

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

Nicolas Choquette-Levy
Postdoctoral Scholar | Boston University
POPJUS Migration and SD Research Group
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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

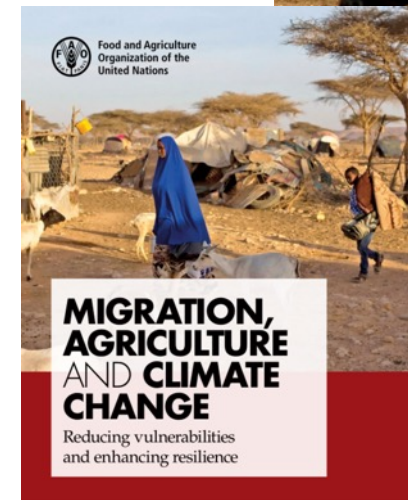
- Interaction between migration and **other livelihood diversification** strategies
- **Non-linear** human responses to climate
- Potential effects of **adaptation policy** interventions

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

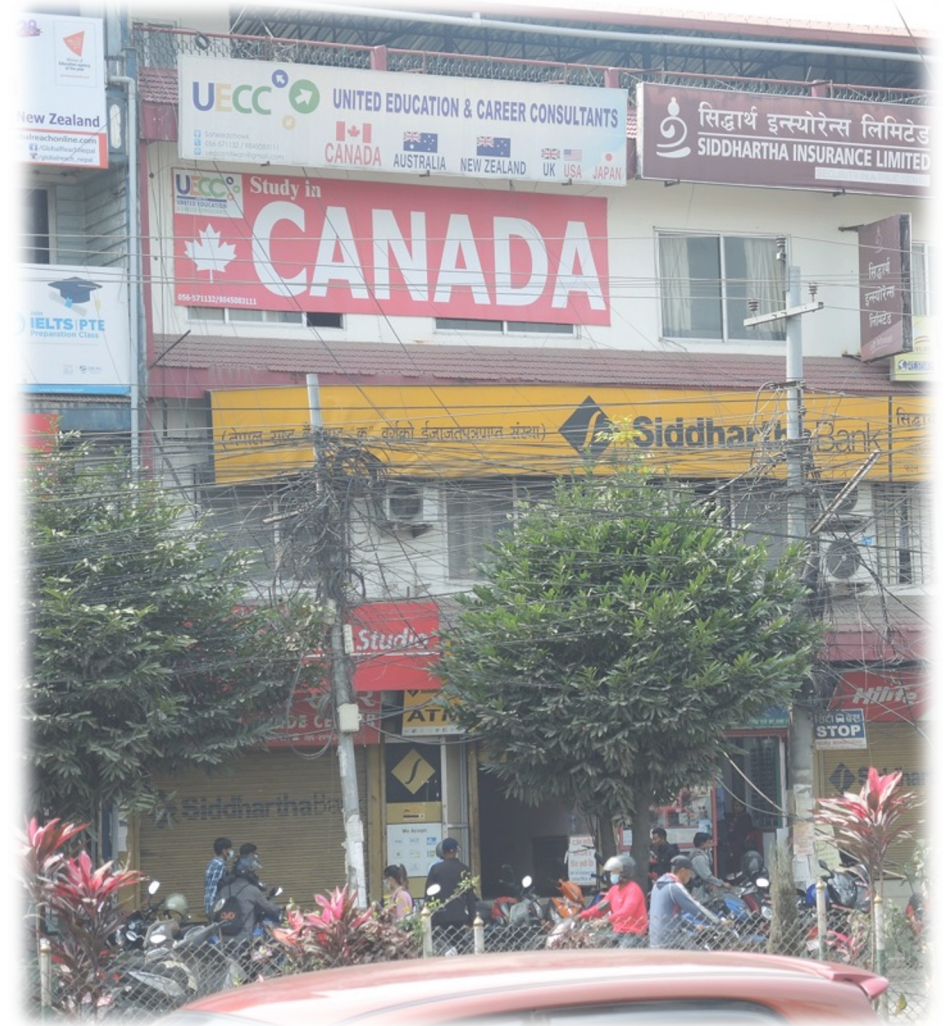
In collaboration with:

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



Motivation: Research Questions

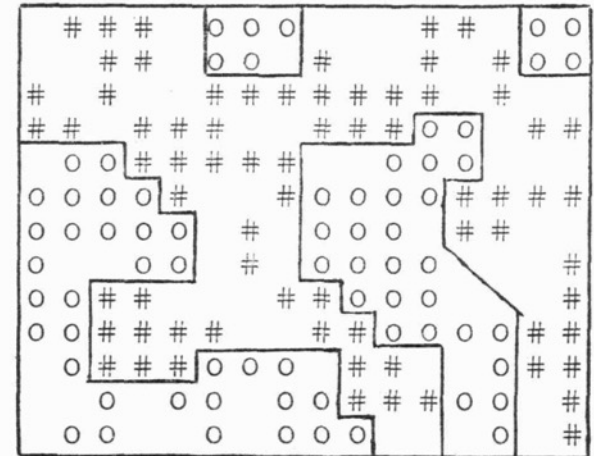
- How does **increased climate stress** impact farmers' **livelihood decisions** among a portfolio of risky strategies?
- What **decision-making factors** have the most impact on these outcomes?
- What **risk-transfer policies** can improve community outcomes (e.g. community income, inequality, poverty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

