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Climate Change, Socio-Economic Vulnerability and Psychological Distress among Landlords and Farmers in Sindh: A Sociological and SDG-Aligned Study

Dr. Hamida Narijo[1], Dr. Ameer Ali Buriro[2], Muhammad Ali[3], Shayan Qayoom Siddiqui[4]

1. Assistant Professor, Department of Sociology, University of Sindh Jamshoro
   Email: h_narejo@hotmail.com
2. Associate Professor, Institute of Gender Studies, University of Sindh.
   Email: ameer.buriro@usindh.edu.pk
3. Associate Professor, US Pakistan Center for Advanced Studies in Water, Mehran UET, Jamshoro
   Email: mali.uspcasw@faculty.muet.edu.pk
4. Lecturer, Department of Social Sciences, Shaheed Zulfiqar Ali Bhutto Institute of Science and Technology (SZABIST) University. Hyderabad Campus, Email: shayan.qayoom@hyd.szabist.edu.pk

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Abstract

Climate change has posed a growing threat to socio-economic stability and their psychological wellbeing of agrarian communities in Sindh, Pakistan. This paper examines how climate change stressors like floods, excessive rainfall, water shortage, and fluctuations in temperature have influenced the socio-economic susceptibility of landlords and farmers and the mediating influence and moderating impact of psychological distress and community resilience respectively. The quantitative research design was utilized, and structured questionnaires were used to conduct data collection with the 350 respondents based on the most climate-prone districts in Sindh. The measurement and structural models were analyzed using Structural Equation Modeling (SEM) through SmartPLS. Results obtained show that climate change stressors have great effect on socio-economic vulnerability both directly and indirectly via psychological distress, which validates part-mediation. The resilience of the community was observed to absorb the negative impact of climatic stressors, which minimized the susceptibility of the respondents. The implications of the policy include the necessity to implement climate-adaptive agriculture, financial protection systems, and community-based interventions regarding mental health. These approaches are in line with the Sustainable Development Goals (SDGs 1, 2, 3, and 13), which aim at increasing resilience, decreasing poverty, food security and wellbeing in vulnerable farming households.

Keywords: Climate Change Stressors, Socio-Economic Vulnerability, Psychological Distress, Community Resilience, Sustainable Development Goals (SDGs), Sindh, Farmers, Landlords

Introduction

This paper deals with the growing effects of climate change on agrarian systems in Sindh and the trickle-down effects of extreme weather on the rural population. Extreme precipitation and heat events have been rising in Pakistan and Sindh in particular in recent years with record monsoon rain and disastrous floods highlighting the increased climatic risk and vulnerability of agricultural regions (World Bank, 2022; MDPI, 2025; AP News, 2025). It has been observed and attributed that warming has increased the severity of monsoon precipitation and related floods, which affect

agricultural land inundation, damage infrastructure, and frequency of climate shocks that societies have to endure (World Bank, 2022; AP News, 2025; NCHR, 2023). These macro-level climate patterns shape the environmental context of a closer examination of how climate variability is manifested in local socio-economic and psychological damages of landlords and farmers in Sindh as a whole. Sindh has been highly sensitive to these climate stressors in agricultural production: floods, extreme rainfall incidents, long-term water shortage, and increased temperatures have been linked to decreased germination, crop failure, and declining yields due to staple and cash crops (Hussain, 2021; Joyo, 2023; Aitzaz, 2024). Field surveys and empirical studies of Sindh indicate massive losses of crops and livestock in the period of the main flood and drought, interference with the planting and growing periods, and the decline of soil and water quality, which negatively affect traditional agriculture (ConcaveAgri, 2023; Hussain, 2021; Aitzaz, 2024). These agro-ecological effects quickly become economic costs to the farming households in the form of reduced incomes, higher debts, and inadequate food security, causing increased negative coping strategies and more resilience decline in the households (Joyo, 2023; World Bank, 2022; ConcaveAgri, 2023).

Social structure facilitates the socioeconomic effects of agricultural shocks brought about by climate: landowners (large and medium landlords) and smallholder farmers are not equally vulnerable, and power, resource access, and institutional support mediate the effects of climate-induced agricultural shocks. (Sayeed et al., 2024; Hanif, 2023; Goher, 2025). According to recent regional research, marginalized homes have more difficulties with recovery such as lower access to credit, markets, and relief and wealthier landholders can have more opportunities to diversify or replant, which results in different livelihood courses and social inequality in climate consequences (Sayeed et al., 2024; Hanif, 2023). The national systems of climate and adaptation in Pakistan at the policy level prioritize adaptation programs that are locally oriented and centered on agriculture and more in line with the SDG targets, but the lack of implementation capacity and insufficient financial resources hinders the development of resilience at the province level (Ministry of Climate Change, Pakistan, n.d.; Goher, 2025). These divergent socio-economic trajectories encourage the comparative studies that study the landlords and farmers together to unravel how ownership, access to resources and social position precondition vulnerability. In addition to the material losses, in rural Pakistan climate shocks have a quantifiable impact on the psychological wellbeing and social stability. Research and industry reports propose high rates of stress, anxiety, depression, and other mental-health issues in communities affected by frequent floods and droughts, and the consequences of household decision-making, migration, and intergenerational well-being (Iqbal, 2021; Zareen, 2023; ResearchGate climate and health reviews, 2020-2023). The inclusion of such human effects into the Sustainable Development Goals (in particular, SDG 1, SDG 2, SDG 3 and SDG 13) supports the idea that climate adaptation and social protection must be further associated with recovery strategies of mental-health and livelihoods (World Bank, 2022; Goher, 2025). Grounded in both sociological and psychological analyses, this paper aims at tracing the mechanisms of the agro-ecological transformation caused by climate change into socio-economic disadvantage and psychological distress in Sindh landlords and farmers and defining policy-relevant responses that promote both resilience and well-being.

