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Southwest climate gap: poverty and environmental justice in the US Southwest

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ABSTRACT

This article examines the "climate gap" in the Southwest US (Arizona and New Mexico), referring to the "disproportionate and unequal implications of climate change and climate change mitigation" for "people of color and the poor" [Shonkoff, S.B., *et al*., 2011. The climate gap: environmental health and equity implications of climate change mitigation policies in California. *Climatic Change*, 109 (Suppl. 1), S485–S503]. The climate and poverty relationship is examined using multi-scaled analysis across three indicators of climate vulnerability, focusing on connections to health, food, and energy during the period 2010–2012. We provide an overview of climate-related social vulnerability in the Southwest based on available federal, state, and county-level census data. We then summarise the results from a stakeholder workshop and in-depth interviews about climate vulnerabilities with social service providers in southern Arizona. We identify a significant Southwest climate gap based on census data and interview findings about climate vulnerability especially relating to high levels of poverty, health disparities, and increasing costs for energy, water, and food. We find that grassroots and community organisations have mobilised to respond to climate and social vulnerability, yet resources for mitigation and adaptation are insufficient given the high level of need. Confronting a changing climate that is projected to be hotter, drier, and with the potential to reach new thresholds, we suggest that more research needs to be done to understand the social and spatial characteristics of climate risk and how low-income populations embody and experience climate risk, and adapt to a changing climate.

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Introduction

The Southwestern United States has among the highest levels of poverty and social deprivation in the country and is a hotspot for climate change, with observed increases in temperature and drought severity and predictions of serious impacts from climate change by 2050. Most studies of climate and poverty focus on the developing world with little attention to the impacts on low-income populations in wealthier countries. Some scholars have characterised climate and poverty in the USA as an environmental justice issue (Chakraborty 2012) and have identified a "climate gap" in which people of colour and the poor are unequally affected by climate change and climate change mitigation policy (Shonkoff *et al.* 2011).

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Hurricane Katrina provides the most powerful US example of unequal impacts of climate extremes on the poor and communities of colour in New Orleans as a result of multiple vulnerabilities that include poverty, poor housing, and lack of transportation. But there are few studies of how climate vulnerability emerges from the everyday challenges of being poor in America.

In this article, we examine the connections between climate and poverty in the Southwestern United States with respect to current climate variability and extremes,[1] focusing on the climate gap in terms of climate impacts and vulnerability, and discussing the implications for preparedness to cope with climate change.[2] We use census data and interviews to understand specific ways individual factors such as age, ethnicity, geography, and socio-economic status may interact with climate, and some of the institutional factors that influence them, resulting in uneven exposure to climate risk across the social landscape.

We connect poverty to climate through three aspects of social needs – health, energy, and food security – that intersect with climate across a spectrum of interconnected risks. Vulnerability across this nexus is significant, but little is known about the contours of these problems, how affected communities may already be adapting, and the relationship to climate variability and climate change. Understanding this relationship is important for climate mitigation and adaptation in the Southwest and other regions and for organisations concerned with the welfare of specific populations.

The paper is based on research we conducted with funding from the National Oceanic and Atmospheric Administration focusing on the period from 2010 to 2012. The study was carried out in three phases: in the first (fall 2010), we conducted a comprehensive review of related literature and archival documents (e.g. reports and studies). In the second phase (spring 2011), we compiled demographic data at the state and county levels for Arizona and New Mexico based on U.S. Census (2010) and American Community Survey (2008–2012) to develop an overview of demographic indicators, including such characteristics as gender, age, ethnicity, income, and language spoken at home. In spring 2011, we conducted a workshop with social service providers that work with low-income populations in southern Arizona to identify specific ways that climate interacts with low-income populations. As a result of the workshop, we focused our understanding of poverty–climate interactions using three sets of indicators: health (conditions and accessibility), energy (accessibility and affordability), and food security. Subsequently, in the third phase (2011–2012), we conducted interviews with representatives of 12 social service agencies and organisations in southern Arizona regarding the impact of the climate/health/energy/food nexus on the populations they serve.

The first section of the article discusses a framework for understanding environmental equity and climate justice and reviews existing scholarship on the climate–poverty relationship in the Southwest in terms of health, food security, and energy poverty. The second section provides an overview of demographic characteristics and develops a poverty profile for Arizona and New Mexico at the state and county levels. The third section presents findings from our archival research and review of the literature, stakeholder workshop, and interviews with social service organisations on how climate issues affect their clientele populations. The fourth section discusses the implications and conclusions of these findings.

Frameworks for understanding climate justice

The notion of the "climate gap" emerges from theories of environmental and climate justice. In the last decade, environmental justice (EJ) has developed as both a scholarly discourse and international movement focused on wedding the concepts of environmental sustainability and justice (Agyeman and Evans 2004, Agyeman 2005). EJ is concerned with the "inequitable distribution of disamenities" (e.g. air pollution, hazardous waste) (Mitchell and Chakraborty 2014) in communities with large, concentrated populations of racial and ethnic minorities and economically disadvantaged populations, and EJ scholars and activists have highlighted the role of race and class in the siting of toxic industries and undesirable land uses (Roberts and Parks 2009). EJ is not a mere critique of siting practices, but rather it articulates a normative goal for environmental fairness. Bullard (1996) defines EJ as the

notion that "all people and communities are entitled to equal protection of environmental and public health laws and regulations". The literature on EJ has been deeply concerned with disproportionate impacts of development and pollution in poor communities and communities of colour. More recent research in EJ emphasises the production, scaling, and politics of environmental (in) justice, assemblage theory, and the politics of mobilisation around EJ (Bickerstaff and Agyeman 2009). While EJ literature has been largely focused on urban issues in the USA and Europe, the recognition that environmental injustices are a global phenomenon has expanded the concept and has been an important inspiration for the climate justice movement and resulting literature (Mohai *et al.* 2009).

Climate Justice, a field with strong overlaps with EJ, centres on the distributional impacts of global climate change and the uneven aspects of mitigation and adaptation (Mitchell and Chakraborty 2014). Traditionally, climate justice has addressed the disparities of responsibility and impacts between industrialised countries and developing countries with respect to climate change. It views climate change as an ethical issue with winners and losers, where poor countries and people least responsible for high greenhouse gas emissions are most vulnerable to climate change impacts they produce. In this sense, climate justice is a human rights issue linked to already existing inequities associated with colonialism, poverty and development (Hayward 2007, Robinson 2011). Climate justice not only recognises the disproportionate impacts of climate change on the poor, but also ways in which mitigation strategies such as the Clean Development Mechanism and carbon trading can also negatively affect marginal populations (Lohmann 2008, Bond 2011, Pearse 2014). While much of the literature on climate justice is concerned with inequities at the international scale, a growing number of scholars are recognising the inequalities *within* countries with respect to climate change which disproportionately affect people based on race, ethnicity, class, and gender and advocate for greater engagement across multiple scales (Baer *et al*. 2009, Mohai *et al.* 2009, Fisher 2015). Climate justice is also attentive to questions of procedural justice, recognition and participation of the poor and developing world in the processes of climate decision-making.

Natural hazards and vulnerability frameworks help unpack the mechanisms whereby climate injustice is produced and structured and provide a critical link in our understanding of the relationship between climate and poverty in the Southwestern United States. Arguments about the disproportional impact of climate on low-income populations originated in hazard studies that demonstrated that some were more susceptible than others to the impacts of drought, floods and hurricanes. Although most of these studies drew on case studies from Latin America, Africa, and Asia, some analyses showed the differential impact of hazards within communities or among farmers in the developed world as a result of where they lived or their access to financial and government resources. Vulnerability is used to capture the differences in ability to prepare for and recover from climate extremes with researchers documenting the vulnerability of various social classes and ethnic groups to in the Sahel (Tschakert 2007), Northeast Brazil (Engle and Lemos 2010), and Mexico (Eakin 2006, Wilder *et al*. 2012). Vulnerability is associated with measures connected to poverty, such as land tenure and housing, and within low-income populations, gender, race, age and ethnicity were shown to exacerbate vulnerabilities.

