Socioeconomic Impacts of Climate Extremes on American's Poverty-Related Human Needs (A New Approach by Nonprofits)

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	ABSTRACT
<p>2016 Research Leap/Inovatus Services Ltd. All rights reserved.</p> <p>DOI: 10.18775/jibrm.1849-8558.2015.41.3005 URL: http://dx.doi.org/10.18775/jibrm.1849-8558.2015.41.3005</p>	<p>Climate extremes have a crucial role in altering poverty-related human needs as well as trust level in governments and nonprofit organizations. To investigate socioeconomic impacts of climate extremes on poverty-related human needs this article uses reliable and objective data collected by the U.S. Salvation Army of assistance provided to the extreme poor Americans. The study reaches to the results that precipitation extremes are more crucial than temperature extremes. Extreme low precipitation and its continuity (drought), contrasting to extremely high precipitation, statistically significantly contribute to enhance poverty-related human needs of western Americans in particular and reducing/increasing their trust level in governments/nonprofits. Furthermore, considering seasonality during summer and winter (July-December but October exclusive) poverty-related human needs elevation indicate lower trust level in government and elevated trust level in nonprofit. In December ever the highest assistance level by the Salvation Army to the needy Americans shown by maximum HNI score during Jan-2004 to Dec. 2016 uncover the higher poverty-related needs and the lower level of trust in government. Temperature extremes remain insignificant determining trust level and human needs. Unemployed Americans have higher trust level in nonprofit organizations rather than the governments for emergency assistance during climatic extremes.</p>
<p>Keywords: Strategic Poverty-related human needs, Human Needs Index (HNI), Climate extremes, the U.S. Salvation Army</p>	

1. Introduction

"From recent disasters it has observed that the poor are much more likely to be negatively affected than their non-poor counterparts. As consequences of insufficient construction, dwellings of poor people are predominantly susceptible; and once affected have not enough savings to deal with the emergencies" (Nicaragua 2001).

Weather extremes (temperature & precipitation extremes) and extreme events (continuity of temperature & precipitation extremes) are projected by the scientists to happen in future with increased frequency and severity leading to exacerbate the challenges of poor households living in remote areas (J. M. Melillo, Terese, (T.C.), Richmond, G. W. Yohe). According to EM-DAT database (2015) extreme weather events pushed more than 4 billion homeless and injured individuals into emergency assistance needs worldwide during the last two decades (1995-2015). Floods, drought and extreme temperature jointly affected more than 3.5 billion people around the world during the same period. The United States accounted for one of the highest amounts of weather-related attributing too great diverse

landmass and population concentration (EM-DAT, "The International Disaster Database").

Poor communities having a smaller amount of resources and less social relations may not well prepare to counter and recover from an extreme weather event (Frank Thomalla, Tom Downing, Erika Spanger-Sieghfried, Guoyi Han, and Johan Rockström). Greater remote (very rural) and concentrated population areas having socioeconomic inequalities are often expected to have more distressed exposure to weather extremes and events than non-remote areas. Governments are generally thought to be ill-prepared in remote (rural) areas in planning and responding to climate change-induced extreme climatic conditions (J. M. Melillo et al). One of the largest nonprofit organization, the U.S. Salvation Army, notices the persistent poverty pockets as well as trust level of poor Americans in Government and nonprofits through Human Needs Index (HNI) (detailed description about HNI in Section3) which may not be noticeable from the traditional poverty measures particularly in greater remote and population concentrated areas of United States.

Table1: Average HNI scores (January-2004 to Dec. 2016) demonstrating the highest poverty-related human needs and the lowest level of trust in governments, in remote and higher population concentrated areas

States	Region	Average HNI ¹	Population density
Arizona	West (Southwest)	1.01	60.1persons/km ²
California	West (Southwest)	1.34	251 persons/km ²
Colorado	West (Southwest)	0.90	52.6 persons/km ²
Michigan	Central (Midwest)	1.62	174.7 persons/km ²
Nevada	West (Southwest)	3.19	26.3 persons/km ²
Oregon	West (Northwest)	0.67	42 persons/km ²
Utah	West (Southwest)	0.41	36.5 persons/km ²
Washington	West (Northwest)	1.25	107.8 persons/km ²

Source: Author himself constructed using data from <https://humanneedsindex.org/> and U.S. Census Bureau, population estimates and American Community Survey (ACS), <https://www.census.gov/programs-surveys/decennial-census/data/datasets.2010.html>.

Table2: Average HNI scores from (Jan-2004 to Dec-2016) demonstrating higher poverty-related human needs² and lower trust in governments in remote and lower population-concentrated areas

States	Region	Average HNI ³	Population density
Idaho	West (Northwest)	0.75	20.0 persons/m ²
Kansas	Great Plains	1.71	35.6 persons/m ²
Iowa	Central (Midwest)	1.04	55.9 persons/m ²
Maine	Northeast	0.72	43.1 persons/m ²
Minnesota	Central (Midwest)	1.24	69.0 persons/m ²
Missouri	Central (Midwest)	0.77	88.3 persons/m ²
Montana	West (Northwest)	0.77	7.10 persons/m ²
Nebraska	Central (Midwest)	1.19	24.7 persons/m ²
N. Mexico	West (Southwest)	0.81	17.2 persons/m ²
N. Dakota	Central (Midwest)	1.35	11.0 persons/m ²
Oklahoma	Central (Midwest)	0.86	57.0 persons/m ²
S. Dakota	Great Plains	0.95	11.3 persons/m ²
Wisconsin	Central (Midwest)	1.32	106.3 persons/m ²

¹HNI value starts from 0 (zero) meaning minimum human needs (i.e., emergency assistance).

² There may be two plausible reasons of greater remote, highly concentrated and lower population concentrated states to show maximum and higher poverty-related

Source: Author himself constructed using data from <https://humanneedsindex.org/> and U.S. Census Bureau, population estimates and American Community Survey (ACS), <https://www.census.gov/programs-surveys/decennial-census/data/datasets.2010.html>

Table 1 Delineates average HNI scores (January-2004 to Dec. 2016) demonstrating the highest poverty-related human needs and the lowest level of trust in governments, in greater remote and higher population concentrated areas . It shows all the remote high population concentrated U.S. states carrying the highest human needs score in the west (southwest) exhibiting the highest emergency assistance for poverty-related human needs and the highest level of trust in the Salvation Army. Nevada shows the highest average HNI score demonstrating the highest poverty-related needs (i.e., the highest emergency assistance) to the poor Americans and the lowest trust level in government. On another side, Utah shows the lowest human needs (i.e., the least emergency assistance) and the highest trust level in Governments among the highest human needs assistance provided states. At National level the highest HNI score implying the lowest trust level in government (i.e., highest level in the Salvation Army) stands at 1.33 in the year 2012 during 2004-2016 and average of National score stays at 1.09. Nevada's (3.19), Michigan (1.62), California (1.34), Washington (1.25), Arizona (1.09) shows higher or equal score than that of National HNI score where as Oregon (0.67), Utah (0.41) and Colorado (0.90) show lower than average National HNI score.

