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Drought impact on peri-urban farmers' mental health in semi-arid Ghana: The moderating role of personal social capital

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ABSTRACT

Drought represents a major climate hazard in semi-arid regions. Existing literature has extensively documented drought's economic and environmental impacts across Africa with little attention to the psychological impact of drought. Our study examined the impact of drought on farmers' mental health in the Talensi district, Ghana. In addition, we investigated the moderating effects of personal social capital on the relationships between drought impact and three mental health outcomes-depression, anxiety, and stress. Based on a survey of 507 farmers, drought impact has a positive statistically significant relationship with depression ($\beta = 0.51$, $p < 0.001$), anxiety ($\beta = 0.24$, $p < 0.05$), and stress ($\beta = 0.36$, $p < 0.001$), implying that extended drought and increased severity adversely affect farmers' mental health. Personal social capital was found to be a moderator between drought impacts and mental health outcomes, which suggests that personal social capital is an essential resource to deal with mental health challenges associated with drought. Policy-wise, we submit that integrating psychological support services in climate adaptation initiatives, weaving social capital with other forms of capital (e.g., human, physical, economic, and cultural), and implementing sustainable livelihood diversification programs could mitigate the underlying issues that exacerbate mental health vulnerabilities associated with drought.

1. Introduction

Drought is a prevalent and inevitable climate hazard that varies in length and severity. It is often referred to as a 'creeping natural hazard' due to the slow accumulation of its complex effects over an extended period, which can linger for years after the event has ended (Drysdale et al., 2021). The complex nature of drought sequelae is primarily attributed to the increased dependence of individuals, communities, and businesses on water to produce goods and services (AghaKouchak et al., 2015; Wilhite et al., 2007). Despite the growing interest in drought as a hazard from scholars and practitioners, there are inconsistencies in the concept and

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terminology (Dai, 2011; OBrien et al., 2014). For this research, drought is defined as a period of below-average rainfall combined with above-normal evaporation, leading to dry soils, diminished plant growth, and reduced agricultural production.

For decades, regions worldwide, including Africa, have regularly experienced drought accompanied by significant psychosocial, economic, and environmental impacts (Kogan et al., 2020; Palmer et al., 2023), which can sometimes extend beyond the affected areas. Between 2002 and 2022, drought affected over 398 million people, killed 23.2 thousand people and inflicted economic damages worth US$ 5.5 billion in Africa (International Emergency Events Database (EM-DAT, 2022). Further data from EM-DAT reveals that 65% of all individuals affected by drought and resulting damages occurred in the last two decades, implying an increase in intensity and severity. This pattern aligns with the Intergovernmental Panel on Climate Change's (IPCC) future forecast, which suggests that droughts in Africa will become more frequent and severe due to climate changes and alterations in the water cycle (IPCC, 2021). For instance, the IPCC indicates that the Sahel, a semi-arid region of Africa, is a hotspot of drought, with its temperature expected to increase by 3°C–6°C interspersed with uncertain rainfall (Niang et al., 2014). Given the region's limited adaptive capacity (IPCC, 2021), this prediction may substantially impact human lives and livelihoods.

Existing literature extensively documents the socio-economic and environmental impacts of drought in Africa. For example, regarding environmental impacts, drought has been found to affect the richness of tree species, decrease tree density and degrade plant cover (Bakhoum et al., 2012; Epule et al., 2014). Kalame et al. (2009) study in Ghana found that drought destroyed many cocoa plantations between 1982 and 1984. Prolonged drought also leads to wildlife starvation, resulting in increased wildlife mortality rates (Marumbwa et al., 2021; Wato et al., 2016). Moreover, research conducted by Djoudi and Brockhaus (2011) and Bhaga et al. (2020) demonstrates that drought can degrade water quality for both domestic and industrial usage. Socio-economic impacts of drought are well-documented in the African context and include the exacerbation of conflict (Adaawen et al., 2019; Benjaminsen et al., 2012; Grote and Warner, 2010), reduction in agricultural production (He et al., 2019; Kasei et al., 2010; Sani et al., 2011), suspension of business operations (Dube et al., 2022) and challenges with water supply (Calow et al., 2010; Meza et al., 2021). For instance, the impact of drought on Botswana's economy was investigated by Juana et al. (2014) using a comprehensive general equilibrium model. As demonstrated by the study's simulation findings, periodic drought significantly impacts sectoral production, factor remuneration, and household welfare. Elsewhere, drought has been linked to adverse nutritional health impacts (Bauer and Mburu, 2017; Belay et al., 2019) and an increased spread of diseases due to microbial contamination of water, such as cholera, malaria, as well as being associated with diarrhoea and scabies (Bakshi et al., 2019; Enbiale and Ayalew, 2018; Rieckmann et al., 2018). Despite this comprehensive body of research, there remains a paucity of empirical studies examining the relationship between drought impacts and mental health outcomes of African individuals and communities. There is also an emerging initiative to examine the effect of social context on mental health (Alexander Priest, 2023; Kawachi, 2006; Noel et al., 2018; Wind et al., 2011).

In response to this clarion call, our study aims to investigate the effects of drought on the mental health - specifically, depression, anxiety, and stress - of farmers (pastoralist, crop grower, and agro-pastoral) in the Talensi district, Ghana. Given the district's high levels of social cohesion and connectedness (Yiran, 2016), we also examine the moderating role of personal social capital on the relationship between drought impacts and depression, anxiety, and stress. This research makes significant contributions to three strands of literature. First, this paper builds upon earlier studies on disaster impacts by addressing the lack of research on the psychological aspect of disaster impact in Africa. Secondly, while social capital has been widely used as a direct predictor (Rung et al., 2017; Wind et al., 2011) and a mediator (Wong et al., 2019) for mental health outcomes, only a few studies have tested it as a potential moderator during disasters (Kang et al., 2023). However, results from these limited studies have shown some inconsistencies. This research examines the moderating effect of personal social capital on the relationship between disaster impacts and mental health outcomes, thereby providing indispensable insights for decision-makers. Finally, the Depression, Anxiety, and Stress Scale (DASS) 21 instrument, since its development, has demonstrated a robust psychometric property across various disciplines and regions. Yet, to our knowledge, no African study has applied the DASS-21 in the context of disasters. Thus, our research enriches the scholarly field by broadening the applicability of the DASS-21 instrument's validity and reliability.

This paper is structured into six sections. Following this introduction, section 2 puts the study in proper context by presenting the theoretical underpinnings and hypotheses. Section 3 provides an overview of the study area and elaborates on our research methodology. Section 4 reports on the key findings drawn from our analyses. Section 5 discusses the study findings, while Section 6 highlights the study's limitations and areas of further research, including the study's conclusion and implications.

2. Theoretical background and hypotheses development

2.1. Disaster impacts on mental health

Disasters are external shocks caused by the complex interaction between the processes of development, which generate conditions of exposure, vulnerability, and hazard. Regardless of the type, disasters cause psychosocial stressors, physical damages, injury, death, and financial losses (Cianconi et al., 2020; Edwards et al., 2015; Norris et al., 2002). Evidence from both theory and practice has established a strong connection between disaster and its negative consequences on mental health (Kienzler, 2019; Zakour, 2022). For example, when a disaster occurs, it inflicts victims with economic hardship, leads to loss of property and lives, and disrupts social connection (Abunyewah et al., 2023a; Foster, 2012; Juana et al., 2014; Louw et al., 2019). The various consequences of a disaster often lead to psychological and emotional distress. The existing disaster literature has identified depression, anxiety and stress as the frequently reported mental health outcomes (Harada et al., 2015; Herd et al., 2016; Mason et al., 2010). For instance, a systematic review by (Harada et al., 2015), which assessed the psychological impact of the 2011 Great East Japan Earthquake on survivors, revealed that anxiety, depression, and Post-Traumatic Stress Disorder (PTSD) were the most common adverse mental health outcomes.

