

“Hunkering Down” under Climate-Driven Risks in Subsistence Farming Communities*

In collaboration with:

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*Currently under review in
Population and Environment

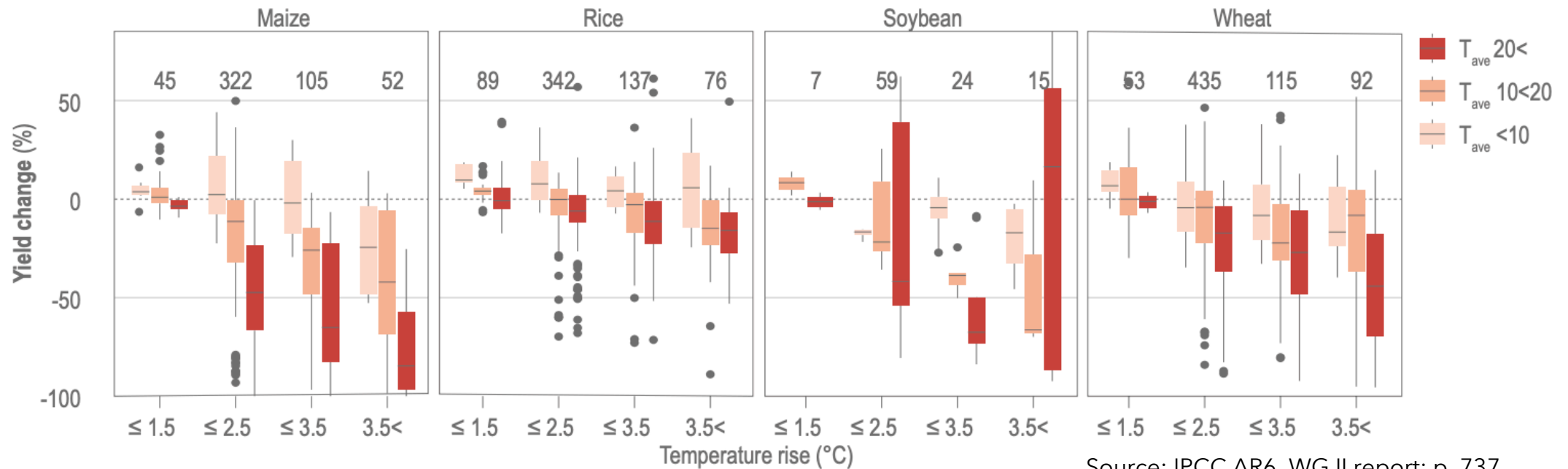
CVFS Webinar | 10 April 2024



Motivation: Climate Adaptation in the Agricultural Sector

IPCC AR6: Climate impacts on global agriculture **likely to worsen** in 21st century...

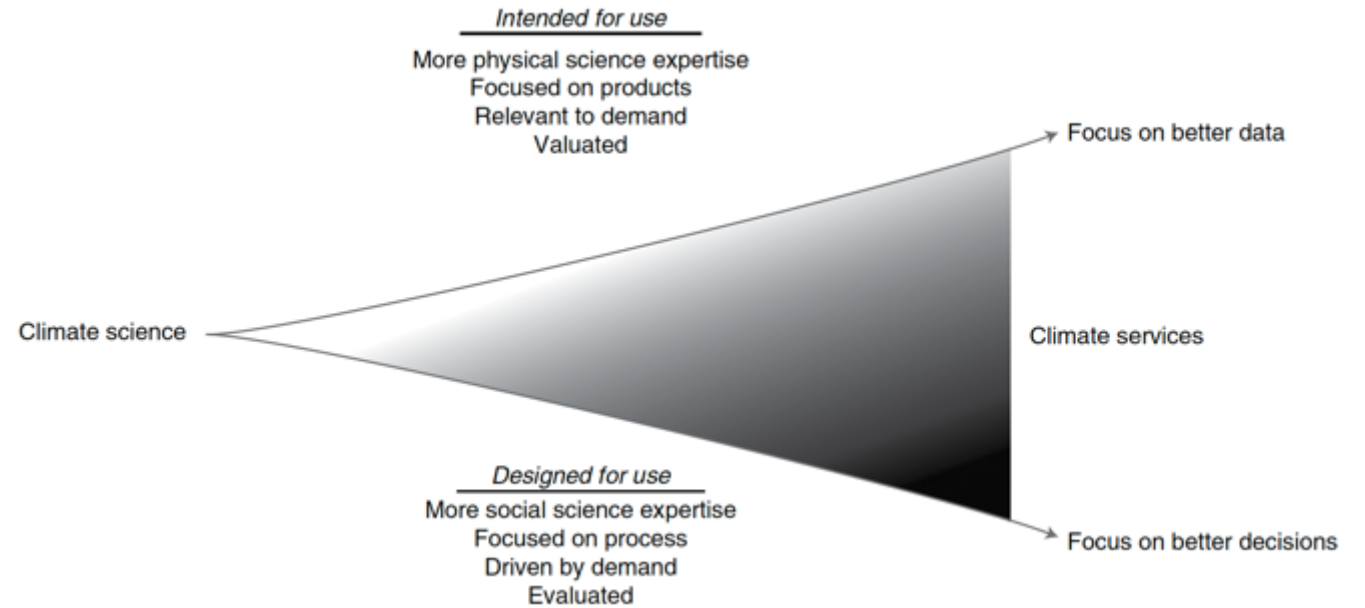
(b) As a function of global temperature rise from the baseline period by three current annual temperature (T_{ave}) levels



... With **high uncertainty** and potential for **maladaptation** (strategies that may be ineffective or counterproductive)

Motivation: Gap Between Climate Data and Decision-Making

- Farmers accurately perceive **general long-term climate trends**^{1,2}
- However, perceived climate risks do not often translate to **adaptive actions**^{2,3}
- Government interventions to promote **climate information services** have limited success⁴



Findlater et al. (2021), *Nat. Climate Change*

1. Manandhar et al. (2011); *Reg. Environ. Change*

2. Truelove et al. (2015), *Global Env. Change*

3. Mulwa et al. (2017), *Climate Risk Management*

4. Ziervogel (2004), *Geographic Journal*

Motivation: Research Questions

- How is **heterogeneity in information sources** correlated with farmers' perceptions of climate risks?
- How do perceptions of climate risks affect perceived risks of **farming alternatives**?
- How do climate risks influence farmers' **income diversification strategies**?



Motivation: Relevant Theories for Farmer Decision-Making

Theory	Decision-Making Objective	Relevant Factors
New Economics of Labor Migration (Stark and Bloom 1985)	Minimize risks to livelihood; Overcome credit constraints	Comparison to social network; Riskiness of strategies

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Protection Motivation Theory (Rogers and Prentice-Dunn 1987)	Mitigate risk of perceived threats	Perceived severity of threat; Perceived capacity to mitigate risk

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Security Potential/Aspiration (Lopes and Olden 1999)	Meet a basic aspiration level; then maximize potential outcome	Aspiration target; Degree to which one cares about meeting aspiration level

Motivation: Key Takeaways



— — — — — → “Official” information sources generally associated with diminished perception of climate risk

Motivation: Key Takeaways



Perception of climate risks appears even more salient to farming alternatives than to farming itself

Motivation: Key Takeaways



Exposure to climate-driven hazards (i.e. droughts, floods) associated with persistent, increased reliance on farming for household income

Motivation: Key Takeaways



Opportunities to combine remotely-sensed climate indicators with detailed social data on human effects of climate hazards



Methods: Nepali Agriculture as a Case Study



Small Plot Sizes



Diversity of Livelihoods



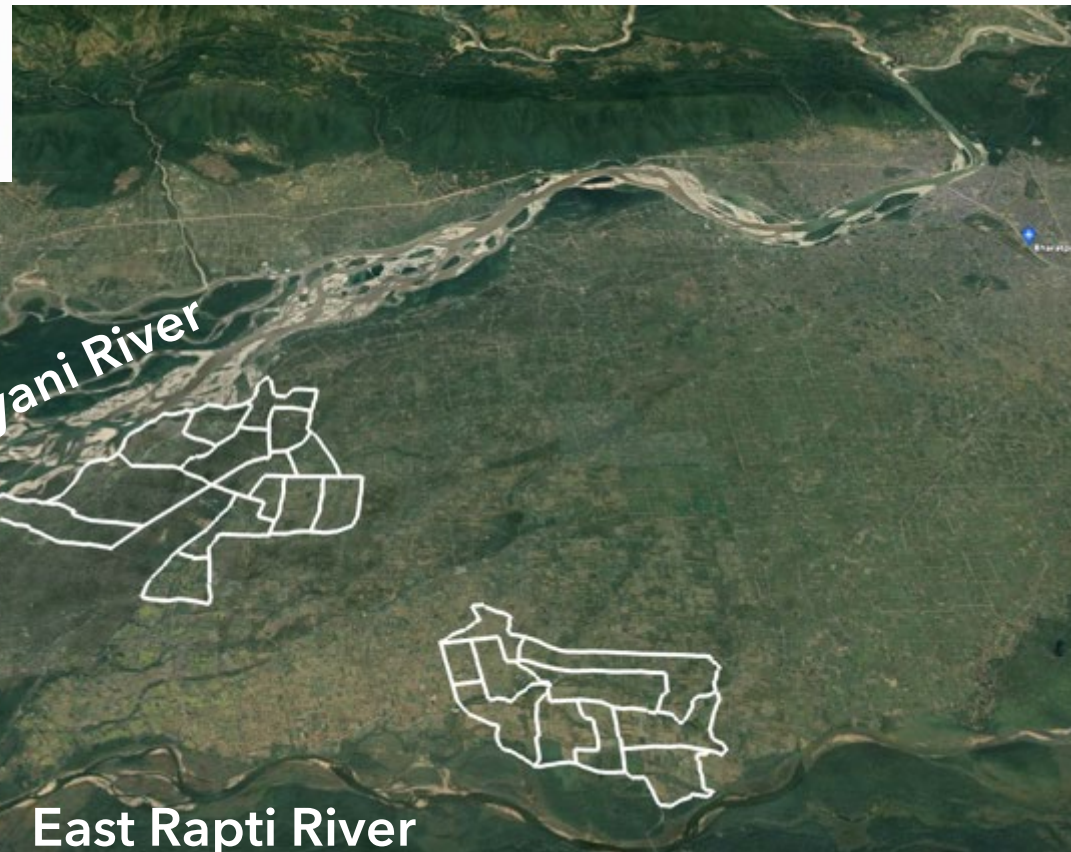
Exposure to Multiple Climate Risks



Reliance on Migration Income

Methods: Survey Design

Survey Areas - Chitwan District



Survey Overview

Face-to-face surveys lasting ~1 hour with 500 households

Calendar data (2015-2021)

- Livelihood choices
- Incomes
- Climate exposure

Cross-sectional data

- Info sources
- Social networks
- Risk perceptions

Demographic Statistics

Compared to Chitwan and Nepal nationally, our survey sample is...

