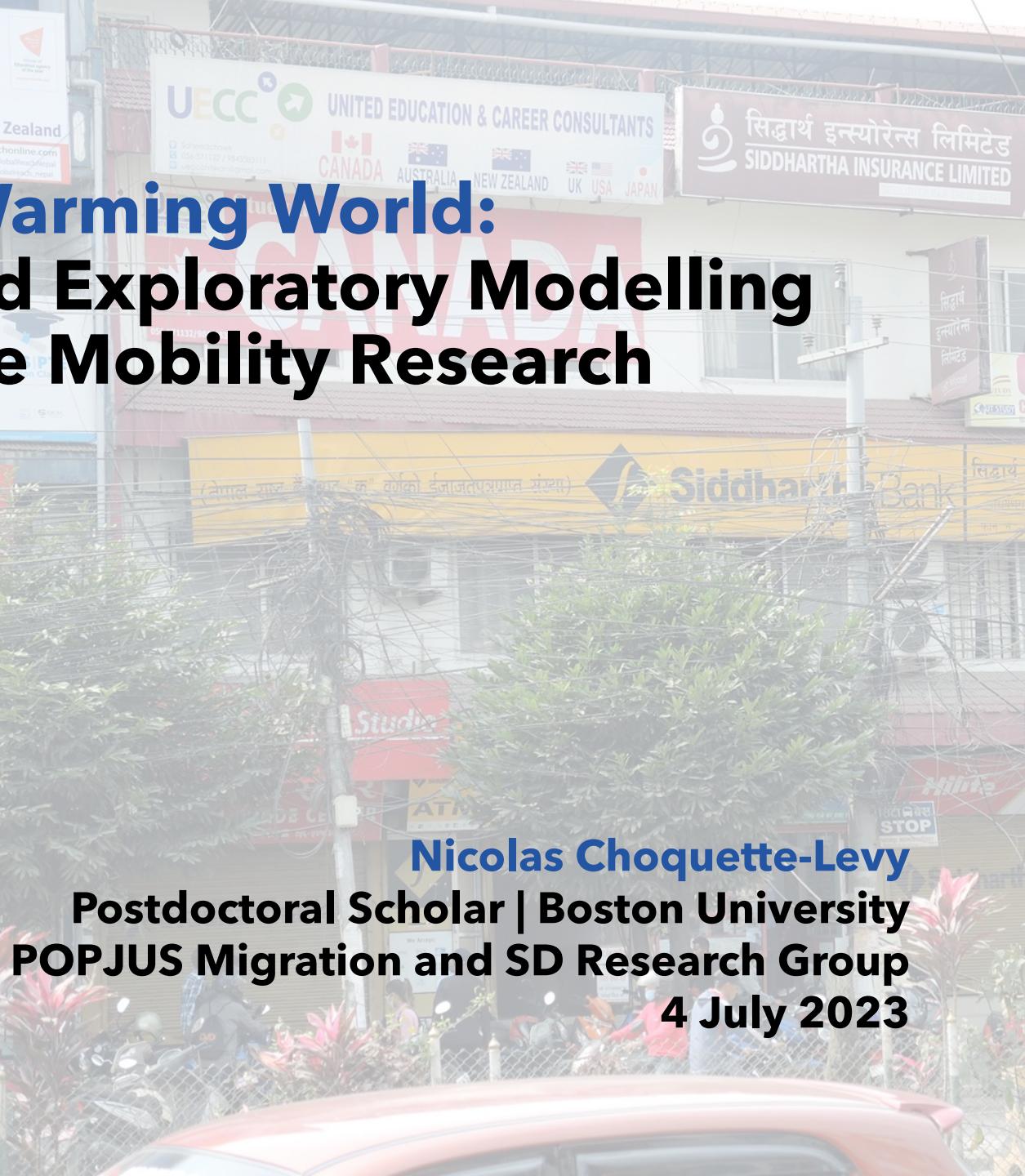


# **Navigating a Warming World: Integrating Empirical and Exploratory Modelling Methods for Climate Mobility Research**



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POPJUS Migration and SD Research Group  
4 July 2023

# Motivation: Climate-Migration-Agriculture Nexus

## Key Findings from Literature

- Migration remittances used as a risk diversification strategy by farming households
- Changes to temp (and sometimes precipitation) linked to changing migration patterns, esp. for agriculturally-dependent countries
- Climate change could add 43-140 million internal migrants by 2050; but constrain international migration

## Understudied Phenomena

- Interaction between migration and other livelihood diversification strategies
- Non-linear human responses to climate
- Potential effects of adaptation policy interventions

Article | Published: 14 September 2020

### A meta-analysis of country-level studies on environmental change and migration

Roman Hoffmann , Anna Dimitrova, Raya Muttarak, Jesus Crespo Cuaresma & Jonas Peisker

*Nature Climate Change* 10, 904–912 (2020) | Cite this article



# Motivation: Nepal as a “Bellwether” Country for Migration and SD

- Highly dependent on agricultural sector
  - 24% of GDP (China: 7%; EU: 2%, US: 1%)
  - 71% of employment (China: 16%, EU: 4%, US: 2%)
- Large rural-urban migration: One of 10 fastest-urbanizing countries; remittances account for 27% of GDP
- High overall vulnerability to climate risks including: floods, droughts, landslides (World Bank; ND-GAIN)
- New constitution in 2015 establishes federal governance system, with distribution of competencies still in development
- Climate adaptation is highly salient public policy → e.g. 2022 National Census on Agriculture and Climate Change



