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Distribution of impacts of natural disasters across income groups: A case study of New Orleans

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ABSTRACT

This paper explores elements of vulnerability to natural disasters in the context of Hurricane Katrina. We examine whether neighborhoods in New Orleans were impacted differently by Hurricane Katrina based on pre-existing social, physical and economic vulnerabilities. We evaluate the degree to which the initial impacts of Hurricane Katrina were distributed among the New Orleans' residents. Geographic Information System (GIS) technology was used to perform analyses using household income, housing values, and elevation and flood levels. Next, we investigate whether particular socio-economic groups in the city were more vulnerable during the response and recovery phases.

Findings indicate that Hurricane Katrina caused severe flood damages in the majority of New Orleans neighborhoods, regardless of income, elevation and other social factors. However, findings do suggest that pre-existing socio-economic conditions play a significant role in the ability for particular economic classes to respond immediately to the disaster and to cope with the aftermath of Hurricane Katrina. The paper concludes with policy recommendations to reduce social and economic vulnerabilities to natural disasters, as well as suggestions for future research.

1. Introduction

Natural disasters are becoming more frequent, expensive and threatening worldwide. The global economic cost associated with natural disasters has increased 14-fold since the 1950s (Guha-Sapir et al., 2004). The impacts of natural disasters are unevenly distributed among nations, regions, communities and individuals as a result of differential exposures and vulnerabilities (Clark et al., 1998).

During the last decade disasters caused an estimated average of US$67 billion/year in damage, with a maximum of US$230 billion and a minimum of US$28 billion worldwide. According to May and Deyle (1998), natural disasters in the United States cause, on average, US$20 billion annually in direct costs to government, the insurance industry, and victims; these costs are continuing to escalate. The United States (US) is seeing the costs of natural disasters increase because people have been migrating towards the coasts, which are more at risk to be hit by natural disasters, and the value of people's possessions has increased (Board on Natural Disasters, 1999).

Increased human and economic costs are associated with an increase in frequency of natural disasters and associated damages in the United States. This is part of a worldwide

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trend, which reflects changing climate patterns. Analysis of hurricane characteristics in the North Atlantic has shown an increase in hurricane frequency and intensity since 1995 (Goldenberg et al., 2001; Elsner and Kocher, 2000; Webster et al., 2005; Emanuel, 2005). During the hurricane season of 2004, there were fourteen named storms in the North Atlantic, nine of which achieved hurricane intensity. Four of these hurricanes struck the southeast United States, causing considerable damage and disruption (Webster et al., 2005). During the 2005 hurricane season there were twenty-seven named storms, thirteen of which reached hurricane status; this set new records for both the number of named storms and the number of hurricanes (Pastor et al., 2006). The recent event of Hurricane Katrina was among the deadliest natural disasters in recent US history with more than 1000 fatalities. Much of the damage caused by Katrina is attributed to the flooding that occurred in the City of New Orleans in the days following the hurricane.

Understanding the distributional impacts of natural disasters across income groups in a given city or community is critical for planning, mitigation and recovery from natural disasters. Although there has been some refocusing of policy in the last 15 years, from relief assistance to an emphasis on mitigation (Changnon and Easterling, 2000), the overall trend in disaster management has been to invest in natural disaster response (Board on Natural Disasters, 1999), rather than on mitigating pre-existing social vulnerabilities. While response and recovery have been the main strategies for many countries, including the US, and are critically important for humanitarian, economic and political purposes, they must be accompanied by increasing attention to reducing losses through effective mitigation programs (National Research Council, 1997). Therefore, improving mitigation and preparedness for natural disasters requires knowledge of how and why certain groups are vulnerable.

