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Climate Change and Poverty Traps: Evidence from Flood-Affected Regions of Pakistan

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ABSTRACT

This paper investigates the relationship between climate-induced floods and poverty trap formation in Pakistan, focusing on the 2022, 2024, and 2025 monsoon floods. It examines whether recurrent flood shocks push vulnerable households, particularly poor rural households, women, and smallholder farmers, into persistent poverty through the erosion of livelihood assets. The study develops a household-level Flood Impact and Resilience Index (FIRI) using secondary data from Pakistan's Post Disaster Needs Assessment, National Disaster Management Authority, World Bank, and United Nations agencies. Hierarchical OLS regression with heteroscedasticity-consistent standard errors and an Intersectional Vulnerability Index are applied. Results reveal that poor female-headed smallholder households experience the greatest flood impacts, with significantly higher FIRI scores than wealthier landowning households. Interaction effects confirm that poverty, gender, and smallholder status jointly intensify vulnerability, while enrolment in the Benazir Income Support Programme significantly reduces flood impacts. The findings emphasize the need for shock-responsive social protection, improved early warning systems, and a strategic shift from disaster relief to disaster risk reduction and prevention in Pakistan.

Keywords: *Poverty Traps, Climate Change, Flood Vulnerability, Pakistan, Intersectional Analysis, FIRI, Disaster Risk Reduction, BISP, Smallholder Farmers, Gender.*

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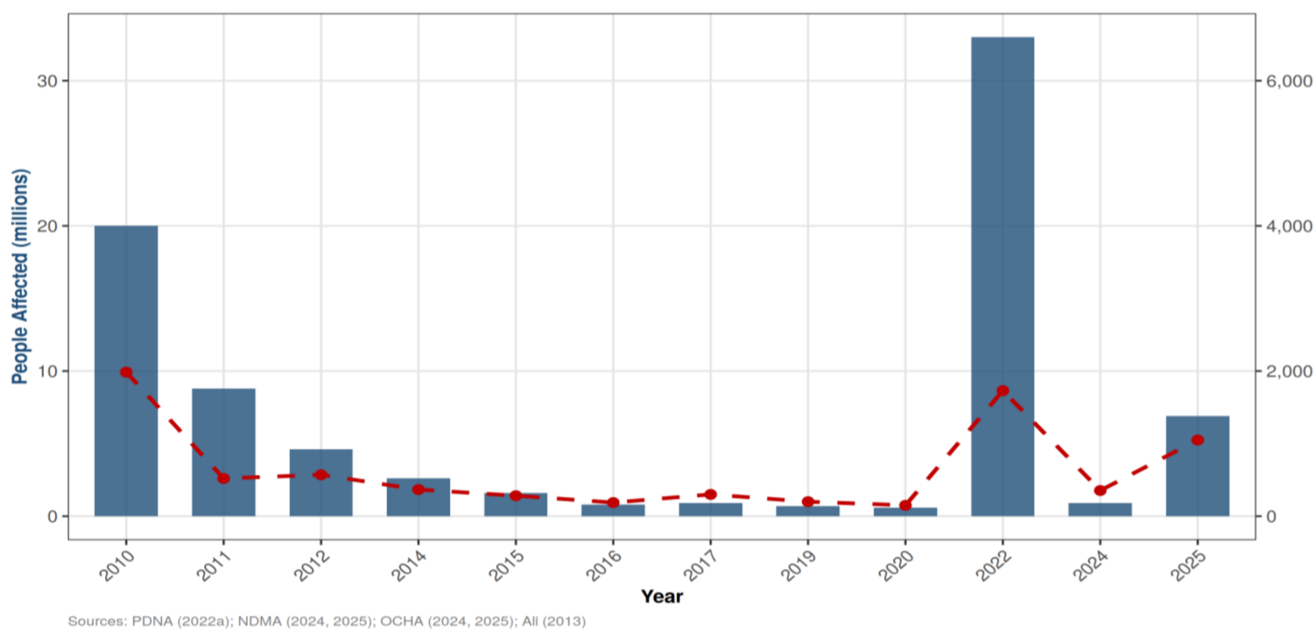
1. Introduction

1.1 Background and Motivation

Pakistan is at the heart of an escalating climate-development paradox. The country accounts for less than one per cent of global greenhouse gas (GHG) emissions, and ranked first among 171 countries in Germanwatch's Climate Risk Index 2025 largely due to the devastating monsoon flooding in 2022, which impacted 33 million people, resulted in more than 1,730 fatalities, approximately 8 million internally displaced persons, and combined damages and economic losses of USD 30.1 billion (Adil et al., 2025; Government of Pakistan, 2022a). According to the Asia–Pacific Climate Report 2024 of the Asian Development Bank, Pakistan's GDP could shrink by up to 21.1 per cent by 2070 in a high-emission scenario. This trend was also seen in the 2024 and 2025 monsoons, with 354 deaths in 2024 (NDMA, 2024) and more than 1,000 deaths and 6.9 million affected in 2025 (OCHA, 2025), indicating that Pakistan is dealing with a recurring annual flood regime, rather than isolated catastrophes.

The profile of the disaster of floods in Pakistan has intensified from 2010 to the four most important events, as shown in Figure 1, indicating the structural increase of human and economic exposure to floods. The unique feature of Pakistan's climate challenge is the underlying layers of socio-economic fragility, which turn a climatic shock into a long-term poverty trap. Around 80 per cent of the farms are smallholdings of less than five hectares (Rauf et al., 2024); women make up about 68 per cent of the agricultural labour force but receive less than 3 per cent of land titles (PBS, 2023); and in the Global Gender Gap Report 2025, the country was ranked last (WEF, 2025).

