Rural Nevada and Climate Change: Vulnerability, Beliefs, and Risk Perception

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Rural Nevada and Climate Change: Vulnerability, Beliefs, and Risk Perception

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In this article, we present the results of a study investigating the influence of vulnerability to climate change as a function of physical vulnerability, sensitivity, and adaptive capacity on climate change risk perception. In 2008/2009, we surveyed Nevada ranchers and farmers to assess their climate change-related beliefs, and risk perceptions, political orientations, and socioeconomic characteristics. Ranchers' and farmers' sensitivity to climate change was measured through estimating the proportion of their household income originating from highly scarce water-dependent agriculture to the total income. Adaptive capacity was measured as a combination of the Social Status Index and the Poverty Index. Utilizing water availability and use, and population distribution GIS databases; we assessed water resource vulnerability in Nevada by zip code as an indicator of physical vulnerability to climate change. We performed correlation tests and multiple regression analyses to examine the impact of vulnerability and its three distinct components on risk perception. We find that vulnerability is not a significant determinant of risk perception. Physical vulnerability alone also does not impact risk perception. Both sensitivity and adaptive capacity increase risk perception. While age is not a significant determinant of it, gender plays an important role in shaping risk perception. Yet, general beliefs such as political orientations and climate change-specific beliefs such as believing in the anthropogenic causes of climate change and connecting the locally observed impacts (in this case drought) to climate change are the most prominent determinants of risk perception.

KEY WORDS: Adaptive capacity; climate change; drought; Nevada; physical vulnerability; ranchers and farmers; risk perception; sensitivity; vulnerability

1. INTRODUCTION

There is a relative gap in the literature regarding the influence of vulnerability to climate change on risk perception.[1,2] In a recent article, Weber[3] emphasized the need for deeper research investigating potential relationships between vulnerability, risk perception, and pro-environmental behavior, especially in Western countries. Satterfield *et al.*[4] attributed the lack of such studies to the disparity among the disciplines within which these research domains exist. The study of vulnerability is prominent within the disciplines of geography, environmental geography, and environmental studies and sciences; whereas, risk perception is prominent within the disciplines of risk analysis and environmental sociology.[1,2]

Through this research, we partially fill the aforementioned gap in the literature, and enrich the

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discourse concerning the determinants of climate change risk perception especially in the American context. We examine whether or not vulnerability to climate change affects individuals' perceptions of climate change impacts. Specifically, we assess how differences in individuals' vulnerability to the risk of climate change induced drought among Nevada ranchers and farmers influence their climate change risk perceptions. We also assess how beliefs regarding the causal relationship between the current drought in Nevada and climate change impact risk perception.

In the remainder of this article, we first discuss the evolution of the concept of vulnerability. Then, we introduce the existing literature concerning the interrelationship between vulnerability and risk perception. We also briefly review the literature on the influence of political orientation, gender, and beliefs on risk perception in the American context. Then we introduce and discuss our hypotheses. Afterward, we describe our research methodology, which includes descriptions of how we assess the relevant variables, in addition to our analytical techniques. Finally, we provide and discuss our findings, including descriptive and quantitative analyses, followed by a conclusion.

1.1. Vulnerability

A growing body of literature, including the writings of the Intergovernmental Panel on Climate Change (IPCC),[5,6] Cutter,[7] Adger,[8] and Smith,[9] integrates both physical vulnerability (P.V.) or exposure to hazards and risks, and the socioeconomic conditions or social vulnerability of affected communities or individuals within an overarching vulnerability definition.[5–9] In this research, we use the definition of vulnerability stated by the IPCC, which is:

> . . .the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.[5,p.995]

Sensitivity (hereinafter Se.) is a measure of the extent to which a system can be harmed or benefit from a given hazard. Se. is a reflection of systems' characteristics that govern outputs of interactions between such systems and hazards once they take place. For instance, women, the elderly, children, and people with disability are more sensitive to risks such as tornadoes, tsunamis, and earthquakes, where they have more difficulty in escaping and adapting to them once they occur. Additionally, individuals and communities who are more reliant on natural resources for living such as ranchers/farmers, foresters, fishermen, and hunters are more sensitive than others to hazards such as droughts, deforestation, and wildfires.[10–13]

Adaptive capacity (Ad.C.) is a measure of the capacity of a system to respond to a given environmental hazard through mitigation, coping, survival, adjustment, or adaptation. Ad.C. reflects the resources available to the system under investigation (community, individuals, etc.) and the accessibility to these resources either for protection from risks or for survival and coping when risks happen. Individuals with higher income, higher education, and greater social status are usually more likely to protect themselves from, or adapt to hazards than those with less resources and political connections. For example, individuals with noteworthy political power usually get earlier alerts regarding the approach of risks such as tornadoes, have more reinforced or better located houses and specialized equipment to protect themselves and families, and have easier and faster access to assistance programs that usually follow the occurrence of hazards.[7,12–18] As noticed by Smith and Wang,[19] Ad.C. also constrains the political validity and efficiency of some hazard management policies such as increasing water tariffs as a demand-side management strategy for droughts. Such policies might impact the very well being of impoverished individuals and families. Thus, the use of tariff schemes such as the "inclining block rates" that keep the water cost reasonable for low-income families and increasing it on those with higher income and higher water use are preferred.[19]

1.1.1. An Evolving Concept of Vulnerability

Researchers from different knowledge domains have been involved in the discourse regarding what constitutes vulnerability to hazards since at least the 1960s. Within this discourse, vulnerability evolved from being centered on the probability and severity of hazards to take place (physical vulnerability or P.V.) and became a comprehensive concept, within which both P.V. and socioeconomic conditions of threatened individuals or communities are intertwined.

The discussion concerning vulnerability has been ongoing within a variety of knowledge subdomains such as political economy and natural hazards, and in the discourse regarding "ecological resilience."[(20–23)] The disparity between those domains resulted in three different sets of definitions, attributes, and focal questions.

As can be seen from Table I, the first approach is the risk/hazard approach mostly used by engineers and economists. This approach focuses on predicting the physical impacts of climate change on physical or/and human systems. The other approach is the political economy approach, which focuses on the ability of humans as individuals or communities to avoid, cope with, and adapt to hazards that threaten their livelihoods and well-being. The third approach is the ecological resilience approach, which focuses on how the human/environmental systems face disturbances while sustaining their functions and main characteristics.[(20–23)]

Adger,[(28)] and Kelly and Adger[(29)] argued that the study of P.V. alone deals with natural hazards such as the impacts of climate change as if they occur in a vacuum. They further argued that when hazards impact a group of individuals, they interact with the socioeconomic conditions of those people. This interaction either enhances and deepens people's vulnerability, or decreases the impacts of the natural hazards and strengthens their (the affected people) Ad.C. (From a political economy lens, this speaks to "environmental justice.") Kelly and Adger's understanding of vulnerability assessment applies what they called the "wounded soldier" approach. Unlike other approaches that focus on determining the severity and probability of hazards to take place in the future, the wounded soldier approach focuses on assessing the impact of the existing conditions (injury) on the capacity of systems (individuals or groups) to avoid, cope with, and adapt to expected hazards or risks. We suppose this naturally must lead to "triage" in one form or another.