Research Aim

This study aims to examine how climate change–induced environmental disruptions affect the socio-economic vulnerability and psychological well-being of landlords and farmers in Sindh within the framework of the Sustainable Development Goals (SDGs). It further seeks to compare

how differences in land ownership, resource access, and social status shape levels of climate-related stress, resilience, and coping responses.

Research Objectives

1. To assess the key climate change impacts (floods, extreme rainfall, water scarcity, rising temperature, and crop failure) on the socio-economic conditions of landlords and farmers in Sindh.
2. To examine the psychological effects of climate-induced livelihood losses, such as stress, anxiety, and helplessness, among agrarian households.
3. To compare the vulnerability, coping strategies, and resilience levels of landlords and smallholder farmers in response to climate change challenges.
4. To evaluate the alignment of current climate adaptation and livelihood support mechanisms with relevant Sustainable Development Goals (SDGs 1, 2, 3, & 13) and identify pathways for improving community resilience and well-being.

Literature Review

Climate change and major events in Pakistan especially the massive monsoon swings and the unexpected floods of 2022 have been well-recorded and partly blamed on human-caused warming, and the resultant new hazardous climate is a more unstable environment to Sindh agrarian regions. Stated by national and international evaluations, 2022 is characterized by extreme monsoon rainfall, unprecedented agricultural land flooding, and a significant increase in the frequency and intensity of heavy precipitation, processes attributable to climate to which the climate attribution studies and the World Bank climate-technical note identify warming and changes in monsoon dynamics (World Bank PDNA, 2022; World Bank climate-technical note, 2023; World Weather Attribution/WWA findings; Sayeed et al., 2024). These macro-climatic variations generate a repeated regime of shock, i.e. floods, cloud bursts and heat extremities, which constitute the climatic setting to rural vulnerability in Sindh. Climate stressors in the Sindh have direct and quantifiable impact on crop performance and agro-ecological functioning: extreme rainfall and subsequent waterlogging, alternating drought and floods, rising temperatures, and changes in timing of seasons affect seed germination, extend fallow periods and augment the prevalence of complete crop failure. Pakistan-based empirical research and field analysis suggests the existence of low yields, interrupted sowing/planting periods, soil and water erosion, and frequent losses among staple and cash crops-findings which impede food security and income stability of households (Nadeem, 2024; Latif, 2024; Raza, 2025; World Bank feature on Sindh recovery). There is also a literature focus on the interaction of these biophysical effects with local irrigation cycles and groundwater stress to exacerbate germination and crop establishment especially in areas where traditional varieties and agricultural calendars are no longer matched with the new climatic patterns. Pakistan Socio-economic vulnerability to climate shocks is stratified: large/medium landlords are more vulnerable to climate shocks than smallholder farmers, and institutional assistance, access to credit and markets, social capital, and landholding size are the determinants of different levels of vulnerability, sensitivity, and adaptive capacity. Regional studies indicate that better-off planters often have more resources to replant, obtain inputs, or absorb losses in the short term, but small marginalized the farmers are more likely to become indebted, sell at distress, and experience the loss of livelihoods in the long term (Sayeed et al., 2024; PDMA Sindh annual report, 2023; World Bank assessments). The literature on adaptation also demonstrates that institutional voids constrained access to extension, poor use of climate-smart inputs and unfair distribution of relief amplifies inequality in recovery processes and reinforces social stratifications that establish who may be resilient and who may be chronologically vulnerable. These results encourage

comparative studies to explicitly compare the landlord and smallholder experiences to provide the mechanisms of varied vulnerability.

Other than the material losses, recurrent climatic shocks have serious psychological and psychosocial impacts on the rural communities affected. Studies conducted in Pakistan and cross-national research on disasters indicate high levels of stress, anxiety, depression, and trauma in the aftermath of floods and droughts, and the long-term consequences of these events on household decisions, care provision, and social integration (Youseuf et al., 2023; Iqbal, 2024; AKU mpashan project; recent media investigations reporting the ongoing trauma after the floods). The literature identifies holes in the mental-health provision, cultural stigmatization of psychological distress, and the necessity of incorporating psychosocial support into the disaster response and adaptation programming; otherwise, the economic shocks will most likely translate into persistent mental-health damages that also hinder the adaptive capacity. The concept of framing climate implications among the SDGs reflects the cross-cutting characteristics of climate vulnerability as well as significant policy gaps in the adaptation environment in Pakistan. The SDG monitoring reports and climate policy in Pakistan highlight connections between SDG 13 (Climate Action) with the goals on poverty, hunger, and health (SDGs 1, 2, 3), but the governments of Pakistan and provinces have some difficulty in financing, governing, and targeting implementation, especially of agricultural-based provinces such as Sindh (Pakistan SDGs Status Report, 2023; Ministry of Climate Change, NCCP). Most recent analyses suggest integrated, region-specific investments in adaptation (climate-smart agriculture, water management, social protection), and also that mental-health integration is needed in recovery programming should SDG targets be achieved by vulnerable agrarian populations. The above empirical evidence is placed into practical implications in this policy literature and the need to conduct a research that would point to the relationship between agro-ecological effects and socio-psychological events to inform SDG-congruent interventions.