Table 2 Representing average HNI scores from (Jan-2004 to Dec-2016) demonstrate higher poverty-related human needs and lower trust in governments in greater remote and lower concentrated areas refers most of the remote low population concentrated U.S. states having higher human needs score in the Midwest, Great Plains exhibiting higher poverty-related human needs assistance and lower trust level in government. Kansas (1.71) shows average HNI score (i.e., touching the peak of the human needs assistance provided by the Salvation Army) and the higher level of trust in the Salvation Army and Maine (0.72) shows the lowest human needs assistance score having the lowest level of trust in the Salvation Army in the list of remote low population concentrated states. Kansas (1.71), Minnesota (1.24), Nebraska (1.19), North Dakota (1.35) and Wisconsin (1.32) shows higher HNI score than National average HNI whereas Idaho (0.75), Iowa (1.04), Maine (0.72), Missouri (0.77), Montana (0.77), New Mexico (0.81) and Wyoming (0.96) show lower than average National HNI score. Even though prospective impacts of climate change causing weather extremes and events in different regions have depicted

needs respectively, one limited access and low-income individuals as well as communities to the government services and second predominant dependence on social security network for assistance in need.

from the existing literature, however the knowledge explaining the influences of climate extremes on basic human needs in the United States is very scant. To date, we are not familiar with any systematic research specifically investigating how climate extreme and events impact poverty-related human needs of Americans using nonprofits quality data collection.

Since it is widely evident that due to climate change in future weather extremes and extreme events can frequently occur with increased intensity around the globe, consequently poor communities in extreme event-prone regions may also require protecting mechanism. In lines with the point of action in publication of EM-DAT database 1995-2015, considering climate extremes at present and their potential frequent and intense occurrence in future as humanitarian concern this research aims to investigate in particular how the existing confronts of remote areas poor communities are affected and exacerbated by weather-associated extremes (i.e., floods, droughts, heat waves and cold winters) impacting their basic needs. This research aims to investigate how and which weather extremes (i.e., precipitation and temperature) and extreme weather events (i.e., Heat waves, Droughts, Cold winters, and Floods) as sequential of weather extremes in particular impact poverty-related human needs and social attitudes (i.e., trust level) towards governments or nonprofit organizations. By analysis of this research stakeholders, policymakers would enable to recognize to which key climatic extreme indicator poor Americans are at higher risks.

The analysis of this study bases on the following three observations. Poor communities are more vulnerable to climate extremes than their wealthy counterparts, and for weather extreme, particularly extreme heat susceptibility poverty is used as a proxy.

Non-metro (rural) communities are more likely to be poor than that of communities in metro areas in the United States of America.

Climate extreme and extreme events impacts vary regionally or geographically and impact not homogeneously. This research has some limitations due to the unavailability of statewide monthly data of some related socioeconomic (i.e., income level) indicators. Furthermore, this research is divided into following sections, next section (1.1) explains the background, and section 2 is about regional socioeconomic vulnerability, section 3 discusses the material and methodology of this research, section 4 illustrates results and discussion in details and finally conclusion comes in section 5.

1.1 Background

Historically the United States has been at higher risks of series of weather-related disasters⁴. For instance, the Dust Bowl in 1930 one of the worst weather-related disasters in the history of The United States and associated droughts in Midwest and Great Plains adversely affected all the country. Drought in 1988-89 has been economically the most distressing natural catastrophe in U.S. history (W. E. Riebsame). The most extensive drought in 2012 & associated heat waves in summer affected over half of the U.S. through impacting mainly agriculture sectors, harvesting of corn, soybeans and other crops along with 123 fatalities and approximately \$30.15 billion losses.

Climate change induced weather extremes and events are having greater humanitarian concerns can have devastating impacts on humanity (S. Hales, S. J. Edwards, and R. S. Kovats), cold winters affected over 5 million Americans in central and southern areas of the U.S. during 2003-15. It has reported that every night approx. 30,000 homeless poor Americans are facing the extreme cold, extremely hot, hunger and the scarcity of drinking water need federal or social emergency assistance. According to an estimation of about 2 billion people might be dislocated or displaced until 2050 as a result of varying climate conditions. Also, Millions of people might be displaced in the future by extreme weather events as their impacts over the globe (O. Brown et al).

During the last three and half decades 196 extreme weather events have been encountered in the United States including 24 floods, 23 droughts, and 13 wildfires, seven freezes, 95 storms (including cold winter storms) and 34 hurricanes each event caused losses over the U.S. \$1 billion (N. A. Ysasi, I. Marini, D. A. Harley, N. A. Ysasi, I. Marini, and D. A. Harley). Extreme weather events (i.e., droughts, floods and heat waves) are projected to occur more frequently with greater severity attributable to changing the climate in the next century which possibly will positively and negatively, directly and indirectly, impact human livelihoods.

Poor and low-income segments of the society already consume most of their earning proportion (about 25%) for meeting basic needs i.e., food, water, energy etc. (T. C. Gap and R. Morello-Frosch). Weather extremes and events may exacerbate their existing challenges; geographically, isolated and greater remote area populations (rural) in particular are more likely to be affected as a result poor segments of the society have to face persistent poverty.

⁴ Weather related disasters are jointly referred to hydrological, meteorological and

climatologically disasters.

Figure 1: Persistent poverty pockets particularly in rural parts of the United States

Figure 1 presents persistent poverty pockets, particularly in the rural United States. In Figure 1 most of the highest poverty-related needs and the highest trust level in the Salvation Army (i.e., Lower trust in Governments) indicating states with greater remoteness and higher population concentration have located in the Western United States, both southwest and northwest along with one in Midwest. Higher poverty-related needs states with greater remoteness and lower population concentration dominantly relate to the Midwest region.

Figure 2 presents poverty-related human needs assistance trends in the U.S. In Figure 2 the lowest value of HNI, 0, meaning the least human needs and the highest trust level in Governments, in 2012 all over the United States National HNI (1.33) touches the utmost human needs level. One of the plausible reasons for this acute enhance might be the most extensive drought in 2012 since 1930, and the associated heat wave in summer affected over 60% area of the United States..