Variable	2022 Survey Population	2021 Census Chitwan District	2021 Census Nepal Population
Total Individuals	2,389	719,859	29,164,578
Households	500	179,345	6,666,937
Average Household Size	4.78	4.01	4.37

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18-34	22.0	44.6	42.5
35-44	30.6	19.6	20.8
45-54	22.2	14.8	15.7
55-64	16.4	10.5	10.7
65+	7.4	10.5	10.4

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Annual Income (NRs)	29,800 (average)		
0- 100,000	17.4		
100,000 - 250,000	32.2	N/A	N/A
250,000 - 500,000	31.8		
500,000 - 1,000,000	15.4		
1,000,000+	3.2		
Educational Attainment (Grade)	5.48 (avg grade)		
0-5	48.2	28.8	33.1
6-10	43.8	33.0	35.4
SLC-Intermediate	6.2	27.8	22.5
Bachelor's or above	1.8	7.8	6.7

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- Composed of more people from castes with historically lower socio-economic status

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Newar	1.8	4.9	4.6
Gurung-Magar-Tamang	12.4	10.6	14.4
Dalit	15.0	N/A	N/A
Tharu-Darai-Kumal	31.4	6.7	6.7
Other	3.6	38.1	45.8

Table 1: Demographic Summary Statistics

Demographic Statistics

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- ... To be expected in rural subsistence communities!

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Methods: Livelihood Calendar Approach

Livelihood Calendar

S.N	Livelihood Strategy	National Events	Earthquake		Local Level Election			COVID-19		
		Local Events								
		English Year	2015	2016	2017	2018	2019	2020	2021	2022
		Animal Year	Sp	Mk	Bd	Dg	Dr	Rt	Cw	Tg
	A. Plantation & Production	Nepali Year	2072	2073	2074	2075	2076	2077	2078	2079
1	1. Rice and Paddy (1.Yes, 0. No)									
	1a. Land area (Bigha/Katha/Dhur)									
	1b. Production (in Quintal or KG)									
2	2. Maize (1.Yes, 0. No)									
	2a. Land area (Bigha/Katha/Dhur)									
	2b. Production (in Quintal or KG)									
3	3. Wheat (1.Yes, 0. No)									
	3a. Land area (Bigha/Katha/Dhur)									
	3b. Production (in Quintal or KG)									
4	4. Non-Cereal Crops (Mustard/Lentil) (1.Yes, 0. No)									
	4a. Land area (Bigha/Katha/Dhur)									
	4b. Production (in Quintal or KG/amount in Rs)									

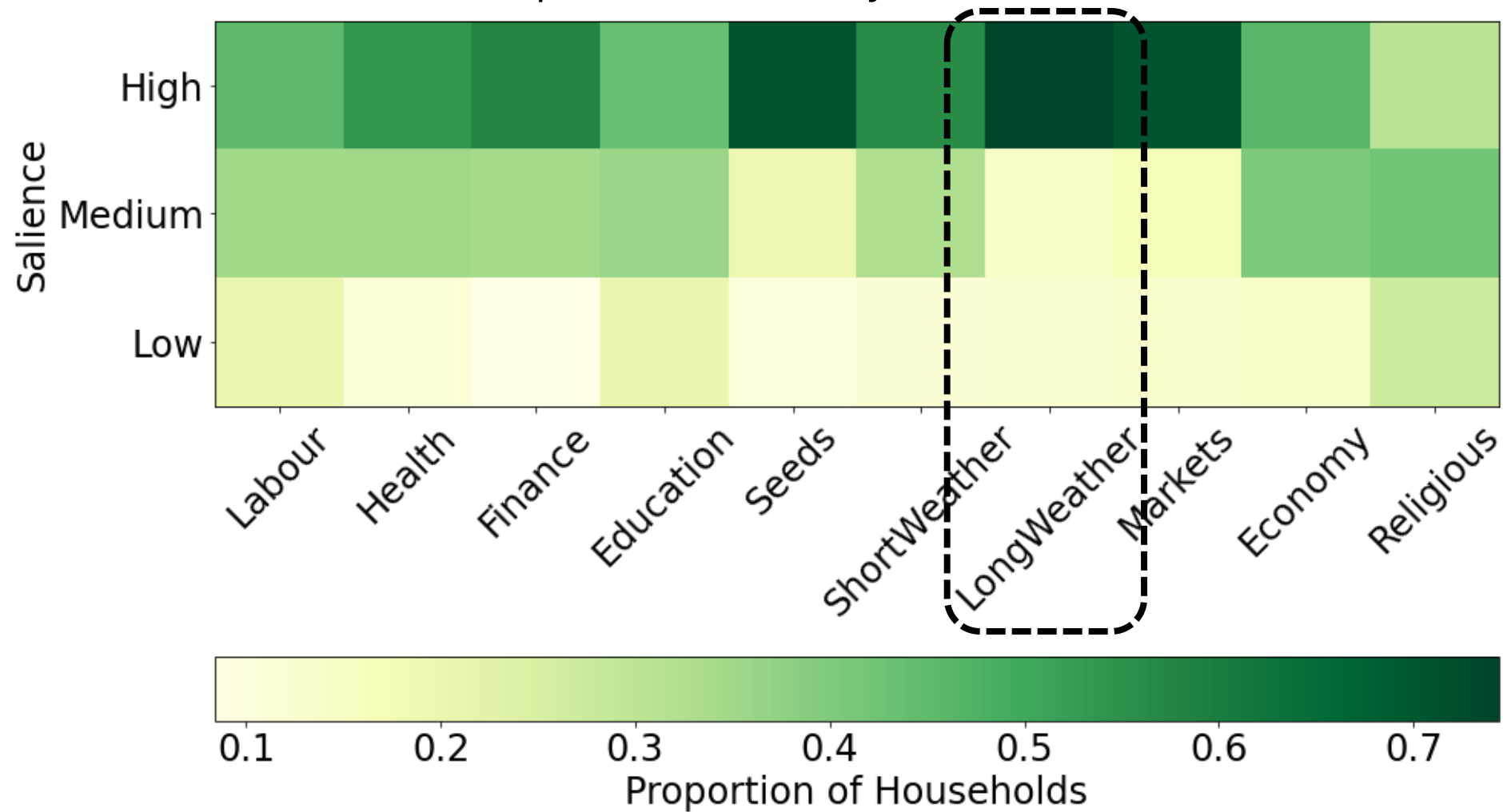
Methods: Livelihood Calendar Approach

Climate-Related Hazards Calendar

S.N	Livelihood Strategy	National Events	Earthquake		Local Level Election			COVID-19		
		Local Events								
		English Year	2015	2016	2017	2018	2019	2020	2021	2022
		Animal Year	Sp	Mk	Bd	Dg	Dr	Rt	Cw	Tg
S.N	E. Climate Risk Perceptions		2072	2073	2074	2075	2076	2077	2078	2079
19	Drought affected your crop plantation and harvests (1.Yes, 0. No)									
20	Flood or heavy rain affected your crop plantation and harvests (1.Yes, 0. No)									
21	Lack of groundwater affected your crop plantation and harvests (1.Yes, 0. No)									
22	Excess heat affected your crop plantation and harvests (1.Yes, 0. No)									
23	Pests affected your crop plantation and harvests (1.Yes, 0. No)									
24	Frost affected your crop plantation and harvests (1.Yes, 0. No)									
25	Hail affected your crop plantations and harvests (1.Yes, 0. No)									
26	Used water from irrigation canal for crop plantations and harvests (1.Yes, 0. No)									
27	Used groundwater for crop plantations and harvests (1. Yes, 0. No)									
28	Purchased insurance for crops (1.Yes, 0. No)									
29	Wild Animals affected your crop planatation and harvests (1. Yes, 0. No)									
			2072	2073	2074	2075	2076	2077	2078	2079