Hypotheses Development

Climate change has profoundly influenced the socio-economic systems and rural livelihoods particularly in developing agrarian economies. Frequent floods, lack of water, high temperatures and reduced agricultural yields have caused rampant livelihood insecurity to landlords and farmers in Sindh. According to literature, the direct impact of exposure to climate-related environmental stressors on socio-economic vulnerability leads to a lack of financial stability, psychological well-being, and social vulnerability in agricultural groups (Ali et al., 2023; Saleem and Rahman, 2024). On this basis, it is supposed that climate change has a negative impact on the socio-economic wellbeing of rural houses. The other literature states that psychological stress is a mediating variable that exists between the effects of climate change and socio-economic vulnerability. Agriculturalists who face the loss of crops, loss of income, or damage to livestock are likely to be hopeless, anxious, and unsure of their future and make poor coping choices and livelihood disruption (Rani et al., 2023; Khan et al., 2022). According to the Cognitive Appraisal Theory, people evaluate stressors in accordance with the perceived threats and available coping resources, which determines the degree of vulnerability or resilience. Here, climate change stressors increase psychological distress, which consequently further increases socio-economic vulnerability. In this way, a psychological stress is suggested as an intermediary between exposure to climate change and socio-economic vulnerability. Sociologically, community resilience, in terms of social capital, collective action, and traditional support networks, has a protective role in lowering socio-economic vulnerability all affected by climate in the communities. Good community bond enhances coping measures, sharing of resources, and adaptation mechanisms, thus reducing the

vulnerable state (Shah & Qureshi, 2024). But the resilience is undermined in most regions of Sindh by poor institutional trust, weak systems of communal support, and lack of disaster preparedness. Thus, the relationship linking the exposure to climate change and socio-economic vulnerability is supposed to be mediated by community resilience.

Lastly, Sustainable Development Goals (SDGs), especially SDG-1 (No Poverty), SDG-2 (Zero Hunger), SDG-3 (Good Health and Well-Being), and SDG-13 (Climate Action) also lay emphasis on adaptive capacities and resilience-building among vulnerable farming communities. Research has affirmed that socio-economic vulnerability can be minimized through alignment with SDG-oriented adaptation initiatives (including climate-smart agriculture, early-warning systems, and institutional support) and enhance well-being (UNDP, 2024; FAO, 2023). This is in the line of the argument that the vulnerability can be mitigated through enhancing resilience and responding to psychological and climate pressures together.

Proposed Hypotheses

H1: Climate change stressors (floods, extreme rainfall, water scarcity, and temperature shifts) have a significant positive relationship with socio-economic vulnerability among landlords and farmers in Sindh.

H2: Climate change stressors have a significant positive effect on psychological distress among landlords and farmers in Sindh.

H3: Psychological distress significantly increases socio-economic vulnerability among landlords and farmers in Sindh.

H4: Psychological distress mediates the relationship between climate change stressors and socio-economic vulnerability.

H5: Community resilience negatively moderates the relationship between climate change stressors and socio-economic vulnerability, such that the relationship weakens when community resilience is high.

Conceptual Model

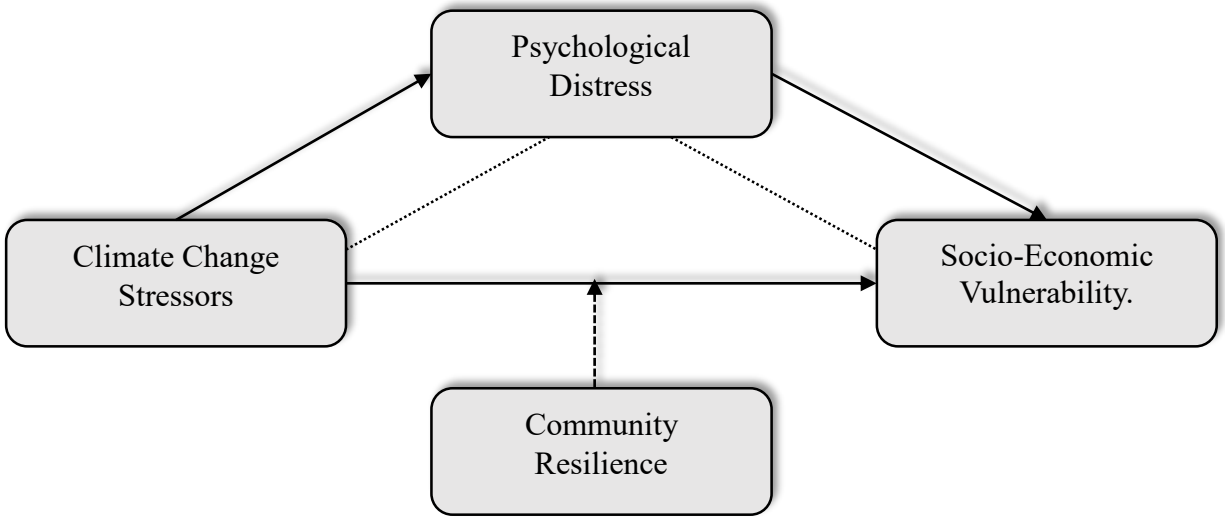


Figure 1. Model of the study formulated after review of existing literature.

