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Population change and social vulnerability in the wake of disaster: the case of Hurricanes Katrina and Rita

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POPULATION CHANGE AND SOCIAL VULNERABILITY IN THE WAKE OF DISASTER: THE CASE OF HURRICANES KATRINA AND RITA

A Thesis

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ABSTRACT

Previous sociological research on natural disasters has highlighted how various dimensions of social vulnerability influence the impact of, and recovery from, such disasters. This research contributes to the literature by examining population change in the wake of Hurricanes Katrina and Rita, with an explicit focus on how social vulnerability moderates this relationship. Using data from the U.S. Census Bureau, I construct a macro-level Social Vulnerability Index (SoVI) for the impacted region and then use regression analysis to explore how various dimensions of social vulnerability are related to population change in the six months following the storms. The results reveal a number of significant relationships, including a history of population flux and the presence of elderly populations. However, the results are just as notable for what they do not show. Overall, I find little evidence that social vulnerability plays a major role in moderating the macro-level relationship between a disaster and population change. Implications for future research and public policy are then discussed.

INTRODUCTION

Previous research has examined the characteristics of individuals and groups that make them more or less socially vulnerable to the impacts of disasters. Additional research has studied how disasters influence human migration. To date, however, little research examines how social vulnerability influences migration in the wake of a disaster. This research aims to fill this void.

On August 29, 2005, Hurricane Katrina made landfall near the Louisiana-Mississippi state border. Less than one month later, on September 24, Hurricane Rita made landfall near the Louisiana-Texas state border. Forced evacuations, destroyed homes, disruption of economic activity, and the ruin of community infrastructures in the wake of these storms led to unprecedented population shifts in the Gulf Coast Region.

In this thesis I examine the population change that resulted from Hurricanes Katrina and Rita. I pay special attention to how social vulnerability moderates the relationship between a disaster and population change. I use regression analysis to tease out how various dimensions of social vulnerability are related to population change on the Gulf Coast following these storms. Implications for future research and public policy are also discussed.

THEORETICAL AND CONCEPTUAL CONSIDERATIONS

Conceptualizing Disaster

The conceptualization of “disaster” has long been a subject of debate within the field of disaster studies (Kreps 1984, 1995; Quarantelli 1987, 1989, 1993, 1998). While no clear consensus has been reached, there are a plethora of agents that wreak havoc on the social and natural environment. For example, environmental degradation, such as drought and desertification; biological hazards, such as insect infestation and disease epidemics; technological agents, such as oil spills and other pollutants; geophysical hazards, such as hurricanes and tsunamis; and war and other types of civil unrest; all can result in disaster (Dynes and Drabek 1994; McGuire, Mason, and Kilburn 2002; Picou, Marshall, and Gill 2004). Because disasters can result from various agents, it is necessary to distinguish between a natural disaster, which is the focus of this project, and disasters of other types. Natural disasters are the result of geophysical processes, meteorological, geological, and hydrological, within the earth and its atmosphere (McGuire, Mason, and Kilbourn 2002; Wright et al. 1979). Natural disasters include such occurrences as tornadoes, floods, earthquakes, tsunamis, drought, and hurricanes (Burton, Kates, and White 1978). These types of disasters differ from industrial agents, such as chemical spills, biological sources, such as disease epidemics, and slow-onset environmental degradation (McGuire, Mason, and Kilbourn 2002; Shrivastava 1987; Wisner et al. 2004).

Scholars argue that sociology should figure prominently in disaster research (Perry and Quarantelli, 2005; Quarantelli 1989, 2000; Quarantelli and Dynes, 1977). Quarantelli (2000: 682) defines disasters as “relatively sudden occasions when, because of perceived threats, the routines of collective social units are seriously disrupted and when unplanned courses of action have to be undertaken to cope with the crisis.” That is, for Quarantelli (2000) sociological considerations are central to the very definition of disaster. Bolin (1998: 27) echoes this view, stating "disasters are fundamentally social phenomena; they involve the intersection of the physical process of a hazard agent with the local characteristics of everyday life in a place and larger social and economic forces that structure that realm."

Smith (1992) describes two key paradigms used to frame the social scientific study of disasters: the behavioral and structural paradigms. The behavioral paradigm, which is slowly waning in dominance, focuses on the geophysical causes of disasters and the use of technology to alleviate damage as the result of such an occurrence. This paradigm holds disasters to be indiscriminate occurrences and emphasizes the significance of human behavior in preventing disasters. However, the behavioral paradigm pays little attention to the social circumstances of areas stricken by disasters. Conversely, the structural paradigm emphasizes the influence of the social structure in which individuals and groups are embedded (Bolin 1998; Smith 1992), and provides recognition that disasters are "products of a nature/society interface which intensify daily economic and social living problems" (Hutton and Haque 2004: 49). This perspective posits that marginalized social groups and individuals are more "at risk" in the wake of natural disasters (Wisner et al. 2004).

An important approach encompassed by the structural paradigm is the vulnerability approach, which focuses on the spatial dimensions of social and economic stratification in relation to disasters (Hewitt 1998). As Tierney (2006: 110) states, "groups are differentially vulnerable … in the face of disasters, depending upon their position in the stratification system." This framework has most often been employed by anthropologists and geographers (Cutter 1996; Oliver-Smith 1996; Oliver-Smith and Hoffman 1999). The approach "does not deny the significance of natural hazards as trigger events, but puts the main emphasis on the various ways in which social systems operate to generate disasters by making people vulnerable" (Wisner et al. 2004:10). That is, the vulnerability perspective examines natural disasters as social phenomena moderated by the existing social structure.

Cutter's (1996) hazards-of-place model is a prominent example of the vulnerability perspective. The hazards-of-place model focuses on how risk to natural hazards is influenced by biophysical/technological vulnerability and social vulnerability to produce an overall vulnerability of place. Specifically, social vulnerability emphasizes the socioeconomic features of a delimited spatial area, such as community composition and stratification, and how such features influence susceptibility to natural disasters (Cutter, Boruff and Shirley 2003).

Disasters and Population Change

Natural disasters can impact societies in a host of ways. One such example is human migration and population change. Disasters act as a "push" factor in the decision to migrate, forcing people to move from one area to another (Bates 2002; Geipel 1982; Hunter 2005; Wolpert 1966). Migration as a coping strategy in the wake of a disaster is fundamentally influenced by the social context in which people are embedded (Hunter 2005). That is, social context moderates the migration process by facilitating or constraining migration decisions in response to disaster, as illustrated in Figure 1.

