Memory sources shape flood risk perception and agricultural decision among farmers in a drought-oriented irrigation district

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Data Availability Statement

Data will be made available on request.

Conflict of Interest Statement

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.

Ethics statement

Approval for all studies was granted by the Institutional Review Board of Nanjing University and performed in accordance with the principles of the Declaration of Helsinki (NJUPSY202507035). All participants provided informed consent before the study.

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Abstract

Irrigation districts that have long been managed around water scarcity are increasingly confronted with rapid-onset flooding, creating new challenges for agricultural flood risk management. This study examines how personal disaster experience, village communication, and social media shape farmers' perceptions of future flood loss and planting intentions in the Hetao Irrigation District of Bayannur City, Inner Mongolia Autonomous Region, China. The case is analytically important because recent flood shocks emerged in a historically drought-oriented human-water system. Based on a field survey of 591 farmers and analyzed using linear and generalized linear mixed-effects models, the results indicate that personal disaster experience is the strongest predictor of future flood loss perception and is also associated with lower willingness to expand cultivated land. Media-based disaster comparison significantly increases perceived future drought loss but does not further increase perceived flood loss. Community disaster communication does not directly heighten flood risk perception, yet it is positively associated with plans to expand production. The study identifies which information channels make flood loss salient and consequential for farm planning after recent events. The findings show that recent flood memory now dominates local risk cognition in this drought-oriented irrigation system. Flood risk management in such settings shouldcombine recent lived experience, locally specific guidance on waterlogging and drainage, and community-based recovery support to strengthen agricultural resilience.

Keywords: flood risk perception; farmers; community communication; social media;

collective memory

1. Introduction

Floods are among the most disruptive hazards affecting agriculture, and their consequences are expected to intensify as climate change increases the frequency of extreme precipitation and compound hydroclimatic events (Calvin et al., 2023; Diffenbaugh et al., 2017; Fischer & Knutti, 2015). These pressures threaten agricultural production and food security both locally and, through increasingly complex supply chains, at the global scale (Davis et al., 2020; Piao et al., 2010). For farming households, flood risk is a question of anticipation and judgment. Farmers decide whether to maintain production under uncertainty, and these decisions depend on how future hazards are perceived (Jianjun et al., 2015; Mase et al., 2017). Understanding how people perceive risk is crucial for managing flood risk in agricultural regions (Etana et al., 2021; Galarza-Villamar et al., 2024).

Risk perception is a subjective construct: individuals' assessments of future hazards depend on objective probabilities, prior experience, and cultural context (Slovic & Weber, 2002; Weber & Hsee, 1998). Flood risk perception is therefore closely tied to livelihood expectations (Adger, 2006). It influences not only how hazards are interpreted, but also whether households feel confident enough to maintain or expand production after a damaging season (Grothmann & Patt, 2005; Jianjun et al., 2015; Mase et al., 2017).

This issue is especially important in irrigation districts whose water management institutions were historically organized around drought prevention rather than flood adaptation. In such settings, long−term human−water interactions have strengthened technical routines and social coordination for managing water scarcity, while the capacities needed to anticipate and recover from rapid-onset flooding have often remained less developed. As climate variability increases, these systems may experience abrupt shifts from scarcity-oriented thinking to flood-related concern (Sivapalan et al., 2012; H. Wang et al., 2024; Zscheischler et al., 2018). The resulting transition is not merely hydrological. It also reshapes memory, risk judgment, and livelihood planning (Pahl-Wostl, 2009).

Existing research shows that disaster experience is a strong predictor of risk perception, but it also suggests that perceptions are filtered through social communication and mediated information (Botzen et al., 2009; Duinen et al., 2015; Ntim-Amo et al., 2022). The Social Amplification of Risk Framework highlights how risk signals are shaped by different communication stations rather than simply read off from hazard statistics (Kasperson et al., 1988). Related work on collective memory in flood risk research further suggests that experience, communication, and repeated exposure influence which hazards remain cognitively available and decision-relevant over time (Candia et al., 2018; Hirst et al., 2018; Hirst & Coman, 2018; Monteil et al., 2020; Song et al., 2021). However, many studies of agricultural risk examine first-hand experience, village interaction, or media exposure separately. Prior work has advanced understanding of each channel in isolation, but a critical gap remains in explaining how their interactions reshape risk perceptions in socio-hydrological systems undergoing rapid regime shifts. The gap is particularly pronounced in large irrigation districts, where institutional legacies of water-scarcity management shape how emerging flood risks are understood (Di Baldassarre et al., 2013). In rural China, digital platforms and acquaintance networks increasingly coexist as risk information environments, making this a particularly relevant setting for examining multiple channels simultaneously (Chung, 2011; McDonald, 2016).