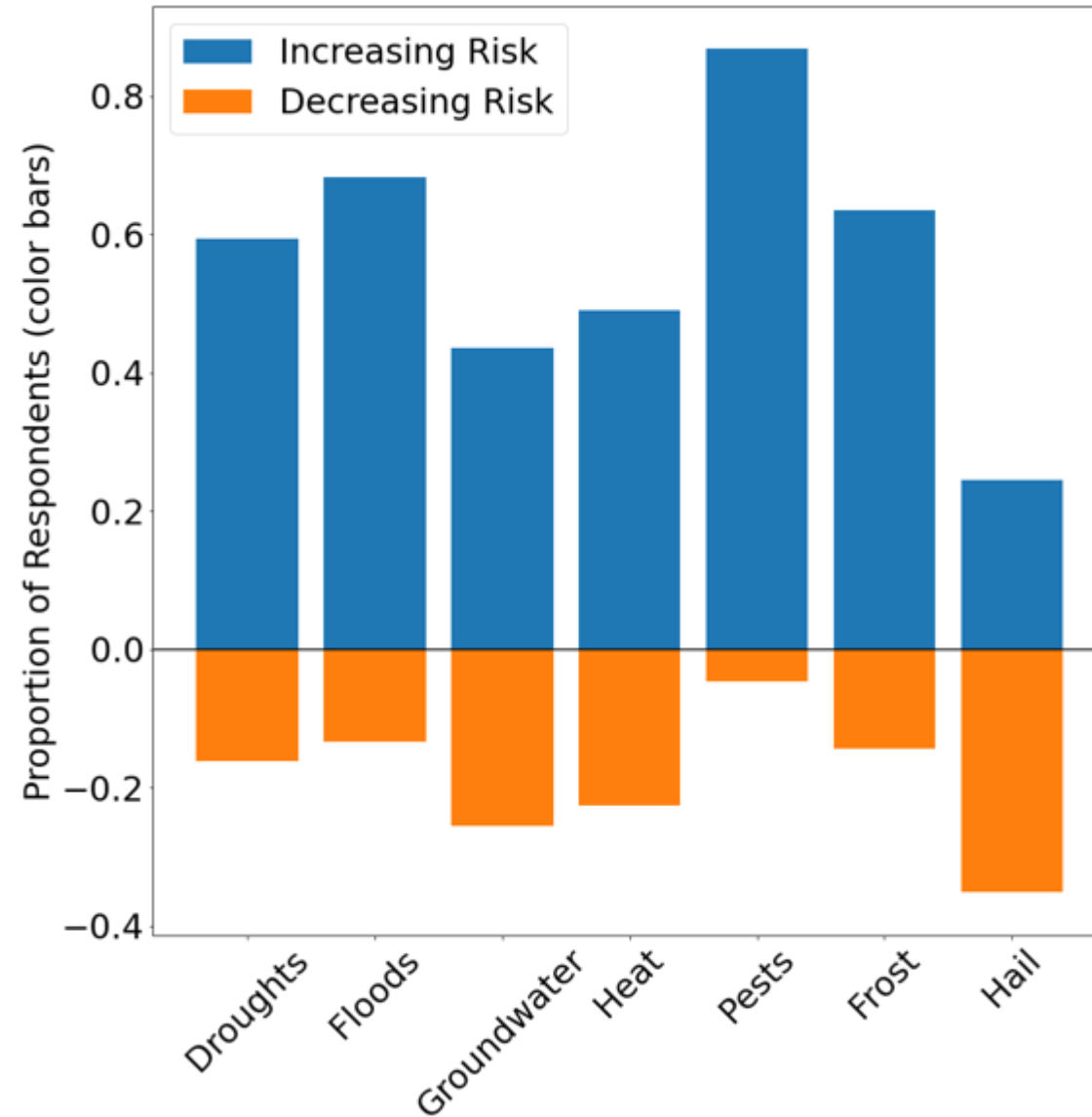
Results: Measurement of Climate Risk Perceptions

Saliency: *How important is X to your economic success?*

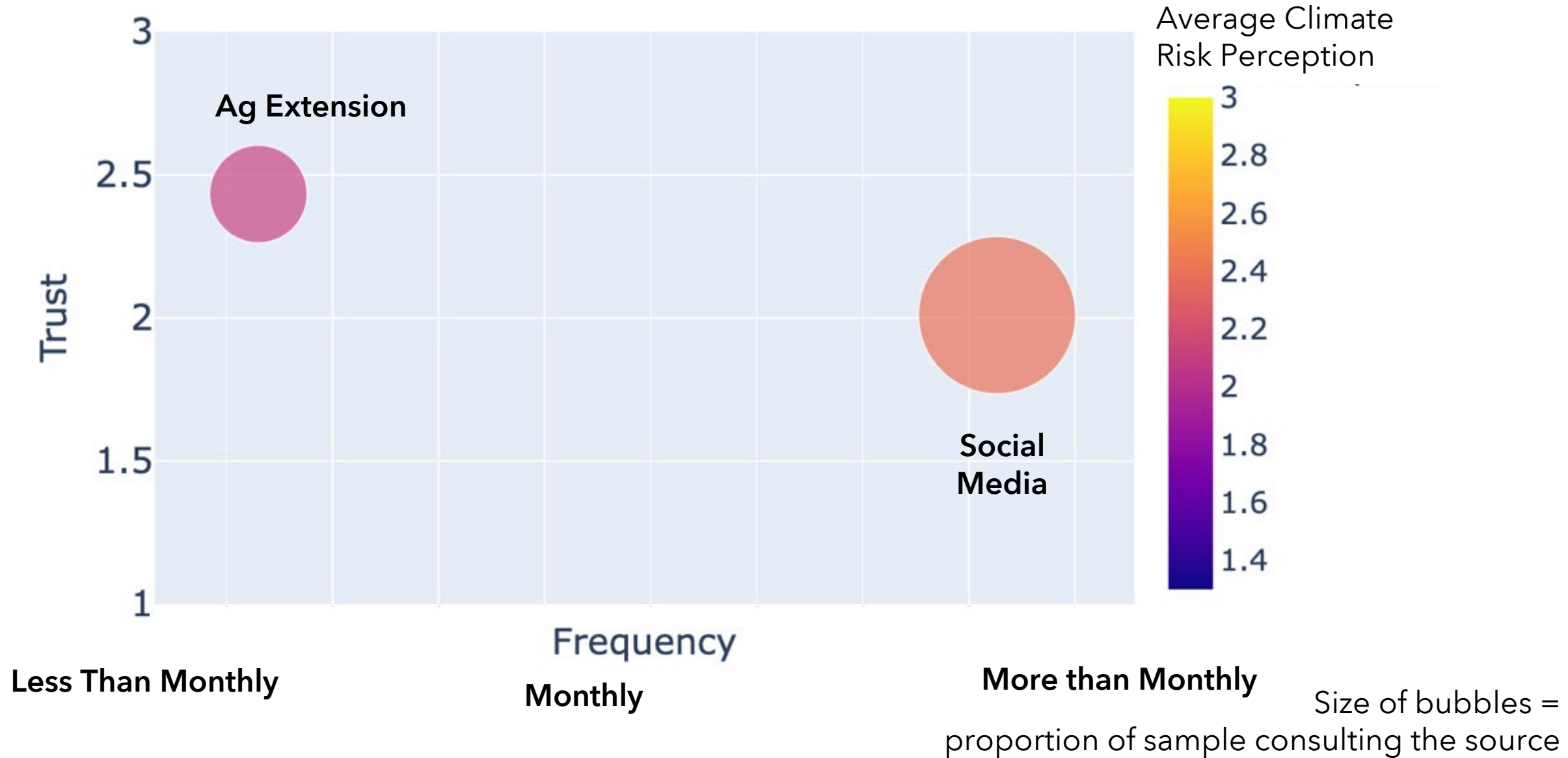


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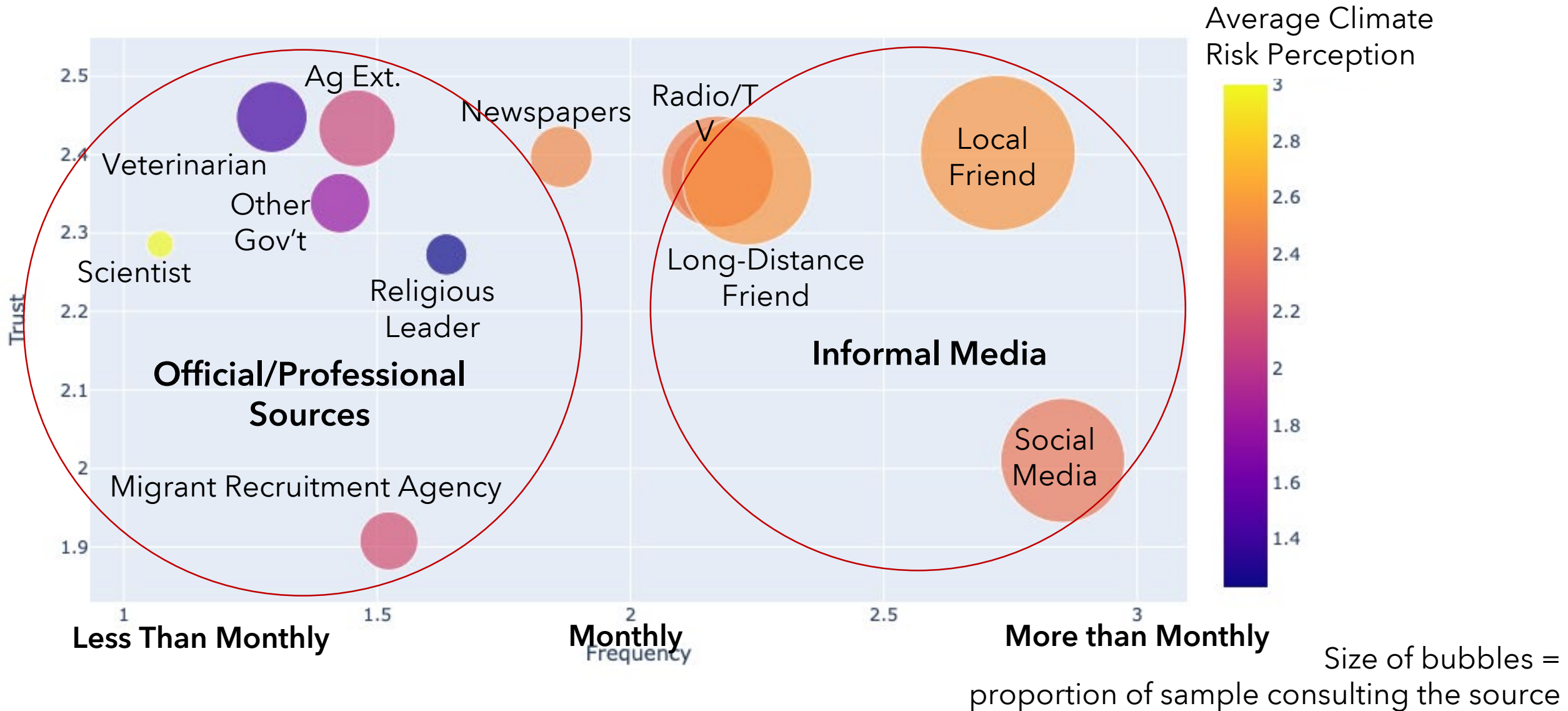
Direction: *Over next 5 years, how will impact of X change?*



Results: Diverse Information Sources and Risk Perceptions



Results: Diverse Information Sources and Risk Perceptions



Results: Climate Drives Higher Perceived Risks of Many Livelihoods

Dependent Variable (Y_i): Livelihood Risk Perception

Q: Generally speaking, how risky do you think [Livelihood] is when it comes to earning a living?