Also, a study of a flood disaster in Britain by Mason et al. (2010) found depressive symptoms, anxiety, and PTSD were the commonly reported mental health consequences among its victims. Similarly, the aftermath of Hurricane Sandy in the United States revealed increased onset of PTSD, anxiety, and depression among exposed individuals (Herd et al., 2016; Schwartz et al., 2015). In a study of the impact of drought on older farmers, Polain et al. (2011) found that anxiety and depression were common negative consequences, frequently manifesting as sleep disturbances, irritability, and increased alcohol consumption. Drawing from the above, this research proposes that:

H1. The impacts of drought are associated with greater levels of depression

H2. The impacts of drought are associated with greater levels of anxiety

H3. The impacts of drought are associated with greater levels of stress

2.2. Disaster impact, mental health, and social capital

Social capital generally refers to the trust, social norms, and networks embedded within a community structure, enabling individuals to achieve personal and collective goals (Abunyewah et al., 2023a; Aldrich, 2012). According to (Putnam, 2000), social capital can be categorised into three types: bonding, bridging and linking. These typologies have been widely applied in recent studies. Whereas bonding social capital involves relationships between individuals sharing similar characteristics, such as family members, close friends, and neighbours, bridging social capital involves relationships with people possessing diverse socio-demographic characteristics, including ethnicity, religion, age, and education. Linking social capital pertains to the relationships that bridge individuals across different social or power hierarchies. Several studies have shown that individuals and communities with homogenous characteristics generally depend mostly on bonding social capital, while heterogeneous groups and communities often adopt bridging and linking social capital (Putnam, 2000; Monteil et al., 2020; Rayamajhee and Bohara, 2019). Some recent studies have recorded that bonding social capital promotes reciprocity (Kao and Sapp, 2020; Kingsley et al., 2020) while bridging social capital facilitates the connection with external assets and the diffusion of information (Monteil et al., 2020; Rayamajhee and Bohara, 2019).

Recent studies (e.g., Savari et al., 2023) document interconnections between social capital and adaptive capacities within climate-dependent livelihoods. While several definitions of adaptative capacity exist, the IPCC (2014) defines it as the ability of systems, institutions, humans, and other organisms to adjust to potential damage, take advantage of opportunities, or respond to consequences. In our context, adaptive capacity implies the ability of farmers to draw on local resources like social capital to respond to the mental health consequences of seasonal drought. Clearly, the adaptive capacity of any socio-ecological system is determined by external and internal factors such as education, technology, infrastructure, and institutions (Adger et al., 2007; Abdul Razak and Kruse, 2017). For farmers in semi-arid regions, there is substantial evidence (See Chepkoech et al., 2020; Carrico et al., 2019) that social capital has a direct impact on the capacity to adapt to climate change stresses. It is worthy of note that the extent of the direct impact of social capital intersects with and depends on other forms of capital (e.g., human, physical, natural, and financial capital) and contextual issues (Abdul Razak and Kruse, 2017; Savari et al., 2023). Nevertheless, in resource-poor and institutionally deficient regions, maintaining social capital under mentally stressful climatic conditions such as drought enables farmers to ameliorate the crises of adaptation for their livelihoods and enhance adaptive capacities (Serrat, 2017). For example, in the Oromia region of Ethiopia, Birhanu et al. (2017) found that during long but recurrent drought-induced psychosocial crises, social capital improved access to psychological support, which they considered essential for adaptative capacity building.

Drawing from existing scholarship, there is a well-documented connection between social capital and mental health recovery, even though the relationship is complex (Wong et al., 2019). However, there is limited empirical evidence, particularly in developing countries, about the instrumental role that personal social capital plays in addressing mental health challenges in the wake of disaster.

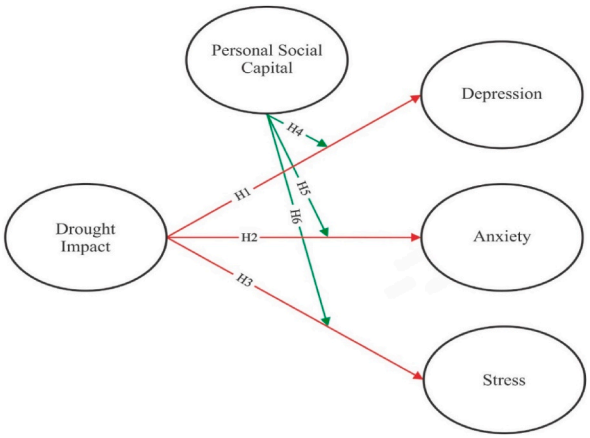


Fig. 1. Conceptual framework for the study.

During a disaster, many people evacuate to find safer havens, leading to dispersion and relocation of ties in the community. As a result, disaster victims are more vulnerable to mental health problems due to social isolation, loneliness, and abandonment (Kawachi, 2006; Norris et al., 2008). Existing literature postulates that individuals and communities with high social capital experience enhanced speedy and successful mental health recovery because victims leverage protective social capital resources to manage their difficulties (Norris and Alegria, 2005; Tsuchiya et al., 2017). Further, support received from social ties during and after disaster events has also been found to reduce stress and anxiety (Ehsan et al., 2019; Thomas et al., 2020). In a study conducted in England by Wind et al. (2011) found that social capital helps mitigate the impact of traumatic events on anxiety, depression, and stress. Research further demonstrates that social interaction and participation after the 2011 Great East Japan Earthquake aided in reducing mental health issues among individuals whose homes were damaged (Hikichi et al., 2020). Recent research has also acknowledged the importance of social capital and psychological effects in times of drought (Carrico et al., 2019; Pendley et al., 2020). For instance, an Iranian study by Savari et al. (2023) found that effectively mobilising local people and actively involving them in drought management projects help improve their mental capacity. Building on this, we propose that:

H4. Social capital moderates the relationship between drought impact and depression

H5. Social capital moderates the relationship between drought impact and anxiety

H6. Social capital moderates the relationship between drought impact and stress.

Weaving together the foregoing literature, Fig. 1 depicts the conceptual framework that guided the present study. It proposes that the impacts of drought negatively affect mental health outcomes (depression, anxiety, and stress). It also suggests that social capital is a protective social resource to moderate the relationships between drought effects and depression, anxiety, and stress.

3. Research methodology

3.1. Study area

We conducted fieldwork in the Talensi district, within Ghana's semi-arid northern savannah agro-ecological zone. The district's tropical climate is typified by two distinct seasons: a variable rainy season from May to October and a dry season from November to April. As per the Ghana Statistical Service (GSS, 2014), the district registers an average annual rainfall of 950 mm. Temperature variation is notable, with peaks reaching 45 °C between March and April and dropping to a minimum of 12 °C in December.

The Talensi district features an environmentally sensitive dryland, and its agriculture operates on a non-irrigated system (Opoku Mensah et al., 2022). In the Talensi district, agriculture is a cornerstone of the local economy, with 91 per cent of households participating in agricultural activities (GSS, 2014). Most of these are smallholders, heavily dependent on favourable climatic conditions for their agricultural yield. The primary agricultural practices consist of crop farming and livestock production, though some households also engage in silviculture and aquaculture (GSS, 2014; Talensi District Assembly (TDA), 2022). The smallholder farming production system of the district is annually affected by climate extremes, deforestation, biodiversity loss, and declining soil fertility, resulting in reduced productivity (Kandel et al., 2022). As such, it is considered among Ghana's most vulnerable production systems (GSS, 2014; TDA, 2022).

