How Does Heterogeneity in Social and Informational Capital Affect Nepali Farmer Climate Risk Management?

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Motivation and Research Questions

Increasing climate risks over the coming decades is likely to threaten the livelihoods of many of the world's 500 million smallholder farmers (i.e., those who farm on less than 2 ha of land).[1] As most smallholder farmers rely primarily on agriculture for subsistence, climate shocks may further entrench poverty traps[2] and lead to maladaptive strategies that can cascade to societal-wide shocks, e.g. involuntary displacement, deforestation, and food insecurity. Therefore, developing a better understanding of tools that can build smallholder farmer adaptive capacity is a key part of developing societal-level climate resilience. In particular, previous work has demonstrated that access to accurate information may significantly impact the propensity of subsistence farming households to adopt *ex ante* adaptation measures,[3–6] but the degree to which these communities are heterogeneous in access to information sources and social networks is still understudied.

In this study, we analyze how farmers' information sources, social networks, previous experience with climatic events, and other sources of demographic heterogeneity (including ethnic identity, educational attainment, and income) shape perceptions of climate risks and potential adaptation strategies. Specifically, through a cross-sectional survey of 500 farming households in the Chitwan Valley of south-central Nepal, this study assesses two main research questions. First, how salient is climate change to farmers' perceptions of livelihood risks, relative to other established risk factors, e.g. access to financial and human capital, availability of farming inputs, and access to markets? Second, how do smallholder farmers' information sources, social networks, and previous experience with climate hazards affect (i) perceived climate risks to livelihood, and (ii) their livelihood strategy choices?

By addressing these questions, we seek to make three contributions to the literature on climate adaptation and demographic heterogeneity, with a focus on subsistence farming communities. First, we assess how differential access to several types of information sources – including conventional radio/TV/print media, digital media, government offices, farmer social networks, and migrant networks – affect perceptions of climate risks specifically, and perceived risks to various livelihood strategies. Second, we investigate how differential exposure to climate hazards (e.g. households living in proximity to flood-prone rivers, vs. those in dryland areas) affect these outcomes. Finally, we assess how risk perceptions are linked to both historical livelihood choices and future livelihood choices, including farming cereal crops, farming cash crops, raising livestock, and/or engaging in rural-urban migration. These contributions help advance the knowledge base on how demographic heterogeneity may translate to differential adaptive capacity within subsistence farming communities, and identify policy priorities to build resilience among the most vulnerable populations.

Theoretical Framework and Hypotheses

This study seeks to test hypotheses emerging from two theoretical frameworks that are especially relevant to questions of how subsistence farming households perceive and act on climate risk. The New Economics of Labour Migration (NELM) postulates that households engaged in rural livelihoods seek to minimize risks to their livelihoods and overcome constraints in access to financial capital.[7] Additionally, households will seek to minimize the sense of relative deprivation, or a perceived gap between their well-being and that of others in their social network.[8] A common strategy to cope with risk is to diversify sources of household income by engaging in multiple livelihood strategies, including rural-urban migration.[9] Based on these principles, if households perceive elevated risks to their livelihoods due to climate change, especially in emerging market contexts with limited access to financial services, then they should be more likely to diversify their livelihood portfolios. Furthermore, we hypothesize that households with larger social networks are more likely to be aware of alternative livelihood strategies, and may be more likely to feel a sense of relative deprivation, further amplifying the likelihood of changing strategies. Conversely, households with smaller social networks, and/or higher financial capital, may be less likely to change livelihood strategies. Therefore, our first formalized hypothesis is:

- *H1: Farmers' perception of overall climate risk to their livelihoods will be positively correlated with (a) their past experience of climatic events and (b) the size of their social networks, and negatively correlated with (c) their access to financial capital.*

