12.3 TESTING FARMERS' PERCEPTIONS OF CLIMATE VARIABILITY: A CASE STUDY FROM THE SULPHUR SPRINGS VALLEY, ARIZONA

Colin Thor West*, Marcela Vásquez-Léon and Timothy J. Finan
University of Arizona, Tucson, Arizona

1. INTRODUCTION

Numerous interdisciplinary teams are currently engaged in regional climate vulnerability assessments. Some authors suggest that stakeholders' perceptions of changing climate are shaped by events rather than observations of meteorological trends (Bryant et al. 2000). This paper contends that farmers do detect meteorological trends and that these perceptions can be correlated with meteorological records. In fact, these perceptions closely match scientific understandings of regional climate variability vis-à-vis ENSO and PDO.

2. SIGNIFICANCE FOR SEASONAL CLIMATE FORECASTING

Most of the vulnerability research mentioned above is oriented around the potential use of seasonal forecasts by stakeholder groups. Since this potential is predicated on the assumption that predictions of the direction of future climate variability, we feel that understanding how people perceive past variability is a necessary first step in the forecasting process.

3. THE PHYSICAL SETTING

Ethnographic fieldwork was conducted in the Sulphur Springs Valley (SSV), southeast Arizona from the summer of 2000 through the fall of 2002. The SSV is located approximately 160 km east of Tucson, AZ. The SSV is divided into two hydrological basins and contains no perennial surface water. Several mountain ranges ring the SSV.

The climate is classified as semi-arid. Mean annual rainfall is 282 mm and average minimum and maximum temperatures range from -1^{o}C in the winter to 36^{o}C in the summer. Rainfall is bimodal with maxima in December and August. Annual precipitation is characterized by high interannual and spatial variability.

4. FARMING IN THE SSV

Despite these constraints, the SSV leads the state in the production of corn, apples, chile and range-fed cattle. Agriculture is economically very important and approximately 225 small (around 1000 acres) family-operated farms lie in the valley. Agriculture is also highly diverse with operations ranging from ranches to corn farms, tomato greenhouses, fruit orchards, nut orchards and chile farms. Current farmers are highly technologically sophisticated and have shown significant interest in seasonal climate forecasts (Vásquez-Léon et al. 2002). Farming relies completely on groundwater irrigation which is very expensive.

5. METHODOLOGY

We compared farmers' perceptions of climate variability with data from the Willcox meteorological station. Perceptions of climate variability were elicited by team members as they interviewed participants in the SSV. Only residents who had resided in the SSV for over ten years discussed observations of climate variability (N = 35). Furthermore, some residents mentioned more than one perception. Thus, the percentages in Table 1 refer to the frequency of that perception among these long-term residents.

Table 1. Interviewee Perceptions

Interviewee Perception	No	Percent
Interviewees that expressed observations of increasing aridity or drought occurrences	14	73.7
Interviewees that expressed observations of oscillations in summer and winter precipitation	11	57.9
Interviewees that expressed observations of current drought	10	52.6
Interviewees expressing observations of increased spottiness of monsoonal precipitation	4	21.1
Interviewees expressing a belief in cycles of drought	2	10.5

Perceptions of increasing aridity and oscillations in summer and winter precipitation had the highest frequencies. As an example of the first perception, one farmer stated, "It's getting drier and drier." In terms of the second, a rancher told us "rainfall is becoming more winter dominant." We compared these two perceptions with the rainfall record.

* *Corresponding author address:* Colin Thor West, University of Arizona, Dept. of Anthropology, Tucson, AZ 85721; email: cwest @u.Arizona.edu