There are many factors that may influence migration in the wake of a natural disaster. Socioeconomically disadvantaged or marginalized groups, including women, the elderly, racial/ethnic minorities, the poor, and those with lower levels of educational attainment, are often disproportionately impacted by disasters (Hunter 2005; Hutton and Haque 2004). In contrast, those with greater means or power have more control over the decision to migrate (Belcher and Bates 1983; Enarson 1998; Fordham 1999; Haas, Kates, and Bowden 1977; Morrow-Jones and

Morrow-Jones 1991). The economic structure, community infrastructure, demographic characteristics, such as population density and the rural-urban continuum, and other features that speak to spatial stratification are also significant factors that may moderate a natural disaster's impact on migration (Cutter, Mitchell, and Scott 2000; Tierney 2006; Wisner and Luce 1993).

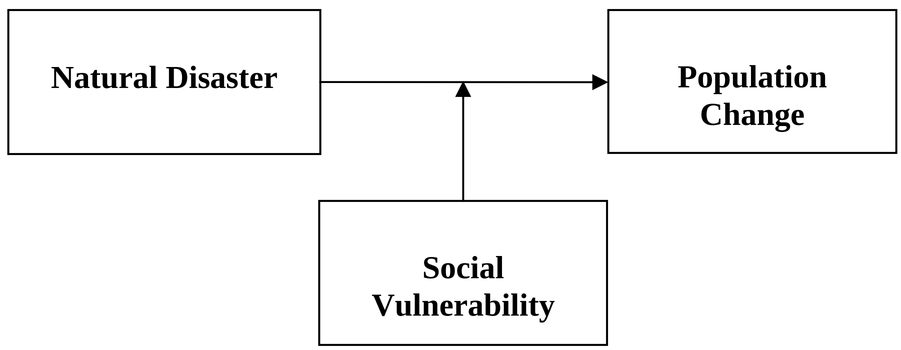


Figure 1. The Relationship between Natural Disasters, Social Vulnerability, and Population Change

EMPIRICAL EVIDENCE

Studies that have examined migration as a response to natural disasters have classified this type of migration as forced or involuntary (Hunter 2005; Hutton and Haque 2004). In their case studies of a hurricane and an earthquake in the Dominican Republic and Guatemala, respectively, Belcher and Bates (1983) highlighted how economic factors shaped the migration process following a natural disaster. These researchers found that those who did not own homes or land, but rather rented, were more likely to migrate in the wake of disaster. Additionally, older age and poor health contributed to individual's migration decisions post-disaster.

Morrow-Jones and Morrow-Jones (1991) also found that migration following a disaster was moderated by socioeconomic and demographic factors. These researchers examined nationwide data over a seven year period within the United States in order to determine how migration caused by natural disasters differed from other forms of migration. Female-headed households, the elderly, and African Americans were especially likely to migrate following a disaster. Additionally, individuals with less political and social power, for example those with lower incomes and lower levels of educational attainment, were found to be disproportionately forced to migrate following such events.

One reason individuals with fewer economic and social resources are more likely to migrate is due to damage sustained to their homes. Peacock and Girard (1997) found that the economically and socially disadvantaged are more likely to reside in housing that is substandard and ill-equipped to avoid damage. Those occupying lower social strata are more likely to be renters, mobile home occupants, and/or reside in housing with lower-quality construction (Fothergill and Peek 2004). Furthermore, households that are socioeconomically advantaged are better able to call upon economic and social resources in order to maintain their residence and livelihood after the occurrence of a natural disaster (Morrow-Jones and Morrow-Jones 1991; Peacock and Girard 1997). The built environment also contributes to vulnerability, including the density and quality of housing stock and commercial and industrial infrastructure, which if poorly constructed, or very dense, can result in greater damage. Vulnerability is also determined by community characteristics, such as population density and the strength of the local economy (Browning et al. 2006; Klinenberg 2002). Areas that are overly dependent on any single type of economic sector may experience greater losses, which is a characteristic of many rural communities that rely upon farming and resource-dependent extractive industries (Gramling and Freudenburg 1990; Freudenburg 1992). Additionally, the impact of disasters on high density populations in urban areas can lead to the displacement of large numbers of people, while those in rural areas may lack formalized means for moving out of the path of a disaster or recovering in its wake (Cutter, Boruff, and Shirley 2003).

In sum, vulnerability studies highlight how social, economic, and demographic characteristics influence the impacts of disasters (Bolin 1999; Bolin 2006; Cutter, Mitchell, and Scott 2000; Klinenberg 2002; Zaman 1999). Vulnerability studies have encouraged the social scientific community to recognize that social stratification is a significant factor in understanding the consequences of disasters (Bolin 1986; Enarson, Fothergill, and Peek; Fordham 1999; Fothergill 1996; Sachs 2007). Despite this, there is still a marked lack of research that addresses how social vulnerability moderates specific post-disaster process, such as population change, in the wake of a natural disaster. In the following analysis, I explore the relationship between population change and natural disasters, with a specific focus on how social vulnerability moderates this relationship.