The objective of the paper is to understand and assess the distribution of the impacts of Hurricane Katrina across income groups in New Orleans and the socio-economic factors that contribute to vulnerability. Specifically, we investigate the vulnerability of different socio-economic groups during: 1) the hurricane event and subsequent flooding; and 2) the response and recovery phases. Response to natural disaster "includes both the short-term emergency actions taken by police, fire, and other agencies as well as the longer-term actions taken to meet needs for food, shelter, rebuilding and restoration of the affected community" (Board on Natural Disasters, 1999, P. 1944). In this paper we refer to the long-term actions of rebuilding as the recovery phase.

2. Vulnerability to natural disasters

Vulnerability in the context of natural disasters is the capacity to anticipate, cope with, resist, and recover from the impact of a natural disaster (Adger, 1999). High levels of vulnerability and low adaptive capacity have been linked to a range of factors that include access and distribution of resources, technology, information, and wealth; risk perceptions; social capital and community structure; and the existing formalized institutional framework which organize warning, planning and other services (Dolan and Walker, 2003). When a disaster hits, some individuals are less affected, or may even benefit, while other individuals may suffer significant or even catastrophic losses depending on where they have settled. Cutter et al. (2000) noted that while economic losses might be large in areas of high biophysical risk, the resident population may also have greater safety nets such as insurance and additional financial resources to absorb and recover from the loss quickly. Thus, vulnerability to natural disasters is a combined function of exposure (risk of experiencing a disaster event) and the ability to cope.

Although the highest magnitude of economic damage is often born by wealthier populations, due to possessions of higher value, the relative impact is generally greater for low-income groups. For people who cannot afford the costs of repair, reconstruction, or relocation, it may take years to recover from the aftermath of disasters. In addition, the effects of a disaster may persist to the next generation because of a lack of resources to recover (Adger, 1996). By focusing on magnitude, traditional risk assessment fails to account for the higher relative burden born by low income populations.

A recent review of studies on the relationship between poverty and disasters in the US by Fothergill and Peek (2004) revealed that socio-economic status is a significant predictor of the physical and the psychological impacts in the pre- and post-disaster stages. According to these studies, the poor are more likely to die, suffer from injuries, have proportionately higher material losses; have more psychological trauma; and face more obstacles during the phases of response, recovery, and reconstruction.

Watts and Bohle (1993), Blaikie et al. (1994), Kelly and Adger (2000) argue that people's vulnerability to natural hazards is determined not so much by the event itself, but rather is a function of social conditions and historical circumstances. Thus, protection from the social forces that create inequitable exposure to risk becomes just as important, if not more so, than protection from natural hazards (Hewitt, 1983).

The ability to respond to and cope with the impacts of natural disaster is a function of socio-economic as well as biophysical factors. Table 1 summarizes the social and economic characteristics that influence human vulnerability at both individual and community levels.

Lack of access to economic or human resources or knowledge can limit the ability of some socio-economic groups to respond adequately to a disaster. Groups who traditionally experience low socio-economic status include minorities, woman-headed households, the elderly, the unemployed, the illiterate or uneducated, the ill or handicapped. In addition, racial and ethnic minorities may be excluded from lines of communication and action due to cultural or language barriers.

Housing status, whether renting or owning property, can also limit an individual's ability to respond to natural disaster. According to Bullard and Wright (2005) home ownership is a cushion against inflation, the cornerstone of economic wealth creation, and a long-term asset that can secure advantages and transfer across generations of material wealth and security. Home ownership is a critical pathway for "transformative" assets, inherited wealth that lifts a family beyond their own achievement. Low-income households tend to rent rather than own their homes. In addition, the type and quality of housing affect the potential for damage. Low-income residents tend to occupy mobile homes and poorly constructed or maintained

Table 1 – Population characteristics influencing social vulnerability. Source: Cutter et al. (2001)

