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Climate Change Adaptation and Mitigation in BRICS Countries: Lessons From South Africa

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Abstract:

Climate change, along with hydrometeorological disasters, is a significant global issue impacting various aspects of society. The rising frequency and intensity of floods have led to droughts and extreme heat events. In recent years, countries like South Africa have experienced severe climate-related events, highlighting the importance of effective climate change management through localised strategies. Objective: The study's objective was to evaluate the effects of climate change on livelihoods and food security in BRICS countries, focusing on South Africa, and assess the climate change adaptation and mitigation measures implemented in response. A literature review of research papers was conducted on research papers. The keywords “climate change, livelihood, and food security” were searched in databases namely, Scopus, EBSCO, and ABI/Inform were utilised, along with online resources from IEEE, PubMed, Science Direct, and Bing. The use of platforms like Web of Science, and Google Scholar was instrumental in acquiring relevant data for the study. From the outcomes of the study, it is deduced that climate change affects livelihoods and food security in South Africa and therefore significant adaptation and mitigation strategies will act as leverage. In line with the study and for theoretical implications it is highlighted that climate change, is driven by human activities, and it alters the global energy balance and subsequently affects the climate for the practical implication of the study climate change practitioners can utilize it to address the escalating climate change crisis effectively and promptly.

Keywords:

Climate Change, Livelihood, Food Security, Global Warming and Droughts.

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Introduction

Global climate change poses significant challenges that endanger the lives of millions globally and result in severe consequences (Pörtner et al., 2022). These challenges frequently occur concurrently and are interconnected (Lawrence et al., 2020), resulting in species decline and mortality (McKechnie, Hockey and Wolf, 2010; Sippo et al., 2018) as well as detrimental effects on ecosystem services (Cheung et al., 2021). The term "BRICS" which represents Brazil, Russia, India, China, and South Africa, originated from the acronym "BRIC" (Brazil, Russia, India, and China) coined by Jim O'Neill in a report he commissioned in 2001. These countries convened for the first time in 2009, and South Africa joined the group in 2010, leading to the updated acronym "BRICS." The primary objective of this coalition is to create a counterbalance to the influence of developed nations in the global economy and to amplify the voices of developing countries, ensuring they are recognized and valued (Rahman and Turay, 2018). Currently, climate change represents one of the most significant challenges of our time, particularly in countries such as those in the BRICS group (Brazil, Russia, India, China, and South Africa). These nations face unique vulnerabilities due to their socioeconomic structures, environmental conditions, and reliance on natural resources. Therefore, this study is aimed at looking at the effect of climate change on livelihood and food security in South Africa and the adaptation and mitigation strategies employed in South Africa which is part of the BRICS countries.

Literature Review

Based on the ongoing discussion regarding the impact of climate change on livelihoods and food security in South Africa as a BRICS nation, as well as the mitigation strategies being implemented, this section of the literature review will provide an understanding of the study's objectives, beginning with an overview of the relevant concepts.

Climate Change

Climate change encompasses long-term alterations in global climate patterns, extending beyond the phenomenon of global warming (Raizada et al., 2022). It involves fluctuations in temperature, precipitation, and the occurrence of extreme weather events, all of which have significant implications for ecosystems and public health (Shivanna, 2022). The primary contributors to climate change are greenhouse gases, particularly carbon dioxide, methane, and nitrous oxide, which are predominantly released through human activities such as the combustion of fossil fuels and deforestation (Raizada et al., 2022). The consequences of climate change include rising sea levels, shifts in agricultural productivity, and a decline in biodiversity (Shivanna, 2022). The ongoing discussion on the seriousness of the effects of climate change, including rising sea levels, changes in crop yields, and a reduction in biodiversity, as noted by Shivanna (2022) and the intergovernmental panel on climate change

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recommends that global warming be restricted to a maximum of 1.5°C above pre-industrial levels to help mitigate these effects.