The Hetao Irrigation District in Bayannur, Inner Mongolia, China, provides a case of this transition. As a typical arid irrigation district in the upper Yellow River basin, agricultural production in Hetao has long depended on canal diversion, gravity irrigation, and collective water allocation, with irrigation serving as the primary technical and institutional means by which recurrent drought stress is buffered in everyday farming (Bai et al., 2017; White et al., 2020). Drought has therefore historically been the dominant, yet relatively familiar and partly manageable, hazard within the local human-water system. Yet this same system is not insulated from the risks posed by excess water. Under recent conditions of intensified summer rainfall and more abrupt drought–flood variability, flooding has emerged as a distinct threat that established irrigation routines are less able to absorb. When heavy rainfall exceeds field drainage capacity, damage to field ridges and canals can disrupt both irrigation and runoff conveyance, thereby increasing crop loss and complicating post-disaster recovery. In this historically drought-oriented irrigation district, excess water now threatens agricultural production through mechanisms that differ fundamentally from the more familiar challenge of drought.

This study addresses that gap by comparing three information channels: personal disaster experience, community disaster communication, and media-based disaster comparison. We ask two questions. First, how do these channels shape farmers' perceptions of future flood loss and future drought loss? Second, how do they relate to anticipated planting decisions? The paper contributes to current discussions on human-water interactions and flood resilience in three ways: it brings a flood-centered perspective to a major irrigation district, compares first-hand and second-hand information channels within the same empirical model, shows why recent flood memory matters for agricultural resilience in systems undergoing rapid hydrological change, and demonstrates that personal experience, community discussion, and media comparison are associated with different management-relevant outcomes.

2. Methods

2.1 Study area and recent flood setting

Bayannur lies in western Inner Mongolia along the upper Yellow River. The municipality covers approximately 6.4×10^4 km², and its irrigated agricultural area along the Yellow River exceeds 7×10^3 km². The Hetao Irrigation District has supported agriculture for more than two thousand years through large-scale canal diversion and gravity irrigation (ICID, 2019; J. Liu et al., 2015). Major crops include sunflower, maize, and tomato, and agricultural livelihoods remain deeply tied to irrigation infrastructure, water allocation, and collective canal management. For most farmers in Hetao, drought has traditionally been the most salient climatic concern. Crop performance depends on access to Yellow River water, and irrigation scarcity can raise pumping costs, intensify soil-salinity stress, and reduce yields over time (Bai et al., 2017; White et al., 2020). Because drought is familiar and partly manageable through established irrigation practices, it is embedded in everyday production knowledge.

The recent flood shocks of 2024 and 2025 changed this balance. According to publicly available meteorological reports (Li, 2025), 2024 was an exceptionally wet year in Inner Mongolia, with annual precipitation 41.6% above the 1991–2020 climatological mean and the highest since 1961. Heavy rainfall episodes during the 2024 flood season increased the risk of urban and farmland waterlogging in parts of Bayannur and the Hetao irrigation area. In July 2025, another extreme rainfall event affected Inner Mongolia; Wuyuan recorded a maximum 1-hour rainfall of 83.4 mm, exceeding its historical extreme, and subsequent reports described crop lodging and emergency drainage in affected farmland. In low-lying fields, intense summer rainfall could quickly create standing water, crop lodging, and losses that were difficult to offset through familiar drought adaptation routines. Flood impacts were amplified by shallow groundwater and the interdependence of canals. In this context, flood risk should not be understood as the inverse of drought. The two hazards differ in timing, visibility, and perceived controllability. Drought in Hetao is familiar, monitored, and partly governed through irrigation scheduling. Flooding is more abrupt, harder to control at the plot level, and more likely to be experienced as an immediate shock. This difference matters for risk perception because farmers may respond more strongly to a recently experienced hazard that disrupts established expectations of how the water system normally works (Brown et al., 2018; Sutcliffe et al., 2024).

2.2 Analytical approach

The analysis treats risk perception as the outcome of three intertwined information channels. The first is personal disaster experience, which captures first-hand memory of severe losses caused by water shortage or flooding. When recent flood impacts are vivid, emotionally intense, and economically costly, they are likely to make future flood loss more salient and more consequential in subsequent production planning (Botzen et al., 2009; Ntim-Amo et al., 2022).

