frontiers | Frontiers in Climate

TYPE Review
PUBLISHED 23 May 2024
DOI 10.3389/fclim.2024.1374469

OPEN ACCESS

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RECEIVED 22 January 2024
ACCEPTED 08 May 2024
PUBLISHED 23 May 2024

CITATION
Moon MP (2024) How does climate change affect the food security and vulnerability of women? A systematic review of gender perspectives.
Front. Clim. 6:1374469.
doi: 10.3389/fclim.2024.1374469

How does climate change affect the food security and vulnerability of women? A systematic review of gender perspectives

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In Bangladesh, vulnerable groups including women and food security are severely impacted by climate change. Due to their lack of means for unequal climate adaptation, the impoverished and marginalized in developing countries are more exposed and vulnerable. This research study looks at how Bangladesh's food security and the status of disadvantaged women are affected by climate change. Gender-based vulnerability is rising as a result of expanding catastrophe consequences, such as decreased agricultural productivity, rising costs, joblessness, food insecurity, post-hazardous illnesses, etc., according to the literature review findings. The assessment highlights the significant risks that climate change poses to Bangladesh's food security and vulnerable women, including increased susceptibility to food shortages and post-disaster issues, given that women in Bangladesh are more susceptible to these issues due to their social, economic, and political circumstances. The literature review demonstrates that disadvantaged groups, particularly women, are negatively impacted by climate change. Profound policy implications should propose for enhancing system performance, coordinating regional agricultural output, and fortifying resistance to climate change.

KEYWORDS

climate change, food security, vulnerability of women, impacts, Bangladesh

Highlights

- The creation of efforts and policies targeted at eliminating dangers resulting from climate change in Bangladesh is greatly influenced by this review article.
- This study will be beneficial in evaluating the potential consequences of climate change on food security and vulnerable women.

Introduction

Globally, gender inequality and climate change are major issues. Because of their interdependence, there is a wider gap between men and women in society. The consequences of catastrophic occurrences brought on by climate change, such as heavy rainfall, severe temperatures, sea level rise, flash floods, and cyclones, primarily increase this imbalance (IPCC, 2001). The world is paying more and more attention to the growing trend of global

warming and climate change, particularly the extreme weather that is influencing food production, pricing, and supply chains (Ledda et al., 2021; Jin et al., 2023; Yang and Hamori, 2023). Food security is the cornerstone of social stability, economic growth, and national security, all of which directly affect the welfare and means of subsistence of the populace. Food security include aspects including food availability, accessibility, use, stability across time, agency, and sustainability (HLPE, 2020). In particular, climate change risks food security for vulnerable populations, causing system breakdown, disruptions in distribution, and disruptions in crops, livestock, and fisheries due to global warming, drought, flooding, and precipitation variability (O'Neill et al., 2022). According to the Global Food Crisis Report 2023, extreme weather events, geopolitical unrest, economic shocks, and climate change all contributed to the increase in food insecurity and global food crisis in 2022 (Amiraslani and Dragovich, 2023; Rice et al., 2023).

Global climate change negatively impacts people's lives and subsistence, especially for disadvantaged groups, especially women, in Bangladesh, a vulnerable country due to its low and flat topography (Chowdhury et al., 2018; Roy, 2020). According to Ngigi et al. (2017), women in Bangladesh are particularly susceptible to climate-related severe events due to their heavy reliance on agriculture, restricted access to resources, and dearth of institutional infrastructure. A recent World Food Program research estimates that roughly 11 million individuals in Bangladesh experience acute hunger due to the pandemic and other factors, making up approximately 25 million people who are food insecure (World Food Programme (WFP), 2021; Moon, 2023). According to Kreft et al. (2017), the country is ranked fifth out of 171 environmentally susceptible nations due to the frequency of rare shocks that have grown and the degree of their effects on society. For instance, 54 tropical cyclones and a strong storm surge affected Bangladesh's coastal communities between 2000 and 2021 (Centre for Research on Epidemiology of Disasters (CRED), 2021). Bangladesh experienced 14 flood episodes, including two exceptional flash floods, in the past decade, highlighting the vulnerability of vulnerable populations, particularly women, to climate-related catastrophes (Annual Flood Report, 2019).