Source: Nepali Times

# Agent-Based Modelling Risk Transfer Policies and Climate-Induced Immobility

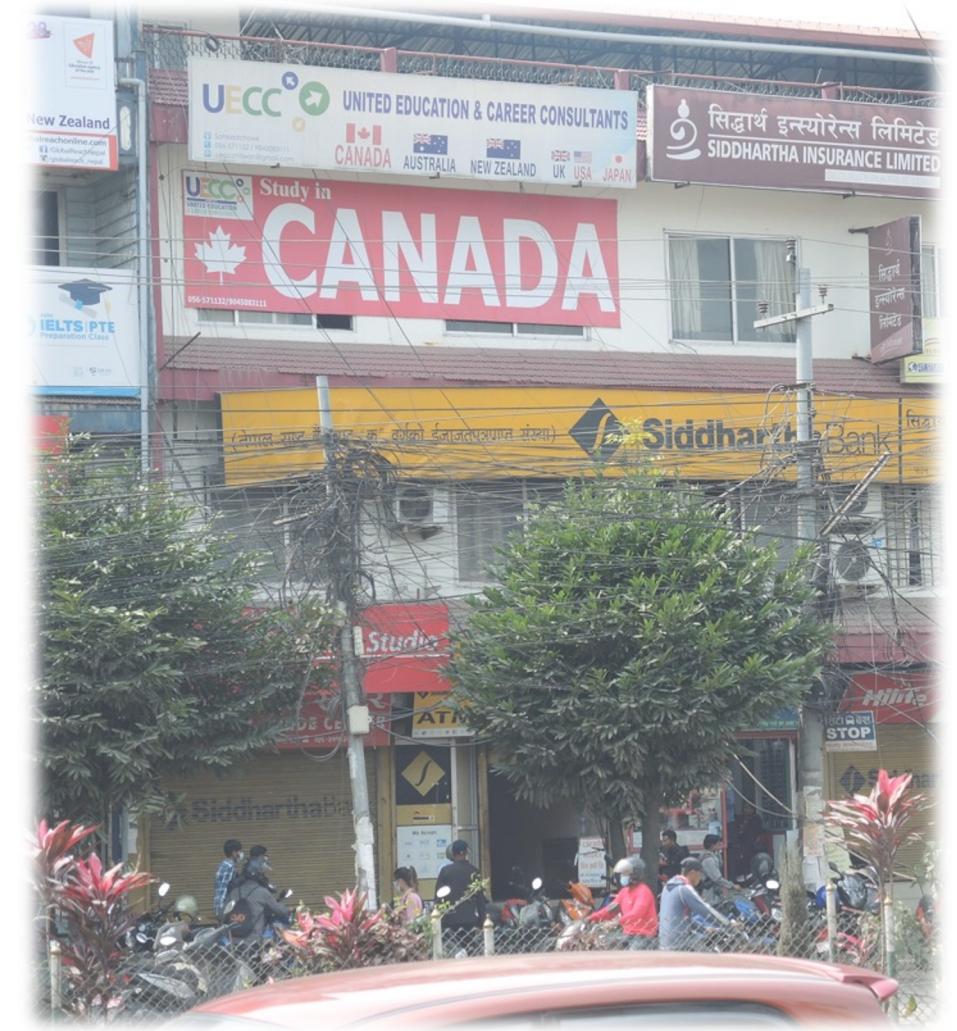
In collaboration with:

Matthias Wildemeersch (IIASA - ASA), Michael Oppenheimer (Princeton), Simon Levin (Princeton)



# Motivation: Research Questions

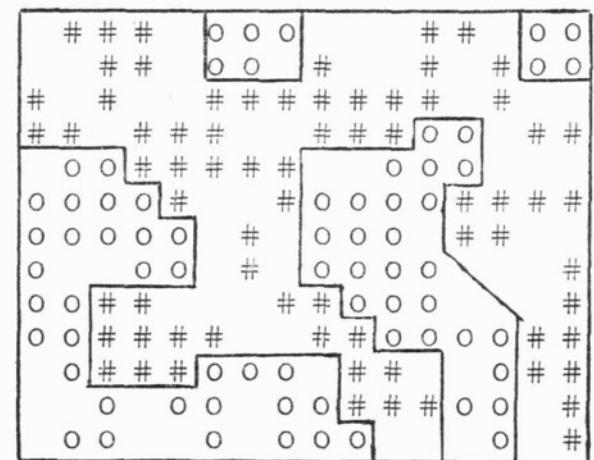
- How does **increased climate stress** impact farmers' **livelihood decisions** among a portfolio of risky strategies?
- What **decision-making factors** have the most impact on these outcomes?
- What **risk-transfer policies** can improve community outcomes (e.g. community income, inequality, poverty rates, etc.)?



# Methods: What are Agent-Based Models (ABMs)?

- Simulate **interactions between decision-making "agents"** that differ based on important properties (e.g. resources, information, etc.)
- Use simple decision rules to explore behavioral patterns that **emerge at larger scales** as a result of lower-level interactions (e.g. Schelling Model of Segregation)
- Explore **non-linearities** in how different conditions (e.g. policy interventions, climate stress) can alter behavior

Source: Schelling (1971), JMS.



# Methods: Agent-Based Model Outline

- **Boundaries:**  
Smallholder farming community based off data from Chitwan District, Nepal, 2006-2050
- **Agents:**  
Individual farming households that choose livelihoods in each season under bounded rationality
- **Agent Goal:**  
Maximize expected income while reducing livelihood risk (New Economics of Labour Migration)
- **Network Interactions:**  
Information Sharing, Reference Points, Migrant Networks