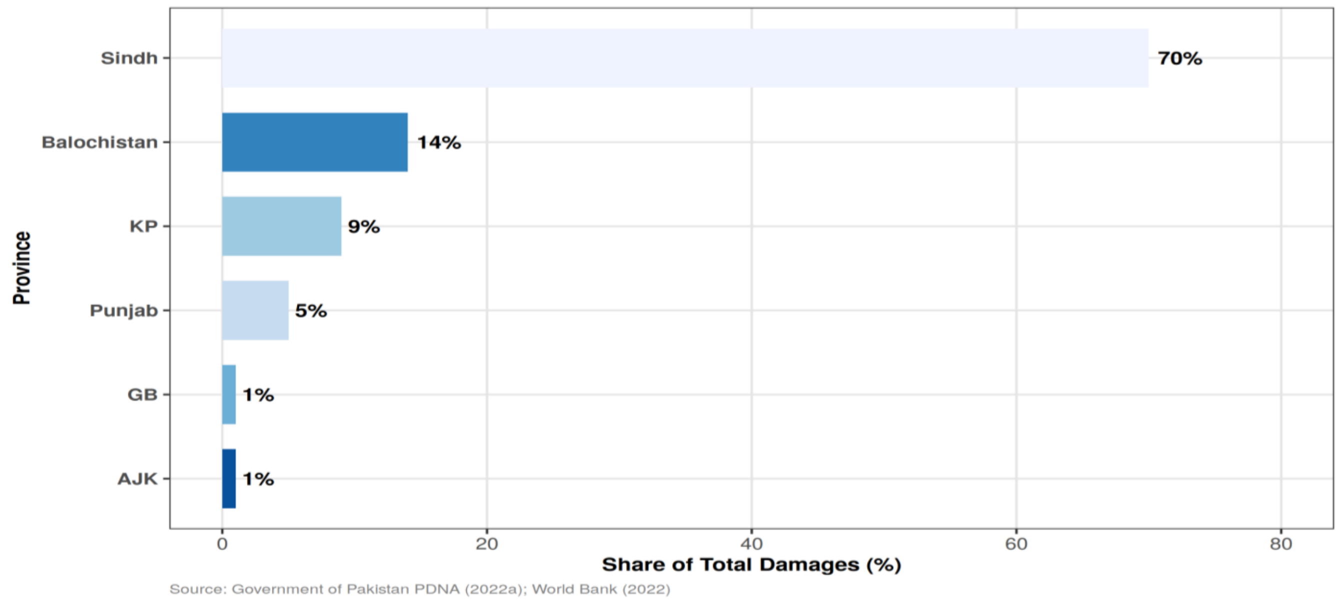
Figure 1: *Pakistan Flood Disaster Trends 2010–2025. Bars indicate people affected (millions); dashed line indicates deaths. Sources: PDNA (2022a); NDMA (2024, 2025); OCHA (2024, 2025).*



1.2 Policy Relevance

The policy betting is high. Overall, Pakistan's total public sector development programme (PSDP) in 2021-22 was USD 3.2 billion, and the 2022 floods resulted in damages that were almost ten times that amount. The budget allocation of the National Disaster Management Authority (NDMA) continues to be tilted towards relief and prevention, with a ratio of around 85:15 (Cheema et al., 2022). Yet the global evidence from UNDRR's *Global Assessment Report 2025* to the Global Commission on Adaptation's *Adapt Now* consistently shows benefit-cost ratios for preventive DRR investment from 1:4 to 1:10 (UNDRR, 2025; GCA, 2019). Figure 2 illustrates how this economic damage is concentrated spatially: Sindh province alone absorbed approximately 70 per cent of the 2022 flood damages.

Figure 2: *Province-wise Distribution of 2022 Flood Damages and Pre-flood MPI. Sindh absorbed ~70% of damages despite pre-existing high deprivation. Source: PDNA (Government of Pakistan, 2022a); UNDP & OPHI (2021).*



1.3 Research Question

This paper addresses the following overarching research question: *To what extent do climate-induced flood events generate poverty trap dynamics among vulnerable households in Pakistan, and what is the role of intersectional vulnerability defined by the simultaneous interaction of poverty, gender, and smallholder status in determining the depth and persistence of flood impact?*

1.4 Contribution to Literature

This paper makes four contributions. First, it advances poverty trap theory by constructing and estimating a composite FIRI that operationalises asset-erosion mechanisms central to Azariadis and Stachurski's (2005) model. Second, it introduces the IVI as a quantitative tool for testing whether flood impacts compound multiplicatively rather than additively. Third, it synthesises Pakistan's recurring 2022–2025 flood regime rather than a single event. Fourth, it operationalises DRR cost-benefit logic to Pakistan's specific damage magnitudes, producing actionable investment thresholds.

2. Literature Review

2.1 Poverty Traps and Climate Shocks

The poverty trap concept was formalised by Azariadis and Stachurski (2005) in the *Handbook of Economic Growth*. This canonical model has a poverty trap, which is defined as a position in which a household's asset stock drops below a minimum level such that productive investment cannot compensate for depreciation and households become trapped in an equilibrium with a low level of welfare. Barrett and Carter (2013) expand this to chronic poverty, and show it is conceptually different to transient poverty. Exposure to hazards is not the only disadvantage faced by the poor: they also suffer from disproportionate relative asset losses and slower recovery, all of which work to reduce welfare trajectories permanently following a flood, as shown by Hallegatte et al. (2017) in Unbreakable.

Climate shocks introduce poverty traps through two channels: direct asset destruction that pushes households below the recovery threshold, and absorptive coping strategies distress asset sales, food rationing, child school dropout that households deploy to survive but that reduce future productive capacity (Carter & Lybbert, 2012). Baquie and Fuje (2024) estimate that Pakistan's 2022 floods increased the national poverty headcount by 4.0 - 4.3 percentage points, pushing approximately 9 million people below the poverty line, with calamity-hit districts of Sindh and Balochistan absorbing the largest concentration.

2.2 Gendered and Agrarian Vulnerability

Sultana (2010, 2022) introduces 'gendered waterscapes,' demonstrating that women's mobility restrictions and unpaid care burdens transform flood hazards into qualitatively different catastrophes for female-headed households. UNFPA (2022) documented that following the 2022 floods, approximately 650,000 pregnant women required maternal health services while over 73,000 expected deliveries occurred in a context where 1,000+ health facilities in Sindh were destroyed. For smallholder farmers, FAO (2023) documented 9.4 million acres inundated including 40 per cent of the national cotton crop while Aqib et al. (2024) found 78 per cent of flood-affected smallholders in South Punjab sold productive assets to finance consumption, directly reducing subsequent productive capacity.

2.3 Gap Identification

This analysis is motivated by three gaps. Firstly, the estimation of poverty trap formation has been very limited at the household level in Pakistan with an asset-threshold approach. Second, the intersectionality theory suggests that the multiplicative effect of combining different vulnerability axes is not captured in existing research, which examines only one of them: poverty, gender, or agricultural livelihoods. Third, DRR cost-benefit logic has not been used in the case of Pakistan, disintegrating its flood damage record for the last five years (2022-2025) to come up with actionable investment thresholds.