Extreme weather is becoming more common and more severe as a result of climate change. Extreme weather events such as floods, droughts, stronger cyclones, rising temperatures, waterlogging, and riverbank erosion are all on the list where agriculture is one of the most susceptible to these changes which decreases productivity (Alston, 2015). As a result, it will affect food production, food security, and the capacity of a large portion of the population to have enough food supplies. During the severe rainy period of 2010, about 700,000 people were forced to flee their homes due to the significant waterlogging that has already occurred in coastal areas (Rashid and Paul, 2014). Bangladesh has experienced drought, river erosion, and increasingly frequent and severe cyclones and storm surges in recent decades. Before, during, and after climate-related disasters, agricultural regions' expected temperature rise and rainfall decline have affected household food supply and security (Hanjra et al., 2013). Half of the population cannot afford nutritious food, and a large fraction lacks access to it. Hunger and malnutrition are especially likely for women and girls under such settings (World Bank, 2012). Rainstorms in northern Bangladesh can affect Rabi and kharif crops (BBS, 2020). Climate events can impact agricultural regions annually or intermittently (Huq et al., 2015). Over the past decade, climate shocks in Bangladesh have raised concerns about agricultural production and food security. Several studies have examined the effects of climate change and natural disasters on agricultural output, food consumption, livelihoods, and poverty (Hossain et al., 2019; Alamgir et al., 2021; Jalal et al., 2021; Islam et al., 2022), but little has been done on household food security (Smith and Frankenberger, 2018; Alam et al., 2020). Surprisingly, there is a lack of study on how the 2017 disastrous floods and excessive rainfall affected the ability of farming households to have enough food (Kamal et al., 2018; Dey et al., 2021; Parvez et al., 2022). Most of the prior studies have mostly concentrated on specific areas, rather than conducting a complete review throughout the three main affected regions of Bangladesh: the coastal, haor, and char regions.

Based on these above considerations, this study's primary goal is to present the effects of climate change on women's vulnerability and food security based on some research questions like (a) What effects does climate change have on women's access to food in vulnerable communities? (b) To what extent does women's access to sustainable food sources become impacted by climate change? (c) What coping mechanisms do women in climate-vulnerable areas use to reduce their risk of food insecurity? and (d) Which policy interventions are successful in mitigating the effects of climate change on women's access to food security? As, Bangladesh is recognized globally as one of the most susceptible nations to the effects of climate change, extreme weather events account for the majority of climate change's negative consequences, and water-related risks including floods, droughts, saline intrusion, bank erosion, and tidal bore are projected to worsen, causing significant harm to crops, jobs, livelihoods, and the country's economy. It is commonly acknowledged that the women are the most disadvantaged population of Bangladesh would endure the biggest difficulties due to climate change. However, there have been few to no studies looking at how the climate affects vulnerable groups like women in Bangladesh, which is known as one of the most sensitive regions to the climate change. Therefore, the aim of this study is to illustrate how women's vulnerability and food security have been impacted by climate change in Bangladesh in order to bridge this gap.

Methodology

Description of the study area

A comprehensive study has been undertaken encompassing Coastal, Haor and Char regions of Bangladesh (Figure 1). The coastal regions of Khulna, Barisal, and Chittagong Divisions are at a high risk due to their low-lying terrain, close proximity to the Bay of Bengal, and susceptibility to cyclones, storm surges, sea-level rise, and saline intrusion. These factors result in extensive flooding and significant damage to infrastructure and agriculture. The Haor Areas in the Sylhet Division are susceptible to sudden floods and erosion along riverbanks, which have a significant impact on agricultural and people's livelihoods. These regions encounter difficulties such as waterlogging and crop loss during the monsoon season. The Char Areas in the Rajshahi and Rangpur divisions are susceptible to riverbank erosion, floods, and droughts, which have a detrimental impact on agriculture and result in the displacement of residents. The Sylhet, Dhaka, and Rangpur divisions are susceptible to flooding and experience substantial precipitation levels (Islam et al., 2022).

FIGURE 1
Map of Bangladesh (Source: Available at https://www.infoplease.com/atlas/asia/bangladesh-map).

Sunamganj and Rangpur are districts located within the Sylhet and Rangpur divisions, respectively. Sunamganj is situated in the northeastern region of the country and is renowned for its Haor-dominated ecosystem. Haor is an exceptional wetland situated in the low-lying floodplain regions of northeast Bangladesh (Hoq et al., 2021; Soldavini and Ammerman, 2021). The Haor families residing in the Sunamganj district are highly susceptible to the detrimental effects of climatic disasters, especially when it comes to obtaining food, water, and healthcare services (Hoq et al., 2021). Kamal et al. (2018) found that 39% of homes in Bangladesh's Sunamganj district were affected by the flash flood that occurred in 2017.

Search strategy

The study utilized data from the 2007 to 2023 from systematically searched related articles in databases like PubMed, Scopus, Google Scholar, and peer-reviewed journals. Study searched for articles based on the effect of climate change on food security and vulnerability of women following PRISMA guidelines (Page et al., 2021), and Key search terms for this study were as follows- "Food Security"; "Climate"; "Climate Change"; "Vulnerability"; "Vulnerable"; "vulnerable women" were used for this comprehensive study. A total 2,310 were initially found via this study's systematic search, and an additional 35 articles were found by searching various databases. 2,243 of these articles were eliminated after abstract screening and 102 has been removed based on title screening. Out of 2,141 screened records, 1950 has been excluded based on abstract. Based on the similarities of this study, 191 complete publications were evaluated for eligibility where 183 full text articles being eliminated for various reasons, including poor quality (96), lack of primary data (23), lack of intervention (11), not fitting into the concept (36) and conference papers (17). In addition, a total of 5 articles were included from the review of references. A

