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Study of the Gendered Impacts of Climate Change in Bol, Lake Province, Chad

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Abstract: Climate change is a global phenomenon impacting ecosystems, economies, and livelihoods. This research carried out in Bol in the Lake Province of Chad, a region heavily affected by climate change, aims to analyze the gender-differentiated impacts of this phenomenon. It was carried out using the rapid analysis and participatory planning (RAPP) method and structural analysis for social systems (SAS2). Meteorological and socioeconomic data were collected through interviews, household surveys, and focus groups. The results indicate variability in rainfall, with a slight downward trend and an increase in temperature. The women identified an increase in the cost of living, human and material losses, warmer housing, and health problems as socioeconomic socioeconomic consequences of climate change. Their coping strategies include community self-help, humanitarian aid, and welfare activities. Obstacles to full participation in the search for solutions include access to education, low decision-making power, and political representation. This research enriches our understanding of the interactions between gender, climate change, adaptation, and inclusive policy importance.

Keywords: gender; climate change; adaptation; Lake Chad; town of Bol

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1. Introduction

Climate change disproportionately affects populations worldwide, with severe consequences in vulnerable regions like Chad as noted in the National Climate Change Adaptation Plan [1]. In the town of Bol, Lake Province, the gender-differentiated impacts of this phenomenon highlight the need for in-depth research to inform inclusive and effective adaptation policies. The link between gender and climate change, explored by many researchers over the last few decades, reveals significant gender disparities shaped by environmental dynamics [2]. This complex and interdependent relationship reveals deep gender disparities shaped by ecological dynamics. Understanding this relationship is crucial for improving the effectiveness of adaptation policies [3].

Gender power imbalances, undervaluation of women's domestic work, and unequal household income distribution [4] expose women to specific vulnerabilities [5]. Women, especially those from low-income groups, suffer disproportionately from extreme weather events and gradual climate change [6]. Over the past two decades, the debate on gender and

climate change has expanded to include gender disparities in vulnerability and responses to climate risks [7,8].Gender identities, social norms, and patriarchal structures shape individual capacities to face climate challenges [9]. Climate change exacerbates vulnerability in the Lake Chad region due to poverty, unemployment, and poor governance [10]. The area's heavy reliance on agriculture, with over 70% of the Lake Chad Basin's population dependent on it [11], highlights the urgent need for an inclusive and sustainable approach. The Lake Chad Basin supports approximately 50 million people across Nigeria, Cameroon, Niger, and Chad [12], emphasizing the importance of addressing gender issues in climate policies.

The Lac province faces sociocultural and economic barriers that hinder women's involvement in climate solutions. Patriarchal structures restrict women's access to the necessary resources for empowerment [13]. With worsening water scarcity impacting agricultural production [14], understanding gender implications is crucial for developing equitable and effective adaptation interventions.

- This research aims to analyze gender issues related to the socioeconomic impacts of climate change, adaptation strategies, and barriers to women's community engagement in Bol. Specifically, the study objectives are to analyze the socioeconomic consequences of climate change for women in Bol after a presentation of changes in local climatic parameters.
- Carry out a gender-based assessment of local approaches to climate change adaptation deployed by residents.

Identify the barriers that limit the effective involvement of women in the search for solutions to climate issues. This paper is structured as follows: The introduction outlines the research context, the literature review examines existing research on gender and climate change in the Lake Chad Basin, and the methodology describes the methods and data collection. The results present findings on changes in local climatic parameters, socioeconomic impacts on women, and barriers to women's participation in climate adaptation. The discussion analyzes these results and compares them to the existing literature. The conclusion summarizes the key findings, policy implications, and recommendations for future research. By focusing on Bol in Lake Province, this study aims to contribute to developing more inclusive and effective policies to address the growing challenges of climate change in the region. developing developing.

2. Literature Review

2.1. Differential Impacts of Climate Change on Women, Particularly in the Agricultural Sector

Climate change disproportionately affects women, particularly in the agricultural sector, where they constitute a large proportion of the workforce. In the least developed countries, four-fifths of economically active women are employed in subsistence agriculture [15]. However, specific challenges remain underexplored.

Ashby et al. highlighted the barriers faced by female-headed farming households [16]. These households often have smaller farms and are also affected by unpaid household chores, limiting their ability to participate fully in income-generating activities. These structural constraints exacerbate women's vulnerability to the impact of climate change, exacerbating existing inequalities. The persistent challenges facing women across Central Africa include illiteracy, barriers arising from customs and traditions, a lack of gender sensitivity in macroeconomic policies and budgets, and limited access to governance and land rights (particularly for rural women), as well as productive resources [17].

Increased climate variability, as discussed by Goh, has a significant impact on agricultural productivity, influencing women's lives differently from men's lives [18]. Fluctuating rainfall and declining soil fertility often force households to expand their fields to compensate for lower yields, increasing women's workload. In southern Tanzania, for example, these environmental and anthropogenic pressures force women to make greater efforts to maintain agricultural production, thereby increasing their vulnerability [19].

The impact of climate change on agricultural productivity has profound implications for decision-making, division of labor, and control of income. These dynamics have a

significant social dimension [20]. Lower productivity can reinforce traditional gender roles, where women are confined to unpaid domestic and agricultural tasks, while men may seek income opportunities outside the agricultural sector. This division accentuates an imbalance in control over resources and financial decisions, further limiting women's economic autonomy.

Although the literature highlights the importance of women in agriculture and the disproportionate impacts of climate change on them, it remains crucial to develop inclusive adaptation strategies that consider the specific realities of women. Developing adapted policies contextually and evaluating their long-term effectiveness is essential for achieving sustainable and equitable resilience in farming communities.

2.2. Gender-Differentiated Adaptation Strategies and Barriers to Coping with Climate Change

The literature on climate change adaptation highlights the influence of social inequalities, including gender, class, and caste, on vulnerability patterns [21]. This research reveals that these inequalities have a significant influence on the adaptive capacities of various communities and individuals, often exacerbating existing vulnerabilities.

Adaptation preferences emerge at the intersection of gender and livelihoods in Ghana [22]. Their research revealed significant variations in adaptation choices between men and women, highlighting the need for a gender-sensitive approach to developing adaptation strategies. For example, women tend to favor strengthening artisanal activities and diversifying livelihoods, which are strategies that are crucial for improving community resilience to climate challenges [23].

Adaptation strategies to the challenges posed by climate change vary but must include a gender perspective if they are to be effective. In addition, community initiatives and gender-sensitive policies are needed to address structural inequalities and promote the equitable participation of women in decision-making processes.

However, implementing these strategies is not without its challenges. In Tanzania, some initiatives, such as homestay-based ecotourism and fruit tree farming, align with women's engagement and offer promising adaptive actions [24]. These examples highlight the potential of inclusive approaches that integrate women's specific needs and capacities. Despite these initiatives, the persistence of traditional norms and patriarchal power structures continues to limit the impact of these strategies.

Traditionally, women play a central role in family and community economies, particularly in agriculture, fishing, and domestic tasks [25]. Their active involvement in adaptation strategies is, therefore, essential for building community resilience. However, changes in the crops grown by farming households in response to climate change are altering participation in decision-making, the division of labor, and control over income from crops.

In short, the diversity of women's strategies for adapting to climate change in sub-Saharan Africa is well documented. Economic empowerment, participation in decision-making processes, and community-based approaches are identified as essential for ensuring sustainable and equitable solutions [26]. However, it is imperative to recognize that integrating a gender perspective into adaptation policies should not be limited to superficial interventions. It is crucial to design contextually adapted strategies that consider local dynamics and existing power structures. Future research could focus on developing these strategies while assessing their long-term effectiveness and their ability to transform unequal social structures. This will not only promote inclusive climate resilience but also foster sustainable and equitable development for all communities.

2.3. Women's Representation and Participation in Climate-Related Decision-Making

Women's underrepresentation in climate decision-making and policy formulation is a significant gender divergence. The 2015 Paris Agreement emphasizes a gender-sensitive approach to adaptation, reinforced by a gender action plan. However, despite these advances, obstacles remain, notably the underrepresentation of women in climate-related decision-making processes. Maraawi et al. (2021) highlighted the importance of capacity

building programs at different levels as a potential strategy to overcome these barriers [27] These programs aim to improve women's representation and participation in political and decision-making spheres by integrating gender capacity building into climate response projects. However, the implementation of these programs faces persistent challenges.

In Chad, for example, prejudices and stereotypes within government departments make it difficult for planners and decision-makers to take ownership of gender issues. The effectiveness of legal rights and formal rules depends on their adaptation to a specific context and their interaction with existing laws and social norms [28]. In other words, measures must be designed with local realities in mind if they are to be truly effective in integrating the gendered approach into adaptation responses to the impacts of climate change.

The situation in Kenya is a good illustration of this dynamic. The Constitution of Kenya requires the state to take legislative and policy measures to ensure that no gender accounts for more than two-thirds of the members of elective bodies. However, as Sadie (2005) points out, the implementation of these constitutional provisions is progressing slowly [29]. Male-dominated institutions, traditional beliefs, and norms about women's roles and status remain largely unchanged, especially in the rural areas of sub-Saharan Africa.

Although legislative frameworks and initiatives exist to promote gender equality in climate decision-making processes, several challenges remain. The persistence of gender stereotypes and the slow implementation of progressive policies are major obstacles. An integrated, context-specific, and gender-sensitive approach is essential for overcoming these challenges and ensuring women's equitable participation in climate governance. Future research should focus on developing strategies that are both contextually appropriate and practically feasible to improve gender mainstreaming in climate decision-making processes.

This literature review enables us to identify some gaps. The gaps in the existing literature relate to the specific challenges faced by women in subsistence agriculture, gender-specific coping strategies, and barriers to women's participation in decision-making, all of which are compounded by traditional norms and patriarchal structures. By examining the socioeconomic impacts on women, assessing local coping strategies, and identifying barriers to participation, this research aims to strengthen women's adaptive capacities and resilience through community self-help and humanitarian aid.