The second channel is community disaster communication. Village-level discussion can amplify risk when negative stories circulate widely, but it can also stabilize expectations by providing information, coordination, and a sense of collective efficacy (Adger, 2003; Conley & Udry, 2010). In an irrigation district, where coping with excess water often requires collective action or shared infrastructure, community interaction may therefore influence planting decisions even when it does not directly raise perceived risk (Hua et al., 2024; G. Wang & Xu, 2024).

The third channel is media-based disaster comparison. Short-video platforms, messaging apps, and television circulate highly visual disaster content that can intensify attention to hazards experienced elsewhere (Bathaiy et al., 2021; Spence et al., 2012). These mediated signals may be especially influential when local first-hand memory is weak. By comparing flood and drought outcomes in the same models, we can assess whether second-hand information mainly amplifies hazards that are not currently dominant in local experience. Figure 1 summarizes this analytical framing.

This channel-based perspective links risk perception to the social maintenance of memory. First-hand losses can make a hazard immediately salient, community discussion can keep that memory active in everyday conversation, and social media can introduce additional disaster examples that reframe what farmers regard as serious or likely. The key question, therefore, concerns not the possession of risk information itself, but the channel through which particular hazards remain salient during production decisions.

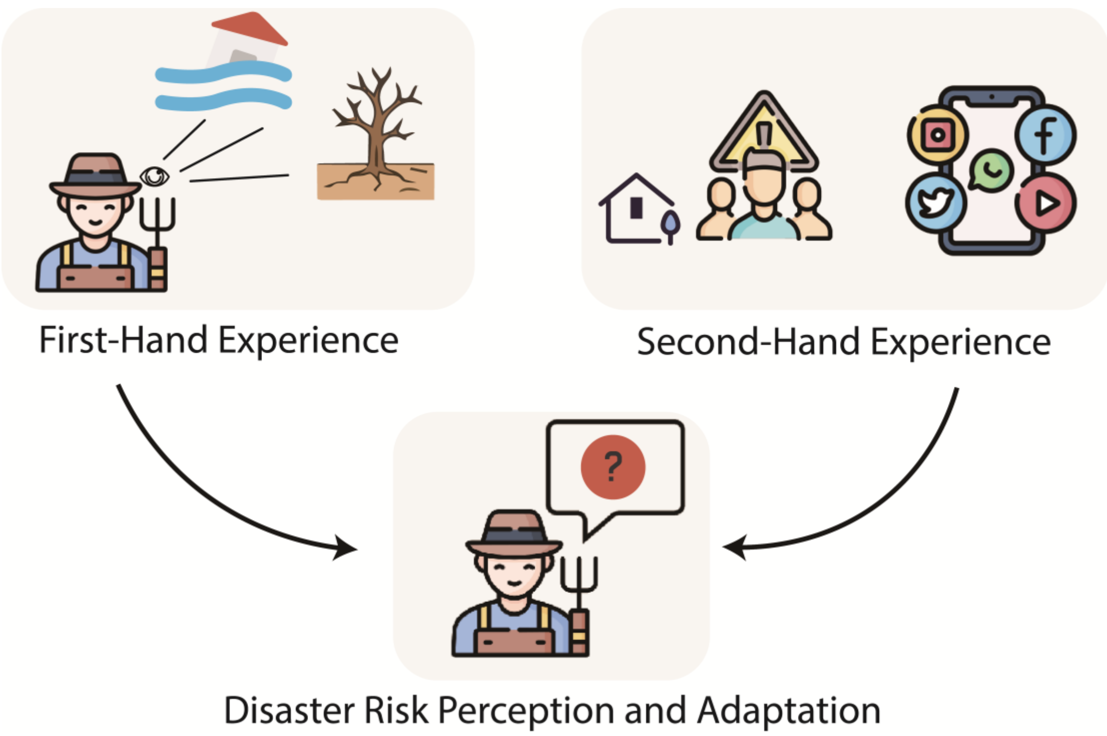

Figure 1. Analytical framing of how first-hand and second-hand information channels shape risk perception and planting decisions.

2.3 Survey and sample

The study is based on a field survey conducted from July to August 2025 in the Hetao Irrigation District of Bayannur (Figure 2). A multistage stratified convenience sampling strategy was used to cover villages with different geographical locations, irrigation conditions, and local development contexts. We selected 107 villages from Linhe District and Wuyuan County, which are broadly representative of the central agricultural area of Hetao. Trained interviewers carried out face-to-face household surveys using a structured questionnaire.

