Nexus between Climate Change and Inequality in Nepal: Evidence from Long Run Temperature Deviations

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Background

The New York Times

As Himalayas Warm, Nepal's Climate Migrants Struggle to Survive

Pushed out of their village by a drought and lack of food, a group of Nepalis are fighting to amplify the voices of those forced to relocate by the planet's warming.

By Bhadra Sharma and Kai Schultz Photographs by Rebecca Conway

April 5, 2020

Background

Climate change

- Not limited to only physical and chemical consequences
- Far-reaching socio-economic ramifications(IPCC et al., 2022)
- Twin issues for the marginalized
  1. Extreme vulnerability
  2. Low-adaptation capacity
- Widening existing and intergenerational inequalities(Otto et al., 2017)

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Nepal

- Contributes 0.04 percent of annual global CO_2 emissions (Our World In Data, 2021)
- Yet, one of the most vulnerable nations to climate change

Research Question

Does climate change increase income inequality in Nepal?

Literature Review

In the literature: General consensus

- Negative impact of higher temperatures on income (Dell et al., 2014)
- Significant impact on poor countries (Tol et al., 2004)
- Most potential channel of effect: agriculture

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Not in the literature: General Caveats

- Dearth of disaggregated microeconomic investigations
- Less emphasis on with-in-country inequality
- Limited work on the identification of the mechanisms

Literature Review

What's new?

- Near causal estimates of the higher temperatures using deviations from long-run average
- Exhaustive identification strategies for agriculture pathway hypothesis
- First study to explore this empirical relationship in the Nepalese context

Theoretical Framework

Impact of higher temperatures on agriculture

- Adverse impact in the developing world (Mendelsohn, 2009)
- Prominent pathways (Paglialunga et al., 2022)
  1. Reduction in agriculture output
  2. Relative decline in labor productivity
  3. Existing social and environmental vulnerability
- Extensive evidence in the context of Nepal
  1. Reduction of 4183 kg in rice production with a degree Celsius rise in the average summer temperature (Rayamajhee et al., 2021)
  2. Significant decrease in overall agricultural output and productivity of major crops (Chalise et al.,2017)

Theoretical Framework

Agriculture pathway hypothesis:

- Disproportionate effect on the income of poorer households
- Greatest share of income coming from agriculture
- Unequal effect; hypothesized to be driven by the exposed vulnerabilities of agriculture dependence
- Agriculture as the most potential mechanism

Data

Income

- Three waves of Nepal Living Standard Survey (NLSS) (1995/96, 2003/04, 2010/11)
- By the National Statistics Office (NSO), Nepal
- Living Standards Measurement Survey (LSMS) methodology developed by the World Bank
- Disaggregated income with other household-level characteristics

Data

Climate

- NASA Langley Research Center (LaRC) POWER Project
- NASA's power access API, also publicly available
- 18 climatic variables, 93 weather stations, 62 districts, for a period of four decades (1981-2019)
- Temperature at 2 meters (degree Celsius) and Precipitation (mm/day) are used.

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Pooled: Repeated cross-section

- 10274 households– 2552 from NLSS-I, 3064 from NLSS-II, and 4658 from NLSS-III with district-level weather shocks