Population characteristics	Description	Increases (+) or decreases (–) social vulnerability
Socio-economic status (income, political power, prestige)	Wealth enables individuals to absorb and recover from losses more quickly using insurance, social safety nets, and entitlement programs.	High status (+/–) Low income or status (+)
Gender	Women often have a more difficult time during recovery than men because of lower wages and family care responsibilities.	Gender (+)
Race and ethnicity	These factors impose language and cultural barriers and affect access to post-disaster funding and occupation of high-hazard areas.	Non-white (+) Non-Anglo (+)
Age	Extremes of age affect the movement out of harm's way. The elderly may have mobility constraints or concerns that increase the burden of care and lack of resilience.	Elderly (+) Children (+)
Residential property	The value, quality, and density of residential construction affect potential losses and recovery. Expensive homes on the coast are costly to replace; mobile homes are easily destroyed and less resilient to hazards.	Mobile homes (+)
Renters	People rent because they are transients, do not have the financial resources for homeownership, or do not want the responsibility of homeownership. They often lack access to information about financial aid during recovery. In extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or too costly to afford.	Renters (+)
Education	Education is linked to socio-economic status in that higher educational attainment affects lifetime earnings, and limited education constrains the ability to understand warning information and access recovery information.	Little education (+) Highly educated (–)
Health status	The public health literature shows that people with preexisting illnesses may be at risk for death/illness/injury in disaster setting. Additionally lack of access to adequate health or health insurance would increase vulnerability to natural disasters.	Major health problems (+) Minor or no health problems (–)
Social dependence	People who are totally dependent on social services for survival are already economically and socially marginalized and require additional support in the post-disaster period.	High dependence (+) Low dependence (–)
Special-needs populations	Special-needs populations (infirm, institutionalized, transient, and homeless) are difficult to identify, let alone measure and monitor. Yet it is this segment of society that invariably is left out of recovery efforts, largely because of this invisibility in communities.	Large number of special needs (+) Small number of special needs (–)

stick-built homes, which are easily destroyed or damaged in the event of a natural disaster (Pastor et al., 2006).

As a result of the combination of these factors, low-income households and communities are more vulnerable to natural disasters than wealthier ones; they tend to live in more hazardous places, have less protection, and have fewer reserves, insurance, and alternatives. People living in poverty or with inadequate resources may be less likely to perform necessary actions to mitigate the effects of hazardous agents because of a lack of a sense of personal control over potential outcomes (Vaughan, 1995). Community-level factors, such as urban versus rural setting, infrastructure, medical services, and available social services also affect hazard vulnerability (Cutter et al., 2001).

3. Inequality in New Orleans

New Orleans, (2002 population 484,674) is a major port and the largest city in the *State* of *Louisiana*. New Orleans is situated between the Mississippi River to the south and Lake Pontchartrain to the north. Prior to Hurricane Katrina, New Orleans was characterized by high poverty rates and low-wage jobs (Gault et al., 2005). New Orleans was one of the nation's poorest cities, with a poverty rate more than twice the national average (Center for Progressive Reform, 2005).

The City of New Orleans was built on the lowest elevation in the state of Louisiana, and is one of the lowest points in the US (Leatherman and Burkett, 2002). The oldest parts of the city were built close to levees along the shores of the Mississippi, but as the city expanded, lower elevation neighborhoods were settled. Much of the city is located between .3 and 3 m below *sea level* and is protected by a series of levees. Because much of New Orleans is located below sea level and lacks natural drainage, the city is geographically predisposed to severe flooding from the Mississippi River, coastal storms, and heavy precipitation (Carter, 2005).

A combination of factors such as the gradual loss of elevation within the city due to high rates of subsidence in surrounding wetlands, and accelerated sea level rise, have further increased the vulnerability of New Orleans to flooding. Since 1940, approximately 1 million acres of coastal wetlands have been converted to open water in southern Louisiana as a result of natural and human-induced environmental change (Burkett, 2001). The wetlands and protective barrier islands that would dampen storm surges and waves during hurricanes have been lost, therefore increasing the risk of flood disaster in New Orleans and the surrounding area (Burkett et al., 2003). During the last century several hurricanes and tropical storms (1947 Hurricane, Hurricane Betsy in 1965, Hurricane Camille in 1969, and Katrina in 2005) have struck New Orleans.

