HOUSING UNMET NEEDS DURING DISASTER PHASES: THE CASE OF HURRICANES KATRINA AND RITA IN TEXAS

A Dissertation

by

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ABSTRACT

The research aim was to examine differences in housing needs during disasters according to homeownership type by examining unmet housing needs in Texas during Hurricanes Katrina and Rita. This dissertation includes: (1) literature review regarding differences in housing needs by housing tenure normally and during disaster phases; (2) decision-making models and methods to handle incomplete tertiary data; (3) patterns of unmet housing need differing through disaster phases; and (4) factors determining likelihood of unmet housing needs for renters vs. owners before, during, and after Hurricanes Katrina–Rita. The longitudinal and logistic analyses used "real-time" reports of unmet housing needs logged in Texas' 2-1-1 dataset covering all 254 counties during 8/1–12/31/2005.

First, previous research has shown that renters faced greater housing struggles than homeowners due to their limited resources in phases spanning from prior to a disaster to post-disaster recovery. Second, a systematic algorithm was developed to solve missing data problems in merging multiple tertiary datasets. This method would enhance opportunities to employ tertiary data for research and management studies, at the same time increasing the validity of the findings for more appropriate planning and policies. Third, in this study during Hurricanes Katrina and Rita, unmet housing needs were mostly financial issues for rental housing. The volume of unmet rental housing needs rose one week after each hurricane's landfall compared to homeowner's unmet needs rising in early recovery. Unmet shelter needs peaked during the immediate disaster

response but extended beyond typical hurricane emergency periods. Fourth, greater affordability constraints were significantly associated with greater likelihood of rental needs prior to and during disaster emergency phases but not during recovery; however, greater affordability constraints increased the likelihood of homeowner needs only during normal phase prior to the disasters. Less availability of housing was strongly associated with greater likelihood of housing needs for both renters and homeowners. Housing quality was not associated with unmet needs when controlling for availability, affordability and disaster location. Overall, this research showed empirical evidence that policymakers need to consider developing different strategies and programs based on various types of housing needs according to homeownership type by disaster phase.

DEDICATION

To my parents and husband

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CHAPTER I

INTRODUCTION

Research Objectives

The purpose of this study was to examine unmet housing needs throughout disaster phases as well as the likelihood of housing needs experienced by renters vs. homeowners. Using the 2-1-1 Texas dataset collected during Hurricanes Katrina and Rita, types of unmet housing needs were recorded in "real time" across Texas's 254 counties. Then the type of housing was enumerated for renters vs. homeowners, aggregated by county, and examined to compare factors accounting for their likelihood of unmet housing needs varying across disaster phases. The five-month study period was divided into four disaster phases, including a month baseline prior to Hurricane Katrina, Katrina emergency management, Rita emergency management, and short-term recovery up to 14 weeks post-landfall of Hurricane Rita.

The research for this dissertation was reported in four papers, each written for publication submission: Chapter II) review of literature about differences in housing needs experienced by renters and homeowners during disasters; Chapter III) report of the method developed to handle missing data when merging tertiary datasets; Chapter IV) discussion of unmet housing needs recorded for 2-1-1 callers to the Texas Information & Referral Network (TIRN) over the five-month study period (Fall 2005) and across Texas' 254 counties that include disaster sites as well as evacuation destinations; and Chapter V) explanation of testing a multivariate logit model to account for the likelihood of unmet

housing needs for renters vs. homeowners for each disaster phase. The final chapter is a brief summary and conclusion of the findings as well as recommendations for planners and policy makers and for future research.

This project was funded by the Department of Homeland Security's Science and Technology Division in collaboration with the Texas 2-1-1 Information & Referral (I&R) Network and United Way Worldwide. The author was involved throughout the study, playing a key role in data cleaning and coding, analysis, reporting, and development of other related presentations and publications. This set of four papers regarding unmet housing needs is a unique contribution to both housing-related research as well as disaster-related research.