Among the various climatic extremes, drought has the most significant and widespread impact in the Talensi district (TDA, 2022; Opoku Mensah et al., 2023). The timing, seasonality, variability, and distribution of rainfall, high temperatures, soil quality, evapotranspiration, climate change, and human activities are contributing factors to drought occurrences in the Talensi district. These factors collectively create conditions where the available water resources become insufficient to meet the needs of agriculture, ecosystems, and communities, leading to periods of drought (TDA, 2022). Similarly, as is the case in most parts of Ghana's semi-arid northern savannah agro-ecological zone (Antwi-Agyei et al., 2012), the soils in the Talensi district are characterized by gravel and stoniness, often containing iron-pan. These soil conditions render soils highly unproductive and poor at retaining moisture (Quansah, 2004).

Drought in the Talensi district results in a wide range of detrimental impacts across the environment, society, and the economy, as classified by Coleen et al. (2006). These impacts encompass crop failure, livestock losses, food insecurity, fire hazards, water shortages, economic downturns, displacement and migration, health concerns, environmental degradation, conflicts, shifts to non/off-farm sectors, and reduced agricultural productivity (Adonadaga et al., 2022; Tangonyire and Akuriba, 2021; Opoku Mensah et al., 2023).

The major crops grown in the district, such as millet, maize, and sorghum, require a significant amount of water during their growth. However, the persistence of droughts in the district often leads to low production (TDA, 2022). Drought also exacerbates the scarcity of various livestock feeds, resulting in a deficiency of essential nutrients and impacting the production of livestock products like milk and meat. The reduced nutritional intake weakens the overall immunity of livestock, making them more vulnerable to diseases. In extreme situations, drought causes livestock to suffer from heat strokes (TDA, 2022; Habiba and Shaw, 2014). Farmers in the district traditionally rely on agricultural extension officers for drought risk information. However, due to a shortage of extension officers relative to the farmer population in the district, approximately 60% of farmers are inadequately equipped to manage drought effectively. Consequently, their prospects for achieving sustainable drought management are adversely impacted (Tindan et al., 2022).

Considering the local socio-economic conditions, natural environment, farming production systems, and institutional presence, we selected two of the district's three area councils for the survey. With the assistance of the district's Department of Agriculture, two farming communities, Awaredone and Yameriga, were chosen for the study (Fig. 2). These communities, discretely located within the district, exhibit similar sizes and populations. Additionally, they house numerous operational institutions and are characterized by

fragile ecological conditions.

In these communities, persistent drought conditions have a significant impact on crop yields, particularly on crops like millet, sorghum, guinea corn, maize, and groundnut, which are vital for their subsistence farming. Rain-fed agriculture is the primary mode of cultivation, and the absence of irrigation facilities means that dry season farming is not feasible. Consequently, these communities experience food deficits for most of the year due to reduced crop yields. Livestock rearing, including cattle, goats, and sheep, is a common practice among households. However, prolonged droughts exacerbate the challenges of livestock management, leading to livestock losses. Thus, prolonged droughts adversely affect both crop yields and livestock, resulting in food deficits and economic challenges for households.

3.2. Sample and data collection

Before data collection, selected members of the research team visited the communities to become familiar with the district's geographical boundaries, physical characteristics and identify and establish strong relationships with key stakeholders. We executed our formal field survey through a multistage stratified random sampling process. Firstly, the Talensi District was purposively selected due to the agrarian nature of its communities and long history of drought. Secondly, the area councils were selected using the purposive sampling technique because of their socio-economic conditions, natural environment, farming production systems, and institutional presence. Thirdly, the study communities, Awaredone and Yameriga were randomly selected. Lastly, we employed simple random and snowball sampling-techniques to select and interview 507 agriculture households from the two study communities. The 507 respondents for the study satisfy the minimum sample size requirement of 100–150 participants for conducting a Structural Equation Modelling (SEM) analysis, as suggested by Bentler and Chou (1987) and Kline (2005). The sample size for the study also satisfies the rule of thumb of 10–25 cases per parameter (Bentler and Chou, 1987; Hancock and Freeman, 2001; Markus, 2012). Participants selected for this study satisfied the following inclusion criteria: i) minimum age of 18 years, ii) household head of family with farming as their main occupation, iii) minimum of 3 years' experience in farming and iv) understand English or any of the main local dialects (Talen and Guruni). We defined farming households as families that primarily rely on crop and/or pastoral farming as their primary income source and own at least five cattle and a herd of sheep and/or goats. We excluded households that did meet these criteria. To gather accurate information and surmount the language barrier, we recruited and trained four research assistants to aid with the data collection process. These assistants were indigenous members of each community and had university-level education. Each interview spanned a duration of 45–60 min.

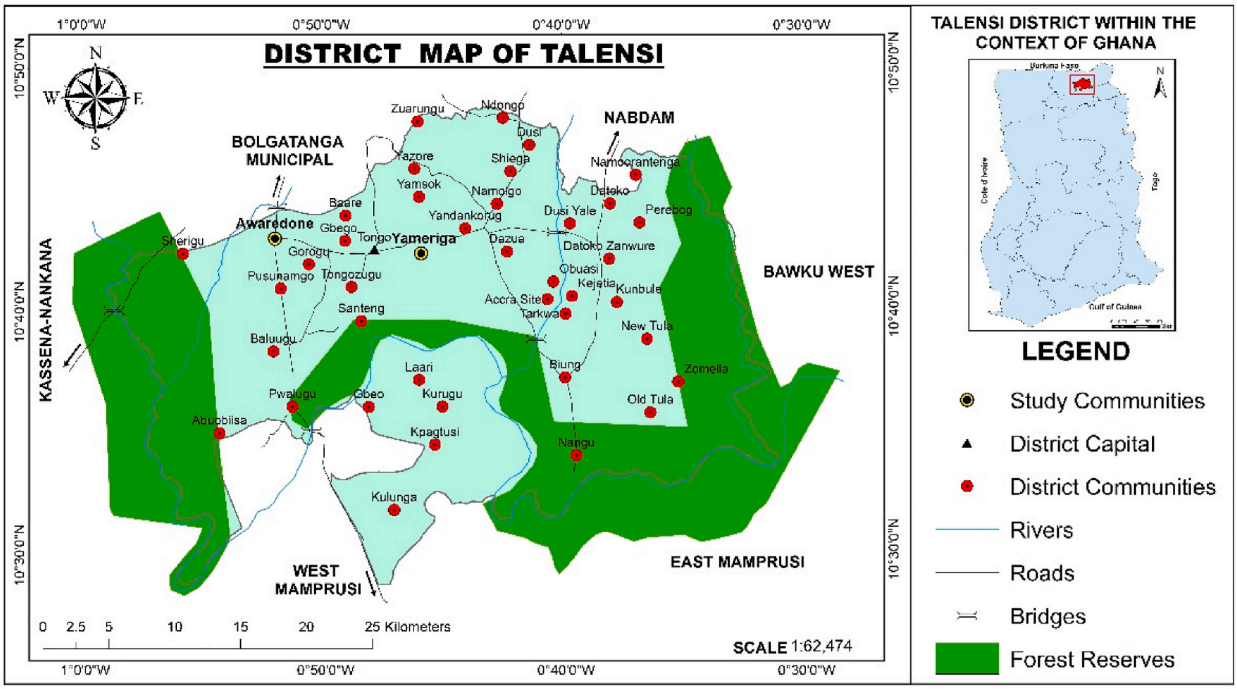


Fig. 2. Map of the Talensi district showing study communities. **Source:** Modified from (Opoku Mensah et al., 2022, 2023).