## Farmer Adaptation Strategy Portfolio



**BAU:** Business-as-Usual Subsistence Farming



**Migrate:** Rural-Urban Migration

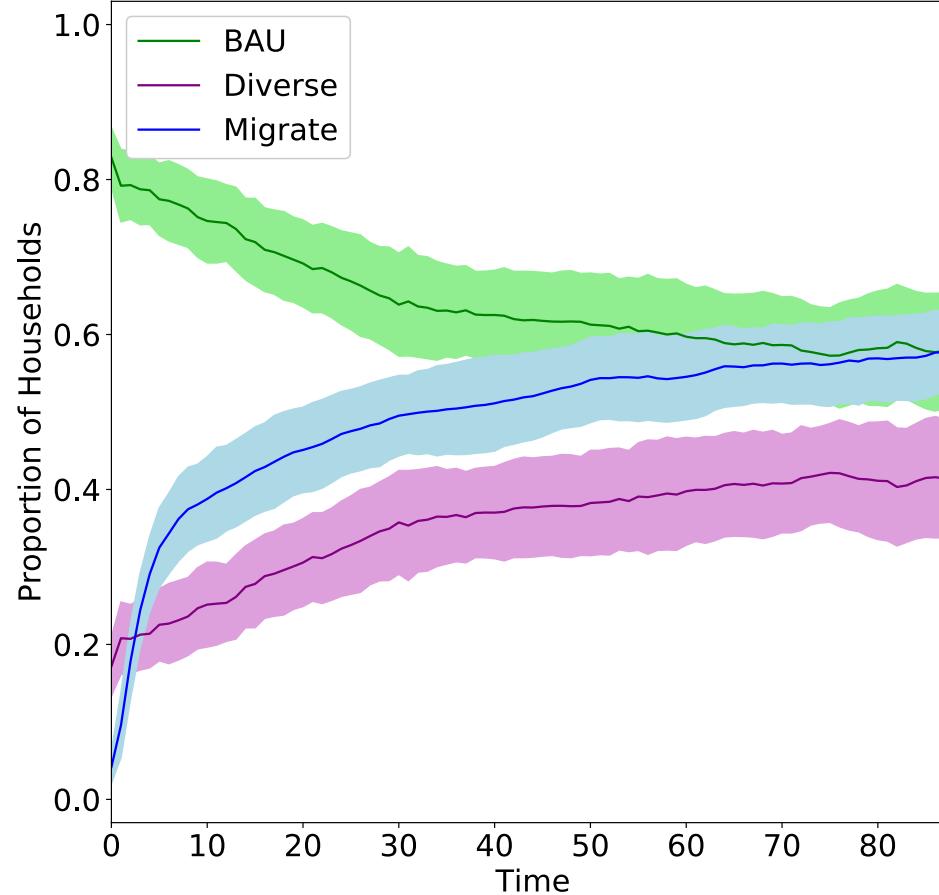


**Diverse:** Cash Crops

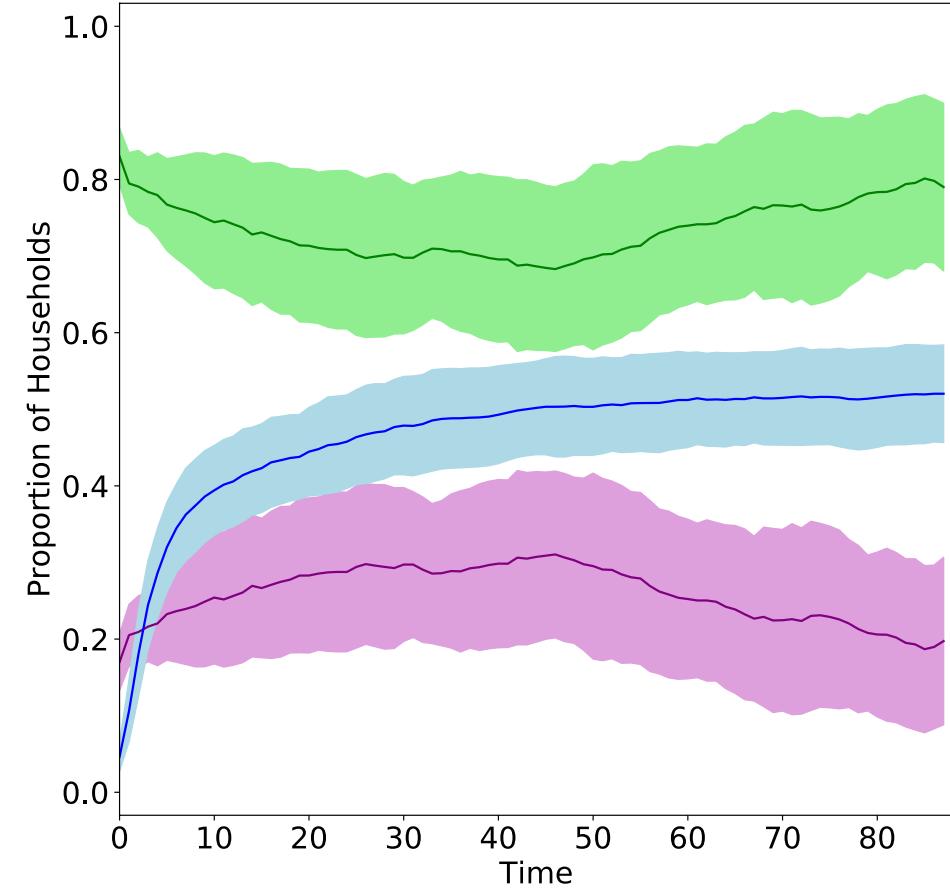
*Higher risk,  
higher reward*

# Results: Climate Effects on Livelihood Decisions

**Stationary Climate, 2006-2050**



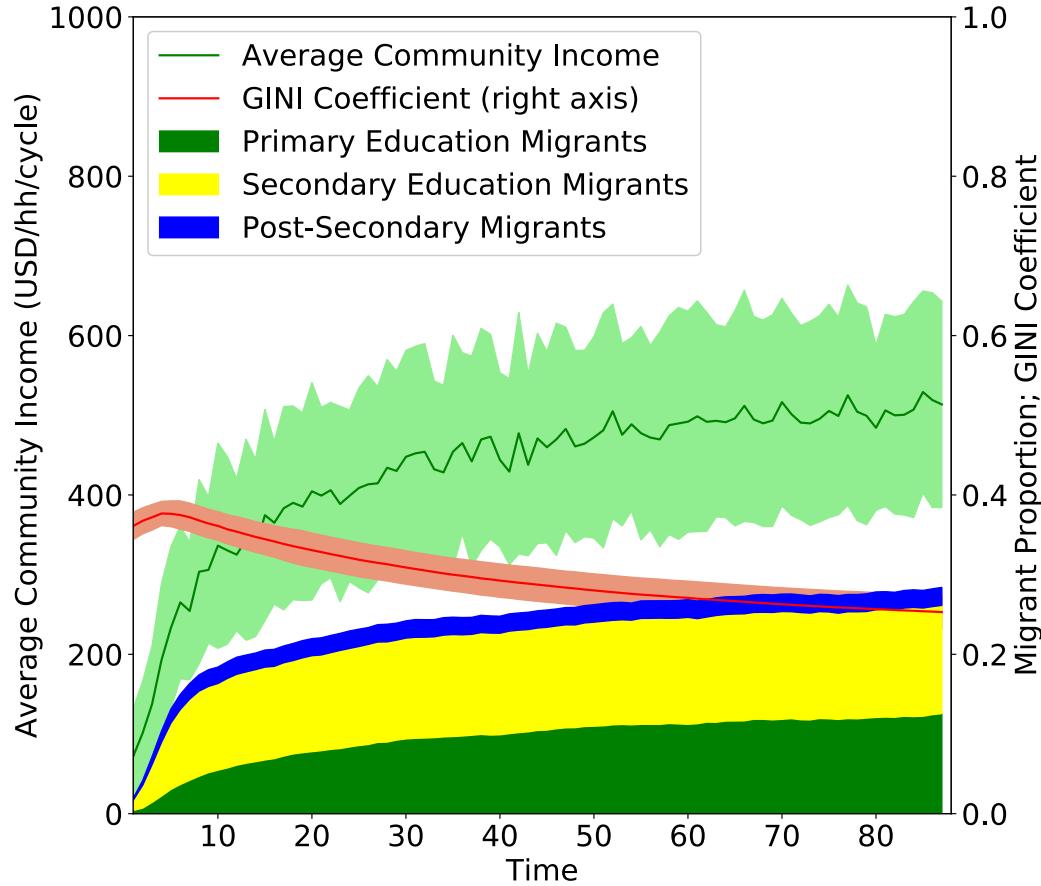
**1.5°C Temperature Increase, 2006-2050**