Data

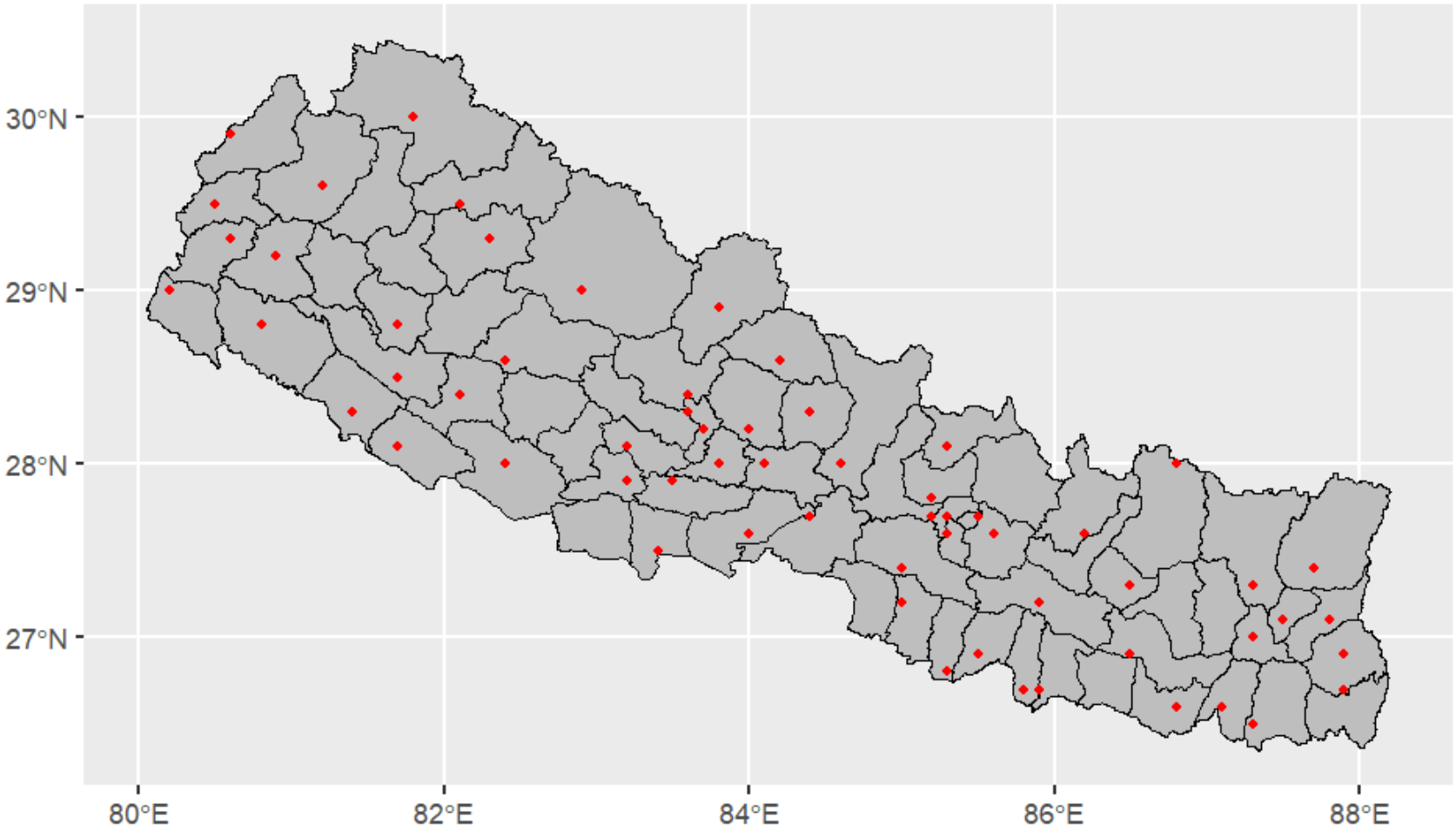

Figure: Distribution of weather stations of climate data across Nepal

Econometric Model

Pooled Ordinary Least Squares (OLS) with year and region-fixed effects

$$Y_{i,t} = \gamma_0 + \sum_{i=0}^{2}\sum_{j=1}^{2}(\alpha_{i,j}T_{i,t-i}^{j} + \beta_{i,j}P_{i,t-i}^{j}) + \gamma_1 \mathbf{X_{i,t}} + \delta_i + \lambda_t + \delta_i \times \lambda_t + \epsilon_{i,t}, \quad (1)$$

- Deviations of climatic variables from long-run average (Kahn et al., 2019) with rescaling (1/100 degree C and 1/10 mm)
- Quadratic terms and lagged weather conditions up to the second lag
- Interaction between the region and year-fixed effects
- Standard errors clustered at district level
- Disaggregation of (1) by quartiles, types of income, and region for identification