3. Materials and Methods

3.1. Study Area

The town of Bol is located on the shores of Lake Chad, approximately 153 km to the north of the capital N'Djamena, in the Sahelian zone of Chad, between 13°27′31″ North latitude and 14°42′53″ East longitude. Due to its strategic geographical position, the town shares borders with Nigeria, Niger, and Cameroon. Administratively, the town of Bol was established as a commune under Decree No. 564/PR/87 of 28 October 1996. It is positioned in a very active commercial trading hub and has established itself as a town whose economy is based on primary sector economic activities, according to the National Spatial Planning Scheme (NSPS) and given its large-scale production from the polders of Lake Chad.

The town of Bol has an arid climate and a large surface water basin known as the "arm of Lake Chad". The average annual temperature is 28 °C, and the average annual rainfall is approximately 234 mm. This thermal regime and the distribution of rainfall give rise to three seasons: the cool, dry season (November to February), the hot, dry season (March to mid-June), and the rainy season (mid-June to early November).

Figure 1 below is a map showing the location of the town of Bol. As previously mentioned, the town is situated on the shores of Lake Chad, around 153 km north of the capital N'Djamena.

The town of Bol has an arid climate and a large surface water basin known as the "arm of Lake Chad". The average annual temperature is 28 °C, and the average annual rainfall is around 234 mm. This thermal regime and the distribution of rainfall give rise to three seasons: the cool, dry season (November to February), the hot, dry season (March to mid-June), and the rainy season (mid-June to early November).

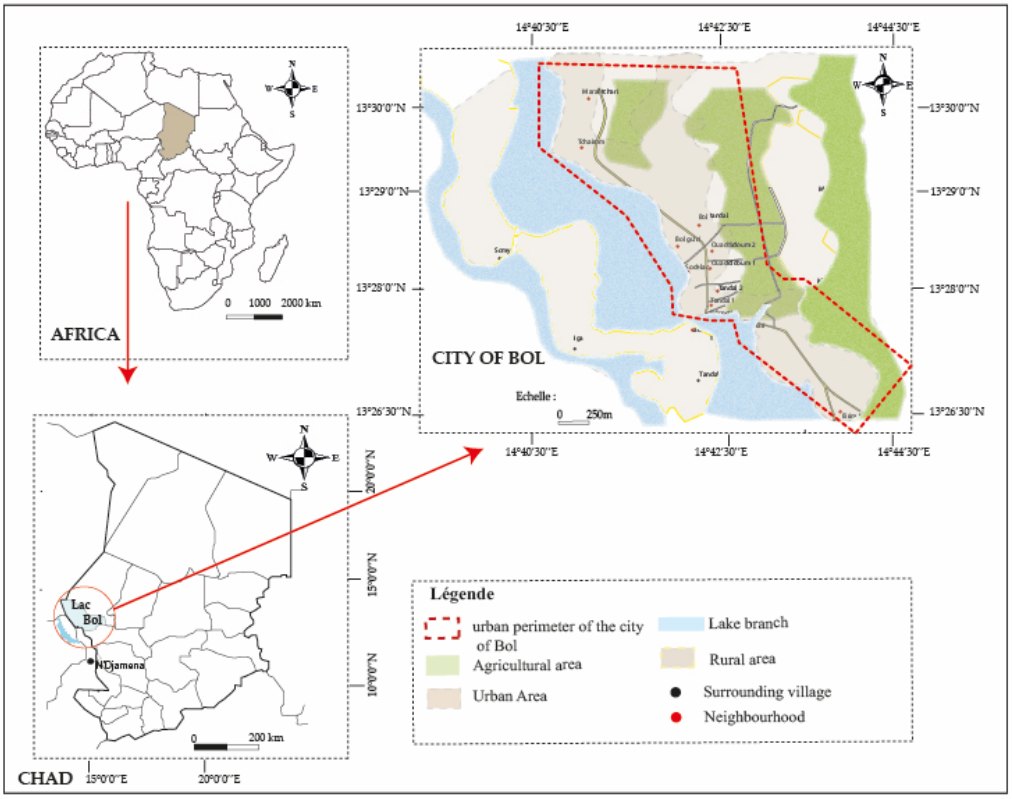

Figure 1. The geographical location of the city of Bol.

Figure 2 below is an umbrothermal diagram illustrating the relationship between rainfall and temperature in at Bol, showing dry and wet periods. It helps to characterize the climate, identify droughts, and assess conditions favorable to plant growth.

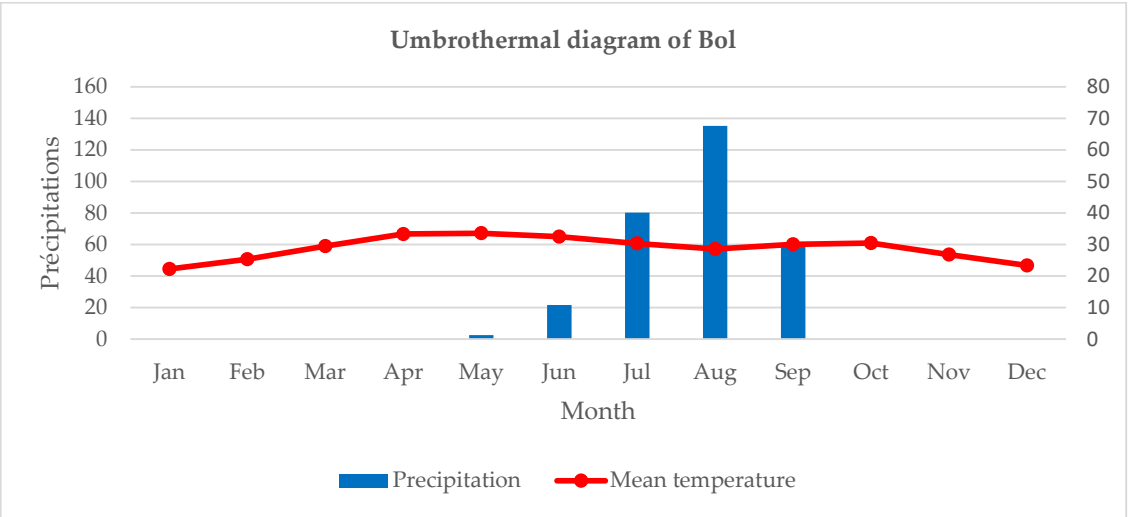

Figure 2. Umbrothermal diagram of Bol.

3.2. Data

Several types of data were used in this study, in particular, climatic data, including monthly and annual rainfall and monthly and annual temperatures for the period from 1970 to 2023. These data were obtained from the Agence Nationale de la Météorologie (ANAM) and used to characterize the current climatic state of the town of Bol. In addition, socioeconomic and demographic data from the National Institute of Statistics, Economic,

and Demographic Studies (INSEED), as well as field surveys, including household surveys, focus groups, and individual interviews, were used. The data included women's perceptions of climate events, the socioeconomic impacts of climate change on their livelihoods, and information on adaptation strategies. The data were collected between April and July 2023.

These different sources of data were used to analyze the impacts of climate change on the women of Bol to carry out a gender-based assessment of the local approaches to adapting to climate change deployed by the population and to identify the barriers limiting the effective involvement of women in the search for solutions to climate issues.

To realize this research, a methodological approach combining the rapid analysis and participatory planning (RAPP) method and structural analysis for social systems (SAS2) was adopted [30]. The choice of these methods is justified by their potential to integrate the local community's knowledge and perspectives, thereby providing an advanced understanding of social, economic, and environmental issues related to gender and climate change.

The rapid analysis and participatory planning (RAPP) method has its origins in participatory approaches to development. It allows for rapid immersion in local realities and encourages the involvement of communities, giving them an active role in identifying problems, priorities, and solutions. This method has been used successfully in similar contexts to elucidate the dynamics of gender and climate change [31,32]. It provides a suitable framework for capturing local specificities and women's perceptions of the impact of climate change.

Structural analysis for social systems (SAS2) is based on methodological tools developed to understand the complexity of social problems, such as gender issues. A systemic and participatory approach encourages collaboration between researchers and local communities to analyze social, economic, and environmental dynamics. SAS2 has been successfully used to explore interactions between gender and the environment, providing a holistic understanding of these issues [33].

3.2.1. Data and Information Collection

Data collection for this research was based on documentary and field surveys. The documentary research made it possible to gather preexisting knowledge on climate change, with a particular focus on the gender approach, based on scientific articles, reports, institutional statistical data, theses, and dissertations.

The field surveys carried out mainly between April and July 2023 in Bol involved various stakeholders and used several data collection techniques, such as household surveys, individual interviews, and focus groups.

Household surveys

The household surveys involved a sample of 378 people, with each household being drawn at random to avoid duplication. The questionnaires were created using KoboToolbox and administered using the Kobocollect application, version 2023.2.4. The sample size was determined using the Daniel Schwartz sampling formula and adjusted to obtain the 378 households surveyed. The questions asked of the participants included their knowledge of climate change, its manifestations, its socioeconomic consequences, and their adaptation strategies, as well as demographic information, such as the gender of the respondents. The sample size (378) was obtained using the Daniel Schwartz sampling formula, where

$$n = z^2 \times \frac{p(1-p)}{m^2}$$

where n = sample size; z = confidence level, which, according to the reduced centered normal distribution, for a confidence level of 95%, $z = 1.96$.

p = estimated proportion of the population that has the characteristic (when unknown, $p = 0.5$ is used, which corresponds to the worst case, i.e., the widest dispersion); m = tolerated margin of error

$$n = (1.96)^2 \times \frac{0.5(1-0.5)}{(0.05)^2} = 384.16$$

A correction coefficient (c) was applied to the sample to obtain the 377 households surveyed instead of the 384.16 households.

$$c = \frac{N}{N+n}$$

where N is the population of Bol in 2023 (21,171 inhabitants) and n = 384.16.