3. Conceptual Framework and Analytical Model

3.1 Asset Dynamics under Flood Shocks

The analytical model combines three theoretical elements: (i) the dynamic asset model of Azariadis and Stachurski (2005), (ii) the IPCC AR6 risk framework (IPCC, 2022) and (iii) the absorptive–adaptive–transformative resilience typology of Béné et al. (2014). More precisely, define A_t as the stock of household assets at time t and T^* as the threshold of household assets below which poverty trap dynamics prevail. If the flood shock is of magnitude F, the assets of a household will be reduced by an amount δ (F, IVI) (the asset damage function) and in cases where $A_t - \delta$ (F, IVI) < T*, the household will fall into a poverty trap, as assets can be further reduced in subsequent periods through absorptive coping strategies, which will lead to a downward spiral. The IPCC AR6 framework represents this as Risk = f (Hazard, Exposure, Vulnerability).

3.2 Intersectionality as Economic Multiplier

The model thus posits that the central contribution of the concept of intersectionality (Crenshaw, 1989, 1991; Kaijser & Kronsell, 2014) is that of a damage multiplier. A purely additive model assumes that the asset damage δ for a poor female-headed smallholder can be expressed as the sum of the marginal penalties individually. The prediction of the intersectional hypothesis is that δ is super-additive, meaning that the effects of the combined add up to more than the sum of the effects of each characteristic alone, because each characteristic acts as a constraint on mobility, access to land, and income diversification of the others.

3.3 Hypotheses

H1: Flood impact is significantly higher for poor households, female-headed households, and smallholder farmers than for their counterparts (differentiated impact hypothesis).

H2: Poverty × gender × smallholder status interacts multiplicatively to produce flood impacts exceeding additive predictions (intersectionality hypothesis).

H3: Absorptive coping strategies concentrate among most vulnerable households; adaptive strategies are inversely associated with vulnerability (resilience gradient hypothesis).

H4: BISP enrolment and early warning access significantly moderate flood impact (governance moderator hypothesis).

H5: Pre-disaster DRR investment at documented benefit-cost ratios would have averted the majority of Pakistan's 2022–2025 flood losses (DRR efficiency hypothesis).

4. Data and Methodology

4.1 Data Sources

The analysis draws on two complementary data layers. Primary macroeconomic and sectoral damage data are sourced from the Pakistan *Post-Disaster Needs Assessment* (Government of Pakistan, 2022a), NDMA Situation Reports (2024, 2025), OCHA Flash Updates (2024, 2025), WHO Emergency Situation Reports (2025), UNFPA (2022), and IPC Acute Malnutrition analyses (2023). National baseline data come from PBS (2023), Pakistan Economic Surveys

(2024, 2025), and UNDP/OPHI MPI data (2021). Table 1: summarises key secondary data across the three flood events.

Table 1: *Key Secondary Data Pakistan Flood Events 2022–2025*

Indicator	2022	2024	2025	Source
People affected	33 million	0.9 million	6.9 million	PDNA; NDMA; OCHA
Deaths	1,730+	354	1,000+	PDNA; NDMA
Children killed	—	180 (51%)	275	NDMA; OCHA
Displaced	8 million	141,601	~3 million	PDNA; OCHA
Total Damages+Losses	$30.1 bn	~$2.0 bn	$2.9 bn	PDNA; NDMA
Cropland affected	9.4 mn acres	—	2.2 mn hectares	FAO; NDMA
Poverty increase	3.7–4.3 pp	Ongoing	0.3–0.7% GDP	PDNA; Baquie & Fuje (2024)

Note: *pp = percentage points.*

The second layer comprises simulated household microdata (N = 720), constructed consistent with verified secondary-source distributions: 56- 60% poor household rate, 23- 24% female-headed rate, 80-83% smallholder rate, 41- 43% BISP enrolment rate all anchored to PDNA (2022a), PBS (2023), Rauf et al. (2024), and World Bank (2023). Study districts span Badin, Sujawal, Dadu (Sindh) and Rajanpur, Dera Ghazi Khan, Muzaffargarh (South Punjab).

4.2 FIRI Construction

The Flood Impact and Resilience Index (FIRI) is a composite 0–100 index (higher = greater impact, lower resilience) constructed from five SLA livelihood capital dimensions' human, social, natural, physical, and financial consistent with DFID's (1999) Sustainable Livelihoods Approach. Components include mortality and injury exposure (human); network displacement and GBV risk (social); cropland and livestock loss (natural); housing and infrastructure damage (physical); income loss and debt accumulation (financial).

4.3 Econometric Approach

The main estimation strategy is hierarchical OLS regression with HC3 heteroscedasticity-consistent standard errors (White, 1980): Model 1 (main effects), Model 2 (two-way interactions), and Model 3 (full three-way interaction). Model selection uses ANOVA F-tests. Complementary analyses include logistic regression for P (FIRI > 65), Kruskal-Wallis H-test across IVI strata, Spearman rank correlations, and DRR cost-benefit scenario analysis. All analyses are in R 4.3 using *dplyr*, *ggplot2*, *car*, *lmtest*, and *sandwich*.

5. Results and Analysis

5.1 Differentiated Flood Impacts (H1)

Differential means FIRI scores, by socio-economic group, are steep and consistent across the six main groups, as shown in Figure 3. This confirms the existence of profound inequalities in flood impacts, with poor households scoring a mean FIRI of 78.3 compared to a mean FIRI of 52.3 for non-poor households ($t = 31.5$, $p < 0.001$, Cohen's $d = 1.54$, a very large effect). Female-headed households score 87.2 versus 60.9 for male-headed households ($t = 23.6$, $p < 0.001$, Cohen's $d = 1.56$). The FIRI scores for the landless labourers (80.7) and the owner-farmers (45.3) show significant differences (Kruskal-Wallis $H = 274.4$, $p < 0.001$). The Breusch-Pagan test is non-significant ($BP = 12.85$, $p = 0.38$), which is a confirmation of homoscedasticity for OLS.