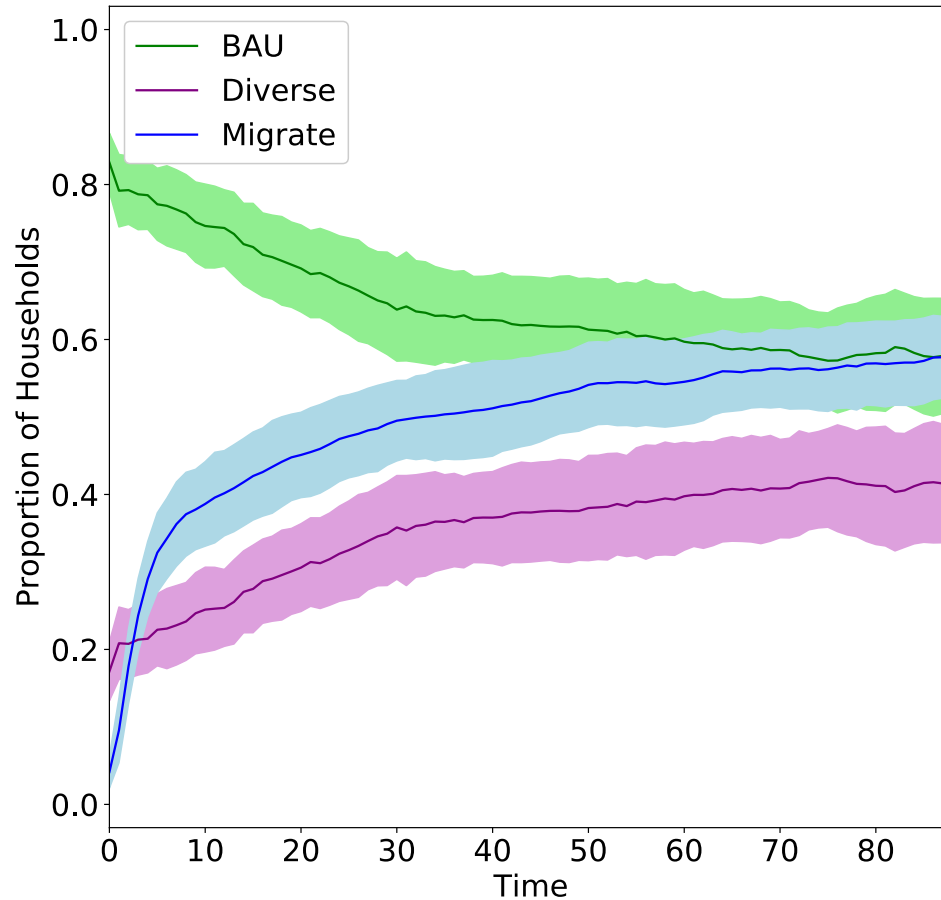


Diverse: Cash Crops

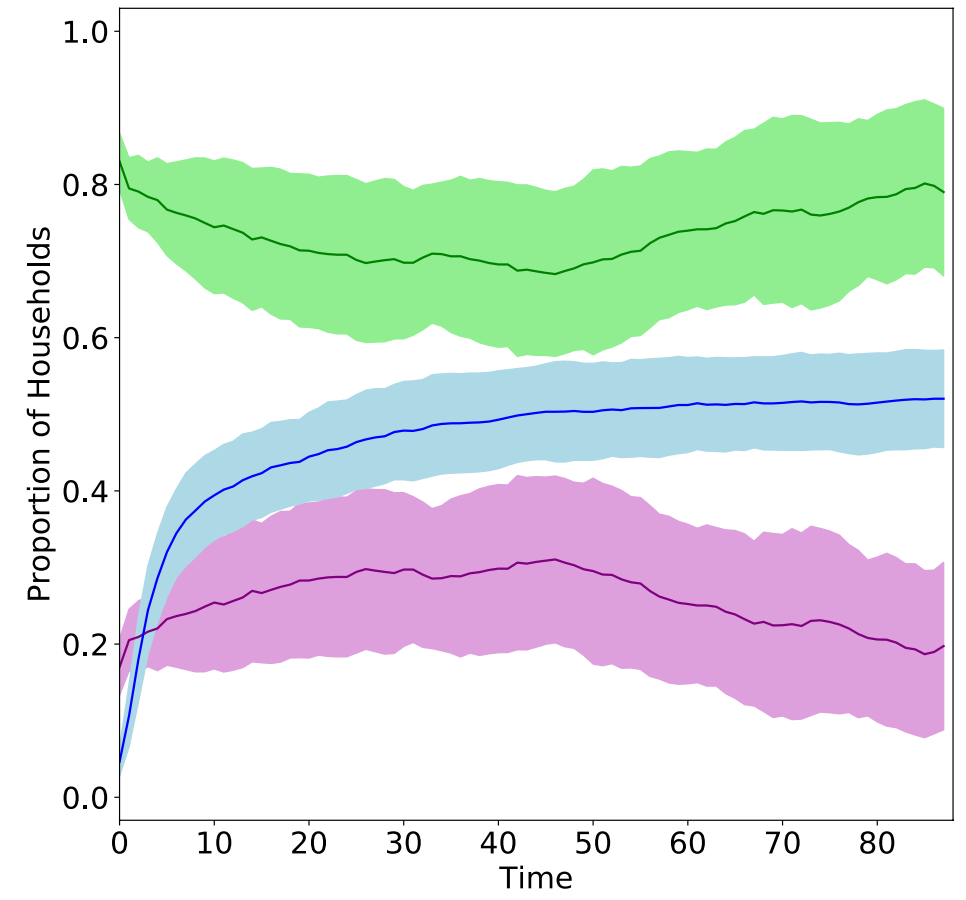
*Higher risk,
higher reward*

Results: Climate Effects on Livelihood Decisions

Stationary Climate, 2006-2050



1.5°C Temperature Increase, 2006-2050