Effects of Climate Change in South Africa

Climate change represents a significant challenge to the health and agricultural sectors in South Africa. Rising temperatures are anticipated to lead to increased morbidity and mortality (Wright et al., 2021). Additionally, extreme weather events such as droughts and floods may exacerbate the transmission of vector-borne, foodborne, and waterborne diseases (Chersich et al., 2018). The psychological and social repercussions are also concerning, particularly for vulnerable populations, including women and rural communities (Chersich et al., 2018). Despite the ongoing assertions, this study emphasizes the effects of climate change in South Africa, with consideration given to livelihoods and food security.

Effect of Climate Change on Livelihoods in South Africa

According to Johnston, et al (2023) In South Africa, climate change has significantly impacted livelihoods, particularly in agriculture and tourism. The agricultural sector, a major source of income and employment, is highly vulnerable to climate fluctuations. Changes in temperature and precipitation patterns have led to reduced crop yields and increased frequency of droughts. For example, recurrent droughts have strained water resources, making it difficult for farmers to sustain their crops and livestock. This, in turn, has led to economic hardships for communities dependent on agriculture. Additionally, climate change affects tourism, another crucial sector in the South African economy. Rising temperatures and changing weather patterns can deter tourists, especially those attracted to South Africa's natural landscapes and wildlife. For instance, shifts in seasonal patterns impact the timing of wildlife migrations and reduce the attractiveness of key tourist destinations.

Effect of Climate Change on Food Security in South Africa

Masipa (2017) asserts that food security in South Africa is under threat due to the impacts of climate change. As temperatures rise and rainfall becomes more erratic, crop production faces significant challenges. Staple crops like maize are particularly vulnerable to changing climate conditions. Reduced yields contribute to higher food prices, which can make basic food items less affordable for the population, particularly for low-income households. Moreover, climate change exacerbates existing inequalities in food distribution and access. Vulnerable communities, especially those in rural areas, are disproportionately affected by food shortages and price increases. This situation is further compounded by the degradation of natural resources, such as soil and water, which are essential for sustainable food production. (Woodhill, Kishore, Njuki, Jones, & Hasnain,2022). In line with the preceding research conducted by Llewellyn (2022) indicates that climate change presents a significant challenge to food security in many developing nations. However, the degree to which residents modify their food

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consumption and adapt to climate change will influence their livelihoods. Adom, Simatele and Reid (2022) assert that in South Africa, climate change is leading to rising temperatures, increasing the frequency of severe droughts, and altering rainfall patterns, which contribute to flooding in certain regions and flash floods in others. These extreme weather conditions are significantly affecting agriculture and exacerbating water scarcity throughout the country.

Climate Change Adaptation and Mitigation Strategies in South Africa

Research indicates that agricultural practices in Africa must evolve to effectively mitigate climate change's effects. For instance, farmers are increasingly adopting various adaptation strategies, such as utilizing drought-resistant crop varieties, diversifying crops, adjusting planting calendars, and enhancing soil moisture conservation through improved tillage and irrigation methods (Magnano San Lio, Favara, Maugeri, Barchitta, & Agodi, 2023). These practices are essential for building resilience against climate impacts, especially in regions like South Africa, which is heavily reliant on agriculture. Furthermore, integrating sustainable agroforestry practices has emerged as a viable approach to achieving both mitigation and adaptation goals in Africa (Mbow, Smith, Skole, Duguma, and Bustamante,2014). By promoting biodiversity and enhancing ecosystem services, agroforestry can significantly reduce the vulnerability of agricultural systems to climate-related shocks. The role of political leadership in climate adaptation cannot be overstated. The presence of environmental champions within political spheres has been shown to catalyze action towards adaptation, particularly when there is an acknowledgement of the intrinsic value of local environments (Azam, Mahdiat, Hafeez, and Bakhtyar, 2022; Niles, Brown, & Dynes, 2016). This highlights the importance of governance structures that support climate action and the necessity for political stability to foster effective adaptation strategies. In addition to adaptation, mitigation efforts are critical in addressing climate change. Research underscores the importance of circular economy strategies to combat environmental issues, including climate change (Yang et al., 2022). These strategies encourage the efficient use of resources, waste reduction, and the promotion of sustainable practices across various sectors, thus contributing to overall environmental sustainability in BRICS countries such as South Africa. Moreover, the aquaculture sector in South Africa can play a significant role in enhancing environmental sustainability while adapting to climate change (Ishfaq, Ahmad, Boote and Hoogenboom, 2020). The integration of climate-smart practices in aquaculture can improve productivity and resilience, making it a cornerstone of adaptation and mitigation strategies in coastal regions.