Finally, the actual number of respondents is $n' = n \times c = 384.16 \times 0.99 = 378$.

Individual interviews

The individual interviews aimed to gather the opinions of local professionals working on climate change and stakeholders whose activities are most affected by this phenomenon. A total of 17 interviews were conducted with technicians from the provincial environment and sustainable development delegation, the Commune of Bol, and the Lake Company of Development, as well as with farmers, fishermen, local authorities, NGO leaders, and people over the age of 45, who were able to provide a historical perspective on climate change.

Focus groups

The focus group is a qualitative technique aiming to gather discussions centered on specific concrete situations and subjects relevant to research [34,35]. Participants in the focus groups represented various socio-professional categories, such as farmers, fishermen, and livestock breeders, as well as women's associations, youth associations, and populations affected by flooding or food insecurity. The choice of participants was strategically planned to ensure a balanced representation of different social strata and their realities and perspectives on climate change, facilitating an in-depth analysis of gender and climate issues.

As part of the gender approach, three focus groups of eight participants each were organized in May 2023 to encourage women to speak out. However, questions about women and climate change were also addressed in groups reserved for men. Interpreters were used to facilitate communication within each group, enabling the effective participation of all stakeholders. In line with the participatory and inclusive approaches chosen for the research, participants in the focus groups were mobilized by a local civil society organization.

Table 1 below shows the types and profiles of participants surveyed according to each data collection technique used. It shows the participatory approach of the research and the importance of having different opinions.

Table 1. Summary of the breakdown of participants by survey type.

Type of Survey	Participants
Household surveys	378 people, each in a different household
Individual interviews	17 interviews – Technicians from the provincial environment and sustainable development delegation – Technicians of the Commune of Bol – Technicians of the Lake Development Company – Farmers on the Lake polders – Farmers cultivating on dry land – Fishermen – Local administrative authorities – Traditional local authorities – People aged over 45 – NGO leaders – Members of groups and associations (civil society)

Table 1. *Cont.*

Type of Survey	Participants
Focus Groups	– Farmers – Fishermen – Breeders – Women's associations – Youth associations – Populations affected by flooding – People affected by food insecurity
Specific participants in the gender focus groups	– 3 groups of 8 women (24 women in total)

3.2.2. Data Processing and Analysis

As part of this research, once the data had been collected, SPSS statistics 2023 and Microsoft Excel 2021 were used to organize and format the data collected from the KoboToolbox platform, as well as for the climate data. It was used to produce tables and graphs. A map showing the location of the study area was produced using ArcGIS software, version 10.8.2, based on geographic data (in shapefile format) obtained from the Geographic Information System (GIS) department of the Bol council town.

The standardized precipitation index (SPI).

The standardized precipitation index (SPI) is used to characterize precipitation deficits over a given period. It is based on two main elements: the definition of a threshold to determine whether the period studied is dry and the identification of the average reference year.

The following formula was used to calculate the SPI and determine the number of years per SPI range and their significance in terms of the extent of the climatic phenomenon (McKee, Doesken, et Kleist 1993) [36]:

$$SPI = \frac{\mathrm{Xi} - \mathrm{Xm}}{\mathrm{Si}} \quad (1)$$

where:

Xi is the sum of the rainfall for year i,

Xm and Si are the mean and standard deviation of the annual rainfall observed over a given series, respectively.

This formula can be used to assess deviations from normal and determine the degree of moderate, severe, or extreme drought or excess rainfall over a given period. Using this formula, we can assess the impact of variations in precipitation and identify episodes of drought or excessive rainfall. This provides a better understanding of climate variations and their consequences for water resources, agriculture, and other sectors that are sensitive to climate change. In this classification, SPI values are used to classify the level of drought, ranging from extreme drought (SPI ≤ -2.00) to very wet conditions (SPI ≥ 2.00). Values close to zero (-0.49 to 0.49) indicate near-normal precipitation.

Table 2 below shows the classification of drought classes according to the standardized precipitation index (SPI).

Table 2. Classification of drought classes according to the standardized precipitation index (SPI).

SPI Value	Drought Class
2.0 and more	Extremely damp
1.5 to 1.99	Very damp
1.0 to 1.49	Moderately humid
−0.99 to 0.99	Close to normal

Table 2. *Cont.*

SPI Value	Drought Class
−1.0 to −1.49	Moderately dry
−1.5 to −1.99	Very dry
≤−2	Extremely dry
−1.0 à −1.49	Modérément sec
−1.5 à −1.99	Très sec
≤−2	Extrêmement sec

4. Results

4.1. Trends in Climatic Parameters (Rainfall and Temperature) from 1970 to 2023

4.1.1. Standardized Precipitation Indices

Figure 3 shows the standardized precipitation indices recorded in Bol from 1970 to 2023, illustrating annual variations in rainfall and revealing temporal trends. This can be broken down into three distinct phases:

The first phase covers years with surplus rainfall when rainfall indices are high, i.e., above 1. These years included 1974, 1975, 1978, 1988, 1994, 1999, 2010, 2019, 2020 and 2021. The second phase groups together years that are close to normal in terms of rainfall, where the rainfall indices are between −0.99 and 0.99. These years included 1970, 1973, 1977, 1979, 1985, 1989, 1995, 1998, 2003, 2008 and 2016. The third phase consists of years with rainfall deficits, where the rainfall indices are below −1. These years include 1972, 1983, 1984, 1990, 1993, 2004, 2017, 2022 and 2023.

An examination of these three phases revealed that Bol experienced 21% of the total number of surplus years, 24% of deficit years, and 55% of normal rainfall years. The general trend shows an unstable variation in rainfall amounts over time, as illustrated by the rainfall variability curve in Figure 4.

Figure 3 below shows standardized Precipitation Indices of Bol from 1970 to 2023. It is an indicator used in climatology to measure the severity of drought. It assesses moisture deficits or surpluses in a region as a function of rainfall.

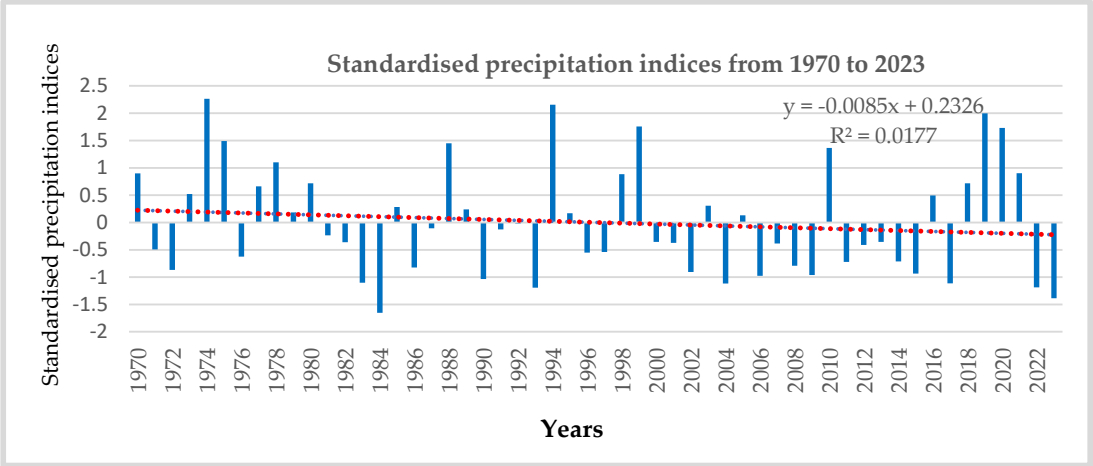

Figure 3. Standardized Precipitation Indices of Bol from 1970 to 2023.

4.1.2. Changes in Annual Rainfall between 1970 and 2023

Figure 4 shows an analysis of the rainfall trends in Bol from 1970 to 2023, revealing significant interannual variability with a downward trend over the whole period. If we analyze the data by decade, we can see that rainfall increased gradually until 1974 and then fluctuated around the average for the rest of the 1970s. The following decade, from 1980 to

1989, showed significant variability, with precipitation levels below the average observed in subsequent decades. The 1990s showed a fluctuating trend, with years of relatively high rainfall alternating with years of low rainfall. The 2000–2009 decade was characterized by interannual variability. In contrast, the period from 2010 to 2019 was marked by higher rainfall on average, with several years recording above-average levels of rainfall. The most recent years, from 2020 to 2023, showed a decreasing trend in rainfall compared with that in previous decades. The three wettest years are 1974, with 409.49 mm; 2019, with 389 mm; and 1999, with 370.35 mm. In contrast, the three least rainy years are 2023, with 127.80 mm; 1984, with 107.21 mm; and 1993, with 142.67 mm.

Figure 4 below shows trends in annual rainfall between 1970 and 2023.

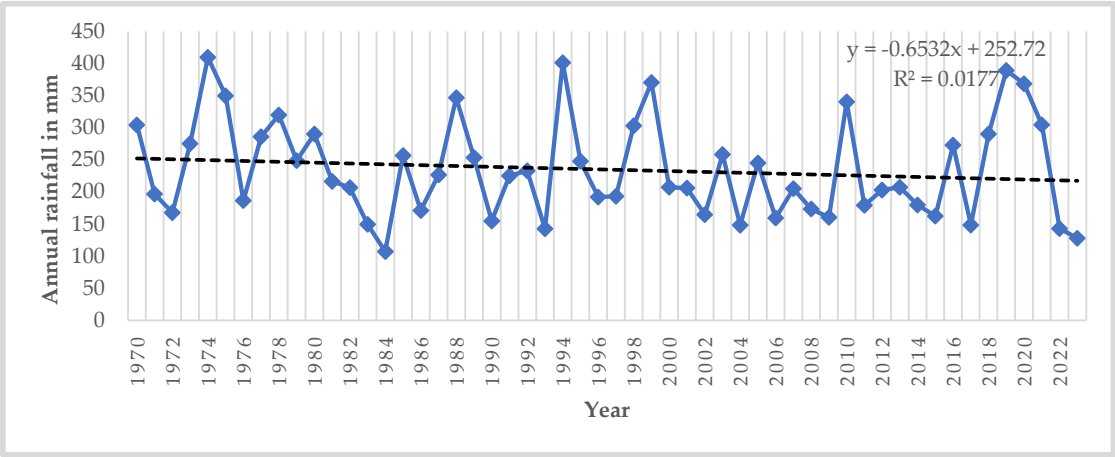

Figure 4. Trends in annual rainfall between 1970 and 2023.