1. Not Risky
2. Somewhat Risky
3. Highly Risky
99. Don't Know

Ordered Logit Model

$$Prob(Y_i \geq j) = \frac{1}{1 + \exp(-\alpha_j - \vec{\beta}_d * \vec{X}_d - \beta_r * X_r - \vec{B}_S * \vec{X}_S)}$$



Dependent Variable
Probability of moving up 1
category in the risk ranking scale

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Demographic Variables

- Gender
- Age
- Education

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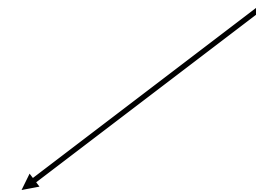
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Social Capital Variables

- Number of Information Sources
- Number of Social Groups

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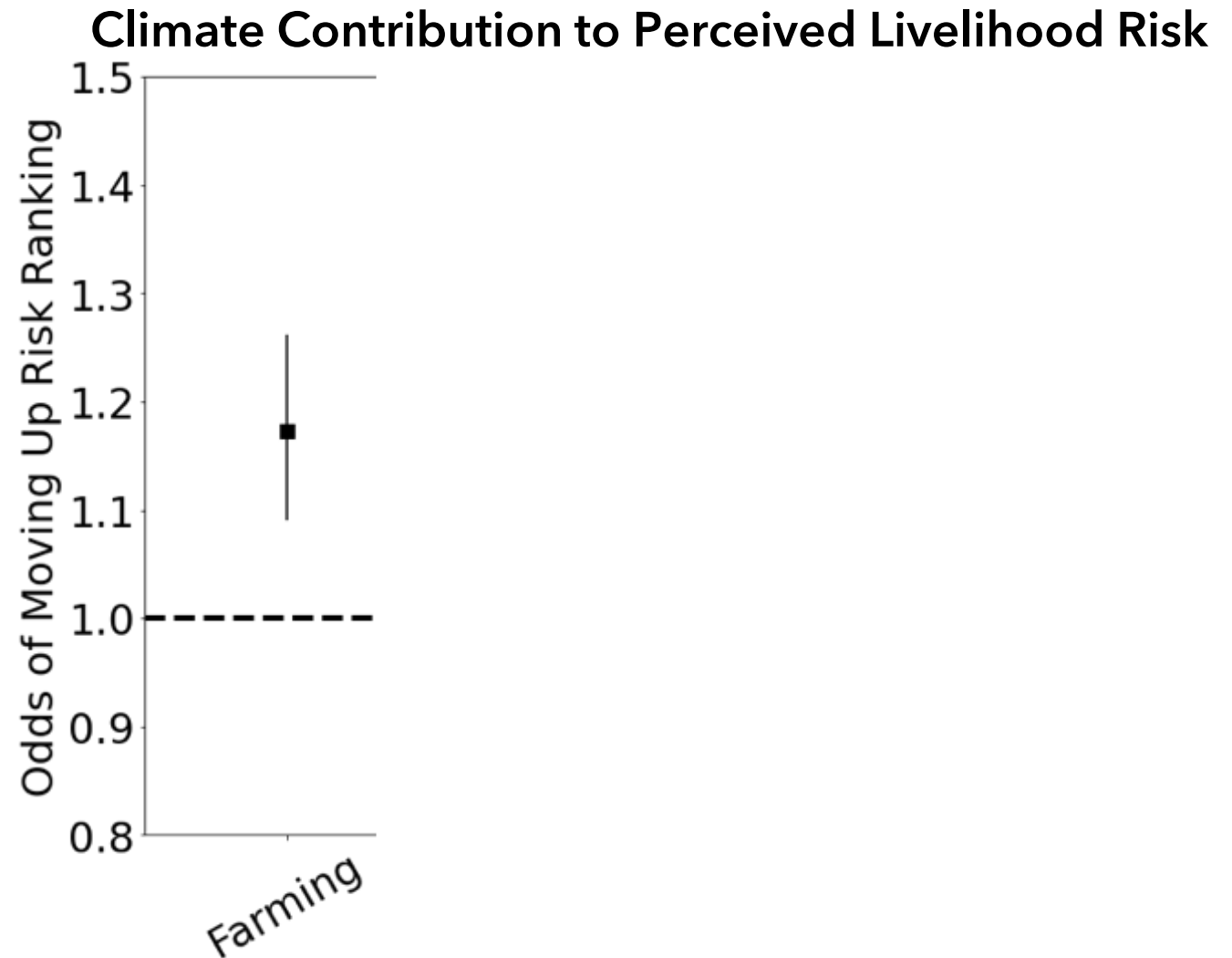
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Climate Risk Perception

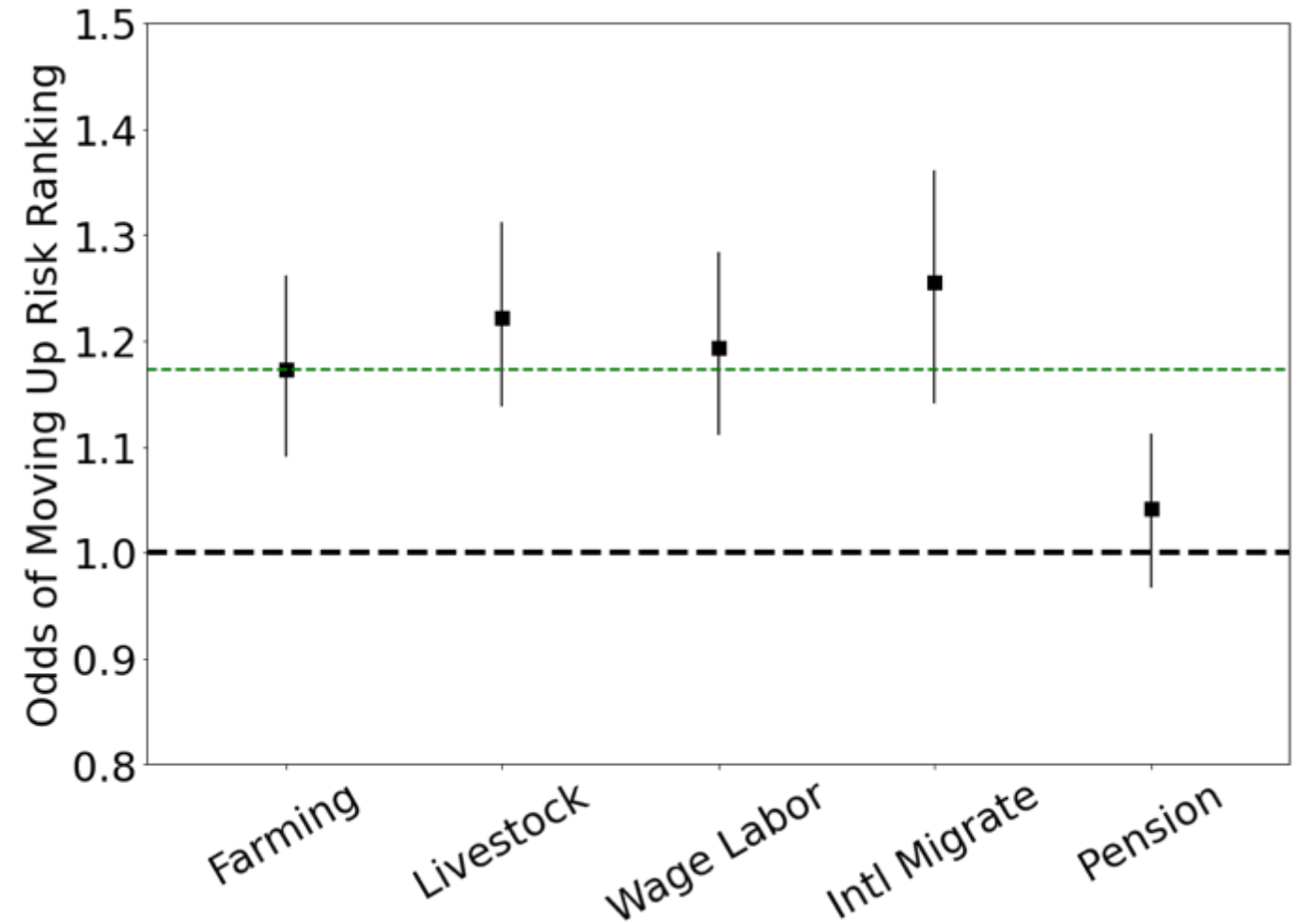
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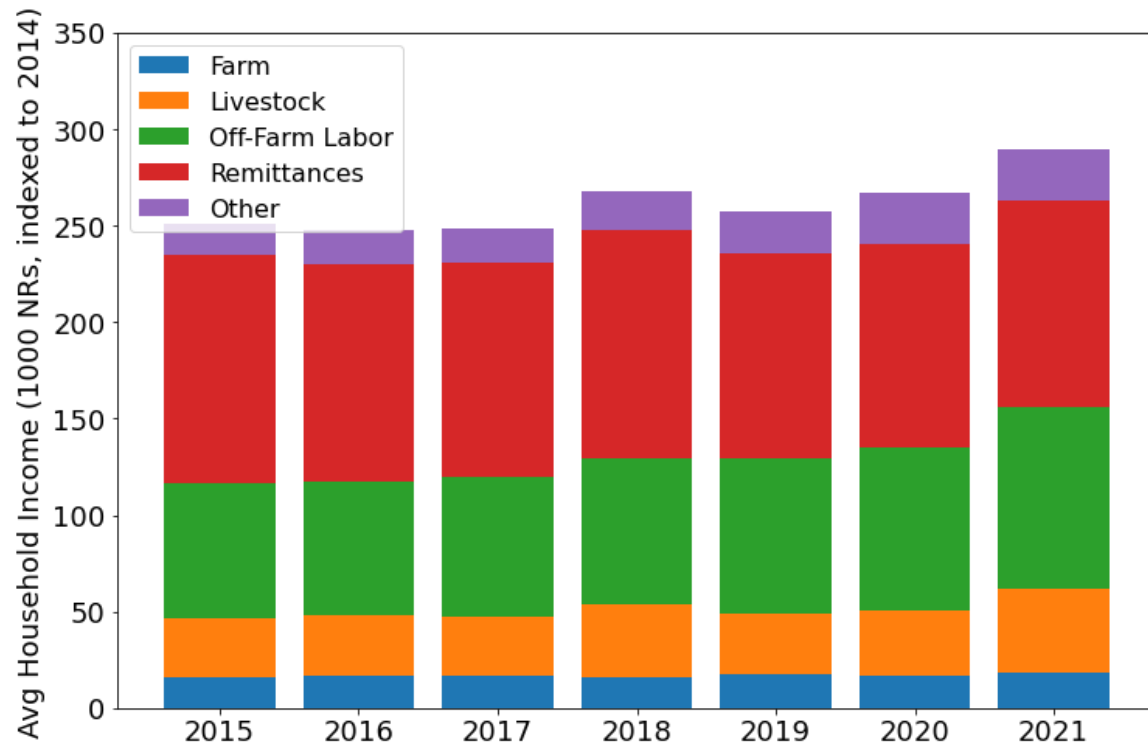
Climate risk perceptions
driving increased
perceived risk of common
livelihood diversification
strategies