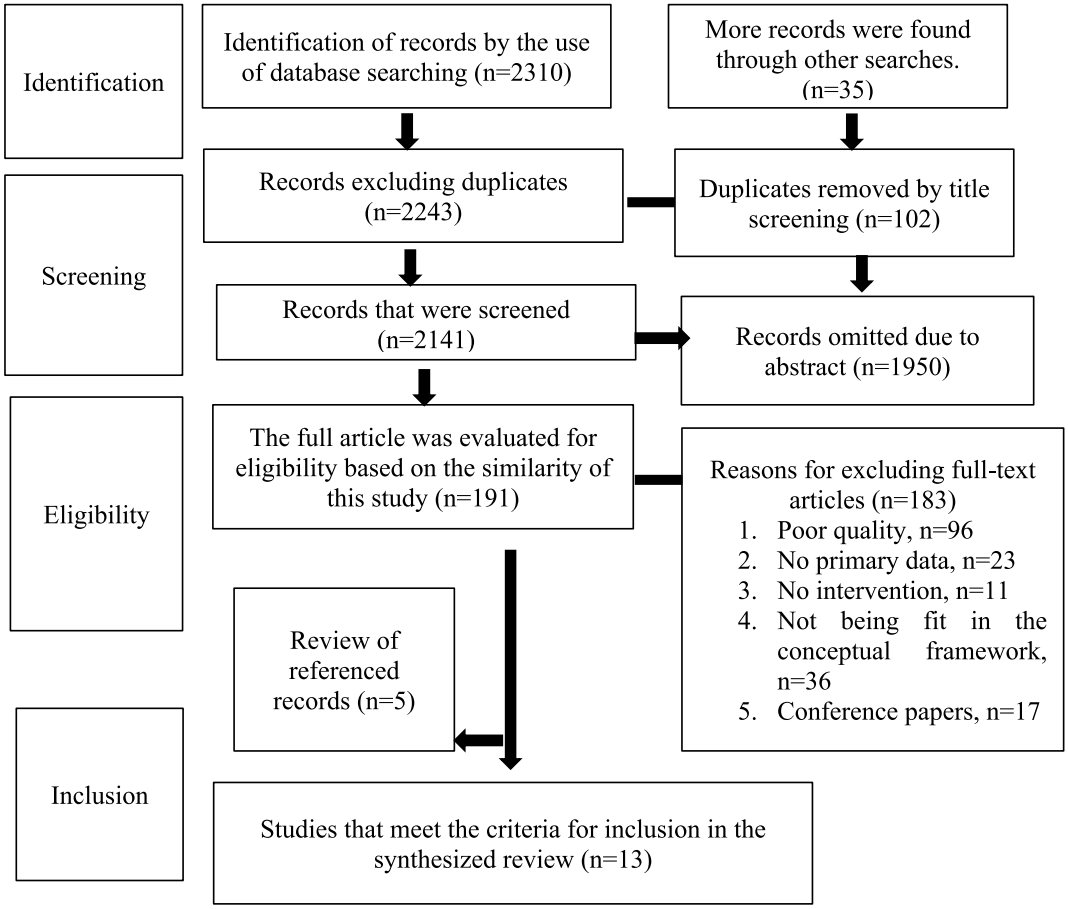

FIGURE 2
Flow diagram of the methodology search for finalized articles for investigations.

final selection of 13 articles were considered for the systematic review (Figure 2).

Study selection criteria

Current studies of impact of climate change on food security and vulnerability of women using extensive inclusion and exclusion criteria. The review included studies on women who are in vulnerable due to only climate change. Additionally, reports from other developing and developed nations were included in the study to allow for showing the actual pictures of the vulnerable situations. Excluded from the study were men who are vulnerable.

Results and discussion

Status of climate change, food security and vulnerability of Women

Food security is greatly impacted by climate change, which increases the hazards of uncertainty for women who are already at risk (Lee et al., 2024). In the 21st century, 70–85% of meteorological disasters are attributed to severe weather events such as heat waves, droughts, and floods and the resulting disaster losses (Moon, 2023; Nie and Lee, 2023; Wang and Lee, 2023). Bangladesh is one of the countries most affected by climate change, mostly because of a lack of institutional, technological, social, and economic resources (Ahmed and Haq, 2017). Many of the causes that drive migration have been impacted by climate change, which has an effect on the most vulnerable people, including women (Bettini, 2017). Global hunger is mostly being caused by rising food costs, which are a result of climate change (Brizmo-hun, 2019). Climate change has the most direct impact on crop output, which is also highly susceptible to it (Guo et al., 2022). Climate change impacts food production, with temperature and rainfall having a greater impact on agricultural productivity, which drives the economy (Casa and Ovando, 2014). Irregular rainfall and high temperatures can disrupt the natural structure and nutritional makeup of food crops like rice, wheat, and maize, leading to reduced crop quality and nutritional deficiencies (He et al., 2020). Insufficient sunshine can negatively impact crop quality, especially in agricultural production areas with poorly ventilated and opaque light. The process of climate change to food insecurity has been shown in Figure 3.