Questionnaires were excluded if respondents were not primarily engaged in local agriculture or if responses were missing on key explanatory or outcome variables. After screening, 591 valid questionnaires remained[1]. The sample reflects the demographic composition of the local farming population, including pronounced ageing. Male household heads accounted for 64.7% of respondents, and farmers aged 50-69 formed the largest age group (63.7%). Nearly half of respondents had primary school education or below. The average cultivated land area was 55.62 mu (1 mu = 0.0667 ha; SD = 54.27). Table 1 reports the sample characteristics.

[1] As the maximum analytical sample; the demographic counts in Table 1 sum to 597 because it reports descriptive characteristics on the full set of completed questionnaires, six of which were subsequently excluded from the regression analyses because of missingness on focal independent variables (personal disaster experience, community disaster communication, or media-based disaster comparison). Effective sample sizes vary slightly across models (498 to 522) because, although missing values on control variables were imputed (see Section 2.4), missing values on the focal outcomes were not imputed and observations were retained model by model.

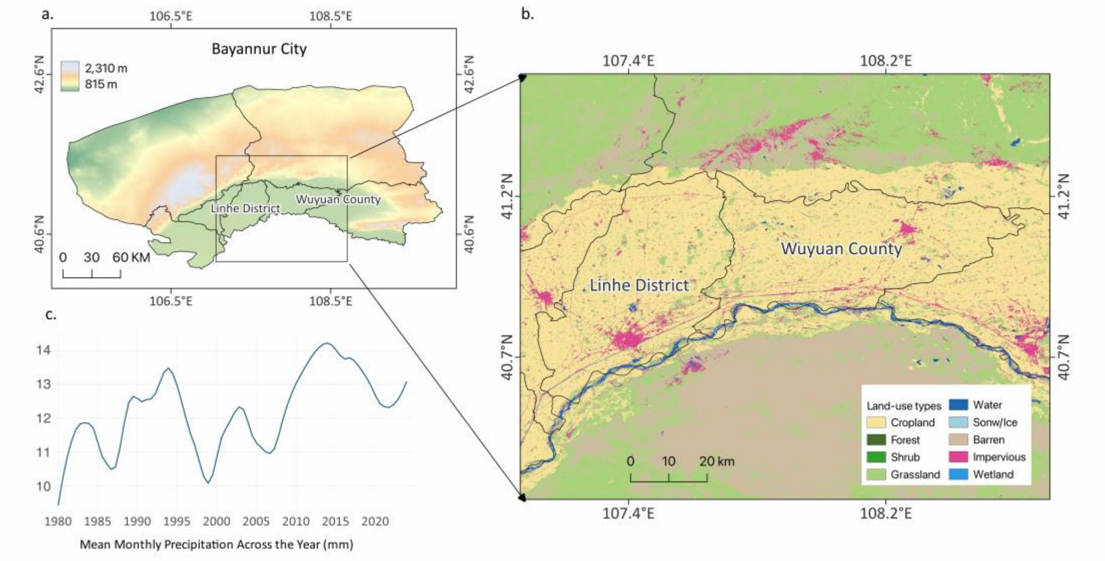

Figure 2. Study villages and historical precipitation in the Hetao Irrigation District. (a) Location of the surveyed area. (b) Detailed spatial distribution of the surveyed sites within the Bayannur Hetao irrigation region. (c) Long-term changes in annual precipitation in Bayannur.

Table 1. Participant Demographics

Variable	Category	n	Percent(%)	Mean	SD
Age [a]	25–49	76	12.7		
	50–69	380	63.7		
	70+	100	16.8		
	NA	41	6.8		
Gender	Female	211	35.3		
	Male	386	64.7		
Education	Elementary school and below	252	42.2		
	Middle school	237	39.7		
	High school	55	9.2		
	College	8	1.3		
	NA	45	7.5		
Labor force (n) [b]		559		2.35	0.9
Land area (mu) [c]		591		55.62	54.27
Perceived social status		522		2.87	0.91

Note: [a] The high proportion of elderly individuals is due to the distinct aging of the local farming population; [b] Labor force refers to the number of individuals in the interviewed households who are engaged in agricultural farming; [c] 1 mu = 0.0667 hectare.

2.4 Measures

Two dependent variables capture future hazard perception. Regarding the dependent variables of this study, similar to earlier studies (Botzen et al., 2009; Hansson & Ferguson, 2011; Ntim-Amo et al., 2022; Spence et al., 2011), perceived future drought loss was measured by asking farmers how likely they thought it was that their crops would suffer losses due to drought or water shortage in the future. Perceived future flood loss used the parallel question for flooding. Both variables were recorded on five-point Likert scales (1 = strongly disagree, 5 = strongly agree). Although this paper focuses on flood risk, retaining drought as a parallel outcome allows us to assess whether information channels shape the dominant local hazard differently from a comparison hazard.