The Intergovernmental Panel on Climate Change (IPCC 2014) highlighted the significance of vulnerability, defining it as the degree to which geophysical, biological, and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change. Vulnerability is seen as a function of exposure (the degree of climate stress), sensitivity (the degree to which a system is affected), and adaptive capacity (the potential to adjust to change). Poverty is seen as one major influence on adaptive capacity along with technology, education, institutions, information, social connections, and infrastructure (Adger 2006, Eakin and Luers 2006, Ribot 2010).

While many studies have focused on climate change vulnerability and the poor in the global South, the literature on climate vulnerability in North America and Europe is smaller and less focused on the poor. Studies tend to focus on overall regional and sectoral vulnerabilities or on the experience of indigenous peoples. Efforts to understand vulnerabilities of the poor include

several mapping efforts such as the Social Vulnerability Index, which shows poverty along with race as one dimension of vulnerability in the Southeastern United States (Wilson *et al*. 2010).

In this paper, we draw on theories and cases in climate justice to understand climate impacts in the Southwest. We focus on marginal populations and the ways in which climate change may affect or create vulnerability and disproportionately affect these groups. Feminist theory – which sees vulnerability as embodied in everyday social reproduction as people encounter heat or hazard in efforts to ensure their food, energy, water and health security – is also relevant to our approach in this paper. Our research contributes to understanding the spatial dimensions of the climate–poverty relationship.

Methodologically, we use census and other large-scale socio-economic surveys to provide estimates of patterns and trends in vulnerability in the Southwest. We look at the embodiment and everyday experiences of climate impacts through the lens of access to energy, food, and health care. Our interview data derive from social service and other agencies that assist low-income populations within our community.

Climate change in the Southwest

The Southwestern United States – defined as comprising the states of Arizona and New Mexico[3] – is one of the most "climate-challenged" regions in North America (Overpeck *et al*. 2013). The region is already experiencing climate change, is projected for major climate changes, and economic and population growth are placing greater demands on natural resources (Table 1). This makes the region an important yardstick for how climate change affects the US and arid regions such as the Mediterranean and Australia. Temperatures have increased about 1.5°F across the region since 1901 with the last decade experiencing more heat waves and severe drought (Garfin *et al*. 2013, p. 75). The years 2005 and 2010 were tied as the warmest years in the 131-year record (NASA, January 2011), and the region has seen several severe droughts in the last decade (www.climas.arizona.edu).

Warming and drought conditions reduce high elevation snowpack critical for feeding southwestern rivers. The Colorado River experienced a 16% decrease in streamflow and a four per cent decrease in precipitation from 2001 to 2010, compared with the twentieth-century average (Garfin *et al*. 2013).

The recent Southwest Climate Change Assessment Report indicates that the Southwest is projected to become much hotter and drier by mid-twenty-first century as climate changes (Garfin *et al*. 2013). If global greenhouse gas emissions continue to rise, the region could warm as much as 9.5°F by the end of the century. Summertime heat waves are projected to become longer, hotter, and more humid with high night-time temperatures (Garfin *et al*. 2013). Anticipated impacts of climate change in the Southwest include continued decrease in the flow of the Colorado

Table 1. Observed and projected climate changes in the Southwest (based on Garfin *et al*. 2013).

Climate variable	Change
Per cent change in average temperature in Southwest 2000–2010, compared to 1901–2000	+1.4F (Summer +2F)
Per cent change in average precipitation 2000–2010, compared to 1901–2000	−0.6 inches
Flow of rivers 2001–2010 compared to 1901–2000	Colorado Lees Ferry −16% Rio Grande El Paso −23%
Projected annual average warming with high emissions compared to 1971–2000	2F to 4F by 2050 2F to 6F by 2070 5F to 9F by 2099
Projected annual average warming with low emissions compared to 1971–2000	1F to 3F by 2050 1F to 4F by 2070 2F to 6F by 2099
Flow of Colorado River	−5% to −20% by 2050

River, more severe drought, increased wildfires, declining water supplies, reduced agricultural yields, and health impacts in cities due to heat (Garfin *et al*. 2014).

The Southwest experienced rapid population growth and economic development in recent decades, as a result of migration from other parts of the USA into the "Sunbelt". Arizona's population increased by 25% (2000–2010) and New Mexico's by 13%. Population growth places greater pressure on land, water, and other resources, increasing the risks from climate change. The growth is concentrated in urban areas, with multiple impacts including the reduction of farmland; competition for resources, particularly water; increasing heat island effects; and the loss of urban green space. Growth-led industries (e.g. construction, tourism) are mainstays of the Southwest economy, despite being among the hardest hit by the foreclosure crisis (Bureau of Labor Statistics 2011). Less well documented but of great political interest are the undocumented migrants who cross the US–Mexico border. Although many are en route to other destinations, many, tragically, die due to heat exposure and thirst when attempting to cross the desert.

As we will see in the next section of the paper, the Southwest is also a vulnerability hotspot because of high levels of poverty and disadvantaged populations in the region. There are particular vulnerabilities associated with the US–Mexico border, a sizeable low-income Hispanic population, and the large areas designated Native American tribal lands as a result of long-term discrimination and inadequate infrastructure and political representation (Redsteer *et al*. 2013, Wilder *et al*. 2013).

Poverty and potential vulnerability in the Southwest

Although there is considerable debate about how to measure climate vulnerability and the availability of appropriate indicators, most authors use standard socio-economic indicators to measure social vulnerability to climate, including poverty, ethnicity, age, food security, and health status. Poverty is perhaps the most common indicator of climate vulnerability used in a wide range of case studies and mapping efforts (Cutter 2001). It is important to emphasise that *age, gender, and ethnicity are not in themselves indicators of social vulnerability to climate; however, when linked with low-income status, some age or ethnic groups have been shown to be disproportionately at greater risk of negative climate-related impacts*. At the same time, factors characteristic of some ethnic or social groups such as strong social networks or multi-generational households may be ingredients of resiliency within these communities (Ribot 2010).

In the following, we provide census data in tables and maps at the state and county levels that indicate high levels of vulnerability in both states when compared with the USA as a whole (statewide data), as well as the spatial dimensions of vulnerability within each state (county-level data and maps). Measures of poverty are varied and relative. In the USA, the poverty threshold is established by the census bureau in relation to family size and composition. In 2015, the individual threshold is set at an income of less than $11,670 (http://aspe.hhs.gov/poverty/14poverty.cfm). Poverty is thus relative in a financial sense but also in terms of disparity with others within a society in relation to access to non-monetary benefits such as food assistance. Poor children and the elderly are often considered at particular risk. Thus, in the USA, a composite poverty measure not only includes the per cent of people beneath the income threshold but also those receiving food assistance and the per cent of children in poverty.

Statewide indicators

By standard US poverty measures, Arizona and New Mexico rank high on multiple indicators (Table 2). From 2008 to 2012, Arizona and New Mexico had almost 1 in 5 people in poverty (17 and 19% of their population, compared with USA average of 15%); they ranked 13th and 2nd place amongst states with the highest poverty levels.

American Indian and Hispanic populations are among the poorest groups in the Southwest and nationwide. American Indians are more than 5% of the population of Arizona and 10% in New

Table 2. Poverty characteristics in Arizona and New Mexico.