4.1.3. Temperature Trends

Figure 5 shows the changes in the average annual temperature in Bol from 1970 to 2023. An analysis of this figure reveals annual temperature variability, although a general upward trend is still discernible. This observation is supported by the analysis of the correlation coefficient R^2, calculated over the study period, which reaches 0.63, exceeding the threshold of 0.5. This significant correlation indicates a strong relationship between the increase in average temperature and the number of years. Despite this upward trend, it is important to note that the 1990s and early 2000s were characterized by relatively high average temperatures, while the 1970s and 1980s showed greater variability. In addition, the most recent years (2010–2023) are characterized by relatively stable average temperatures, with values close to 29.36 °C.

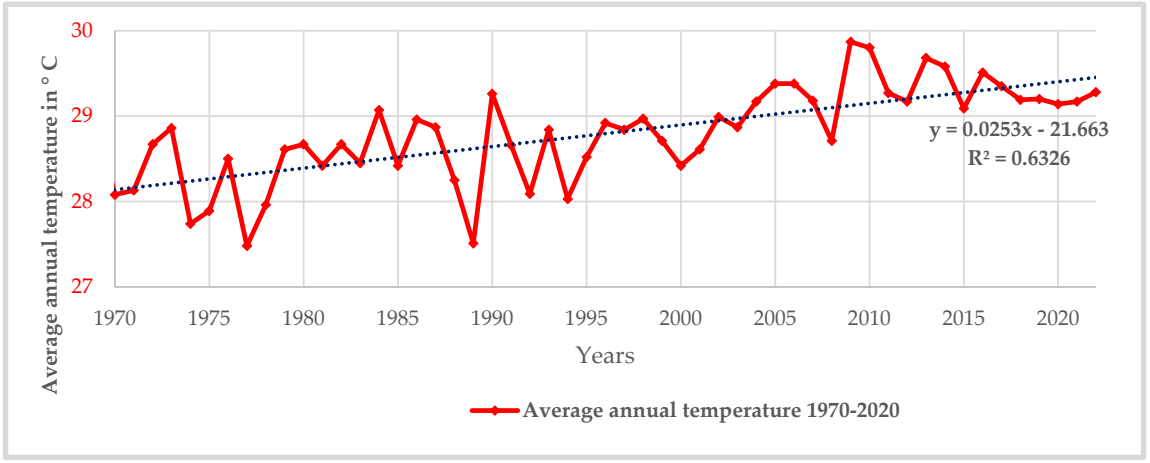

Figure 5. Changes in mean annual temperature from 1970 to 2023.

4.1.4. Perception of Climate Change by Residents of the City of Bol

Breakdown of respondents by gender

A total of 59% of the respondents were male, while 41% were women, which is in line with the trend in Chad, where men are often the heads of households. Although the research is primarily aimed at women, the inclusion of men is explained by their predominant role in family decision-making and the indirect impact of climate change on them through their wives. An inclusive approach is therefore the most appropriate for this research to gain a better understanding of family and social dynamics in the face of climate challenges.

Understanding of the climate change concept

The results of our household survey on knowledge of climate change reveal significant differences between the responses of men and women. Among the men surveyed, 66% claimed to be aware of climate change, while this figure was slightly lower among women, at 43%. On the other hand, 34% of men replied that they did not know about climate change, while this percentage was higher among women, reaching 57%. The results show a significant difference in knowledge of climate change between men and women. This disparity may be linked to sociocultural and economic factors specific to Bol's patriarchal society, where men are likely to have more access to education and information on climate change than women.

Figure 6 shows knowledge of the climate change concept.

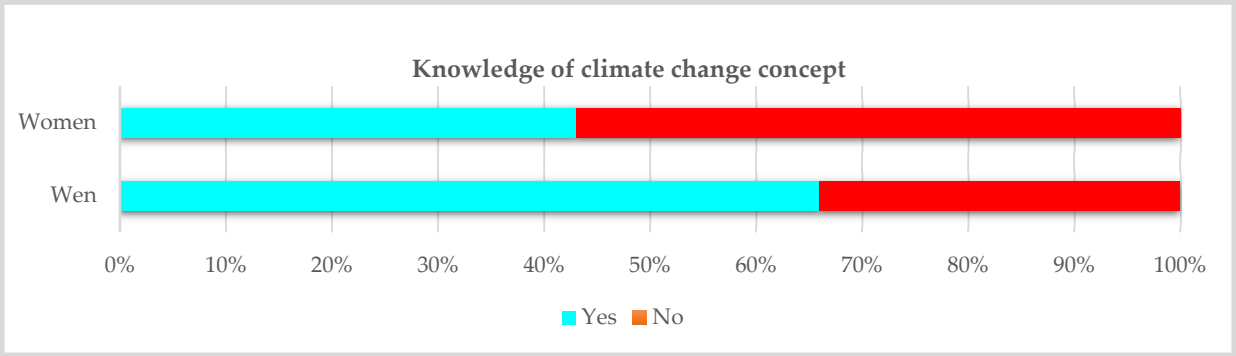

Figure 6. Knowledge of the climate change concept.

Channels through which climate change knowledge is acquired

The results show a diversity of channels through which respondents acquired knowledge of climate change. Gender analysis revealed some interesting trends. Men seem more inclined to acquire their knowledge of climate change through international radio (16%), NGOs (13%), and television (10%), while women seem more active in seeking information from acquaintances (13%), local radio (9%), social networks (9%), and training courses on climate change (10%). This distribution suggests diversity in media preferences and information channels between the two sexes. In short, this research highlights the diversity of channels for acquiring knowledge about climate change while also highlighting the significant nuances in informational preferences and behavior between men and women.

Figure 7 below shows channels through which climate change knowledge is acquired.

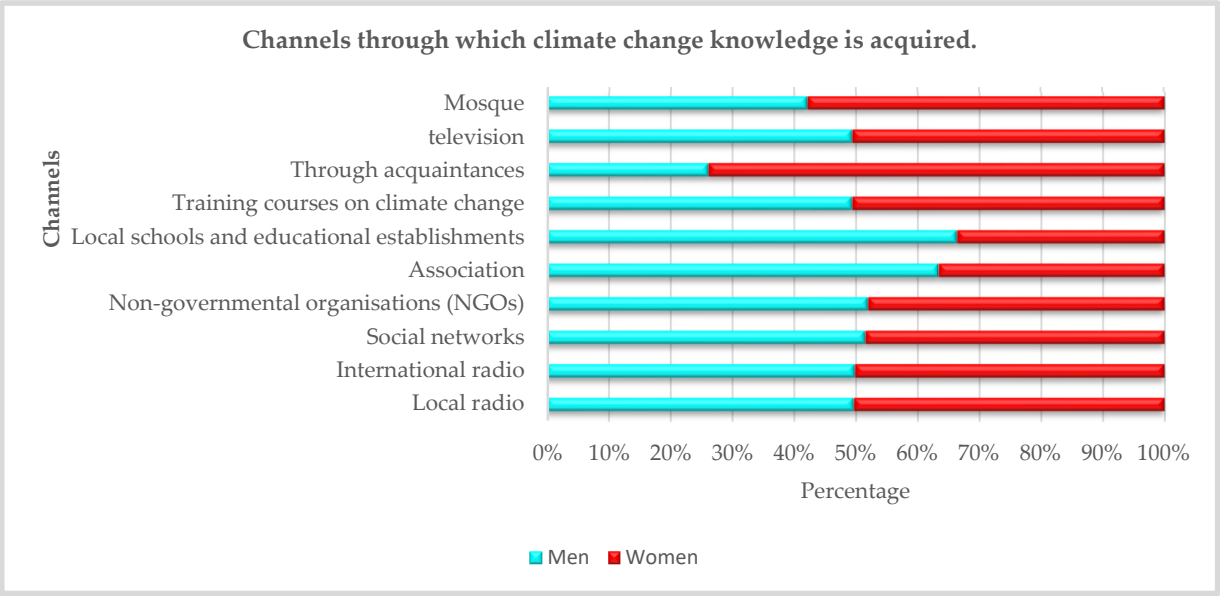

Figure 7. Channels through which climate change knowledge is acquired.

Perception of climate change manifestation

A gendered analysis of the data shows that the manifestations of climate change vary. For men, climate change is manifested in an increase in temperature (19%), a decrease in rainfall (17%), a deterioration in soil quality (15%), and a decrease in harvests (13%). For women, climate change is manifested in a deterioration in soil quality (20%), an increase in perceived temperature (15%), a reduction in harvests (15%), and a reduction in rainfall (13%).

Figure 8 below shows the perception of climate change manifestation.