Exploratory Data Analysis I

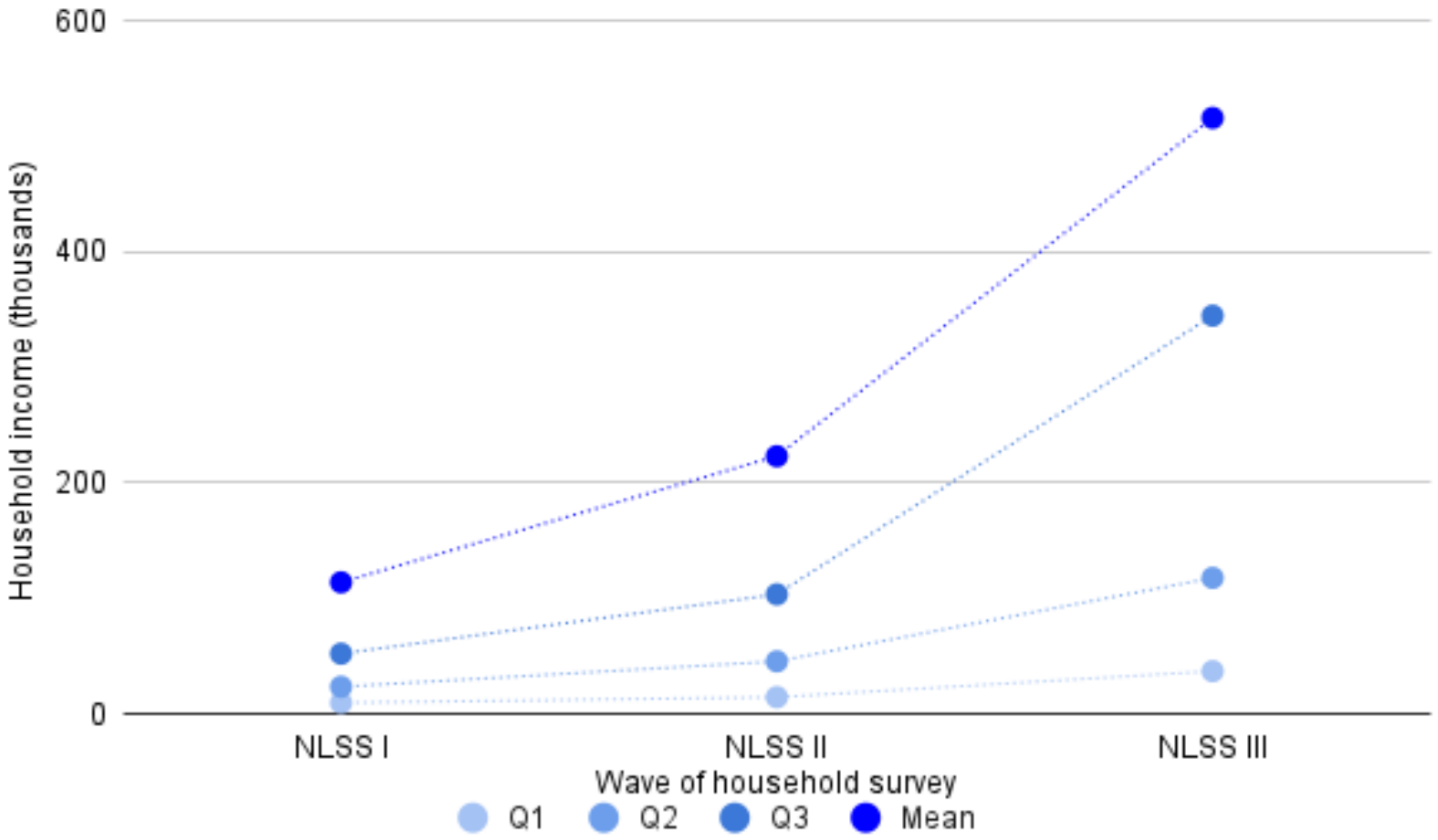

Figure: Evolution of household income over the surveys (quartiles and mean)