DATA AND METHODS

Data

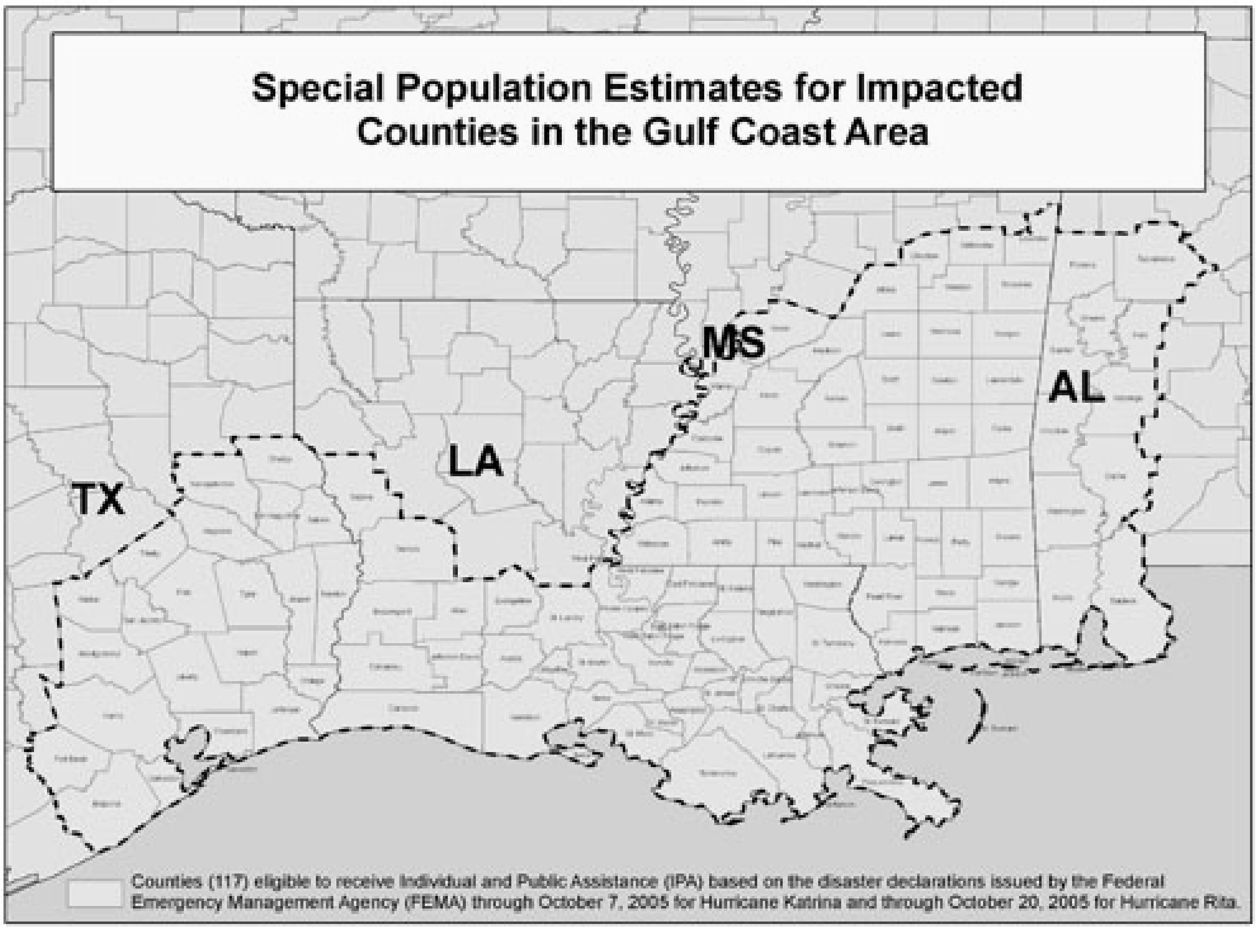
Data for this study were drawn from a variety of sources available from the U.S. Census Bureau. These sources include Summary Files 3 and 4 from the 2000 Census; the County and City Data Book: 2000; and USA Counties. Additionally, data on population change following Hurricanes Katrina and Rita are based upon special population estimates conducted by the U.S. Census Bureau for the impacted region. This region includes 117 counties/parishes within four Gulf Coast states: Alabama, Louisiana, Mississippi, and Texas (U.S. Census Bureau, 2006). Counties/parishes in this study are those in which residents were eligible for Individual and Public Assistance (IPA) following Hurricanes Katrina and Rita, as determined by the Federal Emergency Management Agency (FEMA). Figure 2 provides an illustration of the impacted region, demarcated by the dashed boundary.

Dependent Variable

The dependent variable in this study is the rate of population change at the county/parish level, in the six months following the storms. This time period is based upon special population estimates from the U.S. Census Bureau (2006). Pre-hurricane population estimates are for July 1, 2005, and post-hurricane population estimates are for January 1, 2006. I calculate the rate of population change by subtracting the pre-hurricane population (July 1, 2005) from the post-hurricane population (January 1, 2006), dividing the result by the pre-hurricane population, and then multiplying by a thousand. Specifically, population change is calculated as:

[(Post-hurricane population – Pre-hurricane population) / Pre-hurricane population] * 1000

Descriptive statistics for the dependent variable are presented in Table 1. These data present a number of important limitations. First, the special population estimates only allow for an assessment of short-term population change (6 months). I am also limited by the sample size. The estimates are only available for 117 counties/parishes.



Source: U.S. Census Bureau

Figure 2. Counties/Parishes Designated for FEMA Assistance Following Hurricanes Katrina and Rita

Table 1. Distribution of Dependent Variable: Rate of Population Change, July 2005-January 2006

Mean	-13.33
Median	5.59
Standard Deviation	115.56
Minimum	-947.95
Maximum	73.31

n=117

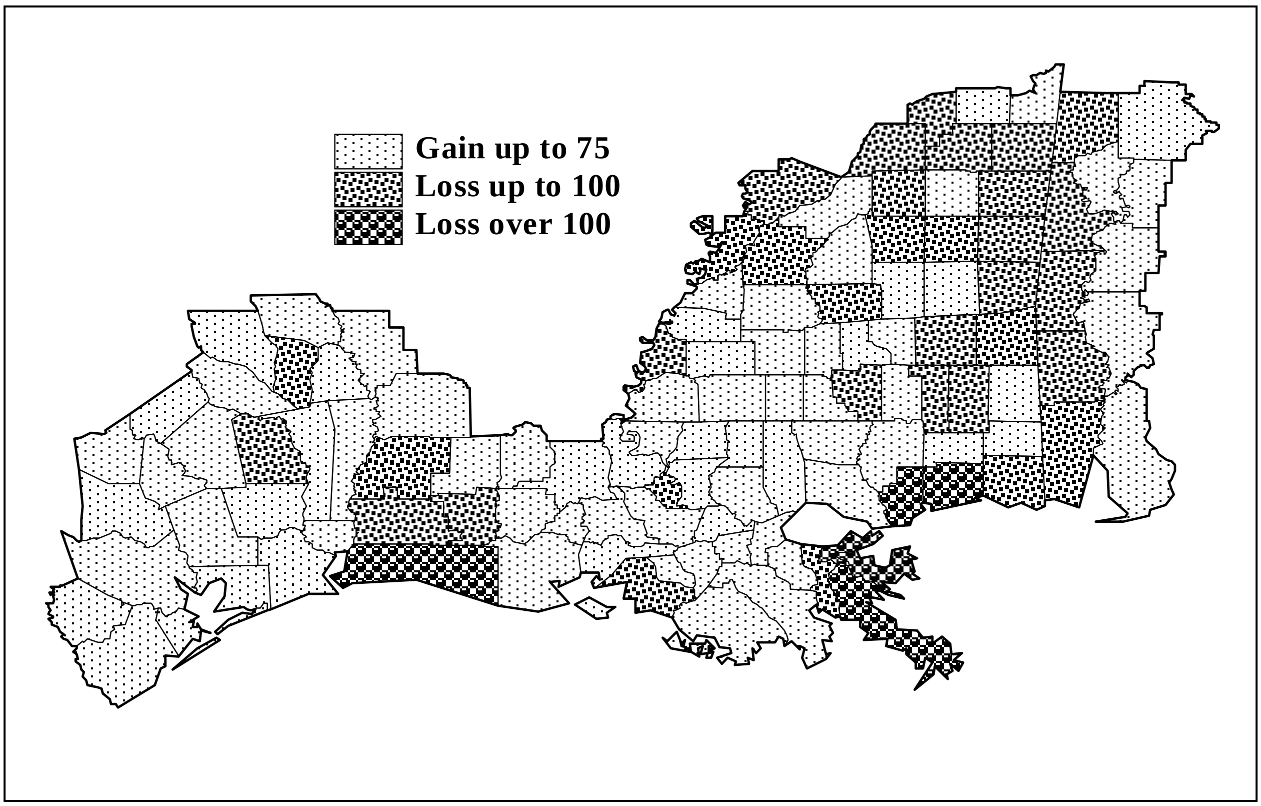


Figure 3. Rate of Population Change for Counties/Parishes in the Impacted Region: July 2005 – January 2006