	US	Arizona	New Mexico
Population 2013 in millions	316.12	6.63	2.09
American Indian population % 2013	1.2	5.3	10.4
Hispanic or Latino population % 2013	17.1	30.3	47.3
Language other than English spoken at home % 2013	20.5	26.9	36
Population growth rate, % 2010–2013	1.3	3.7	2.4
Population in poverty, % (and rank) 2008–2012	14.9	17.2 (13)	19.5 (2)
Children in poverty % 2012	21	26.6	29.2
American Indians in Poverty % 2008–2012	27.8	36.4	28.4
Hispanic or Latino in Poverty % 2008–2012	24.1	27.1	21.3
Counties with more than 25% poverty 2008–2012		Apache, Navajo, Santa Cruz	Cibola, Doña Ana, Luna, McKinley, San Miguel, Sierra, Socorro, Torrance
Number of farms 2012		20,005	24,721
Per cent of cropland irrigated % 2012		74.3	29.9
Top 5 farm products 2012		Cattle, dairy, lettuce, cotton, alfalfa	Cattle, dairy, alfalfa, pecans, chile
SNAP (food assistance) recipients 2013%	15%	17%	21%
People without health insurance 2013%	14.5	17.1	18.6
Food Insecurity % 2011–2013	14.6	15.6	13.2
Meal gap food insecurity 2012		17.8%	18.6%
Counties with more than 20% food insecurity 2013		Apache, Navajo, Yuma	Luna, McKinley

Data sources: American Community Survey 2008–2012 (www.census.gov), USDA State Fact Sheets (ers.usda.gov), Center for Budget and Policy Priorities, Supplemental Nutrition Assistance Program (SNAP), Feeding America Map the Meal Gap www.feedingamerica.org/mapthegap.

Mexico. Arizona is more than 30% Hispanic and New Mexico 47%. The national poverty rate is less than 15%, but 36% of American Indians and 27% of Hispanics in Arizona live in poverty, as well as 28% of American Indians and 21% of Hispanics in New Mexico (www.census.gov).

The Southwest is more ethnically and linguistically diverse than the rest of the country; yet, language can be a barrier to understanding disaster warnings or obtaining social assistance. The high percentages of people who speak languages other than English at home reflect the immense cultural richness of the Southwest. There are many reasons to celebrate this diversity, and it also has important implications for emergency preparedness. Warning systems and community outreach regarding climate risks must be culturally appropriate and linguistically accessible to the entire population.

Compared with the USA as a whole, the percentage of households that speak a language other than English at home (most commonly Spanish or a Native American language) in Arizona and New Mexico is 27% and 36%, compared to the national average of 20%. Diverse populations should be incorporated into planning for climate risk and preparedness in terms of their use of language, what media they engage with, and how they use technology. Efforts need to be made to broaden the participation of underrepresented groups in climate change preparedness.

The 2010 census found 13% of the US population was over 65 and, of these, 39% had a disability. Arizona and New Mexico, despite reputations as retirement states, are close to the national average. The number of Arizonans over age 85 is expected to increase by 102% between 2000 and 2020, and the ageing population is likely to be increasingly diverse. Between 1995 and 2025, the growth of Hispanic persons' aged 65–84 years (59%) is estimated to far outpace the growth of White non-Hispanics this age (16%) (Office of the Governor Janet Napolitano 2005). By 2030, it is estimated that New Mexico will rank fourth in the nation in percentage of population aged 65 and older; currently, New Mexico is 39th. Almost half of New Mexico's grandparents provide a home for their grandchildren (Con Alma Health Foundation 2012). These data suggest that climate studies should recognise the specific social characteristics of ageing communities in terms of health, energy, and food security.

Arizona and New Mexico ranked among the worst states nationwide for children in poverty, food-insecure children, and lack of health insurance. Overall, Arizona ranked 47th for children's well-being and New Mexico was dead last, at 50th place (KidsCount 2013). One-third of Arizona and New Mexico children lived below the poverty line in 2012, and half of these were in extreme poverty (Children's

Defense Fund 2014). Arizona and New Mexico ranked 49th and 50th nationally for children living in food insecure households in 2011, with 30% of its children food insecure, and Arizona ranked 48th and New Mexico 36th nationally for uninsured children (Children's Defense Fund 2014). As with seniors, these data underscore the importance of incorporating a focus on low-income children as part of climate preparedness.

Gender is increasingly seen as a key dimension of climate vulnerability, especially in regions where women are culturally or economically constrained in their literacy, income and access to services and resources. In the USA, the vulnerability of women as compared to men is most closely associated with income differentials and the challenges faced by households headed by a single female. In Arizona and New Mexico, 38% and 43% of female-headed households with children under 18 are below the poverty line compared to only 11.2% and 12.7% of married couples (American Community Survey 2008–2012).

The kind of housing and the percentage of income spent on rent and utilities are also important indicators of a household's ability to cope with climate change. Poor-quality housing may be difficult to heat or cool and may be more easily damaged during extreme weather. Many poorer people live in rented accommodation or mobile homes, with more than one-third of their income going to rent and utilities and will experience difficulty paying higher energy bills to meet increased heating and cooling needs projected for the Southwest as the climate changes. Ten per cent of Arizonans and 18% of New Mexicans live in mobile homes. Forty-five per cent spend more than 30% of their income on rent and utilities (American Community Survey 2008–2012). Technologies used for cooling also vary. In Arizona, 13% of households use evaporative (or "swamp") coolers, while 87% have central air conditioning (Southwest Energy 2014).

County-level indicators: spatial dimensions of vulnerability within states

Vulnerability varies significantly from county to county in the Southwest, with counties at the US–Mexico border and those with high percentages of Hispanics or Latinos or American Indian populations concentrated in low-income counties. This highlights spatial variation in social vulnerability, as indicated by poverty levels, within the two states and the necessity for climate change policy and preventative actions to be crafted in ways that address the unique qualities and needs of each region. Table 3 provides data for ethnicity and poverty by county. Figure 1 shows higher levels of poverty in the northern and western Arizona counties, and the border counties (especially Yuma and Santa Cruz counties in Arizona and all three New Mexico border counties) and in the majority Native American counties of north-eastern Arizona and the Four Corners region.

Figure 2 shows higher concentrations of Hispanics or Latinos in border counties and Figure 3 shows counties where American Indians are the majority. Taken together with Table 3, there is a concentration of Hispanics and American Indian residents in higher poverty counties, demonstrating clear spatial dimensions to poverty and climate impacts. Border and Native American areas of both states are at the highest risk for climate impacts (Redsteer *et al.* 2013, Wilder *et al.* 2013).[4]

Not only are there differences in how ethnic groups are affected by climate change, but there is emerging evidence that some groups have a heightened awareness of it. Surveys of public attitudes suggest that the Hispanic population is much more concerned than other groups about climate change. Nationally, Hispanics are more sure that global warming is happening, more likely to blame it on human activity, and more concerned that it will hurt the world and the country than white/anglo respondents (Leiserowitz and Akerlof 2010, New York Times 2015). They are also more likely to think that the government should act to reduce climate change. A recent survey of climate attitudes in Arizona (Liverman *et al.* 2015) found that more than 88% of Hispanic respondents stated that climate change would be serious for the USA and for the world (compared to 72% of whites) and 85% of them wanted the government to limit emissions (compared to 70% of whites). Hispanics were much more likely to think that climate change was causing an increase in drought (88% compared to 52%) and heat waves (80% compared to 57%).[5]

Table 3. Poverty and ethnicity in the Southwest (county level).