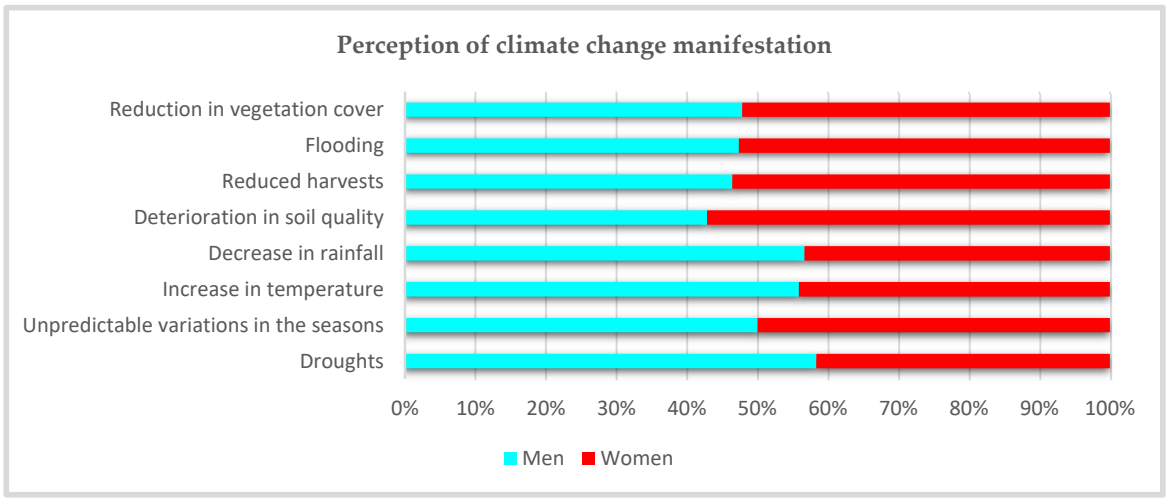

Figure 8. Perception of climate change manifestation.

4.2. Socioeconomic Consequences of Climate Change

Data analysis revealed gender disparities in the socioeconomic consequences of climate change. Men mainly mentioned the loss of livestock through drowning (12%), reduced grazing land (11%), and lower agricultural and fish production (9%), while women were much more likely to mention higher food prices (15%), loss of life and material damage (13%), warmer housing (11%), and health problems (10%).

The data reveal a correlation between the socioeconomic consequences of climate change and the traditional division of roles between men and women. For example, men are more affected by problems related to agriculture and livestock farming, often reflecting their predominant role in these sectors. Women, on the other hand, are more likely to be affected by issues such as rising food prices and health problems, which are linked to their traditional responsibility for managing household resources and family health.

Figure 9 below shows the socioeconomics consequences of climate change.

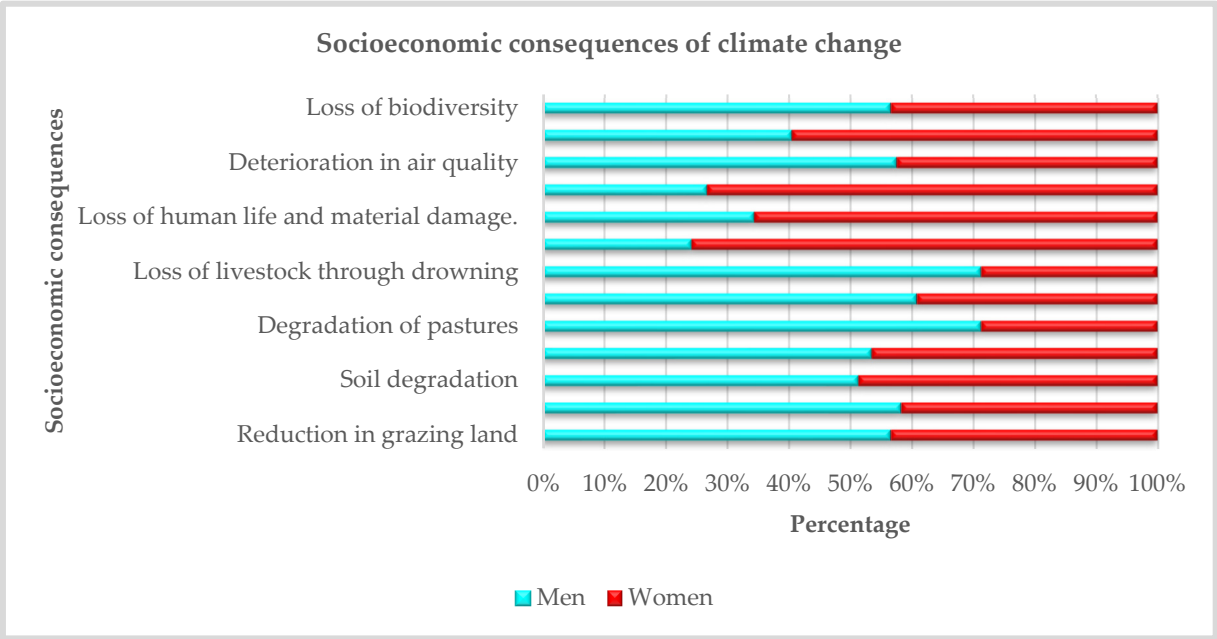

Figure 9. Socioeconomic consequences of climate change.

4.3. Gender-Specific Coping Strategies

4.3.1. Drought Adaptation Strategies

Gender analysis of drought coping strategies in Bol revealed significant differences between men and women. Women are more likely to resort to community self-help (17%), use food not produced locally (14%), change their economic activity (12%), and grow food crops (11%), often reflecting their role in managing household and family activities. In contrast, men were more likely to opt for measures such as selling livestock (12%), introducing new crops (12%), and adapting livestock feed (10%), highlighting distinct gender dynamics in response to drought.

Women's choices, such as community self-help, the use of food not produced locally, and the introduction of new crops, often correspond to their involvement in managing household and family activities. Men are more likely to opt for actions linked to preserving financial resources, such as selling livestock or changing economic activities, reflecting their predominant roles in family decisions linked to material and financial resources. These findings underline the importance of considering gender dynamics when planning and implementing climate change adaptation strategies.

Figure 10 shows drought adaptation strategies.

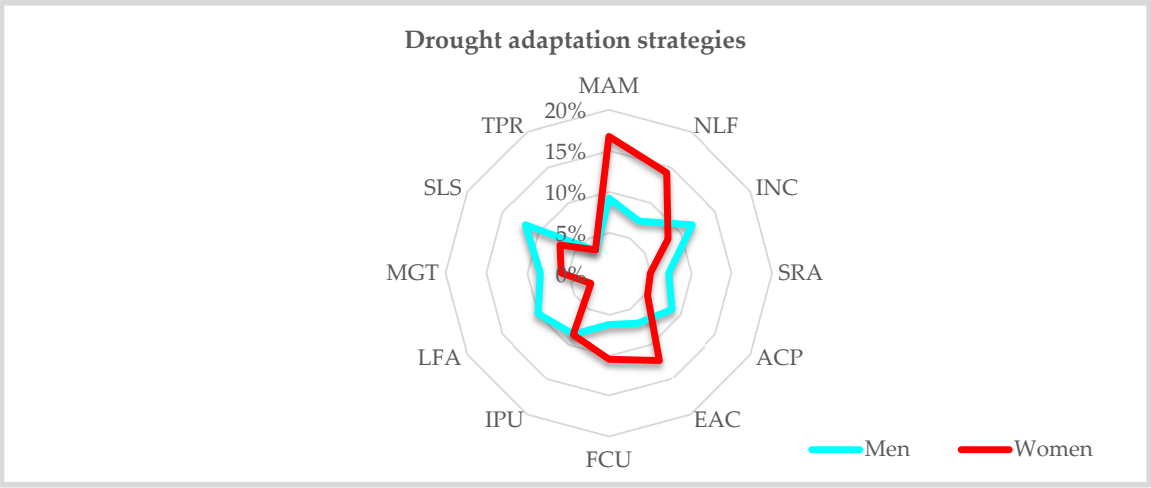

Figure 10. Drought adaptation strategies. MAM: Mutual aid between members of the community; NLF: Non-Local Food Using; INC: Introduction of New Crops; SRA: Soil Restoration by Amendment; ACP: Abandonment of Cultivated Plots; EAC: Economic Activity Changing; PCD: Practice of flood crops; IPU: Irrigated Polders Using; LFA: Livestock Feed Adaptation; MGT: Migration; SLS: Sale of live cattle; PAR: Trees Protection and Reforestation.

4.3.2. Urban Heat Adaptation Strategies

A gendered analysis of strategies for adapting to rising urban heat reveals differences between men and women. Men prefer to wear appropriate clothing, particularly white clothes and turbans (20%), build straw and rammed earth roofs known locally as Dourdour (18%), rest outside their homes (17%), and reforest (15%). Women, on the other hand, are more likely to resort to building straw sheds (18%), resting outside their homes (18%), regular hydration (14%), and treatment in health centers (12%).

Figure 11 shows urban heat adaptation strategies.

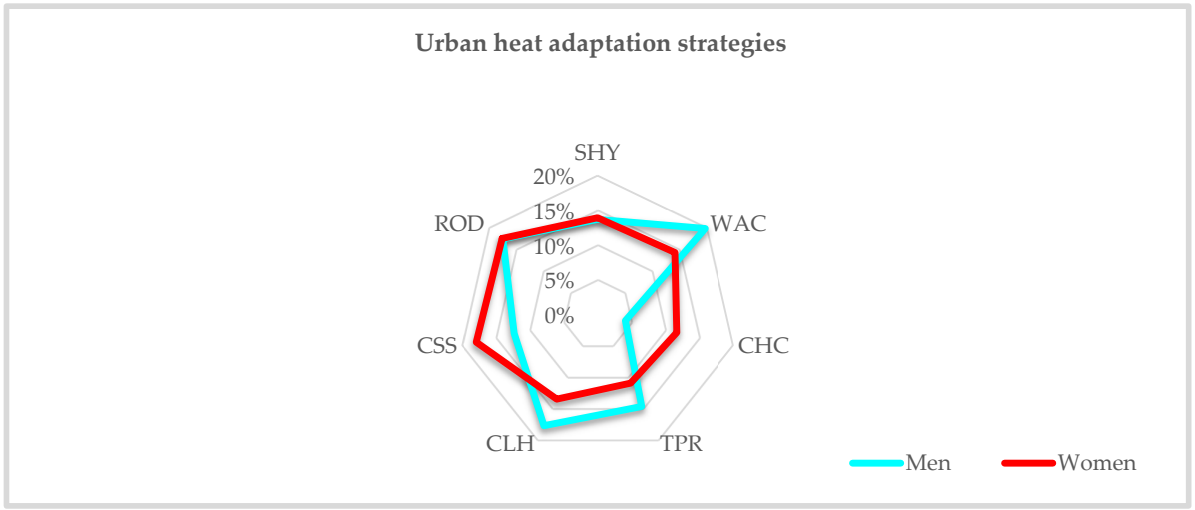

Figure 11. Urban heat adaptation strategies. STY: Stay Hydrated (water and tea); WAC: Wearing Appropriate Clothing, particularly white boubous and turbans.; CHC: Care in Health Centers; TPR: Tree Protection and Reforestation; CLH: Construction of straw and rammed earth roofs (houses known locally as Dourdour); CSS: Construction of straw sheds; ROD: Rest Outside Dwellings (days and nights).