The geography of population change for the region is illustrated in Figure 3. A majority of counties/parishes (66 percent) experienced population gain, while others (29 percent) experienced population loss. Those counties/parishes (5 percent) that experienced population loss of over 10 percent where directly in the paths of the hurricanes. Cameron Parish, Louisiana, on the Texas/Louisiana state border was directly impacted by Hurricane Rita. While Orleans, Plaquemines, and St. Bernard Parishes in Louisiana and Hancock and Harrison Counties in Mississippi were directly impacted by Hurricane Katrina. Many counties/parishes along the Mississippi/Alabama state border experienced population loss of up to 10 percent. Only two counties in Texas, San Augustine and Tyler, sustained population loss, while the rest of the impacted region in Texas experienced population gain.

Independent Variables

The selected independent variables are indicators of social vulnerability that evolve from the literature. Specifically, I use 34 variables that measure various socioeconomic and demographic characteristics for the affected counties/parishes. These variables are largely drawn from previous work in which a Social Vulnerability Index (SoVI) was developed to identify differing levels of social vulnerability at the county/parish level (Cutter, Boruff and Shirley 2003).[1]

In Table 2, I provide descriptive statistics for the predictor variables. Natural log transformations were used to normalize those variables with skewed distributions. I also rescale eleven variables so that positive values indicate higher levels of social vulnerability and negative values indicate lower levels of social vulnerability. For example, the inverse of per capita income was calculated in order to indicate higher social vulnerability in those counties/parishes where per capita income is low and lower social vulnerability in counties/parishes where per capita income is high. The method used to rescale variables is outlined in Table 3.

[1] For an in-depth discussion of the SoVI see Cutter, Boruff, and Shirley (2003).

Table 2. Descriptive Statistics

Independent Variables	Mean	Standard Deviation	Minimum	Maximum
Per capita Income (in dollars)	15444.03	2856.21	9709	24985
Median Dollar Value of Owner-Occupied Housing	63093.16	17361.48	39700	116000
Median Rent (in dollars)	297.74	96.12	125	614
# of Physicians per 1,000 population	1.31	1.29	0.10	6.74
ln Local Government Earnings	11.10	1.19	9.19	15.76
% African American	31.31	18.14	3.40	86.10
% 5 years and younger	7.87	2.10	4.40	15.40
% 65 years and older	12.56	2.94	5.60	24.90
% of Civilian Labor Force Unemployed	7.75	2.27	3.80	18.00
Average # of People per Household	2.65	0.13	2.30	3.10
% Households Earning more than $75,000	12.89	5.91	5.70	41.10
% Living in Poverty	19.58	5.92	7.00	37.90
% of Housing Units : Mobile Homes	22.06	8.74	0.30	42.40
% of Housing Units: Renter-Occupied	23.08	8.06	11.80	53.50
% 25 years or older w/o High School Diploma	28.56	6.63	15.70	46.70
ln # of Housing Units/mi²	3.32	0.24	2.75	3.84
ln # of New Private Housing Units/mi²	-0.23	0.68	-0.69	2.69
ln Earnings in all Industries	6.57	1.42	4.29	11.18
ln # of Commercial Establishments/mi²	0.10	1.28	-2.04	4.07
ln # of Manufacturing Establishments/mi²	-2.66	1.16	-5.02	1.80
% Population Participating in Labor Force	42.40	4.54	30.60	51.60
% Females Participating in Civilian Labor Force	46.31	2.45	39.10	54.10
% Employed in Primary Extractive Industries*	5.38	3.39	0.70	15.90
% Employed in Service Occupations	14.23	2.64	7.90	23.10
Per capita # of Community Hospitals	0.0001	0.0005	0	0.003
Per capita Residents in Nursing Homes	0.02	0.05	0	0.24
% Urban	39.79	30.76	0	99.30
% Female-Headed Households, no spouse present	15.24	4.27	7.50	29.40

(TABLE 2 CONTINUED)

Independent Variables	Mean	Standard Deviation	Minimum	Maximum
Per capita Social Security Recipients	0.18	0.05	0.07	0.38
% Population w/o Health Insurance	17.17	2.60	9.40	24.20
Net Migration Rate, 2000/2005	2.32	61.07	-134.34	250.13
% Population Change, 1980/1990	5.08	12.29	-10.90	72.10
% Population Change, 1990/2000	11.72	12.40	-15.00	61.20
% Change in Housing Units, 1990/2000	15.63	10.33	-4.60	52.70
Control Variables				
% Occupied Housing Units w/ Damage	29.69	21.85	0.40	90.20
Economic Dependence	0.63	0.48	0	1
Coastal County/Parish	0.16	0.37	0	1

*Agriculture, forestry, fishing and hunting, and mining

Table 3. Rescaled Variables

Variables	Rescaling Method
Per capita Income (in dollars)	Inverse
Median Dollar Value of Owner-Occupied Housing	Inverse
Median Rent (in dollars)	Inverse
# of Physicians/1,000 population	Inverse
Local Government Earnings	Inverse
% Households Earning more than $75,000	Inverse
Earnings in all Industries/mi²	Inverse
% Population Participating in Labor Force	Inverse
Per capita # of Community Hospitals	Inverse
# of Housing Units/mi²	Absolute Value
% Urban Population	Absolute Value

* The following variables were not rescaled: % African American; % 5 years and younger; % 65 years and older; % of Civilian Labor Force Unemployed; Average # of People/Household; % Living in Poverty; % of Housing Units: Mobile Homes; % of Housing Units: Renter-Occupied; % 25 years or older w/o High School Diploma;, # of New Private Housing Units per square mile; # of Commercial Establishments per square mile; # of Manufacturing Establishments per square mile; % Employed in Primary Extractive Industries; % Employed in Service Occupations; Per capita Residents in Nursing Homes; % Female-Headed Households, no spouse present; Per capita Social Security Recipients; % Population w/o Health Insurance, Net Migration Rate, 2000/2005; % Population Change, 1980/1990; % Population Change, 1990/2000; % Change in Housing Units, 1990/2000.