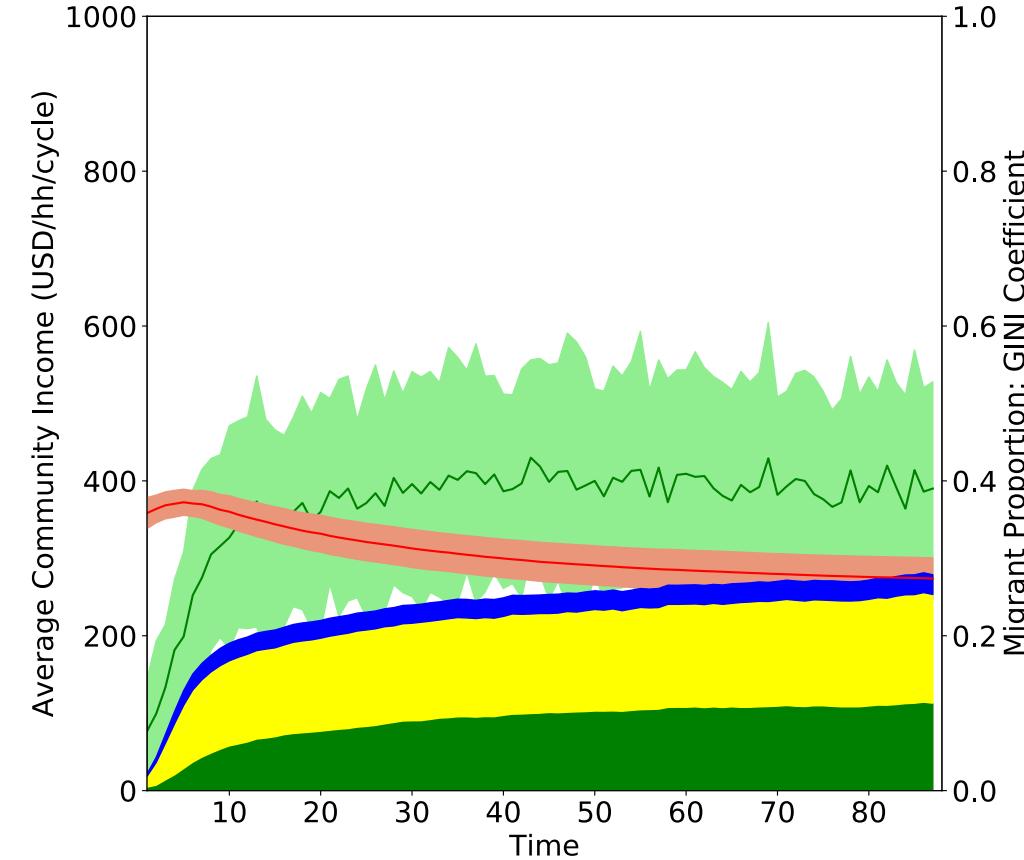
- Climate impacts **reduce the number of households** pursuing **Migration** and **Cash crops** through poverty trap: reduced income reduces ability to diversify livelihoods

# Results: Climate Effects on Economic Outcomes

## Stationary Climate, 2006-2050



## 1.5°C Temperature Increase, 2006-2050



- Reduction in **income by 28%**, in part because of fewer households able to diversify livelihoods
- Households with **less education** are particularly vulnerable to trapping effect on labor mobility

# Methods: Policy Experiments

30 USD/ household/ cycle



## Cash Transfers



- Government provides small cash amounts to households (30 USD/crop cycle; unconditional)

## Index-Based Insurance



- Farmers receive insurance payout if drought index is triggered

## Remittance Bank

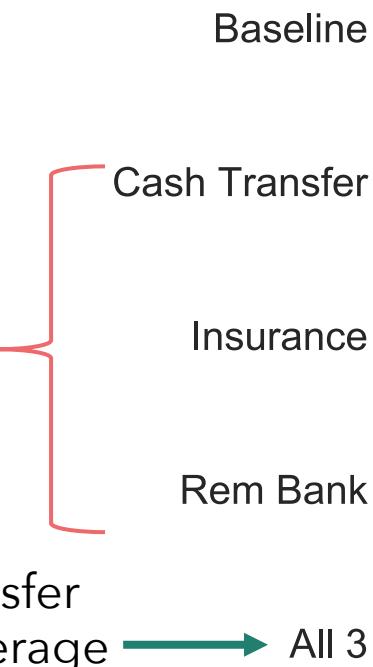


- Pool a portion of remittances from into a community bank
- Bank pays out a fixed amount to each participating household