Exploratory Data Analysis II

Figure: Deviations of annual climatic variables from their long-run averages

Descriptive Statistics

Variables	Mean	SD	Median
Income	325475.35	2182730	54350
Log per capita income	9.23	2.13	9.32
Log per capita agricultural income	7.07	1.64	7.12
Log per capita non-agricultural income	9.07	2.48	9.32
Temperature (ºC)	17.99	5.47	17.38
Total precipitation (mm)	872.98	328.79	829.59
Household size	5.27	2.62	5

Number of observations (n)= 10274

Average Effect

Variables	(1) Log inc	(2) Log per cap	(3) Log per cap	(4) Log per cap
An temp dev (1/100 ºC)	-0.00424***	-0.00403***	-0.00202	-0.0179**
	(0.00139)	(0.00141)	(0.00351)	(0.00732)
An tot prec dev (1/10 mm)	-0.0409***	-0.0448***	-0.00921	-0.0553
	(0.00646)	(0.00652)	(0.0183)	(0.0395)
An temp dev sq.			7.81e-05	6.53e-05
			(5.72e-05)	(9.35e-05)
An tot prec dev sq.			0.000166	0.00463**
			(0.000790)	(0.00188)
Household size	0.0891***			
	(0.00729)			
Observations	10425	10425	10274	10274
Exogenous controls	Yes	Yes	Yes	Yes
First Lag and quadratic term	No	No	Yes	Yes
Second Lag and quadratic term	No	No	No	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Region fixed effects	No	No	Yes	Yes
Ethnicity Fixed effects	No	No	Yes	Yes
Region × Year	No	No	No	Yes
Adjusted R^2	0.1853	0.1991	0.2299	0.282

Standard errors in parentheses (Model 4-Clustered at district level)
*** p<0.01, ** p<0.05, * p<0.1
Exogeneous controls include Gender and Location.

