36.9%	8.3%	10.2%	44.6%
Cause of climate change	29.7%	9.2%	16.0%	45.1%
Climate change is affecting the state	37.0%	4.9%	10.8%	47.3%
Climate change must be stopped	29.7%	11.4%	13.3%	45.6%

Graph 1 :



1.8391 Demographic variables

While Afrobarometer provides data concerning a multitude of topics, the survey questions of interest for this research include demographic data for each respondent, such as urban-rural classification, age, and gender. As determined by previous studies, factors such as gender, age, and the place of residence of individuals may influence climate change perceptions (Echavarren, et al., 816). As such, the Climate Change Perceptions Index shows that in terms of gender, there is a 17 percentage point difference between male and female respondents, indicating that men are more likely to show concern for climate change. This is interesting as similar studies conducted in European states find that women within the European sample are more likely to show concern for climate change (Van Liere and Dunlap, 1980). This reinforces the importance of conducting existing climate change studies in African states, as the findings from existing research cannot be universally applicable.

In addition, the Climate Change Perceptions Index indicates a 7 percentage point difference between urban and rural respondents, where individuals residing in urban areas are more likely to show concern for climate change. Additionally, when looking at the role of age in levels of climate change perception, the index shows that individuals in the age range of 18-34, otherwise referred to as the youth category are more likely to be concerned about climate change than those 35 years and older. However, the difference of proportion between these two age categories is less than 2 percentage points, which suggests that age may not be a strong indicator of cocnern for climate change.

Table 3: Demographic Data

	Percentage of respondents who are concerned about climate change
Female	23.79%
Male	35.82%
Urban	34.48%
Rural	25.61%
Youth (18-34)	30.14%
Other (35 and older)	28.70%

Additional country-level control variables have been incorporated, using World Bank data including variables such as the log of the gross domestic product (GDP) per capita, and the government effectiveness score as determined by the World Governance Indicator. The full data list can be found in the annex. Likewise, access to information has been included to determine the influence that media usage has on individual understanding of scientific phenomena such as climate change. To measure the access to information within the sample of each country case study, an index has been created which combines respondents' use of various sources of information, including radio, television, newspapers, the internet, and social media. The five Afrobarometer survey questions are shown below, and will be referred to as A0, A1, A2, A3, and A4 for ease of use.

Table 4:

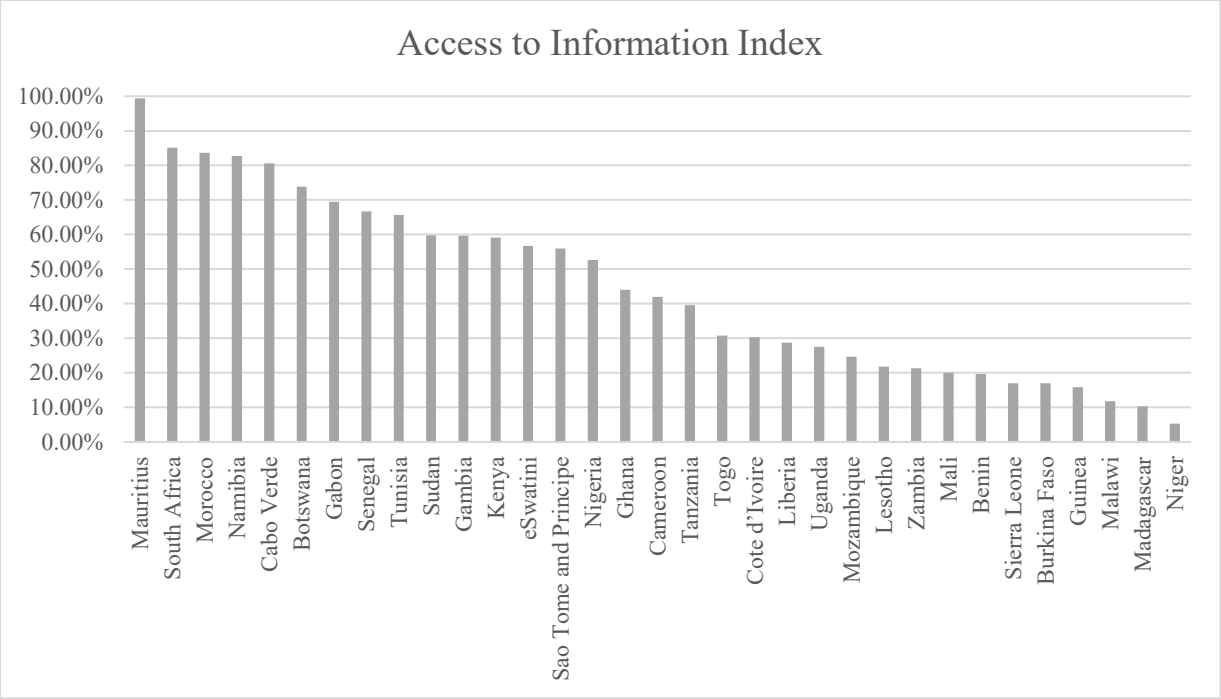
A0: "How often do you get news from the following sources: Radio?"
A1: "How often do you get news from the following sources: Television?"
A2: "How often do you get news from the following sources: Newspapers?"
A3: "How often do you get news from the following sources: Internet?"
A4: "How often do you get news from the following sources: Social media?"
(Afrobarometer, 2020)

This index, consistent with the methodology used to validate the Climate Change Perceptions index, has been validated using several techniques, such as a correlation matrix, Cronbach's alpha to measure the internal consistency of the index, as well as a principal components analysis (PCA) to increase the interpretability of the index. This information is expanded upon in the annex.

The outcomes of the index show that much like the Climate Change Perceptions index, respondents from Mauritius reflect the highest levels of access to information, with 98.9 % of respondents indicating frequent use of various sources of information. Additionally, South Africa, Morocco and Cabo Verde reflect high levels of access to information. On the other hand, Niger is shown to have the lowest levels of access to information, with less than 5% of respondents reporting frequent use of various sources of media. Interestingly, despite having a

high proportion of respondents show concern for climate change, Malawi is shown to have a low proportion of respondents with access to information (5.98%). The outcomes for each country in the index are reflected below:

Graph 2:



9.3 Natural Disasters data

When looking solely at the frequency of natural disasters taking place over a twenty-year period, states such as Kenya and South Africa appear to be the most vulnerable states. Alternatively, it is potentially more useful to conduct an analysis of state-level vulnerability to natural disasters by considering the Germanwatch *Global Climate Risk Index*, which provides an analysis of the exposure to extreme weather events and the directly associated socio-economic impacts such as deaths and losses in Gross Domestic Product (GDP) amongst other factors (Eckstein, et al. 2018). However, this index is limited, particularly as it relates to African states, as it does not provide information on the more indirect impacts of natural disasters such as heat waves, amongst other climate data (Eckstein, et al. 2018). Likewise, the Global Climate Risk Index does not provide data on Sao Tome and Principe.