County	State	Hispanic %	American Indian %	Poverty per cent	Median household	Per cent in poverty
Apache County	Arizona	5.80	49.90	38.70	30,252.00	49.90
Cochise County	Arizona	32.40	51.00	18.80	45,294.00	51.00
Coconino County	Arizona	13.50	49.60	23.20	48,732.00	49.60
Gila County	Arizona	17.90	49.70	22.60	39,868.00	49.70
Graham County	Arizona	30.40	53.70	21.60	43,497.00	53.70
Greenlee County	Arizona	47.90	52.10	11.60	54,673.00	52.10
La Paz County	Arizona	23.50	51.50	23.20	33,994.00	51.50
Maricopa County	Arizona	29.60	49.50	17.60	52,066.00	49.50
Mohave County	Arizona	14.80	50.00	21.30	38,560.00	50.00
Navajo County	Arizona	10.80	50.00	31.80	37,182.00	50.00
Pima County	Arizona	34.60	49.10	19.30	43,926.00	49.10
Pinal County	Arizona	28.50	52.50	16.70	49,887.00	52.50
Santa Cruz County	Arizona	82.80	47.60	22.70	35,753.00	47.60
Yavapai County	Arizona	13.60	49.00	16.40	40,486.00	49.00
Yuma County	Arizona	59.70	50.10	19.20	40,498.00	50.10
Bernalillo County	New Mexico	47.90	49.00	18.70	48,053.00	49.00
Catron County	New Mexico	19.00	52.30	21.70	32,644.00	52.30
Chaves County	New Mexico	52.00	49.50	21.20	41,388.00	49.50
Cibola County	New Mexico	36.50	50.60	32.20	36,307.00	50.60
Colfax County	New Mexico	47.20	50.90	20.10	37,152.00	50.90
Curry County	New Mexico	39.50	50.20	21.10	39,186.00	50.20
De Baca County	New Mexico	38.50	49.10	22.00	33,045.00	49.10
Doña Ana Count	New Mexico	65.70	49.00	27.00	36,831.00	49.00
Eddy County	New Mexico	44.10	49.90	15.10	49,865.00	49.90
Grant County	New Mexico	48.30	49.10	22.40	39,220.00	49.10
Guadalupe County	New Mexico	79.60	56.50	25.80	29,924.00	56.50
Harding County	New Mexico	43.00	52.80	15.20	37,520.00	52.80
Hidalgo County	New Mexico	56.60	50.20	25.70	32,993.00	50.20
Lea County	New Mexico	51.10	51.10	14.80	53,556.00	51.10
Lincoln County	New Mexico	29.80	49.10	18.80	40,756.00	49.10
Los Alamos County	New Mexico	14.70	50.30	4.00	110,930.00	50.30
Luna County	New Mexico	61.50	49.70	31.20	28,040.00	49.70
McKinley County	New Mexico	13.30	48.40	40.30	27,790.00	48.40
Mora County	New Mexico	81.00	51.20	23.80	29,263.00	51.20
Otero County	New Mexico	34.50	50.50	21.30	41,960.00	50.50
Quay County	New Mexico	42.40	49.30	25.80	30,496.00	49.30
Rio Arriba County	New Mexico	71.30	49.40	24.80	36,716.00	49.40
Roosevelt County	New Mexico	39.90	50.30	24.60	35,322.00	50.30

(*Continued*)

Table 3. Continued.

County	State	Hispanic %	American Indian %	Poverty per cent	Median household	Per cent in poverty
San Juan County	New Mexico	19.10	49.60	15.30	56,190.00	49.60
San Miguel County	New Mexico	76.80	49.90	21.80	44,417.00	49.90
Sandoval County	New Mexico	35.10	48.90	32.40	31,222.00	48.90
Santa Fe County	New Mexico	50.60	48.70	18.10	51,697.00	48.70
Sierra County	New Mexico	28.00	50.30	26.90	29,680.00	50.30
Socorro County	New Mexico	48.50	51.30	27.90	32,090.00	51.30
Taos County	New Mexico	55.80	49.20	26.20	33,021.00	49.20
Torrance County	New Mexico	39.10	51.60	27.80	35,046.00	51.60
Union County	New Mexico	39.70	57.00	20.10	37,902.00	57.00
Valencia County	New Mexico	58.30	50.40	23.40	41,412.00	50.40

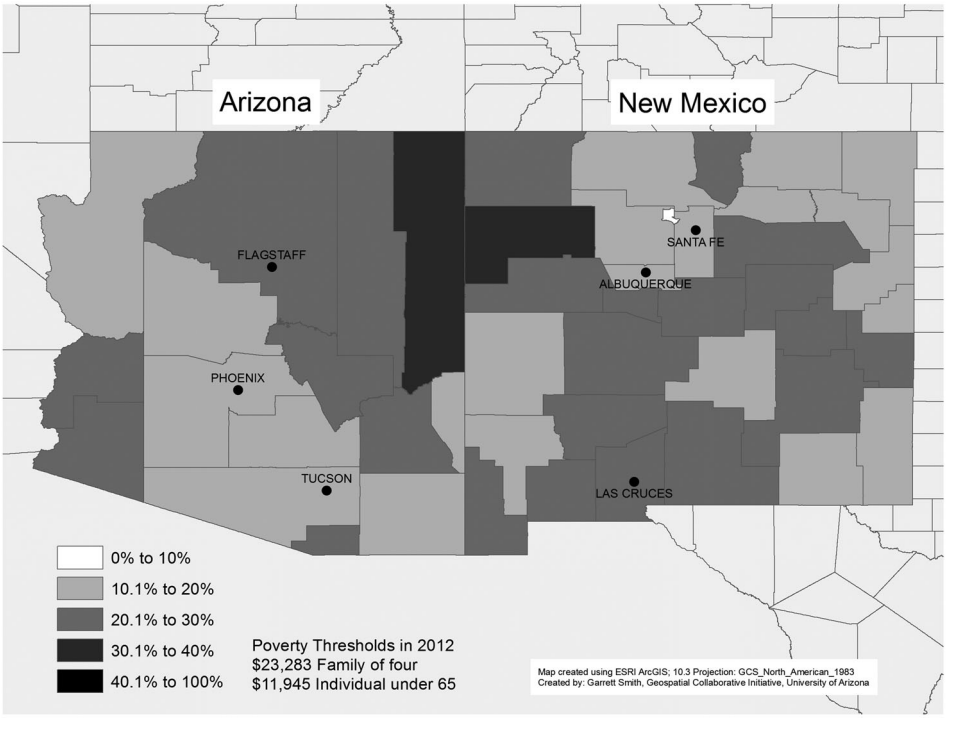

Figure 1. Map of poverty levels, Arizona and New Mexico, 2012.

Views of climate vulnerability: social service agencies

People experience climate through the impacts of climate conditions, especially extremes, on their bodies, families, leisure and work. The most dramatic impacts are associated with natural disasters such as floods and severe storms that can result in loss of life, property and employment. Seasonal

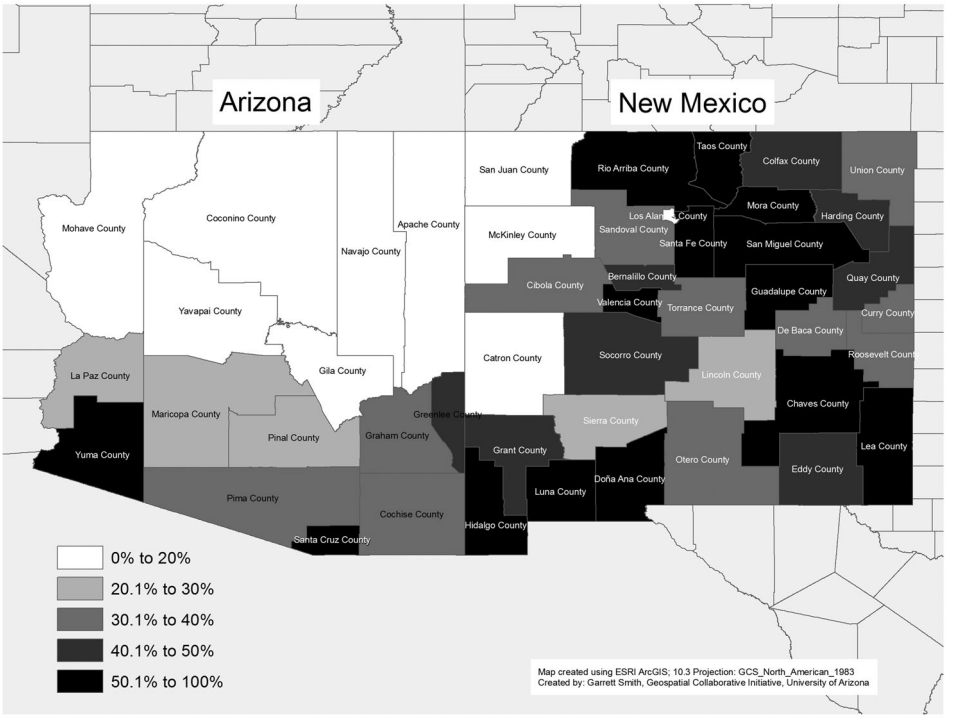

Figure 2. Map of percentage of population, Hispanic or Latino, Arizona and New Mexico.