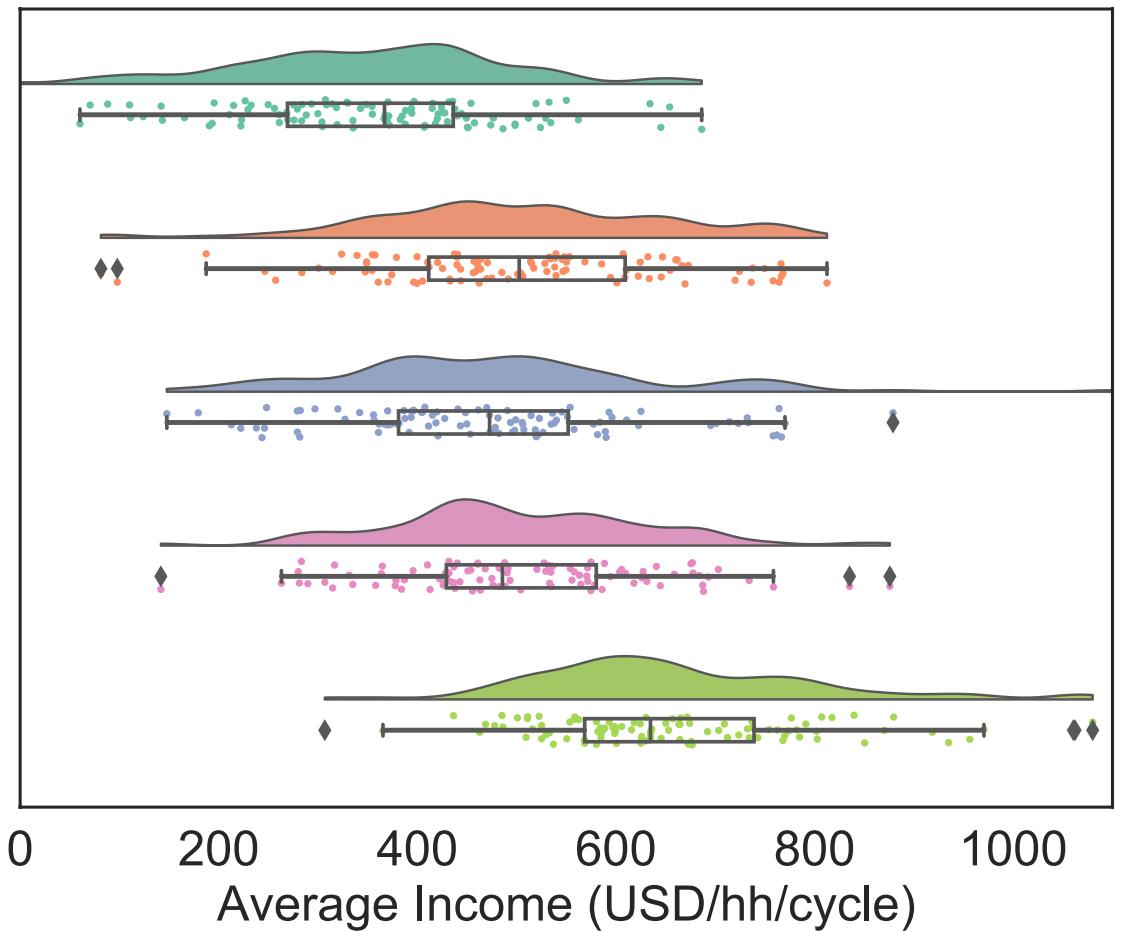
# Results: Policy Impacts on Income and Migration

## Sources of Stochasticity

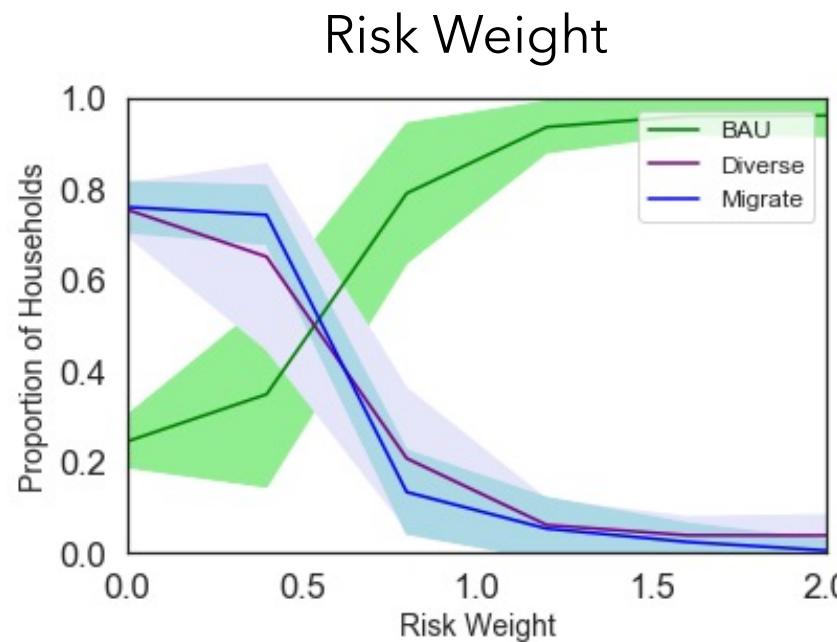
- Income draws
- Social network connections
- Occurrence of droughts
- Each policy increases average income compared to baseline
- A combination of **30 USD/cycle** cash transfer and risk transfer policies can increase average incomes by more than **250 USD/cycle**



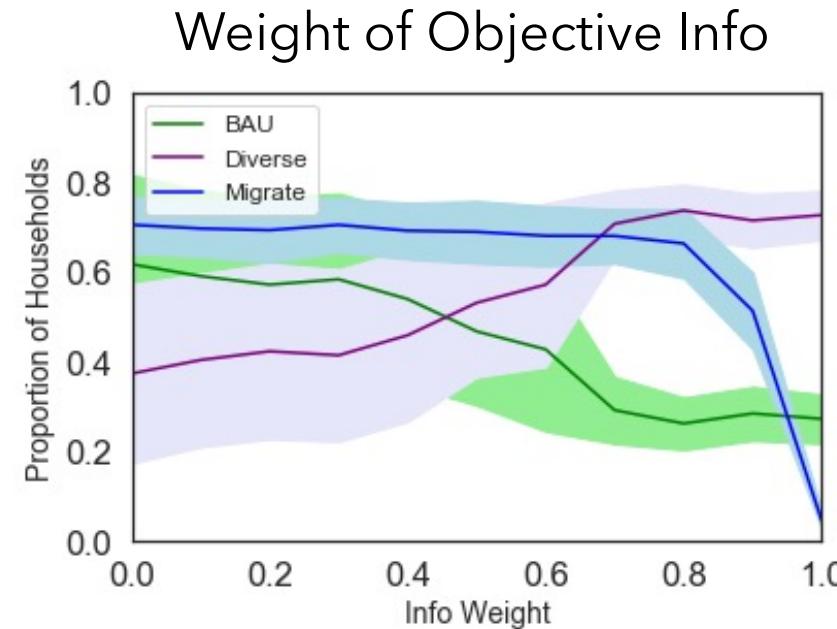
**Average Community Income, 2050**  
(100 model simulations)