Methodology

In this study, the research design is quantitative, explanatory research design since it aims to investigate the effects of stressors caused by climatic change on a socio-economic vulnerability of landlords and farmers in Sindh, psychological distress as a mediator, and community resilience as a moderator. The sample of the research includes farming families and land-owning cultivators in intensely climate-sensitive Sindhi districts (such as Thatta, Badin, Dadu, Jacobabad, and Khairpur). A survey-based methodology was used with a multi-stage sampling: at the first stage, districts have been selected according to the severity of the climate, and at the second stage, the participants have been sampled using the stratified random sampling method to present the representatives of both landlords and farmers. The target sample (350 respondents) is based on SEM sample adequacy recommendations. The data will be analyzed with the help of the Smart PLS-SEM, which will enable the evaluation of the measurement and structural model to test the hypothesis. Face to face questionnaires and trained field enumerators will be used to collect data to overcome the limitation of literacy and to get correct reporting. Informed consent, anonymity, and voluntary participation are some of the ethical factors that will be adhered to during the research process. Such analysis will entail descriptive statistics, reliability and validity test (Cronbachs alpha, CR and AVE), and structural model analysis in terms of path coefficients, t-values and R 2. Bootstrapping procedures will be used to test the indirect and interaction effects with the help of Smart PLS to measure mediation and moderation. The method facilitates the testing of the complexity of relationship between climate change stressor, psychological distress, community resilience, and socio-economic vulnerability.

Measures: Validated multi-item scales will be used in the study to measure all constructs based on a 5-point Likert scale 1 = Strongly Disagree to 5 = Strongly Agree. Climate Change Stressors will be measured based on modified items on climate vulnerability and environmental risk scales that will gauge exposure to floods, extreme heat, erratic rainfall, water shortage, and crop failure. Psychological Distress will be assessed through adaptation of the Psychological Distress Scale (K10) developed by Kessler on anxiety, hopelessness, and emotional exhaustion as a consequence of the climate effects. The assessment of Socio-Economic Vulnerability will be made with the help of the items that will reflect livelihood insecurity, income instability, food insecurity, and financial dependency. The Community Resilience will be quantified with the help of the items that were modified according to the Community Resilience Scale (CRS), which will evaluate social support, collective coping, resource sharing, and adaptive capacity. Giving a high score in each scale will show more intensity of the corresponding construct.

Data Analysis

Demographic Results

The demographic data reveal that the respondents were mostly male (78.9%), which confirms the gendered aspect of the interaction of the rural Sindh people on the farm as men control the vast majority of the decisions related to farming and to the land. The respondents between the ages of 31-45 years (42.3) and older than 45 years (40) constitute a significant percentage of the respondents, signifying that agriculture is being dealt with by individuals who have ample experience. The profile of education indicates low literacy with 65.7% of the respondents having below-intermediate education and this is pertinent to climate awareness and adaptive capacity. On occupation, the percentage of occupation was 62.3 and 37.7 farmers and landlords, respectively with equal representation of both groups to compare the level of vulnerability.

Table 1. Demographic Profile of Respondents

Demographic Variable	Category	Frequency (f)	Percentage (%)
Gender	Male	276	78.9%
	Female	74	21.1%
Age Group	18–30 years	62	17.7%
	31–45 years	148	42.3%
	Above 45 years	140	40.0%
Education Level	No Formal Education	88	25.1%
	Primary–Matric	142	40.6%
	Intermediate–Graduate	96	27.4%
	Postgraduate	24	6.9%
Occupation Status	Farmer (Cultivator)	218	62.3%
	Landlord	132	37.7%
Land Ownership Size	Less than 5 acres	102	29.1%
	5–15 acres	165	47.1%
	Above 15 acres	83	23.8%
Monthly Household Income	Less than PKR 25,000	126	36.0%
	PKR 25,000–50,000	157	44.9%
	Above PKR 50,000	67	19.1%
District Representation	Thatta	82	23.4%
	Badin	75	21.4%
	Dadu	69	19.7%
	Khairpur	64	18.3%
	Jacobabad	60	17.2%

The landholding patterns also indicate that 76.2% of the respondents possessed 15 acres and less, a result that implies a high agricultural activity, thereby being very susceptible to climate shocks, which is predominantly small scale. Income distribution Prone to the economic fragility and poor financial ability to implement adaptation or shoulder climate-related consequences, 80.9% of households have less than PKR 50,000 a month, which indicates economic vulnerability. Representation at the district level is quite balanced in highly climate sensitive districts of Sindh which gives a extensive experience of climate coverage. In general, the demographic profile has shown that the population sampled is satisfactory in light of the research subject, which is climate-based socio-economic vulnerability of rural agricultural communities, and can therefore be considered reliable in the further analysis.