We collected survey data from households in the Talensi district between September 2022 and March 2023. We designed an initial household questionnaire informed by a comprehensive literature review. We pretested the preliminary questionnaire with 20 households in September 2022. This helped eliminate ambiguity in the questions, ensuring the questionnaire survey was reliable and valid. We confirmed the internal consistency of each construct using Cronbach's Alpha. According to Bryman (2008), an Alpha value of 0.80 represents an acceptable level of internal reliability. Our pretesting of the instrument yielded a Cronbach's Alpha of 0.95, indicating a 95% internal consistency among the questionnaire items.

We organised the questionnaire into three sections to extract information on i) the socio-economic characteristics of the households, ii) the level of social capital within households and iii) households' perception of mental health. We digitised the survey instrument using the Open Data Kit (ODK) mobile app to enhance the quality and efficiency of data collection. ODK allowed all collected data to be verified by the lead researcher and uploaded to a secure server daily.

3.3. Ethical approval and consideration

Our study was approved by the Human Research Ethics Committee at the University of Technology Sydney under the approval number UTS HREC ETH22-7303. Before their involvement, each study participant provided formal verbal consent. To ensure comprehension, we clearly explained the study's objectives, the data collection process, and the voluntary nature of participation in the participants' local language. Additionally, we guaranteed all participants both anonymity and confidentiality. Only research participants who read, understood, and either signed the consent form or gave verbal consent participated in the study.

3.4. Measures

The questionnaire survey used for the study, which comprised items measuring socio-demographics, drought impacts, depression, anxiety, stress, and social capital, is described as follows:

Socio-demographic information: This information was obtained by asking respondents questions about their gender, age, household size, marital status, educational background, and type of farming they engaged in. Responses to these questions were categorical and aligned to the 2021 Ghana Population and Housing Census survey instrument.

Drought impact: The 13-item Drought Impact Measurement Scale (DIMS) was developed by the researchers through an integrative literature review and validated by a panel of experts (academics and practitioners) in disaster risk reduction and resilience. The instrument measures drought's environmental, economic, and social impacts using a 5-point Likert scale (1 = strongly disagree, and 5 = Strongly agree). Examples of items measured include "Drought in this community sometimes kills residents", "Drought in this community sometimes causes injury to residents" and "Drought in this community leads to the spread of diseases (e.g., waterborne diseases).

Depression, anxiety, and stress: In this study Lovibond & Lovibond (1995) abridged DASS-21 version was used as it has a 97% concurrence with the 42 item version. This scale consists of three self-report sub-constructs measuring depression (DASS-D), anxiety (DASS-A), and stress (DASS-S). Each sub-scale contains seven items measuring the three conditions on a 5-point Likert scale (1 = strongly disagree, and 5 = Strongly agree). The DASS-21 scale has a satisfactory reliability statistic of 0.95. Items such as "I do not seem to experience any positive feelings at all", "I experience trembling" and "I find it hard to wind down" were among the variables that measured depression, anxiety and stress.

Social capital: We adapted the 16-item Wang et al. (2014) Personal Social Capital Scale (PSCS). The PSCS measures bonding and bridging social capital. Each item was measured on a scale of 1–5, where 1 implies strongly disagree and 5 means strongly agree. The PSCS-16 scale has been used in numerous studies and is valid and reliable ($\alpha = 0.9$). Among the items measuring personal social capital are "I have many friends", "I trust many of my fellows/co-workers" and "There are many governmental, political, economic and social organisations exist in this community".

3.5. Data analysis

We utilised Structural Equation Modelling (SEM) to assess the explanatory power of the study framework depicted in Fig. 1 and examine the hypotheses. We selected Structural Equation Modelling (SEM) as our analytical technique because of its flexibility in linking theory and data (Chin, 1998). Furthermore, SEM offers unique advantages, such as distinguishing between latent constructs and observable variables, estimating and testing relationships between constructs, and addressing measurement errors (Kline, 2005). We employed a three-stage process to test the study's hypotheses: preliminary analysis, which included Exploratory Factor Analysis (EFA); Confirmatory Factor Analysis (CFA); and Structural Model Analysis.

First, we employed the Statistical Package for Social Sciences version 28 to identify and address any issues with missing variables, outliers, normality, and multicollinearity. We also estimated descriptive statistics such as frequencies, means, and standard deviation. Following this, we conducted EFA. The EFA aimed to identify the common indicators that accurately depict the latent variables. Second, we conducted a CFA to validate the measurement. This involved estimating convergent validity (through standardised factor

loadings, Average Variance Extracted (AVE), and construct reliability) and discriminant validity. We measured convergent validity using the three recommended criteria by (Hair et al., 2012); statistically significant factor loadings above 0.6, composite reliability higher than 0.7, and an AVE greater than 0.5. Discriminant validity was evaluated using both (Fornell and Larcker, 1981) and Hetero-trait-Monotrait (HTMT) ratio approaches. We employed various goodness-of-fit indices to assess the model fit to the dataset. These included: i) Chi-square to degree of freedom ratio (χ^2/df) with an acceptable cut-off of less than 3.0; ii) Goodness-of-Fit Index (GFI), Incremental Fit Index (IFI), Normed Fit Index (NFI), Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI) with a minimum threshold of 0.7; and iii) Root Mean Square Error of Approximation (RMSEA) with a threshold of less than 0.05 (Hair et al., 2012).

4. Results

4.1. Descriptive statistics

In this study, we approached 631 farmers of which 507 of them voluntarily participated in the study. This represents a response rate of 80.3%. The demographic characteristics of the sampled respondents are described in Table 1. Based on the gathered data, 63.1% are males, while 23.1% and 34.7% belonged to the age cohorts of 27–35 and 36–44, respectively. Regarding education, most respondents (45.8%) had no formal education, while 30.5% had basic education (primary/middle/JHS). While 42.5% were married, 16.2% and 28.6% were single and separated partners. Approximately three-fifths of the respondents practiced mixed (agro-pastoral) farming. Also, 38.3% of study participants farmed on 1–5 ha of land, while 41.2% cultivated on farmland over 6–10 ha.

Table 2 displays the means, standard deviations, and Pearson correlations among all the variables utilised in the study. The results showed statistically significant correlations for all the variables, with figures ranging from 0.05 to 0.59, demonstrating moderate stability. Specifically, a significant positive correlation was observed between disaster impact and measures of depression, anxiety, stress, and personal social capital.

4.2. Exploratory factor analysis (EFA)

This study's drought impact latent construct is an unvalidated instrument developed through an integrative review. The DASS-21, even though it has been validated in many geographical contexts, to the best of our knowledge, has not been utilised in the context of climate disaster hazards. Given a suggestion by (Juliawati et al., 2022) that a validated instrument may vary across times and cultures, we undertook an EFA to i) ascertain if the DASS-21 and social capital factor structures follow what Lovibond & Lovibond (1995) and Wang et al. (2014), respectively, found and ii) identify the common factors which explain the structure and order of the disaster impact construct. We estimated the EFA using the Principal Component Analysis extraction method and the Promax as a rotation method. Using Hinkin (1998) and Howard (2016) recommendations for factor loadings cut-off of 0.4, two, six, two and one items measuring disaster impact, social capital, anxiety and depression respectively were deleted (see highlighted red questions in Appendix A). Overall, the Exploratory Factor Analysis (EFA) accounted for 81.9% of the total variance, surpassing the recommended threshold of 60% as suggested by (Hair et al., 2020).