Background

In 2005, over a million Hurricane Katrina evacuees were displaced from their homes to other cities or states (Godoy, 2006). Three weeks later, Hurricane Rita displaced another 3.7 million people (Eskovitz, 2006), resulting in unprecedented housing and sheltering needs. Although housing is a fundamental need before a disaster strikes, providing shelter and temporary housing during a disaster is an additional societal demand. Often during a disaster, inadequate houses where low-income renters live suffer a higher percentage of damage. It is not easy for displaced individuals to find affordable housing after a disaster.

To date, several studies have focused on housing needs and affordability during normal times. Low income households typically live in low quality housing and/or low

quality neighborhoods in order to reduce their housing cost burdens. They are likely to suffer after a disaster because of the cost of housing damage, trouble finding adequate shelter, and problems with finding new low income housing after the disaster has passed. Other research has concentrated on a certain time period during disasters, such as shelter and housing recovery. However, little is known about housing needs spanning all disaster phases as examined in this dissertation. In addition, there have been few comparisons made between the needs of homeowners and renters during both normal times and disasters. Although housing tenure—whether a household owns or rents the unit—is an important characteristic and deeply related to the dweller's level of vulnerability (Burby, Steinberg, & Basolo, 2003; Zhang & Peacock, 2010), it has been understudied compared with other population characteristics (e.g., age, gender, race, and income).

Policymakers and researchers seek information about where services are needed during a disaster, what types of needs there are and when those needs peak. Although there is no perfect set of data that covers these complicated issues, 2-1-1 databases have the potential to measure unmet needs of a population experiencing access barriers for meeting their needs in broad geographical areas, collected in real time. Merging the 2-1-1 datasets is challenging given variations in software; however, the coding of needs is standardized using the same taxonomy across 2-1-1 call centers. Merging 2-1-1 data with other datasets (e.g., Census, HUD) is also challenging but enables the ability to analyze factors accounting for unmet needs.

Research Significance

The results of this study will help to identify unmet needs of a vulnerable population, as well as a more complete portrayal of the actual demand for housing according to disaster phase. Disaster planners and managers may use this approach as a template for "real time" analysis of their own local 2-1-1 data to determine types and volume of needs during disaster preparation, emergency management, and recovery phases. This study focuses on the unmet housing needs that emerged during two extensive hurricane disasters—Katrina and Rita—analyzed by disaster phase in a broad geographical area throughout all 254 Texas counties. Although Hurricane Katrina did not directly affect Texas, evacuation and relocation of its victims is still having an impact throughout the state. Hurricane Rita did strike Texas. Thus, the study period and area will show the impact of each hurricane on both affected communities and evacuation host communities. Consequently, the results of this study will be useful for community leaders and policymakers in deciding how to manage assistance efficiently during these dynamic and critical stages of community planning.

Moreover, with growing research interest in employing tertiary data for studies, missing data problems in merging tertiary datasets have become more prominent. This study developed a systematic algorithm within the parameters of the nature of missing data and the logical sources of the comparative data. The ability to salvage an important dataset source would enable researchers to explore a broader variety of tertiary data for more valid meta-analysis approaches.

Although many studies have focused on distinct factors of disaster housing issues such as shelter, temporary housing, or housing recovery, systematic studies related to the longitudinal aspects of housing issues during disasters is still limited. This dissertation synthesized literature on housing needs during normal times as well as literature regarding disaster-related housing needs. The next step was to empirically illustrate the empirical patterns of how housing needs changed during disasters. There is also a discussion regarding how long it might take to become normal, which provided empirical evidence of Quarantelli's (1982, 1995) disaster sheltering and housing typology. The resulting patterns of unmet housing needs may help planners and researchers better understand how these needs change when the temporal aspects of a disaster are considered.

CHAPTER II

DIFFERENCES BETWEEN RENTERS' AND OWNERS' HOUSING NEEDS DURING DISASTERS

Introduction

Housing tenure—whether a household owns or rents the unit—will be one of the most underestimated aspects of social vulnerability to disasters (Peacock, Van Zandt, Zhang, & Highfield, 2014). Housing tenure describes the nature of the relationship between the housing unit and the household occupying it. In this way, it captures both social (i.e., household) and physical (i.e., housing unit) vulnerabilities. This interaction in vulnerabilities manifests itself in a variety of ways during disasters. In this paper, I explore the variation in housing needs among owners and renters during disasters.