Prior to Hurricane Katrina, the city of New Orleans had a higher percentage of minorities and lower income households compared to the state and national average. Minorities made up 72% of the population in New Orleans, compared to the state average of 36.1% and there were a total of 180,382 households in New Orleans, with an average household size of 2.46 people. The median household income ($31,369) and per capita income ($19,711) in New Orleans were all below the national averages of $44,684 and $24,020, respectively (US Census Bureau, American Community Survey, 2004). Moreover, the distribution of income is skewed with about 22% earning less than $10,000/year while only 2% earn $200,000 and more, placing a large percentage of the population in New Orleans below the poverty line (Fig. 1).

This relatively high poverty rate can be further examined as to reveal that poverty is concentrated among certain groups in society. Thirty-eight percent of children younger than 18 were below the poverty level, and 25.9% of women were living in poverty, compared to the state average of 30% of children under 18 and 40% of women living in poverty. Twenty percent of people 65 years old and older were living below the poverty level, but the percentage of women in this age group who were living in poverty was 24.3% (US Census Bureau, American Community Survey, 2004). Eighty four percent of New Orleans residents living in poverty were African–American. Thus, many New Orleans residents faced multiple layers of vulnerabilities based on age, race, or gender, as well as income.

As of 2004, there were a total of 212,781 housing units in New Orleans, 180,382 of which were occupied. Single-unit structures accounted for 62% of the total housing stock. Thirty-seven percent were in multi-unit structures, and less than 0.5% were mobile homes (US Census Bureau, American Community Survey, 2004). New Orleans is highly segregated by income level, and the rate of homeownership in the city was low (46.8%; Table 2). Homeownership is generally believed to create a strong local tax base, increase neighborhood stability, and contribute to individual and household pride and economic stability (Lauria, 1998).

Table 2 – Housing characteristics in New Orleans

	Estimate	Percent	US
Total housing units	212,781		
Occupied housing units	180,382	84.8	89.60%
Owner-occupied housing units	84,472	46.8	67.10%
Renter-occupied housing unit	95,910	53.2	32.90%
Vacant housing units	32,399	15.2	10.40%

Housing prices in the New Orleans area have risen over the past several years, as in much of the country. Between 2004 and 2005, the average sales price for a single-family home jumped 11%, from $174,729 to $194,044. The recent housing boom generated several thousand jobs in the real estate market, and these jobs have relatively high wages. The drawback of this housing boom is that it puts homeownership out of the reach of many New Orleans residents. Median housing values were greatest along the river and lake shores, where residents tended to have higher incomes.