Climate Contribution to Perceived Livelihood Risk



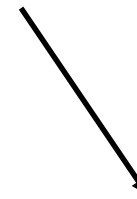
Results: Factors Leading to Income Diversification

Average Household Income, 2015-2021
(2014 thousand NRs)



Ordinary Least Squares Model

$$Y_{i,t}^k = \beta_0 + \vec{\beta}_D * \vec{X}_D + \vec{\beta}_R * \vec{X}_R + \vec{\beta}_{H,t} * \vec{X}_{H,t} + \delta_t + \epsilon_{i,t}$$

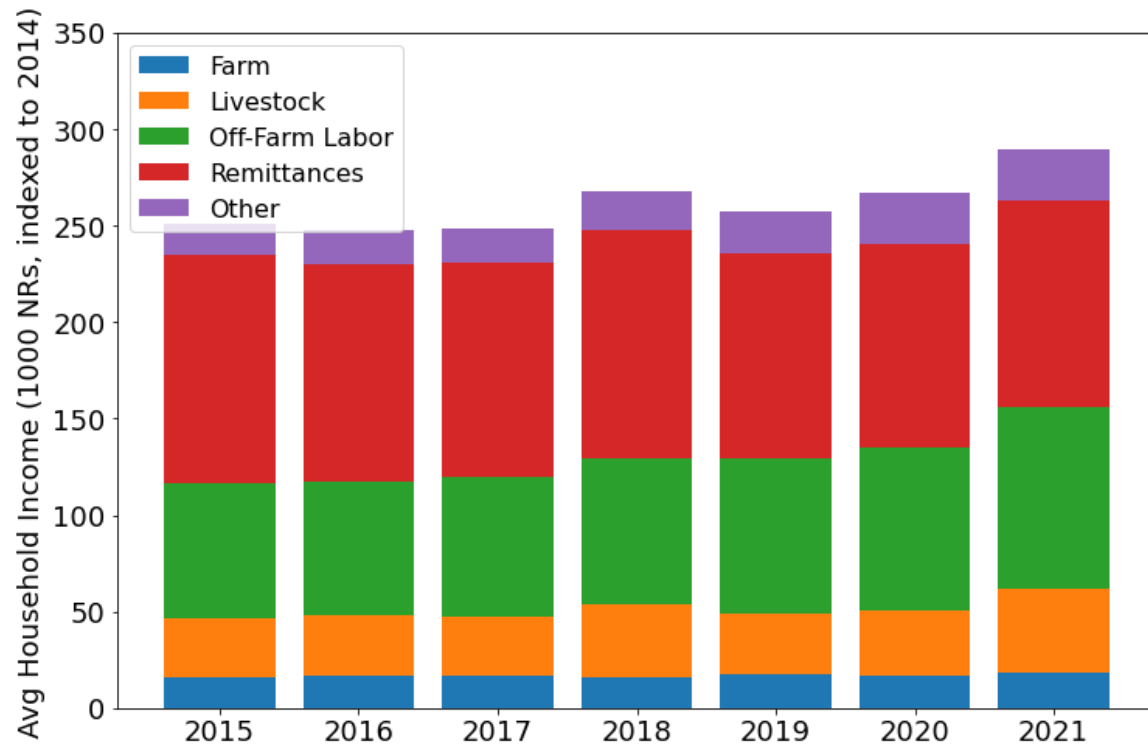


Dependent Variable

Proportion of i 's income from livelihood k in year t

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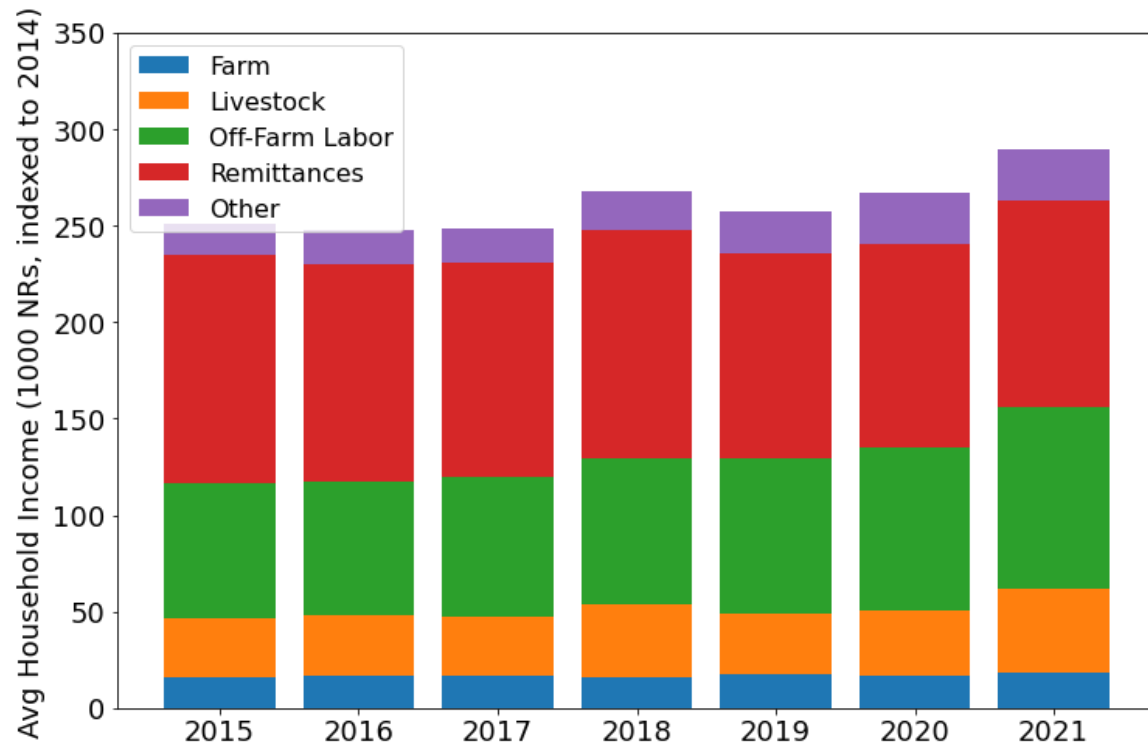
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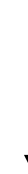
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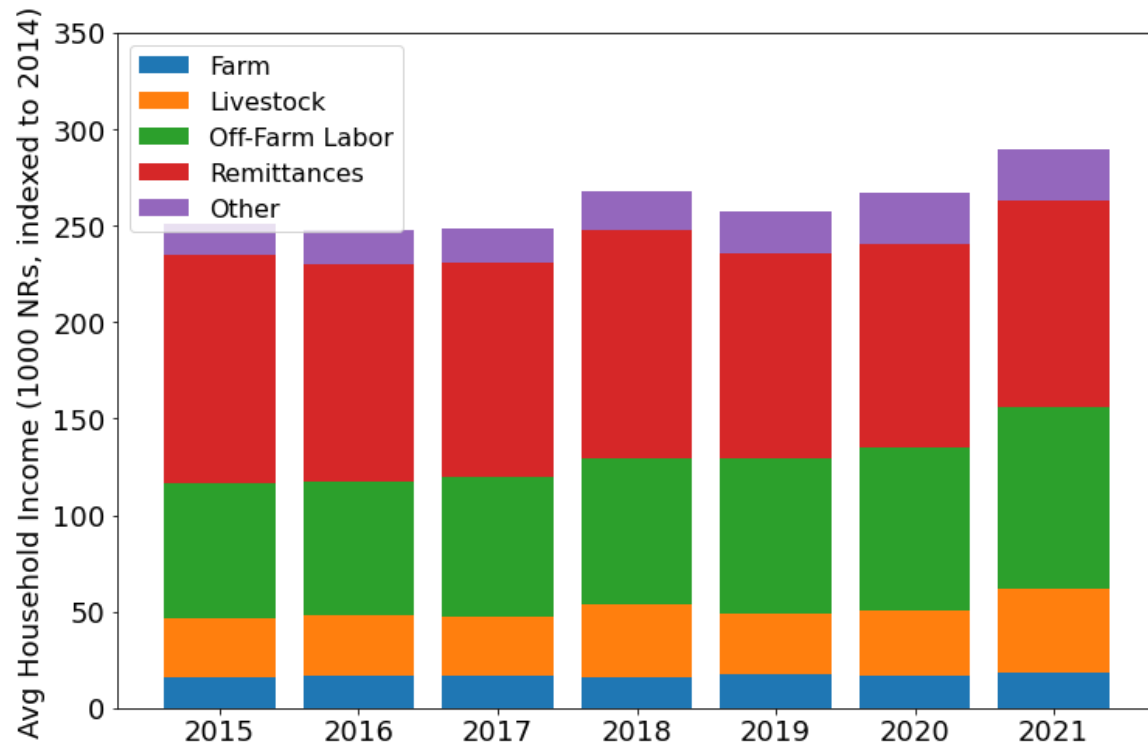