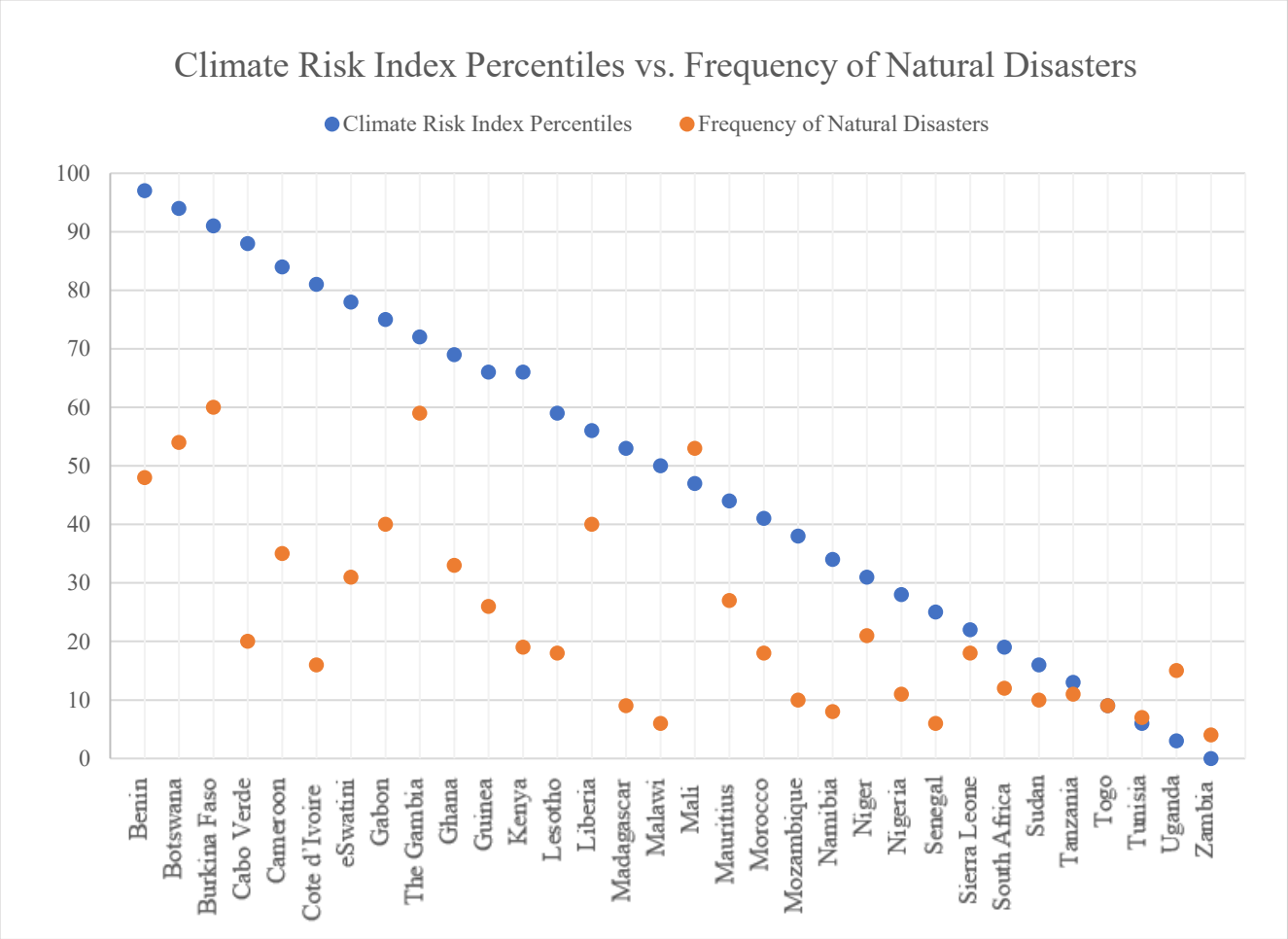
Nonetheless, it provides a useful ranking of country-level vulnerability to the impacts of natural disasters using the same EM-DAT data which has been used when measuring the frequency of natural disasters above. The Global Climate Risk Index provides an annually published index ranking climate vulnerability, as well as a more long-term overview of country-level vulnerability by analysing data from 1997-2016 and providing an average value for each variable within the index. The higher a state lies on the ranking, the lower its determined vulnerability to climate change, meaning that states with frequent and highly impactful natural disasters are allocated lower nominal scores. For example, Zimbabwe was ranked second on the Global Climate Risk Index in 2016 with one of the most frequent rates of fatalities and economic losses due to natural disasters (Eckstein, et al. 2018, 30). However, to improve the visual clarity of this ranking, the data has been limited to only the states within the scope of this research, represented as percentiles.

For example, Benin has been ranked 150th on the Climate Risk Index, which places it in the 19th percentile. This means that Benin is only more vulnerable than 19% of the 33 states within this research. This data transformation allows the Climate Risk Index to be presented in a more logical way, where a higher nominal value is linked with a higher vulnerability. This also allows for a better visualization of the relationship between natural disaster frequency and the corresponding climate vulnerability as determined by the Climate Risk Index, as shown below.

Most states follow a similar trend, where the frequency of natural disasters is in line with the respective vulnerability to climate change. For example, states like Togo have experienced 6 natural disasters from 1998-2017, while also ranked in the sixth percentile, making it one of the least climate-vulnerable states. On the other hand, some states are shown to have a significantly higher climate vulnerability, due to the severity of the natural disasters experienced, rather than purely based on the frequency of those disasters, such as Madagascar which is ranked the most vulnerable state within the pool of case studies, despite states like Kenya and South Africa experiencing more frequent natural disasters. This emphasises the importance of looking at natural disasters from a more complete perspective, rather than merely determining vulnerability based on frequency of natural disasters.

Considering both the frequency of natural disasters over a twenty-year period, as well as the 1997-2016 Global Climate Risk Index, certain states such as Mozambique and Madagascar maintain high vulnerability as per the rate and direct effects of natural disasters. However, when considering factors such as fatality rates and losses per unit of GDP, states like Nigeria may experience a relatively higher rate of natural disasters but are considered much less vulnerable than other states when examining from a socio-economic perspective. In much the same way, states like Namibia experience relatively average number of natural disasters as compared to other states, yet their socio-economic vulnerability ranks them much higher on the Climate Risk Index. This highlights the importance of having a more holistic interpretation of climate vulnerability, as well as underscores the complexity of studying climate-related events and impacts.

Graph 3:


Climate Risk Index Percentiles vs. Frequency of Natural Disasters
Climate Risk Index Percentiles
Frequency of Natural Disasters
100
90
80
70
60
50
40
30
20
10
0
Benin
Botswana
Burkina Faso
Cabo Verde
Cameroon
Cote d'Ivoire
eSwatini
Gabon
The Gambia
Ghana
Guinea
Kenya
Lesotho
Liberia
Madagascar
Malawi
Mali
Mauritius
Morocco
Mozambique
Namibia
Niger
Nigeria
Senegal
Sierra Leone
South Africa
Sudan
Tanzania
Togo
Tunisia
Uganda
Zambia

10. Findings

While the above data has explored the dependent variable presented by country-level perception of climate change and the environment in each of the 33 selected country case studies, as well as the corresponding independent variable measured by the vulnerability to natural disasters within each case study, it is important to look at the relationship between the two variables. The country case study selection has taken states from every region on the African continent, with variations across key factors such as populations, economic activity, governance, as well as access to information, and vulnerability to natural disasters in order to develop an in-depth appreciation of the complexity of understanding individuals perceptions, particularly for a phenomenon as important as climate change – which often presents itself as a contentious topic in international relations and diplomacy.

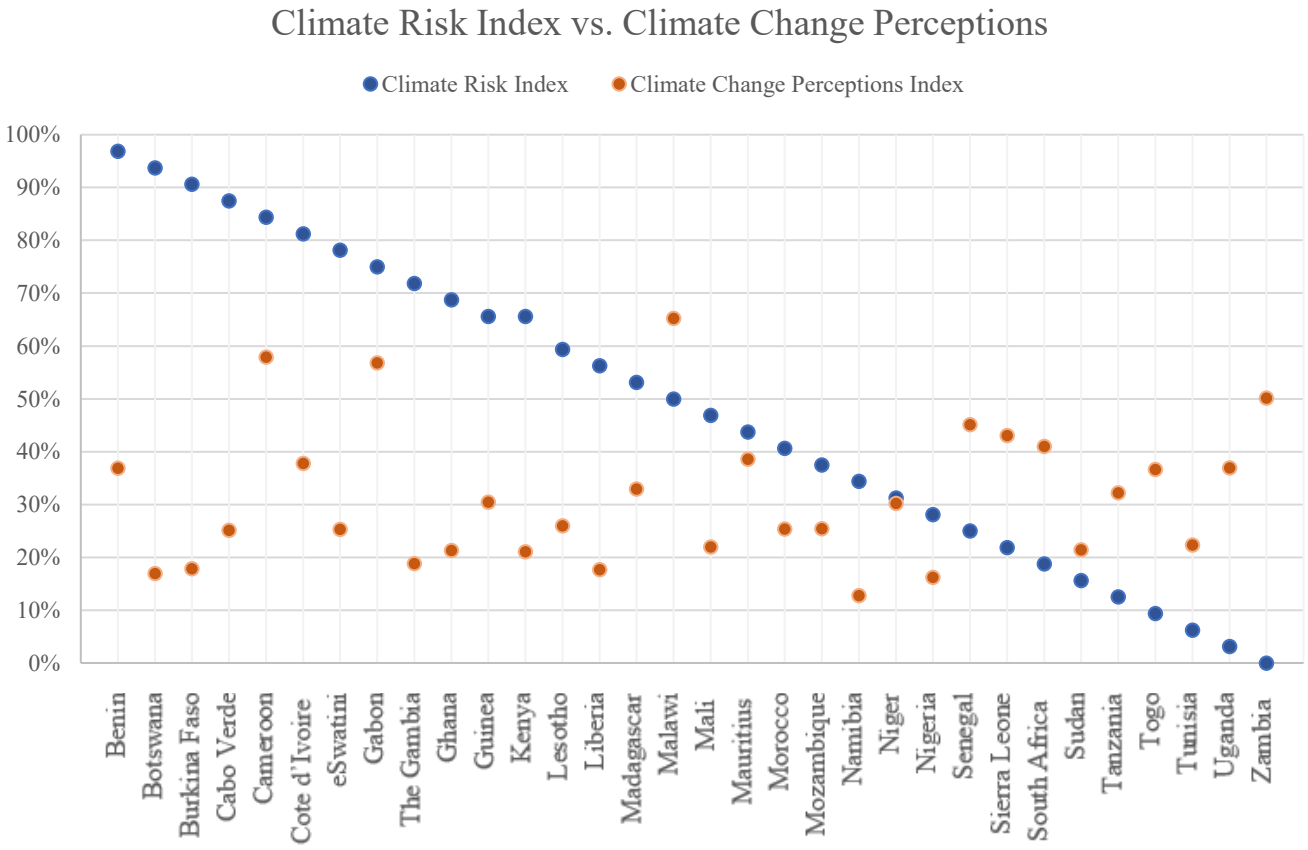
As such, when looking at the relationship between climate change perceptions and vulnerability to natural disasters, it is interesting to note that an inverse relationship appears to occur where states with a high exposure to natural disasters is linked with states where a low proportion of survey respondents express knowledge of and concern for climate change as a negative ongoing event. This is interesting as it suggests the inverse is also true, where the states with the most respondents displaying concern for climate change are also living in the states less vulnerable to the effects of climate change, namely through natural disasters.