Anticipated production behavior was measured through planting plans for the next 5 years. Respondents indicated whether they planned to maintain, expand, or reduce planting scale. For modelling purposes, these responses were recoded into three binary variables corresponding to each decision tendency. The intention measure does not substitute for observed future behavior, but it is informative about the direction of planned adjustment under recent flood experience.

The models also include controls for age, gender, education, household labor force, cultivated land area, and perceived social status. These variables help account for demographic and resource differences that may shape both perception and production planning. Perceived social status is included because subjective social position has been consistently linked to risk perception and economic decision-making. Individuals who perceive themselves as occupying higher positions on the social ladder may differ in perceived resources, risk appraisal, and behavioral responses to shocks; related evidence links subjective social rank to cognition and behavior, and shows that risk appraisal, self-efficacy, and risk preferences shape farmers' adaptation, technology adoption, and post-disaster recovery decisions (Kraus et al., 2013; E. M. Liu, 2013; Peng et al., 2018; Wens et al., 2021). Annual household income was collected during fieldwork but showed substantial missingness and was not retained in the final models. Nonresponse on income is unlikely to be missing completely at random, as income questions are sensitive and cognitively demanding, and prior survey-methodological evidence indicates that nonresponse may be concentrated among both low- and high-income respondents; studies in rural China also report substantial item nonresponse for household income questions (Jabkowski & Piekut, 2024; Wan & Yu, 2023). Missing values in the control variables were imputed using mean substitution for continuous variables and mode substitution for categorical variables so that the focal predictors could be estimated on a consistent analytical sample. An analysis involving the sequential exclusion of control variables indicates that the main results were not affected by the inclusion of these variables. Even with these controls, the models do not capture every factor relevant to future production planning. Household debt, land tenure, access to machinery, drainage equipment, and off-farm income may also shape both perceived risk and adaptive capacity. The empirical goal is therefore to identify how information channels are associated with risk perception and planned adjustment, not to claim a fully exhaustive explanation of farming behavior.

Regarding the independent variables of this study, similar to earlier studies (Le Dang et al., 2014; Udmale et al., 2014; Xu et al., 2020), personal disaster experience was measured by asking farmers whether they had been affected by natural disasters in the past. The item was, "Have you ever experienced severe yield reduction or total harvest failure due to water shortage or flooding?". We used a five-point scale (1 = Strongly disagree, 5 = Strongly agree). Community disaster communication measured the frequency of farmers' interaction with community members in real life. The question was, "How often do you discuss local disaster-related issues when chatting with neighbors?". We used a four-point scale (1 = Never discuss, 4 = Frequently discuss). Media-based disaster comparison measured farmers' comparative severity judgments between mediated and first-hand disaster experience. Specifically, it captured how severe the disasters depicted on social-media platforms appeared relative to the respondent’s own lived experience. The item was, "How do the disasters you see on Kuaishou, WeChat, and TV news in other regions compare to those you have personally experienced?". We used a five-point scale (1 = My experience was more severe, 5 = What I saw in the media was more severe).

2.5 Statistical analysis

Considering that the data has a significant nested spatial structure, where farmers are nested within villages and farmers in the same village are influenced by similar geomorphological and social environments. This study adopted Linear Mixed-Effects Models for parameter estimation. The model form is as follows:

$$Y_{ij} = \beta_0 + \beta_1 X_{ij} + \mu_j + \varepsilon_{ij}$$

Y_{ij} is the dependent variable (perceived future disaster risk) for the i-th farmer in the j-th village; X_{ij} is the vector of explanatory variables at the farmer level; μ_j is the random intercept at the village level to account for differences in the social environment of the villages; and ε_{ij} is the residual term.