Risk Perception Variables

- Livelihood Risk

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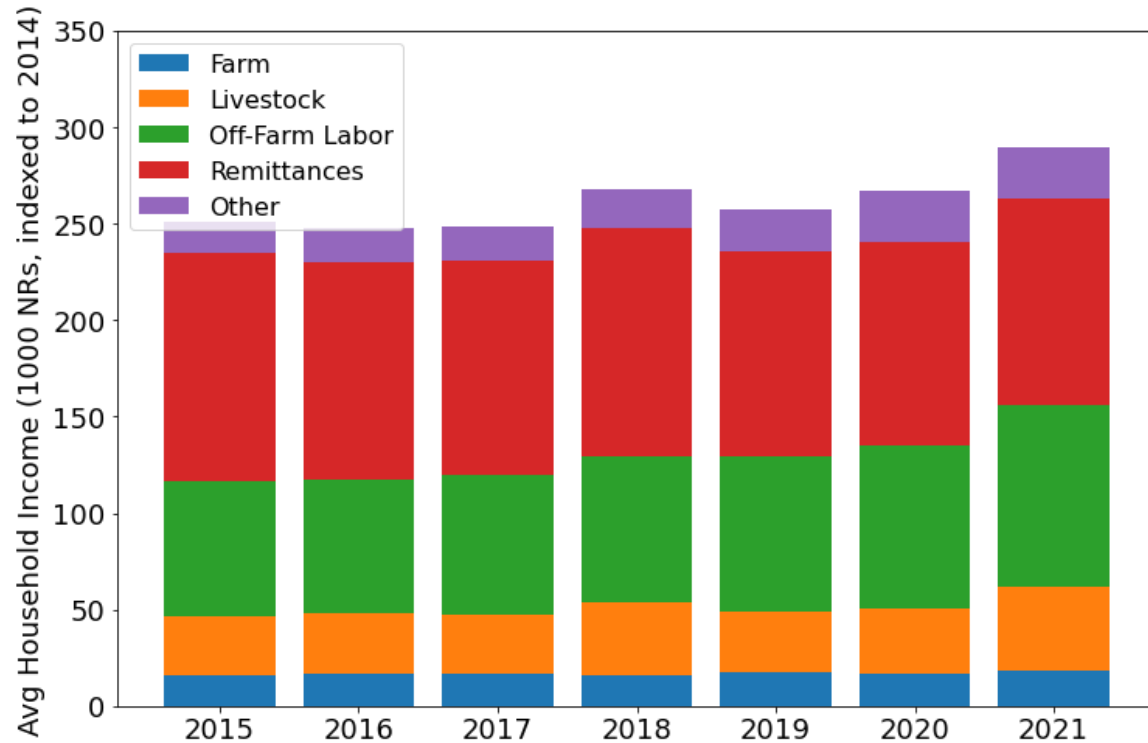
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Self-Reported Hazard Exposure

- Flood Exposure
- Drought Exposure

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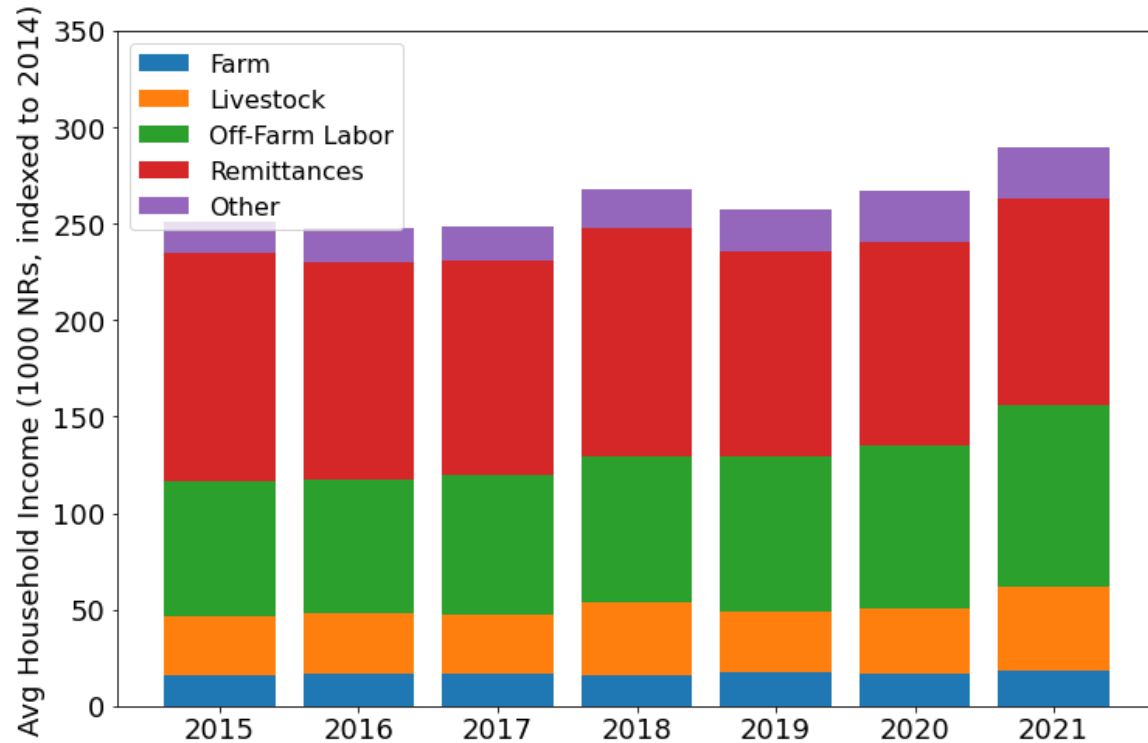
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Time Fixed Effects