As illustrated in the graph below, when directly comparing the outcomes of the Climate Change Perceptions Index with the proportion of responses to the question concerning worsened climate conditions for agricultural output with the percentile rankings of climate vulnerability in the Climate Risk Index, a few interesting points appear. For instance, there seems to be an inverse pattern between CRI percentile rankings and the respondents from that state showing concern for climate change through the Climate Change Perceptions Index. For example, Guinea has a relatively low vulnerability to climate change (3%), but a higher proportion of Afrobarometer survey respondents express concern for climate change and its effects (37%). This variation is more apparent when looking at the proportion of respondents who expressed their concern for worsened climate conditions for agricultural output (69%). This relationship is true for other states such as Benin, Botswana, Cabo Verde, Cameroon, Cote d'Ivoire, Gabon,

Liberia, Mauritius, and Togo, which reinforces the finding that less climate-vulnerable states have higher rates of concern for climate change.

The inverse is also true, where states with a higher vulnerability to climate change corresponds with Afrobarometer survey respondents who express lower levels of concern for the environment and climate change. For example, Mozambique is ranked 94% more vulnerable to the effects of climate change than the other states in this research, yet only 42% have observed worsened climate conditions for agricultural output, and more significantly, a mere 17% of Mozambican respondents expressed concern for climate change. This pattern can also be observed in the following states: Burkina Faso, eSwatini, The Gambia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mali, Morocco, Namibia, Niger, Nigeria, Sierra Leone, South Africa, Sudan, Tanzania, Tunisia, Uganda, and Zambia. Interestingly, Senegal has a near identical proportion of respondents concerned about climate change (30%) and climate risk index percentile, which identifies it as 31% more vulnerable to the effects of climate change, making it the one state in this research which does not firmly fall into the inverse pattern displayed throughout the rest of the data.

Graph 4:



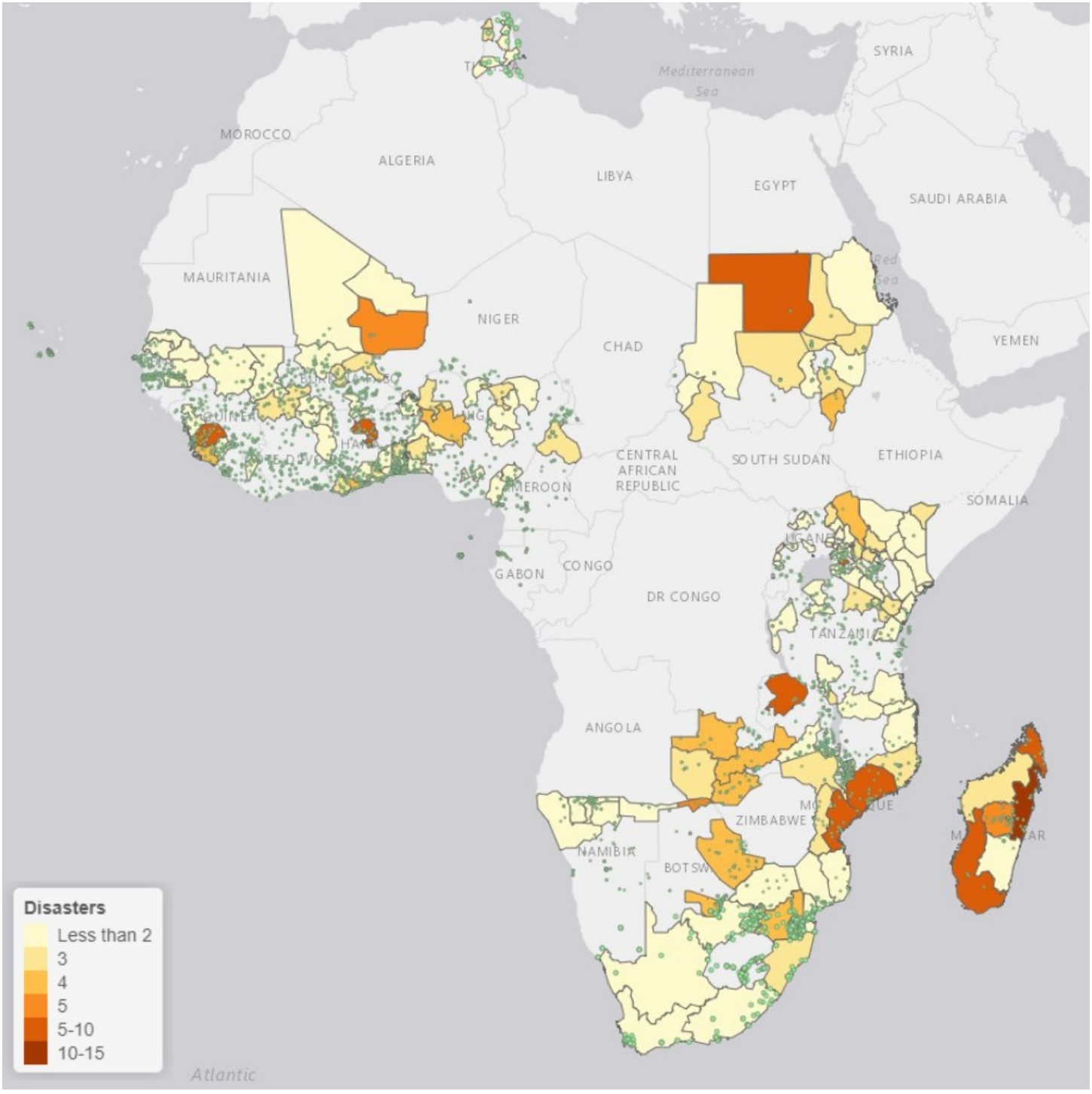
While this analysis provides a country-level overview of the relationship between perceptions of climate change and natural disasters, to enhance this study, the data has been explored at the subnational level. This spatial analysis has been conducted using the point-in-polygon method (Burrough and McDonnell, 1998), which determines the count of individual Afrobarometer respondents who fall within a region which has experienced varying frequencies of natural disasters. This geospatial disaster data uses the disaster data by EM-DAT used throughout this paper, in combination with spatial data by the Database of Global Administrative Areas (GADM) and geocoded disaster data from the Socioeconomic Data and Applications Centre (SEDAC) (Rosvold, & Buhaug, 2021). While point-in-polygon is criticized for the potential to provide less accurate estimates than other spatial analysis, this limitation has been reduced by using source data of smaller zones through subnational data, as compared with the limitations of using country level data (Sadahiro, 2000).