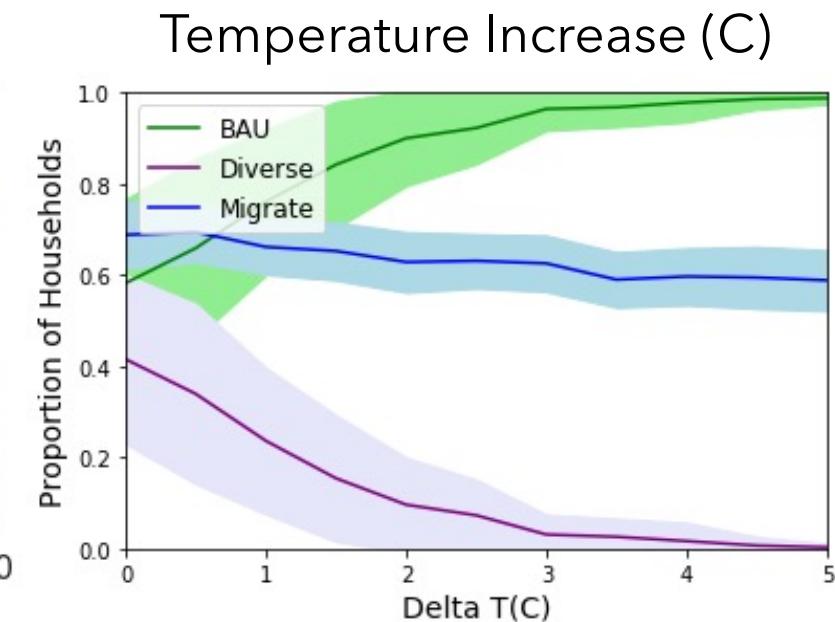
# Results: Key Sensitivities



Higher risk weight decreases adoption of alternate strategies;  
High sensitivity between  $0.5 < b < 1.0$



Higher weight of objective information increases adoption of Cash Crops



Higher temperature increase leads to less adoption of Cash Crops, small effects on Migrate for this parameter range

## Publications:

Choquette-Levy et al (2021), *Nature Climate Change*  
Thalheimer et al. (2022), *iScience*

# Risk Perceptions

## How do Farmers Form Perceptions about Climate and Livelihood Risks?

In collaboration with:

Dirgha Ghimire, Michael Oppenheimer,  
Indra Chaudhaury, Rajendra Ghimire, Dil CK



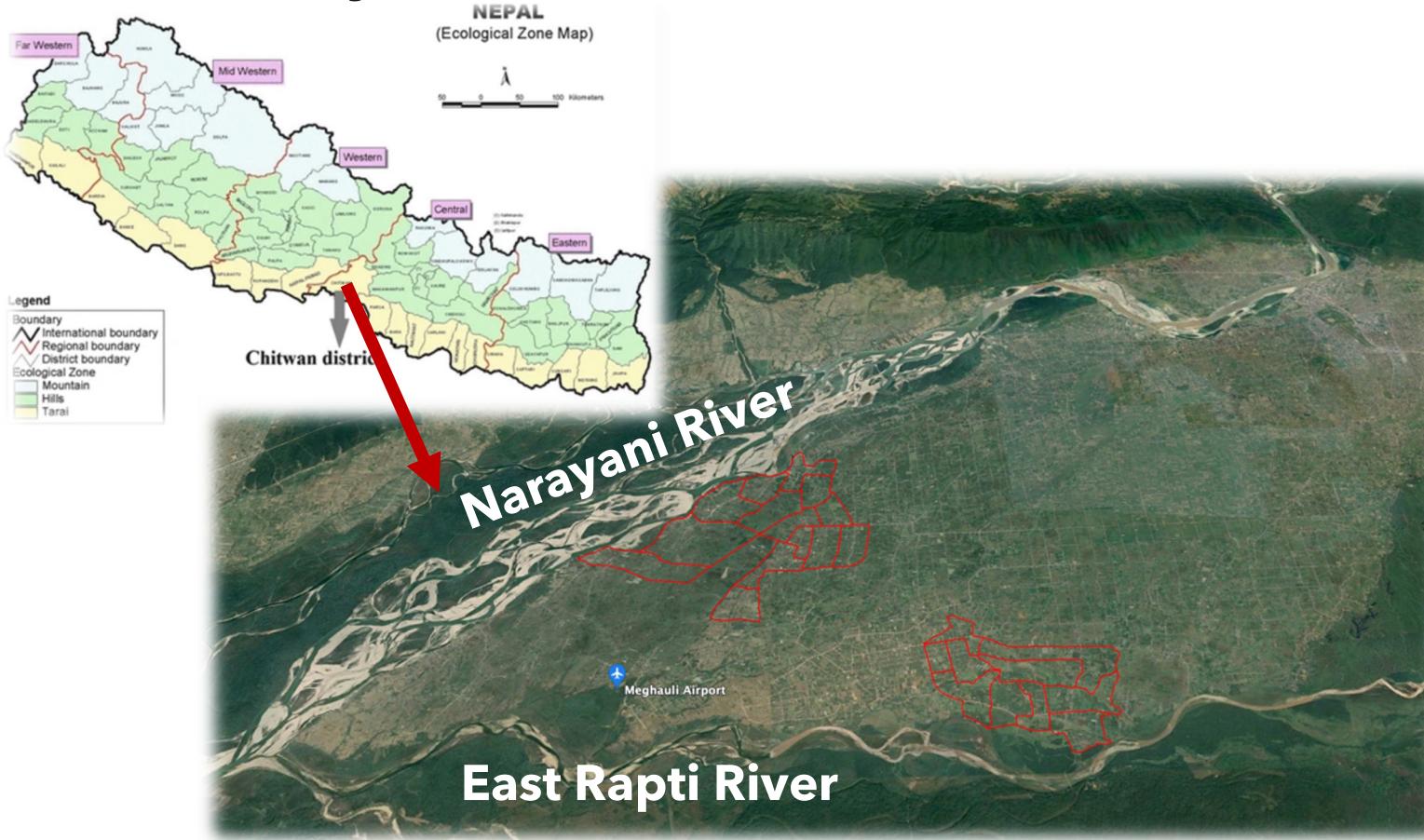
# Motivation: Research Questions

- How **salient is climate** to overall perceptions of livelihood risks?
- How is heterogeneity in access to **information sources** correlated with farmers' perceptions of climate risks?
- How do perceptions of climate risk and livelihood alternatives shape **income diversification strategies**, including through migration?