Decomposition of Effect by Quartiles

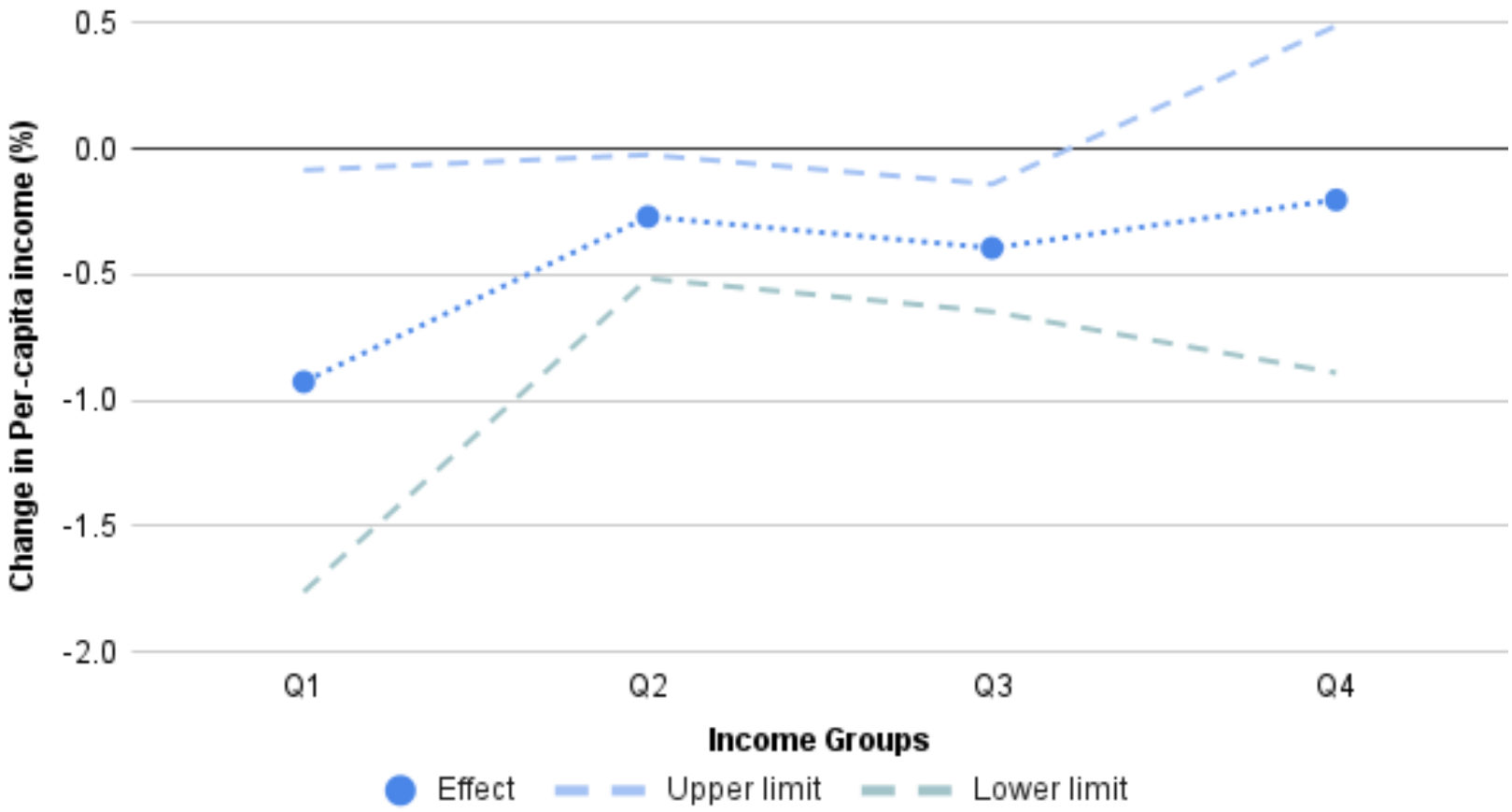

Figure: Estimation results by Income Groups

Identification

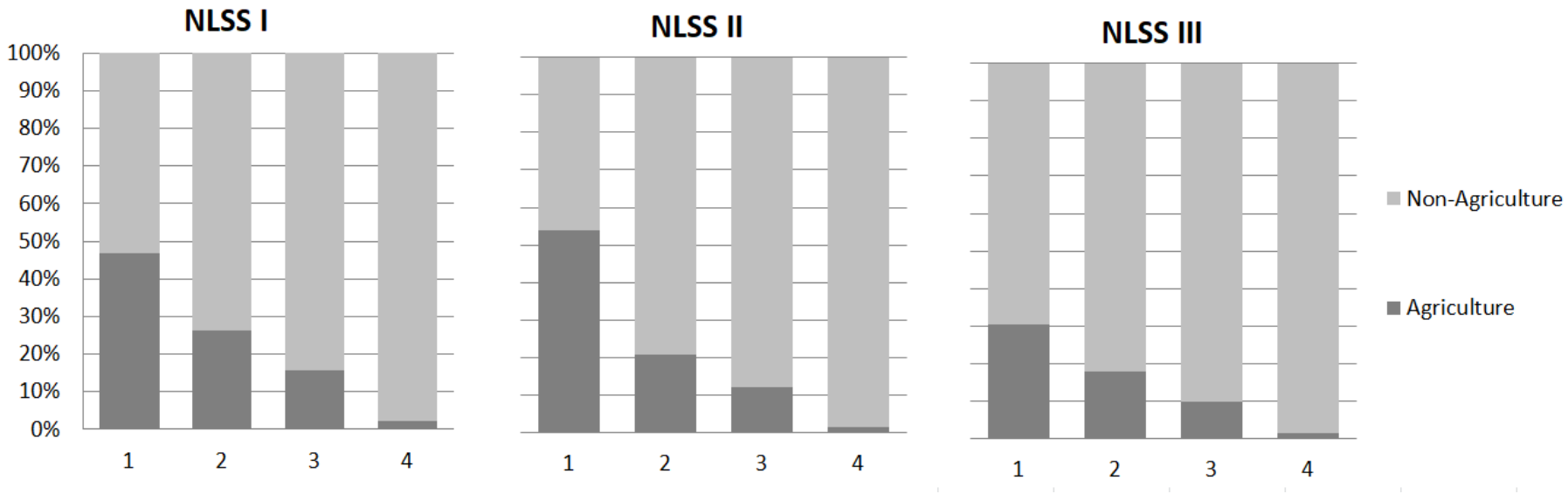

Figure: Evolution of per-capita agricultural and non-agricultural income for each quartile over the surveys (in percentage)

Identification

Evidence for the agriculture pathway hypothesis

- Dependence on agriculture resulting in the apparent vulnerability
- Significant effect on only agriculture income (Appendix I)
- Impact observed only for the Terai region; the bread basket of Nepal (Appendix II)

Discussion and Conclusion

Major Findings

- Negative effect of higher temperatures on per-capita income
  1. Decrease in the per capita income by 1.77 percent with a 0.01 degree Celsius rise in the temperature above the long-run average
  2. Suggests an 11.04 percent loss in 2027, 22.08 in 2043, and 89.2 in 2075. (Based on warming prediction by Kahn et al., 2019)
- Concentrated in lower quartiles (Q1, Q2, Q3); first quartile (greatest impact) and last (no significant effect)
- Higher temperatures are exacerbating income inequality in Nepal
- Extensive evidence for the Agriculture Pathway Hypothesis

Discussion and Conclusion

Policy implications

- Call for extensive climate change mitigation and adaptation
- Effective social protection for the poor
- Initiatives for climate-resilient agriculture
- Climate justice: involved international support

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Further extension of this work

- Long period of income and more disaggregated climate panel data