- Controls for population-wide temporal trends

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Error Term

- Accounts for other unobservable factors that influence dependent variable

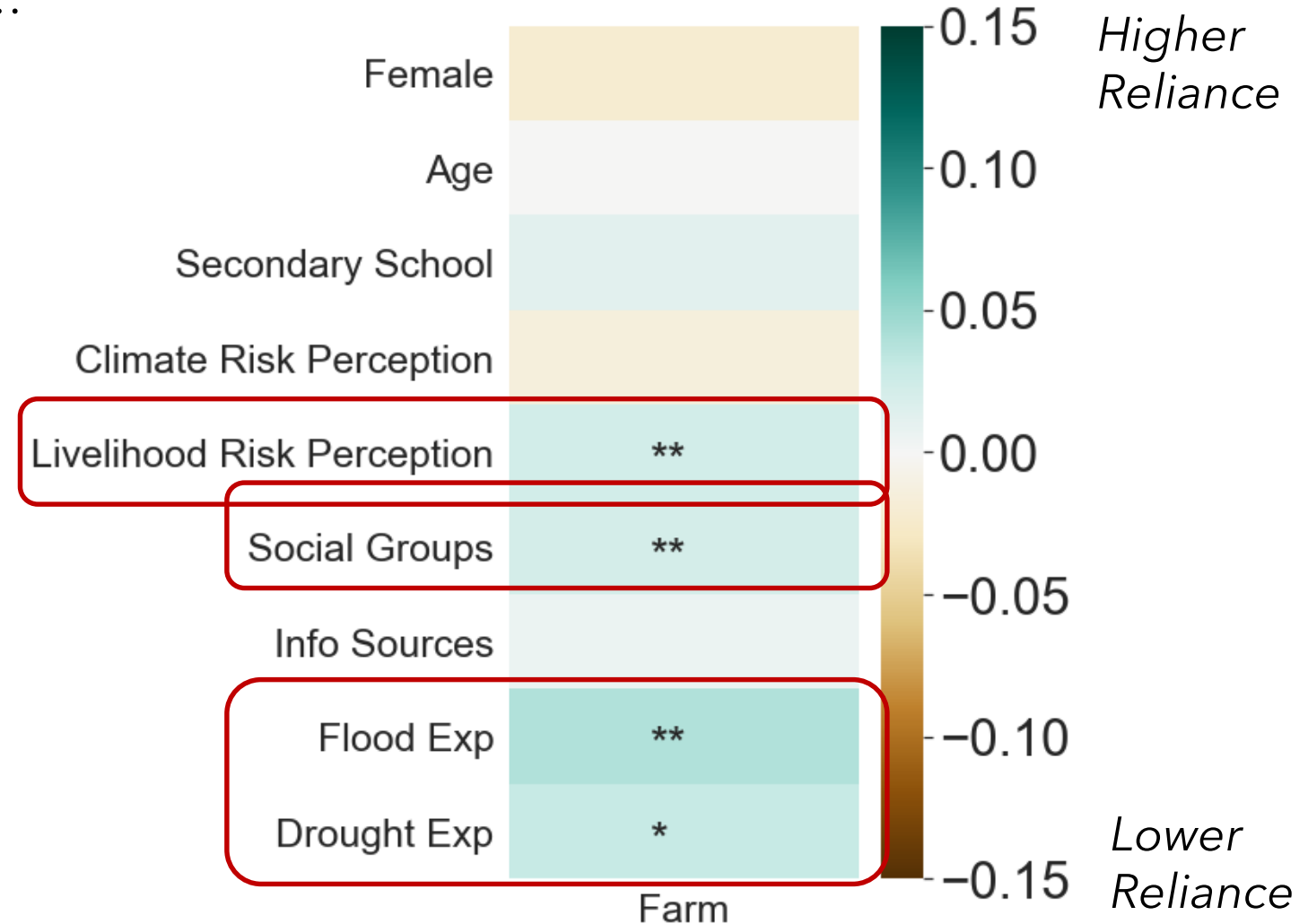
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Households **rely more on farming** if they...

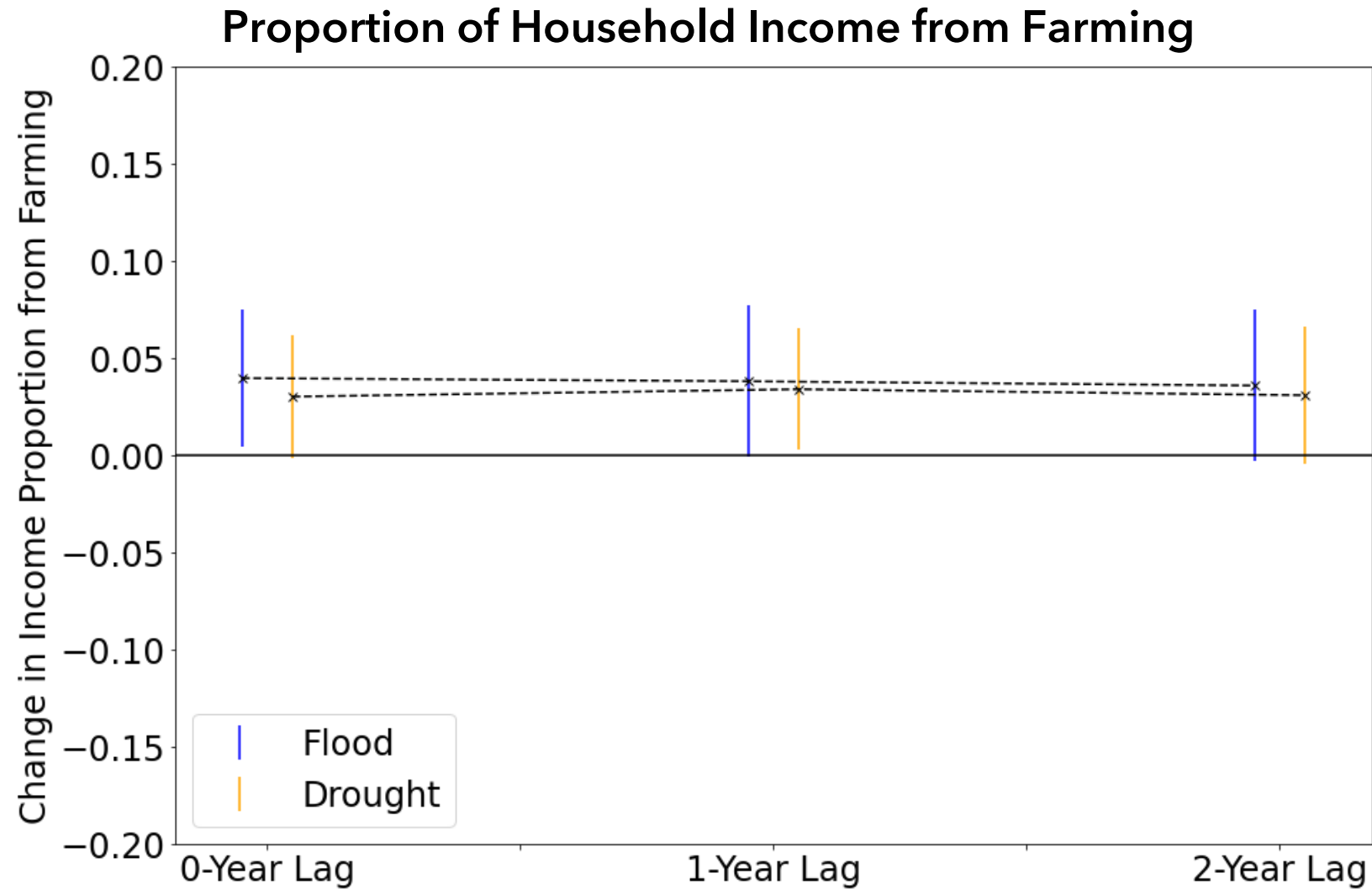
- Perceive it as a risky strategy
- Participate in more social groups
- Experience floods and/or droughts in a given year

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Effect on Annual Farm Income Proportion



Results: Persistent Effects of Hazards on Income Sources



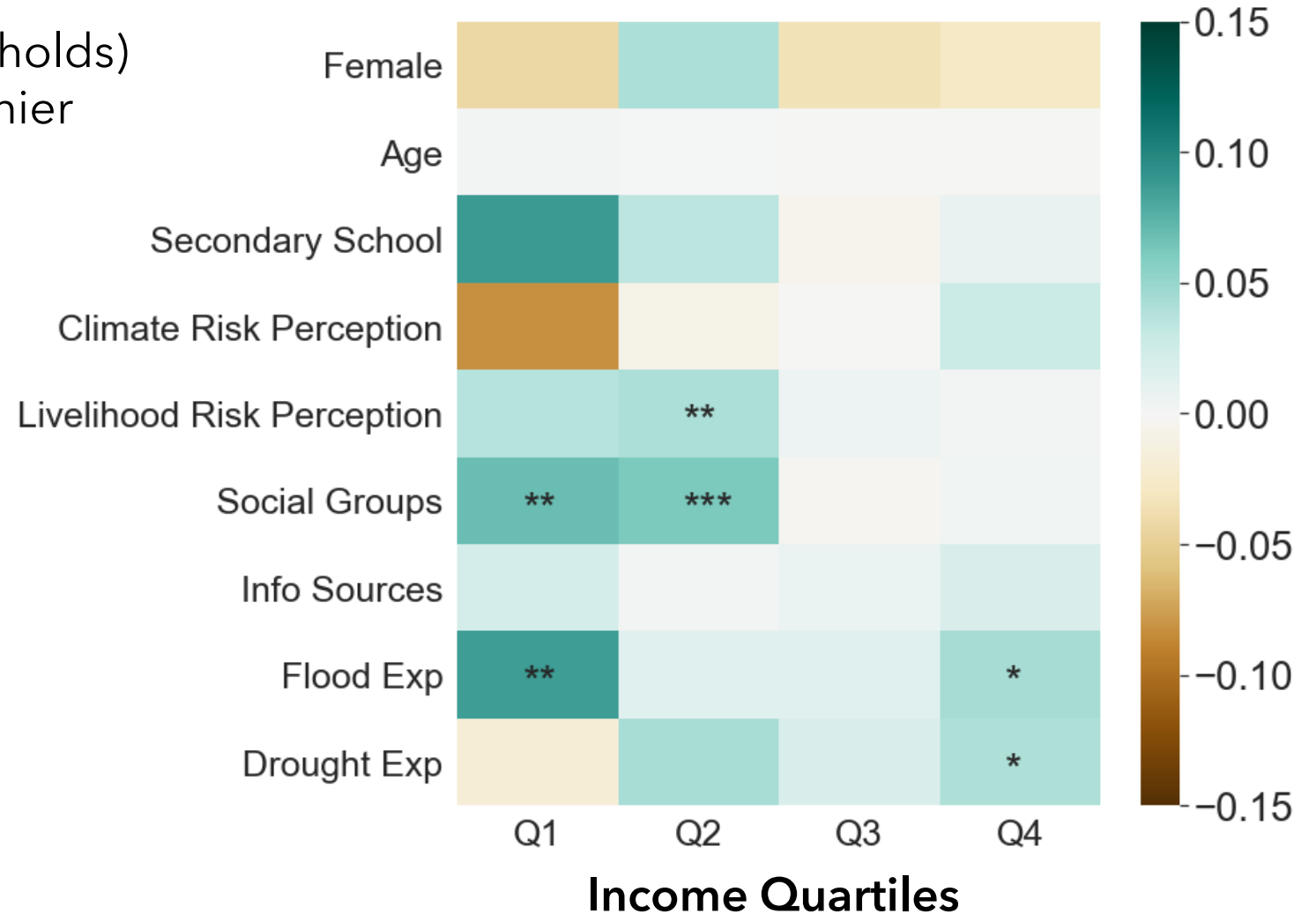
Results: Differentiated Effects by Wealth

Financial Constraints (Poorer Households)
or **Psychological Mechanism** (Wealthier
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Effect on **Farm Income Proportion**



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Results: Differentiated Effects by Wealth

Financial Constraints (Poorer Households)
or Psychological Mechanism (Wealthier
Households)?