1.1.2. The Components of Vulnerability

With the rise in profile of climate change as a complex and multifaceted issue challenging classical disciplinary approaches to vulnerability, there is a growing body of literature, including the IPCC reports, which define vulnerability to climate change as a function of three main components: (1) P.V., (2) Se., and (3) Ad.C.[(4,5,29)] Although P.V. of a particular system (community, individuals) is determined by the probability and severity of certain hazards (natural or technological) affecting this system, both Se. and Ad.C. are determined by the socioeconomic conditions of threatened communities or individuals as discussed earlier.[(6–9,31)]

Adger,[(28)] and Kelly and Adger[(29)] stressed that even though the individual and collective socioeconomic vulnerabilities at the community, city, state, or national scales are intrinsically linked, they still have distinct natures.[(28,29,32–34)] They also stressed the insufficiency of aggregating individual socioeconomic vulnerabilities as an assessment of social vulnerability. They argued that at the individual level socioeconomic vulnerability is a function of relative poverty, social status, diversity of income, and reliance on natural resources for livelihood. As can be seen from Table II, Cutter *et al.*[(35)] added gender, ethnicity, age, household ownership, family size and health status as important factors of individual socioeconomic vulnerability. In addition to the aggregated individual socioeconomic vulnerability indicators stated before, societal socioeconomic vulnerability encompasses the status of available infrastructure and technologies, informal social reciprocity and solidarity norms ("social capital"), the governmental and nongovernmental institutions' efficiency, the market structure, and the status of formal social security arrangements (i.e., insurance).[(28,29,32–34)]

1.2. Risk Perception and Vulnerability

A very limited number of studies have investigated the impact of vulnerability to climate change on risk perception.[(36–40)] These studies focused only on the P.V. component and neglected both the Se. and Ad.C. For example, Brody *et al.*[(36)] investigated the impacts of different types of P.V. on climate change risk perception among the American general public. The researchers found that those who live in areas suffering more numerous natural hazards-induced fatalities, or at lower elevations close to the coast, perceive the risk of climate change greater than those who live in areas with less natural hazards induced fatalities, or at higher elevations and away from the coast. However, contradicting the above-mentioned results, they also found that people who live in 100-year flood plains perceive the risk of climate change lower than those living in flood-safer areas. On the other hand, living in areas witnessing an increasing number of wildfires, or increasing temperature does not influence climate change risk perception.

Whitmarsh[(38)] conducted a similar study in England in 2003. She found that among the population of Southern England, those who personally suffered

Table I. Three Conceptual Lineages of Contemporary Vulnerability Research

Point of Comparison	Risk/Hazard	Political Economy	Ecological Resilience
Focal questions	What are hazards?	How are people and places affected differently?	What and how do systems change?
	What are the impacts?	What explains differential capacities to cope and adapt?	What is the capacity to respond to change?
	Where and when?	What are the root causes and consequences of differential susceptibility?	What are the underlying processes that control the ability to cope or adapt?
Key attributes	Exposure (physical threat, external to systems), sensitivity	Individuals, households, social groups, communities, livelihoods	Ecosystems, coupled human-environmental systems
Exposure unit	Places, sectors, activities, landscapes, regions.	Individuals, households, social groups, communities, livelihoods	Ecosystems, coupled human-environmental systems
Decision scale of assessment	Regional, global	Local, regional, global	Landscape, ecoregions, multiple scales
Selected definitions	"... the likelihood that an individual or a group will be exposed to and adversely affected by a hazard. It is the interaction of the hazardous place with the social profile of communities."[20,p.532]	"The characteristic of a person or persons in terms of their capacity to anticipate, cope with, resist and recover from the impact of natural hazards." [24,p.9]	"Vulnerability defined as the opposite of resilience, where resilience is the capacity of a system to undergo disturbance and maintain its functions and controls."[25,p.766−24].
	"... the idea of potential for negative consequences which are difficult to ameliorate through adaptive measures given the range of possible climate changes that might reasonably occur" [5,p.774]	"Vulnerability comes at the confluence of underdevelopment, social and economic marginality, and the inability to garner sufficient resources to maintain the natural-resource base and to cope with the climatological and ecological instabilities of semi-arid zones."[27,p.28]	"Resilience has the following three properties: A) The amount of change a system can undergo; B) The degree to which the system is capable of self-organization; C) The degree to which the system can build the capacity to learn and adapt"[25,p.766]

Source: Adopted from Eakin and Luers. [21,p.368]

from air pollution (health problems) perceived the risk of climate change higher than those who did not, but those who experienced flooding in the last five years did perceive the risk of climate change the same as the rest of the researched group. She found that flood victims perceive climate change and flooding as two different threats. Additionally, flood victims blamed the improper infrastructure such as blocked ditches and drains, roads, and local development as the reasons behind flooding more than they blamed climate change.

Contrary to Whitmarsh,[38] Spence *et al.*[39] who surveyed a representative sample of the U.K. population in 2010 found that experience with flooding is a significant determinant of concern regarding climate change. Those who experienced flooding tend to be more concerned over climate change and have a higher perception of climate change risk at the community level. The authors partially attributed the difference between their findings and the findings of Whitmarsh to the fact that the United Kingdom witnessed many extremely large-scale flooding events in the period that separated the survey work of Whitmarsh in 2003 and their own work in 2010. According to the authors, those events in addition to the increased prominence of climate change in the mass media, as well as the publication of the IPCC Fourth Assessment Report in 2007 may have enhanced the perceived causality between locally experienced flooding and climate change.

Speaking of drought as a climate change impact, we did not find studies testing the influence of vulnerability to drought or any of its components on risk perception. However, Dessai and Sims[40]

Table II. Individual and Societal Socioeconomic Vulnerability

	General Factors	Description	Category (Se./Ad.C.)
Individual Vulnerability	Poverty	Richer individuals are usually more capable of absorbing hazards impacts than poorer persons (poverty is a function of income and dependency ratio)	Ad.C.
	Social status	Those who enjoy higher social status are more resilient because they are entitled to more individual and social resources that enable them avoid, adopt, and recover faster from hazards impacts. Social status is a function of income, occupations, and education.	Ad.C.
	Dependence on natural resources	Those individuals who are dependent on natural resources for their livelihood such as fishermen, hunters, gatherers, and farmers are usually more vulnerable to natural hazards.	Se.
	Diversity of income	People with more than one source of income are less sensitive to absorbing livelihood threatening shocks than those with one source of income.	Se.
	Age	Elderly and children are usually more vulnerable to extremes such as floods, storms, and heat waves.	Se.
	Gender	Women usually have a slower recovery time than men because of their family care responsibilities, unequal working conditions, and more strict constraints on mobility and responses to hazards. In much of the world, women are responsible for collecting water and wood and preparing food.	Se.
	Race and ethnicity	Minorities often have less power and more difficulty in accessing postdisaster assistance. They often live in more hazardous areas.	Se.
	House ownership	Those who rent may be transient or poor, which limits their knowledge about sources of aid at the time of emergencies. Also they may lack sufficient shelter when lodging becomes uninhabitable.	Se.
Societal Vulnerability	Infrastructure and technologies	The value, quality, density, and sustainability of infrastructure and technologies that predict, prevent, and/or alleviate possible impacts, or speed recovery.	Ad.C.
	Social capital	The stronger the cultural norms of reciprocity and solidarity in a certain community, the more resilient that community is to natural hazards, and the faster its (the community) posthazard recovery may be.	Ad.C.
	Institutional capacity	The more efficient, knowledgeable, and motivated the institutions, the more able they are to predict, mitigate, and adapt to natural hazards and help affected communities recover.	Ad.C.
	Market structure	The value, diversity, quality, and density of commercial and industrial activities determine the societal economic health and thus its level of resilience to natural hazards.	Ad.C.
	Population growth	Fast population growth puts societies under stress in terms of providing the needed infrastructure and service networks, thus making such societies unable to absorb external natural shocks.	Se.
	Medical services	The quantity and quality of health institutions are vital to the capacity of societies to mitigate, and cope with the aftermath of events such as floods, heat waves, epidemics, etc.	Ad.C.
	Special needs populations	The more special needs groups, such as people with physical or mental disabilities, those chronically diseased, homeless, and transient that there are in a community, the more sensitive that community is to natural hazards because of the relative invisibility and magnified susceptibility of those groups during all phases from pre, to during to postevent.	Se.
	Insurance	Nations with more effective and widespread insurance policies are more capable to pool the cost of natural hazards, and thus coping with them.	Ad.C.
	Water accessibility	The percentage of households connected to the water and sewerage networks, the amount of water stored at a given point, the percentage of population dependent on untreated water resources, the percentage and composition of populations without secure water supply, and sewerage in a community are all determinants of the capacity of that community to deal with emergencies.	Se.
	Food accessibility	Crop diversity, dependence on family farms or natural resources for food, and the availability and storage capacity of food throughout all seasons impacts communities' capacity to deal with droughts and other such events.	Se.