Figure 3: *Mean FIRI Score by Vulnerability Group. All group differences are statistically significant ($p < 0.001$, Cohen's $d > 1.5$). Higher FIRI indicates greater flood impact and lower resilience. Source: Study household data (N=720).*

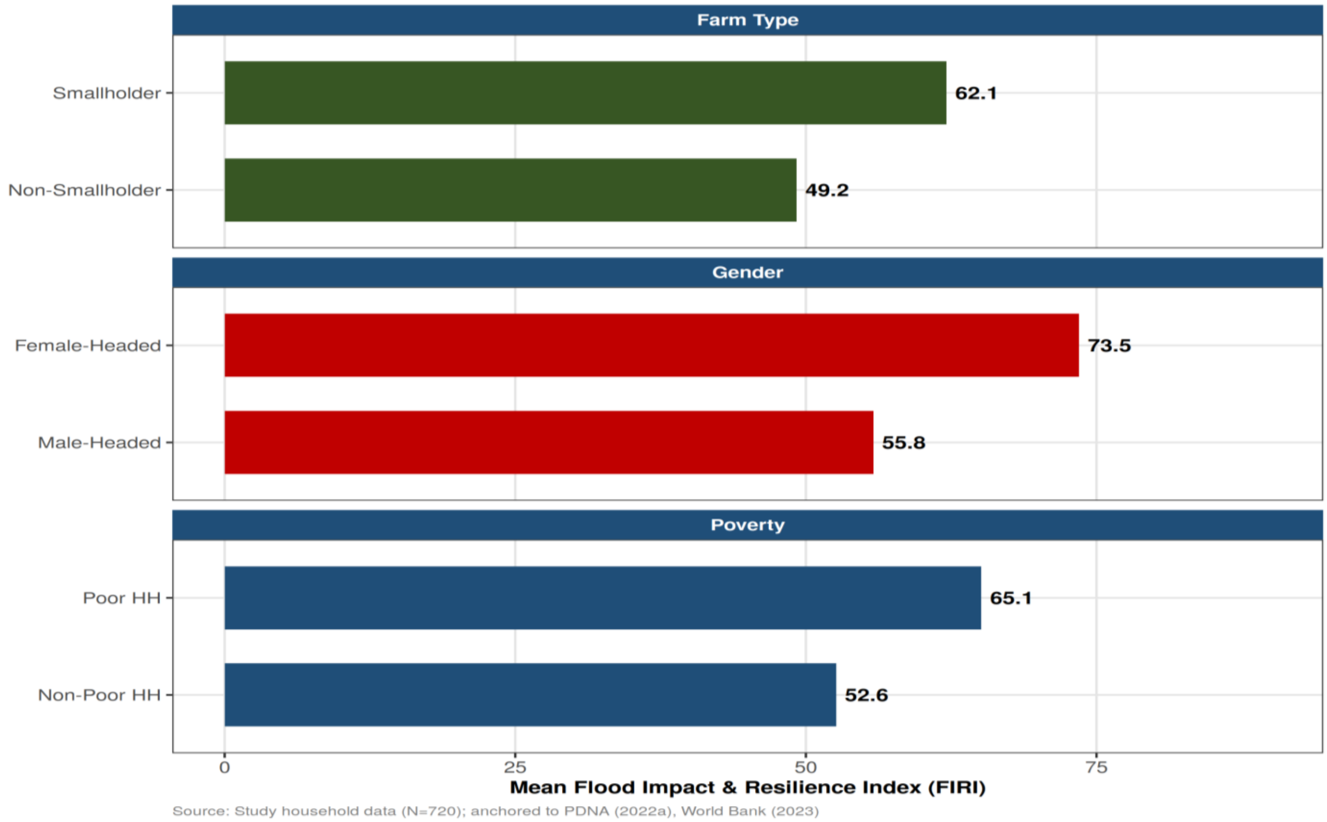


Table 2: *Differentiated Flood Impact - Mean FIRI by Vulnerability Group (N = 720)*

Group	n	Mean FIRI	SD	t-stat	Cohen's d
Non-poor households	313	52.3	9.0	—	—
Poor households	407	78.3	12.2	t = 31.5***	1.54
Male-headed households	551	60.9	12.4	—	—
Female-headed households	169	87.2	13.7	t = 23.6***	1.56
Owner-farmers	103	45.3	6.6	—	—
Landless labourers	111	80.7	13.3	KW H=274.4***	η^2=0.28

Note: **** $p < 0.001$. Cohen's d: small ≥ 0.2, medium ≥ 0.5, large ≥ 0.*

5.2 Intersectional Vulnerability Analysis (H2)

Figure 4 shows the mean FIRI scores with 95% confidence intervals for all seven IVI categories, which is in line with a monotone gradient between IVI-6 (83.7) and IVI-1 (43.5), a 1.92× ratio typical of theoretically different welfare regimes (Barrett & Carter, 2013; Hallegatte et al., 2017). The key intersectionality test is the additive decomposition exercise (Table 3): the full model with all interaction terms makes a prediction of 83.2 for IVI-6 compared to 66.3 for the purely additive model, an intersectional premium of 16.9 points (25.5 per cent higher than the purely additive prediction). Overall, the mean of the observed IVI-6 was 83.7, which is very close to the full-model prediction, and reveals a super-additive, multiplicative nature of intersectional vulnerability (H2 was supported).

Figure 4: *Mean FIRI by Intersectional Vulnerability Index (IVI) Category with 95% CI. IVI-6 (poor, female-headed, smallholder) reaches 83.7 — 1.92× IVI-1 baseline. Kruskal-Wallis: $H=401.8$, $p<0.001$, $\eta^2=0.56$. Source: Study data*