Methods and Data

To gather relevant information in conducting the study, a comprehensive literature review was conducted, focusing on online research papers and articles. The keywords “climate change,”

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"livelihood," "food security," "global warming," and "drought" were searched in several databases, including Scopus, EBSCO, and ABI/Inform, as well as online resources such as IEEE, PubMed, ScienceDirect, and Bing. Additionally, platforms like Web of Science and Google Scholar played a crucial role in obtaining pertinent data for the study. Based on the aforementioned keywords, a search was performed, resulting in a significant number of findings. The authors systematically screened the abstracts and titles of the identified articles against the inclusion criteria, which specified the requirement for articles that directly addressed the keywords. From the initial results obtained through the online search, thirty articles were identified. Subsequently, five studies were excluded as they did not focus on the effects of climate change on livelihood and food security, nor did they address mitigation and adaptation strategies employed in South Africa. This left the study with a total of twenty-five articles for review.

Results

Findings from the reviewed literature postulate that climate change is concerned with long-term changes in global climate patterns, which extend beyond the specific phenomenon of global warming (Raizada et al., 2022). The literature review indicates that climate change poses significant challenges to the health and agricultural sectors in South Africa, as outlined by Wright et al. (2021). Rising temperatures are expected to result in increased morbidity and mortality. This study aims to highlight the effects of climate change in South Africa, focusing on the implications for livelihoods and food security. The findings from the literature review reveal that climate change has profoundly affected livelihoods in South Africa, particularly within the agricultural and tourism sectors. The agricultural sector, a critical source of income and employment, is notably susceptible to climate variability. Changes in temperature and precipitation patterns have led to diminished crop yields and a heightened frequency of droughts. Recurrent droughts, for instance, have strained water resources, complicating farmers' efforts to maintain their crops and livestock (Johnston et al., 2023).

Furthermore, concerning food security, results from the study through the lens of Masipa (2017) emphasize that climate change poses a significant threat to food security in South Africa. As temperatures rise and rainfall becomes increasingly erratic, crop production faces considerable challenges. Staple crops, such as maize, are particularly vulnerable to the shifting climate conditions. Reduced yields contribute to higher food prices, making essential food items less accessible, especially for low-income households. Additionally, climate change exacerbates existing disparities in food distribution and access. The literature also suggests that food security is increasingly at risk, with Llewellyn (2022) indicating that climate change represents a major challenge to food security in numerous developing nations. The extent to which residents modify their food consumption habits and adapt to climate change will impact their livelihoods. The next phase of the discussion focuses on climate

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change adaptation and mitigation strategies specific to South Africa. The literature review indicates that agricultural practices in Africa must evolve to effectively address the impacts of climate change on livelihoods and food security. For example, farmers are adopting a variety of adaptation strategies, including the use of drought-resistant crop varieties, crop diversification, adjustments to planting calendars, and improved soil moisture conservation techniques through enhanced tillage and irrigation methods (Magnano San Lio et al., 2023). These practices are crucial for building resilience against climate impacts, particularly in regions like South Africa, where agriculture plays a vital role. Regarding mitigation, the literature suggests that implementing circular economy strategies is essential for addressing environmental challenges, including climate change (Yang et al., 2022). These strategies promote efficient resource use, waste reduction, and the adoption of sustainable practices across various sectors, thereby contributing to overall environmental sustainability in BRICS countries.