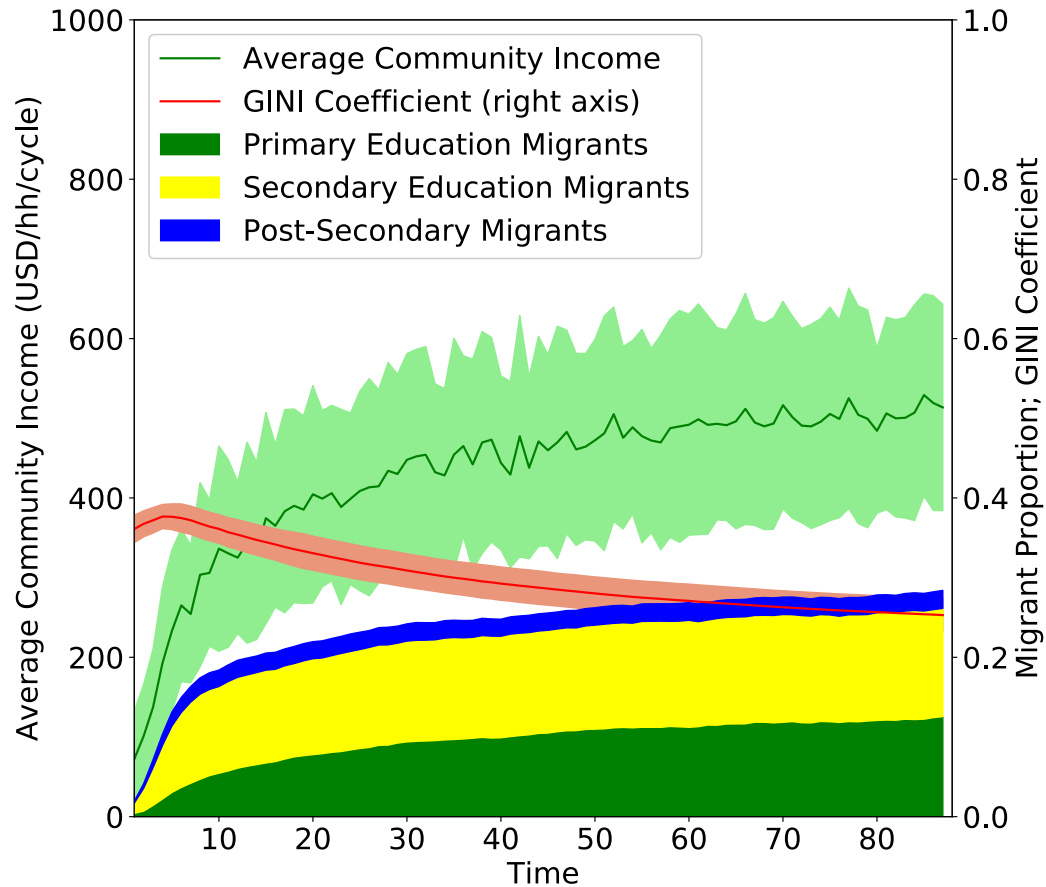


Shaded Areas:
+/- 1 Std. Dev.

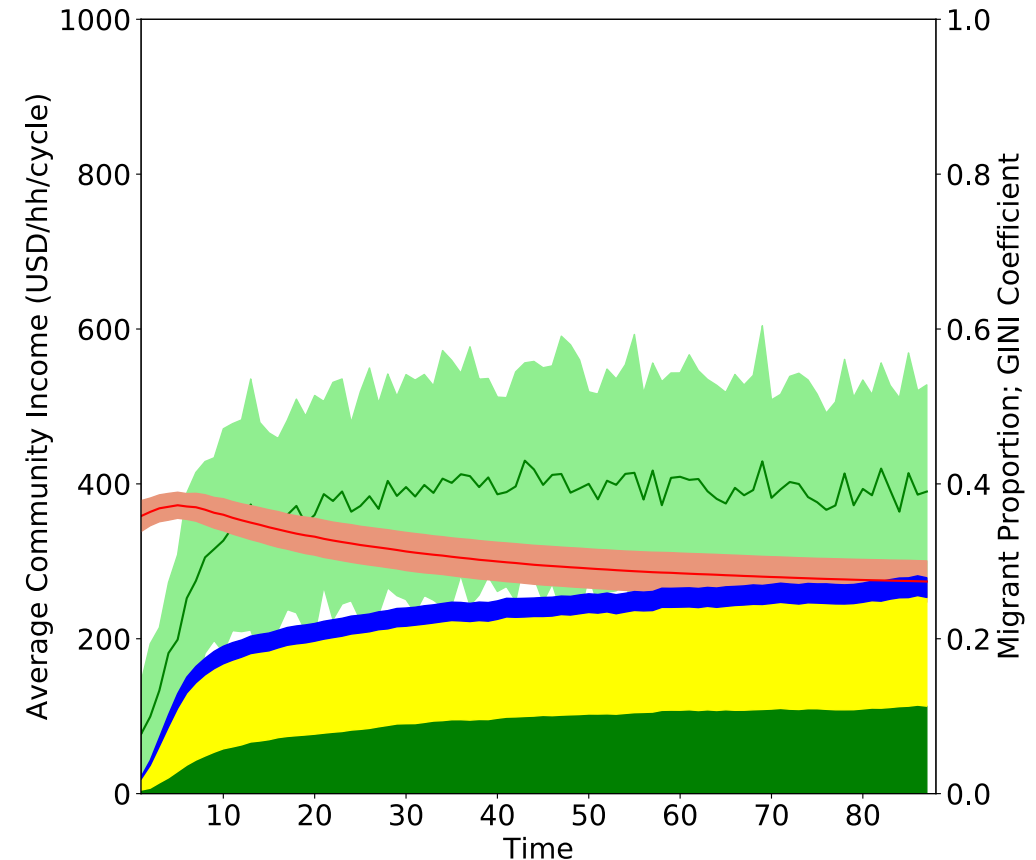
- Climate impacts **reduce the number of households** pursuing **Migration** and **Cash** crops through poverty trap: reduced income reduces ability to diversify livelihoods