** Inverse = 1 / x

*** Absolute Value = | mean – x |

Additional Control Variables

Three additional control variables are also included in the analysis. The first control variable is the percentage of occupied housing units with damage within a county/parish.[2] I also include a dummy variable that identifies whether or not a county/parish is on the coast versus further inland. This variable is coded as 1 for coastal county/parish and 0 otherwise. These variables control for actual and potential direct impacts from the storms. Last, each county/parish is identified as being dependent upon one of five specific economic sectors (farming, mining, manufacturing, Federal/State government, or services) or having a more diversified economy. I coded this as 1 if a county/parish is identified as being economically dependent upon one of these sectors and 0 otherwise.[3] This control variable reflects dependence on a single economic sector, which would further add to social vulnerability.

Analytic Strategy

In the analysis that follows I will undertake an analytic approach developed by vulnerability researchers Cutter, Boruff, and Shirley (2003). While I employ many of the same procedures, I use a modified set of predictor variables. I use principal component factor analysis and variamax rotation to reduce the 34 predictor variables to a smaller set of underlying and independent factors. In comparison to Cutter, Boruff, and Shirley (2003), the smaller number of predictor variables entered into the factor analysis results in fewer factors being produced. Additionally, rather than rescaling entire factor scores so that positive values indicate higher levels of social vulnerability and negative values indicate lower levels of social vulnerability, I rescale the variables as appropriate prior to entering them into the factor analysis (see Table 3).

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[2] This variable was obtained through a report compiled by the Greater New Orleans Community Data Center (2006), which documented the extent of housing damage in the hurricane affected region.
[3] This information was collected from the economic typology codes provided by the Economic Research Service (ERS) of the U.S. Department of Agriculture. http://www.ers.usda.gov/briefing/rurality/typology/

In what follows, I use an additive model to provide a cumulative measure of social vulnerability in the impacted region. I then use Ordinary Least Squares (OLS) regression to examine the relationship between various dimensions of social vulnerability and population change, net of other controls. Throughout, I use the county/parish as the unit of analysis.

RESULTS

Table 4 presents the results of the factor analysis, which produced eight factors that explain 83.4 percent of the variance among the counties/parishes. I discuss each of these dimensions of social vulnerability below.

Affluence

The first factor explains 26.9 of the variance within the index. This factor identifies variables that measure income, wealth, and earnings, as well as variables that indicate the level of commercial and residential development. While this factor emphasizes variables that protect against vulnerability to disasters, such as wealth, it also demonstrates the potential for structural loss. Density of the built environment, for example, heightens potential for structural damage and loss. However, it should also be noted that after a disaster those in affluent communities are more likely to have access to the resources necessary to recover and rebuild (i.e. financial capital and insurance).

Disadvantaged Populations

The second factor represents social groups who experience social marginalization and disadvantage. Percent African Americans, percent living in poverty, percent females in the labor force, and percent female-headed households, explain 16.5 percent of the variation among all counties/parishes. In the wake of disaster, these groups stand to suffer disproportionate negative impacts.

Population Flux

The third factor loads with variables that identify a history population flux. The net migration rate for the previous 5 years, percent population change for the past 20 years, and percent change in housing units in the past decade load on this factor. This factor explains 11.6 of the variance.

Rapid population growth is often an indicator of community instability, which contributes to higher social vulnerability, while community stability lowers social vulnerability.

Elderly Population

The elderly are highlighted in the fourth factor. Both variables that measure elderly populations, percent of the population aged 65 and older and per capita social security recipients, load on this factor and explain 8.3 of the variance. The special circumstances of older populations increase their vulnerability to disasters.

Dependent Populations

Percent of the population 5 years and younger and per capita residents in nursing homes both load on the fifth factor. These populations rely upon others for their safety and well-being, making them particularly vulnerable to disaster. This factor explains 6.2 percent of the variance among all counties/parishes.

Extractive Industries

The sixth factor is represented by a single variable that measures the percent of the labor force employed in primary extractive industries: agriculture, forestry, hunting and fishing, and mining. This variable is important because it highlights industries that depend upon natural resources for their economic viability. Because disasters wreak havoc on the natural landscape, those who are employed in these occupations stand to experience great losses in the wake of a disaster. This factor explains 5.6 of the variance within the index.

Service Occupations

The seventh factor is represented by a single variable that measures percent of the labor force employed in service occupations. This factor explains 4.5 percent of the variance within the index. The service sector is well-known for a disproportionate share of low-wage, low-skill jobs, especially in areas that rely on tourism as a source of revenue. This is important to note because tourism is a thriving industry in the Gulf Coast region, with casinos, hotels, and related businesses being a central part of the economy in many communities (i.e. Biloxi, Mississippi, and New Orleans, Louisiana).

Rural-Urban

The eighth factor is represented by the variable that taps the importance of the rural-urban continuum. Due to denser populations, urban areas often experience significant displacement of people in the aftermath of a disaster. On the other hand, the spatial isolation experienced in rural areas also puts people at risk. Distance from the mean percent urban explains 3.9 of the total variance within the index.

Table 4. Social Vulnerability Index (SoVI) I

Factor	Name	Percent Variance Explained	Dominant Variable	Correlation
1	Affluence	26.9	# of Commercial Establishments	-.940
2	Disadvantaged Populations	16.5	% Female-Headed Households	+.908
3	Population Flux	11.6	% Population Change, 1990/2000	+.880
4	Elderly Population	8.3	% Population 65 years and older	+.863
5	Dependent Populations	6.2	% Population 5 years and younger	+.948
6	Extractive Industries	5.6	% Employed in Primary Extractive Industries	+.691
7	Service Occupations	4.5	% Employed in Service Occupations	+.880
8	Rural-Urban	3.9	% Urban Population*	+.927

*Rescaled as distance from mean percent urban.

