Climate Change in the Andes: Predictions, Perceptions and Adaptation by Rice Farmers

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CLIMATE CHANGE IN THE ANDES: PREDICTIONS, PERCEPTIONS AND ADAPTATION BY RICE FARMERS

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Introduction

Rice farmers in Peru are one of the world's social groups that are more highly and heterogeneously exposed to climate change. Rice cultivation is vulnerable not only to higher temperature, water scarcity and drought (especially during the growing season), but also to excessive flooding (in particular during the ripening phase).

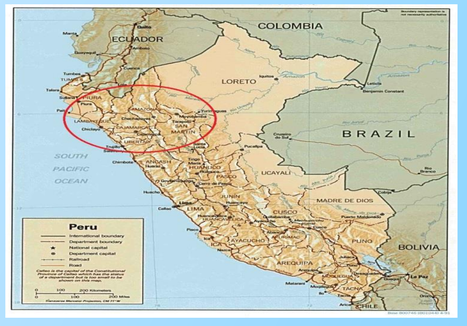
First, we compare climate change aggregate and weather station observations with farmers' perception of climatic changes. While aggregate climate predictions provide important guidance for impact mitigation policy, actual climate perceptions and coping behavior observations provide a unique view into the heterogeneity of households' exposure to climate risks and related livelihood stresses. We also examine the complexity of adaptation strategies by evaluating the complementarity/substitutability between different coping actions.

Our analysis has important policy implications for the establishment of national rice production goals and recommendations on how to achieve these goals. Indeed, while a national policy goal was to shift rice production in the coast to the forest area because of the higher water availability in the latter region, our study shows that the heterogeneous effects of climate change across the country may be altering production conditions in ways that could merit the reformulation of government goals.

Data

We use a survey of 497 rice producers in northern Peru administered by the Peruvian Institute for Agrarian Innovation (INIA) and the International Center for Tropical Agriculture (CIAT). This research was conducted in order to gain knowledge on the characterization of agricultural plots managed by men and women in the main rice producing departments in the country (Amazonas, Cajamarca, La Libertad, Lambayeque, Piura and San Martin). The field work was carried out between October and December 2012 in both coastal and forest regions. The questionnaire was directed to rice farmers with less than 10 hectares.

Figure 1 – Survey region (circled in red)



Aggregate and Weather Station Observations

Figure 2 – Spatial distribution of change in annual mean temperature Celsius/decade) (1965-2006)

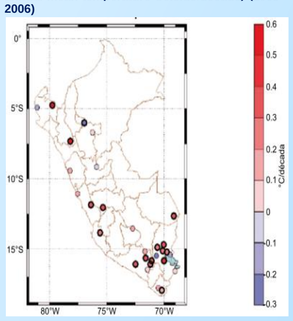
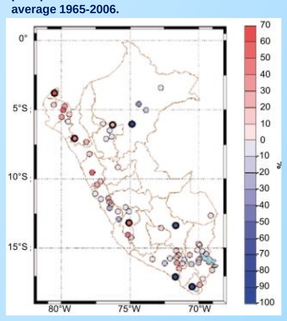
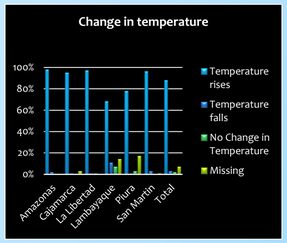


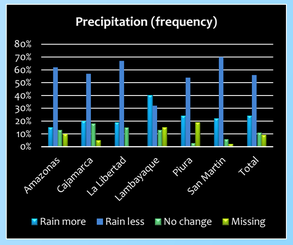
Figure 3 – Linear trend of total annual precipitation in % relative to the multiannual average 1965-2006.



The average increasing trend in air temperature has been established. According to the National Meteorological and Hydrological Service of Peru (SENAMHI), the average temperature in Peru has increased by 0.2 degree Celsius over the last 40 years. Unlike temperature, there is not a clear majority of sites presenting increases or decreases in precipitation at the national level. Average rainfall has increased on the coast and in the northern Andes and decreased in the northern Amazon (SENAMHI 2009).

Farmer Perceptions vs. Aggregate and Weather Station Observations





Consistent with weather station data, we find that the majority of households in all departments perceive that the temperature has increased in the last 5 years (2007-2012).
While weather station observations suggest a generalized increase in precipitation in coastal departments, farmer perception data show a majority of households perceives a decrease in rainfall frequency in two of the three coastal departments (La Libertad and Piura), with a minority also perceiving a decrease in the third one (Lambayeque). Perceptions in the forest departments (Amazonas, Cajamarca and San Martin) are better explained by weather station data, since the majority of farmers in these departments perceive a decrease in precipitation, just as the weather station annual total precipitation data suggests.