Results: Climate Effects on Economic Outcomes

Stationary Climate, 2006-2050



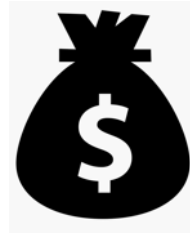
1.5°C Temperature Increase, 2006-2050



- 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

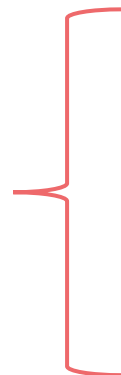
Results: Policy Impacts on Income and Migration

Sources of Stochasticity

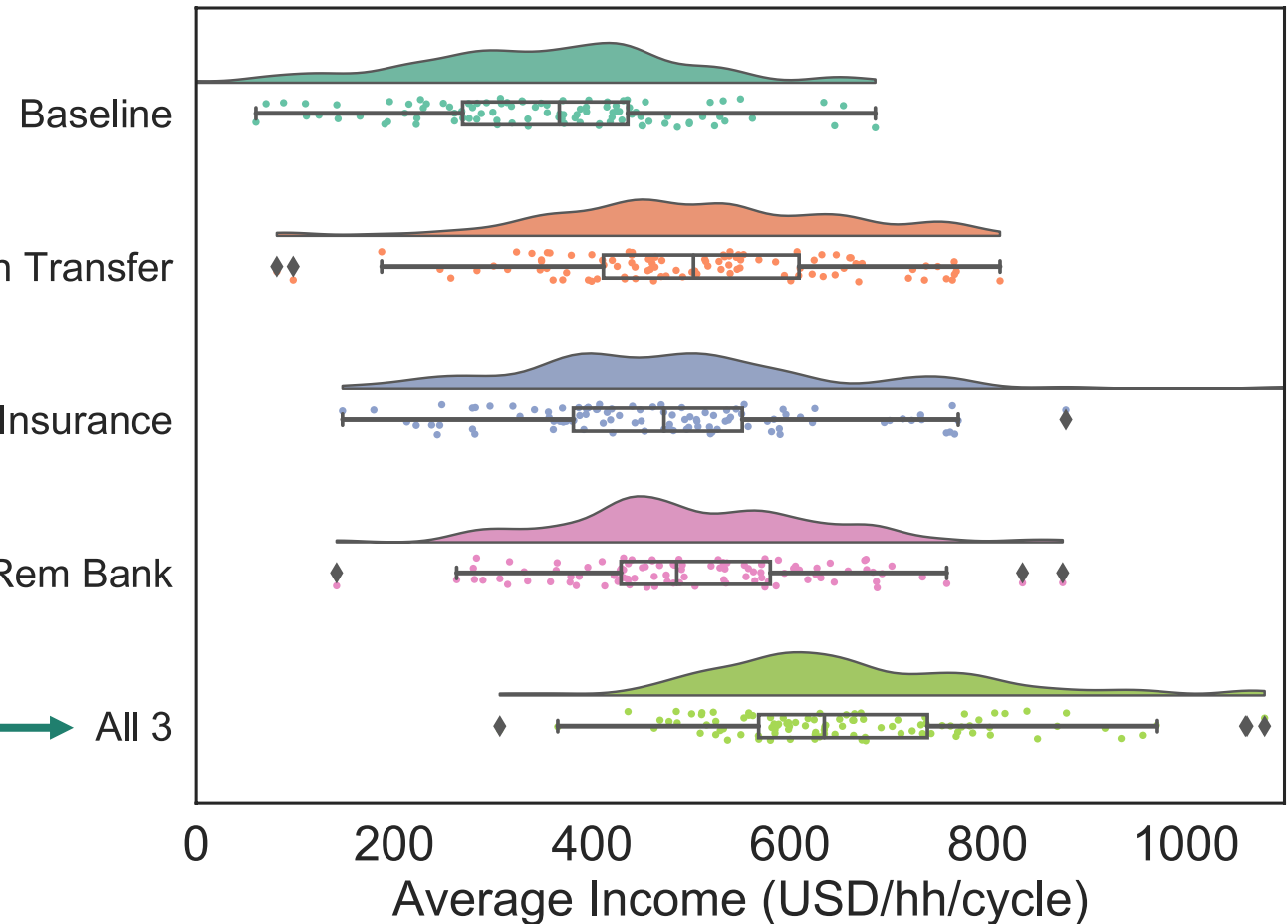
- Income draws
- Social network connections
- Occurrence of droughts