When the outcome variable is categorical, we employed Generalized Linear Mixed-Effects Models for parameter estimation. The model form is as follows:

$$\mathrm{logit}(p_{ij}) = \ln(\frac{p_{ij}}{1 - p_{ij}}) = \beta_0 + \beta_1 X_{ij} + u_j$$

p_{ij} represents the probability that the i-th farmer in the j-th village exhibits a specific outcome (willingness for anticipated planting decision); X_{ij} is the vector of explanatory variables at the farmer level; μ_j is the random intercept at the village level to account for differences in the social environment of the villages; and ε_{ij} is the residual term. All analyses were carried out in R version 4.4.1 (R Core Team, 2024) using the following packages: lme4 (version 1.1-35.5; Bates et al., 2015) for fitting linear and generalized linear mixed-effects models, lmerTest (version 3.1-3; Kuznetsova et al., 2017) for approximate degrees-of-freedom and p-values for fixed effects, performance (version 0.12.3; Lüdecke et al., 2021) for marginal and conditional R^2 statistics, tidyverse (version 2.0.0; Wickham et al., 2019) for data cleaning and visualization, and mice (version 3.16.0; Buuren & Groothuis-Oudshoorn, 2011) for inspecting missingness patterns. Linear mixed-effects models for the continuous risk-perception outcomes were estimated by restricted maximum likelihood (REML), and generalized linear mixed-effects models for the binary planting-intention outcomes were estimated by maximum likelihood with the Laplace approximation. The random-intercept variance σ^2 at the village level was 0.21 for the future drought loss model, 0.10 for the future flood loss model, 0.04 for plan-maintain, 0.36 for plan-expand, and 0.27 for plan-reduce, all consistent with non-trivial between-village clustering and justifying the inclusion of village random intercepts. Variance inflation factors for all fixed effects were below 1.5, indicating no problematic multicollinearity.

3. Results and Discussion

Table 2 reports the mixed-model results. Across all models, personal disaster experience is the most consistent predictor. Its association with future flood loss perception is positive ($\beta = 0.599$, $p < 0.001$), and the coefficient is larger than that for future drought loss ($\beta = 0.255$, $p < 0.001$). Waterlogging and crop lodging, produce a different kind of memory than drought scarcity. They are highly abrupt visible, and difficult to offset through routine management. The stronger flood coefficient suggests that recent flood events have recalibrated farmers' expectations of what the local water environment can do. For farmers in Hetao, recent flood losses represent high-consequence memories that transform risk from abstract statistics into concrete reference points (Pachur et al., 2012; Weber, 2006). The associated tendency toward production contraction also reflects loss aversion. Farmers who have experienced severe losses prefer reducing exposure over maintaining or expanding scale, consistent with evidence from flood-affected agricultural communities elsewhere (Lindell & Perry, 2012; Ricart et al., 2025).

Personal disaster experience is also associated with anticipated planting adjustment. Farmers reporting stronger experience are less willing to expand cultivated land ($\beta = -0.355$, $p < 0.01$) and more willing to reduce scale ($\beta = 0.402$, $p < 0.01$). This suggests that flood memory is not confined to cognitive appraisal; it is linked to defensive livelihood planning. For agricultural flood resilience, reduced exposure may be a rational response to recent flood losses. This is consistent with a broader pattern in natural hazard research in which elevated risk perception does not automatically translate into preparedness or investment (Wachinger et al., 2013). Persistent contraction after flood shocks may weaken local production capacity if recovery support is insufficient.

Table 2. Mixed effects model for disaster risk perception and planting decisions.

	Future Drought Loss	**Future Flood Loss**	**Plan to Maintain**	**Plan to Expand**	**Plan to Reduce**
(Intercept)	1.389***	0.930**	1.229	–2.474*	–2.755**
	(0.394)	(0.350)	(0.810)	(1.248)	(1.058)
Age	–0.047	–0.023	0.065	–0.450**	0.260
	(0.057)	(0.051)	(0.113)	(0.167)	(0.148)
Gender (Ref Female)	–0.162	0.018	0.044	–0.302	0.133
	(0.113)	(0.101)	(0.224)	(0.325)	(0.282)
Education	0.002	–0.065	–0.254	0.304	0.141
	(0.078)	(0.070)	(0.149)	(0.210)	(0.189)
Labor Force	–0.031	–0.059	0.248	–0.178	–0.251
	(0.059)	(0.053)	(0.132)	(0.201)	(0.166)
Land Area	0.044	–0.048	–0.252*	0.114	0.284*
	(0.057)	(0.051)	(0.109)	(0.143)	(0.124)
Social Status	–0.004	0.066	0.109	0.011	–0.146
	(0.064)	(0.057)	(0.129)	(0.188)	(0.162)
Personal Disaster Experience	**0.255*****	**0.599*****	–0.022	**–0.355****	**0.402****
	(0.046)	(0.041)	(0.094)	(0.128)	(0.144)
Community Disaster Communication	–0.009	0.077	–0.183	**0.445***	–0.017
	(0.054)	(0.049)	(0.115)	(0.197)	(0.138)
Media-based disaster comparison	**0.177*****	0.053	0.004	–0.020	0.008
	(0.041)	(0.036)	(0.080)	(0.121)	(0.100)
Marginal R^2	0.103	0.318	0.057	0.144	0.100
Conditional R^2	0.240	0.388	0.111	0.291	0.215
AIC	1695.164	1564.062	613.981	363.231	453.443
BIC	1746.071	1614.875	660.816	410.066	500.278
Num. obs.	514	510	522	522	522
Num. groups: village	107	107	106	106	106