Climate Change: Coping Strategies

Rice farmers were asked about the strategies that they have used in order to cope with climate change in the past 5 years. Households were allowed to report more than one coping strategy. We group the coping strategies into four main categories: Change rice variety, acquire credit, use other agricultural strategies or use non-agricultural strategies.

Coping strategies	N	Percentage
Change rice variety	267	54%
Acquire credit	110	22%
Other Agricultural strategies	103	21%
Cultivate less area	44	9%
Diversify crops	72	14%
Non-Agricultural strategies	148	30%
Seek wage jobs	74	15%
Pawn assets	29	6%
Rely on family and friends	79	16%
Mortgage land	33	7%
Migrate	21	4%
Total households	497	

The majority of rice farmers (54%) change the rice variety to cope with climate change, 21% adopt other agricultural strategies such as cultivating less area and diversifying their crop. 30% of households use non-agricultural options such as: seek wage jobs, pawn assets, rely on family and friends etc... 22% acquire farm credit to deal with climate change. The credit acquired by these households were mostly for agricultural investments.

Methods: Multivariate Probit

The Multivariate Probit model (MVP) a discrete choice model to simultaneously examine the relationship between each adaptation option and a common set of explanatory variables while allowing for the correlation across error terms due to unobservable explanatory variables.

For each strategy type i we will simultaneously estimate a set of binary logistic regressions as follows:

$$\begin{cases} y_{1h} = X\beta_1 + \varepsilon \\ .... \\ y_{Jh} = X\beta_J + \varepsilon \end{cases}$$

where $y_j$is equal to 1 if the household h chooses the strategy type j and 0 otherwise. X is a vector of covariates, β_j is a vector of coefficients to be estimated for strategy j. ε_j is normally distributed with mean 0 and variance 1 and the covariance matrix V where V has values of 1 on the leading diagonals and correlations $\rho_{JK} = \rho_{KJ}$ for strategies j and k for instance. The correlation coefficient ρ_{JK} indicates if strategies j and k are used as substitutes or complements.

Results (MVP)

	(1)	(2)	(3)	(4)
VARIABLES	Change rice variety	Obtaining farm credit	Reduce Cultivation area or diversify crops	Non-agricultural strategies
Number of working adults (15-65)	-0.109*	0.133*	0.294***	0.249***
Years of farming experience	-0.00156	0.0317**	0.0222*	0.0242**
Farm size	0.0903**	0.0480*	-0.0541	0.0229
Women to men ratio	-0.249*	-0.00275	-0.218	-0.0914
Male managed plots	-0.368	-0.970**	-0.490	-0.223
Female managed plots (Base= Couple managed plots)	-1.569**	-0.454	-1.679	0.302
Amazonas	1.627**	-5.931	0.380	-1.514**
Cajamarca	0.951**	0.837*	0.528	-1.730***
La Libertad	-1.25***	-0.451	-0.644	-1.441***
Lambayaque	-0.269	0.269	0.402	-0.385
Piura (Base=San Martin)	-0.150	0.372	0.933*	-1.313**
Perceive Change in Temperature	-0.0801	-0.232	-1.144	0.153
Perceive change in Rain frequemcy	-0.766*	-0.135	-0.564	0.0521
Perceive change in rainfall	-0.235	-0.0542	0.475	-0.275
Perceive Change in Raining season (whether or not rain started earlier or later than normal)	0.515*	0.432	-0.105	0.533
Perceive Change in Water level (for rivers)	0.222	0.402	0.643**	0.495
Observations	280	280	280	280
Other control variables include: Types of assistance received, types of additional income received, age and education of plot managers.				

Household size and farm size have significant impact on the propensity to reduce the cultivation area and obtain farm credit and adopt non-agricultural coping strategies.

Households with female managed plots and those with high women to men ratio are less likely to change variety as a coping strategy.

Households in Amazonas and Cajamarca (forest departments) are more likely to change variety and are less likely to adopt non-agricultural strategies compared to households in San Martin. Households in La Libertad (Coastal) are less likely to adopt a strategy compared to households in San Martin.

Perception had little impact on the propensity to adopt a coping strategy

Correlations of strategies

	Change rice variety	Obtaining farm credit	Reduce Cultivation area or diversify crops	Non-agricultural strategies
Change rice variety	-	-0.180	-0.160	0.179
Obtaining farm credit	-0.180	-	0.274	0.441**
Reduce Cultivation area or diversify crops	-0.160	0.274	-	0.458***
Non-agricultural strategies	0.179	0.441**	0.458***	-

Households adopting new rice varieties as a coping strategy use this option as a substitute to getting credit, reducing the cultivation area or diversifying the crop.

Non-agricultural strategies such as migrating, mortgaging the land and pawning assets are high complements of asking for credit, reducing area or diversifying the crop, and relying on the help of family and friends.