• 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**

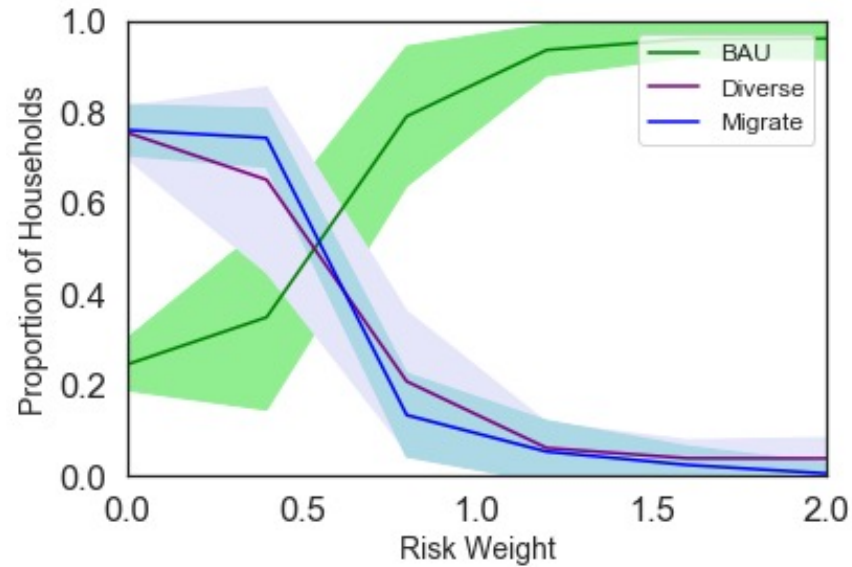


Average Community Income, 2050
(100 model simulations)



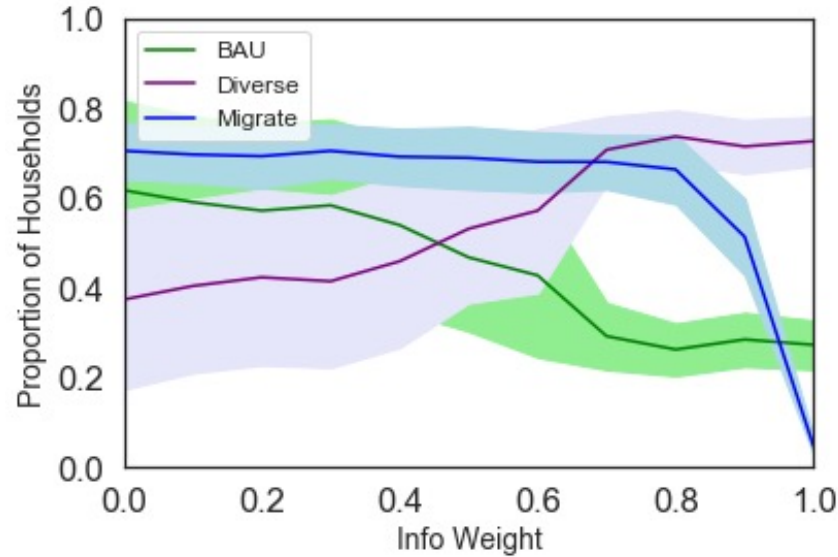
Results: Key Sensitivities

Risk Weight



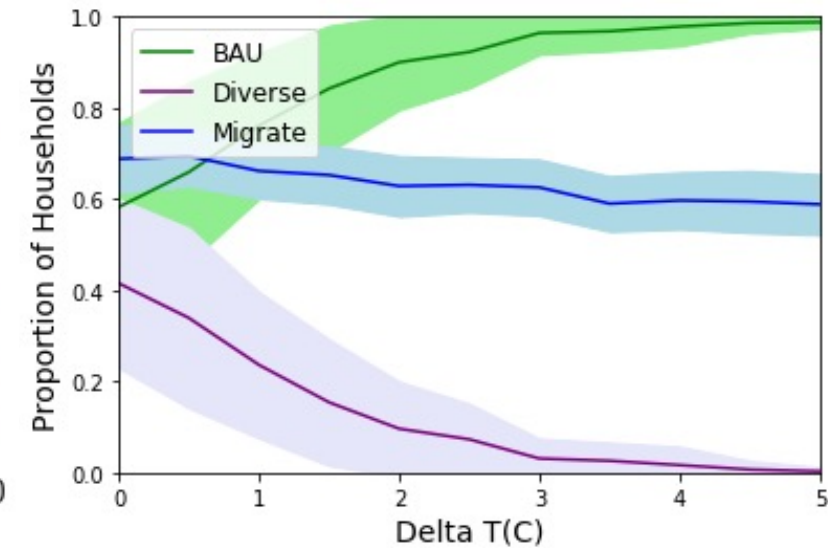
Higher risk weight decreases adoption of alternate strategies; High sensitivity between $0.5 < b < 1.0$