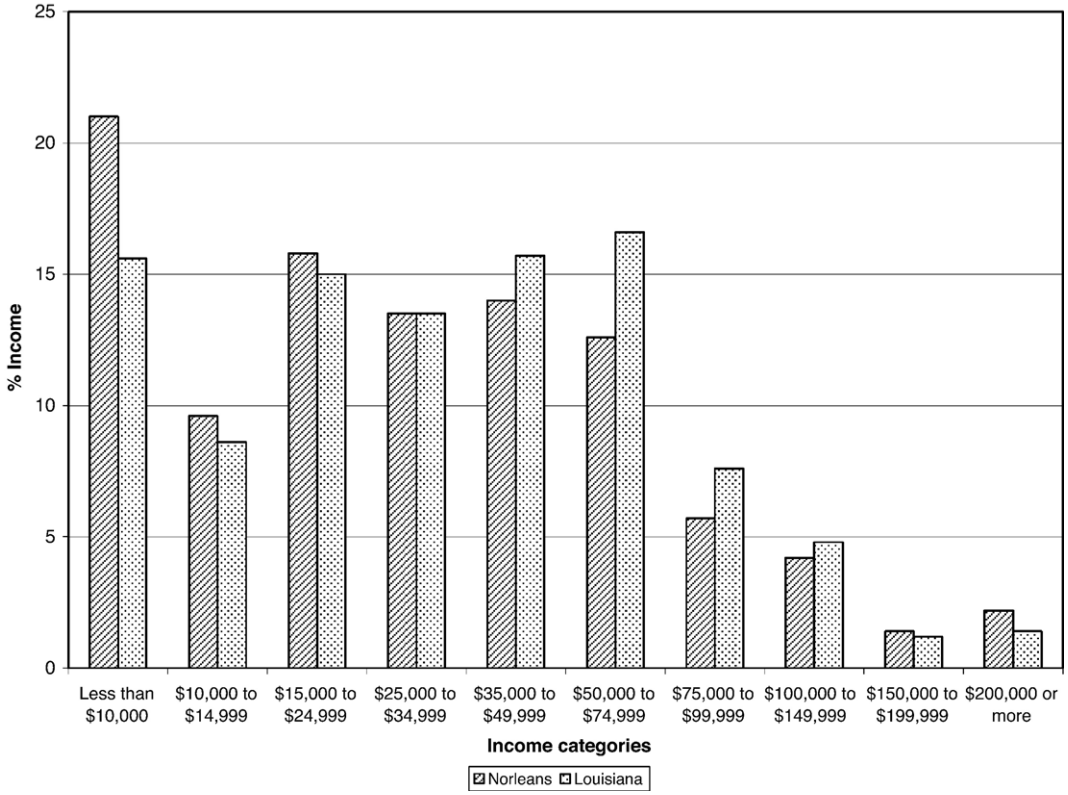

Fig. 1 – Income distribution in New Orleans and Louisiana (US Census Bureau, 2000).

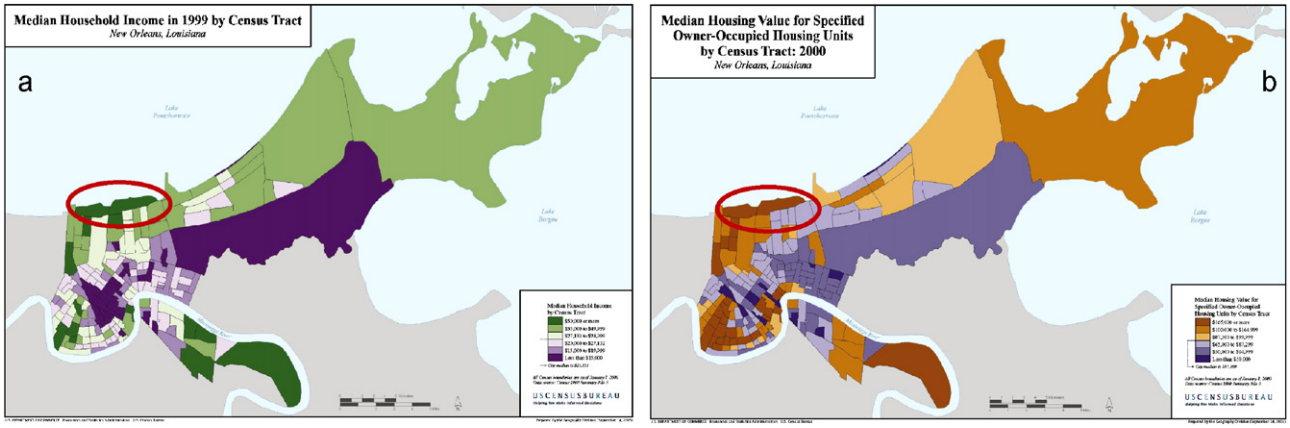

Fig. 2 – Spatial distribution of population in New Orleans by median household income by census tract (a), median housing value (b). neighborhoods circled in red are Lake Vista and Lake Terrace.

Initial analysis of income distribution in the city indicates that there was a wide variance in income among the city's neighborhoods (Fig. 2).