Source: Modified from Cutter *et al.*[35] using other sources.[28–33] investigated the impact of living in drought-prone areas (P.V.) on the appreciation of seriousness of drought conditions. They found that people who live in areas with higher water stress rate the seriousness of the water situation in their areas higher than those who live in less water-stressed areas. Additionally, they did not find correlations between concern over climate change and willingness to pay more for water, or accept water conservation measures. The authors partially justified the failure of concern over climate change in enhancing water conservation behavior by suggesting a possible disconnect between household water resource situation as a personal concern and climate change as a global phenomenon in the public mind.

In addition, many studies concerning environmental risks other than climate change (natural and technical) have shown a strong impact of actual P.V. to environmental hazards on risk perception concerning such hazards. Drori and Yuchtman-Yaar,[41] Elliot *et al.*,[42] and Brody *et al.*[43] investigated the impact of living in areas with higher risks of air pollution, and hurricanes. They all found significant correlations between actual risks and the corresponding perceived risks, as those who live in more hurricane-prone areas or areas of greater air pollution report higher risk perceptions with regards to those hazards. But will this hold true in the case of climate change? This was a question we attempt to answer.

As can be seen earlier, the works of Brody *et al.*,[36] Whitmarsh,[38] and Spence *et al.*,[39] reached mixed conclusions—as some physical vulnerabilities increase risk perception, others are neutral, and yet others even decrease risk perception.[36–39] Such results may stem from the focus on P.V. and neglecting the other two components of Se. and Ad.C. Those two other components may strengthen the positive role of P.V. or correct its negative impact on risk perception within the framework of an overarching understanding of vulnerability.

In contrast to previous research that focused on the impact of P.V. to climate change on risk perception, our research studies vulnerability as an integrated function of P.V., Se., and Ad.C. We use variations in existing water stress in Nevada as a proxy for the P.V. component. We use the level of reliance on agricultural income for livelihood (agricultural income/the total family income) as an indicator of Se. to drought among Nevada ranchers and farmers. We utilize both the Poverty and Social Status indices as proxies to Ad.C. Finally, we use all these indices to develop a vulnerability index for Nevada ranchers and farmers, a framework based on the work of Hahn *et al.*[30]

1.3. Risk Perception and Politics in the American Mind

According to Dunlap and McCright,[44] McCright and Dunlap[45,46] climate change has been politically polarized in the U.S. context since its emergence as a public sphere issue in the 1980s. The polarization of the climate change discourse has increased over the years.[47,48] While the gap between republicans and democrats in terms of believing in the reality of climate change was only 4% in 1997, it reached 34% in 2008.[48] The gap apparently shrank a little bit between 2008 and 2010 as at the end of 2010, 69% of democrats believed that climate change is happening, whereas only 41% of the republican did.[49] McCright and Dunlap[45,46] justified such political polarization by the nature of climate change as a high stake policy issue that calls for rethinking the widely accepted virtues of industrial capitalism in light of its potential catastrophic environmental consequences (reflexivity) and thus ignites very aggressive and divisive value and cultural debates.

Many studies have investigated the impacts of political orientations on risk perception among the American public. Those studies established that individuals who are more liberal and democrats are generally more concerned about the impacts of climate change than those who are more conservative and republicans.[45,50–55] In this research, we examine how political orientations (conservatives vs. others) interact with other climate change-related beliefs in shaping Nevada ranchers' and farmers' risk perception.

1.4. Gender and Risk Perception

Gender also appears to be an important determinant of risk perception in the United States and elsewhere. For example, Leiserowitz,[53] Sundbladt *et al.*,[56] and Semenza *et al.*[57] found that women are more concerned than men regarding the impact of climate change. Yet such gender influence may in some cases not be a reflection of inherent differences between females and males in terms of risk appreciation, but rather a result of the lack of gender equity, differentiated political power, and thus varying vulnerabilities between males and females. In a recent study, Oloffson and Rashid[58] found that in Sweden, where there is more gender equity than the United States there is no difference in risk perception between white males and white females; nonetheless, those Swedish who are of foreign backgrounds, thus subjected to latent racism (note the 2011 attacks in neighboring Oslo), perceive the risk of many domestic and environmental hazards such as natural disasters, smoking, alcoholism, HIV, and fires higher than native persons. In this research, we investigate the impact of gender on climate change risk perception among Nevada ranchers and farmers.

1.5. Climate Change Beliefs and Risk Perception

Bord *et al.*[59] found that those who acknowledge the anthropogenic causes of climate change perceive its risk as personally and socially more threatening than others. Krosnick *et al.*[60] revealed that beliefs regarding climate change determine perceived seriousness of climate change as a national concern. In a more recent study, Jenkins-Smith *et al*.[61] found that believing that greenhouse gases increase the average global temperature is a significant determinant of risk perception. Similar to the studies mentioned earlier, we investigate the influence of believing that climate change is partially anthropogenic on Nevada ranchers' and farmers' risk perception.

Additionally, we test the influence of beliefs regarding the relatedness of a locally suffered environmental hazard (drought) and climate change on risk perception. Connecting locally suffered environmental hazards and climate change is a necessary bridge between experiencing environmental hazards, being concerned about them and being concerned about climate change. If people do not perceive a relationship between what they observe and suffer in their local environments and climate change, they may deal with them as two separate issues as suggested by Dessai and Sims.[40]

1.6. Study Hypotheses

At the outset of our research, we had predicted that vulnerability to climate change would increase risk perception. When it comes to the individual components of vulnerability, we had also predicted that P.V. and Se. would increase risk perception, whereas Ad.C. would decrease it. We based these predictions upon the plausible assumption that those who are more exposed and susceptible to a certain risk should "naturally" be more concerned about it. As discussed earlier, our predictions are partially supported by the findings of Spence *et al.*[39] and Brody *et al.*[36] noting that those studies focused only on P.V. Findings from the literature of risk perception regarding environmental hazards other than climate change support these hypotheses.[41–43]

Based on the literature regarding the influence of gender and political orientation on climate change risk perception in the United States,[43,48–55] we predicted that being conservative will significantly decrease climate change risk perception, whereas being female will increase such perception.

The literature on the determinant of risk perception has established that believing in anthropogenic causes of climate change will increase risk perception.[59–61] Guided by those findings, we expected that believing that climate change is partially caused by human activities will increase Nevada ranchers' and farmers' risk perception. We also expected that believing in a potential causality between locally experienced hazards (in this case drought) and climate change will enhance risk perception.