Weight of Objective Info



Higher weight of objective information increases adoption of Cash Crops

Temperature Increase (C)



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 Chaudhary, Rajendra Ghimire, Dil CK



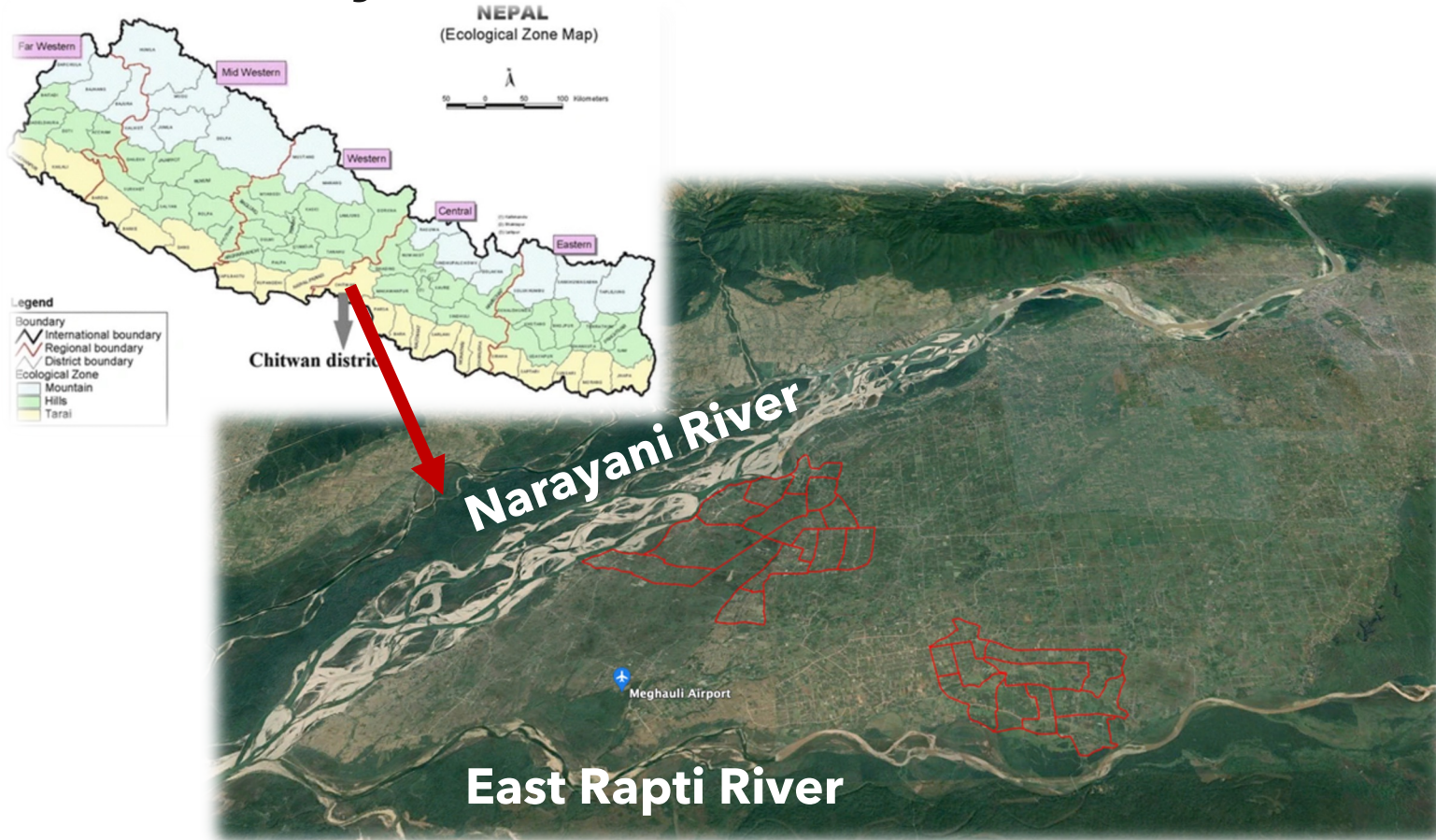
Motivation: Research Questions