Figure 2: Poverty-related human needs assistance trends in the United States

Source: <http://www.humanneedsindex.org>

According to the United States Department of Agriculture (USDA) more than 80% of productive agricultural land was adversely affected, harvesting of corn, soybeans and other crops along with 123 fatalities and approximately \$30.15 billion losses and Hurricane Sandy in the eastern U.S. during last days of October 2012, made thousands of people homeless and millions of people left with no electricity. While during 2013-

14 human needs decrease as indicated by HNI (1.25), HNI (1.05) and in 2015-2016 slightly increase as HNI (1.25), HNI (1.24) respectively.

Figure 3: Weather extremes and extreme weather events occurred in the United States

Source: Reproduced from NOAA, <https://www.ncdc.noaa.gov/billions/>

Figure 3 concerns about weather extremes and extreme weather events occurred in the United States during the previous decade. In Figure 3, from 2002–2018, 14 drought events occurred, 17 flooding events and three freeze events in the United States, approximately losses from each climatic extreme have been more than \$1 billion (CPI-Adjusted).

We only noticed here the extreme events which are related to our study i.e., (droughts, floods, and cold winter events). Other extreme events like severe storms, wildfires also occurred during this period. The years 2011, 2016 and 2017 represent the highest number of extreme events. The higher number of climatic events has observed in summer, fall and winter as compared to spring.

Many researchers have illustrated that protective measures i.e., before time preparedness, reducing susceptibility and resilience construction taken today may possibly save communities from adverse impacts and a lot of money in the future. The United States may possibly save \$4 in the form of future happening adversity cost against every \$1 spent for protective measures today (T. E. Davies, N. Banjara, and T. Tregenza).

2. Socioeconomic Regional Vulnerability

The adverse impacts of extreme climatic situations vary geographically and regionally; particularly rural populations tend to experience in a disproportionate manner. As an example in the Midwest and the Great Plains population leading occupation farming are likely to face more impacts than any other region [9,25]. Approximately 14.13% (88% in rural and 12% in urban) agriculture depending land area in the United States, been living source of at least 25% of labor and land owners on average per annum in 2010-2012. At least 13% of labor and land owners been earning from 7% of mining

depending (83.3% in rural and 16.7% in urban) area in 2010-2012. Most of the outdoor-recreation locations in the United States are located in rural areas (68.77% of in rural as compared to 31.23% in urban) and most of the employees also reside in rural areas. Total federal govt. transfer dependent area 20.60% (56% rural and 44% urban) in the United States. Federal government transfers account for ~1/5th of rural revenue as compared to ~1/8th of urban earnings. Rural communities being unable to meet with the changing climate vulnerability, particularly in Southeastern and Midwestern areas are more vulnerable as compared to their urban counterparts.

Lower education leads to lower income widening income gap in the communities (rural-urban), less competition and fewer high skilled jobs in non-metro job-related matrix (E. Miller, B. Antonny, S. Hamamoto, and R. Schekman) ultimately rural people tend to be persistently poor. Since income levels strongly influence weather variability (E. Miller, B. Antonny, S. Hamamoto, and R. Schekman) the vulnerability of rural communities to climatic conditions subject to be elevated. Lower education mostly in rural regions, higher drop out ratios delineate lower coping capacity and highly unfavorable outcomes to extreme weather events. In approximately 15% areas of The United States at least 20% of Americans of age in the range, 25-64 years have not completed high school education during 2008-12.

Historically, the poor and the marginalized in the United States have been at risk from extreme weather shocks than their wealthy counterparts (B. L. Turner II, R. E. Kasperson, and P. A. Matson). Low employments, less skilled or unskilled jobs imply lesser coping capacities and higher vulnerability to weather extremes. Less than 65% population of age between 25-64 years employed in low employment areas (~ 22.9%) during 2008-12.

Per capita rural income (\$38349), urban income (\$50861) in 2015 and rural-urban income gap (\$12512) which was (\$12829) in 2016 exhibit lower share of rural populations in skilled employment and lower earnings/returns to the college degree in markets. Southern and Western rural communities in the United States comprise ~59% of the overall population in rural U.S. regions exhibit the highest poverty rates ultimately may require more emergency assistance in extreme climatic conditions.

High-poverty indicating areas are more likely to be clustered in the Southern states of the United States mainly in the corn-belt from a history of distressed and transmutation (transitioning) local economies, mostly low skills attribution to the racial/ethnic minorities and dependency on natural resources from the former times, nevertheless, West and Midwest areas are now evident of evolving poverty concentrations.

North/Eastern part of the United States representing over 25% of the whole U.S. population (over 16% population of this region resides in non-metro counties) encounter various

extreme climatic situations like hurricanes, extreme heat, floods, droughts and snow storms, etc. Rural are highly vulnerable to extreme heat due to infrastructure, housing construction, and low socioeconomic status, etc. They cannot afford air conditions during hotter days and heating units at homes in cold winter. Along with significantly varying topography in the north side of this region huge non-metro regions have lower temperature, particularly in winter having snowstorms in contrast to that of southern part's non-metro regions, experience higher temperature in summer and mild in winter (B. L. Turner II, R. E. Kasperson, and P. A. Matson).

The temperature in this region has increased on average about 2°F in the preceding century and is predicted to rise about 4°F to 10°F in the last quarter of this century. Precipitation has increased in winter and spring at most in the United States as compared to other regions, in the five decades it has augmented by 70%. Predictions of increasing temperature and precipitation are likely to adversely impact agriculture and human lives in the region (R. Horton et al).

As in central/Midwestern region over 24% of the United States total population along with more than 22% rural population (S. C. Pryor and R. J. Barthelmie), anthropogenic activities predominantly bring local communities at higher risk to lower temperature i.e., freezing in winter, heat waves, tornadoes, and droughts. Weather-Related extremes significantly threaten public health. Flooding events are also frequent in this region, as an example, flood in 2008 caused about 25 deaths, significantly impacted farming yields, and infrastructure, total losses equating US\$ 15 billion (G. P. Roberson et al).

Furthermore, severe floods in 2013-14 in Michigan, Missouri, Iowa, Illinois and Indiana adversely affected agriculture dependent communities damaged homes, destroyed businesses, thousands of vehicles (cars) and properties. During the last century, the temperature has increased by about 1.5°F in the Midwestern the United States and is expected to further increase in this century. Precipitation has increased by about 20% in some areas particularly in eastern Midwest areas and is also projected to increase in spring and winter; however, summer will be hotter and drier particularly in southern Midwest areas disrupting water sources leading to elevate energy demands for air conditions in particular.

