

Climate Change in Arid Lands: Assessing the Agricultural Vulnerability of Tribal Nations in the American West

Anna Palmer, M.S. candidate & Derek Kauneckis, Ph.D.

VOINOVICH SCHOOL of Leadership and Public Affairs

INTRODUCTION

The American Southwest is at risk for severe droughts in the 21st century. American Indians in this region may be disproportionately harmed due to geographic exposure and socio-economic imbalances on sovereign tribal lands. This research operationalizes the Intergovernmental Panel for Climate Change (IPCC) vulnerability framework with a composite index approach to assess agricultural vulnerability across 72 tribal nations. It is the first comparative analysis of climate vulnerability on tribal lands. The goal is to provide a framework for identifying vulnerabilities to assist in strengthening the climate resiliency of tribal communities and encourage the diffusion of solutions between tribal communities.

KEY CONCEPTS

Vulnerability - the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.

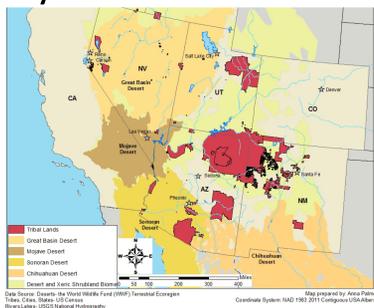
Exposure (E) - The nature and degree to which a system is exposed to significant climate variations.

Sensitivity (S) - The degree to which a system is affected, either adversely or beneficially, by climate related stimuli.

Adaptive Capacity (AC) - The ability of a system to adjust to climate change, variability and extremes to moderate potential damages, to take advantage of opportunities or to cope with the consequences.



Study Area

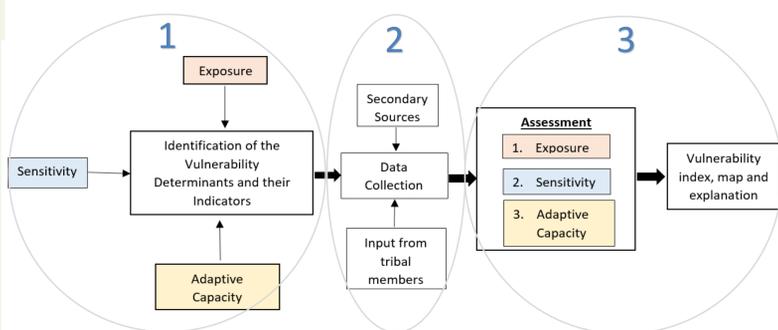


72 Native American Communities
 57,287 mi²
 2015 Population: 399,165

Expected climate impacts include:

- changes in precipitation patterns
- decreased snowpack
- increased frequency of drought, extreme weather, flooding and fire events which occur with greater severity and longer duration.

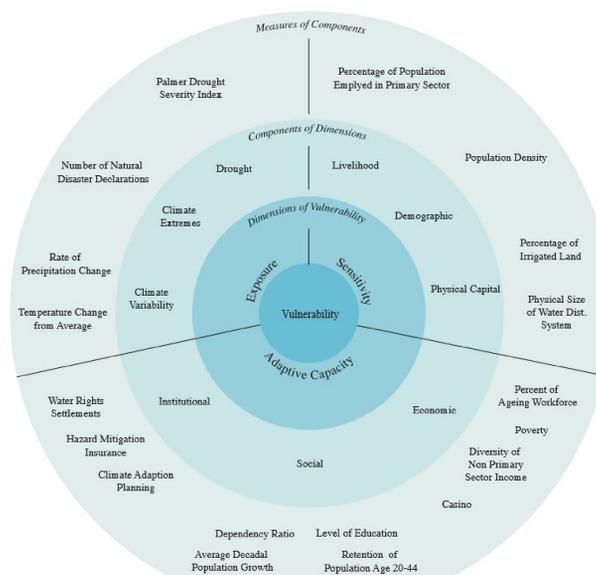
Stages of Vulnerability Assessment Process