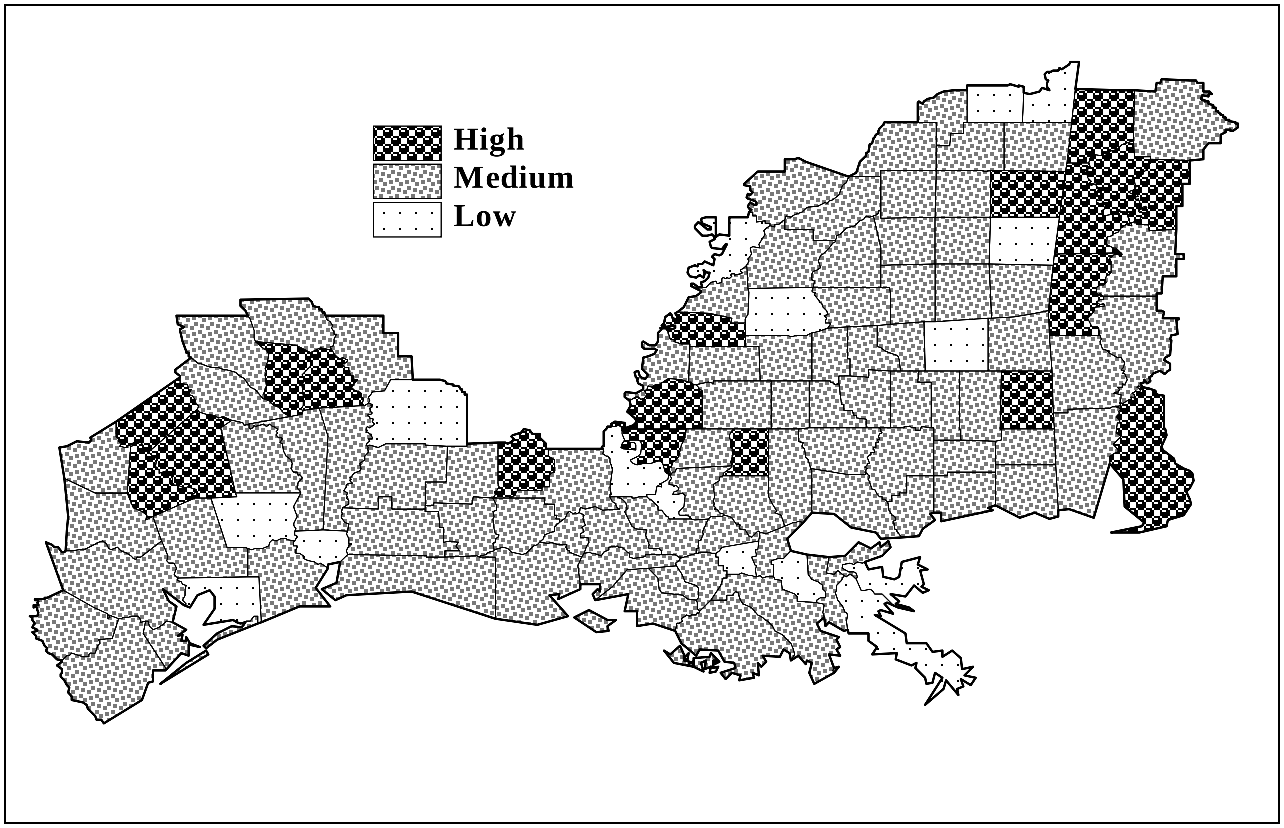

Figure 4. The Geography of Social Vulnerability for Counties/Parishes in the Impacted Region

The Geography of Social Vulnerability

I use the factor scores produced by the factor analysis to construct a cumulative model of overall social vulnerability at the county/parish level. Specifically, I sum across the rotated factor score to develop an over all Social Vulnerability Index (SoVI). Counties/parishes one standard deviation above the mean SoVI score are labeled with "high" social vulnerability, while those one standard deviation below the mean SoVI score are labeled with "low" social vulnerability. Those within one standard deviation of the mean SoVI score are labeled with "medium" social vulnerability. The geography of social vulnerability is illustrated in Figure 4.

Most counties/parishes (71 percent) demonstrate medium levels of social vulnerability. Yet, eighteen counties/parishes (15 percent) have high levels of social vulnerability and sixteen (14 percent) have low levels. The most socially vulnerable county/parish is Greene County, Alabama, with a SoVI score of 10.4. Greene County's population is 81 percent African American, 27 percent of all households are female-headed, and 34 percent of the population lives in poverty. The least socially vulnerable county/parish is Chambers County, Texas, with a SoVI score of -4.7. Only 10 percent of Chambers County's population is African American, 8 percent of households are female-headed, and 11 percent of the population lives in poverty.

Regression Analysis

I use OLS regression analysis to assess the relationship between various dimensions of social vulnerability and population change in the wake of a disaster. The eight rotated factor scores that resulted from the factor analysis, along with the three additional control variables, were regressed against the rate of population change (Model I). Due to the negative skewness of the dependent variable, I use a natural log transformation to correct for heteroscedasticity. I present the results of the regression analysis in Table 5.

Of the eight factor scores included in the regression analysis, only Factor 3, Population Flux, is significantly related to the rate of population change, and its relationship is negative. That is, places with a history of population change were significantly less likely to witness population change following the hurricanes. This is contrary to the expectations that areas with a history of population flux would be more vulnerable to disaster, and therefore be subject to greater population change in its wake. Not surprisingly, no other dimensions of social vulnerability are significantly related to the rate of population change. The model does show that coastal counties were significantly more likely to witness population change following the storms.

In order to address possible problems associated with using measures of population change before the storm as predictors of post-storm population change, I conducted a second factor analysis that excluded the four population flux variables (Factor Analysis II). While this factor analysis did not yield results identical to the initial one, it did produce a comparable factor structure. I present the results of the second factor analysis in Table 6. The seven factor-scores produced from the second factor analysis, as well as the additional control variables, were then regressed against the dependent variable (Model II). These results are shown in Table 7. This regression analysis shows Factor 3, Elderly Population, to be significantly and positively related to the rate of population change following the hurricanes. That is, those counties/parishes with larger elderly populations prior to the hurricanes were more likely to experience population change in the aftermath of the storms. This is consistent with the expectation that elderly populations are disproportionately vulnerable to disasters. Again, the control variable for coastal county/parish remains significant. No other variables were shown to be significant determinants of population change.

Table 5. OLS Regression Model I: Rate of Population Change, July 2005 – January 2006

Independent Variables	Unstandardized Coefficients
Factor 1:Affluence	0.011
	(0.069)
Factor 2: Disadvantaged Populations	0.011
	(0.067)
Factor 3: Population Flux	-0.179**
	(0.063)
Factor 4: Elderly Population	0.100
	(0.064)
Factor 5: Dependent Populations	0.004
	(0.065)
Factor 6: Extractive Industries	-0.051
	(0.064)
Factor 7: Service Occupations	0.054
	(0.063)
Factor 8: Rural-Urban	0.012
	(0.065)
Additional Control Variables	
% of Occupied Housing Units w/ Damage	0.001
	(0.003)
Economic Dependence	-0.119
	(0.136)
Coastal County/Parish	0.750***
	(0.212)
Constant	4.106***
Adjusted R^2	0.244

Note. Standard errors are reported in parentheses. p: † < .10; * <.05; ** <.01; *** < .001