Table 1
Demographic characteristics of respondents.

Demographics	Categories	Frequency	Percentage (%)
Gender	Male	320	63.1
	Female	187	26.9
Age	18–26	16	3.2
	27–35	117	23.1
	36–44	176	34.7
	45–53	112	22.1
	54–62	71	14.0
	63 and above	15	2.9
Educational background	No Formal Education	232	45.8
	Primary/middle/JHS	155	30.5
	Senior High School	71	14.0
	Polytechnic	41	8.1
	Undergraduate	8	1.6
Marital status	Single	82	16.2
	Married	216	42.5
	Separated	145	28.6
	Divorced	54	10.7
	Widowed	10	1.9
Farming type	Cropping farming	20	3.9
	Animal farming	187	36.9.
	Mixed farming	300	59.2
Farm size	1–5 ha	194	38.3
	6–10 ha	209	41.2
	11–15 ha	29	5.7
	16+ hectares	75	14.8

Table 2
Means, standard deviation, correlation matrix and square root of AVE.

Latent variable	Mean	SD	1	2	3	4	5
1. Drought Impact	3.14	1.37	**0.89**				
2. Personal Social Capital	3.16	0.99	0.05[a]	**0.93**			
3. Stress	3.30	1.25	0.27[a]	0.20[a]	**0.87**		
4. Depression	3.11	1.23	0.30[a]	0.08[a]	0.59[a]	**0.86**	
5. Anxiety	3.15	1.17	0.28[a]	0.13[a]	0.55[a]	0.50[a]	**0.81**

[a] $p < 0.001$, diagonal figures in bold are the squared root of AVE.

As a problem in most survey data, common method bias was assessed following the approach by (Podsakoff et al., 2003). Herman's single-factor test revealed no biases in the data, as the first extracted factor accounted for less than 50% of the total variance. Also, the intercorrelations between the variable shown in Table 2 shows no multicollinearity concerns. The dataset exhibited a Kaiser-Meyer-Olkin (KMO) sampling adequacy of 0.94 and a statistically significant Bartlett test of Sphericity ($X^2 = 16{,}835$, df = 780, $P < 0.01$). These results indicate that the data is suitable for conducting further factor analysis.

4.3. Confirmatory factor analysis (CFA)

We performed CFA to evaluate the relationship between the manifest and latent variables and validate the measurement model. The CFA model was evaluated, and the results indicated a good fit ($\chi^2/df = 2.06$, $P < 0.001$; GFI = 0.85; AGFI = 0.82; TLI = 0.96; CFI = 0.97, IFI = 0.97 and RMSEA = 0.06). We estimated convergent validity by utilising the following criteria suggested by (Hair et al., 2020) - i) statistically significant factor loadings with items greater than 0.6, ii) composite reliability of greater than 0.7, and iii) AVE greater than 0.5. Table 3 shows statistically significant factor loadings ranging from 0.69 to 0.95, Composite Reliability (CR) between

Table 3
Convergent and discriminant validity.

Latent construct	Item	Factor loadings	Cronbach's α	AVE	CR
Drought Impact	DI1	0.87***	0.97	0.79	0.97
	DI2	0.89***			
	DI3	0.87***			
	DI4	0.94***			
	DI5	0.89***			
	DI6	0.91***			
	DI7	0.89***			
	DI10	0.91***			
	DI11	0.89***			
	DI12	0.91***			
	DI13	0.87***			
Social Capital	SC1	0.91***	0.98	0.87	0.98
	SC2	0.93***			
	SC4	0.95***			
	SC5	0.94***			
	SC6	0.74***			
	SC8	0.93***			
	SC9	0.92***			
	SC10	0.94***			
	SC11	0.94***			
	SC15	0.95***			
Depression	DP1	0.85***	0.96	0.76	0.96
	DP2	0.81***			
	DP3	0.93***			
	DP4	0.83***			
	DP6	0.85***			
	DP7	0.90***			
Stress	ST1	0.80***	0.95	0.74	0.93
	ST2	0.73***			
	ST3	0.89***			
	ST4	0.76***			
	ST5	0.91***			
	ST6	0.91***			
	ST7	0.95***			
Anxiety	AX1	0.90***	0.94	0.65	0.90
	AX2	0.95***			
	AX3	0.69***			
	AX5	0.76***			
	AX7	0.71***			

Table 4
Hetero-trait-Monotrait approach of assessing discriminant validity.

Latent Variable	1	2	3	4	5
Drought Impact					
Social Capital	**0.04**				
Depression	**0.30**	**0.18**			
Stress	**0.33**	**0.08**	**0.32**		
Anxiety	**0.29**	**0.16**	**0.19**	**0.38**	

0.9 and 0.98, and AVE of all constructs higher than 0.5.

We assessed discriminant validity using both (Fornell and Larcker, 1981) and Hetero-trait-Monotrait (HTMT) ratio approaches. In Fornell and Larcker's approach, we compared the square root of AVE with the inter-item correlations between drought impact, depression, anxiety, stress, and social capital. The results, presented in Table 2, indicate that the square root of AVE is greater than the inter-correlations between the variables, supporting discriminant validity. The HTMT approach (see Table 4) was also employed, and the results ranged from 0.04 to 0.38, meeting the recommended criterion of HTMT <0.85.

4.4. Structural model and hypotheses testing

The results of the SEM, as shown in Fig. 3 and Table 5, reveal that the path coefficients from drought impact to depression ($\beta = 0.27$, $p < 0.001$), anxiety ($\beta = 0.21$, $p < 0.001$), and stress ($\beta = 0.26$, $p < 0.001$) are all statistically significant. Therefore, hypotheses 1, 2, and 3 are supported. These findings indicate that prolonged periods of drought and increased severity harm farmers' mental health. The model fit indices confirm the accuracy of the structural model, with an acceptable fit observed ($\chi 2/df = 2.53$, $p < 0.001$; GFI = 0.84; AGFI = 0.80; TLI = 0.95; CFI = 0.95; IFI = 0.95; RMSEA = 0.07).

Hypotheses 4, 5 and 6, which examine the moderating role of personal social capital in the relationships between drought impact and depression, anxiety, and stress, were evaluated using the approach recommended by (Dawson, 2014). This approach involves centring the data and addressing the collinearity between the primary effect constructs and the interaction term. First, the researchers computed the standardised scores for the independent variable (drought impact), moderator (personal social capital), and dependent variables (depression, anxiety, and stress). Additionally, the standardised scores of drought impact were multiplied by social capital to create an interaction term. The model was estimated using the standardised scores of drought impact, social capital, depression,