- Cross-country studies with household-level microdata
- Casual identification strategy

Thank You for Listening

Any questions, suggestions, or feedback are heartily welcome!

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Appendix 1

Variables	(1) Agriculture	(2) Non-Agriculture
Annual temperature deviation (1/100 ºC)	-0.00916**	-0.0104*
	(0.00404)	(0.00534)
Annual total precipitation deviation (1/10 mm)	0.00856	-0.0510*
	(0.0280)	(0.0269)
Annual temperature deviation lag (1)	-0.00150	-0.00530
	(0.00358)	(0.00407)
Annual total precipitation deviation (1)	-0.0804	-0.0620
	(0.0577)	(0.0577)
Observations	5292	9502
Second Lag	Yes	Yes
Controls (Female, Rural, Agri house)	Yes	Yes
Year fixed effect	Yes	Yes
Region fixed effects	Yes	Yes
Ethnicity Fixed effects	Yes	Yes
Region × Year	Yes	Yes
Adjusted R-squared	0.1	0.20

Robust and clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix 2

Variables	(1) Mountain	(2) Hill	(3) Terai
Annual temperature deviation (1/100 ºC)	-0.0183	-0.0154	-0.0104***
	(0.0136)	(0.0108)	(0.00351)
Annual total precipitation deviation (1/10 mm)	-0.0189	-0.0878*	2.06e-05
	(0.107)	(0.0514)	(0.0335)
Annual temperature deviation lag (1)	-0.00420	-0.000671	-0.00584
	(0.0132)	(0.00577)	(0.00646)
Annual total precipitation deviation (1)	-0.171	0.00511	-0.115
	(0.145)	(0.0756)	(0.0985)
Observations	978	5987	3309
Second Lag	Yes	Yes	Yes
Controls (Female, Rural, Agri house)	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Ethnicity Fixed effects	Yes	Yes	Yes
Adjusted R-squared	0.267	0.277	0.263

Robust and clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1