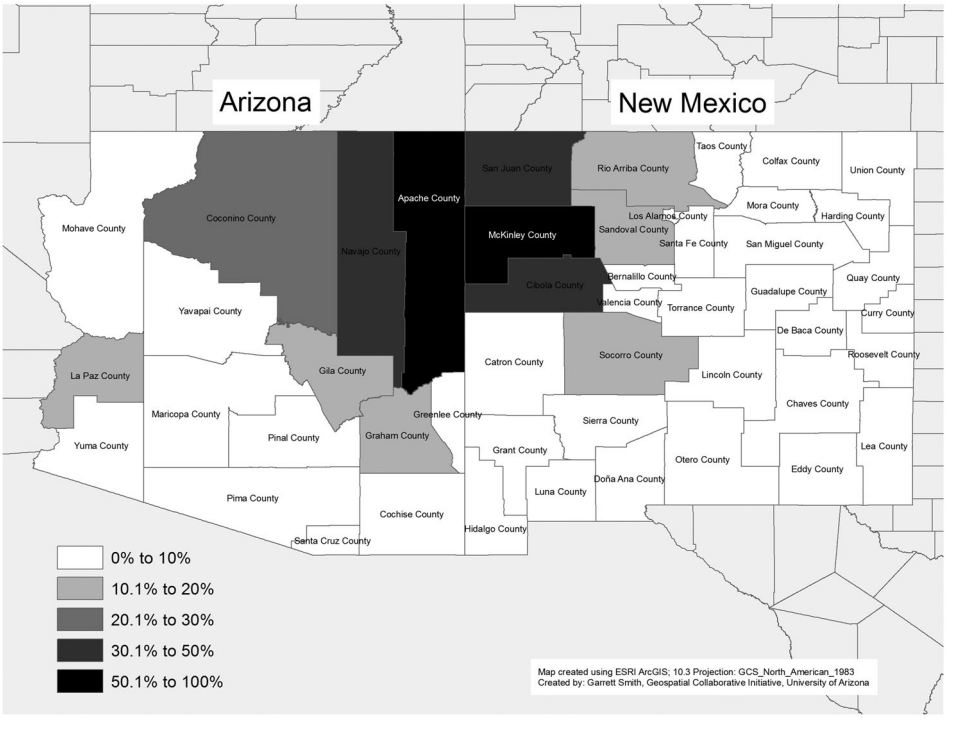

Figure 3. Map of percentage of population, American Indian or Alaska Native, Arizona and New Mexico.

shifts in temperature and precipitation influence household costs of energy for heating and cooling, water for irrigation, and food costs, and affect health status when people are inadequately protected from heat and cold stress, or when climate drives insect, pest and disease outbreaks.

Climate also has significant impacts on the health and productivity of those who work outside and on outdoor recreation opportunities and comfort. Climate extremes and changes can change the costs borne by organisations, resulting in economic and job loss for employers and workers. Because climate changes in the Southwest are associated with warmer, drier and more extreme conditions, the everyday impacts on residents are most likely experienced through heat stress and insect-borne disease, the cost of air conditioning and water, and the production of and access to locally produced food. In almost all cases, we suggest, lower income populations are most vulnerable to these embodied and everyday impacts of climate. In this section, we explore these impacts through interview data that connect climate to health, energy, and food.

The research took place in three phases, including a review of literature and archival documentation, a stakeholder organisation workshop, and semi-structured interviews with organisation representatives. In total, the workshop and interview phases included a total of 20 unique community agencies/organisations in southern Arizona (Table 4). We developed a case study for southern Arizona only in this initial study, due to the available funding. In 2015–2016, the project will develop two additional case studies sited in a) southern New Mexico, and b) the US–Mexico border counties of Arizona, and focused on extreme heat and vulnerable populations.

Stakeholder workshop

We hosted a workshop in 2011 at the University of Arizona with climate researchers, local government agencies and non-profit social service organisations in southern Arizona. A total of 12 community agencies/organisations participated in the workshop. The goal was to facilitate stakeholder dialogue and feedback regarding the issues connecting climate, poverty, and vulnerability and to identify vulnerable areas and priorities for future research and collaboration. The workshop included several presentations on climate, including our preliminary results, but most time was spent in facilitated discussion. We asked questions about the impacts of climate and strategies for adapting to extreme and changing conditions.

We were surprised that "climate" resonated strongly as a risk factor for their clientele populations, given the many other priorities and concerns of government and social service agencies in our region. As one participant succinctly stated, that, for their clients: "If it's a matter of feeding my kids and my health, then climate becomes a real issue rather than an abstract, out-there concept."

The discussion focused on identification of problems and solutions, raising a variety of issues including the need to increase the awareness and adaptive capacity of communities as the

Table 4. Organisation and agency types (by category) participating in study (workshop and/or interviews).

Organisational focus	Number of organisations
Health	3
Food security	3
Poverty relief and social justice	3
Sustainable development	1
Hispanic focus	1
Tribal focus	1
Border focus	1
Ageing population	1
Women	1
City of Tucson	3
Total organisations	20

Note: Two organisations participated in both the workshop and interviews, and are counted only once in this table.

climate changes. There was an overall feeling among participants that much can be accomplished through education, effective communication of climate-related problems, and the implementation of climate-friendly options, such as bike lanes, community gardens, and community outreach, which can positively impact people's health, quality of life and daily environment. Workshop participants emphasised that on-the-ground efforts must be met with parallel advances in the reach of social safety nets such as food stamps, energy assistance, and emergency preparedness. Aspects of climate vulnerability raised by participants included US–Mexico border dynamics, public health concerns, emergency preparedness, lack of planning for climate adaptation, communicating climate issues, food security, affordable housing and the need to build adaptive capacity at the neighbourhood level. Participants suggested that climate-related vulnerability should be framed as a public health issue, with more effective public education programmes about multiple benefits to the environment, climate, and personal health from individual and social behavioural changes (e.g. walking as a way to reduce air pollution; community gardens to increase nutrition and local food security). While there is growing awareness of the role neighbourhood associations play in creating resilient communities, there is a dearth of information regarding detailed knowledge of vulnerable populations (e.g. location of people on oxygen or with immobility). This impedes emergency response capabilities in the event of climate-related hazards (such as heat wave, hard freeze, or dangerous storm).

Interviews

At the end of the workshop, we used "snowball sampling" to gather participants' suggestions of the organisations to contact for interviews regarding the linkages among social vulnerability, poverty, and climate in the Southwest. Interview participants were then selected based on these recommendations and our own web-based search of social service and environmental agencies working in southern Arizona. In-depth, semi-structured interviews were conducted with 12 social service and sustainability organisations, representing a broad cross-section of perspectives on how the poverty–climate nexus affects different sectors of the population. Organisations interviewed included food banks, senior citizen assistance, border/migrant support, Latino community assistance, tribal nations, municipal housing and development, and environmental education/sustainability organisations (Table 4). Interviews lasted an average of 1.5 hours and were conducted at the organisations' headquarters. Two interviews were conducted in Spanish at the request of the interviewees. Questions were directed at how the clientele of these organisations experience climate in general and with specific reference to health, food, and energy.