Over the past two decades, researchers have expanded our understanding of disaster impacts to include variation based on social factors, rather than just hazard exposure and physical vulnerability. Most researchers find that socially vulnerable populations have been disproportionately affected by disasters compared to other population groups (Bates, 1982; Bates & Peacock, 1987; Blaikie, Cannon, Davis, & Wisner, 1994 *cited in Peacock et al., 2007*; Bolin, 1986; Levine, Esnard, & Sapat, 2007; Peacock & Girard, 1997; Quarantelli, 1982). Previous disaster-related studies have focused on socially vulnerable populations, for example age (Bolin & Klenow, 1982-83; Bolin & Klenow, 1988; Ngo, 2001), gender (Enarson, 1999; Enarson, Fothergill, & Peek, 2007; Enarson & Morrow 1997; Fothergill, 1996), race (Bolin, 2007; Elliott &

Pais, 2006; Flynn, Slovic, & Mertz, 1994; Fothergill, Maestas, & Darlington, 1999; Peacock & Girard, 1997), and income (Dash, Peacock, & Morrow, 1997; Elliott & Pais, 2006; Fothergill & Peek, 2004).

Among vulnerable populations, housing tenure has been relatively understudied to date. Many characteristics of renters are not mutually exclusive to other social and physical vulnerable characteristics (Morrow, 1999), which include low-income, minority, low quality housing condition (Kreimer, 1980; Morrow, 1999; Peacock, Dash, & Zhang, 2007) as well as lack of resources and even its limited control (Van Zandt et al., 2012). Compared with owners, renters have limited financial resources (such as income, savings) to maintain, improve, and repair their housing (McCarthy, Van Zandt, & Rohe, 2001; Van Zandt & Rohe, 2011). While owners have higher levels of ability to control housing units and housing security (Rohe, Van Zandt, & McCarthy, 2001), renters do not have control over housing units (Burby, Steinberg, & Basolo, 2003; Morrow, 1999); for example, renters do not get to decide whether the unit will be rebuilt or redeveloped, and have little to no control over their ability to return to the original unit, putting them at risk of temporary or permanent displacement.

Moreover, many previous studies were focused on a single disaster phase (e.g., preparedness, emergency response, or recovery), but rarely spanned all disaster phases using the available empirical data. Burby, Steinberg, and Basolo (2003) studied the vulnerability issues of renters in terms of threat of disaster and preparedness. Comerio (1997) explained housing recovery issues for tenants and homeowners after the Northridge earthquake. Recently, Zhang and Peacock (2010) considered the relationship

between housing tenure and recovery patterns from the case study of Hurricane Andrew. Mukherji (2010) also reported the housing recovery in India following the 2001 Gujarat earthquake by focusing on housing tenure.

Compared to owners, renters have a wider range of housing problems that are generally more severe during normal periods. They bear an affordable-housing shortage problem in the U.S. (Apgar, 2004), which could become worse after disasters. The number of affordable housing units was increased about 0.4 million from 2000 to 2005-07, however units for households under 50% of average middle income (AMI) were reduced by about 1.6 million (National Low Income Housing Coalition, 2011). Renters' housing issues include not only housing quantity but also housing condition. The condition of housing for low-income and minority households is bad; that is, older, poorly built, lacking sanitation, located in vulnerable areas, and less-maintained (Kreimer, 1980; Morrow, 1999; Peacock & Girard, 1997). Housing in poor condition is apt to be damaged or destroyed during disasters, reducing inventory, particularly for low-income households. In the case of earthquakes, housing location is an important factor in the impact the disaster will have, along with housing type and the quality of construction of low income households (Bolin & Stanford, 1991).