Extreme weather occurrences in Bangladesh have been more frequent and intense over the past few decades (Dastagir, 2015; Table 1). The average temperature has been rising by 0.20°C every 10 years. Bangladesh's riverine and coastal populations are particularly

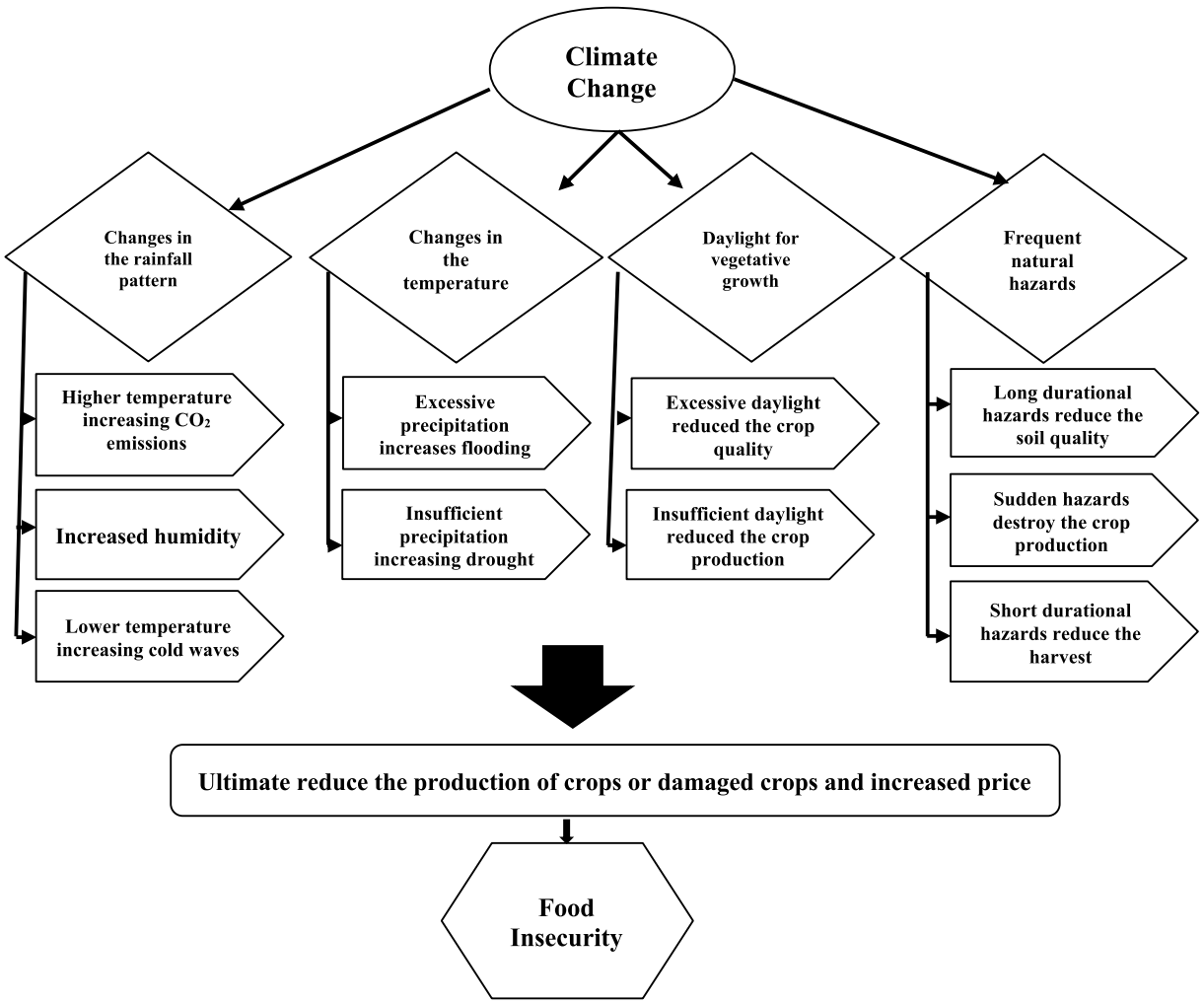

FIGURE 3
The process of climate change to food insecurity (Author's conception, 2024).

TABLE 1 Climatic hazards in Bangladesh.

Year	Cyclone	Economic loss (US$)
14-May-2023	Mocha	7.5 million people affected
24-October-2022	Sitrang	1.9 million people affected
26-May-2021	Yaas	21.3 million
20-May-2020	Amphan	131 million
09-Nov-2019	Bulbul	31 million
04-May-2019	Fani	63.6 million
May 29–31, 2017	Mora	34.2 million
21-May-2016	Roanu	19.3 million
29-Jul-2015	Komen	18.1 million
May 16–17, 2013	Viyaru	35.3 million
May 27–29, 2009	Aila	269.28 million
15-Nov-2007	Sidr	1.7 billion

Source: ReliefWeb (a Humanitarian Information Portal) (2023).

susceptible due to their limited ability to adapt and frequent exposure to natural catastrophes (Uddin et al., 2019). Climate change risks have led to many individuals transferring their families to isolated char land islands, primarily due to the risk of flooding. According to a number of studies, the char land community is particularly vulnerable to climate change (Monirul et al., 2017).