2. METHODOLOGY

2.1. Study Population and Area

Rural Nevadans, including ranchers and farmers represent a natural target group for this research, because they are one of the most vulnerable groups among Nevada residents as a result of their intensive reliance on scarce water resources for their livelihoods.[62] Also, their intimate relationships with natural resources make their climate change-related observations, risk perceptions, and beliefs worth noting. In addition, Nevada ranchers and farmers are important stakeholders in any potential discussion about water rights and resource reallocation as a result of both naturally occurring and climate change-induced extended droughts, as well as increasing urbanization and urban thirst.

Nevada is anticipated to suffer a rising average temperature and more frequent and severe droughts due to climate change.[62,63] According to CIER,[62] by 2100, Nevada is projected to witness a temperature rise of 1.7–2.2 °C (3–4 °F) in the spring and fall seasons, and of 2.8–3.3 °C (5–6.4 °F) in the summer and winter seasons. Additionally, CIER[62] expected Nevada winter precipitation to increase, and summer precipitation to decrease.

The expected temperature upturn in the U.S. West may result in decreasing the snowpack feeding the Colorado River Basin, the main source of water for Southern Nevada, where the majority of Nevadans live.[63–66] Nevada is already facing a severe drought dating back to the end of last century.[66] The Southern Nevada Water Authority[67,p.13] described the average five-year water flow of Colorado River over the period 2000–2004 as the, "lowest five-year average flow since record keeping began in 1906." The expected decrease in annual runoff of the Colorado River ranges from 5% to 45% by 2050.[68–71]

Similarly, the Truckee River Basin is expected to undergo warmer temperatures, decreased snowpacks, earlier snow runoff, and decreased annual flow. The Truckee River Basin is the second biggest surface water system in Nevada. It primarily feeds the biggest urban centers in Northern Nevada, Reno, and Sparks cities. The mean annual runoff is expected to decline by 2.5–4.5% by 2050.[68]

2.2. Data Collection

We collected both secondary and primary data to calculate the different indices and variables necessary for answering our research questions. We collected secondary data to assess water resources vulnerability in Nevada, and primary data that help to assess both the Se. and Ad.C. of individual Nevada ranchers and farmers, in addition to exploring ranchers' and farmers' climate change risk perceptions and beliefs, and political orientations.

2.2.1. Primary Data

Nevada ranchers and farmers were surveyed in two phases—the first phase was on December 2009 and the second phase was in August 2010. We took this approach in order to achieve a higher response rate for an arguably difficult to research group—especially within the context of climate change. In the two phases, the surveys were distributed to 1,872 farmers and ranchers, representing the majority of Nevada ranching and farming community.[72] The list was collected from a partner university program which prefers to remain anonymous. Mail-out/mail-back survey packets were sent to all farmers on the list. In the two phases, each packet included an eight-page survey (including the exact same questions and wording, a cover letter personally signed by Smith Jr. as the Principal Investigator (PI), and a prepaid return envelope. Because it was the holiday season when the first surveying phase was launched, the packets included additional holiday season cards.

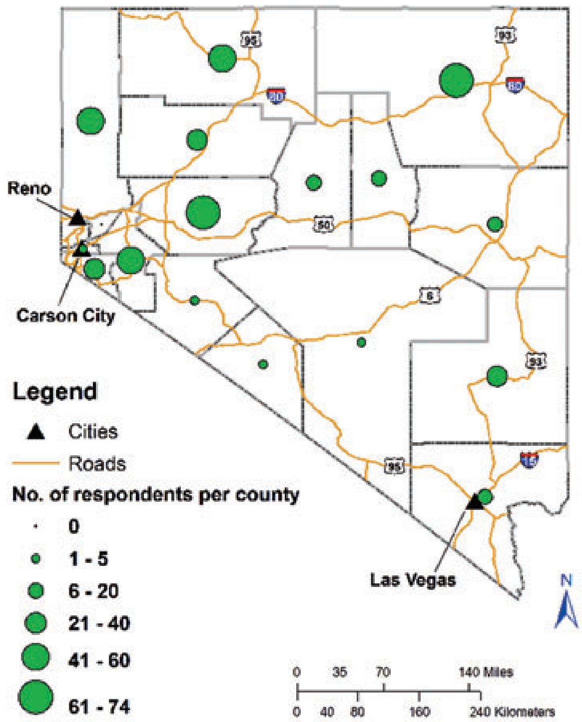

Fig. 1. Distribution of respondents by county in Nevada ($N = 458$).

In the cover letter sent to the ranchers and farmers in the second wave, we asked only those who did not fill the survey in the first wave to fill one and send it back to us using the prepaid return envelope.

In total, 479 (321 in the first wave and 158 in the second wave) surveys from ranchers and farmers almost from all over Nevada (Fig. 1) were filled and sent back to create a response rate of 25.6%. However, it is worth mentioning that not all surveys were completed entirely. Although this method succeeded in obtaining a fairly accepted response rate, it raises the possibility of producing biased results. This bias stems from the fact that some highly motivated ranchers and farmers could have refilled the surveys to manipulate the survey results toward their viewpoints; a scenario that the authors find very unlikely to happen considering the nature of our respected research population and the length of the survey. However, the descriptive statistics of some main measures such as age, gender, and political orientation were compared for the respondents from the first wave, the second wave, and the complete sample and found to be almost identical which suggest a high representativeness of our sample.

2.2.2. Secondary Data

We also collected secondary data on Nevada water resources availability and use, and population distribution. For water availability and use, we utilized the latest version of the Water Global Assessment and Prognosis (WaterGAP 3.1) data set developed by the Center for Environmental Systems Research, Kassel University, Germany in cooperation with the National Institute of Public Health and the Environment. The population database (LandScan 2008) was collected from the Oak Ridge National Laboratory, Tennessee.

The WaterGAP 3.1 data set lists the mean surface water availability and use monthly values and annual sums during the period 1971–2000. The data set is available in gridded vector format with a spatial resolution of $5' \times 5'$ or about 9 km × 9 km. The LandScan 2008 population database is available in raster format with spatial resolution of $30'' \times 30''$ or about 1 km × 1km. The LandScan uses the best available census data and four primary population indicators including land cover, roads, slopes, and night time lights to map population distribution at finer scales than the block-level census data.[73]

As can be seen from the discussion on data collection earlier, we collected secondary data with two different spatial resolutions, 9 km × 9 km (Water GAP 3.1) and 1 km × 1 km (LandScan 2008). We also collected data on the respondent ranchers' and farmers' addresses in zip codes. We used the ArcGIS 9.3 procedures (mostly spatial join function) to aggregate the three databases to the zip code scale.

2.3. Measures

2.3.1. Dependent Variables

Respondents rated their risk perceptions regarding the impacts of climate change on eight different risk targets including: (1) oneself; (2) family; (3) ranching and farming community; (4) the United States; (5) wealthy nations; (6) least wealthy nations; (7) plants and animals; and (8) future generations. The question was "Please use the scale below to indicate how much you think climate change will negatively impact the following." The respondent indicated their appreciation of risk on a four-point scale, where 1 is not at all, 2 is only a little, 3 is a moderate amount, and 4 is a great deal, in addition to "I don't know" as a fifth option.[74] For the sake of data analysis, we excluded all the "I don't know" answers keeping only those ranging from 1 (not at all) to 4 (a great deal). Then, we combined all the eight risk targets in one compound risk perception measure (Cronbach's alpha = 0.97, which indicates very high construct reliability) by summing all the answers for the eight risk targets and dividing by 8.