This paper is focused on differences in housing needs experienced by renters and owners during disasters. To build a framework for understanding how housing tenure relates to social vulnerability, I first characterize the differences in characteristics of owners and renters. Next, I review recent literature on the impacts of disaster for owners

and renters at each stage of disaster. Finally, I discuss disaster housing policies and programs for renters and owners.

Social Vulnerability

Vulnerability is generally defined as "the potential for loss" (Cutter, 1996, p. 529), though other definitions have been presented (see definitions of vulnerability in Cutter, 1996). Office of the United Nations Disaster Relief Co-ordinator (UNDRO) (1980, p. 5) defines vulnerability as "the degree of loss to a given element at risk or set of such elements resulting from the occurrence of a natural phenomenon of a given magnitude." Several studies have focused primarily on the physical aspects of vulnerability, such as biophysicality and the built environment; but recent studies have also focused on the social and economic aspects (Cutter, Boruff, & Shirley, 2003; Zahran, Brody, Peacock, Vedlitz, & Grover, 2008). Blaikie, Cannon, Davis, and Wisner (1994, p. 9) defined vulnerability as "the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impacts of a natural hazard," which is a way of describing social vulnerability. In 1996, Cutter developed the hazards-of-place model of vulnerability, which considers both biophysical and social vulnerabilities for place vulnerability. More recently, Peacock and his colleagues (2008) discussed that researchers still have different definitions of vulnerability, and they use different measurements (e.g. the integration of physical and social vulnerability, "the direct consequences of multiple dimensions of vulnerability," see detail in Peacock et al., 2008, p. 9) at various levels.

Researchers have expressed concern that disasters can reveal and even magnify existing pre-disaster social problems such as social inequality (Bolin & Stanford, 1991; Greene, 1992). Bolin and Stanford (1991) noted that the success of the overall recovery process (including housing recovery) is strongly related to social structure. For example, many low income populations face difficulties related to housing shortages before a disaster strikes, and after such disasters it only becomes worse; examples include Hurricane Katrina (Popkin, Turner, & Burt, 2006) and the Whittier-Narrows earthquake (Bolton, Liebow, & Olson, 1993). It is likely that residents have different levels of information; financial, social, and physical resources; and the control or power to use those resources within their community or society (Van Zandt et al., 2012, p. 32), which creates a complex and varied set of situations to consider. Policy makers and practitioners continue to pay limited attention to issues of inequality with regards to residents' varied capacities to handle the impact of a disaster. Some populations—the elderly, female-headed households, children, the disabled, minorities, and renters—are all likely to face additional barriers after a disaster. These socially vulnerable populations face a greater likelihood of being affected by disasters, as compared to other populations, because of their limited resources (financial, social, and physical).

Differences Between Renters and Owners

Housing tenure describes the relationship between the household and the housing unit. Ownership conveys bundles of interests or benefits, including both use and exchange interests (Davis, 1991). Others refer to these interests as consumption and

investment interests (McCarthy, Van Zandt, & Rohe, 2001). Use or consumption interests refer to the shelter and accommodation that housing provides, while exchange or investment interests refer to the value that housing and land have that can be sold or exchanged. These interests have both social and economic impacts that may be relevant to a household's vulnerability (McCarthy, Van Zandt, & Rohe, 2001; Rohe, Van Zandt, & McCarthy, 2001).

Comparing these differences in characteristics between renters and owners in a normal period allows us to understand how these differences may lead to vulnerabilities during a disaster. The difference in resources between renters and owners is described based on the three distinct types: household resources (age, marital status, life cycle stage, employment status, children, income, and race/ethnicity), social resources (attachment/stability of neighborhood, and civic participation), and physical resources (structure age, overcrowding, maintenance, and location).

Household Resources

Life cycle differences, along with mobility, explain many of the differences between owners and renters. Younger and unmarried people are more likely to move because of changes in their job and/or marital status, as compared to older and/or married people with children. Thus the proportion of renters is higher for younger households, partly because the relatively low transaction costs associated with renting make it a good option for households who are faced with a change in job or marital status (Alexander et al., 2006). On the other hand, households who are older and who

have children are more likely to be owners. Once they settle down with a job, people are more likely to decide to purchase a house because they want to secure tenure. As of the fourth quarter of 2010, the homeownership rate for households whose age is 65 or over was 80.5 percent, which is the highest rate; in contrast, the homeownership rate for households whose age is under 35 was 39.2 percent, which is the lowest rate (Callis & Kresin, 2011, p. 7). In sum, renters are more likely to be young, single, and childless.