Gender is a significant indicator of vulnerability, encompassing issues like resource depletion, knowledge and decision-making access, and livelihood prospects (Dankelman, 2010; Alston, 2013). The primary causes of women's increased susceptibility include sociocultural norms and unequal power-based dynamics across a range of formal and informal organizations (Hunt and Watkiss, 2011). The availability of food and water is impacted by climate change, which puts more strain on women who are typically expected to do household chores (Alston and Akhter, 2016; Tanjeela and Rutherford, 2018). Natural disasters and water shortages cause women to trek long distances for water, while unsanitary habits, illnesses, hypertension, and eclampsia affect women and teenage girls, reducing earning potential (World Health Organization, 2014).

Gendered impacts of climate change

Climate change impacts human health, food security, livelihoods, and natural resources, posing a serious threat to all aspects of human

life due to our intrinsic connection to the environment. Climate change impacts women, who are less likely to own productive assets and rely on natural resources for livelihoods, disproportionately due to social norms requiring them to manage time-consuming tasks like food gathering and fuel fetching. Women face disadvantages like overrepresentation in the poor, decision-making barriers, mobility challenges, and unequal access to resources, necessitating understanding gendered climate change effects for inclusive strategies. In order to do this, this research investigates the relationships between gender and the effects of climate change in Bangladesh. For instance, uneven property damage, asset losses, and lost productivity due to climate-related hazards exacerbate inequality (Islam and Winkel, 2017). As a result, vulnerable populations—particularly women in developing nations like Bangladesh face disparities in food insecurity, financial hardship, and precarious employment (Azad et al., 2013; Reggers, 2019).

The effects of climate change are intimately associated with how women are divided into different genders globally. Balgis (2009) notes that in developing nations' rural areas, where the most impacted sectors reside, women have the primary responsibility for the provision of energy and water connected to family food security. Women spend hours waiting in line for water, even in metropolitan settings, which limits their prospects for social interaction and economic activities. The Food and Agricultural Organization (2010) supports these results and predicts that women would experience increasing poverty, social disruption, and food insecurity as a result of climate change. According to a study by Regmi (2011), explored that women's livelihoods are at risk due to climate uncertainty, which therefore affects household food security and income. In addition, poverty, biological disparities, and societal prejudice make them more vulnerable. They are consistently ignored in their family, which limits their ability to participate and play a part in decision-making. They are never given an education and are constantly left to take care of the house; child marriages shift the responsibility for providing for the family at a younger age, leaving them even more vulnerable. Globally, 60% of undernourished individuals are women and girls, who have limited resources to care for them. Underdeveloped countries lack effective laws and policies to protect women's social, economic, and cultural rights, resulting in gender imbalances and putting women at risk of vulnerability (IUCN, 2020). It is imperative that we empower them in every way. They frequently should not be viewed as victims because of their weak knowledge and abilities.

Impact of climate change on vulnerable women

Human health is seriously threatened by climate change, especially in Bangladesh's heavily populated cities. Furthermore, women are more prone than males to migrate because of the loss of their communities' means of subsistence, food insecurity, and alternatives for adaption. Human health is seriously threatened by climate change, especially in Bangladesh's heavily populated metropolitan regions. The movement of people from rural to urban regions is one of the main effects of climate change in Bangladesh. A recent survey conducted by UN Women Bangladesh found that over 70% of Dhaka's migrants come from coastal areas that are badly impacted by floods, cyclones, saline intrusion, and sea level rise. Due to lack of choices for adaptation in their villages, food insecurity, and loss of livelihoods, women are more prone than males to migrate (The Business standard, 2023). In Bangladesh, climate change affects many sectors, including agricultural agriculture, forestry, renewable energy, and water resource management, in a gendered way, according to a recent report by UN Women (2023). For example, although women have less access to and influence over natural resources than males do, they are more dependent on them for both their income and means of survival. Women face disproportionate unpaid care work, increased vulnerability to violence, and higher exposure to public spaces during climate-induced disasters, and are more likely to live in poverty. Gender inequality exacerbates climate change effects by limiting women's access to education, resources, and decision-making in climate change mitigation and adaptation processes. Problems facing by Vulnerable women due to climate change in Bangladesh has been shown in Figure 4.

Apart from substance abuse, another matter of concern is the psychological well-being of men living in impoverished metropolitan areas. Their mental health suffers as a result of the stresses brought on by social injustice, poverty, and restricted access to mental health care. The climate change in Bangladesh disproportionately affects women, leading to untreated mental health issues. Gender-sensitive strategies, specialized healthcare, resilience building, and community-based initiatives are needed to address these issues. Through acknowledgement and resolution of these gendered issues, urban Bangladesh may construct a more robust and inclusive healthcare system that safeguards the health and welfare of all of its citizens, irrespective of gender.