Table 6. Social Vulnerability Index (SoVI) II

Factor	Name	Percent Variance Explained	Dominant Variable	Correlation
1	Affluence	27.5	# of Commercial Establishments/mi^2	-.916
2	Disadvantaged Populations	19.9	% Female-Headed Households	+.944
3	Elderly Population	10.4	% Population 65 years and older	+.857
4	Extractive Industries	7.6	% Employed in Primary Extractive Industries	+.760
5	Dependent Populations	6.9	% Population 5 years and younger	+.959
6	Service Occupations	5.0	% Employed in Service Occupations	+.875
7	Rural-Urban	4.6	% Urban Population	+.912

Table 7. OLS Regression Model II: Rate of Population Change, July 2005 – January 2006

Independent Variables	Unstandardized Coefficients
Factor 1: Affluence	0.018
	(0.070)
Factor 2: Disadvantaged Populations	0.066
	(0.067)
Factor 3: Elderly Population	0.132*
	(0.065)
Factor 4: Extractive Industries	-0.034
	(0.065)
Factor 5: Dependent Populations	0.001
	(0.067)
Factor 6: Service Occupations	0.070
	(0.064)
Factor 7: Rural-Urban	-0.004
	(0.066)
Additional Control Variables	
% of Occupied Housing Units w/ Damage	0.002
	(0.003)
Economic Dependence	-0.077
	(0.137)
Coastal County/Parish	0.821***
	(0.214)
Constant	4.041***
Adjusted R^2	0.205

Note. Standard errors are reported in parentheses. p: † < .10; * <.05; ** <.01; *** < .001

DISCUSSION

This research aimed to examine the relationship between social vulnerability and population change in the Gulf Coast Region following Hurricanes Katrina and Rita. I used factor analysis to identify the underlying dimensions of social vulnerability as indicated by the social and economic characteristics of counties/parishes in the impacted region. Using the resulting rotated factor scores, I then employed OLS regression to identify indicators of social vulnerability that were significantly related to population change.

The first regression model indicated that counties/parishes with a history of population flux were significantly less likely to witness population change following the storms. This finding is contrary to expectations. Previous research suggests that areas with a history of population flux are more vulnerable to disasters and their impacts. However, the results shown here suggest that in the case of population change following Hurricanes Katrina and Rita, exactly the opposite occurred.

Previous social vulnerability research examining Gulf Coast counties/parishes found elderly populations to be the most important dimension of social vulnerability (Boruff, Emrich, and Cutter 2005). The results presented here support this point. Specifically, I found that elderly populations were significantly and positively related to post-storm population change. The dependence of the elderly upon others for financial and social support causes this demographic group to be significantly more vulnerable to disasters.

Limitations

This research was limited in a number of important respects. First, the lack of current migration data for the Gulf Coast area is a key limitation of this study. Data provided by the Special Population Estimates program by the U.S. Census Bureau includes population numbers related to both natural increase and migration. The current data only allow for the inference of the demographic process of migration through the use of population change as the dependent variable. Additionally, it is important to note that social vulnerability may not vary greatly within counties/parishes. Therefore, the use of counties/parishes as the unit of analysis may be masking much intra-category diversity. Finally, the time frame allowed by the current data may not reflect a complete picture of population redistribution and its relationship with social vulnerability. It may simply be that in the immediate wake of the storms all were impacted by the storms, regardless of social vulnerability. This, however, does not rule out the likely possibility that social vulnerability will influence long-term changes.

Implications

Future research should employ better data as it becomes available. Further, future research should consider how the relationship between social vulnerability and population change differs across demographic and social sub-groups. In sum, more nuanced analyses of the relationship between social vulnerability and population change in the wake of disaster are called for.

The SoVI is an important diagnostic tool for policymakers interested in identifying the social and economic characteristics that place communities at disproportionate risk to disasters. When preparing for and recovering from disasters, special provisions should be made for areas that are more socially vulnerable. By legislating recovery programs and aid packages that give special consideration to these at-risk populations, policymakers can avoid having a natural disaster become a social disaster.

REFERENCES

Bates, Diane C. 2002. “Environmental Refugees?: Classifying Human Migrations Caused by Environmental Change.” *Population and Environment* 23:465-77.

Belcher, John C. and Frederick L. Bates. 1983. “Aftermath of Natural Disasters: Coping Through Residential Mobility.” *Disasters* 7:118-27.

Bolin, Robert. 1986. “Disaster Impact and Recovery: A Comparison of Black and White Victims.” *International Journal of Mass Emergencies and Disaster 35-50.*

Bolin, Robert. 1998. *The Northridge Earthquake: Vulnerability and Disaster*. London: Routledge.

Bolin, Bob. 2006. “Race, Class, Ethnicity, and Disaster Vulnerability.” Pp. 113-129 in *Handbook of Disaster Research* edited by Havidan Rodriguez, Enrico L. Quarantelli, And Russell R. Dynes. New York: Springer Press.

Browning, Christopher R., Danielle Wallace, Seth L. Feinberg, and Kathleen A. Cagney. 2006. “Neighborhood Social Processes, Physical Conditions, and Disaster-Related Mortality: The Case of the 1995 Chicago Heat Wave.” *American Sociological Review* 71(4): 661-678.

Burton, Ian, Robert W. Kates, and Gilbert F. White. 1993. *The Environment as Hazard.* New York: Guilford.

Cutter, Susan L. 1996. “Vulnerability to Environmental Hazards.” *Progress in Human Geography* 20:529-39.

Cutter, Susan L., Bryan J. Boruff, and W. Lynn Shirley. 2003. “Social Vulnerability to Environmental Hazards.” *Social Science Quarterly* 84:242-61.

Cutter, Susan L., Jerry T. Mitchell, and Michael S. Scott. 2000. “Revealing the Vulnerability of People and Places: A Case Study of Georgetown County, South Carolina.” *Annals of the Association of American Geographers* 90:713-37.

Dynes, Russell R. and Thomas E. Drabek. 1994. “The Structure of Disaster Research: Its Policy and Interdisciplinary Implications.” *International Journal of Mass Emergencies and Disasters* 12:5-23.

Enarson, Elaine. 1998. “Through Women’s Eyes: A Gendered Research Agenda for Disaster Social Science.” *Disasters* 22:157:73.

Enarson, Elaine, Alice Fothergill, and Lori Peek. 2006. “Gender and Disaster: Foundations and Directions.” Pp. 130-146 in *Handbook of Disaster Research* edited by Havidan Rodriguez, Enrico L. Quarantelli, and Russell R. Dynes. New York: Springer Press.

Fordham. Maureen H. 1999. “The Intersection of Gender and Social Class in Disaster: Balancing Resilience and Vulnerability.” *International Journal of Mass Emergencies and Disasters* 17:15-36.