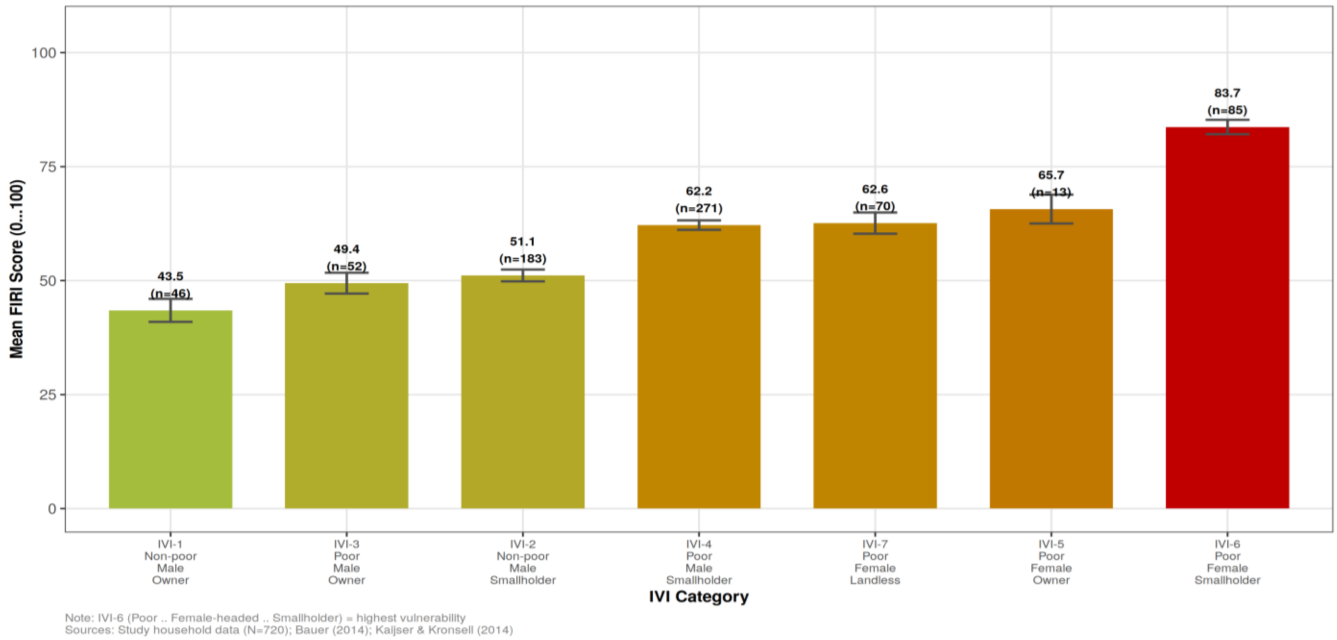


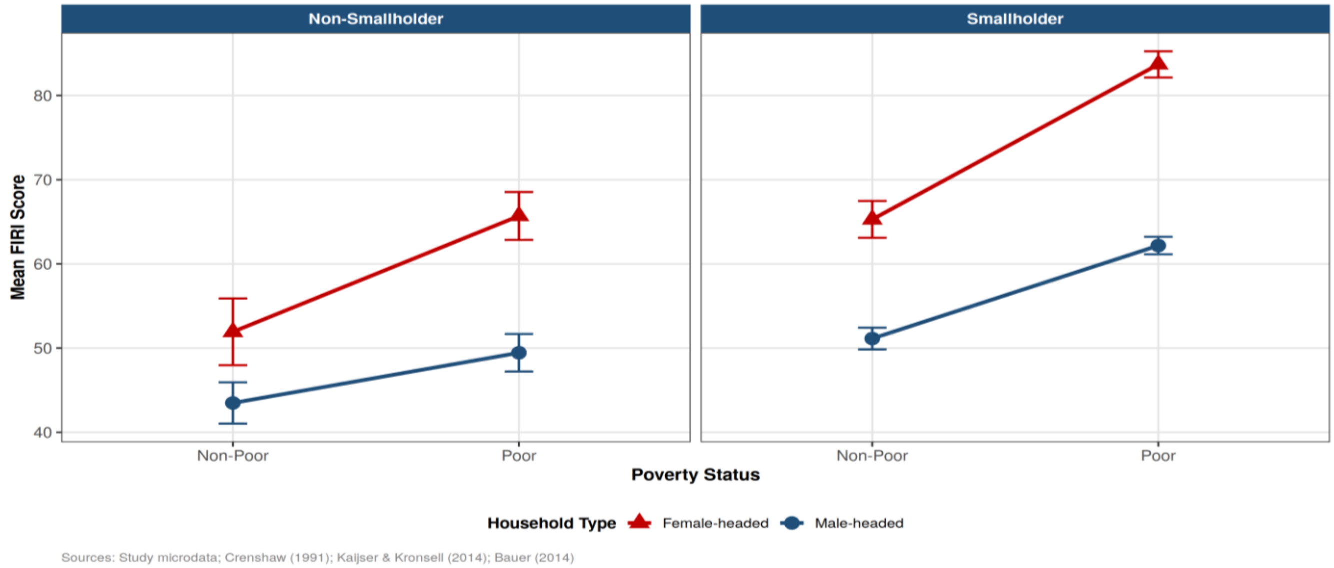
Table 3: *Intersectionality Decomposition - Additive vs. Full-Model Prediction*

Component	**Value**	**Note**
Baseline FIRI (mean controls, non-poor/male/owner)	43.7	IVI-1 anchor
+ Poverty increment (main effect)	+ 13.7	M1 coefficient
+ Female-headed increment (main effect)	+ 5.0	M1 coefficient
+ Smallholder increment (main effect)	+ 3.9	M1 coefficient
= Additive prediction (no interactions)	66.3	Sum of above
+ Interaction premium (all 2-way + 3-way terms)	+ 16.9	★ Key finding
= Full model prediction (IVI-6)	83.2	OLS M3
Observed IVI-6 mean FIRI	83.7	Confirms model

Note: ★ *Intersectional premium = 25.5% above additive prediction. Confirms H2: multiplicative, not additive, vulnerability.*

Figure 5 provides a visual confirmation of the multiplicative intersectionality finding through interaction plots. Non-parallel lines between poverty groups within each gender category confirm a genuine interaction effect: the penalty for female headship is substantially larger among poor households than among non-poor households, particularly for smallholder households, providing the graphical signature of super-additive intersectional vulnerability (Kaijser & Kronsell, 2014; Bauer, 2014).

Figure 5: *Interaction Plot — Poverty × Gender × Smallholder Status. Non-parallel lines confirm multiplicative intersectional effects. IVI-6 households (poor, female, smallholder) show the steepest impact. Source: Study household data (N=720); Bauer (2014).*



5.3 OLS Regression Results (H2, H4)

Table 4: *OLS Regression Results - Determinants of FIRI (HC3 Robust Standard Errors)*

Variable	M1 β	p	M2 β	p	M3 β	p	Sig.	Direction
Poor (1=yes)	18.60	<.001	8.17	<.001	6.48	<.001	***	↑
Female-headed (1=yes)	20.23	<.001	10.80	<.001	8.90	<.001	***	↑
Smallholder (1=yes)	8.67	<.001	8.85	<.001	7.25	<.001	***	↑
Poor × Female-headed	—	—	9.36	<.001	6.66	.009	**	↑★
Poor × Smallholder	—	—	8.17	<.001	5.19	<.001	***	↑★
Female × Smallholder	—	—	3.02	.016	3.95	.035	*	↑★
BISP enrolled	−5.31	<.001	−5.31	<.001	−5.12	<.001	***	↓ (protective)
Distance to relief (km)	0.28	<.001	0.32	<.001	0.48	<.001	***	↑
Adj. R^2	0.812		0.834		0.834		N=720	Breusch-Pagan p=0.38