Economic factors are also useful when considering differences between renters and owners. Renters tend to have lower-incomes than owners (Alexander et al., 2006; Belsky & Drew, 2007). A person who is not permanently settled in place or does not have the financial resources to buy a home generally becomes a renter (Cutter, Boruff, & Shirley, 2003). The median household income of owner-occupied housing units was about twice that of renter-occupied housing units (U.S. Census Bureau, 2010). As of the fourth quarter of 2010, households with family income above (or equal to) the median have 30 percent higher homeownership rate than households with family income below the median, (Callis & Kresin, 2011, p. 9). Low-income households are more likely to have rentership compared to middle- or high-income households (Apgar, 2004). Generally, renters have limited financial resources compared to owners.

Finally, race and ethnicity are also important factors for divergence between renters and owners (Alexander et al., 2006; Belsky & Drew, 2007). Racial discrimination is an ongoing issue for minorities, particularly African-Americans, when they buy, sell, and rent a house (Feagin & Sikes, 1994; Guy, Pol, & Ryker, 1982; Horton, 1992; Oliver & Shapiro, 1995; Sagalyn, 1983). The origination rate for home

mortgages is lower for African-Americans than it is for whites, even when controlling for differences in creditworthiness such as education and income (Oliver & Shapiro, 1995). Further, Guy, Pol, & Ryker (1982) found that the percentage of African-Americans in a neighborhood has a significantly negative relationship with the volume of mortgage lending. African-Americans (and other minorities) are also likely to have more limited housing choices (Sagalyn, 1983)—homes that are in poorer condition (Friedman & Rosenbaum, 2004) and located in lower-quality neighborhoods (Flippen, 2004; Van Zandt, 2007). Due to this poorer neighborhood quality, minorities face higher mortgage interest rates and lower home appreciation rates (Flippen, 2004; Oliver & Shapiro, 1995). The homeownership rate of Whites was higher than that of minorities (e.g., Blacks, Hispanics, and Asians) (Apgar, 2004; Coulson, 1999; Rosenbaum, 1996). As of the fourth quarter of 2010, the order of homeownership rates (highest to lowest) by race is Whites (74.2%), other races (57.7%), Hispanics (46.8%), and Blacks (44.8%) (Callis & Kresin, 2011, p. 8). The differences in homeownership rates among the races are closely related to income (Painter, Gabriel & Myers, 2001; Wachter & Megbolugbe, 1992), education (Painter, Gabriel & Myers, 2001), immigrant status (Painter, Gabriel & Myers, 2001), age of owner household (Coulson, 1999; Masnick, 1998), and culture (Rohe & Stewart, 1996).

Those who frequently move their dwelling may have less information regarding hazards in their home location, because of a lower number of social attachments or little concern for disaster situations (Burby, Steinberg, & Basolo, 2003). Minorities may also face an additional language barrier in communicating about hazard-related information,

a condition which encourages little preparation for a disaster (Burby, Steinberg, & Basolo, 2003). Low-income populations often face obstacles finding affordable shelter and temporary housing after a disaster. Since they have limited financial resources, many must choose public shelters because they lack other options. The situation becomes even worse when they seek temporary housing, because rental housing is the preferable housing type for a temporary stay; this is likely to increase both demand and rent.

Further, minorities, particularly those that are low-income, often face inequalities when they obtain homeowners insurance, making home purchase more difficult (Squires, 1998; Squires, O'Connor, & Silver, 2001; Squires & Velez, 1987). Further, these difficulties may also complicate attempts to qualify for loans for housing repair after a disaster (Bolin & Stanford, 1998; Peacock & Girard, 1997). Minorities, low-income, and renters are less likely to receive sufficient support from federal sources in the United States than middle-class homeowners (Fothergill & Peek, 2004; Kamel & Loukaitou-Sideris, 2004; Mueller, Bell, Chang, & Henneberger, 2011).