Climate change impact on food security

Global economic development is causing the planet to warm, leading to increased natural disasters and challenges for poverty eradication and food security due to repeated catastrophic events such floods, droughts, and cyclones, which has a substantial influence on food security (Alamgir et al., 2018; Ali et al., 2020; Moon, 2023). Recent research indicates that Bangladesh's volatile climate and harsh weather patterns significantly affect agricultural productivity, particularly rice cultivation, which is a major grain in the country. Bangladesh's northern region and the southern coastal belt have been particularly severely affected (Sarwar and Khan, 2007). Decreased agricultural yields caused by floods and saltwater intrusion into fields have an influence on the availability and accessibility of food and reduced 7–10% agricultural production (Government of Bangladesh, 2017). In Bangladesh, climate change is not just lowering agricultural production but also affecting the quality and safety of food (Moon, 2023).

Climate change is causing significant negative impacts on food production and distribution, potentially leading to acute food scarcity for five to 170 million people globally by 2080 (Josef and Tubiello, 2007). Similar to this, Food and Agricultural Organization (FAO) (2020) reported that Bangladesh's total food imports in FY 2019–20 accounted for 23% of its total goods exports. Bangladesh's policy planners have misunderstood the country's food security, ignoring the recurring economic burdens of natural disasters like floods, droughts, and cyclones (Sarker et al., 2012). Furthermore, a drought severely reduces agricultural productivity, which causes a lack of food grains. Bangladesh's severe history of droughts dates back to its independence in 1971 and includes the years 1973, 1978, 1979, 1981, 1982, 1989, 1992, 1994, and 1995

FIGURE 4
Problems facing by vulnerable women due to climate change in Bangladesh. Source: Husaini and Davies (2022) and Reliefweb (2019).

(Hossain, 1990). Therefore, severe events have a substantial influence on Bangladesh's food security, impeding the self-sufficiency and increasing dependency on the global food market, which in turn hinders economic growth. In Bangladesh, there is expected to be a rise in rainfall-associated severe tropical cyclones and floods and extreme weather events linked to climate change are predicted to become more frequent and intense, which would result in significant loss and damage since there would be limited choices for adaptation (Hoegh-Guldberg et al., 2018).

In actuality, Bangladesh has already seen catastrophic weather occurrences linked to climate change in the last 10 years (Figure 5). 6.1 million people were affected by a protracted period of flooding in Bangladesh in 2017 that submerged 42% of the nation (Davis, 2017). According to historical data of cyclones over the past 100 years, 50% of all global mortality and damages occurred in Bangladesh (Alam et al., 2018). As a result of climate change and increased regional and worldwide weather variability, the frequency of extreme climatic events is rising. As a result, the study's evaluation of loss and damage may serve as a reference for assessing loss and damage from future climatic disasters as well.

Barriers to climate change adaptation

Climate change's global impact is unmeasurable due to institutional obstacles and natural causes, increasing vulnerabilities and hindering adaptive capabilities (Uittenbroek et al., 2013). The major obstacles for climate adaptation, food security and Vulnerability of women are shown in Figure 6 including gender inequality, availability of resources, Increasing frequency of climate change scenarios, Knowledge on climate change impacts, Competition among different planning obstacles, Absence of proper responsibilities and inadequate infrastructure, Inappropriate addressing of vulnerable populations, Less teamwork among vulnerable women, Insufficient Cooperation among different stakeholders etc. To ensure appropriate adaptation, one of the biggest obstacles is integrating policies (Chowdhury and Hossen, 2017). Weak organizational capacities and a lack of institutional mechanisms impede the implementation of initiatives and programs linked to adaptation (Combes et al., 2019). The creation of reliable and equitable resilience assessment frameworks is not without its difficulties. Adapting to climate change might be hampered by a lack of understanding, spiritual standards, and conventional structures. Moreover, regional gender norms and beliefs influence adaption strategies and potentially obstruct livelihoods (Kamal et al., 2018). Bangladesh faces a complex issue with climate change impacting food and health security, with the lack of institutional and financial support being a significant barrier to adaptation (Haider et al., 2018). Bangladesh faces food and health security challenges due to gender inequality, education gaps, and ignorance about climate-smart behaviors. Innovation and sustainable agriculture investments are needed for overcoming the obstacles for