- 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

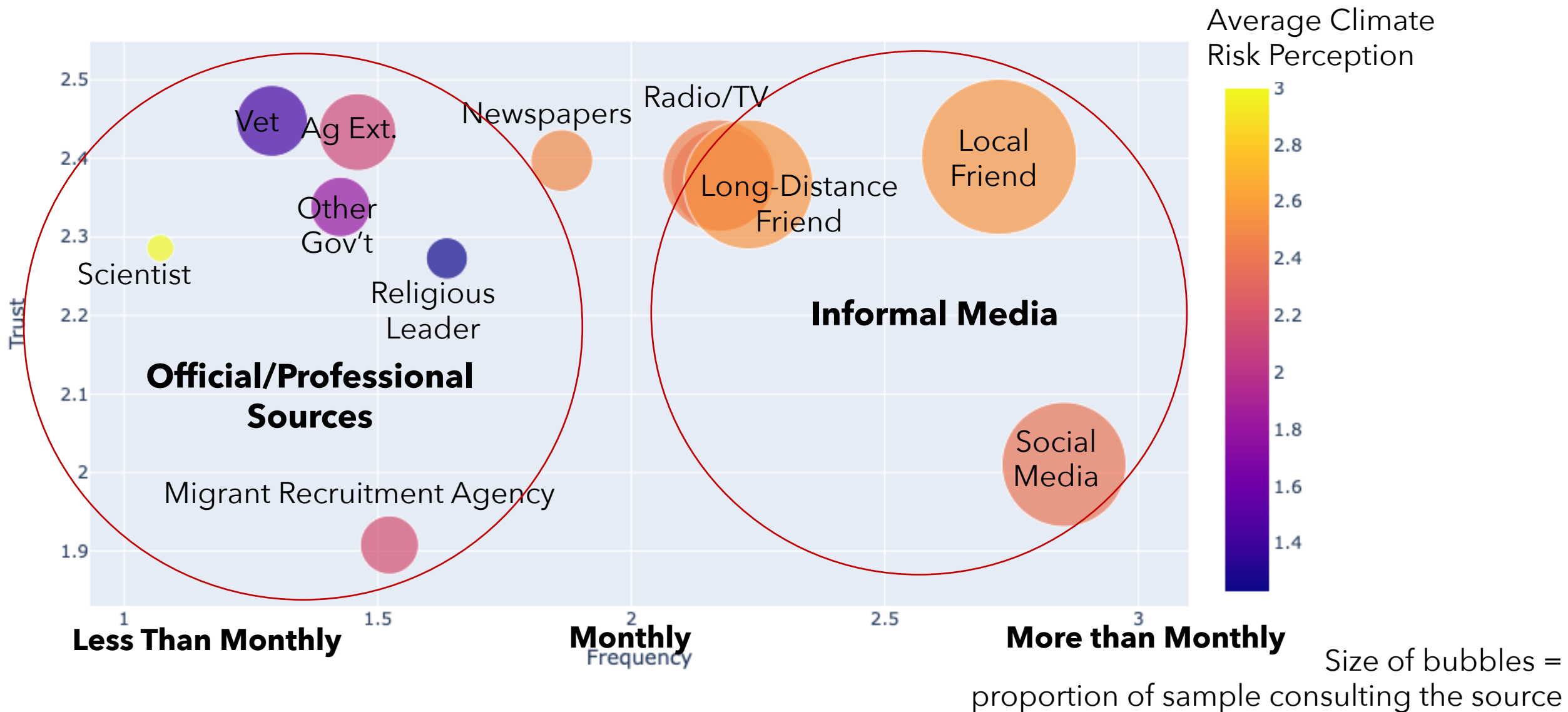
Panel data (2015-2021)

- Livelihood choices
- Incomes
- Climate exposure

Cross-sectional data

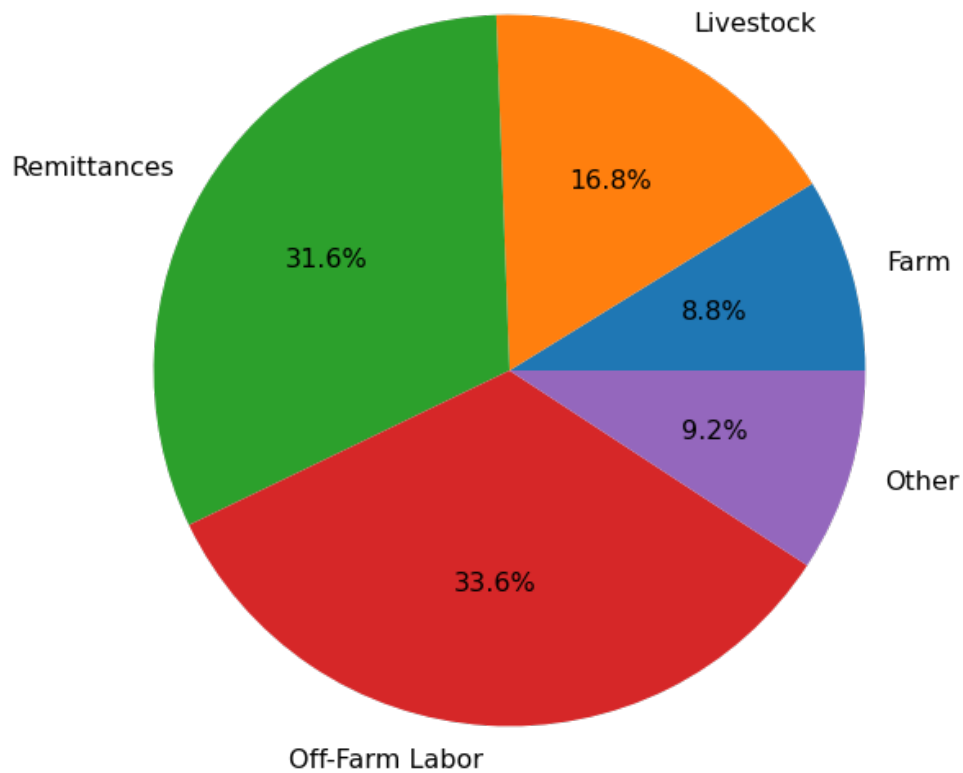
- Info sources
- Social Networks
- Risk perceptions