Note. * p < .05. ** p < .01. *** p < .001. Missing values in control variables were imputed before analysis: mean substitution for continuous controls and mode substitution for categorical controls. The significance results for the primary predictor variables (excluding control variables) are displayed in bold. A total of 107 distinct village-level clusters in the final dataset, which are used as the random-intercept grouping in all mixed-effects models; sample sizes per model vary slightly because not every cluster contributed observations to every outcome.

Community disaster communication shows a different pattern. It is not significantly associated with perceived future flood or drought loss, but it has a positive association with plans to expand production ($\beta = 0.445$, $p < 0.05$). This suggests that village discussion functions less as a panic mechanism and more as a coordination resource, contrary to accounts that emphasize community rumour and collective anxiety as the primary product of disaster communication (Tierney et al., 2006). Evidence from flood-prone communities elsewhere supports this more nuanced reading: in European settings, dense local ties can simultaneously enhance self-efficacy and mobilize mutual support, even while sometimes downplaying formal risk estimates (Babcicky & Seebauer, 2017; Hudson et al., 2020). In flood-vulnerable rural Asia, different forms of social capital tend to function at different stages of the hazard cycle (Azad & Pritchard, 2023).

In Hetao, where agricultural production depends on shared irrigation infrastructure, community communication plausibly may function primarily as social support and as a source of collective efficacy, although collective efficacy itself was not directly measured in this survey and remains a proposed mechanism (Zhang et al., 2023), enabling farmers to maintain production confidence even in the face of recent flood damage. When farmers believe that neighbours, village leaders, and local irrigation networks can respond collectively, they can reduce uncertainty about how to continue farming under mixed drought-flood conditions, strengthen informal risk-sharing arrangements (Fafchamps & Lund, 2003), and facilitate the sharing of specific local adaptation knowledge, such as drainage routing, waterlogging-tolerant varieties, and field repair methods [2] (Tai et al., 2020; Tozier De La Poterie et al., 2018). In that sense,

[2] These specific knowledge-transfer practices are plausible mediating channels suggested by the existing literature;

community communication supports recovery and continuity.

Media-based disaster comparison reveals a third mechanism. Farmers who perceived disasters seen on social media and television as more severe than their own experience reported higher perceived future drought loss ($\beta = 0.177$, $p < 0.001$), but the same variable is not significant for future flood loss. It suggests that mediated disaster signals do not operate uniformly across hazards. They matter most when local first-hand memory is comparatively weaker or less dominant. The amplification mechanism for drought perception operates through vicarious exposure (Holman et al., 2014). Social media platforms deliver visually intense disaster content from other regions that triggers emotional responses even without local equivalents (Houston et al., 2015; Joffe, 2008). By translating geographically distant hazards into proximal, concrete exemplars, mediated signals can reduce the psychological distance of climate risks and elevate both societal and personal risk judgments (Spence et al., 2012; Van Der Linden, 2015).

For flood perception, recent lived experience already provides a strong and locally anchored signal (Lechowska, 2018). Additional media exposure may add less when the hazard has already been made salient by recent firsthand experience (Xu et al., 2020). Drought perception, by contrast, remains more open to amplification through cross-regional comparison. In practice, farmers may see drought devastation elsewhere and incorporate those images into their own expectations even if recent local experience is dominated by flooding (Rosenthal, 2022). This finding helps explain why digital media can expand the hazard imagination beyond what is immediately experienced on the ground. In Hetao, historically, local knowledge, infrastructure, and policy attention have emphasized the management of water scarcity. Recent flood shocks have not

they were not directly measured in our survey, and future research should test them with targeted items on drainage practice, varietal choice, and repair-cooperation behaviour erased that history, but they have overlaid it with new memories of excess water, drainage failure, and sudden loss. As a result, farmers' perceptions now reflect a mixed-risk environment. First-hand flood experience anchors local judgment, while second-hand media exposure continues to shape concern about other possible hazards. This selective amplification matters because digital communication redistributes attention across hazards. Risk communication strategies therefore need to be hazard-specific and locally grounded rather than assuming that all disaster information has the same behavioral effect.