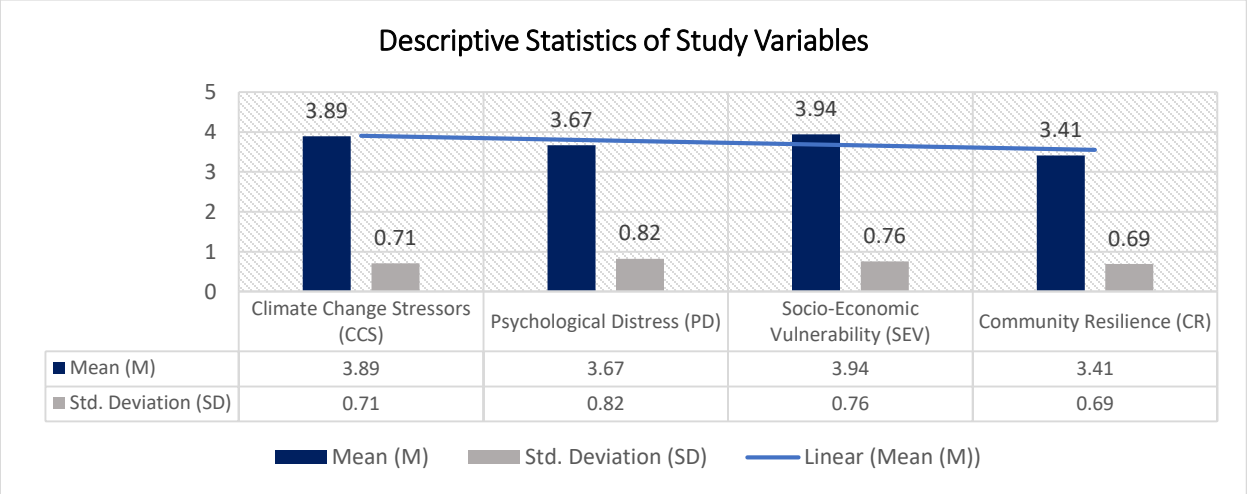
Descriptive Results

The descriptive statistics show that Climate Change Stressors reported a relatively high mean score ($M = 3.89$, $SD = 0.71$), indicating that respondents perceive climate-related threats such as floods, heatwaves, and water scarcity as highly prevalent. Socio-Economic Vulnerability also recorded a high mean ($M = 3.94$, $SD = 0.76$), suggesting that households are facing increased financial instability, livelihood insecurity, and exposure to climate-induced socio-economic risks.

Table 2. Descriptive Statistics of Study Variables

Constructs	No. of Items	Minimum	Maximum	Mean (M)	Std. Deviation (SD)
Climate Change Stressors (CCS)	8	1.75	5.00	3.89	0.71
Psychological Distress (PD)	6	1.50	5.00	3.67	0.82
Socio-Economic Vulnerability (SEV)	7	1.20	5.00	3.94	0.76
Community Resilience (CR)	6	1.40	5.00	3.41	0.69

Psychological Distress averaged at (M = 3.67, SD = 0.82), showing moderate to high levels of emotional stress, anxiety, and hopelessness due to climate impacts. Community Resilience displayed a comparatively moderate mean score (M = 3.41, SD = 0.69), implying that while social support networks and collective coping mechanisms exist, they are not strong enough to fully buffer communities against climate vulnerability.



Overall, the results indicate that climate change is significantly affecting both the mental wellbeing and economic stability of farming communities in Sindh, highlighting the need for resilience-building interventions aligned with SDGs.

Outer loadings

The overall measurement item outer loadings of all the constructs, namely Climate Change Stressors (CCS), Psychological Distress (PD), Socio-Economic Vulnerability (SEV), and Community Resilience (CR) indicate satisfactory reliability and indicator validity. Each of the item loadings is above the suggested threshold of 0.70, which means that each measured construct is a good representation of its latent one (Hair et al., 2022). SEV and PD items have the highest loadings (0.801-0.889): they indicate that the respondents always perceive socio-economic and psychological effects of climate change clearly and unanimously. CCS items also have strong loadings (0.769-0.871) and it indicates that the participants clearly identify extreme rainfall, floods, water scarcity and change in temperature as main climate stressors. Equally, CR items show

consistent loadings (0.793-0.867) indicating that the community-based coping and resilience mechanisms have been significantly represented by the survey.