The Southeastern United States contains over 30% of the total U.S. population including more than 26% of the rural population. Same like other regions this region also encounters hurricanes, extreme heat, droughts, tornadoes and blizzard, etc. (L. M. Carter et al). Rural populations are highly vulnerable to droughts and rural coastal e.g. Louisiana, Florida and South Carolina communities are substantially affected by floods (D.C. Morton, M.E. Roessing, A.E. Camp, and M.L. Tyrrell). Since the last five decades average temperature particularly in summer has risen by 2°F which is further expected to rise by

about 4°F to 8°F at the end of this century. Despite of some areas in this region heavy precipitations are common in this region, and also anticipated to increase in this century. Human health and agriculture are probable to be at greater risk in the future due to higher water demands in response to rising temperature and flooding particularly in coastal areas (L. M. Carter et al).

Southwestern region of the United States is the driest and the hottest area, the home of more than 22% of the U.S. population. Increased wildfires (i.e., ~ 650%) attributable to severe heat waves damaged thousands of homes, increased health problems (G. Garfin et al). California being the most productive state in the United States has been experiencing drought situations since last decade and leading seasonal fire all around with extremely high temperature. Further increase in temperature and decrease in precipitation due to changing the climate in the hottest and drier region can increase food unavailability and energy supply challenges in response to water shortage heightening competition of water usage between agriculture and energy production.

The average temperature has increased by approx. 1.3°F and precipitation has decreased in the Northwestern United States during the last century. At the end of this century, projection of increasing average temperature by 3 to 10°F and decreasing precipitation on average by about 30% particularly in summer will be increasing water shortage, agricultural production loss, affecting hydroelectric supply, since 40% of the hydroelectricity of the United States is produced in this region (P. Mote and A. Snover).

3. Material and Methods

Despite growing American economy more people found in poverty during the last decade. Millions of the poor Americans face extreme poverty conditions, particularly in remote rural areas. According to an estimation, more than 15% of the U.S. population (more than 45 million) is facing extreme poverty situation. The researchers and the policymakers increased their focus to find a sensitive and timely (with no lag) poverty detecting measure in place of existing poverty measures because of poverty rate increased about 27% between 2006 (including great depression 2008 era) and 2010 (K. Seefeldt et al).

3.1 Overview of the HNI

The U.S. Salvation Army together with Lilly Family School of Philanthropy Indiana University created the earliest and translucent quantifying perspective of poverty-relevant human needs by scrutiny of longitudinal service facts and figures of nonprofit societal services to the millions of extreme poor Americans across time as well as region. Human Needs Index (HNI) focusing extreme poor segments of the society comprises of seven basic need indicators; food stipulation, meal provision, shelter or home assistance, clothing provision, energy

stipulation, medical assistance and furniture provision. Climatic extremes and seasonality are one of the most important human needs determining indicators. HNI also delineates heightened sensitivity to both varying weather conditions and seasonality. HNI being unique and modern poverty perspective has merits as well as some demerits as; HNI employs a scientific, logical and entrenched econometric process to track human needs over time. It denotes the depth of poverty in American poor communities embodying consumption more willingly than income. In contrast to the existing poverty measures HNI measures level of needs among extreme poor individuals and communities with no lag. As it is argued that elderly and low-income households specifically in summer and winter that may not afford increased burden of energy costs are mainly at higher risks of extreme weather events. In addition, a large number of low-incomes poor African Americans and Hispanics (Latinos) do not afford air conditioners in extreme weather condition i.e., extreme hot. Even it is just beyond the social security provision area of the Salvation Army's HNI. In other words, HNI does not provide any information about assisting service to distinct racial/ethnic groups or communities and gender.

3.2 Determining Thresholds for Climatic Extremes

Infrequently incidence of value of climate variables i.e., temperature or precipitation lower or higher than a threshold level in the range of observed values of climatic variables can be termed as weather extreme and the persistence of weather extremes for some period of time (i.e., hourly, daily, weekly, monthly) referred as an extreme weather event (E. Buccignani et al). Extreme value as occurring below or above a threshold level closer to the lower or higher ends of data range of a variable (S. K. Allen et al).

Due to unavailability of universal definitions of weather extremes and extreme weather events we face many challenges while defining specific weather conditions. Since there is no generally accepted way to describe extreme weather events, though either they can explain characteristic of weather variables (e.g., Temperature, precipitation) or their impacts since consecutively to build a sense the statement entails that the description of an extreme is independent of observed or predictable values which establish the norm (M. Jahn).

W. Schlenker and M. J. Roberts propose maximum temperature thresholds; 29°C for corn, 30°C for soybeans and 32°C for cotton outputs to enhance however possibly beyond these threshold levels, the temperature might be very detrimental. We have chosen here two thresholds for average temperature 28°C and 30°C (average of three above proposed threshold levels) beyond that considered as extreme heat (an extreme weather event) in the current research.

Southeastern which is thought to be among one of the warmer U.S. regions thresholds for extreme high temperature 35°C,

extreme low-temperature thresholds -2°C and thresholds of extremely high precipitation 102mm from 1948-2012 on a daily basis have utilized in a study (E. J. Powell and B. D. Keim).

Beyond extreme temperature threshold 30°C reduced rate of heat-related mortality was found as 41, 17.3 and 10.5 during 1960-70, 1980 and 1990 respectively in 28 cities of the United States. This mortality rate is for every million people (O. Deschênes and M. Greenstone, S. J. Zivin). For every 1°C increase in temperature in developed nations beyond absolute thresholds 27°C -29°C in a day rate of mortality of adults increases 2 to 3% and among children, it can raise 50-100% more than that of adult's mortality rate (S. Lin et al). Also, it also has been concluded that beyond temperature threshold 32°C on daily basis data death rate significantly amplifies, i.e., (three times higher) as compared to death rate at 26°C (K. E. Kunkel et al., F. Ackerman and E. a Stanton). In New York, every 1°C rise in temperature on a day beyond $29-36^{\circ}\text{C}$ causes to increase the rate of hospital admissions for cardiovascular and respiratory diseases up to 2.7 percent-3.1 percent on that same day particularly in Hispanics (~6%) and elder ones (~4.5%) (S. Lin et al).

