Vulnerability Patterns of Farm Household Systems of the Andes to Climate Variability and Change

A case study of the Mantaro River Basin, Peru

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ABSTRACT

This research deals with the vulnerability and adaptation of traditional Andean Farm Household Systems (FHS) to climate extremes, focusing on a case from the Mantaro River Basin, Peru. Participatory rural assessment and multivariate analysis techniques were employed to: a) examine weather-related sources of vulnerability in agriculture, and b) typify different FHS groups according to found patterns.

Household members that were studied mentioned frost and excess of rainfall as the currently main sources of sensitivity and exposure for their agricultural endeavors, and reported that they were mainly impacted by location and physical characteristics of the FHS, the crop mix, technology available, among other. Cluster analysis revealed five vulnerability patterns that show combinations of the five adaptive capitals. FHSs with least vulnerability were off-farm oriented and kept overall a high capital portfolio to draw upon in case of climatic impacts or other causes of stress. On the other hand, the most vulnerable FHSs were severely constrained by the limited size of their owned agricultural land and scarce livestock resources, and were exposed to the highest risk of harvest failure due to their use of just one agro-ecological zone. Moreover, these farmers lacked access to off-farm labor. These FHSs overall low adaptive capacity limits their ability to respond effectively to climatic stresses.

Aim

To investigate the vulnerability and adaptation of traditional Andean Farm Household Systems (FHS) to climate extremes, using a case study of the Mantaro River Basin, Peru.

Methods

Research Approach: Sustainable Livelihood Approach

Data collection: courtesy meetings with authorities, semi-structured interviews with local households (n=137, 2011), participatory rural workshops (n=5), direct observation in gathering qualitative data, and data triangulation.

Methods (cont.)

Data Analysis:

- ***Correlation analysis***,
- ***Principal Component Analysis***
- ***Cluster Analysis:*** sequence of hierarchical (hclust) and partioning (kmeans) algorithms.
- ***Consistency measure*** and ***variance ratio:*** determination of optimal number of clusters for the dataset.

Software: R software and excel

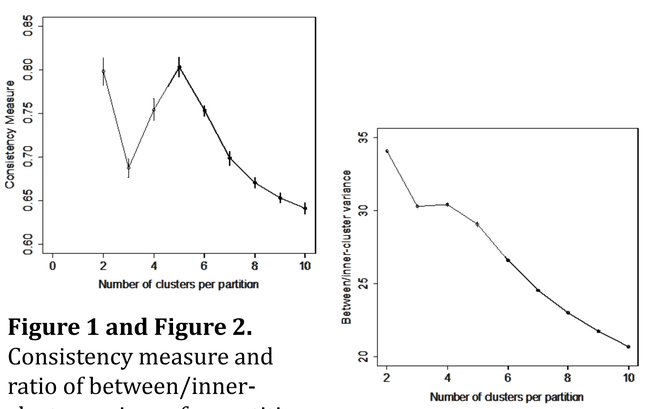

Figure 1 and Figure 2. Consistency measure and ratio of between/inner-cluster variance for partitions with 2–10 clusters. Whiskers indicate standard deviations of 50 repetitions of 400 cluster runs, i.e. 200 pairwise comparisons for the consistency measure

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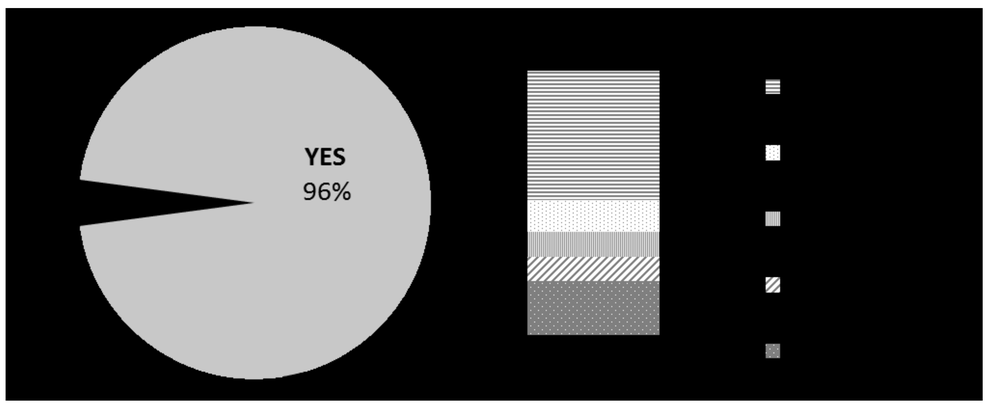
Current Vulnerability