Fig. 1, Annual Departures from 1961-1990 Mean Rainfall, Willcox, AZ: 1959-1999

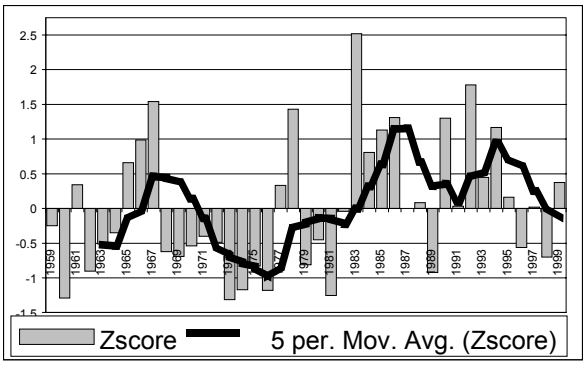
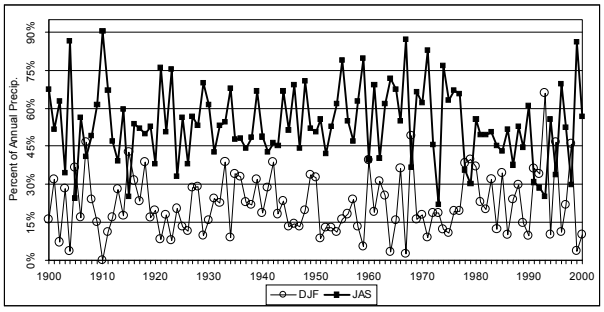


Figure 1 indicates that there is a recent slight trend toward increasing aridity as evinced by the 5-year moving average. But, the perception that annual rainfall is declining is not significantly substantiated by the record.

Next, we compared the perception of increased winter precipitation dominance with the meteorological record. We calculated the ratio of winter (DJF) and summer (JAS) precipitation to the annual water-year (Oct.-Dec.) amount. The results are shown in Figure 2.

Figure 2 indicates that for any given water year, winter precipitation rarely exceeds summer. However, between 1990 and 2000, this occurred five times: 1991-1993, 1995 and 1998. Since 1978 and 2000, this has happened on seven occasions. Thus, there is a strong correlation between the perception that precipitation is becoming more winter dominant and rainfall data. Moreover, this is valid on time-scales of at least decades.

Fig. 2, Ratio of Winter and Summer Precip. to Water year Precip., Willcox, AZ, 1900 to 2000



6. CLIMATOLOGICAL EXPLANATIONS

Physical scientists on the CLIMAS project have focused on understanding the reasons behind climate variability in the Southwest. Interannual variation in winter rainfall is strongly influenced by the El Niño-Southern Oscillation (ENSO). El Niño years tend to be cool and wet whereas La Niña ones tend to bring warmer and drier conditions (Sheppard et al. 1999:10-11). Multi-decadal variability is strongly driven by the Pacific Decadal Oscillation (PDO) of sea surface temperatures in the North Pacific Ocean. PDO cool and warm regimes persist on the order of 22 to 30 years (Mantua et al. 1997). When PDO and ENSO events are in phase, their general effects on Southwest precipitation are enhanced (CLIMAS 2001).

A shift in PDO from cool to warm phase occurred in 1977 (Mantua et al. 1997) and this possibly corresponds to the increased frequency of winter dominant precipitation in the SSV.

7. CONCLUSION

Farmers in the SSV are able to detect climate variability on periods of at least a decade. Perceptions concerning seasonal precipitation show the highest correlation with both meteorological records and with climatological explanations of climate variability. This has ramifications for seasonal climate forecasting particularly in the Southwest because it demonstrates that the way past climate variability has been perceived by farmers closely matches empirical observations. Thus, continued research on the causes of seasonal rainfall variability and predictions of seasonal precipitation fall into cognitive frameworks held by some stakeholders.

This research also shows how collaborations between stakeholders, social scientists and physical scientists can result in understanding the physical and social dimensions of climate variability.

8. REFERENCES

Bryant, C.R., B. Smit, M. Brklacich, T.R. Johnston, J. Smithers, Q. Chiotti, and B. Singh, 2000: Adaptation in Canadian agriculture to climatic variability and change. *Climatic Change,* **45**, 181-201.

Climate Assessment for the Southwest, 2001: What is the "Pacific Decadal Oscillation" and what does it mean for the Southwest? CLIMAS forecast accessed at http://www.ispe.arizona.edu/climas/forecasts/pdo/.

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis, 1997: A Pacific interdecadal climate oscillation with impacts on salmon production. *Bull. Am. Meteorol. Soc*., **78**, 1069-1079.

Sheppard, P.R., A.C. Comrie, G.D. Packin, K. Angersbach, and M.K. Huges, 1999: The climate of the Southwest. CLIMAS Report Series CL1-99. Tucson: Institute for the Study of Planet Earth, University of Arizona.

Vásquez-Léon, M., C.T. West, J. Moody, B. Wolf, and T.J. Finan, 2002: Vulnerability to climate variability in the farming sector: A case study of groundwater dependent agriculture in Southeastern Arizona. CLIMAS Report Series forthcoming. Tucson: Institute for the Study of Planet Earth, University of Arizona.