The asymmetry in model fit reinforces this interpretation. The marginal R^2 for future flood loss perception is 0.318, while the marginal R^2 for future drought loss perception is only 0.103. The three information channels we measure (personal experience, community communication, and media-based comparison) jointly capture much more of the variance in flood-loss perception because in the current Hetao context flood-loss perception is being actively reshaped by a recent, unfamiliar, and locally concentrated experience that the three channels are well-suited to register. Drought-loss perception, by contrast, sits within a long-standing, broadly shared, and culturally familiar hazard schema that varies less sharply with recent first-hand experience and is may shaped by additional factors, including inherited family narratives and farm-level adaptation history.

3.1 Policy Implications

Based on these findings, agricultural risk management policies for the Hetao Irrigation District and comparable ecologically fragile regions should adopt channel-differentiated intervention strategies. First, personal disaster experience appears to have a lasting restrictive effect on production expectations. Farmers with stronger first-hand experience of the currently salient hazard are more likely to anticipate higher future losses and to plan production contraction, suggesting that simple disaster relief payments may be insufficient to restore production confidence. Targeted, multi-year recovery instruments, such as subsidized stress-tolerant seed packages and policy guidance for moderate production recovery, may help prevent severe loss experience from becoming a persistent cycle of risk avoidance and production contraction. Second, community communication should be treated as a core resource for local risk management (Adger, 2003; Yijia et al., 2022). Its positive association with willingness to expand indicates that village-level discussion networks can strengthen production confidence and support adaptive decision-making. Local extension services and irrigation-district administrators could therefore organise structured community fora that link experienced farmers with technical staff, combining peer learning with formal agronomic, hydrological, and insurance-related advice. Third, media-based disaster comparison should be used more selectively. Because mediated disaster content increases concern about historically familiar risks but not necessarily about the currently unfolding local risk, generic media warnings may misallocate attention or amplify anxiety without producing adaptive action. Meteorological and agricultural departments should make fuller but more targeted use of communication platforms: messages about past, well-known threats should be paired with concrete, locally tested adaptation options to translate vigilance into action, while communication about present risks should rely more heavily on local evidence, field-level cues, and practical response guidance rather than stylised warning narratives (Witte, 1992). More broadly, comparable regions facing mixed hydroclimatic transitions may apply the same channel-differentiated approach, while calibrating interventions to local crop structures, market conditions, and social institutions. As anthropogenic warming is expected to increase the likelihood of compound hydroclimatic extremes and rapid transitions between different forms of water-related stress in the twenty-first century, calibrated interventions that align personal experience, community communication, and media-based risk comparison are likely to become increasingly important for sustaining agricultural resilience (H. Wang et al., 2024; Zscheischler et al., 2018).

The findings also speak to broader work on socio-hydrology and collective memory. Recent flood events can rapidly shift the reference hazard in local decision-making, even where long-term water institutions were built around another problem. For comparable river basins and irrigated floodplains, resilience planning should therefore pay closer attention to how new flood memories are incorporated into advisory systems, infrastructure management, and community coordination. Future research can extend this analysis by tracking whether the influence of recent flood experience persists over time and whether anticipated planting adjustments translate into observed changes in crop choice, land area, or household preparedness.

4. Conclusion

This study examined how personal disaster experience, community communication, and media-based disaster comparison shape farmers' risk perception and planting intentions in the Hetao Irrigation District. The main finding is that recent flood experience now dominates local risk cognition in a historically drought-oriented irrigation system. Farmers who reported stronger disaster experience perceived higher future flood loss and were more likely to plan production contraction. By contrast, community communication was associated with greater willingness to expand, suggesting that local discussion networks support coordination and confidence rather than simply amplifying fear.

Media-based disaster comparison heightened drought risk perception but had no significant effect on future flood loss perception. This indicates that second-hand information is most influential where local first-hand memory is less dominant, whereas recent flood shocks provide a sufficiently strong signal on their own. For flood risk management, the implication is that communication strategies should distinguish between hazards anchored in lived experience and hazards circulating primarily through mediated comparison. For the Hetao Irrigation District and comparable agricultural regions, strengthening flood resilience requires more than reinforcing flood warnings. It requires reconnecting risk communication with the specific flood characteristics of the local water system. In systems shaped by long-term human-water interactions, recent flood memories can become a powerful basis for adaptive change.

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