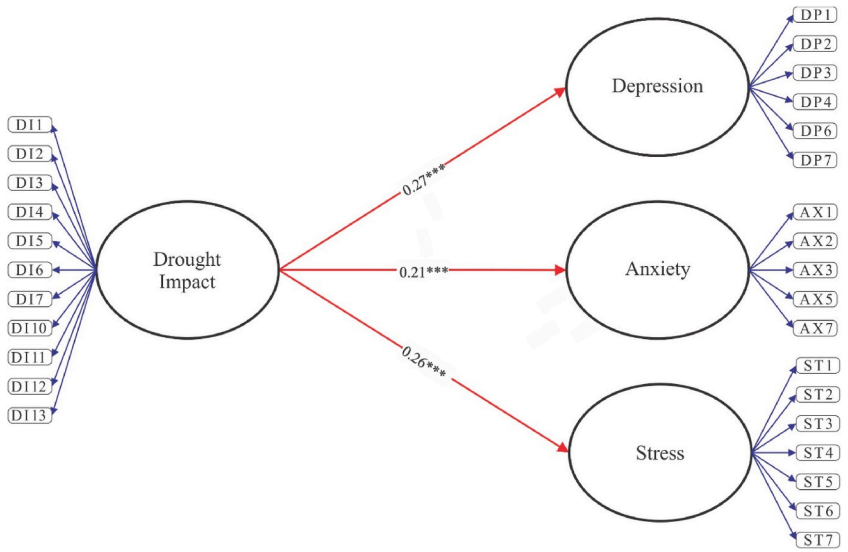
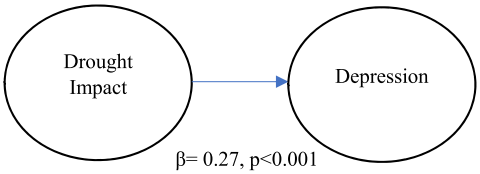
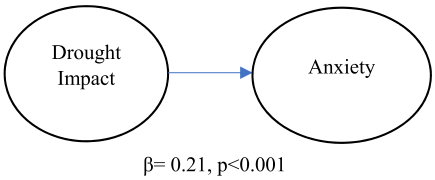
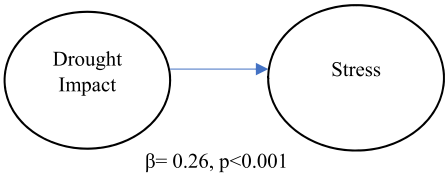
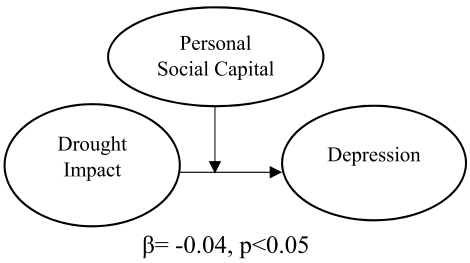
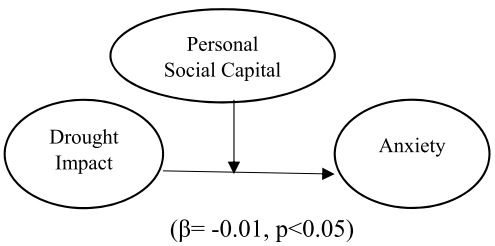


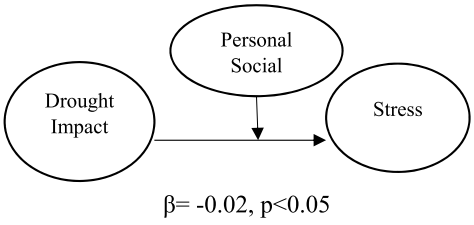
Fig. 3. Structural model.

Table 5
Hypotheses of the study.

Hypotheses	Path	Outcome
H1: The impacts of drought are associated with greater levels of depression		**Supported**
H2: The impacts of drought are associated with greater levels of anxiety		**Supported**
H3: The impacts of drought are associated with greater levels of stress		**Supported**
H4: Social capital moderates the positive relationship between drought impact and depression		**Supported**
H5: Social capital moderates the positive relationship between drought impact and anxiety		**Supported**

(*continued on next page*)

Table 5 (*continued*)

Hypotheses	Path	Outcome
H6: Social capital moderates the positive relationship between drought impact and stress		**Supported**

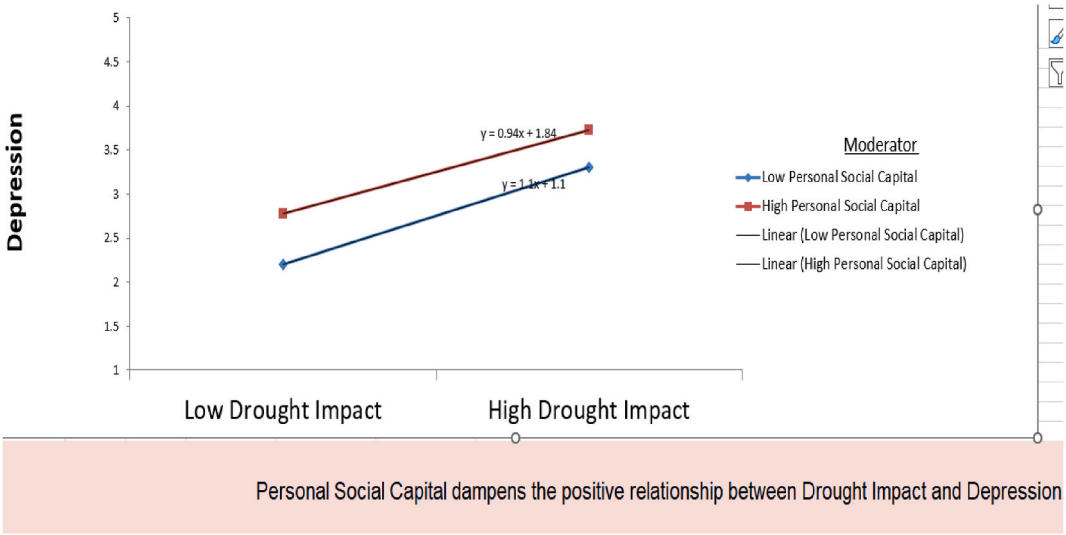


Fig. 4. Moderating effect of personal social capital on drought impact and depression.

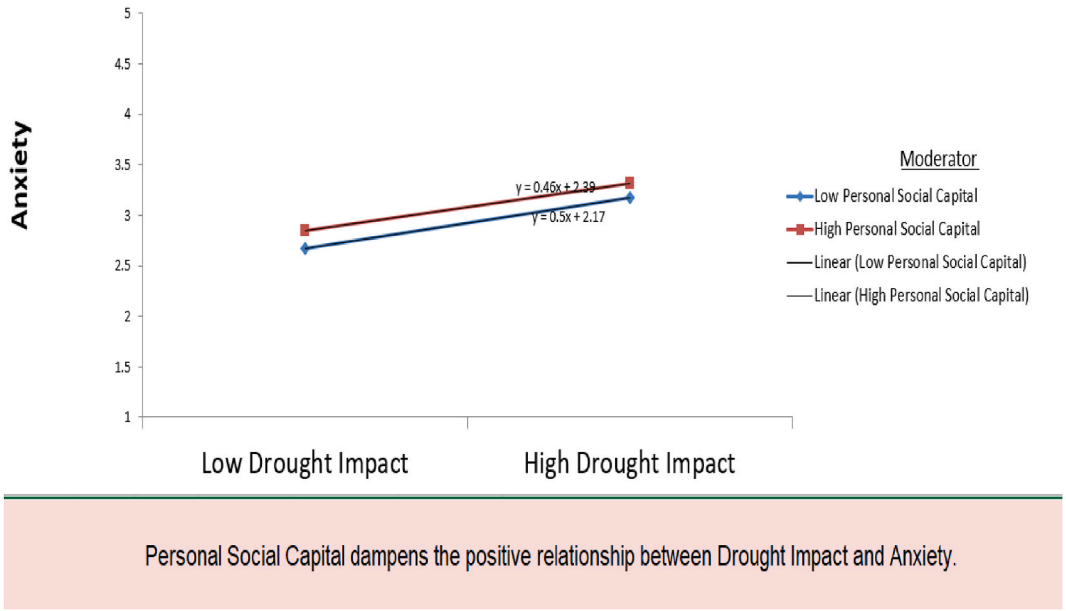


Fig. 5. Moderating effect of personal social capital on drought impact and anxiety.