Social Resources

Owners are more likely to stay in their home and neighborhood longer than renters (Goodman, 1974; Roistacher, 1974; Rossi, 1955; Speare, 1970; Varady, 1983). Their residential stability is associated with strong attachment to the neighborhood. Also, ownership provides the basis for homeowners to become civically engaged (Rossi & Weber, 1996). Stemming from a time when only landowners were permitted to vote,

homeownership often acts as the stake that stakeholders claim. The protection of property (and often of property values) becomes a high priority for homeowners and motivates many to lobby for their neighborhood and property interests. Thus, owners are more likely to be politically active in the community (Ahlbrandt & Cunningham, 1979; Blum & Kingston, 1984; Cox, 1982; Guest & Oropesa, 1986; Lyons & Lowery, 1989; Rohe & Stegman, 1994; Rossi & Weber, 1996). Rossi and Weber (1996) found that there are some different political behaviors between owners and renters; for example, owners were more likely to be interested in public affairs, serve on a committee or as an officer for a local improvement group, attend conferences of local improvement groups, and donate money to local improvement groups. Recently, Manturuk, Lindblad, and Quercia (2012) reported that homeowners would be involved in a neighborhood group than renters, although they were less likely to have regular conversations among the group than non-mobile renters possibly because of a dwelling type (multifamily housing vs. single-family detached housing).

Compared to owners, renters are more transient and may be new to their neighborhood (Burby, Steinberg, & Basolo, 2003). They are less stable and the attachment to their neighborhood may also be low. Neighbors may consider them to be transient residents, making them less likely to participate in neighborhood groups (Manturuk, Lindblad, & Quercia, 2012). Furthermore, renters are less likely to be involved in political behavior (Rossi & Weber, 1996). Morrow (2008) also mentioned renters have weak control over community decisions compared to homeowners. Homeowners, and property owners more generally, are often given more weight in

community decision-making due to both their perceived and real "stake" in the community. Homeowners are invested, both literally and figuratively in their communities, while renters may not be. Thus their opinions and input may not be valued in the same way.

This creates a stark contrast between homeowners and renters, where renters are seen as not fully citizens (Perin, 1977). Renters, therefore, are not as likely to be civically engaged, not as likely to advocate for their rights, and are not as likely to generate social and political capital (Rohe, Van Zandt, & McCarthy, 2001) that may become important in the aftermath of a disaster. Further, they are less likely to be involved in local decision-making; thus their needs and perspectives are less likely to be incorporated or addressed.

The housing security that comes with ownership provides literal protection from weather, from invaders, or from other physical threats. While renters also have access to shelter, the rental agreement typically does not convey protection from entry by the landlord or maintenance and repair personnel. Renters recognize that someone other than themselves ultimately controls who enters the unit and how it is maintained. Security also refers to the ability to retain the home. Owners have much stronger rights to stay in their homes than do renters. Although through the recent housing crisis, we have seen the number of foreclosures skyrocket and forced evictions occur, the process for this is much more elaborate and longer than it is for renters. Thus, renters have less control over their unit and typically cannot initiate any changes that may be needed, including

those to harden the unit against physical hazards as well as recover from damage that the unit may incur.

Physical Resources

Differences exist in the physical resources between renters and owners in terms of housing condition and its spatial location; homeowners, on average, enjoy larger units, newer units, more rooms, private yards, and garage or covered parking, for example (U.S. Census Bureau, 2011). The condition of rental housing is generally poor in that it is often older, overcrowded, and maintained less. According to the U.S. Census Bureau (2004), about 30 percent of rental housing stock was built before 1950 and only 11 percent during 1990-2003. In the case of resident-owned housing stock, about 22 percent was built before 1950 and also about 22 percent during 1990-2003 (U.S. Census Bureau, 2004). Although problems with overcrowding conditions have diminished because of smaller family size and larger size per residential unit, there are still issues among foreign immigrants who are characteristic of renters (Schwartz, 2006). Rental housing units are less likely to be well maintained (Apgar, 2004). From the perspective of a property's preservation, renters have little incentive to keep their property well compared to owners. Additionally, renters have little authority to install any safety and protection features (e.g., shutters, wind protection, and roofing) that would help the housing unit withstand a disaster better (Morrow, 1999). As a result, much rental stock faces risk of loss. Peacock and his colleagues have found that renter-occupied single-family housing and housing types that are more common for renters (duplex and multi-