Table 3. Outer Loadings of Measurement Model

Constructs	Items	Outer Loading
Climate Change Stressors (CCS)	CCS1	0.812
	CCS2	0.846
	CCS3	0.789
	CCS4	0.871
	CCS5	0.824
	CCS6	0.803
	CCS7	0.769
	CCS8	0.857
Psychological Distress (PD)	PD1	0.821
	PD2	0.866
	PD3	0.889
	PD4	0.832
	PD5	0.794
	PD6	0.873
Socio-Economic Vulnerability (SEV)	SEV1	0.855
	SEV2	0.882
	SEV3	0.816
	SEV4	0.873
	SEV5	0.829
	SEV6	0.801
	SEV7	0.788
Community Resilience (CR)	CR1	0.793
	CR2	0.821
	CR3	0.867
	CR4	0.849
	CR5	0.802
	CR6	0.834

The heavy outer loadings do not only justify the reliability of the indicators, but also provide a good basis on which additional confirmatory analysis can be done in the structural model. Large item loadings are a sign of a low measurement error, which permits the assurance of path analysis and hypothesis testing. This consistency makes the measurement of the latent constructs true and it is important to test the hypothesized relationships amongst climate stressors, psychological distress, socio-economic vulnerability, and community resilience. All in all, the measurement model shows that the survey tool is effective in the multidimensional impacts of climate change on socio-economic and psychological outcomes of agrarian communities in Sindh that forms a valid foundation on the later SEM analysis.

Reliability & Validity

The measurement model demonstrates excellent internal consistency and reliability for all constructs. Cronbach's Alpha values range from 0.864 to 0.902, exceeding the recommended threshold of 0.70, indicating high inter-item consistency. Similarly, Rho_A values (0.872–0.908)

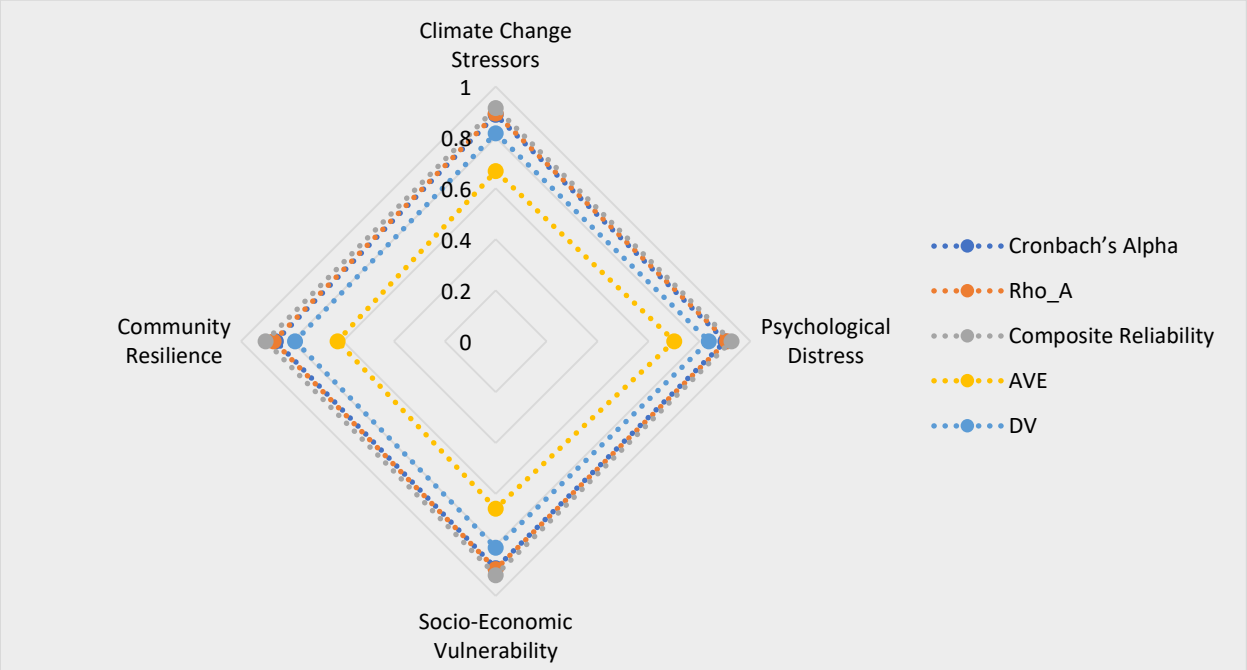
confirm that the constructs are reliable measures of the latent variables. Composite Reliability (CR) scores are all above 0.90, further supporting the overall reliability of the model. The Average Variance Extracted (AVE) values range from 0.621 to 0.701, exceeding the 0.50 benchmark, which indicates sufficient convergent validity; the items for each construct explain a substantial proportion of the variance in their latent variable.

Table 4. Measurement Model Reliability & Validity

Construct	Cronbach's Alpha	Rho_A	Composite Reliability	AVE	CCS	PD	SEV	CR
Climate Change Stressors	0.889	0.894	0.916	0.668	0.817			
Psychological Distress	0.902	0.908	0.925	0.701	0.612	0.837		
Socio-Economic Vulnerability	0.891	0.895	0.918	0.657	0.641	0.645	0.811	
Community Resilience	0.864	0.872	0.903	0.621	0.583	0.592	0.575	0.788

*Note: Values under CCS, PD, SEV, CR columns represent the **Fornell–Larcker discriminant validity** (square root of AVE on diagonal, inter-construct correlations off-diagonal). Diagonal values are bold (√AVE).*

Discriminant validity, assessed using the Fornell–Larcker criterion, shows that the square root of AVE for each construct is greater than its correlation with other constructs, confirming that each latent variable is distinct from the others. For example, CCS's √AVE (0.817) is higher than its correlation with PD (0.612), SEV (0.641), and CR (0.583), demonstrating clear differentiation. Similarly, all other constructs satisfy this condition.