Psychological: Droughts (slow-onset)
increase reliance on farm income for
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Effect on Farm Income Proportion



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Results: Differentiated Effects by Wealth

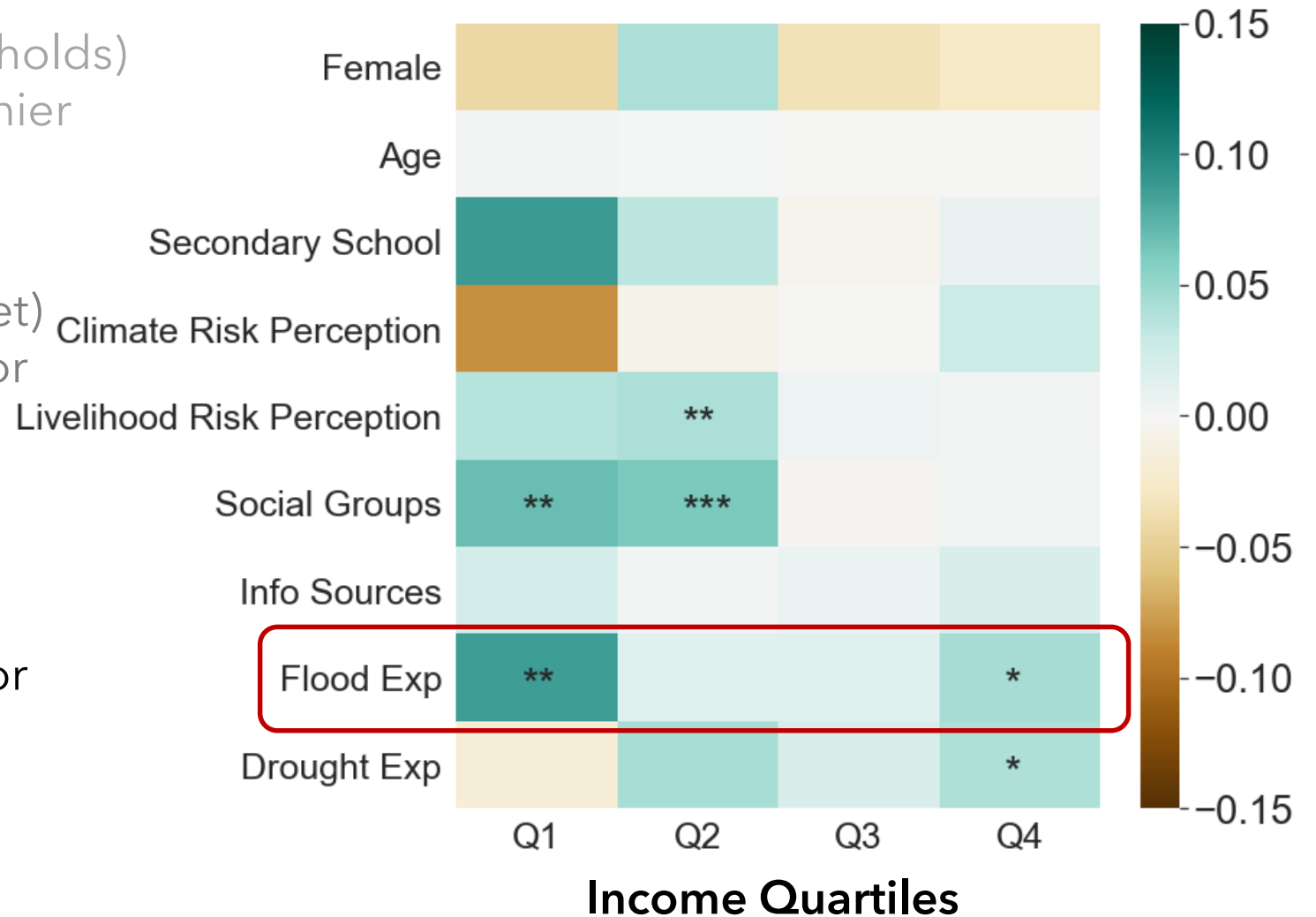
Financial Constraints (Poorer Households) or **Psychological Mechanism** (Wealthier Households)?

Psychological: Droughts (slow-onset) increase reliance on farm income for richest households

Psychological and Financial Constraints: Floods (fast-onset) increase reliance on farm income for poorest and richest households

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Effect on Farm Income Proportion

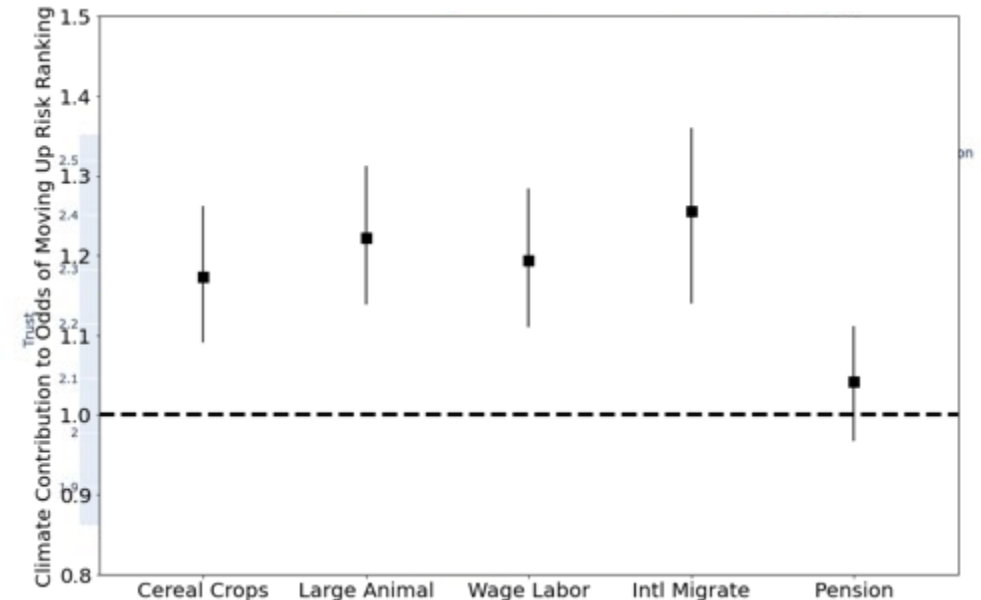


Discussion: Summary of Key Findings

- Differentiated access to information leads to heterogeneity in risk perceptions
- Climate contributes to increased perceived risk of income diversification strategies
- Households “double down” on farming during extreme events through both financial and psychological mechanisms

Policy Takeaways

- Climate information services may be unintentionally lowering perceived climate risks
- Information on livelihood alternatives, combined with risk transfer mechanisms, may better enable livelihood diversification



Discussion: Other Data That Was Collected (and may be useful)

Livelihood
Calendar

Land use and tenure;
Migration in
Nepal/internationally;
Water use

Likert Scale
Questions

Life aspirations;
Actions taken in
response to hazard;
Factors affecting
migration

Vignette
Experiments

Hypothetical livelihood
decisions and risk
perceptions under cash
transfer vs. crop
insurance




Discussion: Developing Socially-Informed Hazard Indicators

nature reviews earth & environment

<https://doi.org/10.1038/s43017-023-00457-2>

Perspective

 Check for updates

Toward impact-based monitoring of drought and its cascading hazards


S.N	Formula Bar Food Strategy	National Events		Earthquake		Local Level Election		COVID-19	
		Local Events							
		English Year		2015	2016	2017	2018	2019	2020
		Animal Year		Sp	Mk	Bd	Dg	Dr	Rt
S.N	E. Climate Risk Perceptions			2072	2073	2074	2075	2076	2077
19	Drought affected your crop plantation and harvests (1.Yes, 0. No)								
20	Flood or heavy rain affected your crop plantation and harvests (1.Yes, 0. No)								
21	Lack of groundwater affected your crop plantation and harvests (1.Yes, 0. No)								
22	Excess heat affected your crop plantation and harvests (1.Yes, 0. No)								
23	Pests affected your crop plantation and harvests (1.Yes, 0. No)								
24	Frost affected your crop plantation and harvests (1.Yes, 0. No)								
25	Hail affected your crop plantations and harvests (1.Yes, 0. No)								
26	Used water from irrigation canal for crop plantations and harvests (1.Yes, 0. No)								
27	Used groundwater for crop plantations and harvests (1. Yes, 0. No)								
28	Purchased insurance for crops (1.Yes, 0. No)								
29	Wild Animals affected your crop planatation and harvests (1. Yes, 0. No)								
				2072	2073	2074	2075	2076	2077

Discussion: Developing Socially-Informed Hazard Indicators

- How well do **different drought indicators** reflect farmers' self-reported experience with droughts?

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Discussion: Developing Socially-Informed Hazard Indicators

- How well do **different drought indicators** reflect farmers' self-reported experience with droughts?
- How to connect early warning drought indicators with **downstream impacts**?
 - Risk perceptions
 - Income diversification
 - Migration

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Discussion: Developing Socially-Informed Hazard Indicators

- How well do **different drought indicators** reflect farmers' self-reported experience with droughts?
- How to connect early warning drought indicators with **downstream impacts**?
 - Risk perceptions
 - Income diversification
 - Migration
- Do households report experience with **compound hazards**? If so, how are they connected?

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Thank you!

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