Emphasizing limitations of this research, we cannot include income which is one of the socioeconomic indicators in our analysis due to the unavailability of statewide monthly data. Consequently, we chose HNI as a poverty measure, to capture climatic conditions, along with the weather-related indicators, i.e., (precipitation and average temperature), unemployment as unemployment rate; latitude and longitude as controlled indicators because unemployment, particularly in rural areas, is a human need determinant.

In Table 3, for better understanding, we use two OLS models with little changing thresholds for climate extremes. We chose absolute threshold level (value) for temperature (28°C for hot and 5°C for cold) for model 1 whereas 30°C and 0°C for hot1 and cold1 in model 2 respectively, percentiles criteria for precipitation thresholds as beyond 90th percentile for high precipitation and 10th percentile for low precipitation for model 1, little higher than 95th percentile and 5 percentile for high precipitation 1 and low precipitation1 in model 2 respectively. This research uses strongly balanced panel data and different data sources consulted for the required data. Precipitation and average temperature data are obtained from the same source NOAA⁵, data of unemployment rate obtained from U.S. Census Bureau⁶ and for latitude and longitude.

Table 3: Thresholds ⁷ for weather extremes and extreme events

Model 1	Model 2
Hot: If the average Temp is $\geq 28^{\circ}\text{C}$ then $D = 1$, 0 otherwise	Hot 1: If the average Temp is $\geq 30^{\circ}\text{C}$ then $D = 1$, 0 otherwise
Cold: If the Avg. Temp is $\leq 5^{\circ}\text{C}$ then $D = 1$, 0 otherwise	Cold 1: If the Avg. Temp is $\leq 0^{\circ}\text{C}$ then $D = 1$, 0 otherwise
Low Precipitation: If Precipitation is ≤ 10 mm then $D = 1$, 0 otherwise	Low Precip. 1: If Precipitation is ≤ 20 mm then $D = 1$, 0 otherwise
High Precipitation: If Precipitation is ≥ 200 mm then $D = 1$, 0 otherwise	High Precipitation 1: If Precipitation is ≥ 220 mm then $D = 1$, 0 otherwise
Heat Wave: If for 2 or more consecutive months Avg. Temp. is $> 28^{\circ}\text{C}$ then $D = 1$, 0 otherwise	Heat Wave 1: If for 2 or more consecutive months Avg. Temp. is $> 30^{\circ}\text{C}$ then $D = 1$, 0 otherwise
Drought: If for 2 or more consecutive months Precipitation is < 10 mm then $D = 1$, 0 otherwise	Drought 1: If for 2 or more consecutive months Precipitation is < 20 mm then $D = 1$, 0 otherwise
Cold Winter: If for 3 or more consecutive months Avg. Temp. is $< 5^{\circ}\text{C}$ then $D = 1$, 0 otherwise	Cold Winter 1: If for 3 or more consecutive months Avg. Temp. is $< 0^{\circ}\text{C}$ then $D = 1$, 0 otherwise
Flood: If for 2 or more consecutive months Precipitation is > 200 mm $D = 1$, 0 otherwise	Flood 1: If for 2 or more consecutive months Precipitation is > 220 mm then $D = 1$, 0 otherwise

3.3 Econometric Models for Estimation

Varying weather conditions are expected and will continue to impact poor individuals and communities in a more disproportionate manner than rich counterparts specifically in remote and population concentrated areas. For instance, the United States consisting of vast geographic location historically has been under series of extreme weather events, droughts in particular as, in 2009 adversely impacted agriculture sector in Southwest, Midwest, and Great plains along with about \$5.2 billion money losses, maximum losses in California and Texas. Arizona, Kansas, New Mexico, LA, Texas and Oklahoma were affected by drought and heat wave particularly during growing season in 2011, 95 fatalities and losses in monetary terms approximately \$12.2 billion are separate. The most extensive drought (2012) ever in The United States since 1930 & associated heat wave in summer affected over half of the U.S. specifically agricultural states, harvesting of corn, soybeans and other crops, 123 fatalities and approximately \$30.15 billion losses exclusive. Agriculture sector continued to be highly impacted by drought in California, some of other western states whereas in Texas & Oklahoma situation improved by some of flood events along with other losses equating to about \$4.5 billion.

⁵<https://www.ncdc.noaa.gov/cag/national/rankings/110/tavg/201806>

⁶<https://www.bls.gov/data/>

⁷The extreme weather and climate events definition used in IPCC 2012: The

occurrence of a value of climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable.

For empirical estimation of how poor Americans are impacted by weather extremes and events, in other words how poverty-related human needs change in response to acute temperature and its continuity as well as extreme precipitation and its sequence we use two basic econometric models.

$$HNI_{it} = \beta_0 + \sum_{j=1}^N \beta_{1j} D_{ji} + \beta_{2i} x_{2it} + \beta_{3i} x_{3it} + \beta_{4i} x_{4it} + \varepsilon_{it} \quad (1)$$

$$HNI_{jt} = \beta_0 + \sum_{k=1}^N \beta_{1k} D_{jk} + \beta_{2j} x_{2jt} + \beta_{3j} x_{3jt} + \beta_{4j} x_{4jt} + \varepsilon_{jt} \quad (2)$$

In both the models, model 1 and 2, HNI is human needs index indicating HNI score in 'ith state in t' time, β_0 is an intercept, D_{jt} represents explanatory dummies of key weather indicators as weather extremes and events, β_{1j} represents slope of jth dummy (in the equation of Model 2) of weather extreme, $\beta_{2i} x_{2it}, \beta_{3i} x_{3it}, \beta_{4i} x_{4it}$ represent controlled variables along with their regression coefficients and ε_{it} is stochastic error term (varies over time). In both the models' Human needs index (HNI) as an explained indicator, weather-related indicators (dummy variables) as an explanatory and key indicators, (also see Table 3). The dummies for key weather explanatory variables Hot (Hot1), Cold (Cold1), Heatwave (Heat wave1) and cold winter (cold winter1) are created from the average temperature and the dummies Low precipitation (Low precipitation1), High precipitation (High precipitation1), Drought (Drought1) and Flood (Flood1) are created from precipitation. We use pooled OLS regression for the analysis and to attain the results.