family housing) are more likely to experience greater levels of damage and be slower to recover after disaster (Peacock, Van Zandt, Zhang, & Highfield, 2014; Zhang & Peacock, 2010).

Along with the residence's condition, the spatial location of the property is another important issue. Due to a shortage of rental housing, low-income renters have fewer choices when selecting their living location, which illustrates a consequence of shortages of affordable housing (Schwartz, 2006). Although job locations changed from central city areas to suburban areas (Alexander et al., 2006), it is not easy for low-income renters to afford rental housing in a suburban community because it often lacks affordable rental housings due to local regulations (Alexander et al., 2006; Apgar, 2004). Thus, low-income renters are more likely to stay in available housing in the central city and commute to suburban areas (Alexander et al., 2006). Furthermore, low-income renters who live in poor and/or minority neighborhoods faced more problems such as crime, low-quality schools, inadequate housing, poor-quality infrastructure, and hazardous locations (e.g., floodplains, landfills, toxic waste depots, and areas exposed to natural and technological hazards) (Belsky & Drew, 2007; Bullard, Mohai, Saha, & Wright, 2008; Morrow, 1999; Phillips, 1993). Overall, many low-income renters have little choice about the location or condition of buildings in which they live (Schwartz, 2006).

Figure 2.1 shows the relationship between resources linked to tenure and how they might affect the ability of residents to respond to a disaster. It shows that their resources during a normal period are related to their response during a disaster. For

example, renters generally have low financial resources and therefore experience problems finding temporary housing after a disaster, whereas owners have more ability to respond to the situation because they have more financial resources.

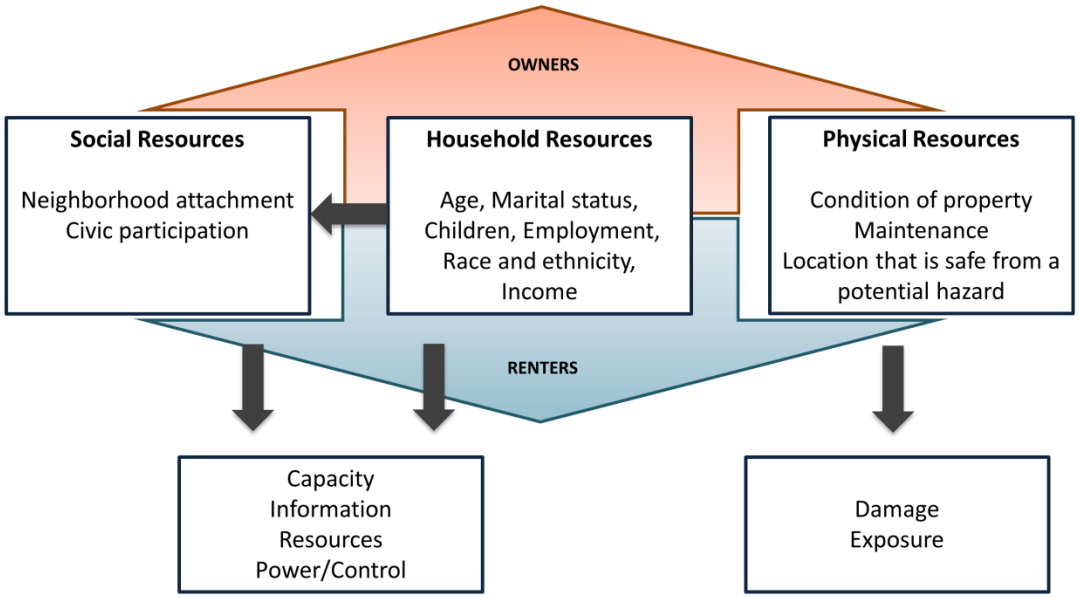


Figure 2.1. Relationship between renter and owner resources and the ability to respond to a disaster