The findings of this point-in-polygon analysis can be viewed in the map shown below. It is important to note that this point-in-polygon method relies on geospatial data, and as such the sample pool of data excludes Afrobarometer observations for which geocoding is unavailable. This reduces the full data set from 43 423 observations to 37 185 observations, which reduces the data set by around 14%. The point data, visualized with green dots, represent respondents who have expressed concern for climate change. However, this interactive map has been attached in html format titled “Interactive Map: Climate Change Concerns and Natural Disasters” for easier viewing, with the ability to analyse the graphic in more detail. Likewise, the attached Interactive Map also includes data related to Afrobarometer respondents who have expressed concerns for worsened climate conditions for agricultural production, which allows for a comparative display of the views of the Afrobarometer respondents.

This point-in-polygon method indicates that out the 6 928 Afrobarometer respondents who display concern for climate change, 2 482 of them are located within an area which has experienced at least one natural disasters over a twenty-year period, with the remaining respondents concerned about climate change falling within a region which has not experienced any natural disasters. With around 36% of respondents who are concerned about climate change having experienced natural disasters, this suggests that personally experiencing natural

disasters potentially does not contribute to individuals perceiving more direct concern for climate change.

Map: Climate Change Concerns and Natural Disasters



To confirm this relationship, a standard linear model has been constructed using subnational and national level data. Considering the dependent variable (y) as individual concern for climate change as determined by the Climate Change Perceptions Index, the model includes a square root of the frequency of natural disasters on a subnational level as the independent variable (b_1), in order to analyse the data as a weighted average. The model likewise includes the intercept term (b_0), and the error term I as is standard for a linear model (Fox & Weisberg, 2019). Additionally, the education level of the individual respondents has been included as a control variable (x). This is due to the notion that individuals with a higher level of education are more likely to have heard of climate change and understand the dangers it poses. Additionally, the model includes an interaction term (b_1x) which determines the role of both natural disasters and education levels, thus enhancing the understanding of the interaction between these two variables on the outcome of the model. Interpretations of the models will only be given if the coefficients are statistically significant at the 95% confidence level.

$$Y = b_0 + b_1 + x + (b_1x) + e$$

The results of the linear model indicate that the role of natural disasters on individual concern for climate change is negative, and the coefficient for this relationship is -0.05. Likewise, this model also indicates that the relationship between concern for climate change and the respective education levels for individuals is negative, which suggests that individuals with higher levels of education are less likely to express concern for climate change, where the coefficient is -0.10. On the other hand, the interaction term which looks at the combined effect of natural disasters experienced, and education levels indicates a positive relationship with climate change concerns, meaning that individuals who have experienced natural disasters and have a higher level of education are likely to show more concern for climate change, with a coefficient of 0.02. This is interesting as it suggests that personally experiencing at least one natural disaster does not contribute to an individual's concern for the effects of climate change, as previously hypothesised.

This model has been repeated using a measure of individual awareness of climate change based on the responses to the Afrobarometer survey question: "have you heard about climate change […]?" (Afrobarometer, 2020). This question focuses on the baseline awareness levels of individuals rather than their overall understanding of the phenomenon determined by the

Climate Change Perceptions Index. In this model, a similar trend emerges, where natural disasters have a negative relationship with awareness of climate change, with a coefficient of -0.09. Likewise, the role of education on climate change concerns suggests a negative relationship, with a coefficient of -0.26, which indicates that individuals with a higher level of education are less likely to be aware of climate change. This highlights a key similarity between the two models, where individuals with a higher level of education may be less likely to be aware of climate change, and less concerned about the phenomenon. On the other hand, the interaction term of education levels combined with disasters experienced indicates a positive relationship, with a coefficient of 0.06.

In addition, this model has been repeated with the observations concerning perceptions of climate conditions for agricultural production, to determine whether individuals who may not be aware of or concerned with climate change as a phenomenon may still be expressing concerns for the impacts to their environment, specifically as it relates to agriculture. This model indicates that the relationship between natural disasters experienced and concern for climate conditions for agricultural output is negative, with a coefficient of -0.06. On the other hand, education levels of respondents have a positive relationship with climate concerns for agriculture, with a coefficient of 0.02. Likewise, the interaction term indicates a positive relationship with a coefficient of 0.003. This reinforces the notion that education levels contribute to individuals expressing concern for their environment, while experiencing natural disasters has the opposite effect.

Lastly, this linear model has been conducted with individual concern for climate change as the dependent variable, with natural disasters as the independent variable. However, the role of education levels has been replaced by the influence of access to information, using the Access to Information Index. This is due to the hypothesis that individuals may learn more about climate change from various sources of information such as newspapers, television, and social media. The results of this model indicate that the relationship between natural disasters and concern for climate change remains negative, with a coefficient of -0.03, while access to information is indicated to have a positive relationship with concern for climate change, with a coefficient of 0.08. This confirms the hypothesis that individuals with access to information

are more likely to be concerned about climate change. The results of each linear model have been included in the annex.

11. Qualitative Analysis

The quantitative large *n* study has provided an overarching insight into the understanding of climate change across many African countries, as well as the factors which may contribute to the shaping of climate change perceptions within each country case study. However, to gain a more nuanced understanding of the factors which may influence the understanding of climate change, a qualitative analysis is needed. This section will look closely at a variety of national-level data such as population, economic activity, political stability, as well as natural disaster risk levels. It will also analyse the level at which each selected case study is engaged with climate change through civic engagement and policy documents focused on climate change. While the quantitative study encapsulates the way in which natural disasters influence individual perceptions of climate change in a broader way for African states, it may be useful to consider a wider range of factors. Within the scope of this study, it is more feasible to look at two case studies, as opposed to studying the pool of 33 African states in such depth.

Considering the data produced by the Climate Change Perceptions Index, as well as the Access to Information index, combined with the trends observed in natural disasters across the African continent, it has been determined that Tanzania and South Africa hold large explanatory potential in the study of climate change perceptions. Both states indicate similarly low levels of individual climate change concern, yet South Africa experiences a higher level of natural disasters and is shown to be more vulnerable to the effects of climate change. Moreover, there are differences in economic performance, governance, civic engagement, and climate change policymaking, and most notable, access to information, which may provide additional insights.

A. South Africa

<u>Disaster risk profile:</u>

South Africa is particularly vulnerable to the effects of climate change through three key climate-related disasters, namely floods, droughts, and wildfires (The World Bank Group, 12). According to the World Bank, South Africa is projected to continue experiencing increased temperatures which will greatly impact aspects of health, agriculture, and water resources (The World Bank Group, 9). Likewise, parts of South Africa experienced one of the most devastating droughts of the last century, and this water scarcity is expected to increase (The World Bank Group, 12).

To analyse the vulnerability of states to the effects of climate change, whereby climate vulnerability is defined as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of. Climate change, including climate variability and extremes," (IPCC, 2001). The Global Climate Risk Index is a useful tool as it provides some of the most in-depth publicly available analyses of the impacts of climate-related events by examining the levels at which states are experiencing climate-related disasters such as floods, droughts, and extreme temperatures (Eckstein, et al. 2018). While this index uses comprehensive data from the Munich Re NatCatSERVICE, which is the "world's leading re-insurance company" it has its limitations due to its failure to account for rising sea levels amongst other variables (Eckstein, et al. 2018, 19). The index uses indicators such as economic losses through units of Gross Domestic Product (GDP) and the sum of losses in US$ in purchasing power parity (PPP), as well as the social impacts such as the number of fatalities (Eckstein, et al. 2018, 19).

The Global Climate Risk Index for 1997-2016 measures the aggregate impacts of climate-related impacts over a twenty-year period to showcase the longer-term effects of climate change. The Climate Risk Index ranks South Africa as the 88th most vulnerable state in the world to climate change, reporting 45.20 annual average fatalities caused by climate-related events (Eckstein, et al. 2018, 34). Likewise, it is estimated that South Africa experiences an average loss of 492.750 million US$ (PPP) or 0.09% of its GDP on average (Eckstein, et al. 2018, 34). It is noted that the Climate Risk index also provides yearly indices to provide information on a specific year, but for the purposes of this research, the aggregate data has been used as it provides a more cumulative view of climate vulnerability.