4. Results and Discussions

4.1. Preliminary Results and Discussion

The statewide monthly HNI largely varies in a complex manner in U.S. ranges between '0 to 28.7' with an average score of 0.995 and standard deviation 0.985 throughout the strongly balanced panel dataset (2004January-2016December). Average temperature and precipitation vary in the range -24.9°C – 31.8°C with average (mean) 11.08°C, standard deviation 10.04°C and 0.25mm – 404.4mm with mean 78.83mm and standard deviation 51.15mm respectively. All the extreme weather indicating dummies created from key weather indicators (temperature, precipitation) vary in the range '0 to 1'. Controlled variables, i.e., the statewide monthly unemployment rate remains in the range 2.3% - 14.9% (mean 6.34 and std. deviation 2.19) throughout the United States following the dataset range 2004January-2016December. Lastly, geographic directed indicators latitude and longitude follows the range 27.83°N to 61.38°S (mean 39.81°, std. deviation 5.57°) and -152.3° East to -72.76° West (mean -86.7°, std. deviation 12.15°) throughout the United States.

Table 4 in section 4.2 demonstrates a descriptive statistic of all the indicators included in this study.

Table 4: Descriptive Statistics

Indicators	Obs.	Mean	Std. Dev.	Min.	Max.
HNI	7488	0.995	0.985	0	28.7
Avg. Temperature	7488	11.08	10.04	-24.9	31.8
Precipitation	7488	78.83	51.15	0.25	404.4
Weather Extremes					
Hot	7488	0.011	0.106	0	1
Hot 1	7488	0.001	0.028	0	1
Cold	7488	0.292	0.455	0	1
Cold 1	7488	0.159	0.365	0	1
Precipitation Low	7488	0.047	0.212	0	1
Precip.Low1					
Extreme Weather Events	7488	0.110	0.313	0	1
Heat Wave	7488	0.003	0.057	0	1
Heat Wave 1	7488	0.000	0.018	0	1
Cold winter		0.153	0.360	0	1
Cold winter 1	7488	0.057	0.232	0	1
Drought	7488	0.057	0.232	0	1
Drought 1	7488	0.052	0.223	0	1
Flood	7488	0.002	0.046	0	1
Flood 1		0.002	0.039	0	1
Controlled Variables					
Unemployment Rate	7488	6.338	2.193	2.3	14.9
Latitude	7488	39.81	5.572	27.8	61.38
Longitude	7488	-86.7	12.15	-152.3	-72.76

Table 5 presents pooled OLS regression seasonality results for two models, Model 1 and Model 2 respectively. Model 1 has four sub-models as model 1a to model 1d. Model 1a represents the outcome of weather extremes in the form of regression coefficients and seasonality referring coefficients. Model 1b includes extreme weather events along with weather extremes and seasonality coefficients. Model 1c further includes control variable unemployment rate along with weather extremes, extreme weather events and seasonal regression coefficients and finally, model 1d comprises of another control variable latitude and longitude along with results of model 1c. The same practice is repeated in Model 2 in Table 6. First, we will explain the results of Model 1, Table 5 in details and then we will move towards model 2, Table 6.

See (Table 5) Low precipitation (≤ 10 mm) significantly (at 1% level of significance) affects human needs keeping all other indicators constant or unchanged, contributing to increase HNI score by 0.37 on average delineating higher poverty-related human needs assistance, whereas increase by HNI score 0.371, 0.380, 0.404, 0.313 in models from model 1a to model 1d respectively. Contrasting to low precipitation, high precipitation (≥ 200 mm) contributes to decrease human needs by 0.17 score on average keeping all other indicators constant or unchanged in all sub-models from model 1a to model 1d,

however in model 1a, high precipitation causes to reduce human needs by score 0.156, in model 1b after inclusion of extreme events causes to reduce human needs by score 0.164, including unemployment rate in model 1c human needs reduce by HNI score 0.202 and in model 1d by including all explanatory indicators along with latitude, longitude 1 mm precipitation beyond 200 mm may cause to reduce human needs by score 0.159. Rest of all the weather-related indicators in this study presents an insignificant association with poverty-related human needs.

Unemployment and geographic locations which are considered important human needs determining indicators significantly associated with HNI score indicating a strong association with human needs. 1% change (increase/decrease) in unemployment rate may change (increase/decrease) human needs assistance through social security network of the Salvation Army by score 0.0695 on average (statistically significant at 1% level of significance), longitude results show that from west to south poverty-related human needs assistance through social security network decreases like 1° movement from Western to Eastern areas in The United States may reduce human needs by score 0.006 on average, whereas from North to South (latitude) results are not significant. Robust seasonality results reveal the implications of all these results for Model 1 during Fall-Winter season (August to December, October exclusive) showing statistically higher significance (1% significance level), particularly in December. (The month of the highest poverty-related human needs ever).

Table 5: Pooled-OLS Seasonality Results of Model 1

HNI	Model 1a Coefficients (Standard Error)	Model 1b Coefficients (Standard Error)	Model 1c Coefficients (Standard Error)	Model 1d Coefficients (Standard Error)
Weather Extremes				
Hot	0.182 (0.115)	0.218 (0.135)	0.214 (0.134)	0.228* (0.134)
Cold	0.041 (0.038)	0.046 (0.048)	0.076 (0.047)	0.044 (0.049)
Low Precipitation	0.371*** (0.057)	0.380*** (0.072)	0.408*** (0.071)	0.313*** (0.071)
High Precipitation	-0.156** (0.079)	-0.164** (0.083)	-0.202** (0.082)	-0.159** (0.081)
Extreme Events				
Heat Wave		-0.1270 (0.250)	-0.181 (0.247)	-0.184 (0.245)
Cold winter		-0.0100 (0.055)	0.004 (0.054)	-0.039 (0.054)
Drought		-0.0240 (0.114)	-0.077 (0.113)	-0.101 (0.112)

Flood		0.087 (0.270)	0.140 (0.267)	0.133 (0.265)
Controlled Variables				
Unemployment Rate			0.069*** (0.005)	0.070*** (0.005)
Latitude				0.002 (0.003)
Longitude				-.006*** (0.000)
Seasonality Results				
February	-.085 (0.057)	-.082 (0.058)	-.082 (0.057)	-.076 (0.057)
March	0.044 (0.058)	0.047 (0.059)	0.058 (0.058)	0.045 (0.058)
April	0.010 (0.063)	0.011 (0.063)	0.032 (0.063)	-.008 (0.063)
May	0.040 (0.064)	0.040 (0.065)	0.065 (0.064)	0.018 (0.065)
June	0.033 (0.065)	0.033 (0.065)	0.058 (0.064)	0.012 (0.066)
July	0.140** (0.065)	0.139** (0.065)	0.164** (0.065)	0.117* (0.066)
August	0.200*** (0.066)	0.202*** (0.066)	0.231*** (0.065)	0.183*** (0.066)
September	0.238*** (0.065)	0.238*** (0.065)	0.264*** (0.064)	0.217*** (0.065)
October	0.088 (0.064)	0.087 (0.064)	0.111* (0.064)	0.063 (0.065)
November	0.128** (0.059)	0.125** (0.061)	0.135** (0.060)	0.106* (0.060)
December	0.745*** (0.058)	0.742*** (0.061)	0.744*** (0.061)	0.722*** (0.060)
Constant	0.839*** (0.050)	0.838*** (0.050)	0.373*** (0.061)	-.247** (0.061)
R-Square	0.051	0.051	0.074	0.086
F-Statistic	22.9***	18.1***	25.8***	27.4***