Results: Information Sources and Risk Perceptions

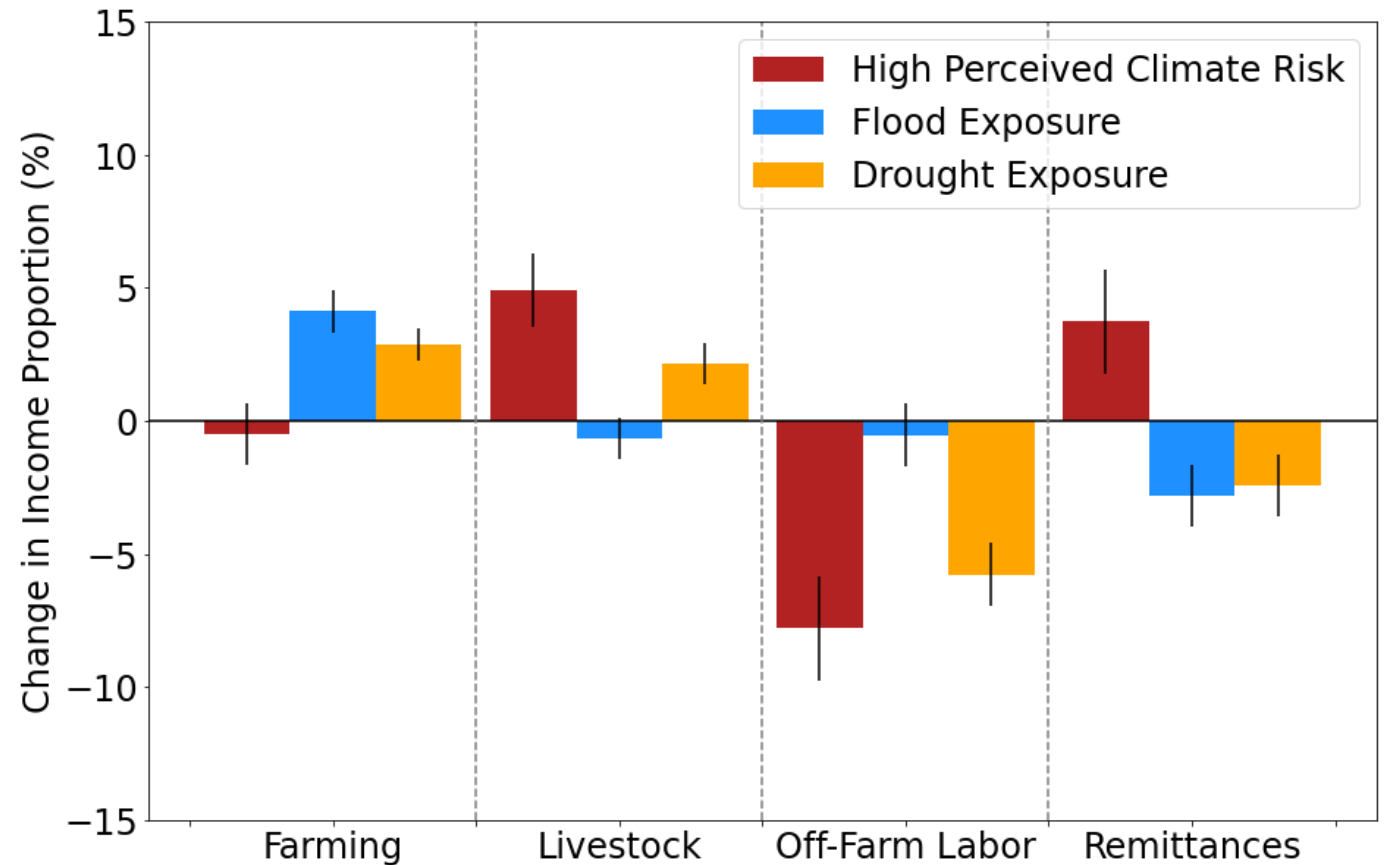


Results: What Factors Lead to Income Diversification?

Average Household Income by Source across all Years



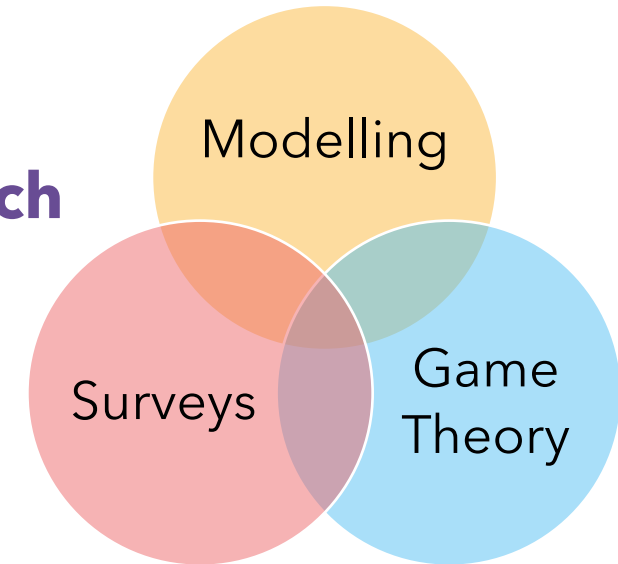
Effect Sizes on Proportion of Household Income From Each Livelihood



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

Contact

E: nclevy@bu.edu

T: [@nchoquettelevy](https://twitter.com/nchoquettelevy)

W: <https://nchoquettelevy.github.io/>