2.3.2. Independent Variables

Within this research, we calculated indices for climate change P.V., Se., and Ad.C. of Nevada ranchers and farmers, and then we aggregated those indices into a composite vulnerability index. In the following subsections, we provide a detailed description of the calculations we performed.

P.V.: We used water resource vulnerability as an indicator of the P.V. of Nevada ranchers and farmers to climate change. We used ARCGIS 9.3 software to map and calculate both the inverse Falkenmark Index (population/natural surface water availability) and Criticality Ratio (water use/natural surface water availability by zip code.[75–78] These indices were used because they connect water supply, water demand, and population, which provides for a more overarching understanding of water stress and vulnerability and their spatial distribution.[74–77] As discussed earlier, we used both the WaterGAP.3.1 database for data on natural water availability and use, and the LandScan 2008 population data set. We normalized the two indices using the following equation as in Hahn *et al.*:[30]

$$\mathrm{Index}S_{\mathrm{d}} = S_{\mathrm{d}} - S_{\min}/S_{\max} - S_{\min}. \qquad (1)$$

We then used both the normalized inverse Falkenmark Index and Criticality Ratio to estimate the Water Vulnerability Index (WRV) which is used as the P.V. index in this research. The WRV was calculated by averaging the inverse Falkenmark Index and the Criticality Ratio for each zip code.

Se.: We used the External Income Diversity Index as a proxy for ranchers' and farmers' Se. to climate change. This index differentiates between ranchers and farmers on the basis of their variable reliance on the heavily water-dependent agriculture for livelihood, which represents their Se. to drought as the major climate change impact in Nevada (Table II).[28–30,32–34] For every rancher and farmer, we calculated the proportion of her/his household income originating from agricultural activities to the total income.[30] Then, we normalized the index using Equation (1). Although we find it difficult to

Table III. Presentation of Variables and Descriptive Statistics

Variable	N	Min	Max	Mean	Std. Deviation
Vulnerability (L.V.I.)	399	−0.29	0.46	0.12	0.16
Physical vulnerability (P.V.)	458	0.00	0.50	0.113	0.10
Sensitivity (Se.)	425	0.00	1.00	0.58	0.36
Adaptive capacity (Ad.C.)	417	0.01	0.96	0.31	0.17
Age (A)	472	21	95	61.78	13.27
Beliefs regarding the causes of climate change (CC.B.)	445	1	5	2.55	1.37
Risk perception on oneself	427	1	4	2.19	1.03
Risk perception on family	421	1	4	2.30	1.04
Risk perception on agricultural community	426	1	4	2.52	1.12
Risk perception on the United States	405	1	4	2.52	1.07
Risk perception on the wealthy nations	388	1	4	2.44	1.06
Risk perception on the least wealthy nations	393	1	4	2.55	1.20
Risk perception on future generation	384	1	4	2.58	1.19
Risk perception on plants and animals or ecology	398	1	4	2.49	1.15
Aggregate Risk Perception Index (R.P.)	351	1	4	2.38	1.02

operationalize age and gender as indicators of Se. within the context of farming and ranching in relation to drought as a climate change impact, as can be seen later, we tested the influence of those two measures independently as potential predictors of risk perception.

Ad.C.: For Ad.C., we calculated two indices: The Social Status Index and the Poverty Index. As can be seen from Table II, these two indices comprise the major factors that determine individuals' social status, and thus access to resources which in turn determine their Ad.C.[28–30,32–34] We calculated the Social Status Index based on Hollingshead[79]. It ranges from 26 to 66. This index is derived from four factors which are occupation (career), education, income, and marital status.[79,80] For married ranchers/farmers, we averaged the education scores of both the rancher/farmer and her/his spouse. The scores for education are listed in the Appendix, Table A.I. For career or occupation scores, we used the total income of each rancher/farmer to assign her/him a score as seen in Table A.I.

The Poverty Index was calculated by deducting the poverty line from the household income for every rancher and farmer surveyed (income–poverty line) as developed by Foster *et al.*[81] The Poverty line was derived from the U.S. Department of Health and Human Services[82] based on the household size (see the Appendix, Table A.II). Then, we normalized both indices using Equation (1). Finally, we averaged the two indices to formulate the Ad.C. index.

Vulnerability: As a composite vulnerability index, we used the approach of Hahn *et al.*[30] in calculating the Livelihood Vulnerability Index ranges from −1 (least vulnerable) to 1 (most vulnerable). We used the following equation improved from Hahn *et al.*:[30]

$$\text{Vulnerability} = \text{L.V.I} = (\text{P.V.} - \text{Ad.C.} + \text{Se})/3. \tag{2}$$

2.3.3. Model Parameters

In addition to the variables explained earlier, our models include the following variables (Table V):

(1) Age: The ranchers and farmers were asked to state their age in question 1.
(2) Gender: Using question 2, we asked the ranchers and farmers to check their gender.
(3) Ideological affiliation: In question 21 of the survey, ranchers and farmers were asked to indicate their political orientation on a range from 1 (very liberal) to 5 (very conservative). For the sake of analysis, we modified the scale to 1 (conservative) and 0 (nonconservatives).[51]
(4) Beliefs regarding the causes of climate change: Those beliefs were measured through asking the participants to rank their agreement on the statement "I believe that human activity has been playing a significant role in recent climate change" using a scale that ranges from 1 (Strongly disagree) to 5 (Strongly agree). This was a part of question 30 of the survey.