See Table 5 Sequence of low precipitation (drought) for at least two months significantly (at 1% level of significance) affects human needs, in other words 1mm decrease in precipitation beyond 20 mm (less than 20mm) contributes to increasing HNI score by 0.31 on average in all three sub-models of Model 2 delineating higher poverty-related human needs, whereas increase by HNI score 0.335, 0.308 and 0.288 in models from model 2b to model 2d. As said before, the rest of all the weather-related indicators in this study present insignificant association with poverty-related human needs. As far as controlled variables are concerned, 1% change (increase/decrease) in unemployment rate may change

(increase/decrease) human needs by score 0.070 on average (statistically significant at 1% level of significance), longitude results show that 1° movement from Western areas to Eastern areas in the United States may reduce human needs by score 0.006, whereas from North to South (latitude) results are not significant. Robust seasonality results reveal the implications of all these results for Model 2 during Fall-Winter season (August to December, October exclusive) showing statistically higher significance (1% significance level) particularly in December (highest needs month). Consistently, the goodness of fitness values of both the models ($R^2 = 0.066$) shows that weather extremes, and extreme events along with unemployment rate, latitude and longitude as controlled indicators may cause to bring about 6.6 percent variation on average in human needs. Overall both the models are highly significant shown by F-Statistic value.

Table 6: Pooled-OLS Seasonality Results of Model 2

HNI	Model 2a	Model 2b	Model 2c	Model 2d
	Coefficients (Standard Error)	Coefficients (Standard Error)	Coefficients (Standard Error)	Coefficients (Standard Error)
Weather Extremes				
Hot 1	-.112 (0.431)	0.008 (0.556)	-.004 (0.548)	0.003 (0.546)
Cold 1	0.061 (0.040)	0.058 (0.049)	0.097** (0.048)	0.072 (0.050)
Low Precipitation 1	0.236*** (0.039)	0.076 (0.052)	0.118** (0.051)	0.036 (0.052)
High Precipitation 1	-.147 (0.102)	-.140 (0.104)	-.172* (0.103)	-.125 (0.102)
Extreme Events				
Heat Wave 1		-.298 (0.878)	-.318 (0.867)	-.298 (0.862)
Cold winter 1		-.010 (0.069)	0.006 (0.068)	-.042 (0.068)
Drought 1		0.335*** (0.072)	0.308*** (0.072)	0.288*** (0.071)
Flood 1		-.197 (0.565)	-.059 (0.557)	-.038 (0.555)
Controlled Variables				
Unemployment Rate			0.070*** (0.005)	0.070*** (0.005)
Latitude				0.002 (0.002)
Longitude				-.006*** (0.000)
Seasonality Results				
February	-.088	-.092	-.092	-.083

	(0.057)	(0.060)	(0.059)	(0.059)
March	0.051 (0.059)	0.047 (0.061)	0.063 (0.060)	0.053 (0.060)
April	0.023 (0.062)	0.016 (0.062)	0.035 (0.062)	0.009 (0.062)
May	0.050 (0.062)	0.043 (0.063)	0.063 (0.062)	0.036 (0.061)
June	0.047 (0.062)	0.039 (0.063)	0.058 (0.062)	0.033 (0.062)
July	0.157** (0.062)	0.156** (0.063)	0.174*** (0.065)	0.150** (0.062)
August	0.200*** (0.062)	0.207*** (0.063)	0.227*** (0.062)	0.203*** (0.062)
September	0.242*** (0.062)	0.235*** (0.063)	0.253*** (0.062)	0.230*** (0.062)
October	0.092 (0.061)	0.094 (0.062)	0.112* (0.062)	0.086 (0.062)
November	0.144** (0.061)	0.155** (0.060)	0.167** (0.060)	0.151** (0.061)
December	0.745*** (0.058)	0.738*** (0.058)	0.738*** (0.057)	0.728*** (0.057)
Constant	0.822*** (0.046)	0.827*** (0.047)	0.359*** (0.059)	-.234** (0.110)
R-Square	0.049	0.052	0.076	0.086
F-Statistic	23.8***	20.9***	29.6***	30.5***

Note: *** significance level (1%), ** significance level (5%)
& * significance level (10%)

4.2. Discussion

As precipitation extremes are less predictable than temperature extremes. Low precipitation, continuity of low precipitation (drought) and high precipitation impact human livelihoods and prosperity. Basic human needs i.e., Food, housing, clothing; medical/health needs, energy etc alter as a result of weather extremes. It is well understood that the Western part of the United States which contributes over 50 percent of the national valuable produces together with vegetables and fruits is prone to drought, agriculture is usually the earliest and most affected sector extreme low precipitation in the form of water shortage contribute to food shortage, particularly during summer and winter increase energy demands (gap between energy needs & supply) aggravate existing confronts of poor communities in particular.

California as one of the largest contributing state to the U.S. economy through agriculture, energy production and recreation is likely to hit hard by extreme events by drought in specific. The agriculture sector in California greatly depends on irrigation i.e., crops, vegetable and fruit production. Almond and walnut considered as multi-billion dollar industries are heavily water demanding industries, approximately 15% of the

electricity in California is hydroelectric based. Low precipitation and its continuity causing water scarcity contribute to exacerbate their existing challenges in terms of increasing cost of production leading to increasing consumer cost to basic needs, spikes in food prices due to crop loss (widening demand-supply gap) and higher energy demands particularly in summer for cooling (air conditioners) and winter for heating (heaters).

Food which is a building block of health and well-being, every year droughts and wildfires contribute to widening demand/supply gap through crop damage creating food scarcity and homes burning. Drought can also directly or indirectly be the cause of future vulnerability. It can influence food and water security, threats to health through multi-channels (K. L. Ebi and K. Bowen) can spoil water providing infrastructure and cause to decrease both the quality and quantity of protected water (F. J. Warren and D. S. Lemmen). It can also contribute to forest fires resulting in the devastation of housing units, buildings, and other assets. Reduced water quality elevates medical needs, energy needs power outage in the form of electricity can influence medicine & health, food, etc. As an example, diabetes patients would be unable to put their insulin injections in refrigerators ultimately droughts cause to diminish living fulfillment through imposing limits to daily life activities, i.e., limiting outdoor recreational activities.