4.3.3. Flood Coping Strategies

Gender analysis of flood coping strategies also revealed significant disparities between men and women. Men prefer to turn to measures such as rebuilding their homes (18%), moving from rural to peri-urban areas (15%), helping each other in the community (13%), and finding pasture using a pirogue (12%). On the other hand, women said that their strategies included helping each other in the community (26%), seeking humanitarian aid (23%), and buying food that is not locally produced and/or manufactured (18%).

Figure 12 below shows flood coping strategies.

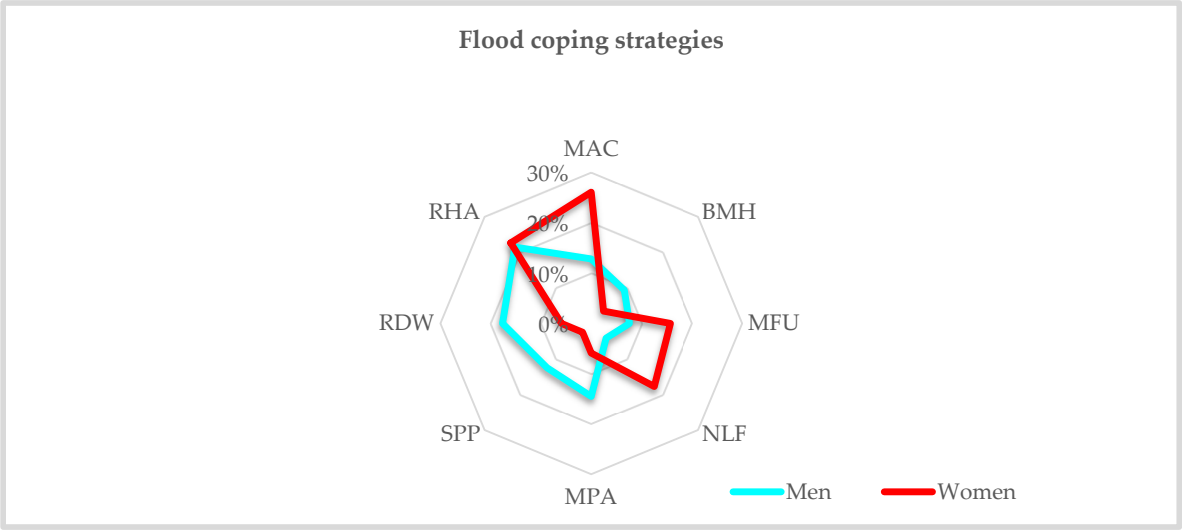

Figure 12. Flood coping strategies. MAC: Mutual aid between members of the community; BMH: Building Makeshift Housing; MFU: Manufactured Food Using; NLF: Non-Local Food Using; MPA: Moving to Peri-urban Areas.SPP: Searching for pasture by pirogue; RDW: Reconstruction of dwellings; RHA: Recourse of humanitarian assistance.

4.4. Barriers to Women's Involvement in the Fight against Climate Change

The barriers to women's involvement in the fight against climate change are presented in Table 3 below.

Table 3. Barriers to women's involvement in the fight against climate change.

Barriers to Women's Involvement in the Fight against Climate Change	**Focus Group Women**	**Focus Group Men**
Poor access to education and training	– Poor access to formal education; – Lack of specific training on Climate Change	– Perception that education on Climate Change is reserved for men; – Lack of specific training programs for women
Family and domesticresponsibilities that preventactive participation	– High domestic workload; – Lack of support for the redistribution of domestic tasks	– Cultural gender expectations regarding family roles
Limited access to economic resources to undertake actions	– Weak control over financial resources; – Economic dependence on their husbands	– Cultural preference for investing resources in activities promoted by men; – Restricted access to loans and grants for women
Lack of political representationand decision-making power	– Underrepresentation in local political bodies; – Little involvement in local decision-making processes	– Patriarchal culture influencing – decision-making; – Lack of opportunities for womento participate actively in local governance

Table 3. *Cont.*

Barriers to Women's Involvement in the Fight against Climate Change	Focus Group Women	Focus Group Men
Stigmatization and marginalization of women involved in public activities	– Fear of social judgment; – Negative perception of women activists	– Social pressure for women to conform to traditional roles; Risk of violence or intimidation for women involved in public action
Traditional assignment ofdomestic and family roles towomen	– Traditional social expectations regarding women's domestic roles	– Reinforcement of gender – stereotypes on the division of – domestic labor
Weak decision-making power	– Lack of participation in community decision-making processes;	– Male decision-making predomination
Limiting participation in community initiatives	– Restricted access to networks and opportunities for community involvement	– Cultural and social barriers to women's access to community initiatives
Restricting mobility and accessto information	– Constraints linked to women's freedom of movement; – Limited access to information sources	– Gender perceptions restricting women's freedom of movement; – Limited access to information and communication technologies
Difficulties accessing land	– Traditional social norms limiting access to land;	– Predominance of male ownership
Difficulties accessing financial resources	– Limited access to loans and grants; – Economic dependence	– Exclusion of women from – certain financial networks; – Lack of guarantees for loans to women

Gender analysis of the impact of climate change on Bol revealed significant obstacles to women's involvement in the fight against this phenomenon. The barriers to women's involvement in the fight against climate change were addressed during focus groups dedicated to women and those reserved for men. Among the obstacles discussed were women's lack of decision-making power, difficulties in accessing quality education, difficulties in accessing financial resources and land, and the traditional assignment of domestic and family roles. These barriers compromise women's ability to make a significant contribution to solving this major problem.

5. Discussion

5.1. Trends in Climatic Parameters (Rainfall and Temperature) from 1970 to 2023

Our analysis of climate trends in Bol from 1970 to 2023 reveals several important conclusions and significant implications for understanding climate change in this vulnerable region. First, our finding of significant interannual variability in rainfall in Bol is consistent with much previous research in similar semi-arid and Sahelian regions. These include, for example, the works of [37,38], according to which current climate change appears to impact the Sahelian zone of west-central Africa, with greater interannual variability affecting rainfall amounts from year to year [39]. Moreover, our results reinforce the idea that rainfall variability is a major challenge for the region's agricultural and ecological systems, requiring flexible and effective adaptation strategies, which corroborates the results of the work of [40]. Second, the downward trend in rainfall observed over the five decades in Bol from the trend curve linked to the SPI (Figure 3) is consistent with climate change projections in the Lake Chad Basin and the Sahel according to several previous studies. Indeed, earlier research by Bedoum et al. (2014) [41] showed a strong downward trend in rainfall in the southern part of Chad from 1960 to 2008. Annual and seasonal rainfall decreased throughout the Lake Chad Basin from 1951 to 2015 [42]. The Sahelian regions are particularly sensitive to rainfall variability and may face an overall decrease in rainfall in the context of climate change [43,44]. This reduction in rainfall will have major implica-

tions for food security, water resource management, and economic stability in the region, requiring appropriate policy interventions and investments to strengthen the resilience of local communities, as shown by the works of several authors [45].

Finally, the upward trend in the mean annual temperature at Bol, demonstrated by the trend line in Figure 5, highlights the extent of global warming in the Lake Chad Basin. This is consistent with the findings of (Adeyeri et al. 2019) [46] that there is a trend toward increasing maximum and minimum temperatures, with minimum temperatures increasing more rapidly in the Lake Chad Basin. These results also corroborate those of (Sylla et al. 2016) [47], who projected an average increase of 1.8 °C up to 2035 compared with the period 1976–2005, as well as those of (Nwilo et al. 2019) [48], according to whom there was a general trend toward an increase in surface temperatures in the region between 1987 and 2017. This temperature increase will have multiple complex effects on ecosystems, human health, and local economies, as mentioned in several works [49–51]. Our results are in line with those (Peirce, Espira, and Larson 2022) [51] and (Lala et Hagishima 2023) [52] according to which rising temperatures increase the risk of fatal heat waves, as well as those of Musa et al. 2022) [53] and (Jellason et al. 2021) [54], according to which temperature increases disrupt traditional agricultural cycles. These findings highlight the need for effective adaptation measures and ambitious climate policies to mitigate the effects of climate change in Bol and other similar regions of the Sahel.

5.2. Socioeconomic Consequences of Climate Change

Our findings reveal significant gender disparities in the socioeconomic impacts of climate change. Men predominantly face direct consequences, such as agricultural and livestock losses, while women experience indirect effects, including higher food prices and health issues. These results confirm the findings of previous research that highlighted the differential impacts of climate change on the livelihoods and food security of men and women due to their differentiated roles in society, such as those of (Basyouny, 2023) [55] and (Eastin, 2018) [56]. Calvin et al. 2023 also observed economic damage in climate-exposed sectors, with regional effects on agriculture, forestry, fisheries, energy, and tourism [57]. Moreover, vulnerability to flood mortality varies between developing and developed countries due to differences in men's and women's lifestyles and resources to mitigate flood impacts [58]. Our results are consistent with those of) (Pradhan et al. 2007), according to which data from the 1993 floods in Nepal show that women were 1.4 times more likely to die than men [59].