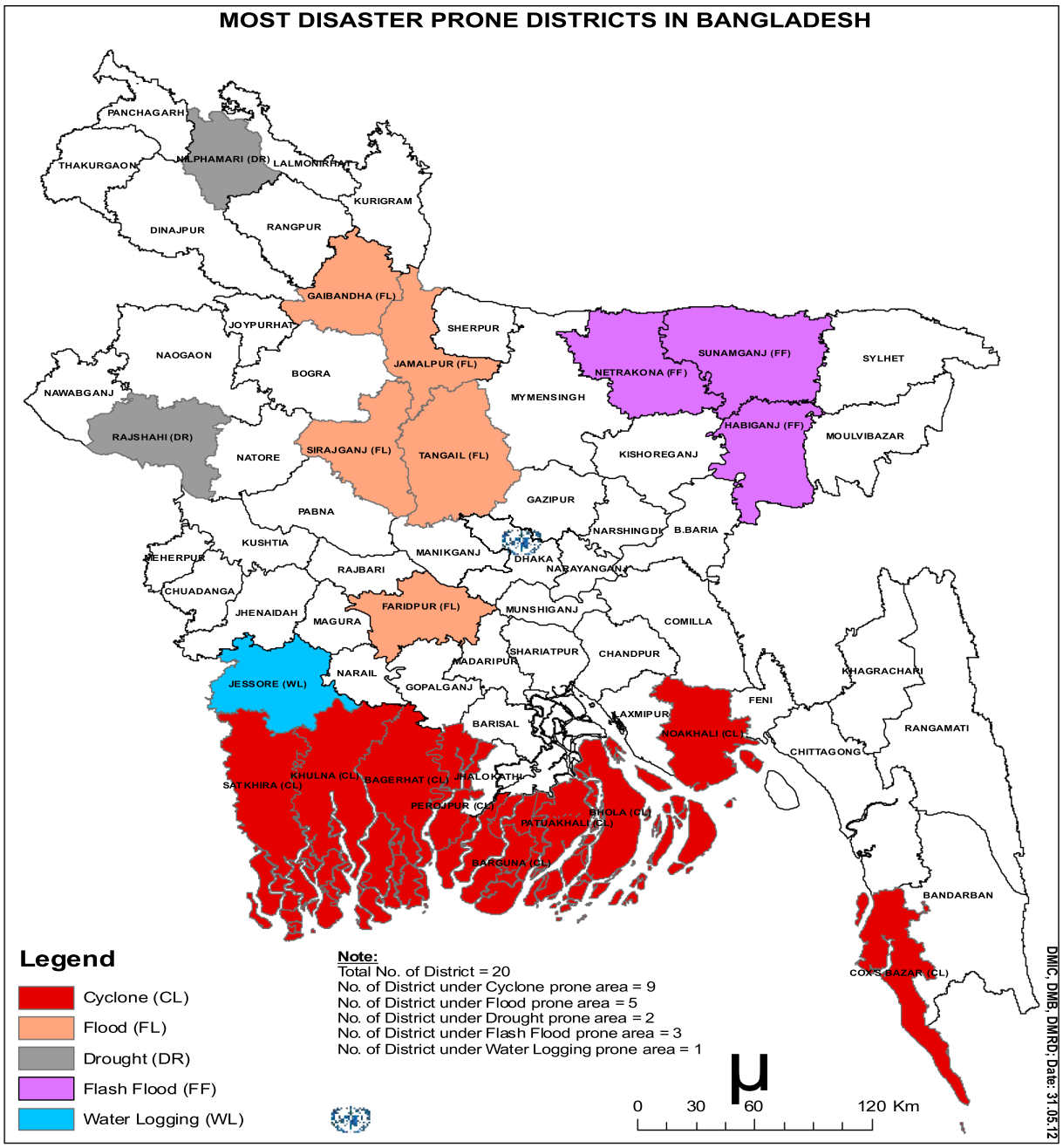

FIGURE 5
Natural disaster-prone districts in Bangladesh (Natural Hazards). Source: Government of Bangladesh (2012; Link: https://reliefweb.int/map/bangladesh/most-disaster-prone-districts-bangladesh).

climate adaptation, food security and Vulnerability of women in Bangladesh.

The study on the impact of climate change on vulnerable women in Bangladesh, especially in terms of food security, is limited and requires further investigation. Tanny and Rahman (2016) highlighted the vulnerability of women in Bangladesh, particularly in areas like health, security, and work participation, to climate change and power disparities. Ferdous and Mallick (2019) demonstrate how prejudice brought on by the dowry system, restricted access to education, and domestic abuse leaves women very vulnerable. Furthermore, Naz et al. (2018) found that for women to be able to adapt to floods brought on by climate change, they require better access to land and literacy. Islam (2017) identifies comparable actions to lessen women's susceptibility to flood dangers. The findings align with previous observations of gender-based drought vulnerabilities in other national contexts (Ncube et al., 2018; Ndlovu and Mjimba, 2021). Because of their gender roles, which are formed by socioeconomic institutions and old patriarchal norms, women are perceived as susceptible in these circumstances. The literature study mentioned above makes clear how significant of a threat climate change is. Nevertheless, there aren't