4. Distribution of impacts of Hurricane Katrina across income groups in New Orleans

Hurricane Katrina impacted an estimated 90,000 square miles along the Gulf Coast and displaced 400,000 individuals (FEMA, 2005). The extent of human tragedy caused by Hurricane Katrina has raised many questions of how impacts of the hurricane were distributed across income groups in New Orleans. Media reports in the wake of Hurricane Katrina focused on those left stranded in the city, and contributed to the impression that the poor and blacks suffered disproportionately when the hurricane hit.

To understand the distribution of impacts of Hurricane Katrina across income groups in New Orleans, we used data on elevation, flood levels, median household income and median housing value for each census block group in the city. Household income and housing value were used as proxies for socio-economic status, and flood level and elevation were thought to be good indicators of impact, given that most of the damage to the city was caused by flooding. We assessed the correlation between mean elevation and median housing value in each census block group. We found no statistically significant correlation between elevation and housing value. Furthermore, results of the analysis between flood levels and median household income indicate low-income communities in the city did not experience more flooding than higher income communities.[1] Thus, the analyses show that Hurricane Katrina caused severe flood damages in the majority of New Orleans neighborhoods, regardless of income, elevation and other social factors.

However, a recent report by Logan (2006) that looked at the level of damages indicates that the poor may have suffered higher levels of damage. According to Logan's report, a higher percentage of poor people lived in areas that sustained higher levels of damage, than in areas that experienced limited or no damage. Overall, 73% of New Orleans' total population lived in areas that experienced moderate damage or worse, according to FEMA classification. In areas of New Orleans that experienced moderate damage or worse, 29.2% of the population was poor; in the areas of the city that were undamaged or only had limited damage, 24.7% of the population was poor (Logan, 2006).

4.1. *Ability to respond: transportation*

While our analyses show that low-income residents were not more likely to be harder hit by the physical event of Hurricane Katrina, there is evidence to suggest that they were disadvantaged during the response phase due to lack of transportation.

Transportation is a major component in any emergency preparedness and evacuation plan. Unequal access to transportation alternatives in natural disasters increases the vulnerability of the poor, elderly, and disabled people. One of the factors that increased the vulnerability of lower income groups in New Orleans was the lack of access to transportation to evacuate the city as Hurricane Katrina approached. As of 2004, 1 in 5 New Orleans households did not have access to a car, truck, or van for private use. However, twenty-eight percent of households had two vehicles and another 6% had three or more (US Census Bureau, American Community Survey, 2004).

As illustrated in Fig. 3, we found a positive correlation between the percentage of residents living below the poverty level and the percentage of residents who did not own a vehicle for neighborhoods in New Orleans. Thus, there was a wide variance in households' ability to appropriately respond to the hurricane, with those in poverty lacking the resources needed to evacuate. Lack of adequate transportation explains, in part, why more than 20,000–30,000 residents were stranded in the Superdome (Center for Progressive Reform, 2005).

Our findings, which suggest that low-income neighborhoods were more vulnerable during the response phase, are consistent with previous research. A study done by Gladwin and Peacock (1997) reported people with lower incomes are less able and less likely to evacuate in the case of a natural

[1] GIS layers were flood levels on September 2nd, 2005 in New Orleans. Data courtesy of U.S. Geological Survey and Dartmouth Flood Observatory.