<u>Country-level information:</u>

When looking at the effects of climate-related disasters on individual perceptions of climate change, it is important to contextualise the data within its country-specific demographic information. The South African state has a population of 57 339 635 million people, as of 2018, making it the third largest state by population within the sample of states used in this paper (World Bank, 2018). Its Gross Domestic Product (GDP) per capita (constant 2015 US$) is 6 251, with the fourth highest GDP per capita within the sample pool of states (World Bank, 2018). According to the World Governance Indicators, South Africa is estimated to score 0.132596701 on a -2.5 to +2.5 scale, indicating a moderately positive level of government effectiveness across the state. Likewise, according to the Access to Information index

constructed in this research, around 85% of South African respondents are shown to have access to information which is significant. On the other hand, South Africa has an estimated score of -0.2278 on a -2.5 to 2.5 scale, concerning Political Stability and Absence of Violence/Terrorism according to the World Governance Indicators (World Bank, 2018). Given this information, South Africa is shown to be a somewhat prosperous state as compared to the states in the sample pool – despite its challenges in terms of its political, economic, and social conditions.

Climate-related engagement and policy:

As argued by Lorenzoni et al. (2007), it is relevant to measure the beliefs and concerns of a country's population, as these factors often influence public policy. Therefore, it is pertinent to analyse South Africa's climate-related policy, firstly to better understand the commitment by the government to the creation and implementation of climate-related policies, and secondly to gain a better understanding of the factors which drive the development of these policies. For example, as determined by the Grantham Research Institute on Climate Change and the Environment, South Africa has a total of 13 climate-related policies, as well as 6 executive laws, 9 litigation cases and 29 climate targets as of January 2023 (Grantham Research Institute, 2023). It is important to note that the climate-related policies outlined by the Grantham Research Institute are only those directly linked with climate change, and the South African government may have additional policies indirectly related with the phenomenon and thus the analysis of the South African climate policy may be limited.

Nonetheless, considering the first documented policy related to climate change, namely the Drought Management Plan was produced in 2005, indicating the South African government developed six climate-related policies in the 12-year period from 2005-2017 (Grantham Research Institute, 2023). Yet, considering that seven of the thirteen climate policies were developed after the 2018 Afrobarometer survey round, over four years, this is an indication that South Africa has been developing its climate and environmental policies at a much faster rate in recent years. This is somewhat expected as climate change rapidly gains traction as an international topic of relevance.

Likewise, the factors which drive these climate policies may arguably be determined by the language-use within the policy documents themselves through discourse analysis (Gee, 2010).

Many these climate-related policies were developed in 2019 and 2020, and largely focus on existing socio-economic challenges within the state. For example, the 2019 *National Energy Efficiency Strategy* focuses on improving energy usage and economic growth, while the 2019 *Integrated Resource Plan* does not directly focus on climate change but considers the implications of it when generating national energy and mining plans.

While the Afrobarometer survey provides insights into individual perceptions of climate-related events and climate change, a closer look at civic engagement in South Africa may provide additional information concerning the factors which influence public movements. For example, Cock (2004) argues that there is no singular climate movement connected by an overarching ideology in South Africa but many varying civic approaches to the environment, such as urban rights-based approaches, mining, agriculture, and corporate accountability. This reinforces the notion that while individuals may not understand or perceive climate change as a scientific phenomenon which explains the anthropogenic effects of human activity on the environment, South Africans are concerned about environmental issues.

Moreover, research indicates that "environmental rights in the South African constitution are framed in health terms" (Cock, 2, 2004). This notion is reinforced by the 2014-2019 *National Climate Change and Health Adaptation Plan,* which approaches climate change primarily as a national health issue, by stating that "[human] beings are directly exposed to the negative impacts of climate change through extreme weather events (droughts, rising sea levels, floods, cyclones and hurricanes) and indirectly through weather or climate-related impacts on food, water, air, infrastructure, agriculture, ecosystems and livelihoods" (Department of Health, 2014, 4). This is a fundamental factor to consider in examining the sphere of climate change in South Africa and further underscores the notion that while individuals may not appear overly concerned with the effects of climate change, the public approaches environmental concerns from a specific lens – in this case, it is argued to be a health lens. In that vein, there are other much larger and impactful movements in South Africa, such as those engaged with economic and political issues such as access to basic services (McDonald, 2002), emphasising the belief that South Africans are much more engaged and concerned with these issues than climate change – even when these economic and political issues are inextricably linked with climate change.

Climate change perceptions:

However, despite the high level of access to information within the state, as well as its relatively high GDP within the range of sample states in this research pool, South African respondents are shown to have a significantly low perception of climate change with less than 20% of respondents showing concern for the risk posed by climate change. On the other hand, Afrobarometer data shows that, compared to the Climate Change Perception Index created in this paper, South African respondents display much more awareness of environmental changes, with 56% of respondents observing worsened climate conditions for agricultural output, around 62% of South African respondents have experienced worsened levels of droughts and 52% observing worsened floods (Afrobarometer, 2020).

This data indicates a more than 30 percentage point difference between the proportion of respondents who have observed worsening climate conditions and those who are concerned about climate change. This indicates that respondents observe changes in their immediate environmental conditions yet fail to identify climate change as a result of these worsened conditions. This may be due to a number of factors, such as cognitive dissonance, lack of education on climate-related issues in public education programs, as well as a more focused approach to other economic and political issues within the country, such as access to energy, poverty, employment, and inequality, which are major points of tension within the state.

B. Tanzania

Disaster risk profile:

Tanzania has been selected as the second qualitative case study for the purpose of this research due to its largely similar national characteristics, with key differences regarding the principal variables of the study which may provide useful insights into the formation of climate change perceptions. More specifically, Tanzania is highly vulnerable to frequent flooding, which according to the Climate Change Knowledge Portal, contributes to Tanzanian food insecurity, health, and economic activity amongst other negative effects (World Bank, 2023). Likewise, Tanzania is susceptible to severe droughts, which negatively impact the state's socio-economic performance and poses a great risk to the health and survival of the population (World Bank, 2023). In conjunction with these natural disasters, Tanzania is also susceptible to longer term climate change such as increased temperature and precipitation which is projected to contribute to higher levels of malaria epidemics (World Bank, 2023).

This positions the state as highly vulnerable to the effects of climate change, creating a sense of urgency in developing effective adaptation and mitigation policies related to the environment. Notably, Tanzania has an almost identical population to South Africa of 58 090 443 people (World Bank, 2018). In comparison, the Global Climate Risk Index for 1997-2016 indicates that Tanzania is ranked 116th regarding climate vulnerability globally. It has been estimated to experience an annual average of 25.35 fatalities, with an average of 61.719 million US$ (PPP) losses. Similarly to South Africa, it experiences an average annual loss of 0.0745% of its GDP (Eckstein, et al., 2018, 34). However, South Africa exhibits more vulnerability to natural disasters when considering the full range of factors explored here.

Country-level information:

Contrastingly, Tanzania is positioned much lower regarding its government effectiveness score of -0.754, which ranks it as 22nd in the pool of 33 sample states (WGI, 2018). Similarly, Tanzania has a score of -0.571 concerning its political stability, indicating Tanzania experiences significantly higher level of political instability when compared with South Africa (WGI, 2018). Tanzania is also shown to have less than a fifth of South Africa's Gross Domestic Product (GDP) per capita, at 1011.08 per capita (constant 2015 US$) (World Bank, 2018). Afrobarometer data also indicates that Tanzanian respondents have significantly lower access to information in relation to South Africa, with fewer than 40% of respondents relying on any of the included sources of information (Afrobarometer, 2020). Based on these socio-economic and political measurements, Tanzania underperforms when compared with South Africa.

Climate-related engagement and policy:

Tanzanian climate policy has also shown to progress at a similar rate to that of South Africa. When looking at the same data made available by the Grantham Research Institute on Climate Change and the Environment, Tanzania is recorded to have 11 climate-related policies and 4 laws related to climate change (Grantham Research Institute, 2023). Unlike South Africa, Tanzania's first climate-related policy listed in this resource was published much earlier, with the 1997 National Environmental Policy which may indicate that the state has been Id to the environment for longer than South Africa (Grantham Research Institute, 2023). Interestingly, 9 of the 11 policies were developed prior to the 2018 Afrobarometer survey round, while only 2 have been developed in the last 5 years. Likewise, the National Climate Change Strategy of 2021-2026 is a replacement for the 2012-2017 National Climate Change Communication Strategy (Grantham Research Institute, 2023). While Tanzania evidently updates its climate

policies which indicates its renewed commitment to climate change, it is interesting that the state develops its national climate polices at a less frequent rate than South Africa in recent years. Additionally, while this information is useful in gauging the country-level agenda for environmental issues, the commitment of a state to climate change is a complex issue and cannot fully be explored within the parameters of this study.