5.3. Barriers to Women's Involvement in the Fight against Climate Change

The results of our focus group sessions highlight a range of factors hindering women's involvement in the fight against climate change. These findings reveal the sociocultural, economic, and political dynamics that pose major challenges to women's active participation in this crucial area. The first significant observation concerns the close link between girls' and women's poor access to formal education and specific training on climate change, and their low level of participation in initiatives to combat this phenomenon. These conclusions corroborate those previously put forward by several researchers, underlining the crucial importance of raising education and awareness- to increase women's involvement in environmental actions. This aligns with the findings of Raimi and al. 2019 who emphasized the role of education in raising awareness and building capacity [60]. Carolyn (2011) also highlighted the need for gender-sensitive educational programs to ensure balanced information distribution [61]. In addition, work carried out in South Africa by Archer (2003) highlights the impact of the level of education on the ability to adapt to climate change, stressing obstacles to women's access to meteorological information [62]. Furthermore, women struggle to access necessary training, extension services, and technology for effective adaptation [63]. Moreover, family and domestic responsibilities have a major impact on women's ability to fully engage in the fight against climate change. These findings concur with previous work highlighting the need to recognize gender roles in environmental policy

planning. Furthermore, the domination of scientific and political institutions by men, as mentioned by MacGregor (2010) [64] as well as the marginalization of women's concerns in climate policy, as mentioned by Denton (2002) [65], constitute additional obstacles.

6. Conclusions

This research investigated the interactions between gender and climate change in Bol, which is in the Lake Chad Basin, an area heavily impacted by the consequences of climate change. Based on a methodology involving meteorological data and a gender-focused participatory approach, this study identified the socioeconomic impacts of climate change, adaptation strategies, and obstacles encountered by women in the quest for solutions to climate challenges in Bol. The results highlight the annual variability of rainfall and the increase in temperature, highlighting socioeconomic repercussions such as the increase in the cost of living, human and material losses, and the impact on women's health and well-being. Women's adaptive actions, including community self-help and recourse to humanitarian aid, are identified as crucial responses to climate challenges. However, it is essential to recognize the limitations of this research, which focuses mainly on the socioeconomic impacts of climate change on women and their adaptation strategies, excluding other key aspects such as the implications for mental health, family dynamics, and food security. Despite these limitations, this research highlights the vital importance of inclusive policies to strengthen the resilience of urban and agricultural-economic communities to climate challenges. These limitations of the present research may constitute avenues for future research. To mitigate the different impacts of climate change on women in Bol, we make recommendations that include strengthening education and access to training, promoting economic empowerment, improving political representation, strengthening infrastructure and social services, and integrating a gender approach into climate policies at all stages of their development and implementation.

This research explored the interactions between gender and climate change in Bol, located in the Lake Chad Basin, an area severely affected by climate change. Using meteorological data and a gender-focused participatory approach, this study identified the socioeconomic impacts of climate change, adaptation strategies, and challenges faced by women in addressing climate issues in Bol. The findings indicate significant annual rainfall variability and rising temperatures, leading to socioeconomic consequences such as increased living costs, human and material losses, and negative effects on women's health and well-being. Women's adaptive responses, including community self-help and reliance on humanitarian aid, are crucial for tackling climate challenges. However, this research mainly addresses socioeconomic impacts and adaptation strategies, omitting other important aspects such as mental health implications, family dynamics, and food security. Despite these limitations, this study underscores the necessity of inclusive policies to bolster the resilience of urban and agricultural communities against climate challenges. These limitations suggest potential avenues for future research. To mitigate the disparate impacts of climate change on women in Bol, we recommend enhancing education and training access, promoting economic empowerment, improving political representation, strengthening infrastructure and social services, and integrating a gender perspective into climate policies at every stage of their development and implementation.

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References

1. Ministère de L'environnement et du Développement Durable; Programme des Nations Unies pour le Développement. *Premier Plan National d'Adaptation au Changement Climatique de la République du Tchad*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2020.
2. Gonda, L. Alexandre Magnan, Changement climatique: Tous vulnérables ? *Lectures* **2013**. [CrossRef]
3. Makina, A.; Moyo, T. Mind the gap: Institutional considerations for gender-inclusive climate change policy in Sub-Saharan Africa. *Local Environ.* **2016**, *21*, 1185–1197. [CrossRef]
4. Bryant, R.L. Power, knowledge and political ecology in the third world: A review. *Prog. Phys. Geogr. Earth Environ.* **1998**, *22*, 79–94. [CrossRef]
5. Hardoy, J.; Pandiella, G. Urban poverty and vulnerability to climate change in Latin America. *Environ. Urban.* **2009**, *21*, 203–224. [CrossRef]
6. Diana, R.; Creutzig, F.; Blanca, F.; Shuaib, L.; Tovar-Restrepo, M.; Mcevoy, D.; Satterthwaite, D. Climate change, equity and the Sustainable Development Goals: An urban perspective. *Environ. Urban.* **2017**, *29*, 159–182.
7. Corcoran-Nantes, Y.; Roy, S. Gender, Climate Change, and Sustainable Development in Bangladesh. In *Balancing Individ-ualism and Collectivism: Social and Environmental Justice*; Contemporary Systems Thinking; McIntyre-Mills, J., Romm, N., Corcoran-Nantes, Y., Eds.; Springer International Publishing: Cham, Switzerland, 2018; pp. 163–179.
8. Sharmin, Z.; Islam, M.S. Consequences of Climate Change and Gender Vulnerability: Bangladesh Perspective. *SSRN J.* **2013**. [CrossRef]
9. Kanchana, G.; Amaratunga, D.; Richard Haigh, R. Tackling women's vulnerabilities through integrating a gender perspec-tive into disaster risk reduction in the built environment. *Procedia Econ. Financ.* **2014**, *18*, 327–335.
10. Oyekanmi, O. Climate Change and Environmental Conflict in The Lake Chad Region. *J. Adm. Publik (Public Adm. J.)* **2022**, *12*, 270–279.
11. Granguillhome, R.; Marco, H.; Samantha, L.; Takaaki, M.; Carlos, R.-C. *Mémorandum Économique Régional sur le Bassin du lac Tchad*; Groupe de la Banque Mondiale: Washington, DC, USA, 2021.
12. Commission du Bassin du lac Tchad (CBLT). *Plan de Développement et d'Adaptation au Changement Climatique du Lac Tchad*; Groupe de la Banque Mondiale: Washington, DC, USA, 2015.
13. Nchu, I.N.; Kimengsi, J.N.; Kapp, G. Diagnosing Climate Adaptation Constraints in Rural Subsistence Farming Sys-tems in Cameroon: Gender and Institutional Perspectives. *Sustainability* **2019**, *11*, 3767. [CrossRef]
14. Ajibade, I.; McBean, G.; Bezner-Kerr, R. Urban flooding in Lagos, Nigeria: Patterns of vulnerability and resilience among women. *Glob. Environ. Chang.* **2013**, *23*, 1714–1725. [CrossRef]
15. Doss, C. If women hold up half the sky, how much of the world's food do they produce? In *Gender in Agriculture; ESA Working*; Springer: Dordrecht, The Netherlands, 2011; p. 19.
16. Ashby, J.; Kristjanson, P.; Campbell, B.; Vemeulen, S.; Wollenberg, E. 2012. CCAFS Gender Strategy. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). 2012, 6. Copenhagen, Denmark. Available online: www.ccafs.cgiar.org (accessed on 1 July 2024).
17. Communauté Economique des Etats d'Afrique Centrale. *Stratégie et Plan d'Action Genre de la CEEAC pour la Réduction des Risques de Catastrophe 2020–2030*; Communauté Economique des Etats d'Afrique Centrale: Kinshasa, Congo, 2019.
18. Goh, A.H.X. *A Literature Review of the Gender-Differentiated Impacts of Climate Change on Women's and Men's Assets and Well-Being in Developing Countries*; International Food Policy Research Institute (IFPRI): Washington, DC, USA, 2012; p. 10.
19. Nelson, V.; Stathers, T. Resilience, power, culture, and climate: A case study from semi-arid Tanzania, and new research directions. *Gend. Dev.* **2009**, *17*, 81–94. [CrossRef]
20. Tavenne, K.; Mark Van, W.; Simon, F.; Hammond, J.; Isabelle, B.; Nils, T.; Esther, K. Intensifying Inequality? Gendered Trends in Commercializing and Diversifying Smallholder Farming Systems in East Africa. *Front. Sustain. Food Syst.* **2019**, *3*, 10.
21. Reid, P.; Vogel, C. Living and responding to multiple stressors in South Africa—Glimpses from KwaZulu-Natal. *Glob. Environ. Chang.* **2006**, *16*, 195–206. [CrossRef]
22. Codjoe, S.N.A.; Owusu, G. Climate change/variability and food systems: Evidence from the Afram Plains, Ghana. *Reg. Environ. Chang.* **2011**, *11*, 753–765. [CrossRef]
23. Nsengiyumva, G.; Kagabo, D.; Gumucio, T. Exploring pathways for gender-responsive climate services in Rwanda. In Proceedings of the Gender Summit—Africa: Climate Change through the Gender Lens, Kigali, Rwanda, 19–20 March 2018.