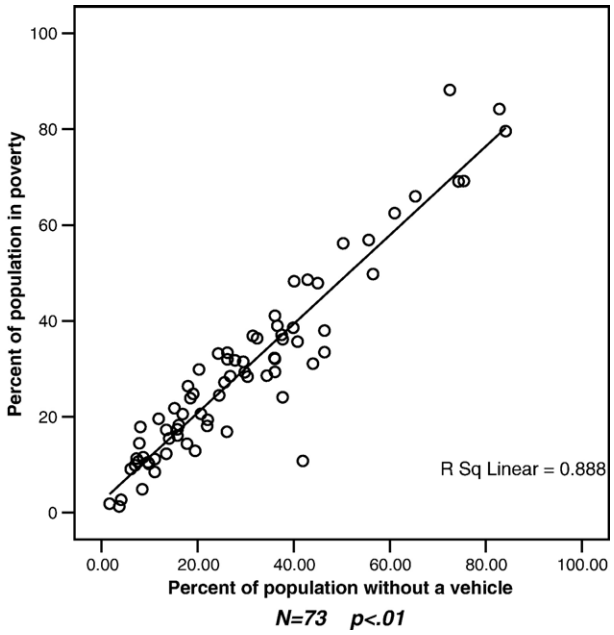

Fig. 3 – Relationship between percent of population in poverty and percent of population without a vehicle for neighborhoods in New Orleans. $N=73$ $p<.01$.

disaster, due to a lack of transportation. Morrow and Enarson (1996) found that poor women are generally unable to evacuate when a disaster hits because they lack economic resources for supplies and transportation.

4.2. *Recovery*

Disaster scholars have documented that socio-economic status plays an important role during the recovery period. In addition to income, savings, employment, access to communication channels and information, insurance influences whether a household will be able to recover from a natural disaster (Hewitt, 1983; Peacock et al., 1997). Using data from the US Department of Housing and Urban Development, we measured the correlation between the percentage of households who had flood insurance and were flooded with the percentage of people living in poverty in the city planning districts of New Orleans. We found a negative correlation between poverty and flood insurance (Pearson's correlation coefficient = −0.55497 and p value < 0.05). This suggests that city planning districts that had a high percentage of poverty also had a low percentage of flood insurance coverage.

Another factor that influences the recovery process is the ease with which certain groups are able to negotiate bureaucratic systems. Fothergill (2004) found that middle and higher income disaster victims were more comfortable than low income groups in negotiating disaster recovery bureaucracy for assistance. According to a recent report by Eaton and Nixon (2005) the Small Business Administration, which runs the federal government's main disaster recovery program for both businesses and homeowners, has processed only a third of the 276,000 home loan applications it has received. Eighty-two percent of applicants were rejected because they did not have incomes high enough or credit ratings good enough to qualify. This situation has been documented in similar situations by Fothergill (2004) who found that some low income families were denied SBA loans because their household income was too low.

5. Conclusion and policy implications

Findings suggest that Hurricane Katrina caused severe flooding in the majority of New Orleans neighborhoods, regardless of income, elevation and other social factors. However, our study does indicate that lower income groups were more vulnerable to Hurricane Katrina during the response and recovery phases. To minimize the impact on this population, disaster management policy should focus on mitigating socio-economic conditions that make certain groups more vulnerable.

The catastrophic disaster of Hurricane Katrina has demonstrated the vulnerability of low-income groups in the city of New Orleans. Pre-existing socio-economic conditions were not predictors of flood damage, but they played an important role in the response and recovery phases. Those with the fewest resources and the least mobility suffered disproportionately in the aftermath of Hurricane Katrina.

This devastation should serve as a catalyst for the city of New Orleans, the state of Louisiana and FEMA to modify how they plan for pre- and post-disasters. In addition it should encourage the city to address the physical, social, and economic factors that caused some groups to be much more vulnerable than others. While assisting current victims to get through their hardships is necessary and appropriate in the short-term, emphasis should also be on reducing vulnerabilities of future generations to such disasters. To support their long-term economic recovery, lower income groups must have access to reconstruction jobs, investment funds, and housing in safe locations and more importantly support from FEMA and the SBA.

The trend in the aftermath of Hurricane Katrina has been to rebuild New Orleans back to what it was before the storm. However, the following aspects should be considered by the local and federal authorities when planning to rebuild New Orleans to reduce the vulnerability of the poor.