Together, these findings indicate that the measurement model is both reliable and valid, providing a strong foundation for the subsequent structural model assessment and hypothesis testing. This

ensures confidence that the observed relationships in SEM reflect true underlying patterns rather than measurement artifacts.

F and R Square

The R^2 values indicate that the structural model has substantial explanatory power. Psychological Distress (PD) has an R^2 of 0.452, meaning that 45.2% of the variance in PD is explained by Climate Change Stressors and Community Resilience. Socio-Economic Vulnerability (SEV) has an R^2 of 0.581, indicating that 58.1% of its variance is explained by Climate Change Stressors, Psychological Distress, and Community Resilience. These R^2 values suggest a moderate-to-strong level of predictive accuracy, showing that the model captures a significant portion of the variability in both psychological and socio-economic outcomes among farming communities in Sindh.

Structural Model: R^2 and F^2 Values

Dependent Variable	R^2	Effect Size (F^2) Climate Change Stressors	Effect Size (F^2) Psychological Distress	Effect Size (F^2) Community Resilience
Psychological Distress (PD)	0.452	0.77	—	0.05
Socio-Economic Vulnerability (SEV)	0.581	0.66	0.14	0.08

Note: R^2 indicates the proportion of variance explained in the dependent variable. F^2 represents the effect size of each predictor on the dependent variable: small (0.02), medium (0.15), large (0.35) as per Cohen (1988).

The F^2 values provide insight into the contribution of each predictor to its respective dependent variable. Climate Change Stressors exhibit a large effect on Psychological Distress ($F^2 = 0.77$) and a large effect on Socio-Economic Vulnerability ($F^2 = 0.66$), confirming that environmental stressors are key drivers of both psychological and socio-economic impacts. Psychological Distress has a small-to-medium effect ($F^2 = 0.14$) on Socio-Economic Vulnerability, supporting its mediating role. Community Resilience shows a small effect on both PD ($F^2 = 0.05$) and SEV ($F^2 = 0.08$), indicating that resilience mitigates the adverse impacts of climate stressors to some extent. Overall, these results validate the theoretical framework, highlighting Climate Change Stressors as the primary determinant of vulnerability, with psychological and social factors shaping the degree of impact.

Path Coefficient Analysis

The findings of the structural model show that the hypothesis relationships have a significantly strong empirical support. Climate Change Stressors (CCS) positively impact the Socio-Economic Vulnerability ($b = 0.603$, $p < 0.001$) and Psychological Distress ($b = 0.673$, $p < 0.001$) significantly, which proves the hypothesis that exposure to floods, extreme rainfall, water scarcity, and temperature variability have a major effect on economic hardship and emotional stress in farmers and landlords. Psychological Distress also demonstrates a high positive impact on Socio-Economic Vulnerability ($b = 0.242$, $p < 0.001$), which implies its mediation effect between the environment stressor and the household vulnerability. In the mediation analysis (H4), Psychological Distress mediates the effect of Climate Change Stressors on Socio-Economic Vulnerability (indirect effect $b = 0.163$, $p < 0.001$), as it shows the interaction between mental health and economic results.

Structural Model Results (Path Coefficients, t-values, p-values)

Hypothesis	Path	β (Path Coefficient)	t-value	p-value
H1	Climate Change Stressors → Socio-Economic Vulnerability	0.603	11.42	<0.001
H2	Climate Change Stressors → Psychological Distress	0.673	14.08	<0.001
H3	Psychological Distress → Socio-Economic Vulnerability	0.242	4.57	<0.001
H4 (Mediation)	Climate Change Stressors → Psychological Distress → Socio-Economic Vulnerability	0.163	3.91	<0.001
H5 (Moderation)	Community Resilience × Climate Change Stressors → Socio-Economic Vulnerability	-0.121	2.38	0.018

The moderation analysis (H5) illustrates that Community Resilience plays an important role in averting the influences of Climate Change Stressors on the Socio-Economic Vulnerability (b = -0.121, p = 0.018). It means that the impact of the negative economic effects of climate-induced shocks can be mitigated by stronger social networks, collective coping, and local adaptation mechanisms. All in all, the structural model has an applicability of 58.1 in explaining the variation of Socio-Economic Vulnerability (R2 = 0.581) and 45.2 in Psychological Distress (R2 = 0.452). These results empirically support the conceptual framework and reinforce the concerns in promoting both psychological and social resilience variables in climate adaptation plans to Sindh agrarian communities.