Civic engagement in Tanzania varies in its approach to the environment, as well as the factors which most influence civic engagement. For example, Haapanen (2007) claims that religious or faith-based organizations are considered to have the most amount of influence over individual behaviours and concerns. On the other hand, this author also finds that non-governmental organizations (NGOs) have the most significant influence over policymaking but notes these NGOs and faith-based organizations function mostly in the spheres of education and gender equality (Haapanen, 2007: 5). From an environmental perspective, Haapanen (2007) notes that climate-related issues are slowly becoming more prominent for civil society organizations, while Neumann (1995) argues that environmental movements in the state are largely centred on issues of wildlife conservation and the often-conflicting focus on pastoralist rights. This highlights a key difference between South Africa and Tanzania, where one state approaches the issue of climate change from a health lens, while the other approaches it from a wildlife and pastoral lens, reflecting the economic and social landscape of the respective states.

Climate change perceptions:

This highlights the key social, political, and economic differences between the two states, and yet Afrobarometer data reflects near identical individual perceptions of climate change amongst Tanzanian and South African respondents. For example, around 18% of Tanzanian respondents show concern for climate change, yet over 64% of the same respondents have expressed the observation that environmental conditions for agricultural production have worsened over a ten-year period. This shows a difference of proportion of more than 40 percentage points, highlighting the significant difference between individual observations of environmental changes and a corresponding recognition of climate change as one of the key causes of the environmental degradation.

On the other hand, Tanzanian and South African respondents have almost identical observations of environmental conditions for droughts, with over 55% of respondents

observing that droughts have worsened over a ten-year period (Afrobarometer, 2020). This is to be expected as both states are prone to droughts, which are shown to be one of the key climate-related disasters projected to increase in occurrence and severity as the effects of climate change continue to worsen (World Bank, 2023). On the other hand, around 17% of Tanzanian respondents express that floods have worsened over the ten-year period, which is significantly lower than that of South African respondents. This is surprising considering the vulnerability of Tanzania to floods and storms (World Bank, 2023).

Both states in this case study analysis showcase similar levels of concern for climate change, while South Africa exhibits greater vulnerability to natural disasters. Key differences in economic performance, governance, civic engagement, climate change policymaking, and most notably, access to information have also been noted. Of note is the shared disparity between individuals observing that environmental conditions for agricultural production have worsened over a ten-year period, and those expressing concern for climate change. Ultimately, these cases highlight the overwhelming lack of knowledge of or concern for climate change in African states, even when looking at states that have differing levels of access to information, climate vulnerability, or political commitment to climate change issues. This conforms with the literature that highlights the potential of cognitive dissonance, where individuals are experiencing the effects of climate change, but reflect conflicting beliefs or perceptions of those experiences, (Brownlee et al., 2013).

12. Conclusion

This study has been premised on the hypothesis that individuals living in countries which experience more frequent and hazardous natural disasters would be more likely to express concern for climate change and its consequences. This notion stems from similar studies conducted in the global North, many of which find that climate change perceptions play a pivotal role in influencing climate action (Krkoška Lorencová et al., 2019). Likewise, scholars argue that natural disasters have a larger and more direct impact on individuals than other long-term effects of climate change, such as deforestation and desertification, thus enforcing the importance that natural disasters could have on individual perceptions of climate change in this study (Sloggy et al., 2021, 25).

The methodology for this paper includes an in-depth quantitative analysis of 33 African countries to determine the country-level perceptions of climate change, as well as the country-level frequency of and vulnerability to natural disasters. Furthermore, the study has been strengthened by an individual-level analysis of climate change perceptions for 37 185 individuals to determine the role of experiencing natural disasters in shaping individual perceptions of climate change. Thereafter, a qualitative case study of two countries within the study pool has been conducted to determine the role of additional political and socioeconomic factors such as GDP per capita, and government effectiveness, as well as national policymaking for climate change on shaping these country-level perceptions of climate change.

However, once examining the data available for 33 African states, it appears that an inverse relationship exists between the *vulnerability* of states to natural disasters and country-level concern for climate change in those states. This result is interesting as it provides potentially impactful information for policymaking, as well as furthering the study of climate change perceptions in African states. Additionally, the linear model – which analyses 37 185 individual Afrobarometer respondents, indicates a negative relationship between natural disasters experienced and concerns for climate change on the individual level.

There appears to be a general trend across African states in the sample pool which reflects a lack of understanding or concern of climate change, regardless of demographic information. This finding is congruent with the understanding that African states are often overlooked in the global discussion surrounding climate change and its processes, impacts and influence on

individuals, which potentially leads to a lack of public awareness raising for climate change. Moreover, this research expands the study by Ifegbesan et al. (2021), which finds that, in Nigeria, factors such as access to information are key to shaping individual beliefs and concerns of climate change. This finding thus holds true for a much larger pool of country cases.

Limitations of this study include data availability. As only 33 of the 54 African countries have been analysed in this study, due to a lack of data concerning one or more of the variables, this leaves a significant proportion of the continent understudied. For instance, states like Zimbabwe, which according to the Global Climate Risk Index was ranked as part of the top 10 most vulnerable states globally to the effects of climate yet a lack of data concerning climate change perceptions amongst other variable restricts the findings of this paper (Eckstein, 2018). Likewise, while the qualitative country case studies provide more insight into the specific context within which climate change perceptions may be shaped, additional factors may need to be analysed at the quantitative level to further establish the variables which influence climate change perceptions.

From a theoretical perspective, environmental realism dictates that climate change poses a threat to state sovereignty, and consequently, climate policies differ across states dependent on national interests (Lieven, 2020). Thus, while it may be hypothesised that states more vulnerable to climate change effects, namely natural disasters, would respond to those threats through more advanced climate policies, the findings of this study are inconclusive.

On the other hand, democratic eco-socialism suggests that anti-systemic movements "have an important role to play in creating a socio-ecological revolution committed to both social justice and environmental sustainability" Baer (2016, 7). The country-level case studies find that, despite the low levels of concern shown for climate change, grassroots environmental movements remain prevalent, and individuals continue to engage in anti-systemic movements. However, whether these movements have indeed created a socio-ecological revolution requires much more in-depth study.

Moreover, as argued by Lorenzoni et al., (2007), climate policies are at risk of rejection or ineffectiveness within a public which lacks an understanding of climate change. When looking at the case studies focused on South Africa and Tanzania, this theory may hold true, where both states display a commitment to climate change through a range of public policies, yet

public concern for climate change is significantly low, which could potentially impede the overall public support for these policies. Moreover, this study has the potential to conform with literature focused on cognitive dissonance, as data suggests that individuals experiencing natural disasters are not likely to express concern for climate change, showcasing conflict between lived experience and corresponding perceptions of those experiences (Brownlee et al, 2013). However, Averchenkova, et. Al. (2019, 4) argues that in the particular case of South Africa, tensions between public institutions and non-state actors based upon mistrust and historical difficulties are more often the cause for ineffective public policies, including those focused on climate and environmental issues. As it stands, this notion requires further study.

Recommendations for future studies include expanding upon the analysis of Afrobarometer survey results. For example, as Afrobarometer conducts surveys every few years, new data concerning climate change beliefs and understandings will become available. Likewise, Afrobarometer Round 8 survey data is set to expand its range of questions concerning climate change, which indicates a growing interest in individual perceptions of climate change across the African continent. This provides an interesting opportunity to replicate this study with new data in order to provide a comparative analysis of climate change perceptions and improve the understanding of climate change beliefs in African states.