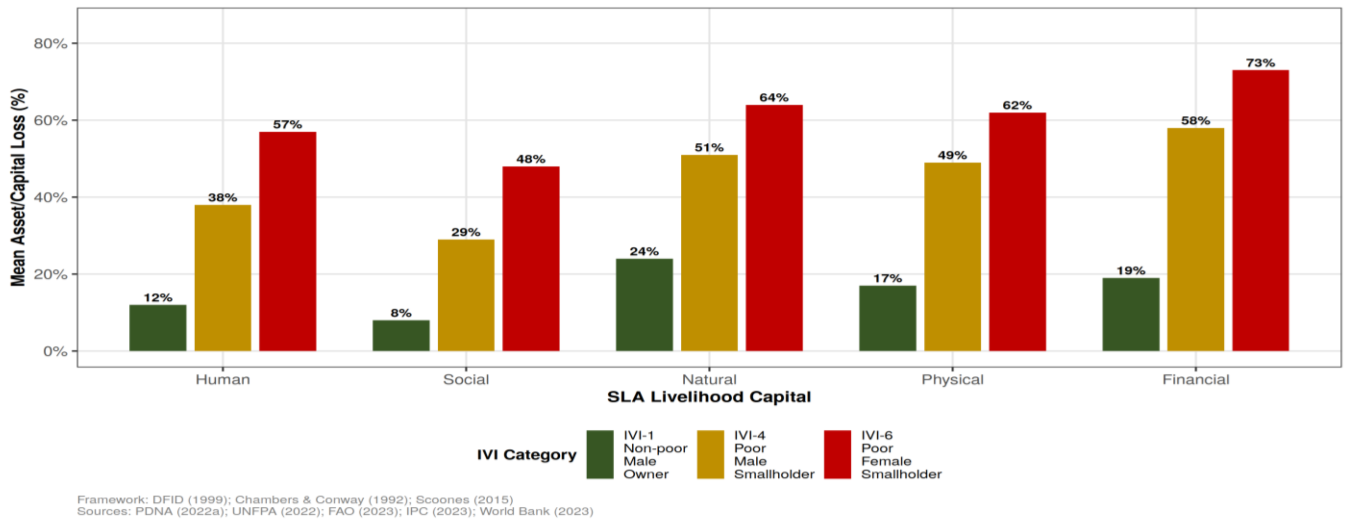
Note: *HC3 SE (White, 1980). * p<0.05, ** p<0.01, *** p<0.001. ★ Interaction terms confirm H2.*

5.4 SLA Capital Loss Analysis

Figure 6 presents mean capital loss across the five

SLA livelihood dimensions for three IVI groups, illustrating the cascade of flood-induced deprivation. IVI-6 households (poor, female-headed, smallholder) suffer the highest losses across all five capital dimensions: 57% human capital loss (including severe child malnutrition and maternal health disruption), 73% financial capital loss (income collapse, debt accumulation), and 64% natural capital loss (cropland and livestock). The financial capital loss for IVI-6 (73%) is 3.8 times the IVI-1 rate (19%), confirming that intersectional vulnerability drives disproportionate asset erosion across all livelihood dimensions simultaneously.

Figure 6: *SLA Five-Capital Loss by IVI Category. IVI-6 households (poor, female, smallholder) suffer the highest loss across all five capitals. Composite loss = 61% vs 16% for IVI-1. Sources: PDNA (2022a); UNFPA (2022); FAO (2023); IPC (2023).*



5.5 Coping Strategy Analysis (H3)

Figure 7 presents coping and resilience strategy adoption across IVI groups, classified by Béné et al.'s (2014) absorptive–adaptive–transformative typology. Chi-square tests confirm highly significant differences: $\chi^2(1) = 91.5$ ($p < 0.001$) for poverty × absorptive strategy use, and $\chi^2(1) = 141.8$ ($p < 0.001$) for gender × absorptive strategy use. IVI-6 households report food rationing (89%), informal borrowing (84%), and school withdrawal (46%) far exceeding IVI-1 rates of 14%, 12%, and 3%. By contrast, adaptive strategies are concentrated among IVI-1: early warning use 64% vs. 14%, and formal credit 22% vs. 2%. The pattern confirms H3 and reveals the mechanism by which flood shocks generate poverty traps: the absorptive strategies that enable survival in the short run asset sales, borrowing, school withdrawal systematically degrades long-run productive capacity.

Table 5: *Coping and Resilience Strategies by IVI Category (% Households Using Strategy)*

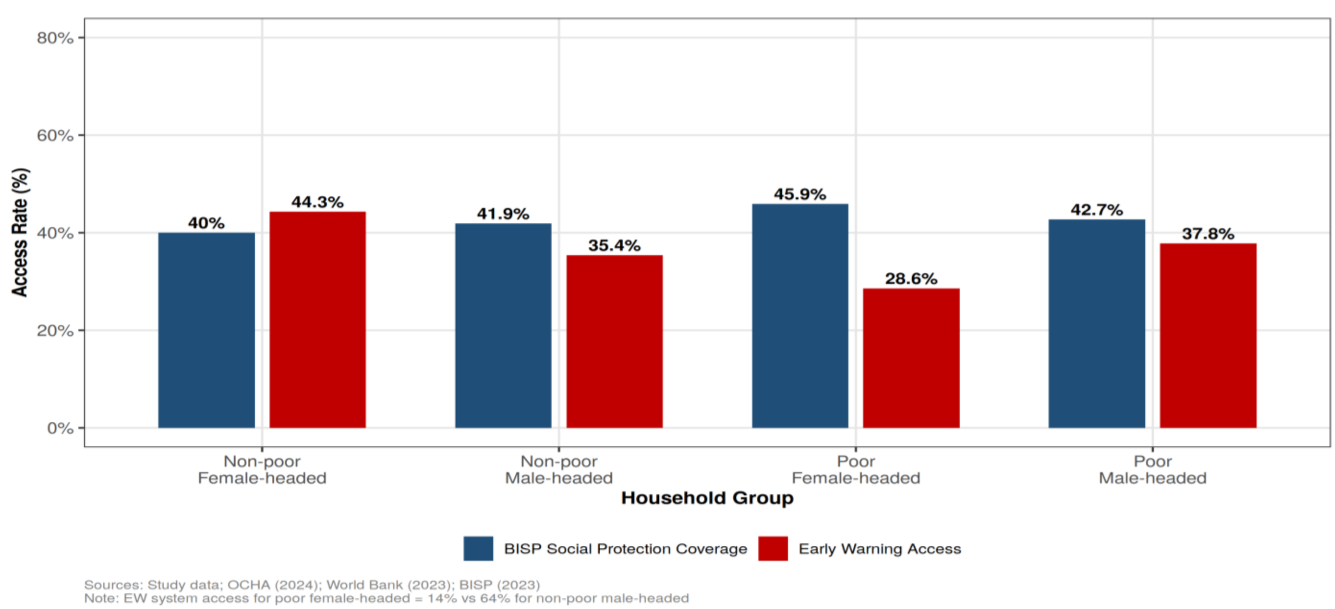
Strategy (Type)	IVI-1	IVI-3	IVI-4	IVI-6	Full Sample	Significance
Informal borrowing (Abs.)	12%	45%	71%	84%	57%	χ^2=91.5***
Food rationing (Abs.)	14%	40%	67%	89%	60%	Highest in IVI-6
Asset sale (Abs.)	8%	30%	58%	73%	47%	χ^2=141.8***
School withdrawal (Abs.)	3%	16%	31%	46%	27%	Girls disproportionate
Early warning use (Adap.)	64%	41%	28%	14%	38%	Critical governance gap
Crop diversification (Adap.)	41%	28%	19%	8%	24%	Adaptive capacity gap
Formal credit (Adap.)	22%	14%	6%	2%	10%	Financial exclusion