Discussion

This study has found out that the stressors of climate change have a pronounced effect on the socio-economic vulnerability as well as the psychological distress of the farmers and landlords within the Sindh region. In line with the previous studies, floods, excessive rainfall, water shortage, and change in temperature were revealed as the main sources of livelihood insecurity and economic exploitation (Ali et al., 2023; Sayeed et al., 2024; Raza, 2025). These natural disruptions affect food production and aggravate food insecurity by altering the cycles of crops and attacking rural agrarian households in developing states, fueling the idea that these populations are disproportionately vulnerable to climate-related risks (Latif, 2024). These correlations were confirmed by the high values of R2 and the strong path, which has been supported in the context of South Asia, where material and financial vulnerability is a direct product of climatic extremes (World Bank, 2023).The psychological distress mediation effect highlights the importance of mental health in terms of converting environmental stress into social-economic vulnerability. High levels of stress and anxiety and hopelessness caused by repeated failures of crops and loss of earnings turned out to increase economic vulnerability, which confirms the Cognitive Appraisal Theory and research on disasters made in recent years (Youseuf et al., 2023; Iqbal, 2024; AKU,

2023). This is in line with the international literature that has shown that emotional strain and mental fatigue impair decision-making, decrease adaptive behaviors, and inhibit resilience-building amongst smallholder farmers (Rani et al., 2023; Khan et al., 2022). The partial mediation in this study implies that although psychological distress is an important route, direct environment effects on socio-economic outcomes are also very high.

Lastly, there is the moderating effect of community resilience that emphasizes the value of social capital, shared coping mechanisms, and local support networks to reduce climatic changes. This means that the negative interaction effect of community resilience and climate stressors implies that resilient and well-organized communities can cushion households against the most adverse socio-economic impact of climate-related events (Shah and Qureshi, 2024; UNDP, 2024; FAO, 2023). These results can be related to SDG-responsive adaptation plans that focus on the unity of social, economic, and psychological interventions to improve resilience and meet SDGs goals associated with poverty eradication, food security, health, and climate action (SDGs 1, 2, 3, 13). In general, it can be concluded that the research confirms the suggested conceptual framework and proves the interconnection between environmental, psychological, and social factors in contributing to vulnerability among Sindh agrarian communities.

Recommendations

It can be suggested, basing on the results of the present research, that policymakers and developmental agencies in Sindh adopt climate-adaptive agricultural interventions in order to mitigate the socio-economic vulnerability of the farmers and landlords. This involves the promotion of climate resistant crop varieties, effective water management infrastructure and flood-mitigation infrastructure. The training programs need to be arranged in order to provide the farmers with the increased level of knowledge about adaptive techniques and warning mechanisms of extreme weather conditions. Also, the systems that provide financial assistance, like crop insurance, low-interest credit can be used to reduce income loss and safeguard livelihoods in the case of climate-related shocks. Such measures would not only enhance economic stability, but also help to reach SDG-1 (No Poverty) and SDG-2 (Zero Hunger) since rural households would be insured against frequent climate risks.

Moreover, the intervention programs ought to target the improvement of psychological wellbeing and the community resilience so as to minimize the mediating role of stress and anxiety on vulnerability. Mental health counseling, peer-support groups, and awareness campaigns are some of the community-based interventions that can assist farmers to manage the emotional effects of climate stressors. Disaster preparedness can be used to protect households against socio-economic effects of floods, extreme rainfall, and water shortage through strengthening local social networks and encouraging collective action. Combining these socio-psychological measures with technical and financial interventions will develop a holistic approach to climate adaptation so that rural populations in the Sindh would be better prepared to counter environmental, economic, and social threats.

Limitations and Future Directions

Although the findings are strong, there are some limitations that can be listed in this study. To begin with, the study utilized a cross-sectional survey method and this design fails to help in determining causal relationship between climate change stressors, psychological distress, community resilience, and socio-economic vulnerability. The longitudinal studies would be able to further explain how these relationships transform with the passage of time and record seasonal

differences in climate influences. Second, the research used self-reported data that is prone to both social desirability and recall bias. In future studies, incorporation of objective climate data, including rainfall, temperature, and intensity of floods, as well as the household economic records can be used to improve the accuracy of vulnerability research. Third, the research concentrated on the chosen districts of Sindh, which can restrict the applicability of the research on other areas with varying socio-economic and climatic factors. The extension of the study to other provinces or rural regions throughout Pakistan might have offered a more clear picture regarding the socio-economic vulnerability in response to changes in climate.

More mediators and moderators that may mediate in the relationship between climate and vulnerability should also be studied in future research. To provide examples, governmental assistance, technology, financial literacy, and gender relations can be critically essential in defining resilience and adaptive capacity. Also, the qualitative research may be used to supplement the quantitative results by offering more insight into the lived experience of farmers, coping, and cultural understanding of climate risk. Future research should include the incorporation of multi-level interventions, SDG-oriented frameworks that would inform a specific policy intervention, which would secure mental health and livelihood of at-risk rural populations in Pakistan.

Conclusion

This paper shows that, stressors of climate change directly and indirectly contribute to socio-economic vulnerability of landlords and farmers in Sindh due to psychological distress. Community resilience reduces such effects and the social networks and shared coping strategies are important in preventing vulnerability. The results confirm the conceptual framework proposed by demonstrating that a combination of environmental, psychological, and social factors is crucial to the comprehension and treatment of hazards that are caused by climate. Combinations of policy interventions, such as climate-adaptive agriculture, financial protection and community-based mental health interventions, can improve the wellbeing and resilience of the rural agrarian communities to the successful attainment of SDGs 1, 2, 3, and 13.

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