A second relevant theory from the decision sciences is Protection Motivation Theory (PMT), which states that decision-makers generally seek to mitigate the risk of perceived threats.[10,11] The degree to which they act in accordance with this principle depends on two main variables: the perceived severity of a threat, and the perceived capacity to mitigate this risk.[12] Therefore, the more that farming households perceive climate change as a threat, and/or the more that such households believe they have sufficient resources to mitigate climate hazards, the more likely they should be to take observable forms of climate adaptation (including planting different crops, changing the timing of planting and harvesting seasons, and/or changing livelihood strategies). Here, we hypothesize that households with recent experience with climate hazards are more likely to perceive climate change as a salient risk to their livelihoods. Furthermore, access to diverse sources of information is likely to increase the perceived severity of climate change, as well-informed households are more likely to hear of and understand climate information. Finally, in contexts with limited access to formal institutions, households with larger social networks are more likely to believe they have the financial and social capital to address such risks. Our second formal hypothesis is thus:

- *H2: Farmers' likelihood of taking an adaptive action to a climate event (e.g. switching crops or sending a household member as a migrant) will be positively correlated with (a) past experience with climate hazards, (b) the diversity of information sources to which they have access. and (c) the size of their social networks.*

The conceptual model that underlies our hypotheses regarding farmers' climate risk perceptions and propensity to engage in adaptive strategies is summarized in Fig. 1.

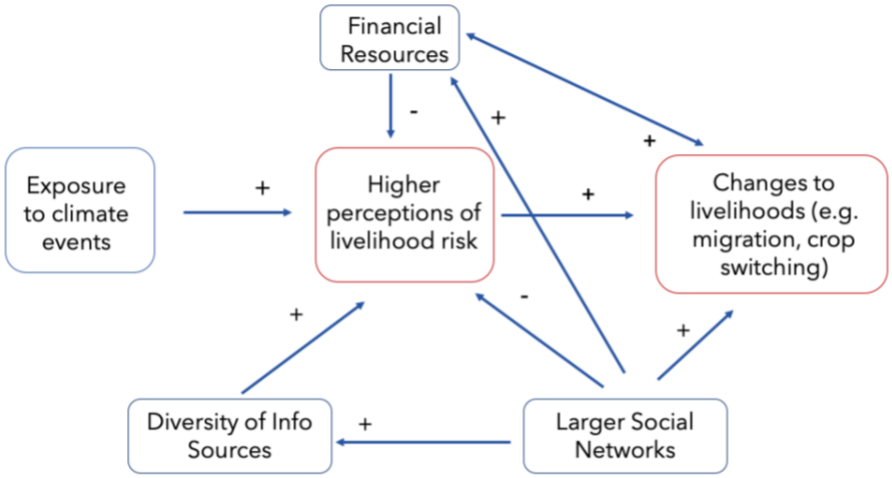

Fig. 1. Conceptual model of farmers' risk perceptions and propensity to change livelihood strategy. The hypothesized directional relationships between key factors affecting farming households' perceptions of risks to their livelihoods and propensity to change livelihood are indicated via a '+' (for positive correlation) or '-' (for negative correlation). Our research design incorporates changes to livelihood strategies as a key dependent variable, with perception of livelihood risk a key intervening variable. Exposure to climate events, financial resources, diversity of information sources, and size of social networks are all posited as key independent variables that may vary across a subsistence farming community.

Methods and Data

To test these hypotheses, we administered a cross-sectional, face-to-face survey of 500 farming households in Nepal's Chitwan Valley from May – July 2022. Agricultural communities in Nepal are a particularly important case study for such questions, given the country's high dependence on rainfed, subsistence agriculture;[13] low access to formal financial institutions and non-farm livelihoods; and high vulnerability to several climate risks, including floods, droughts, and changes in monsoonal precipitation patterns.[14–16] The Chitwan Valley is one of the country's main agricultural regions, cultivating a variety of subsistence and cash crops, and livestock ranging from capital-intensive buffalo and cows, to less-expensive goats and chickens. The region is also home to a diverse mix of ethnic and caste groups, including Brahmin, Chetri, Gurung, and Indigenous Tharu and Janjati populations. Additionally, over the last 20 years, the Chitwan Valley has seen a marked increase in outmigration to several countries, including India, Saudi Arabia, Qatar, and East Asian countries.[17–19] This study site therefore provides a high degree of variation in livelihood strategies, ethnic/caste identity, and connection to migrant networks, which allows us to assess how multiple forms of demographic heterogeneity may translate to important differences in factors hypothesized to underlie risk perceptions and climate adaptation strategies.