The interviews were transcribed in Microsoft Word. Interviews were then analysed based on the common themes and distinct challenges identified. Common themes emerged through the interviews regarding how low-income people generally experience climate. Among the most salient points were that people experience climate by staying indoors and through their pocketbooks, pointing to multi-layered vulnerabilities that cause them to engage in constant trade-offs for basic needs.

Lastly, key quotes were extracted from the interviews and were included in the discussion below in order to share how the organisations/agencies themselves observe and narrate their direct experiences with these issues.

Results from workshops and interviews

Each section below begins with a background and context section based on our archival sources documentation and comprehensive literature review, including sector-specific reports and grey literature. Subsequently, each section provides summary findings directly from our interview data across the key indicators of health, food, and energy, and includes additional important themes that arose in the interviews.

Health. Health disparities between high- and low-income populations and among various ethnic groups are well documented (ADHS 2012), but the relationship among climate, poverty, and public health is less well understood. Arizona and New Mexico are among the most health-deprived states (ADHS 2012).[6]

A comprehensive 2013 assessment of climate change and health in the Southwest (Brown *et al.* 2013) reported that climate change will exacerbate heat-related morbidity and mortality in the Southwest, will increase particulate matter levels from wildfires with effects on respiratory health, and will influence vector-borne disease prevalence, but the direction of the effects (increased or decreased incidence) will be location- and disease-specific. The less well-off are less likely to have screens on windows to reduce insects, and are more likely to live in areas with poor sanitation and drainage that can also increase disease and insects after rainstorms. Finally, disadvantaged populations are expected to bear a greater burden from climate change due to reduced access to medical care.

Health impacts from excessive heat are closely related to the accessibility and affordability of household energy for low-income communities. Harlan *et al.* (2013) studied how neighbourhood characteristics influenced heat exposure deaths from 2000 to 2008 in Maricopa County, Arizona and found higher probabilities of death for lower income, older, non-white populations living in less vegetated locations, especially in the inner city of Phoenix. Grineski *et al.* (2013) found disproportionate impacts of extreme heat in Ciudad Juarez, Mexico,

Heat is the primary cause of weather-related deaths in the USA. (National Weather Service 2007). In a study of death due to excessive heat, the Arizona Department of Health Services (ADHS) (2012) found that a total of 1535 people died between 2000 and 2012 (Table 5). Half of these were undocumented migrants, mostly young men, who attempted to cross the desert between May and September. Of the 589 Arizona residents who died from heat in this period, more than half were Hispanic and half were over the age of 57 – with two-thirds of the elderly dying in their homes. Homeless people are very vulnerable to temperature extremes because of their exposure to the elements.[7]

In the last decade, some of the most tragic heat-related deaths in Arizona are of migrants from Mexico and Central America who die from dehydration and heat stress as they cross from Mexico and walk through the desert during the intense summer heat (www.nomoredeaths.org, www.humaneborders.org, www.colibricenter.org). Humanitarian organisations estimate that more than 10,000 migrants have died on the border since 2000, although only just over 5000 deaths are officially recorded. A map for Arizona shows 2,869 deaths along the border, including many in remote desert regions where there is no water (Figure 4). The response has been to place water stations and warning signs in the desert.[8]

Health – interview findings. Most of the organisations interviewed reported that climate has a role in restricting choices that can improve health, such as outdoor activity, and "green" the community, such as walking or biking. They noted that those working outdoors must constantly negotiate the climate in Arizona in order to work safely in the hottest months. Some workers shift work hours to the coolest hours of the day and emphasise protective clothing and hydration. Most people,

Table 5. Heat-related deaths in Arizona.

	2000–2012
Total deaths	1535
Arizona residents	589
Latin Americans	736
Female	392
Male	1142
Hispanic/Latino	898
White non-Hispanic	444
Median age all	51
Median age Hispanic/Latino	30

Source: ADHS (2012).

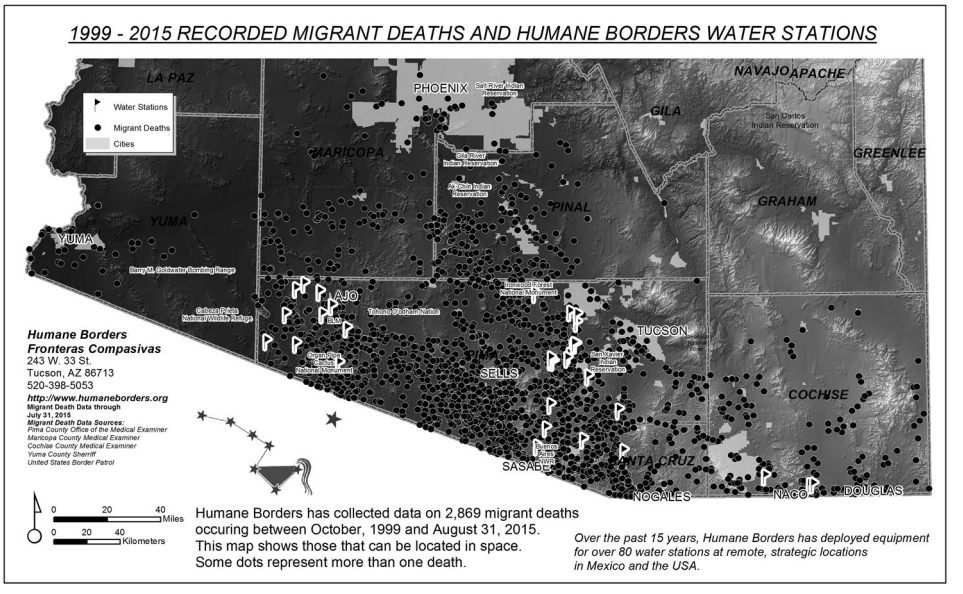

Figure 4. Map of migrant deaths in the desert.
Source: Migrant death map courtesy of Humane Borders, Inc., 8/31/2015. Cartographic design by John F. Chamblee. Reproduced with the permission of Humane Borders and John Chamblee.

however, work and live the *majority of their lives indoors* and their experience of climate extremes and climate changes are mitigated by air conditioning and thus experienced through their thermostat and electricity bills.

Several interviews noted that hot climate limits activity in the summer for many, contributing to diseases such as obesity, diabetes and cardiovascular disease. The link between climate and obesity is anecdotal at present, as we were unable to substantiate such a correlation in the public health literature; however, this is an important arena for future research. High temperatures also increase air pollution in the form of dust and ozone, and climate change alters allergies and insects affecting those with asthma and inability to control mosquitos. There is an increasing population of elderly residents due to migration patterns and the ageing of baby boomers. Elderly people lack mobility to a greater degree than younger people and may experience heat stress if they cannot drive and use public transportation.

Food supply and food security. For low-income populations, who spend a higher proportion of their incomes on food, higher food prices can be a problem. The USDA estimates that in 2012, Americans spent an average of 10% of their income on food (http://www.ers.usda.gov/data-products/food-expenditures.aspx), but the lowest earning 20% of the US population spend 16% of their income on food. Nationwide, the social groups showing the highest rates of food insecurity include single women with children (36.5%), black non-Hispanics (27.75%), Hispanics (23.8%), and low-income populations (35%). While the national food hardship rate for households without children was 11.1% in 2014, it was 19.4% for families with children (Coleman-Jensen *et al.* 2015).

Climate impacts on food accessibility and affordability in the Southwestern United States are difficult to define due to the nature of southwestern foodsheds where 97% of food consumed in the Southwest is imported from outside the region (Nabhan and Fitzsimmons 2011). A high percentage of the food produced in the Southwest is exported out of the region. Thus, climate impacts on agriculture in other regions cause food supply and price volatility in the Southwest, and climate impacts on southwestern agricultural crops may be experienced elsewhere.