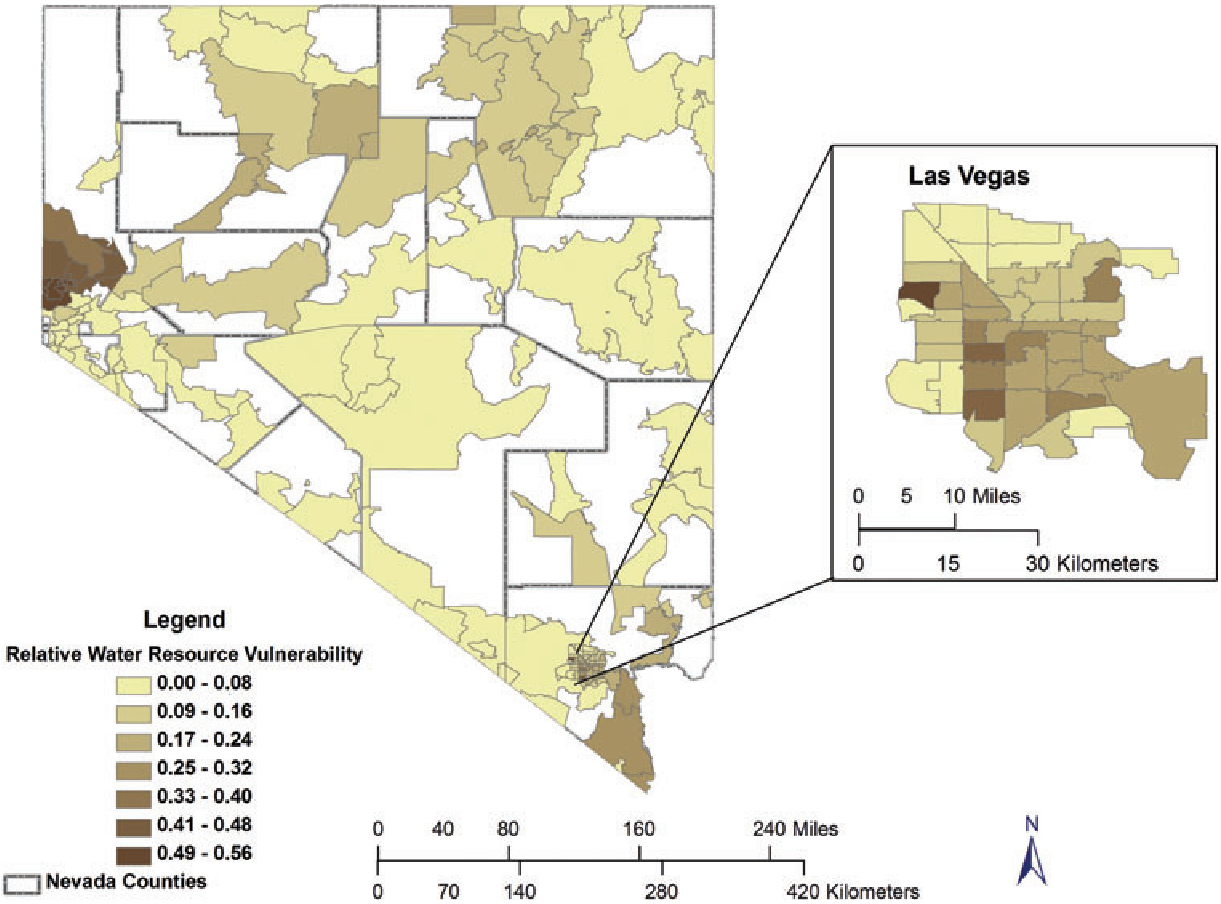

Fig. 2. Water resource vulnerability by zip code in Nevada.

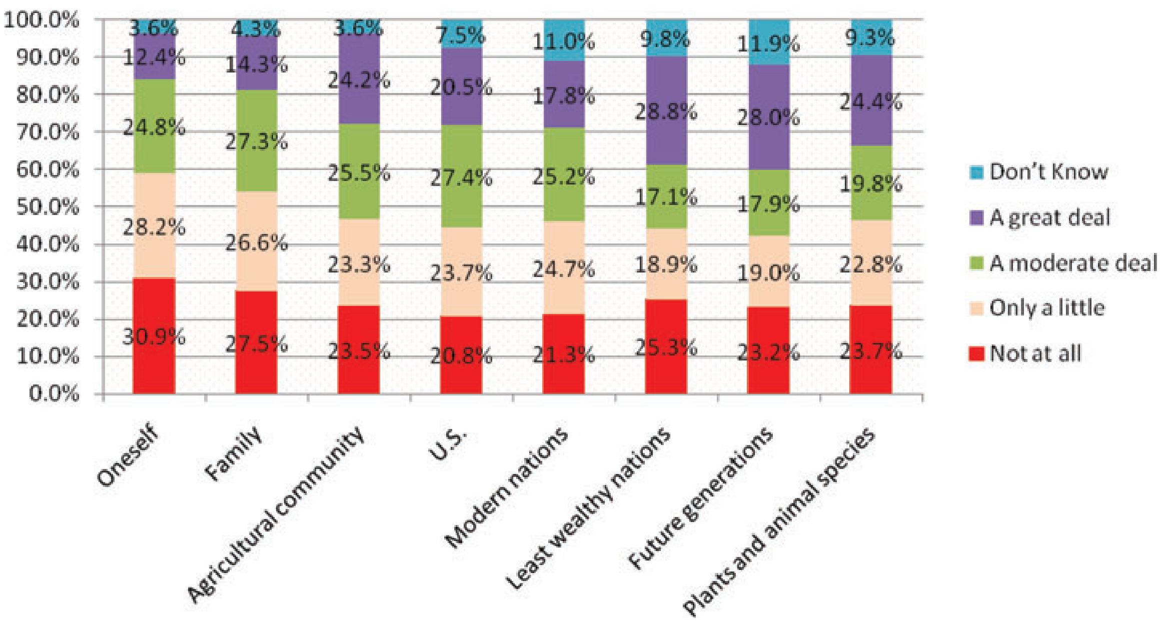

Fig. 3. Nevada ranchers' and farmers' climate change risk perception.

Table IV. Correlation Matrix of Risk Perception and Determinants

R.T	R.P	L.V.I.	P.V.	Ad.C.	Se.	A	G	PO.O	C.H.B	D.B.
R.P.		(0.000) $N = 297$	(0.079) $N = 337$	(0.046) $N = 310$	(0.015) $N = 317$	(−0.045) $N = 347$	(−0.305)** $N = 350$	(−0.432)** $N = 335$	(0.701)** $N = 342$	(0.556)* $N = 351$
L.V.I.			(0.178)** $N = 399$	(−0.712)** $N = 399$	(0.918)** $N = 399$	(0.081) $N = 396$	(−0.081) $N = 399$	(0.086) $N = 394$	(−0.038) $N = 389$	(−0.048) $N = 399$
P.V.				(−0.012) $N = 404$	(−0.041) $N = 411$	(0.046) $N = 453$	(−0.005) $N = 457$	(−0.190)** $N = 435$	(0.143)** $N = 445$	(0.166)** $N = 458$
Ad.C.					(−0.450)** $N = 413$	(−0.129)** $N = 414$	(0.137)** $N = 417$	(−0.063) $N = 412$	(0.020) $N = 407$	(0.017) $N = 417$
Se.						(−0.044) $N = 421$	(−0.029) $N = 424$	(0.139)** $N = 420$	(−0.071) $N = 415$	(−0.099)* $N = 425$
A							(−0.011) $N = 471$	(0.014) $N = 450$	(0.004) $N = 458$	(0.011) $N = 472$
G								(0.196)** $N = 453$	(−0.179)** $N = 462$	(−0.129)** $N = 479$
PO.O									(−0.450)** $N = 443$	(−0.283)** $N = 454$
CC.B.										(0.469)** $N = 465$
D.B.										

Note: Pearson correlation coefficients in parentheses.
*significant at the 5% level; **significant at the 1% level.

(5) Beliefs regarding the connection between the temporary drought in Nevada and climate change: In question 40 of the survey, ranchers and farmers were asked to check what they perceived as causes of the contemporary drought in Nevada. We used only the subdivision on climate change as a cause. The value of this variable ranged from (1) if checked to (0) if not checked.

2.4. *Data Analysis*

Our hypotheses predicted that increased vulnerability to climate change in terms of P.V., Se., and Ad.C. enhances individuals' perception of climate change risk. The other predictions were that both P.V. and Se. to climate change as separated factors increase risk perception, whereas Ad.C. decreases risk perception. Additionally, we predicted that gender, political orientation, beliefs regarding the anthropogenic causes of climate change, and beliefs regarding the causality between the locally suffered drought in Nevada and climate change are all significant determinants of risk perception.

To test these hypotheses, a set of bivariate correlations and multiple regression analyses were performed. The correlation analyses included testing the relationships between the respondents' risk appreciation and the composite vulnerability index, P.V. index, Se. index, and Ad.C. index. Additionally, the analyses included possible correlations between risk appreciation and other parameters including age, gender, political orientation (conservative or not), beliefs regarding climate change (believing in the

Table V. O.L.S Regression Results Explaining Risk Perceptions Using a Model That Includes the Composite Vulnerability Index.