Discussion

The reviewed literature enhances our understanding of climate change, which pertains to variations in climate patterns. This perspective is supported by Rayhan, Kinzler, and Rayhan (2023), who describe climate change as the long-term modifications in the earth's typical climate, encompassing shifts in temperature, precipitation, and other climatic factors. A significant factor contributing to current climate change is global warming, which specifically refers to the rise in the earth's average surface temperature due to human activities. Practices such as the combustion of fossil fuels, deforestation, and various industrial processes have resulted in the emission of greenhouse gases into the atmosphere, thereby intensifying the natural greenhouse effect and leading to an increase in global temperatures.

Based on the results of the findings insight into the effect of climate change on livelihood was offered, it was deduced from the results that climate change has affected livelihoods in South Africa, predominantly within the agricultural and tourism sectors. The agricultural sector, a critical source of income and employment, is notably susceptible to climate variability. Changes in temperature and precipitation patterns have led to diminished crop yields and a heightened frequency of droughts. Recurrent droughts, for instance, have strained water resources, complicating farmers' efforts to maintain their crops and livestock (Johnston et al., 2023). Furthermore, a study conducted by Sahoo et al. (2023) examined the effects of climate change on livelihood security and biodiversity, addressing pertinent issues and potential mitigation strategies. Findings postulate that climate change is currently having a significant impact on people's lives, particularly among vulnerable communities. As rural populations depend heavily on natural resources, their livelihoods are jeopardised by ongoing climate changes. The effects of climate change on resource-based rural occupations are anticipated to be uneven, and enhancing ecosystem resilience through biodiversity conservation will enable ecosystems to better provide essential functions in the face of increasing climate stresses.

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The results indicate that climate change affects food security. This perspective is supported by a study conducted by Masipa (2017), which explored the impact of climate change on food security in South Africa. The findings suggest that climate change presents a substantial risk to food security in sub-Saharan Africa, influencing various aspects from crop production to food distribution and consumption. Research demonstrates that climate change, especially global warming, affects food security by impacting food availability, accessibility, utilization, and affordability.

Results about climate change adaptation and mitigation strategies, particularly concerning the impact of climate change on livelihoods and food security, the perspective offered by Ansah, Amoadu, Obeng, et al. (2024) emphasizes the importance of critical activities. These activities include the dissemination of updated climate information, the establishment of early warning systems, the development of comprehensive plans, and the implementation of targeted interventions aimed at addressing poverty and infrastructure deficiencies.

The results also suggest mitigation practices which are crucial for building resilience against climate impacts, particularly in regions like South Africa, where agriculture plays a vital role. Alemu and Mengistu (2019) state that climate change mitigation policies and implementation strategies should emphasize a coordinated, evidence-based, and climate-smart approach to addressing food security at all levels, from national to local, encompassing research, policies, and investments. This approach should engage stakeholders across private, public, and civil society sectors to achieve the scale and pace of change needed.

Conclusion

The study highlights the urgent need for both adaptation and mitigation strategies to address the multifaceted challenges posed by climate change in BRICS countries, with South Africa serving as a critical case study. By synthesizing existing knowledge and identifying gaps, this review underscores the importance of collaborative research that integrates political, environmental, health, and socio-economic perspectives to foster resilience in the face of climate change.

- Theoretical Implications: The theoretical implications of this study highlight that climate change, driven by human activities, alters the global energy balance and subsequently affects the climate. Human actions, such as deforestation for agricultural purposes and the release of pollutants into the atmosphere, contribute to these changes and influence environmental conditions. Consequently, further empirical research that explores these theoretical concepts and informs climate change mitigation and adaptation strategies is valuable for scientists and practitioners in the field.

- Practical Implications: The practical implication of this study is that climate change practitioners can utilize it to address the escalating climate change crisis effectively and promptly. The research is significant as it can be integrated into both national and international policies related to climate change mitigation and adaptation.

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