Nabhan and Fitzsimmons (2011) report that due to high poverty rates in Arizona and New Mexico, food security is a challenge for low-income populations. The US–Mexico border region has an integrated foodshed whose boundaries are not "coterminous with national borders" (Banister 2012, p. 6). Although the binational region is an abundant agricultural producer, paradoxically, Arizona and New Mexico have high levels of food insecurity. Between 2007 and 2010, 12.9–18.6% of Arizona households were food insecure, as were 14.7–15.4% of New Mexico households. Arizona was ranked third worst, and New Mexico 11th, nationally for food insecurity (Nabhan *et al.* 2012, p. 4).

A report on food hardship in America in 2012 (FRAC 2013) shows a national food hardship rate of 18.2% that measured the per cent of people who responded that there were times when they did not have enough money to buy food for themselves or their family. The rate for the Southwest was (along with the southeast) the highest in the nation at 21.1%, and the cities of Albuquerque and Tucson had rates above the national average (Mabli *et al.* 2010, New Mexico Association of Food Banks 2010). Many food bank clients reported having to choose between food and education, medical care, housing, transport or utilities, and 25% of recipients grow their own food (Feeding America 2014). Climate change is also anticipated to impact agricultural employment, production, and food prices across the USA.

The Food Research and Action Center finds that food insecure and low-income people are particularly vulnerable to obesity. Causes for this correlation include: lack of access to healthy, affordable food; fewer opportunities for exercise; lack of parks; stress and irregular eating patterns; and limited access to health care (Food Research and Action Center 2015). One report found that income, household composition and education all influence eating choices and habits that result in obesity (Mancino *et al.* 2004). "In 2007, childhood obesity affected 30.6% of all school children in Arizona and 32.7% in New Mexico" (Watters 2011, p. 30). Obesity can add to health stress during heat waves.

In sum, economic insecurity combined with changes in climate and more frequent extreme weather events both within and beyond the Southwest result in a cascade of effects impacting agricultural labour, food availability and accessibility, and the food security of low-income populations.

Food – interview findings. The organisational representatives reported that climate variability and uncertainty are a problem for food supply in terms of purchases, food assistance and cultivating gardens'. Unpredictable climate affects planting calendars and growing seasons; irregular precipitation increases uncertainty for crop planning. Almost all gardens in Tucson are irrigated and it is difficult to promote home gardens if water is limited or expensive. Extreme heat presents a challenge for outdoor labour – for example, for community gardens and agricultural workers, extreme heat deters outside work. Prolonged drought conditions harden the soil and heat affects the ability to have year-round production.

The foodshed is partially dependent on food supply from Mexico; yet, climate impacts and management practices there may differ from those in Arizona and New Mexico. There was a shared feeling among several respondents that being so removed from the basic elements we depend on to survive (e.g. food production), puts agencies and organisations at a disadvantage for informing people about climate change issues and what they can do to both prevent and buffer the impacts:

> I know also from the school garden programs you really see how removed people are from the source of their food. You see this when you show them a seed and how things grow. So how are they going to understand climate change if they are so far removed?

Traditional residents of southern Arizona including native populations and those of Mexican heritage had many strategies for growing food in a hot dry climate including a focus on well-adapted, low water-use plants and well-managed irrigation and rainwater harvesting systems. Many of these strategies have been lost as a result of imposition of modern agriculture, urbanisation and loss of traditional knowledge and because of advertising that promotes mainstream American diets that rely on foods imported from beyond the regions. What is grown locally – such as native plants – is not

necessarily what people want to eat. Many people have become disconnected from the food that grows in the Sonoran desert of southern Arizona.

Food insecurity is related to the multiple vulnerabilities low-income people experience, caught in constant trade-offs among paying for food, medical or other expenses. Interview respondents reported that nutrition and food insecurity is a growing issue, as funding for safety net programmes (like Meals on Wheels) is reduced.

Energy. Energy poverty has traditionally been defined as a situation in which a household spends more than 10% of its income on energy (Boardman 1991). But it can also be linked to macro-level infrastructure and both energy and capital flows and affects micro-scale supply and accessibility of energy at the household and neighbourhood levels (Harrison and Popke 2011). One of the main ways in which Southwest residents maintain health and productivity during warmer months is through air conditioning such as fans, evaporative coolers, window units, or central air conditioning. Electricity bills in the summer months can easily exceed $200 per month per household, especially for poorly insulated or shaded dwellings. For the less well-off, these energy costs can define them as energy-poor – although energy poverty has largely been defined as a "cold" region phenomenon or only associated with extreme heat waves.

As southern states with semi-arid warm climates in their lower altitudes, Arizona and New Mexico are often ignored in discussions about high *per capita* energy consumption and costs. Air conditioning dominates electricity use, except in the higher altitude regions of the Southwest. In terms of absolute and average outlays *per capita*, that impression is correct: in 2009, household energy expenditure for Arizona was $1959 and for New Mexico $1802, below the national average ($2024) and at the low end of the range of all states for average annual energy expenditures (http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption#summary).

However, energy costs per square foot are slightly higher and inequalities in income across the region mean there are many people who are energy-poor in relation to their income and needs (Table 6).

In Arizona, the number of households eligible for energy assistance under the Low Income Home Energy Assistance Program (LIHEAP) has risen in the last decade, although only 16,000 households received assistance in 2013 and this was mostly for heating rather than cooling (LIHEAP 2013). Three-quarters of these households were below the poverty threshold and one-third were homes occupied by elderly residents. In New Mexico, one of every five families is estimated to be in energy poverty, using 20% of household income for utility bills (Prosperity Works data: http://prosperityworks.net/energy-advocacy/). In 2010, only $35 million of an estimated need of $222 million was available for energy assistance for LIHEAP-eligible families in Arizona (Barnhart 2011).

Energy poverty is severe in rural areas. In the Southwest Navajo Nation, where 30% of households are off the grid, water must be trucked in from 40 miles away, and most people rely on portable gas generators for home energy needs (Barnhart 2011). In sum, energy poverty is a climate-related challenge for the Southwest as average temperatures increase and extremes are reached.

Energy – interview findings. Respondents uniformly agreed that the primary response to summer climate in southern Arizona is to stay indoors, and they noted the multiple health implications of that choice. Due to high summer heat, the way people connect to climate is "through their energy

Table 6. Energy data for Arizona and New Mexico.

2009 residential energy consumption survey	Arizona	New Mexico/Nevada	USA
Energy cost per household	1959	1802	2024
Energy cost *per capita*	756	678	787
Energy cost per square foot	1.09	1.07	1.03

Source: http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption#summary.

bills". Housing – especially rental housing and mobile homes – is inefficient and lacks weatherisation. As with growing food, the traditional strategies for cooling buildings in the region have been phasing out, including thick adobe walls, shaded verandas, and interior courtyards.

Insufficient cooling or heating is a concern for welfare organisations and local government, especially for low-income elderly people. One respondent told us:

> Then there is the utilities piece – this is clearly a direct impact of climate. We see more people already living with less and unfortunately these problems increase when they have system failure such as the cooler breaking down or a broken window screen. They may not be able to afford replacing the damage and there is a concern, particularly for older adults, that they may live in unsafe temperatures from month to month. We receive an increase in calls about heating and cooling not functioning and that means a big concern for the health, safety and well-being of the elderly.

Other interview findings

The interviews raised a number of additional themes, addressed below with direct interview findings.