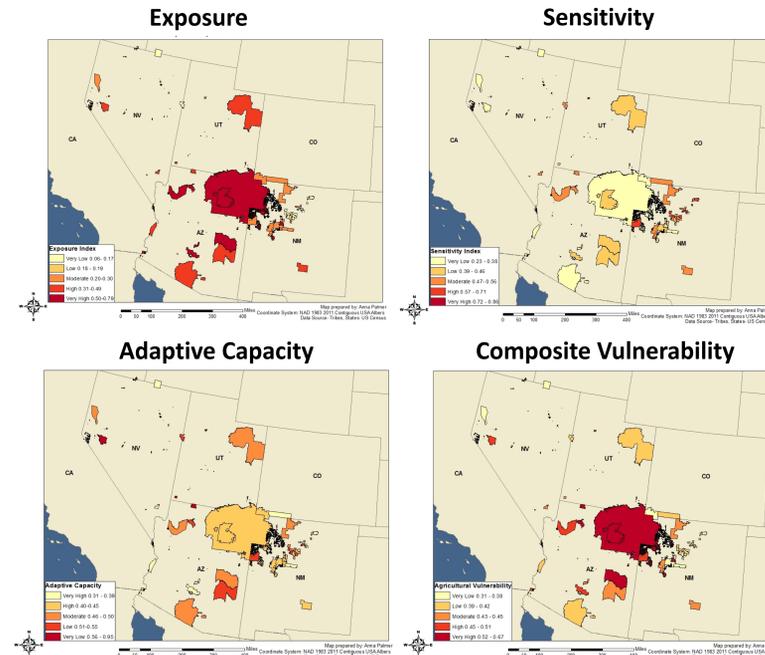
METHODS

Information from tribal members was gathered during first *Native Waters on Arid Lands Tribal Summit* (2015). Based on the literature on cross-national climate vulnerability assessments a standardized method of for cross-territory comparison was developed. Socioeconomic data sources included *The Tiller's Guide to Indian Country*, U.S. Census, USDA, BIA, FEMA, tribal websites and published papers. Drought data will come from US drought monitor. Precipitation and temperature data will come from National Climatic Data Center (NCDC). Research literature and expert judgement used to determine functional relationship between component index and vulnerability. Min max method was used to normalize indicators. Aggregate indices are presented on maps to provide comparisons across diverse tribal lands. Applied equal weighting techniques and simple average to generate composite vulnerability indices.

Dimensions of Vulnerability and Component Measures



RESULTS



Spider Diagrams Comparing Vulnerability Components Between Tribes



CONCLUSIONS

This research develops a tool to identify and compare component of climate vulnerabilities across sovereign tribal territories. Assessments are useful for starting dialog on how identified vulnerabilities can be reduced and community resilience enhanced. These indicators represents only the first stage of an iterative process for communities themselves to determine the most relevant indicators and means to address local challenges. In some cases the indicators used here may not capture the inherent resilience of tribal communities or their values. An online data visualization portal will be developed to better allow tribal communities to access the data used in this analysis and control the relative weight of the various components to better suit their own needs.



Relationships between indicators and vulnerability index					
Dimension of Vulnerability	Components of Dimensions	Component indicators	Functional Relationship	Hypothesized functional relationship between indicator and vulnerability	
EXPOSURE	Drought	Palmer Drought Severity Index (2001-20016)	↓	The smaller the value of PSDI (indicating higher levels of long term drought), the higher the vulnerability.	
	Extremes	FEMA disaster declarations (1990-2017) (#)	↑	The greater the # of FEMA declarations (indicating greater risk for climate extremes events), the higher the vulnerability.	
	Variability	Rate of Precipitation Change (1901-2016) (%)	↓	The smaller the value of PRECIP_CHG (indicating precipitation decreases are occurring at a faster rate), the higher the vulnerability.	
		Temperature Change (200-2015 vs long term average) (°F)	↑	The greater the value of TEMP_CHG (indicating increases in temperature from long-term average), the higher the vulnerability.	
SENSITIVITY	Human	Rural Population Density (people per mi ²)	↑	The greater the population density, the higher the vulnerability.	
	Livelihood	Primary Sector Employees (%)	↑	The greater the ratio of agricultural employment, the greater the vulnerability.	
	Physical Capital	Extent of Irrigation (%)	↓	The higher the proportion of irrigated area, the lower the vulnerability.	
Perennial Water Distribution Network (m)		↓	The longer the length of man made perennial water distribution network (canals ditches or aqueducts) the lower the vulnerability.		
ADAPTIVE CAPACITY	Social	Level of Education (%)	↑	The higher the proportion of people with less than a high school education, the higher the vulnerability.	
		Dependency Ratio	↑	The greater the dependency ratio, the higher the vulnerability.	
		Population Growth Rate (1996-2015) (%)	↓	The greater the rate of population growth, the lower the vulnerability.	
		Population Retention Ratio Ages 20-44 (2000-2010)	↓	The larger the retention ratio of population aged 20-44 between 2010-2000 the lower the vulnerability.	
	Economic	Poverty (%)	↑	The higher poverty rate, the higher the vulnerability.	
		Older Employees (%)	↑	The greater the ratio of older employees, the greater the vulnerability.	
	Institutional	Off-farm Income Sources (#)	↓	The greater the number of non-climatic dependent sectors present, the lower the vulnerability.	
		Casino (Y/N/IP)	↓	Casino operations, reduce vulnerability	
	ADAPTIVE CAPACITY	Water Rights Settlement (afa/acres)	Water Rights Settlement (afa/acres)	↓	The greater the water entitlement, the lower the vulnerability.
			Climate Adaptation (rank)	↓	Climate adaptation planning efforts, reduce vulnerability.
FEMA Hazard Mitigation Plan (Y/N)		FEMA Hazard Mitigation Plan (Y/N)	↓	FEMA approved hazard mitigation plans, reduce vulnerability.	

Anna Palmer is an MSES candidate at the Voinovich School of Leadership and Public Affairs at Ohio University. She is interested in climate resilience, urban sustainability, participatory mapping, environmental justice, and the interplay of institutions with environmental policy. Contact: ap744415@ohio.edu



Dr. Derek Kauneckis is an associate professor at Voinovich School, where he teaches in the Environmental Studies program. His research focuses on governance institutions, community level adaptation, policy design and the science-policy interface. Contact: kaunecki@ohio.edu