Fothergill, Alice. 1996. “Gender, Risk, and Disaster.” *International Journal of Mass Emergencies and Disasters* 14:33-56.

Fothergill, Alice and Lori A. Peek. 2004. “Poverty and Disasters in the United States: A Review of Recent Sociological Findings.” *Natural Hazards* 32:89-110.

Freudenburg, William R. 1992. “Addictive Economies: Extractive Industries and Vulnerable Localities in a Changing World Economy.” *Rural Sociology* 57(3):305-332.

Geipel, Robert. 1982. *Disaster and Reconstruction.* London: George Allen & Unwin.

Gramling, Robert and William R. Freudenburg. 1990. “A Closer Look at “Local Control”: Communities, Commodities, and the Collapse of the Coast.” *Rural Sociology* 55(4): 541-558.

Greater New Orleans Community Data Center. 2006. *Current Housing Units Damage Estimates: Hurricanes Katrina, Rita, and Wilma.* Retrieved on February 1, 2007 from http://www.gnocdc.org/reports/Katrina_Rita_Wilma_Damage_2_12_06___revised.pdf.

Haas, Eugene, Robert W. Kates, and Martyn J. Bowden. 1977. *Reconstruction Following Disaster*. Cambridge MA: MIT Press.

Hewitt, Kenneth. 1998. “Excluded Perspectives in the Social Construction of Disaster.” Pp. 75-91 in *What is a Disaster?: Perspectives on the Question* edited by E.L. Quarantelli. London: Routledge.

Hunter, Lori M. 2005. “Migration and Environmental Hazards.” *Population and Environment* 26:273-302.

Hutton, David and C. Emdad Haque. 2004. “Human Vulnerability, Dislocation and Resettlement: Adaptation Processes of River-bank Erosion-induced Displacees in Bangladesh.” *Disasters* 28:41-62.

Klinenberg, Eric. 2002. *Heat Wave: A Social Autopsy of Disaster in Chicago.* Chicago: The University of Chicago Press.

Kreps, Gary A. 1984. “Sociological Inquiry and Disaster Research.” *Annual Review of Sociology* 10:309-30.

Kreps, Gary A. 1995. “Disaster as Systemic Event and Social Catalyst: A Clarification of Subject Matter.” *International Journal of Mass Emergencies and Disasters* 13:255-84.

McGuire, Bill, Ian Mason, and Christopher Kilburn. 2002. *Natural Hazards and Environmental Change*. New York: Oxford University Press.

Morrow-Jones, Hazel A. and Charles R. Morrow-Jones. 1991. "Mobility Due to Natural Disaster: Theoretical Considerations and Preliminary Analyses." *Disasters* 15:126-32.

Oliver-Smith, Anthony. 1996. "Anthropological Research on Hazards and Disasters." *Annual Review of Anthropology* 25:303-28.

Oliver-Smith, Anthony and Susanna Hoffman. 1999. *The Angry Earth: Disaster in Anthropological Perspective*. New York: Routledge.

Peacock, Walter G. and Chris Girard. 1997. "Ethnic and Racial Inequalities in Hurricane Damage and Insurance Settlements." Pp. 171-90 in *Hurricane Andrew: Ethnicity, Gender, and the Sociology of Disasters* edited by Walter G. Peacock, Betty H. Morrow, and H. Gladwin. New York: Routledge.

Perry, Ronald and E.L. Quarantelli. 2005. *What is a Disaster? New Answers to Old Questions*. Xlibris Corporation.

Petersen, William. 1958. "A General Typology of Migration." *American Sociological Review* 23:256-66.

Picou, Steven J., Brent K. Marshall, and Duane A. Gill. 2004. "Disaster, Litigation, and Corrosive Community." *Social Forces* 82:1493-1522.

Quarantelli, E.L. 1987. "What Should We Study? Questions and Suggestions for Researchers about the Concept of Disasters." *International Journal of Mass Emergencies and Disasters* 5:7-32.

Quarantelli, E.L. 1989. "Conceptualizing Disasters from a Sociological Perspective." *International Journal of Mass Emergencies and Disasters* 7:243-51.

Quarantelli, E.L. 1993. "Community Crises: An Exploratory Comparison of the Characteristics and Consequences of Disasters and Riots." *Journal of Contingencies and Crisis Management* 1:67-78.

Quarantelli, E.L. 1998. *What is a Disaster? Perspectives on the Question*. London: Routledge.

Quarantelli, E.L. 2000. "Disaster Research." Pp. 681-88 in *Encyclopedia of Sociology*, Edited by E.F. Borgatta and Rhonda J. V. Montgomery. New York: MacMillan.

Quarantelli, E.L. and Russell R. Dynes. 1977. "Response to Social Crisis and Disaster." *Annual Review of Sociology* 3:23-49.

Sachs, Caroline. 2007. “Going Public: Networking Globally and Locally.” *Rural Sociology* 72 (1):2-24.

Shrivastava, Paul. 1987. “A Cultural Analysis of Conflict in Industrial Disaster.” *International Journal of Mass Emergencies and Disasters*. 5:243-64.

Smith, Keith. 1992. *Environmental Hazards: Assessing Risk and Reducing Disaster*. London: Routledge.

Tierney, Kathleen. 2006. “Social Inequality, Hazards, and Disasters.” Pp. 109-127 in *On Risk and Disaster* edited by Ronald J. Daniels, Donald F. Kettl, and Howard Kunreuther. Philadelphia: University of Pennsylvania Press.

U.S. Census Bureau. 2006. *Special Population Estimates for Impacted Counties in the Gulf Coast Area.* Retrieved on December 1, 2006 from http://www.census.gov/PressRelease/www/emergencies/impacted_gulf_estimates.html.

U.S. Department of Agriculture: Economic Research Service. 2006. *Measuring Rurality: 2004 Typology Codes.* Retrieved on December 1, 2006 from http://www.ers.usda.gov/briefing/rurality/typology/.

Wisner, Ben and Henry R. Luce. 1993. “Disaster Vulnerability: Scale, Power, and Daily Life.” *Geojournal* 30:127-40.

Wisner, Ben, Piers Blaikie, Terry Cannon, and Ian Davis. 2004. *At Risk: Natural Hazards, People’s Vulnerability and Disasters*. London: Routledge.

Wolpert, Julian. 1966. “Migration as an Adjustment to Environmental Stress.” *Journal of Social Issues* 22:92-102.

Zaman, Mohammad Q. 2002. “Vulnerability, Disaster, and Survival in Bangladesh: Three Case Studies.” Pp. 192-210 in *The Angry Earth: Disaster in Anthropological Perspective* edited by Anthony Oliver-Smith and Susanna Hoffman. New York: Routledge.

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