Annex

Table 5: Climate Change Perception Index

Country	*Index*
Benin	41.0%
Botswana	21.43%
Burkina Faso	30.46%
Cabo Verde	45.1%
Cameroon	43.06%
Cote d'Ivoire	32.23%
eSwatini	32.96%
Gabon	50.14%
The Gambia	37.82%
Ghana	25.97%
Guinea	36.96%
Kenya	17.85%
Lesotho	25.42%
Liberia	22.37%
Madagascar	36.85%
Malawi	56.82%
Mali	38.60%
Mauritius	65.23%
Morocco	21.04%
Mozambique	16.95%
Namibia	25.16%
Niger	25.32%
Nigeria	21.96%
São Tomé and Príncipe	35.71%
Senegal	30.24%
Sierra Leone	16.22%
South Africa	18.84%
Sudan	21.29%
Tanzania	17.68%
Togo	36.67%
Tunisia	12.77%
Uganda	57.90%
Zambia	25.35%
Zimbabwe	0%**

Table 6: Afrobarometer Survey Results: Proportion of individuals concerned for climate change

Country	*P1*	*P2*	*P3*	*P4*	*Index*
Benin	48.5%	44.1%	52.4%	49.5%	41.0%
Botswana	40.9%	34.0%	36.9%	30.7%	21.4%
Burkina Faso	46.1%	34.9%	41.6%	44.9%	30.5%
Cabo Verde	62.2%	46.1%	63.4%	49.8%	45.1%
Cameroon	55.1%	49.2%	54.4%	49.3%	43.1%
Cote d'Ivoire	44.8%	38.3%	45.8%	42.9%	32.2%
eSwatini	46.8%	39.8%	48.1%	41.7%	33.0%
Gabon	60.4%	60.4%	57.2%	50.6%	50.1%
The Gambia	49.4%	39.8%	47.6%	45.3%	37.8%
Ghana	40.0%	36.5%	36.7%	40.3%	26.0%
Guinea	44.0%	48.7%	48.5%	52.1%	37.0%
Kenya	49.0%	46.7%	0.0%	47.0%	17.9%
Lesotho	42.0%	29.8%	41.8%	30.0%	25.4%
Liberia	35.6%	29.8%	36.6%	26.5%	22.4%
Madagascar	48.3%	44.8%	51.2%	50.8%	36.9%
Malawi	69.3%	60.3%	74.4%	69.0%	56.8%
Mali	53.0%	36.4%	49.7%	55.4%	38.6%
Mauritius	79.9%	66.3%	75.3%	70.3%	65.2%
Morocco	44.3%	43.8%	35.7%	44.6%	21.0%
Mozambique	35.4%	25.6%	24.9%	29.1%	17.0%
Namibia	41.3%	29.2%	38.8%	26.2%	25.2%
Niger	45.1%	24.8%	50.0%	47.8%	25.3%
Nigeria	35.5%	30.4%	31.7%	31.4%	22.0%
São Tomé and Príncipe	45.9%	48.8%	45.6%	42.8%	35.7%
Senegal	42.9%	32.2%	42.5%	35.3%	30.2%
Sierra Leone	34.4%	30.3%	33.3%	33.6%	16.2%
South Africa	32.6%	29.1%	29.3%	22.1%	18.8%
Sudan	43.8%	41.4%	35.0%	30.0%	21.3%
Tanzania	29.3%	28.8%	28.0%	27.5%	17.7%
Togo	46.3%	43.0%	47.6%	47.8%	36.7%
Tunisia	26.6%	23.1%	23.4%	20.6%	12.8%
Uganda	69.7%	61.9%	74.8%	71.8%	57.9%
Zambia	43.3%	36.8%	39.6%	37.6%	25.4%
Zimbabwe	55.8%	0.0000000**	0.0000000**	0.0000000**	0.0000000**

As discussed, several robustness checks have been conducted to validate the use of this index, including the use of a correlation matrix to determine the relationship between each factor of the index, as well as a correlation matrix of the index itself tested against each individual factor to determine the internal consistency of the index. In addition, a series of robustness checks have been included, such as the use of Cronbach's alpha to further indicate how closely related the individual factors are within the multi-item index. Cronbach's alpha illustrates the consistency of the sum of a number of measurements, where the measurements may represent questionnaire items, amongst others (Bonett and Wright, 2015). The value of Cronbach's alpha is determined to be 0.93 which is accepted as a valid indication of internal consistency.

Correlation Matrix:

	Index	*P1*	*P2*	*P3*	*P4*
Index	1.00	0.93	0.91	0.91	0.92
P1	0.93	1.00	0.79	0.81	0.80
P2	0.91	0.79	1.00	0.75	0.79
P3	0.91	0.81	0.75	1.00	0.78
P4	0.92	0.80	0.79	0.78	1.00

Cronbach's alpha:

	Cronbach's alpha
Index	0.9358003
P1	0.9102238
P2	0.9201050
P3	0.9197018
P4	0.9145681

Likewise, a principal components analysis (PCA) has been conducted, which aims to display the pattern of similarity of the observations within a data structure (Abdi and Williams, 2010). The results of the PCA indicate a similarity between the components of the multi-item index, where each of the four factors are negative and consistent with one another. Likewise, as the test provides results for four principal components, wherein the standard deviation of the first principal component is significantly higher than the value of the second principal component, which indicates that it accounts for the most variance in the data.

Principal Components Analysis:

	PC1	*PC2*	*PC3*	*PC4*
Standard Deviation	1.8320501	0.5091372	0.4503847	0.4260580
P1	-0.5058218	-0.6543637	-0.35437250	0.7574322
P2	-0.4959684	-0.6495701	-0.44561843	-0.3567179
P3	-0.4963318	0.6839482	-0.02436761	-0.5341121
P4	-0.5018111	-0.2432323	0.82173632	0.1173588

Importance of Components:

	PC1	*PC2*	*PC3*	*PC4*
Standard Deviation	1.8321	0.50914	0.45038	0.42606
Proportion of Variance	0.8391	0.064810	0.05071	0.04538
Cumulative Proportion	0.8391	0.90391	0.95462	1.00000

To improve the interpretability and ease of use, the multi-item index concerning perceptions of climate change has been dichotomized to present the proportion of individuals within each country case-study who show an understanding and concern for climate change as a phenomenon as compared to those who have not heard of climate change as well as show a lack of understanding of it. In terms of the results of this index, respondents from Zimbabwe** were not asked three of the four survey questions which comprise the index, and thus their results are not applicable to the study to ensure comparability.

Table 7: Afrobarometer Survey Results: Proportion of individuals displaying concern for environmental conditions

	Agricultural conditions worsened	*Droughts worsened*	*Floods worsened*
Benin	82.25%	78.17%	63.17%
Botswana	47.66%	53.84%	55.26%
Burkina Faso	80.42%	83.33%	46.58%
Cabo Verde	80.67%	85.00%	57.75%
Cameroon	67.39%	70.80%	54.91%
Côte d'Ivoire	67.42%	78.08%	51.83%
eSwatini	63.83%	75.25%	74.92%
Gabon	73.81%	79.65%	86.49%
Gambia	69.08%	64.50%	38.00%
Ghana	53.38%	50.75%	45.63%
Guinea	68.51%	76.05%	56.87%
Kenya	72.86%	N/A	N/A
Lesotho	83.75%	85.08%	33.75%
Liberia	73.42%	66.33%	74.33%
Madagascar	84.08%	95.17%	93.33%
Malawi	85.25%	89.25%	65.67%
Mali	73.92%	72.58%	46.08%
Mauritius	79.00%	82.25%	87.17%
Morocco	34.50%	40.33%	39.08%
Mozambique	41.97%	55.94%	47.45%
Namibia	51.17%	55.67%	43.50%
Niger	76.92%	77.42%	58.67%
Nigeria	58.56%	59.56%	52.75%
São Tomé and Príncipe	59.92%	61.50%	51.67%
Senegal	48.75%	40.42%	36.75%
Sierra Leone	51.08%	31.75%	42.33%
South Africa	56.47%	62.39%	52.01%
Sudan	60.75%	48.42%	44.25%
Tanzania	63.67%	56.67%	16.50%
Togo	75.75%	78.75%	42.33%
Tunisia	71.56%	69.72%	44.79%
Uganda	88.83%	90.33%	22.17%
Zambia	46.50%	43.08%	46.25%

(Afrobarometer, 2020)

Table 8: Access to Information Index

	Proportion of Afrobarometer respondents with access to information
Benin	19.68%
Botswana	73.80%
Burkina Faso	17.00%
Cabo Verde	80.62%
Cameroon	42.02%
Cote d'Ivoire	30.30%
eSwatini	56.74%
Gabon	69.51%
Gambia	59.64%
Ghana	44.01%
Guinea	15.83%
Kenya	59.15%
Lesotho	21.76%
Liberia	28.70%
Madagascar	10.27%
Malawi	11.80%
Mali	20.00%
Mauritius	99.40%
Morocco	83.67%
Mozambique	24.66%
Namibia	82.76%
Niger	5.35%
Nigeria	52.60%
Sao Tome and Principe	55.95%
Senegal	66.67%
Sierra Leone	17.02%
South Africa	85.09%
Sudan	59.72%
Tanzania	39.62%
Togo	30.80%
Tunisia	65.65%
Uganda	27.56%
Zambia	21.35%

The Access to Information Index used in this paper has been validated using similar techniques used to validate the Climate Change Perceptions Index. However, since the Access to Information Index merely aims to provide an indication of the proportion of respondents who have access to any of the listed sources of information, it is not integral for the index to maintain a high level of internal consistency. This is due to the notion that correlation between the various sources of information is not expected to be high, for example, individuals who mostly use the internet and social media as sources of information are not likely to also rely on the radio and newspapers for the same information. Thus, the correlation matrix indicates that all the factors included in the index correlate with one another, with the exception of radio as a source of information. This merely indicates that individuals who rely on the radio for information are not likely to also rely on the other listed sources of information. However, radio has been included in the index despite its lack of correlation as it contributes to the overall measurement of access to information in a significant manner. Cronbach's alpha for this Access to Information index is determined as 0.72, which is noted as an acceptable indicator of internal consistency.