Variable	Correlation Coefficient	Standard Error	Significance
Intercept	1.802	0.276	0.000
Vulnerability (L.V.I.)	0.235	0.247	0.342
Age (A)	−0.000	0.003	0.992
Gender (G)	−0.260**	0.093	0.005
Political orientation (Po.O.)	−0.208*	0.103	0.045
Beliefs regarding the causes of climate change (CC.B.)	0.380**	0.035	0.000
Beliefs regarding the causes of the NV drought (D.B.)	0.584**	0.101	0.000
Adjusted R^2	0.608		
N	284		

*significant at the 5% level; **significant at the 1% level.

anthropogenic causes of climate change), and beliefs concerning the causes of the contemporary drought in Nevada (believing in climate change as a possible cause or not). It is important to note that correlation tests do not establish relationships between independent and dependent variables, yet they show linear associations between variables in one-to-one basis. Correlations tests also help to discover possible multicollinearity between variables and thus help to avoid the use of highly correlated variables in regression models.[83]

Two tests utilizing ordinary least-square multiple regression analysis were performed. In one test, we regressed risk perception as a dependent variable on a model that comprised the composite vulnerability index, age, gender, political orientation, beliefs regarding climate change, and beliefs regarding the causes of the contemporary drought in Nevada. In the other test, we regressed the same risk perception variable on a model that enclosed indices of the separated components of vulnerability (P.V., Se., and Ad.C.), age, gender, political orientation, beliefs regarding climate change, and beliefs concerning the causes of the contemporary drought in Nevada.

3. DESCRIPTIVE RESULTS

3.1. Respondents Characteristics and Vulnerability

The survey data indicate that only 26.3% of Nevada ranchers and farmers are females ($N = 476$). Nevada ranchers' and farmers' average age is 61.8 $\pm$ 13.3 years (Median 62, $N = 472$); whereas, the minimum age is 21 and the maximum is 95 years (Table III). The vast majority of Nevada ranchers and farmers ($N = 473$) are married (83.7%), whereas 7.8% of them are widowed, 4.4% are divorced, and 4.1% are single. The average size of Nevada ranchers' and farmers' households is 2.6 $\pm$ 1.4 members ($N = 449$). The smallest household's size is 1 and the largest is 9.

Mapping water stress in Nevada using data on surface water availability and use in the state from 1971 to 2000, and utilizing 2008 population by zip code reveals that the most water stressed areas are those in Washoe, Carson City, and Clark counties. Washoe, Carson City, and Clark counties include the largest urban centers in Nevada, which are the Reno, Carson City, and Las Vegas metropolitan areas, respectively (Fig. 2). The range of WVI spans from 0.0 at zip code 89883, Elko County, to 0.56 at zip code 89134, Clark County, NV.

The composite index of vulnerability ranges from −0.29 to 0.46 (Table III). The −0.29 vulnerability value is assigned for a participant who lives in a relatively water rich area, holds a four-year college degree, married to a four-year college graduate spouse, and earns a household income that exceeds the million dollars limit, whereas only 9% of this income originates from ranching/farming. Whereas, the vulnerability index value of 0.46 is assigned to a participant who is married, lives in a water stressed area, holds a high school degree (the spouse has some college education), and earns a household income of less than $25,000, which originates entirely from agriculture.

3.2. Risk Perception

Nevada ranchers and farmers show optimistic bias in their climate change risk judgments, as they tend to rate climate change risk on themselves and family lower than other risk targets such as their ranching and farming communities, least W.N., future generations, and ecosystems. As can be seen from Fig. 3, only 12.4% ($N = 443$) and 14.3% ($N = 440$) of Nevada ranchers and farmers rate the expected impact of climate change on themselves or their families, respectively, to be a great deal, but 28.8% ($N = 438$) rate climate change impacts on the least W.N. to be a great deal, compared to 28.0% ($N = 436$), and 24.4% ($N = 439$) for future generations and plants and animals, respectively. Almost 59.1% and 54.8% of Nevada ranchers and farmers believe that climate change will not impact or impact themselves and their families only a little, respectively. These percentages go down to 44.3%, 42.2%, and 46.5% when using least W.N., future generations and plants and animals as risk targets. When using the United States and the W.N. as risk targets, 20.6% ($N = 438$), and 17.8% ($N = 437$) of Nevada ranchers and farmers rate climate change risk as a great deal, respectively, compared to 44.5% and 46% who rate climate change risk as nonexistent or only a little.

4. RESULTS AND DISUSSION

4.1. Correlation Tests Results

The correlation analyses reveal that neither the composite vulnerability nor its components correlate with ranchers' and farmers' climate change risk perception (Table IV). Age also seems not to correlate with risk perception; however being a male and conservative correlates negatively with risk perception.

Believing in the anthropogenic causes of climate change correlates strongly and positively with risk perception, with a Pearson correlation coefficient of 0.701. Moreover, believing that climate change is a possible cause of the contemporary drought in Nevada also significantly enhances risk perception, with a Pearson correlation coefficient of 0.556. However, being a male and conservative correlates negatively with both believing in the anthropogenic causes of climate change and connecting the currently suffered drought in Nevada to climate change.

4.2. Regression Analyses Results

The regression analyses of risk perception, and a model that includes vulnerability to climate change as composite index of P.V., Se., and Ad.C., illustrates that vulnerability to climate change is not a determinant of risk perception (Table V). Age is not a significant determinant of risk perception, but being a female significantly increases climate change risk perception. Conservatives perceive climate change risk lower than others. Ranchers and farmers who believe that climate change is anthropogenic and a possible cause of Nevada drought perceive climate change risk higher than these who don't. The model is a robust model explaining about 61% of the risk perception of our respondents.

The multiple regression analyses of risk perception and the model that includes the separated components of vulnerability reveal a little bit more complicated picture on the influence of vulnerability components on climate change risk perception (Table VI). The model is a robust model that explains 62% of the variance in risk perception. The regression analyses results establish that P.V. doesn't influence the perceived risk of climate change. *In other words, those farmers/ranchers who live in a more water stressed areas, and thus are more vulnerable to possible climate change-based drought in Nevada, perceive the risk of climate change the same as those who live in less vulnerable areas.*

Both Ad.C. and Se. significantly increase risk perception. In other words, ranchers and farmers who depend more on agriculture for their living and those who enjoy higher social status (more income, and more education) perceive the risk of climate change higher than those who have higher share of their income originating from other sources and those who possess less social status.

Similar to the outputs of the previous regression analysis, this analysis shows that age does not influence risk perception; whereas, being a male decreases it. Being conservative decreases risk perception; although, believing in the anthropogenic causes of climate change and connecting the current drought of Nevada to climate change strongly enhances climate change risk perception.

4.3. Discussion

4.3.1. Vulnerability and Risk Perception

As can be seen earlier, vulnerability to climate change measured as a function of P.V., Se., and Ad.C. does not impact climate change risk perception (Table V). This is mostly because the impacts of its three components do not enhance each other as expected, but cancel each other out, thus make the impact of the overarching vulnerability index on risk perception weak or insignificant (Table VI). In the case of Nevada ranchers and farmers, Se. to climate change impacts (reliance on Agriculture for income)

Table VI. O.L.S Regression Results Explaining Risk Perceptions Using a Model That Includes the Three Components of Vulnerability Separated

Variable	Correlation Coefficient	Standard Error	Significance
Intercept	1.537	0.304	0.000
Physical vulnerability (P.V.)	−0.519	0.373	−0.053
Sensitivity (Se.)	0.318**	0.117	0.007
Adaptive capacity (Ad.C.)	0.542*	0.250	0.031
Age (A)	0.001	0.003	0.755
Gender (G)	−0.295**	0.092	0.002
Political orientation (Po.O.)	−0.222*	0.104	0.034
Beliefs regarding the causes of climate change (CC.B.)	0.385**	0.035	0.000
Beliefs regarding the causes of the NV drought (D.B.)	0.588**	0.099	0.000
Adjusted R^2	0.618		
N	285		

*significant at the 5% level; **significant at the 1% level.

increases risk perception as hypothesized; however, Ad.C. also appears to increases risk perception contrary to our hypothesis and thus cancels out the impact of Se., to make the overarching vulnerability indicator insignificant in terms of determining climate change risk perception. P.V. does not show any significant impact on risk perception.