Geographically, the 15 km by 30 km region is located in the *Terai* plains and is transected by two main rivers, the Narayani and East Rapti, with different propensities to flood during the monsoonal rains. We exploit variation in exposure to climate hazards by stratifying the survey sample was stratified into three groups. We create two treatment groups of 200 respondents that are located within 1 km of each riverbank, and a control group of 100 households located in upland farming areas, at least 3 km from either river. This design allows us to test for localized variation in climate risk exposure, while controlling

for similar economic and political conditions across the region, strengthening causal inference regarding the impact of past climatic events on livelihood risk perceptions and adaptation strategies.

Survey questions were designed to measure the main dependent variables of this study: respondents' livelihood choices (including farming cereal crops, farming cash crops, raising livestock, engaging in non-farm livelihoods, and engaging in rural-urban migration) and climate adaptation strategies (including changing the timing of planting/harvesting, planting new crop varieties, purchasing insurance, etc.) in each year from 2015-2021. We further assess two groups of intervening variables: respondents' perception of the severity of various climate hazards (including droughts, floods, hailstorms, heat waves, etc.) and their perception of overall risk to livelihood options. We also measure several independent variables, including respondents' access to various information sources, the size and types of the social networks to which they belong, access to financial resources, and self-reported experience with past climate events. Finally, we conduct a vignette experiment in which households are read a prompt of a hypothetical policy that seeks to minimize risks to various livelihoods (either crop insurance or a cash transfer). Households are asked to assess their likelihood of adopting each of 11 livelihood options in the next 3 years both before and after the prompt, providing within-subjects variation that can be used to further assess the effect of risk perception on livelihood choices. Data collection was finalized in early July 2022, with the data cleaning and analysis stages currently underway.

The survey measures several covariates that may mediate these relationships, including household income, educational attainment, ethnic/caste group, and land tenure. A key assumption in our research design regards the direction of causality: we assume that information sources, social networks, and access to capital are more static and affect household risk perceptions, which in turn influence livelihood choices. However, reverse causality is also possible, e.g. if livelihood choices influence risk perceptions, social networks, and/or access to capital. We discuss strategies to address this endogeneity in the next section.

Data Analysis Plan

To test hypothesis *H1*, we will conduct a series of ordered probit regressions to test the impact of heterogeneity in household information sources, social networks, and previous experience with climate events on the two main intervening variables: perceptions of climate risks and perceptions of livelihood risks. As these variables are measured on a Likert scale, an ordered probit can allow for more precise estimation of how changes in the independent variables may lead to changes in the intervening variables. To test hypothesis *H2*, we plan to conduct a series of logistic regressions on households' livelihood and adaptation choices. Here, we are especially interested in measuring which factors are significant in predicting the propensity of households to adopt an adaptation action, and/or report a change in livelihood strategies during the seven-year period from 2015-2021. To control for possible endogeneity between livelihood choices and risk perceptions (i.e. that risk perceptions are influenced *ex post* by household livelihood decisions), we plan to compare models using respondents' self-reported livelihood risk perceptions with models that estimate this variable through our set of independent variables and covariates.

We expect to obtain initial results from this analysis in August-September 2022. While we currently do not know the degree to which our hypotheses will be supported or refuted, we expect our findings to be useful in designing more effective climate information services for subsistence farming communities with similar characteristics as the Chitwan Valley: a high reliance on rainfed agriculture, a monsoonal climate. and high degree of outmigration.

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