Multi-layered vulnerabilities. Several respondents highlighted how age and ethnicity combined with low-income status create multi-layered vulnerabilities for low-income populations. People are forced to choose among paying for air conditioning/cooling (or heating in winter), housing, health care, and food. Ageing is seen as a cross-cutting factor; people tend to "slide off" the social safety net once they retire and begin to experience nutrition and financial problems. Arizona is the home of many tribes that have high levels of unemployment, lack of infrastructure (especially water), undefined water rights, lack of comprehensive health care, and ways of life threatened by drought and fire. Interview respondents were clear that while climate is one critical driver of vulnerability across the health/food/energy nexus, it is not the principal explicit challenge low-income populations face. Daily survival and trade-offs among essential needs are the major challenges low-income people confront.

Immigration status. Many of our respondents linked immigration status to climate vulnerability. Although the interview protocol did not ask about immigration status as a factor, interview participants raised it with us. Most respondents mentioned undocumented and/or mixed-status families as facing disproportionate climate risk. Respondents told us that undocumented migrants are concerned with basic survival and they distrust police, hospitals, and other "safety net" institutions. In Arizona, the state's strict policing and federal Homeland Security policies have raised the level of fear and insecurity among undocumented and mixed-status families. Because of this, respondents reported, many of the most needy families are not accessing support programmes such as food stamps, weatherisation assistance, or utilities payment support. One respondent noted that,

> In Yuma, a single mother doesn't drive because she's scared of being stopped and undocumented. She walks everywhere and is very thin. *Para cubrir una necesidad tiene que brincar dos mas*. (To deal with one necessity, she has to jump over two others). To avoid the heat, she goes to the library, but she has to walk there with her family.

Another respondent noted: "[Undocumented] people stop going for food aid because of fear of reprisals."

Community action and climate adaptation. We heard that community organisations already address many issues at the heart of climate and climate change because of their close linkages to their poverty reduction and neighbourhood improvement goals to create healthy, resilient, communities. This implies making structural changes to the community, such as shading, community gardens, or retrofitted housing, that result in benefits at multiple levels. Many of these changes not only decrease greenhouse gas emissions (e.g. through promoting non-carbon-based transportation), but also increase buffering mechanisms, resilience, and preparedness of communities

confronting climate change and weather events while promoting healthy and productive activities. Grassroots and sustainable policy initiatives, for example, help reduce heat island effects, expand native vegetation, increase water harvesting, and encourage outdoor activity.

Examples of "climate-friendly" activities being pursued in southern Arizona include both mitigation and adaptation measures such as shaded alleyway initiatives; home gardens based on agroecological principles; water harvesting; local sourcing of food bank produce donations; compost production; and arid-adapted grains and milling. One community-wide health sustainability group organises public meetings to talk about issues such as climate change and how to reduce vulnerability and another has produced a citizen's guide for resilience to climate extremes (http://www.psr.org/chapters/arizona/assets/pdfs/citizens-guide-resilience-climate-extremes.pdf). Many neighbourhood associations engage in tree-plantings and other "green" activities and asset-based community development. The City of Tucson has adopted environmental policies related to climate adaptation including tree planting and building regulations and Arizona's Department of Health Services has a major programme on extreme heat and public health (http://www.azdhs.gov/preparedness/epidemiology-disease-control/extreme-weather/index.php).

Conclusion

Is there a climate gap and what does it look like in the Southwest? And what are the implications for EJ as climate changes? Our research found that the southwestern region is a hotspot both for physical climate change and for social vulnerability with a clear "climate gap" between rich and poor. The Southwest is projected to become hotter and drier under future climate change, creating the potential for heightened vulnerability and increasing challenges to achieve EJ. The Southwest exhibits high social vulnerability, with rankings among the worst in the USA on a range of indicators, including poverty, health insurance, energy and food security, and childhood well-being.

Data for Arizona and New Mexico and interview data from southern Arizona social service providers demonstrate that climate risk in the Southwest is not equal opportunity, but rather is unevenly distributed across the social and ethnic landscape. Low-income communities are disproportionately affected by heat-related illnesses and insufficient access to energy for heating and cooling, and are forced to make trade-offs among essential needs. Climate is linked to health disparities in both direct (e.g. heat-related illnesses, high incidence of asthma) and indirect ways (e.g. causing people to stay inside and miss exercise, gardening, and other healthful activities). Undocumented immigration status makes people more vulnerable to climate risk through restricting their ability to access services and for border crossers generates extreme risks of death from heat stroke and dehydration.

Despite growing efforts to stem greenhouse gas emissions, even the most optimistic projections anticipate substantial climate change for the coming years. Communities need to establish emergency preparedness and build local resilience to respond to climate change and ensure climate justice. This requires identifying and addressing the various vulnerabilities of populations according to their unique cultural, socio-economic, and environmental context. In the Southwest, important actions to buffer the complex intersections of climate change and social vulnerability include: housing weatherisation, affordable energy, identification of the most vulnerable populations and emergency planning, job security, and community greening and gardening projects to reduce heat island effects and increase local food security.

The Southwest climate gap – the connections between poverty and climate that we have outlined here – is an urgent need to be addressed. Climate is beginning to rise on the agenda of social service providers and social vulnerability is rising on the agenda of climate researchers. Looking at the material effects of climate on low-income households, embodied in risks to health, energy and food, provides powerful everyday examples of how climate affects ordinary Americans across different social, age, and ethnic backgrounds. In contrast to the traditional "climate stakeholder" – farmers, water managers, and natural resource planners – the poverty–climate link defines a new set of stakeholders, including vulnerable communities and the government agencies and social services

providers that serve them. Thinking across this nexus may yield fresh insights into how climate extremes and climate thresholds are *defined, embodied*, and *experienced* by vulnerable communities.

Notes

1. Overpeck *et al*. (2013, p. 1) define the Southwest's natural climate variability as including "droughts, floods, heat waves, cold snaps, heavy snow falls, severe winds, intense storms, the battering of coastal areas, and acute air-quality conditions".
2. The IPCC WGII AR5 defines climate change as "a change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer". Available at: http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Glossary_FGD.pdf.
3. The Climate Assessment for the Southwest (CLIMAS) programme under which this research was funded, is NOAA's regional integrated science assessment programme for the southwest region, comprising Arizona and New Mexico. Garfin *et al*. (2013) used a broader definition of the region, encompassing Arizona, New Mexico, California, Nevada, Utah, and Colorado.
4. A national analysis corroborates this finding. Researchers created an index of vulnerability using 39 variables including poverty, age, race/ethnicity, pollutant exposure, and several measures of health disparity by county within a geographic information system (Wilson *et al.* 2010). Mapping the index in five categories from low- to high-climate vulnerability, this study showed 9 of Arizona's 15 counties in the highest vulnerability category, along with 4 in New Mexico. Border counties were included in the highest vulnerability category and the Southwest was among the most vulnerable regions.
5. Possible explanations include political affiliation (more likely to be Democrats who are generally more concerned about climate change), empathy for suffering in Latin America and developing countries, a lack of scepticism in the Spanish language media, and a higher level of exposure to climate stress through outdoor work and costs of air conditioning to poorer households.
6. For example, a higher proportion of Arizonans report that they lack health insurance (20%) or that they cannot afford health care (20%) than the national average, and low-income and Hispanic residents have even greater challenges (more than 35% without insurance) (ADHS 2012).
7. In 2005, in the month of July alone, Phoenix experienced 14 days with temperatures of 110 or higher. In one week, at least 21 people died in Phoenix in this extraordinary heat wave (the total heat deaths for the year was 34), 14 of whom were identified as homeless (Anthony 2005). The homeless were also vulnerable during a more recent heat wave in 2013.
8. The vulnerability of migrants to extreme climates results from the increased security along the border including fences in California and urban locations that have forced people into hotter climates in Arizona and checkpoints that force migrants into the desert (Rose 2012). Although immigration numbers are declining overall, migrants are taking riskier routes, and there are a larger proportion of Central American migrants who may be unaware of the risks of the desert climate.

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