# Methods: Survey Design

## Survey Areas - Chitwan District



## Survey Overview

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

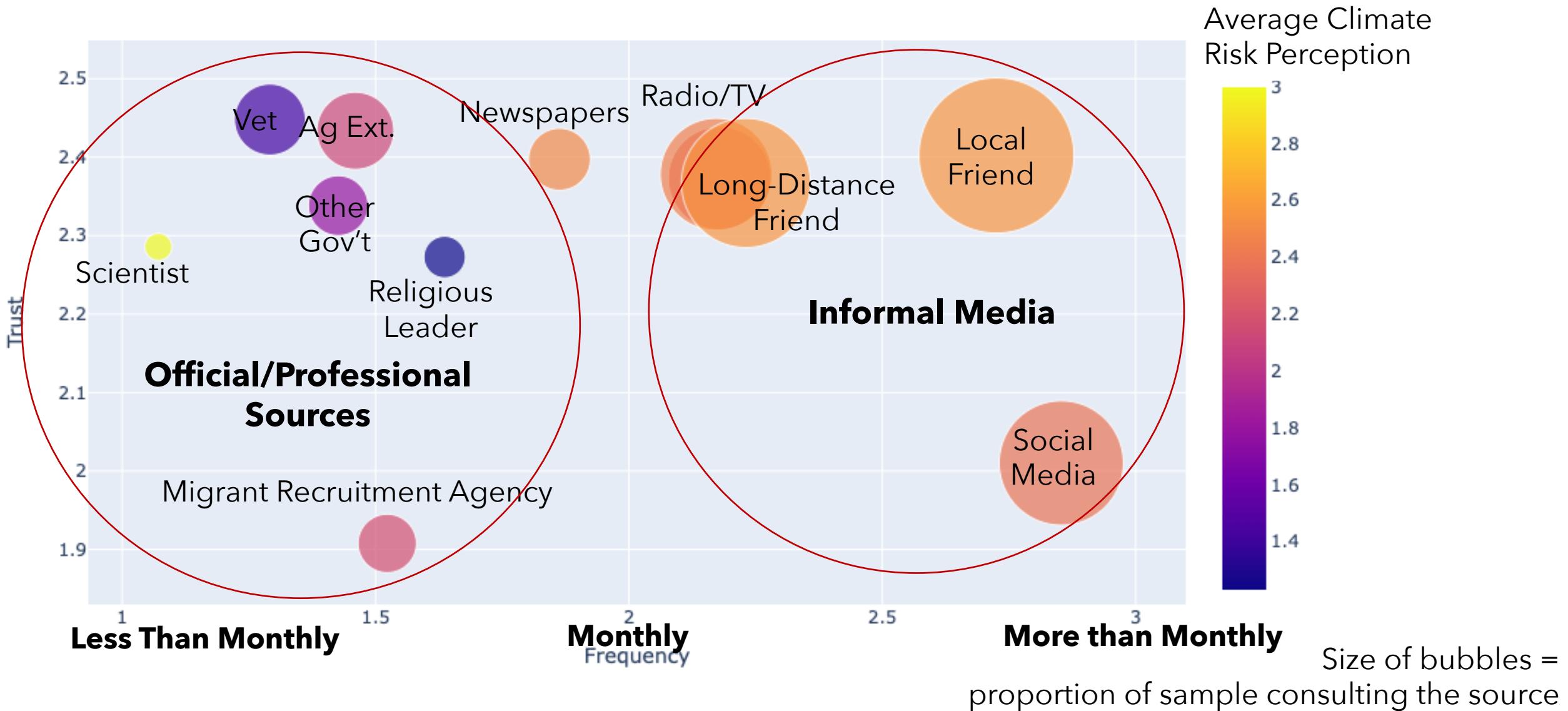
Panel data (2015-2021)

- Livelihood choices
- Incomes
- Climate exposure

Cross-sectional data

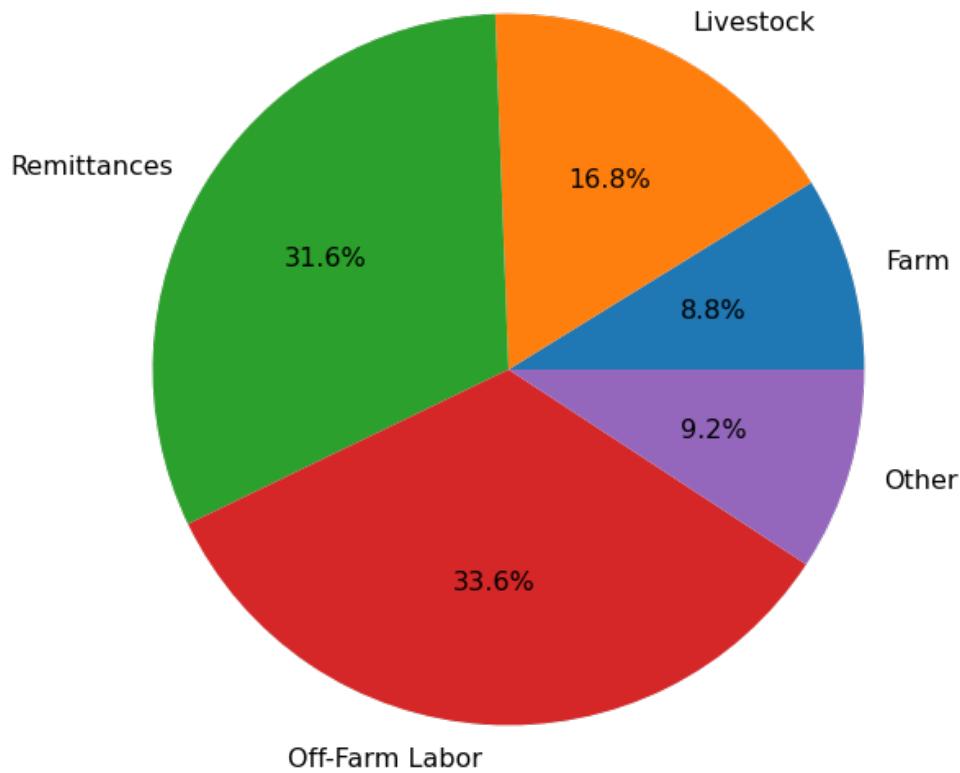
- Info sources
- Social Networks
- Risk perceptions