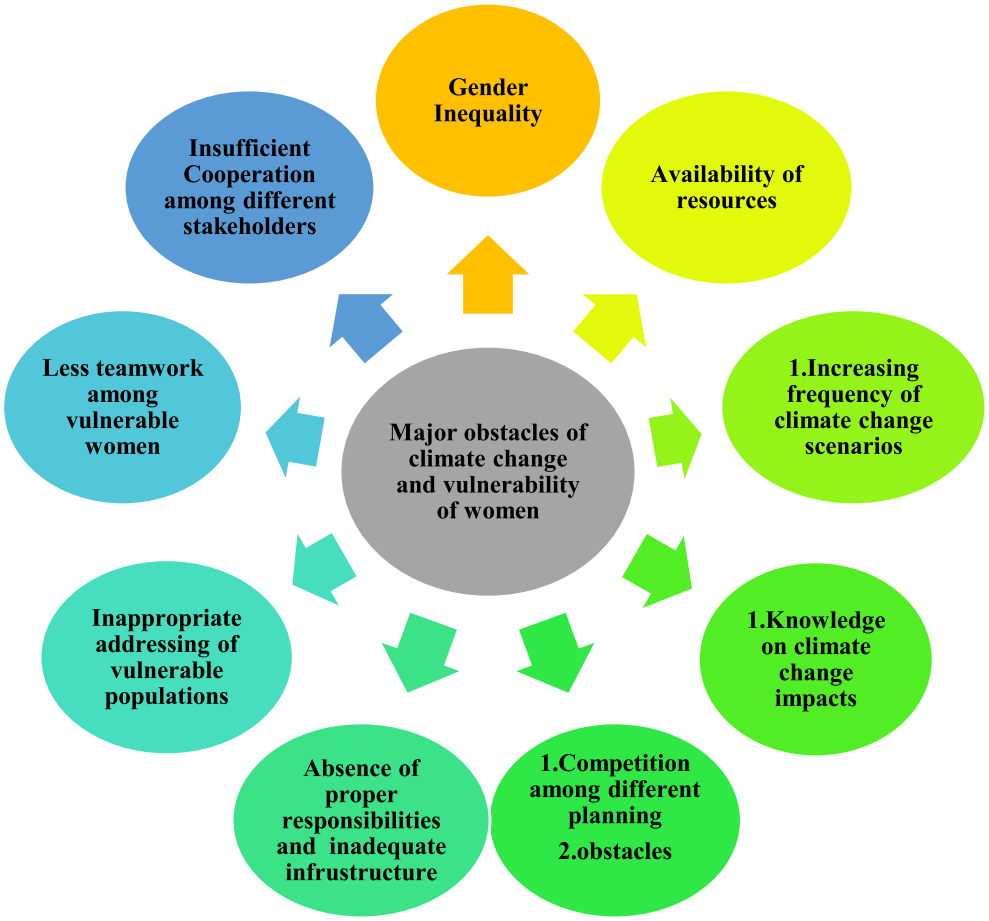

FIGURE 6
Major obstacles for climate adaptation, food security and Vulnerability of women. Source: Moon (2023); Chowdhury et al. (2022); Biesbroek et al. (2013); Moser and Ekstrom (2010) and Runhaar et al. (2012).

many studies done in Bangladesh that look at how the weather impacts food security and the lives of low-income women.

Conclusion and recommendations

Bangladesh's food production is vulnerable, thus developing adaptation plans tailored to individual varieties may help lessen the negative consequences of climate change and lower the likelihood of food insecurity. In order to decrease the consequences of natural catastrophes, this article has evaluated current adaptation and mitigation techniques and looked at how climate change affects vulnerable groups such as women and food security. According to the most recent systematic assessment of research, women are more likely than males to be the most susceptible category. Less empirical data is available about how these groups are affected by climate change and the appropriate adaptation measures that may be used to lessen the negative effects of such disasters. It is important to highlight that the extensively reviewed research particularly found that women are less equipped to counteract the effects of climate-induced disasters, making them more susceptible to their effects. In addition, there is an urgent need to address other places that are susceptible to other extreme weather occurrences, such as floods, droughts, extreme temperature events, etc. (Chen et al., 2021). Recent successful releases of high-yielding rice cultivars to coastal areas in Bangladesh may guarantee food security for vulnerable coastal people, particularly women (Islam et al., 2016). Since women have a wealth of indigenous knowledge and culture, it has been determined that their high death rate and lack of mobility are a loss to society. Therefore, more empirical study is required to determine how well government interventions work to support vulnerable women before, during, and after climate-related disasters. Future studies should explore the efficacy of current adaptation interventions in mitigating climate-induced disaster impacts on vulnerable populations and ensuring food security. Policymakers should increase the number of crops stored for emergency situations and offer financial assistance to aid in the recovery from the effects of climate-related disasters and loss of agricultural output in order to increase the adaptive capacity of vulnerable populations to climate change, particularly women.

The study has certain drawbacks. First, information regarding the precise effects of climate change on food security and the disparities in its effects on women is frequently lacking. Second, we are unable to determine whether there are regional variations in the relationship between food security, vulnerable populations, and climate conditions since we do not have access to data at the province or

county level. Third, implementing sustainable solutions to alleviate food insecurity and women's vulnerability may be hampered by a lack of funding. Furthermore, interdisciplinary methods are necessary for effective solutions due to the complexity of the interactions between gender dynamics, food security, and climate change. However, the strengths are about women's vulnerability in the context of food security can be addressed to promote gender equality and empowerment, and the obstacles presented by climate change spur agricultural innovation that results in more resilient farming methods. Furthermore, there are many of research opportunities on this topic to comprehend the intricate relationships between gender dynamics, food security, and climate change.

Author contributions

MM: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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