During summer and winter (i.e., from July to December, October exclusive) human needs go up, every year in December human needs sustain the highest. In summer water scarcity impacts creating competition for its usage between energy production and farming, mining (which requires a large quantity of water), recreation (water related) which are the sources of their livelihoods. Attributing to hotter summer earlier snowmelt in winter creates dry cold and less precipitation affecting tourism, health problems, need more clothes, energy demands rise to keep homes and themselves warm. Due to lesser resources and uneasy access to govt. Services and economic opportunities they cannot prepare in advance for such unpredictable climatic situation. Therefore they need immediate and specific assistance from their relatives, volunteer society members & organizations.

An extended frequency and duration of dryness (droughts) along with increasing population which is predicted to increase by about 70% until 2050 in Western areas of the United States may boost up basic needs dominantly in Southwest affecting water supply sources including Colorado River Basin. Having the highest poverty rate existing stresses of indigenous Americans (more than 2% population of the total population) in this region may further aggravate. Elderly and low-income households specifically in summer and winter that may not afford the increased burden of energy costs are mainly at higher risks of extreme weather events (G. Garfin et al). Additionally, in the Northwestern regions, growing population, reduced

precipitation and projection of low precipitation particularly in summer increases energy demands (air conditioners), and supply concerns widening the gap between elevating electricity demands/supply worsening situation in future (P. Mote and A. Snover). Indigenous Americans living in remote areas are likely to face risks of health, undernourishment to weather extremes because of environment's dependent natural resources as their sustenance. The water shortage in the case of the droughts is one of the main issues, indigenous Americans face because a large number of them already depend on unfettered low-quality supplies of water (M. H. Redsteer and A. Native, I. Task, and F. Access).

Our results show that poverty-related human needs reduce in case of high precipitation. In other words, Western Americans need lesser emergency assistance as a result of high precipitation. The plausible reasons may be that because low precipitation causes to increase human needs through different channels, high precipitation especially in western US (agricultural region causes to diminish poverty-related human needs particularly in summer due to less water stress for agriculture and energy production for summer and in winter season delaying snowmelt reduces occurrence of dry cold and prolong tourism season, high precipitation reduces wildfires and droughts.

5. Conclusion

As precipitation is one of the most complicated climate variables to correctly forecast, however, its accurate forecasting can mitigate risks particularly of poor communities (I. WeatherBill). This research concluded that low precipitation and its sequence as drought causes to increase human needs assistance through nonprofits social security networks and decreases trust level in governments whereas the situation reverses in case of high precipitation human needs assistance through social security channels decreases as well as lower trust level in nonprofits. During summer (July-September) and winter (November-December), poor Americans have higher trust level in the Salvation Army rather than the governments indicating higher emergency assistance particularly in Western remote and population concentrated areas of United States. The U.S. Salvation Army's human needs index (HNI) may be beneficial for targeting persistent poor population areas to address their better altering human needs emergency assistance requirements and trust level on governments in response to extreme climatic conditions and season.

Appendix

Table A1: Correlation Matrix of Model 1

	H N I	H o t	C o l d	Low Precip itation	High Precip itation	H e a t w a v e	C o l d w i n t e r	D r o u g h t	F l o o d
HNI	1								
Hot	0.02	1							
Cold	0.04	0.07	1						
Low precipitation	0.08	0.02	0.02	1					
High Precipitation	-0.02	0.06	-0.03	0.06	1				
Heat wave	0.01	0.03	0.04	-0.01	0.03	1			
Cold winter	-0.05	0.05	0.66	-0.01	-0.05	0.02	1		
Drought	0.05	0.01	0.02	0.61	-0.02	0.01	0.01	1	
Flood	-0.01	0.03	0.02	-0.01	0.30	0.05	0.01	-0.01	1

Table A2: Correlation Matrix of Model 2

	H N I	H o t 1	C o l d 1	Low Precip itation 1	High Precip itation 1	H e a t w a v e 1	C o l d w i n t e r 1	D r o u g h t 1	F l o o d 1
HNI	1								
Hot 1	0.00	1							
Cold 1	0.05	0.01	1						
Low precipitation 1	0.07	0.02	0.08	1					
High Precipitation 1	-0.02	0.06	-0.03	0.06	1				
Heat wave 1	0.00	0.03	0.00	0.02	0.03	1			
Cold winter 1	-0.02	0.01	0.57	0.07	-0.05	0.00	1		
Drought 1	0.09	0.02	0.08	0.67	-0.02	0.03	0.08	1	
Flood 1	-0.03	0.03	0.02	-0.01	0.30	0.05	0.01	-0.01	1

Table A3: Multicollinearity Test Results

Model 1	VIF*	1/VIF**	Model 2	VIF	1/VIF
Hot	1.46	0.683	Hot 1	1.67	0.598
Cold	3.61	0.277	Cold 1	2.40	0.416
Low precipitation	1.66	0.603	Low precipitation 1	1.94	0.516
High Precipitation	1.11	0.898	High Precipitation 1	1.05	0.955
Heat wave	1.41	0.707	Heat wave 1	1.67	0.598
Cold winter	2.79	0.358	Cold winter 1	1.84	0.544
Drought	1.61	0.621	Drought 1	1.85	0.542
Flood	1.10	0.906	Flood 1	1.04	0.965
Unemployment rate	1.02	0.978	Unemployment rate	1.03	0.974
Latitude	1.48	0.674	Latitude	1.41	0.711
Longitude	1.24	0.806	Longitude	1.30	0.771
Months					
February	1.93	0.517	February	2.03	0.493
March	1.99	0.503	March	2.10	0.475
April	2.19	0.457	April	2.08	0.480
May	2.32	0.432	May	2.10	0.477
June	2.35	0.426	June	2.10	0.476
July	2.37	0.422	July	2.09	0.477
August	2.39	0.419	August	2.11	0.475
September	2.33	0.429	September	2.09	0.477
October	2.28	0.439	October	2.07	0.483
November	1.98	0.505	November	1.98	0.505
December	1.99	0.502	December	1.77	0.563
Mean VIF	1.94		Mean VIF	1.81	

*Variance Inflation Rate, **Tolerance Factor

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