Correlation Matrix :

	Index	***A0***	*A1*	*A2*	*A3*	*A4*
Index	1.00	0.45	0.71	0.64	0.81	0.80
A0	0.45	1.00	0.21	0.18	0.09	0.09
A1	0.71	0.21	1.00	0.35	0.42	0.41
A2	0.64	0.18	0.35	1.00	0.40	0.37
A3	0.81	0.09	0.42	0.40	1.00	0.85
A4	0.80	0.09	0.41	0.37	0.85	1.00

Cronbach's alpha:

	Cronbach's alpha
Index	0.7196738
A0	0.7826190
A1	0.6681954
A2	0.6799896
A3	0.5917279
A4	0.5997590

Likewise, the PCA outcome shows consistency where all values for the first principal component are negative and comparable with one another, with the exception of radio (A0).

Principal Components Analysis:

	PC1	*PC2*	*PC3*	*PC4*	*PC5*
Standard Deviation	1.5825032	1.0147875	0.8266900	0.8017722	0.3736774
A0	-0.1678925	-0.8781503	0.3938756	-0.2133474	0.002998362
A1	-0.4299223	-0.1805842	-0.1104213	0.8776862	-0.005498350
A2	-0.4109139	-0.2041675	-0.8177334	-0.3463462	-0.028665898
A3	-0.5594586	0.2718872	0.2645799	-0.1803392	0.714533924
A4	-0.5523900	0.2839619	0.3065594	-0.1779661	-0.698985204

Importance of Components:

	PC1	*PC2*	*PC3*	*PC4*	*PC5*
Standard Deviation	1.5825	1.0148	0.8267	0.8018	0.37368
Proportion of Variance	0.5009	0.2060	0.1367	0.1286	0.02793
Cumulative Proportion	0.5009	0.7068	0.8435	0.9721	1.00000

The Access to Information index has been dichotomized, with those who have reflected frequent use of various sources of information (ranging from multiple times a week to somewhat regularly throughout the month) interpreted as having access to information, while those who did not respond to the question, as well as those who responded having very little to no engagement with any sources of information determined to have no access to information.

Table 9: Global Climate Risk Index (1997-2016) (Eckstein, 2018)

CRI Rank	Country	CRI score	Fatalities (avg.)		Fatalities per 100 000 inhabitants (avg.)		Losses in million US$ (PPP) (avg.)		Losses per unit GDP in % (avg.)	
			Total	Rank	Total	Rank	Total	Rank	Total	Rank
150	Benin	135.83	4	113	0.046	132	5.287	152	0.0345	143
155	Botswana	141.17	0.6	152	0.031	150	12.863	137	0.0559	129
107	Burkina Faso	98	7.75	92	0.054	125	40.167	106	0.2045	70
148	Cabo Verde	134.33	0.25	162	0.052	128	1.856	164	0.0776	112
149	Cameroon	134.83	7.9	91	0.042	139	11.794	138	0.0242	151
159	Cote d'Ivoire	145.83	5.7	99	0.03	153	6.651	148	0.0121	161
174	Gabon	167.67	0.45	156	0.031	152	0.012	182	0	182
76	Gambia	75.5	4.9	105	0.318	49	7.253	146	0.3289	52
115	Ghana	103	29.65	62	0.135	84	32.131	114	0.0469	137
172	Guinea	159	1.85	134	0.018	162	1.274	166	0.0085	165
43	Kenya	56	57.4	40	0.161	76	354.698	44	0.362	50
134	Lesotho	119.33	0.2	164	0.011	168	19.238	126	0.421	45
170	Liberia	157.83	0.35	160	0.01	169	1.141	169	0.0408	140
13	Madagascar	37.83	78.6	36	0.408	39	196.408	61	0.7388	26
83	Malawi	78.83	11.35	76	0.078	111	61.802	95	0.4979	40
125	Mali	113.33	5.9	97	0.043	135	25.746	119	0.1026	97
119	Mauritius	107.67	0.95	148	0.078	112	26.632	118	0.1608	78
107	Morocco	98	17	70	0.055	124	172.142	66	0.0975	102
18	Mozambique	40.83	103.1	29	0.462	34	108.428	82	0.6174	33
57	Namibia	66.5	11.35	76	0.568	31	32.705	113	0.1903	74
79	Niger	77.17	14.9	72	0.11	97	47.016	101	0.3828	48
122	Nigeria	111.83	83.15	33	0.058	121	108.748	80	0.0151	158
141	Senegal	126.67	5.05	103	0.042	138	15.396	133	0.0622	124
143	Sierra Leone	127.33	8.3	89	0.159	77	0.243	177	0.0036	172
88	South Africa	84.17	45.2	49	0.093	103	492.75	34	0.09	108
98	Sudan	94	46.8	48	0.134	85	82.755	86	0.0553	130
118	Swaziland	106.5	0.55	153	0.054	126	23.538	124	0.308	55
116	Tanzania	104.17	25.35	65	0.065	116	61.719	96	0.0745	116
161	Togo	148	2.25	129	0.039	142	1.502	165	0.0198	155
138	Tunisia	122.5	3.65	115	0.036	145	64.145	94	0.0724	118
67	Uganda	70.67	36.6	54	0.133	86	122.804	76	0.254	61
131	Zambia	116.5	5.45	101	0.042	136	38.263	108	0.0882	109

Table 10: Percentile rankings of the sample pool of case study countries as transformed from the Global Climate Risk Index (Eckstein, 2018)

Country	*Percentile*
Madagascar	97%
Mozambique	94%
Kenya	91%
Namibia	88%
Uganda	84%
Gambia	81%
Niger	78%
Malawi	75%
South Africa	72%
Sudan	69%
Burkina Faso	66%
Morocco	66%
Ghana	59%
Tanzania	56%
Swaziland	53%
Mauritius	50%
Nigeria	47%
Mali	44%
Zambia	41%
Lesotho	38%
Tunisia	34%
Senegal	31%
Sierra Leone	28%
Cabo Verde	25%
Cameroon	22%
Benin	19%
Botswana	16%
Cote d'Ivoire	13%
Togo	9%
Liberia	6%
Guinea	3%
Gabon	0%

Table 11: Linear Model Outputs

	Coefficient	P-value
Model 1 : Concern for climate change		
Intercept (concern for climate change)	0.251579	< 2e-16*
Natural Disasters (square root)	-0.045443	< 2e-16*
Education	-0.101241	< 2e-16*
Interaction term: Natural disasters and education	0.023831	0.00139*
Model 2: Awareness of climate change		
Intercept (awareness of climate change)	0.716859	< 2e-16*
Natural Disasters (square root)	-0.092645	< 2e-16*
Education	-0.260608	< 2e-16*
Interaction term: Natural disasters and education	0.054737	3.72e-09*
Model 3: Concern for climate conditions for agricultural production		
Intercept (concern for climate conditions for agricultural production	0.662688	<2e-16*
Natural Disasters (square root)	-0.064118	<2e-16*
Education	0.021964	0.00111*
Interaction term: Natural disasters and education	0.002748	0.76580
Model 4: Concern for climate change		
Intercept (concern for climate change)	0.193453	< 2e-16*
Natural Disasters (square root)	-0.030334	2.08e-14
Access to information	0.082189	< 2e-16*
Interaction term: Natural disasters and access to information	-0.029243	0.016*

** Statistically significant at the 95% confidence level*

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