5.1. *Promote a just distribution of wealth through living wage jobs*

Arguably, the most important factor in determining vulnerability to natural disasters is wealth. Wealth dictates what kind of housing, transportation, health care, and property insurance families can afford. New Orleans, and many other US cities have entrenched poverty that persists in communities generation after generation. In order to break this cycle of poverty, individuals must have access to jobs that pay workers a living wage. These jobs have been scarce in New Orleans, where the economy is dominated by the service sector. As of 2004, 44% of working age Americans living below the poverty line held a full-time or part-time job (Gault et al., 2005). Efforts at reducing individual's vulnerability to future natural disasters must address the low-wages of many of the city's workers.

This effort at raising wages can start during the reconstruction phase, by giving reconstruction contracts to firms

committed to paying workers a living wage. Days after the hurricane hit, the President repealed the Davis–Bacon Act in areas affected by Katrina. This law required that contractors working on federal contracts pay their workers prevailing wages for the area. Adhering to the Act would have required contractors to pay workers involved in rebuilding roughly $9/h (Edsall, 2005). The justification for this action was that more jobs would be created if the wage floor was removed. However, New Orleans residents do not need more low-wage jobs. To support the long-term economic recovery of lower income groups, the government must promote living wage jobs, not act to remove worker protections already in place.

If New Orleans is going to address poverty within the city, its efforts must not be hindered at the state or national level. New Orleans was one of the first cities in the country to pass a living wage ordinance, through a city ordinance passed in February 2002. The ordinance, which was supported by 65% of the voters in the city, would have raised the wages of 50,000 workers in the city (Pollin et al., 2005). But the State Legislature, under pressure from the business community, passed a law prohibiting municipalities from setting wage levels. In September 2002 the State Supreme Court upheld the state law (Murray, 2004).

5.2. *Facilitate equal access to loans and financial incentives*

Easy access to loans is another mechanism to help the poor recover from the aftermath of Katrina. Many families will not be able to afford the cost of repair, reconstruction, or relocation if the government doesn't facilitate easy access to loans. Further, reducing the bureaucratic procedures for lower income groups to get loans and grants will help them rebuild and relocate in an efficient and timely manner. Therefore, equity considerations argue for providing this group with low interest loans and grants to rebuild their houses and the city.

Despite the widespread poverty in the most damaged regions, the Small Business Administration (SBA) has not adjusted its creditworthiness standards, which are roughly comparable to a bank's (Eaton and Nixon, 2005). The loans that have been approved appear to be flowing to wealthy neighborhoods in New Orleans but not to poor ones.

Also it is important to encourage New Orleans residents to engage in mitigation measures by providing them with tax or other financial incentives. For example, homeowners could get a tax rebate by undertaking a mitigation measure, thereby lowering the costs for disaster relief.

5.3. *Improve access to transportation*

Efforts at rebuilding must address the fact that many of the city's families are poor and do not own their own vehicle. As Katrina illustrated, lack of access to transportation inhibits mobility and increases vulnerability. An evacuation plan which relied on personal automobiles, in a city where one in five families did not own automobiles was an inexcusable institutional failure. Thus, the city needs to invest in public transportation infrastructure, including light rail and buses (Katz, 2005).

If we do not address these financial and transportation needs, highly vulnerable communities will continue to exist in New Orleans. Part of planning for disasters must include eliminating socio-economic vulnerabilities that exacerbate the damage from natural disasters and increase human suffering. Investing in the economic well-being of communities will reduce vulnerability and ultimately damages suffered in future natural disasters.

While it's time to think about a new New Orleans, it is very important for the federal, regional and local authorities to consider a comprehensive mitigation plan that should: 1) determine the location and nature of potential hazards; 2) characterize the population and structures (present and future) that are vulnerable to specific natural disasters and adopt appropriate mitigation strategies; and 3) ensure effective community participation in the decision making during the reconstruction phase. Community participation will be critical in planning, designing and developing a long-term recovery plan that is just, fair and sustainable.

Further, additional research is needed to assess the spatial and temporal impacts of Hurricane Katrina, and the impact of federal reconstruction funds on affected communities. Finally, studies that analyze the long-term reconstruction effort will be useful in developing policies that improve natural disaster management.

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