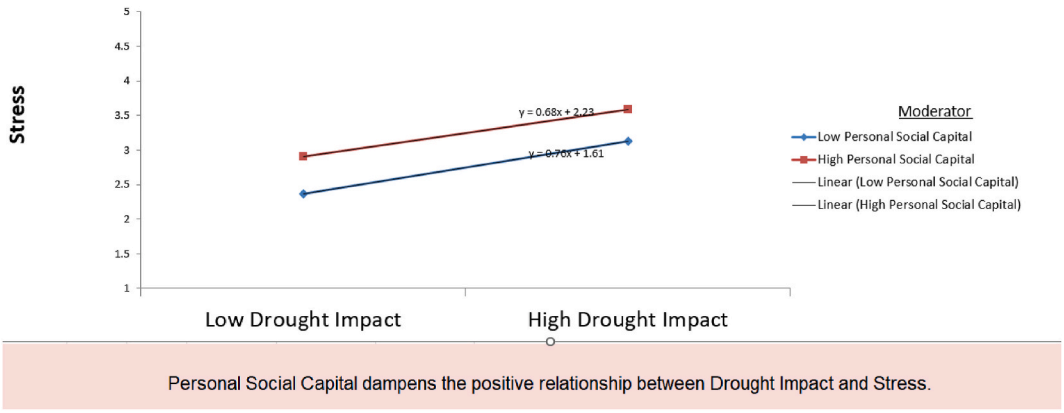


Fig. 6. Moderating effect of personal social capital on drought impact and stress.

anxiety, stress, and the interaction term. The resulting output from the model estimation was plotted in a two-way interaction Excel sheet, as demonstrated in Figs. 4–6.

Estimating the moderation effect of personal social capital on the relationships between drought impact and depression, anxiety, and stress yielded statistically significant results. The study found a significant positive relationship between drought impact and depression ($\beta = 0.51$, $p < 0.001$), anxiety ($\beta = 0.24$, $p < 0.05$) and stress ($\beta = 0.36$, $p < 0.001$) as displayed in Figs. 4–6 and Table 5. Also, the results demonstrated a statistically significant negative relationship between the interaction term and depression ($\beta = -0.04$, $p < 0.05$), anxiety ($\beta = -0.01$, $p < 0.05$), and stress ($\beta = -0.02$, $p < 0.05$). These findings support hypotheses 4, 5, and 6, indicating that personal social capital is a protective resource for managing mental health challenges associated with drought impact. The goodness of fit indices indicates an acceptable fit of the model ($\chi^2/df = 2.53$, $P < 0.001$; GFI = 0.77; CFI = 0.76, IFI = 0.76, NFI = 0.76 and RMSEA = 0.08).

5. Discussion

Examining the mental health impacts of drought on farmers in semi-arid regions is critically essential for comprehending the broader impacts of climate hazards on the adaptive capacity of vulnerable populations. While the frequency and intensification of drought occurrences reflect the many challenges of climate change confronting farmers in northern Ghana (Diko et al., 2021; Opoku Mensah et al., 2022) and other similar agro-ecological regions, applying a psychological lens through analysis of mental health impacts offers a more nuanced understanding of climate-stressed populations. Here, social capital remains a crucial resource in areas experiencing the stresses of climate change, and its role in traversing mental health impacts must be engaged empirically, beyond mere theoretical conjectures and postulations. In this section, we discuss three significant takeaways from our analysis.

First, drawing on the conceptual framework and referencing the SEM model (See Fig. 3), our findings point to drought significantly impacting three elements of mental health: depression, anxiety, and stress. Thus, our study findings support our three hypotheses (H1, H2, H3) regarding the mental health impacts of drought on farmers in semi-arid Ghana. This situation is underpinned by the nature of farming in the study area, which is heavily dependent on favourable climatic conditions and faces structural challenges regarding adequate and accessible climate data on drought risks and extension support services (Tindan et al., 2022). Thus, drought risks layered on existing vulnerabilities in agro-based livelihoods generate livelihood stability stress, anxiety about changing climate conditions, and depressive feelings about the future. These findings align with existing evidence highlighting the impact of climate change on the mental health of affected populations (Harada et al., 2015). Specifically, our study corroborates (Wossen and Berger, 2015) finding that farmers' high dependence on the environment for their non-diversified livelihoods makes them susceptible to climate-induced mental health risks.

Second, our study aligns with the burgeoning scholarship on the significance of social capital in helping communities cope with the impacts of climate change in vulnerable regions (Abunyewah et al., 2023a). In the context of mental health recovery, studies conducted in diverse geographic areas affected by climate hazards (Ehsan et al., 2019; Heid et al., 2017) have consistently demonstrated the positive role of existing social support networks, social trust, and access to available support systems in reducing and facilitating recovery from mental health impacts. Interestingly, our study revealed a significant finding: social capital moderates the relationship between drought impacts and all three dimensions of mental health (H4, H5, and H6). This suggests that having access to social capital is crucial in effectively managing and mitigating the mental health impacts of drought among farmers in semi-arid regions. In our study, farmers' access to friends, the presence of trusted relatives and neighbours, and the availability of cultural and recreational groups to help in times of difficulties were identified as necessity-driven forms of social capital for navigating reported drought-induced mental health issues. If carefully reasoned within the systemic neglect of psychological services for vulnerable populations in Ghana's climate riskscapes, this finding elevates the urgency to not only integrate existing social capital (soft infrastructure) into climate change adaptation initiatives but also to weave together public health and psychosocial services into planning for sustainable and resilient livelihood support services for farmers.

Building on the above, our third takeaway notes that the psychological aspects of climate change impact, such as drought, are gaining ground in the climate adaptation discourse and praxis globally (Abunyewah et al., 2023b; Bourque and Cunsolo Willox, 2014; Chapman et al., 2018). However, the intersecting issues of drought and mental health remain artificially divorced from farmers' adaptation services in Ghana, leading to suggestions to integrate psychological services and adaptation planning into farmers' livelihoods in arid regions (Acharibasam and Anuga, 2018). Our robust and validated structural model (See Fig. 3) confirms these observations and suggestions. Specifically, using the SEM model in our study has provided empirical evidence to establish and test the relationship between drought and mental health. This finding adds weight to the growing recognition of the need to address the psychological aspects of climate change impacts more seriously. Thus, our study not only affirms previous research on the impact of acute weather events such as floods, hurricanes, and fires on mental health (Page and Howard, 2010) but also advances the significance of utilising tools such as SEM to support psychology-based integrated, intersectoral, and holistic approaches to climate adaptation decision-making in semi-arid regions.

6. Conclusion and policy implications

Smallholder farmers in semi-arid regions play a crucial role in achieving sustainable development and climate change adaptation goals (Acharibasam and Anuga, 2018). In semi-arid ecological zones, such farmers are disproportionately exposed to acute weather events such as droughts and associated psychological consequences due to their susceptibility to adverse climate conditions and preexisting poor adaptive capacities. However, the relationship between climate change impacts such as drought and mental health is understudied and only emerging in global south contexts. By employing SEM to analyse the impacts of drought on farmers' mental health and the moderating role of social capital, this paper contributes significantly to the climate change-psychology nexus in sustainability research and practice (Acharibasam and Anuga, 2018; Chapman et al., 2018). Our results indicate that all eight hypotheses which underpinned this study are supported. In summary, the study findings suggest that drought impact is positively associated with mental health outcomes, including stress, anxiety, and depression. Additionally, the results highlight the moderating role of personal social capital in the relationship between drought impact and mental health. This underscores the importance of personal ties, networks, and support systems in addressing and managing the mental health consequences farmers face.