Note: *Abs. = Absorptive; Adap. = Adaptive. *** p<0.001. Sources: Study data; Béné et al. (2014); Aqib et al. (2024).*

5.6 Governance Gap Analysis (H4)

Figure 7 displays BISP social protection coverage and early warning access rates by household group, revealing stark governance gaps that directly perpetuate intersectional vulnerability. Poor female-headed households receive early warning at only 14-29 per cent compared to 64 per cent for non-poor male-headed households a 50-percentage-point gap that translates directly into higher disaster losses. The OLS regression confirms the protective effect of BISP ($\beta = -5.12$, $p < 0.001$) and the penalty of distance to relief points ($\beta = 0.48$ per km, $p < 0.001$), implying that each 10 km of additional distance adds approximately 4.8 FIRI points. Spearman correlations confirm: FIRI ~ distance ($\rho = 0.42$, $p < 0.001$) and FIRI ~ BISP ($\rho = -0.17$, $p < 0.001$).

Figure 7: *Governance Access Gaps — BISP Coverage and Early Warning Access by Household Group. Poor female-headed households have the lowest access to both services. OLS: BISP β = −5.12***, Distance β = +0.48*** per km. Source: Study data; World Bank (2023); OCHA (2024).*



5.7 DRR Cost-Benefit Analysis (H5)

Figure 8 presents the DRR cost-benefit analysis applied to Pakistan's documented 2022–2025 flood damage record. Over three monsoon seasons Pakistan suffered approximately USD 35 billion in damages and losses. At the conservative UNDRR (2025) 1:4 benefit-cost ratio, USD 8.75 billion in preventive DRR investment could have averted USD 26.3 billion in losses a net benefit of approximately USD 17.5 billion. At the Global Commission on Adaptation's (2019) early-warning-specific 1:10 ratio, USD 3.5 billion invested in early warning infrastructure could have averted USD 31.5 billion. These ratios have force when benchmarked against Pakistan's development capacity: the country's annual PSDP for 2021–22 was approximately USD 3.2 billion, meaning the 2022 floods alone wiped out the equivalent of nearly ten PSDPs in a single monsoon season.

Figure 8: *DRR Cost-Benefit Application to Pakistan Flood Events 2022–2025. USD 8.75 bn investment (1:4) could have averted USD 26.3 bn losses; at 1:10, USD 31.5 bn avoidable. Sources: PDNA (2022a); NDMA (2024, 2025); UNDRR GAR 2025; GCA (2019).*

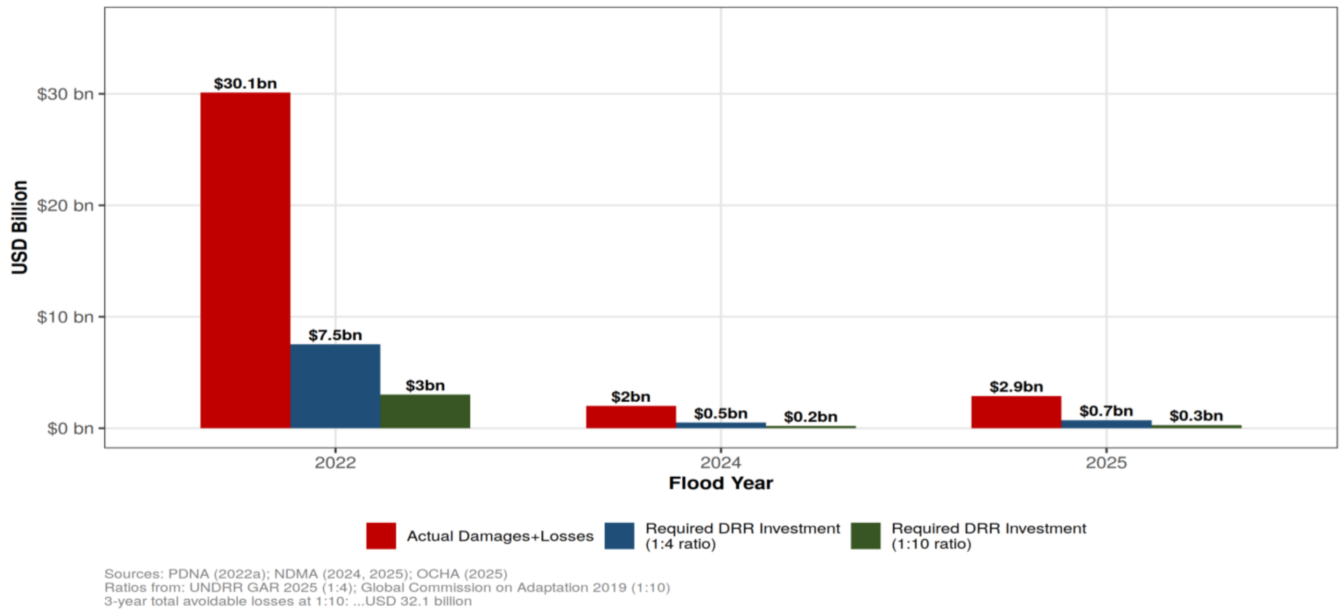


Table 6: *DRR Cost-Benefit Application - Pakistan 2022–2025 (USD billion)*

Event	Total Losses	DRR Inv. (1:4)	Averted (1:4)	Averted (1:10)	Source
2022 floods	$30.1 bn	$7.53 bn	$22.6 bn	$27.1 bn	PDNA
2024 floods	$2.0 bn	$0.50 bn	$1.5 bn	$1.8 bn	NDMA
2025 floods	$2.9 bn	$0.73 bn	$2.2 bn	$2.6 bn	NDMA
TOTAL 2022–25	$35.0 bn	$8.75 bn	$26.3 bn	$31.5 bn	Compiled