# Results: Information Sources and Risk Perceptions

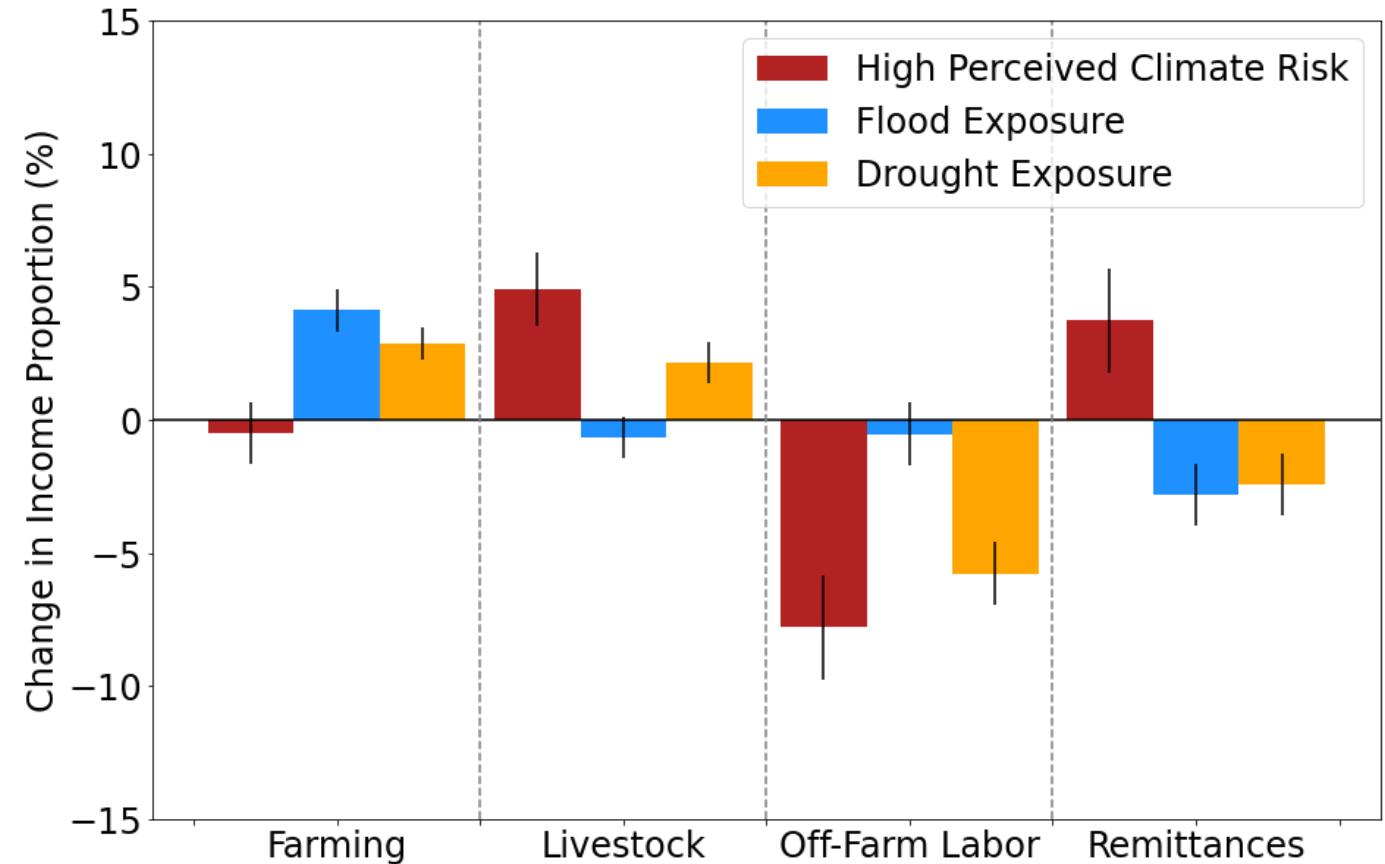


# Results: What Factors Lead to Income Diversification?

**Average Household Income by Source across all Years**



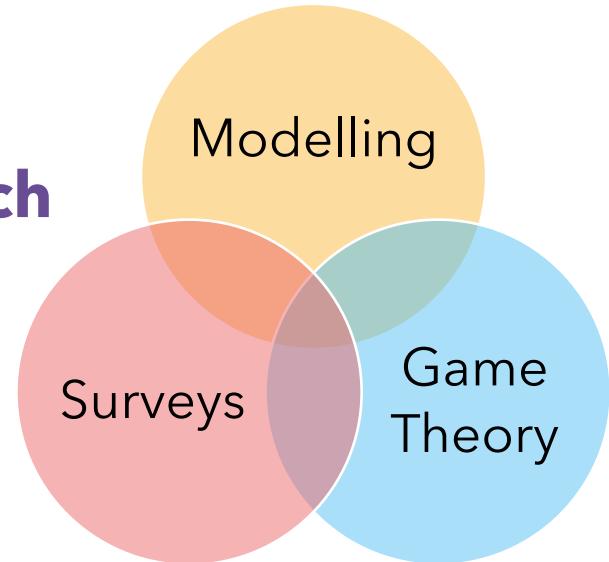
**Effect Sizes on Proportion of Household Income From Each Livelihood**



# Discussion: Methodological Insights

## Strengths of Combined Modelling/Data Collection Approach

- Investigate feedbacks and non-linear relationships
- Isolate complex effects through counterfactuals
- Identify high-value parameters that need more data
- More sophisticated modelling and data collection → more customizable models and insights



## Next Steps

- Prioritizing which patterns to capture through participatory modelling
- Incorporating data with different breadth and depth
- Incorporating more “human” decision-making processes (e.g. aspirations-capabilities framework)
- Distinguishing different types of migration behaviour (e.g. aspirational migration vs. displacement)

# Viele Dank!

Happy to meet in person  
until 21 July

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