There is no literature that explains the impact of vulnerability, Se., and Ad.C. on risk perception, especially in the case of drought as a climate change impact. Brody *et al*. [36] discussed the impact of different types of P.V. on climate change risk perception (the list did not include drought). They found that different types of P.V. impose various impacts on risk perception. For example, living closer to the beach, thus being more vulnerable to sea level rise hazard, increases risk perception, living in 100-year flood plain, thus being more vulnerable to increased weather extremes and fresh water floods, decreases risk perception, whereas living in areas with increasing forest fires does not affect risk perception.

Consequently, drought as a climate change risk looks like one of those impacts that do not impose influence on climate change risk perception. This might be due to the fact that drought is a natural component of the climate cycle in Nevada and the U.S. Southwest and thus it is hard to be connected to the anthropogenic climate change. Smith[84] listed drought as a "creeping hazard" because it takes place over a long period of time and because it is hard to determine its severity. Perhaps living in a drought-prone area for decades, and adapting to and surviving droughts repeatedly make ranchers and farmers exaggerate their fitness to deal with droughts when they take place and underestimate the possible extent of droughts' severity. On the other hand, those ranchers and farmers who are more sensitive to climate change-induced hazards are more concerned about their impacts than others. This agrees with our hypotheses, as those who are more reliant on agriculture for living are more interested in keeping their jobs viable and profitable, and thus are more concerned about the impact of drought than those whom most of their incomes originate from other sources than agriculture. The more reliant a rancher or a farmer on agriculture is, the more concerned she/he is about water rights and the possible increase in water prices imposed by droughts.

On the other hand, Ad.C. is also a significant determinant of risk perception but in the opposite direction of our hypothesis. Those who have higher status, higher education and income are more concerned regarding the impacts of climate change. This may be because those ranchers and farmers who live better off have perceivably higher stakes to lose as a result of climate change, and thus they are more concerned about its impacts.

Even though, vulnerability to climate change impacts does not affect risk perception, yet connecting such impacts to climate change increases risk perception strongly. The role of believing in climate change as a possible cause of the contemporary drought in Nevada is evident in the results of all correlation tests and regression analyses conducted. This suggests the need to downscale climate change impacts into spatial resolutions that relate more to people's interests and livelihoods. Additionally, those predicted impacts should be communicated precisely to the public as recommended by Brody *et al.*[36]

4.3.2. Age, Gender, and Risk Perception

The results of both correlation tests and regression analyses show that age is an insignificant determinant of climate change risk perception. This agrees with the findings of other research works.[38,53] The results of the bivariate correlation tests and regression analyses show that being female correlates positively with risk perception. This agrees with studies conducted by Leiserowitz,[53] Sundblad *et al.*,[56] and Semenza *et al.*[57] which concluded that females are more concerned about climate change than males.

4.3.3. Political Orientations, Beliefs, and Risk Perception

Results of the correlation tests and regression analyses establish that being conservative significantly decreases risk perception. As discussed in the Introduction, the impact of political orientation on Americans' risk perception of climate change is well established in the literature.[44–53]

One of the most important determinants of climate change risk perception is beliefs regarding the causes of climate change. All the correlation tests and multiple regression analyses show that those who believe in the anthropogenic causes of climate change perceive the risk of climate change higher than those who do not. This agrees with the findings of Bord *et al.*,[59] Krosnick *et al.*,[60] and Jenkins-Smith *et al.*[61] as discussed earlier.

Consequently, from an outreach and policy making perspective, our empirical findings indicate that making more efforts to communicate the science of the greenhouse gases effects on the climate, and clarifying which climate variations are natural and which are anthropogenic, will make people more sensitive toward climate change consequences. (However, we also found that the messenger may be as important as the message, and so building bridges to messengers may be of equal importance.)

Nevertheless, beliefs regarding the anthropogenic causes of climate change are themselves partially, and perhaps increasingly and alarmingly, functions of political orientations and worldviews. Jenkins-Smith *et al.*[61] found that political affiliation and ideology are significant determinants of people's beliefs regarding the anthropogenic causes of climate change. In a recent study, Kahan *et al.*[85] found that beliefs and worldviews even determine the public appreciation of the scientific consensus in regards to issues such as gun-control, nuclear waste disposal, and climate change. More surprisingly, the researchers found that people judge the credibility and trustworthiness of scientists depending on the level of scientists' agreements with their beliefs, not based on scientists' credentials and experiences (resumes). Again, the core point being, it may be the messenger, as much as the message, that must be considered in changing behaviors concerning this mass population issue of mitigating and adapting to the anthropogenic climate change. However, it is worth mentioning that the influence of political orientation on believing in climate change and its anthropogenic causes is not only limited to the American public, as it exists in milder fashions in the United Kingdom and Canada.[49,86]

4.4. Research Limitations and Future Directions

While ranchers and farmers represent a typical research group for our work because of their clear connection to water, water stress, and climate change, their sociopolitical atypical features make them not very representative of the general public in the United States. For example, our results show that ranchers and farmers tend to be of higher age, more conservative and more politically engaged than the average American. Additionally, in an urbanizing country ranchers' and farmers' livelihood is not shared by nearly as many Americans as it was only 50 years ago. This limitation suggests the need to conduct similar research with the general public or more typical groups.

Drought appears to be unique in its characteristics as a risk and climate change impact as discussed earlier. These characteristics validate the argument that other climate change impacts that are more direct and catastrophic in nature such as heat waves, tsunamis, and tornadoes may reveal different relations between risk perceptions and vulnerability. Accordingly, there is a need for more research that investigates those hazards in relation to the type of research discussed here.

5. CONCLUSIONS

Vulnerability to climate change as function of P.V., Se., and Ad.C. does not impact climate change risk perception. P.V. or living in a more water stressed area does not influence risk perception, whereas both Se. and Ad.C. increase risk perception.

However, political orientations, beliefs regarding climate change and beliefs regarding the impacts of climate change are all strong determinants of risk perception. These conclusions are in agreement with other recent studies on climate change-related beliefs and risk perception. This and other studies suggest that, at least in the United States, climate change is increasingly becoming "abortion politics," where the value divide is high, and not "tornado politics," where the value divide is limited.[87,88] In this sense, political economy and related literature are central to coping with climate change. And, political division around the subject of climate change, nested in ideology, "gotcha politics," and vested domestic and international economic interests at multiple scales, hinders the progress of climate change communication, produces ever increasing pressure on the most vulnerable in a world with limited resources, and limits the chances of enacting effective climate change mitigation policies.

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APPENDIX: SCORES AND POVERTY LINES USED FOR CALCULATING THE ADAPTIVE CAPACITY

Table A.I. Education and Occupation Scores for Calculating the Social Status Index

Education Scores	
Educational degree	Score
Middle school	6
High school	12
Some college or two-year college degree	15
Four-year college degree	18
Graduate and professional	21
Occupation Scores	
Income	Score
$0–25,000	20
$25,000–50,000	25
$50,000–100,000	32.5
$100,000–300,000	40
>300,000	45

Source: Created from Hollingshed.[78]

Table A.II. The 2010 Poverty Guidelines for the 48 Continuous States and the District of Columbia

Family Size	Poverty Line
1	$10,830
2	$14,570
3	$18,310
4	$22,050
5	$25,790
6	$29,530
7	$33,270
8	$37,010

Source: Adopted from USDHHS.[81]

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