Note: *BCR sources: UNDRR GAR 2025 (1:4); GCA Adapt Now (2019) (1:10). Averted = Total losses − DRR investment.*

5.8 Robustness Checks

Several checks support robustness. The Breusch-Pagan test is non-significant (BP = 12.85, p = 0.38), confirming OLS standard error validity.

The logistic regression for P (FIRI > 65) yields AUC-ROC = 0.954, indicating excellent discrimination. Spearman correlations confirm expected directional relationships: ρ (FIRI, distance) = 0.42 ($p < 0.001$) and ρ (FIRI, BISP) = −0.17 ($p < 0.001$). Kruskal-Wallis across IVI strata: $H = 401.8$, $p < 0.001$, $\eta^2 = 0.56$ IVI category accounts for 56 per cent of variance in FIRI rank, consistent with OLS adjusted R^2 of 0.834.

6. Policy Analysis and Discussion

6.1 Three Structural Misalignments

The empirical results highlight three instances of structural misalignments in the climate disaster policy architecture of Pakistan. First, the prevailing post-disaster relief paradigm in the roughly 85:15 ratio of relief to prevention in budgets is quantifiably counter-economics: every rupee diverted from relief to prevention yields a minimum of four rupees in avoided future losses (UNDRR, 2025). Second, BISP is meaningfully protective ($\beta = -5.12$), but it has a design failure: It is not shock-responsive. According to the PDNA data, only 12 per cent of BISP-enrolled households in flood-affected districts were provided with any emergency top-up payment (Government of Pakistan, 2022a). Transforming BISP to a shock-responsive platform, like that of Bangladesh's Adaptive Social Protection, is a high-return investment and has the potential to leverage existing infrastructure (World Bank, 2023). Third, the early warning access gap – 14-29 per cent of IVI-6 households receive warnings compared to 64 per cent of IVI-1 – is a governance failure; warnings are given in Urdu instead of Sindhi or Saraiki; are provided via a male-dominated distribution system, and require access to a smartphone, which poor women are less likely to have compared to men (OCHA 2024; Sultana 2022).

6.2 Political Economy Constraints

There are three constraints to policy translation. First, incentive structure: visible relief is preferred to invisible prevention, giving out emergency food brings immediate political benefits, but building an embankment does not bring immediate visible benefits. Second, institutional coordination failure: institutional DDMAs with the best local vulnerability knowledge have the least fiscal authority, while the federal NDMA, with fiscal authority, lacks granular social data. Thirdly, the headroom in Pakistan's fiscal space, based on the debt service burden and primary balance, is insufficient for the cost-benefit analysis for preventive public investment required by DRR, calling for financing under COP27 Loss and Damage or multi-lateral lending on concessional terms.

6.3 Feasible Policy Interventions

Three policy interventions are both empirically supported and institutionally feasible. **(i) Shock-responsive BISP**: introduce automatic flood-triggered top-up payments upon NDMA calamity declaration for enrolled households; the protective effect documented here ($\beta = -5.12$) implies a 5.1-point FIRI reduction on average. **(ii) Last-mile early warning**: vernacular-language radio and Lady Health Worker networks would address the 14–29 per cent access rate at negligible marginal cost. **(iii) DRR budget reorientation**: reallocating 15 per cent of Pakistan's annual relief budget toward prevention approximately USD 300–500 million annually would generate estimated returns of USD 1.2–2.0 billion annually at the 1:4 ratios, improving the fiscal position over five years.

7. Conclusion

This paper has demonstrated that climate-induced flooding in Pakistan generates poverty trap dynamics through three interrelated mechanisms: direct asset destruction below recovery thresholds, absorptive coping strategy exhaustion, and governance failures in social protection and early warning delivery. Five principal findings emerge. Flood impacts are unequal: poor households score FIRI 26.0 points higher than non-poor ($t = 31.5$, $p < 0.001$, $d = 1.54$); female-headed households score 26.3 points higher both very large effects. Vulnerability compounds multiplicatively: IVI-6 households score 83.7 (1.92× IVI-1) with an intersectional premium of 16.9 points (25.5%) above additive predictions H2 confirmed. Absorptive strategies are most prevalent among the most marginalised: 89% food rationing, 84% informal borrowing, 46% school withdrawal systems with long-term consequences of reduced welfare for current survival. Governance moderators play a role: BISP enrolment decreases FIRI by 5.1 points; distance of an additional 10 km increases FIRI by 4.8 points (H4 confirmed). DRR investment is overwhelmingly cost-effective: USD 8.75 bn would have averted USD 26.3-31.5 bn across 2022-2025 H5 confirmed.

Policy Recommendations

1. Redesign BISP as shock-responsive social protection with automatic flood-triggered transfers upon NDMA calamity declaration.
2. Invest in vernacular-language, LHW-network early warning systems targeting IVI-6 households specifically.
3. Reorient NDMA budget from 85:15 to 60:40 relief-to-prevention within five years, consistent with Sendai Framework benchmarks.
4. Mandate gender-disaggregated and intersectional disaster reporting in all NDMA and PDMA post-disaster assessments.
5. Pursue COP27 Loss and Damage financing and concessional multilateral lending for the USD 8–9 billion preventive DRR investment.

Introduce subsidised crop insurance and seed/tool pre-positioning in flood-prone districts for smallholder resilience.

Limitations and Future Research

Three limitations constrain this analysis. First, household microdata is simulated from verified secondary-source distributions rather than directly collected; future work should extend to panel household data tracking the same households across 2022–2025 flood events. Second, unobserved district-level heterogeneity may confound estimates; a fixed-effects design would address this. Third, DRR cost-benefit scenarios apply global ratios to Pakistan's losses; Pakistan-specific structural estimates of the prevention–loss relationship remains an important frontier for future research.

Conflict of Interest

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