24. Van Aelst, K.; Holvoet, N. Climate change adaptation in the Morogoro Region of Tanzania: Women's decision-making participation in small-scale farm households. *Clim. Dev.* **2018**, *10*, 495–508. [CrossRef]
25. Chikuruwo, R.E. Navigating shifting currents: Gendered vulnerabilities and climate change in the Lake Chad Basin. *Agenda* **2023**, *37*, 105–118. [CrossRef]
26. Nyasimi, M. *Making Climate Action in Agriculture More Gender Responsive and Socially Inclusive at County Level*; CGIAR Reseach Program on Climate Change, Agriculture and Food Security (CCAFS): Wageningen, The Netherlands, 2021.
27. Maraawi, E.; Moreira, V.; Petitbon, F.; Lorioux-Chevalier, Z.; Pereira-Nunes, E. Le Changement Climatique a t'il des Effets Genrés? **2021**, *4*.
28. O'Neil, T.; Domingo, P.; Valters, C. Progress on women's empowerment: From technical fixes to political action. *Dev. Prog.* **2014**, *3*.
29. Sadie, Y. Women in political decision-making in the SADC region. *Agenda* **2005**, *19*, 17–31.
30. Chevalier, J.M.; Buckles, D.J. *SAS2: Guide sur la Recherche Collaborative et L'engagement Social*; IDRC: Paris, France, 2009.
31. Kanoun, M.; Meguellati-Kanou, A.; Abdelali-Martini, M.; Fodil, S. *Marginalisation de Savoir-Faire des Femmes en Milieu Éleveurs Liée aux Changements des Sociétés Pastorales et à L'altération des Ressources Naturelles*; CIRAD: Paris, France, 2011.
32. Hindou, O.I. *Dialogue Entre Systèmes De Savoirs et Adaptation aux Changements Climatiques: Etudes de cas sur les Communautés Nomades Peules M'bororo*; UNESCO: Paris, France, 2021.
33. Bourassa, M.; Bélair, L.; Chevalier, J. Les outils de la recherche participative. *Éducation Francoph.* **2007**, *35*, 1–11. [CrossRef]
34. Kitzinger, J.; Markova, I.; Kalampalikis, N. Qu'est-ce que les focus groups ? *Bull. Psychol.* **2004**, *57*, 237. [CrossRef]
35. Stewart, D.W.; Shamdasani, P.N.; Rook, D.W. *Focus Groups: Theory and Practice*; Sage: Newcastle upon Tyne, UK, 2007.
36. McKee, T.B.; Doesken, N.J.; Kleist, J. The relationship of drought frequency and duration to time scales. In Proceedings of the 8th Conference on Applied Climatology, Anaheim, CA, USA, 17–22 January 1993; p. 2.
37. Taylor, C.M.; Belušić, D.; Guichard, F.; Parker, D.J.; Vischel, T.; Bock, O.; Harris, P.P.; Janicot, S.; Klein, C.; Panthou, G. Frequency of extreme Sahelian storms tripled since 1982 in satellite observations. *Nature* **2017**, *544*, 475–478. [CrossRef] [PubMed]
38. Nkiaka, E.; Nawaz, N.R.; Lovett, J.C. Analysis of rainfall variability in the Logone catchment, Lake Chad basin. *Int. J. Climatol.* **2017**, *37*, 3553–3564. [CrossRef]
39. Olowoyeye, O.S.; Kanwar, R.S. Water and Food Sustainability in the Riparian Countries of Lake Chad in Africa. *Sustainability* **2023**, *15*, 10009. [CrossRef]
40. Riebe, K.; Dressel, A. The impact on food security of a shrinking Lake Chad. *J. Arid. Environ.* **2021**, *189*, 104486. [CrossRef]
41. Bedoum, A.; Biona, C.B.; Adoum, I. Impact de la Variabilité Pluviométrique et de la Sécheresse au sud du Tchad: Effets du Changement Climatique. *Rev. Ivoirienne Sci. Technol.* **2014**, *23*, 13–30.
42. Mahmood, R.; Jia, S.; Zhu, W. Analysis of climate variability, trends, and prediction in the most active parts of the Lake Chad basin, Africa. *Sci. Rep.* **2019**, *9*, 6317. [CrossRef]
43. Keilar, A.T.; Djeko, M.D.; Yameogo, V.B. Changements climatiques et évolution des écosystèmes autour du lac Fitri en zone sahélienne du Tchad: Climate change and ecosystems evolution around lake Fitri in the sahelian area of Chad. *Int. J. Biol. Chem. Sci.* **2023**, *17*, 2037–2047. [CrossRef]
44. Mahamat, N.A.; Vallet-Coulomb Sylvestre, F.; Deschamps, P. Response of rainfall variability on the evolution of the vege-tative cycle in the Chari-Logone basin (Lake Chad basin). *J. Soil Sci. Environ. Manag.* **2023**, *14*, 14–24.
45. Nilsson, E.; Hochrainer-Stigler, S.; Mochizuki, J.; Uvo, C.B. Hydro-climatic variability and agricultural production on the shores of Lake Chad. *Environ. Dev.* **2016**, *20*, 15–30. [CrossRef]
46. Adeyeri, O.E.; Lawin, A.E.; Laux, P.; Ishola, K.A.; Ige, S.O. Analysis of climate extreme indices over the Komadugu-Yobe basin, Lake Chad region: Past and future occurrences. *Weather. Clim. Extrem.* **2019**, *23*, 100194. [CrossRef]
47. Sylla, M.B.; Nikiema, P.M.; Gibba, P.; Kebe, I.; Klutse, N.A.B. *Climate Change over West Africa: Recent Trends and Future Projections. In Adaptation to Climate Change and Variability in Rural West Africa*; Yaro, J.A., Hesselberg, J., Eds.; Springer International Publishing: Cham, Switzerland, 2016; pp. 25–40.
48. Nwilo, P.C.; Umar, A.A.; Adepoju, M.O.; Okolie, C.J. Spatio-temporal assessment of changing land surface temperature and depleting water in the Lake Chad area. *S. Afr. J. Geomat.* **2019**, *8*, 144–159. [CrossRef]
49. Ruppel, O.C.; Funteh, M.B. Chapter 5: Climate change, human security and the humanitarian crisis in the Lake Chad Basin region: Selected legal and developmental aspects with a special focus on water governance. In *Law | Environment | Africa*; Kameri-Mbote, P., Paterson, A., Ruppel, O.C., Orubebe, B.B., Yogo, E.D.K., Eds.; Nomos Verlagsgesellschaft mbH & Co. KG: Baden, Germany, 2019; pp. 105–136.
50. Péres, W.E.; Ribeiro AF, S.; Russo, A.; Nunes, B. The Association between Air Temperature and Mortality in Two Brazilian Health Regions. *Climate* **2020**, *8*, 16. [CrossRef]
51. Peirce, A.M.; Espira, L.M.; Larson, P.S. Climate Change Related Catastrophic Rainfall Events and Non-Communicable Respiratory Disease: A Systematic Review of the Literature. *Climate* **2022**, *10*, 101. [CrossRef]
52. Lala, B.; Hagishima, A. Impact of Escalating Heat Waves on Students' Well-Being and Overall Health: A Survey of Primary School Teachers. *Climate* **2023**, *11*, 126. [CrossRef]
53. Musa, S.S.; Ela, T.B.; Manirambona, E.; Shomuyiwa, D.O.; Haruna, U.A.; Lucero-Prisno, D.E., III; Muhammad, A. How cli-mate change and insecurity pushed 5 million people to hunger in Chad, Africa. *Public Health Chall.* **2022**, *1*, e47. [CrossRef]
54. Jellason, N.P.; Conway, J.S.; Baines, R.N.; Ogbaga, C.C. A review of farming challenges and resilience management in the Sudano-Sahelian drylands of Nigeria in an era of climate change. *J. Arid. Environ.* **2021**, *186*, 104398. [CrossRef]

55. Basyouny, O. Climate Change and Gender Inequality. *Intersect Stanf. J. Sci. Technol. Soc.* **2023**, *16*.
56. Eastin, J. Climate change and gender equality in developing states. *World Dev.* **2018**, *107*, 289–305. [CrossRef]
57. Calvin, K.; Dasgupta, D.; Krinner, G.; Mukherji, A.; Thorne, P.W.; Trisos, C.; Romero, J.; Aldunce, P.; Barrett, K.; Blanco, G.; et al. *IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*; Core Writing Team, Lee, H., Romero, J., Eds.; IPCC: Geneva, Switzerland, 2023.
58. Rufat, S.; Tate, E.; Burton, C.G.; Maroof, A.S. Social vulnerability to floods: Review of case studies and implications for measurement. *Int. J. Disaster Risk Reduct.* **2015**, *14*, 470–486. [CrossRef]
59. Pradhan, E.K.; West, K.P.; Katz, J.; LeClerq, S.C.; Khatry, S.K.; Shrestha, S.R. Risk of flood-related mortality in Nepal. *Disasters* **2007**, *31*, 57–70. [CrossRef]
60. Raimi, M.O.; Suleiman, R.M.; Odipe, O.E.; Salami, J.T.; Oshatunberu, M.; Awogbami, S.O.; Makanjuola, B.C. Le rôle des femmes dans la conservation et le développement de l'environnement au Nigeria (23 juillet 2019). *Ecol. Conserv. Sci.* **2019**, *1*, 555558. [CrossRef]
61. Carolyn, H. An overview of women, gender and climate change issues. In Proceedings of the Education International's World Conference "On the Move for Equality, Bangkok, Thailand, 20–23 January 2011.
62. Archer, E.R.M. Identifying Underserved End-User Groups in the Provision of Climate Information. *Bull. Am. Meteorol. Soc.* **2003**, *84*, 1525–1532. [CrossRef]
63. Witinok-Huber, R.; Radil, S.; Dilshani, S.; Nyaplue-Daywhea, C. Gender, place, and agricultural extension: A mixed-methods approach to understand farmer needs in Liberia. *J. Agric. Educ. Ext.* **2021**, *27*, 553–572. [CrossRef]
64. MacGregor, S. 'Gender and climate change': From impacts to discourses. *J. Indian Ocean. Reg.* **2010**, *6*, 223–238. [CrossRef]
65. Denton, F. Climate change vulnerability, impacts, and adaptation: Why does gender matter? *Gend. Dev.* **2002**, *10*, 10–20. [CrossRef]