The findings offer four ramifications for adaptation policy and practice in the context of smallholder farmers' psychological well-being. First, the significant impact of drought on farmers' mental health suggests that experts such as clinical psychologists, social service personnel, and their respective institutions must be considered core agents in climate adaptation planning. This implies intersectoral and multi-actor policy frameworks to promote and deliver psychological support as part of extension services to farmers. Second, policymakers should have inter-sectoral strategies for enhanced medical insurance systems incorporating psychotherapy to ensure that climate-poor people have physical and mental health security. It is important for the government to offer targeted treatments and psychological counselling services to farmers in semi-arid regions who live in conditions of mental risk due to climate-induced disasters like drought. Third, given the unique socio-economic profile of farmers, mental health support by social service institutions must encompass both formal and informal processes by tapping into existing social networks as risk communication channels. As part of this process, the government must encourage other social organisations, such as nongovernmental organisations (NGOs), to actively participate in risk communication channels. Fourth, while policymakers and planners anecdotally express the relevance of social capital for climate-stressed populations, this rarely translates into *real capital* for building adaptative capacities to respond to climate change impacts. The government can assist the necessary health support services (e.g., mental health nurses) using social capital. One way in which policymakers can strengthen social capital is by investing in social infrastructure-events and festivals for people to know each other and build stronger relationships. Our study provides empirical justification to utilise the transformative potential of social capital to help farmers cope with and recover from drought-induced mental health challenges. We acknowledge that social capital can have a dark side, particularly in closed and homogeneous networks that lack access to external resources. Yet, we reason that by combining social capital with other forms of capital (e.g., human, physical, economic, and cultural capital), sustainable livelihood diversification programmes could reduce the underlying issues that compound vulnerabilities to the mental health impacts of drought.

Despite its contributions, this study has some limitations, implying a cautious interpretation and generalisation of findings. This research is based on data collected from farmers in the Talensi district of Ghana, and drought impacts may be unique to the study area and different from other farming locations. As a result, we suggest future studies to test and cross-validate the structural model across different contexts. While our study showed that personal social capital is a protective resource to navigate through the mental health challenges of drought, it did not explicitly provide a clear understanding of how bonding and bridging social capital individually influence mental health outcomes. Given this, our study recommends future studies to empirically explore the differential influence of bonding and bridging social capital on mental health outcomes. A complementary social network analysis could also be employed to understand the nexus between each type of personal social capital and mental health responses to drought impacts. Also, using subjective self-reported measures in the study may introduce bias in the result. Future research should adopt objective approaches in the measurement of constructs. Although multiple factors influence farmers' mental health, this study relied on only drought impacts as a predictor. This is an entry point for subsequent studies examining other multiple and intersecting factors within the climate-psychological nexus in semi-arid regions. Our study adopted a cross-sectional design to examine the relationship between drought impacts and mental health outcomes. Future studies may consider longitudinal data and study designs to understand how mental health outcomes develop over time by looking at changes in farmers' conditions due to social capital.

CRediT authorship contribution statement

Matthew Abunyewah: Conceptualization, Methodology, Validation, Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization, Project administration. **Seth Asare Okyere:** Conceptualization, Writing - original draft, Writing - review & editing, Visualization, Project administration. **Seth Opoku Mensah:** Methodology, Data curation, Writing - original draft, Writing - review & editing. **Michael Erdiaw-Kwasie:** Conceptualization, Writing - original draft, Writing - review & editing, Visualization, Project administration. **Thayaparan Gajendran:** Writing - review & editing. **Mitchell K. Byrne:** Writing - review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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Appendix 1

Drought Impact		
Code	Items	Source
DI1	Drought in this community sometimes kills residents	Qin et al., 2023; Sternberg, 2011; Webb and Reardon, 1992
DI2	Drought in this community sometimes causes injury to residents	
DI3	Drought in this community leads to the spread of diseases (e.g., waterborne diseases)	
DI4	Drought in this community results in the breakdown of economic activities (e.g., animal farming)	
DI5	Drought in this community leads to loss of income	
DI6	Drought in this community sometimes impedes accessibility to key services (e.g., schools, hospitals, recreation)	
DI7	Drought in this community sometimes displaces some residents	
DI8	Drought in this community sometimes causes damage to property	
DI9	Drought in this community sometimes prevents residents from utilising their skills	
DI10	Drought in this community sometimes impedes travel by road.	
DI11	Floods in this community prevent many people from going to work	
DI12	Drought in this community sometimes leads to the loss of social ties	
DI13	Drought in this community impedes participation in social activities (e.g., community meetings, funerals)	
Depression		
DP1	I do not seem to experience any positive feelings at all	Lovibond and Lovibond, 1995
DP2	I find it difficult to work up the initiative to do things	
DP3	I feel that I had nothing to look forward to	
DP4	I feel down-hearted and blue	
DP5	I am unable to become enthusiastic about anything	
DP6	I feel I am not worth much as a person	
DP7	I feel that life is meaningless	
Anxiety		
AX1	I experience breathing difficulty (e.g., excessively rapid breathing, breathlessness in the absence of physical exertion)	Lovibond and Lovibond (1995)
AX2	I experience trembling	
AX3	I am worried about situations in which I might panic and make a fool of myself	
AX4	I feel I am close to panic	
AX5	I am aware of the dryness of my mouth	
AX6	I am aware of the action of my heart in the absence of physical exertion (e.g., sense of heart rate increase, heart missing a beat)	
AX7	I feel scared without any good reason	
Stress		
ST1	I find it hard to wind down	Lovibond and Lovibond (1995)
ST2	I tend to over-react to situations	

(*continued on next page*)

(*continued*)

Drought Impact		
Code	Items	Source
ST3	I feel that I am using a lot of nervous energy	
ST4	I find myself getting agitated	
ST5	I find it difficult to relax	
ST6	I am intolerant of anything that keeps me from getting on with what I do	
ST7	I feel that I am rather touchy	
Personal Social Capital		
SC1	I have many friends	Wang et al. (2014)
SC2	Most of my friends have the same ethnic background as myself or are my schoolmates	
SC3	I trust many of my fellows/co-workers	
SC4	I trust many of my relatives and neigbours	
SC5	Many of my relatives, neigbours, friends and fellows have broad connections with others	
SC6	Many of my relatives, neigbours, friends and fellows have professional jobs	
SC7	Many of my fellows/co-workers will help me in times of need	
SC8	Many of my relatives, neigbours and friends will help me in times of need	
SC9	There are many cultural, recreational and leisure groups are available in this community	
SC10	There are many governmental, political, economic and social organisations exist in this community	
SC11	Many of these groups and organisations in this community possess broad social connection	
SC12	Many of these groups and organisations in this community possess broad social influence	
SC13	Many cultural and recreational groups are available in this community represent my interest	
SC14	Many of the governmental, political, economic and social organisations in this community represent my interest	
SC15	Many of the cultural, recreational and leisure groups in this community will help me in times of difficulty	
SC16	Many of the governmental, political, economic and social organisations in this community will help me upon request	

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