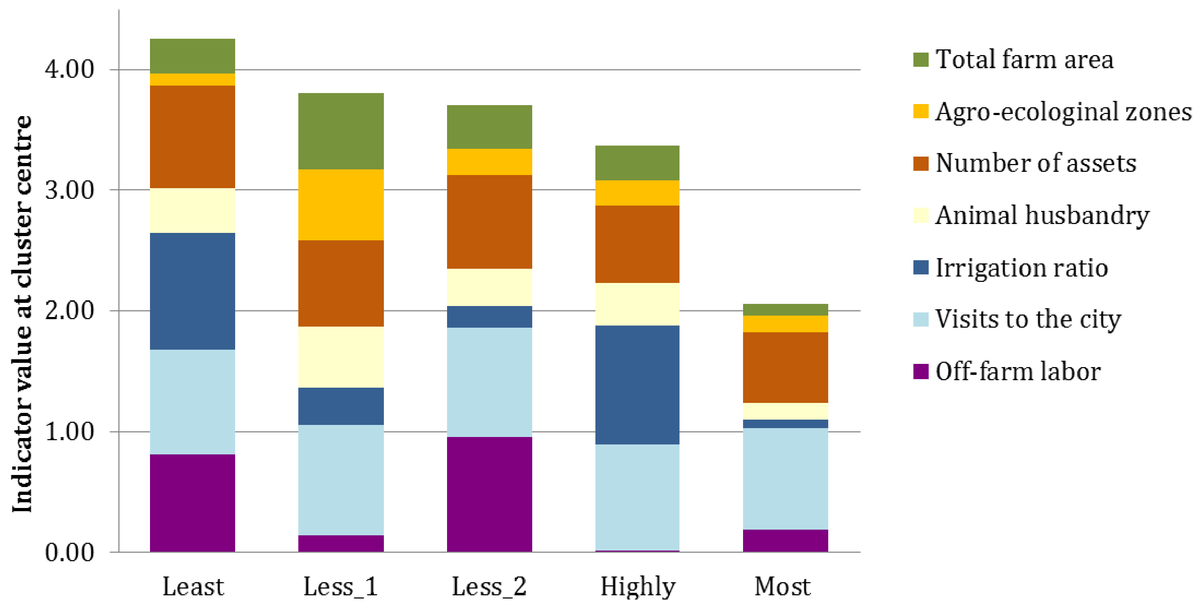
According to the local farmers, the negative impacts of the climatic hazards on the FHS are strongly influenced by the season of the year, the physical characteristics of the FHS (e.g. location specially altitude and slope, soil type), the crop type (including the phenology and stage of development of the crop) and technology available (mainly availability of water and drainage systems). It also will depend on the intensity of the climatic hazards.

Figure 3. This pie chart shows sample survey results on reported crop losses due to climatic hazards in the past 5 years. The bar chart shows the distribution of the hazards per type and frequency, as was reported.



Vulnerability Patterns

Vulnerability profiles with indicator values at cluster centers. Adaptive Indicators are normalized according to their minimum and maximum, whereby low values contribute to vulnerability



Least. Off-farm oriented FHSs, with a large pool of capital resources

Less 1. On-farm oriented FHSs, low failure risk due to their diversification into various agro-ecological zones and productive activities (agriculture and animal husbandry)

Less 2. Off-farm oriented FHSs. They risk failure as a result of lack of productive resources

Highly. On-farm oriented FHSs with constrained assets to draw upon in case of risk

Most. Highly constrained FHSs, no response capacity, most likely marginalized and poor