Differences in Ability and Disaster Response between Renters and Owners during Disasters

The differences between owners and renters may have a real impact on the ability of renters to anticipate, prepare for, respond to, and recover from a disaster. For example, renters cannot entirely control their dwelling in terms of preparing for disasters (Morrow 1999); lack of preparation can cause heavy damage, in particular public

housing units, as was the case with Hurricane Andrew (Morrow 1997a; Morrow 1999). Yet owners are able to install shutters or protective roofing, so in certain ways they can be better prepared for a disaster. After a disaster, low income renters face difficulties concerning both temporary and permanent housing, because they cannot decide whether or how soon their dwelling will be repaired, or when they can return to their original dwellings. Furthermore, during a recovery, renters have little power to control any decisions related to the greater community (Morrow 2008).

To review these differences, I organize the literature according to disaster phase. Although the typology of disaster phases has some issues, it has been widely accepted as a standard by many researchers. Researchers and practitioners should understand that each disaster phase is not mutually exclusive, meaning phases are not clearly distinct from one another (Neal, 1997). This issue was mentioned in an earlier study by Haas, Kates, and Bowden (1997) and Quarantelli (1982). While some victims stay in shelters, others seek temporary housing or immediately repair their homes. Researchers and practitioners might want to identify the objective—not subjective or social—time periods of disaster phases. However, each household, group, or community may experience different disaster phases for varied lengths of time because individuals face different levels of barriers. Earlier studies have concerned the 'social time' aspect—for example, Dynes (1970) *cited in Neal, 1997*; Haas, Kates, and Bowden (1977); Quarantelli (1982). Phillips (1991) found that the transition time from shelter to permanent housing for both the elderly and Hispanics is much longer, for instance, than it is for other population groups (*cited in Neal, 1997, p. 250*).

Notably, researchers have been developing the disaster phase classification since the 1930s (see detail in Neal, 1997). Each study (e.g., Faulkner, 2001; Fothergill & Peek, 2004; Haas, Kates, & Bowden, 1977; Mileti, Drabek, & Haas, 1975; Roberts, 1994) uses a different number of phases, but they fall within four general groups: 1) preparedness and warning phase, 2) impact phase, 3) emergency response phase, 4) recovery and reconstruction phase. Recovery and reconstruction phases are sometimes separated depending on the study, but because the two phases address similar issues in sequential time periods, they were combined in this work.

Preparedness and Warning Phase

The first phase is the pre-impact or prodromal period, so preparedness behavior and warning response can be considered (see for example, Fothergill & Peek, 2004). In this phase, residents are anticipating the onset of the hazard, and are undertaking preparedness activities, which may include stocking up on foods, evacuating, sheltering in place, or battening down. While few studies address housing tenure explicitly, most studies indicate that owners were better prepared for a disaster compared to renters. Turner, Nigg, and Paz (1986) found that owners were better prepared with emergency staples during an earthquake. Burby, Steinberg, and Basolo (2003) focused on disaster preparedness during joint natural and technological disasters and found that renters are less prepared compared with owners in the study of the Torrance and New Orleans refinery disasters. They explained that renters are more likely to move frequently, thus they are usually not familiar with their new community, and they have less of a

communication channel to obtain information. Also, they mentioned renters did not have enough financial resources to properly prepare for the disaster. Importantly they insisted that "tenure itself may also play a role" (Burby, Steinberg, & Basolo, 2003, p.47), along with income, ethnicity, and length of residence. They found that, regardless of income level, owners were better prepared for hurricanes than were renters in the study of New Orleans.

Gladwin and Peacock (1997) described although it was not statistically significant, renters are likely to start preparation a little later than owners based on their study of Hurricane Andrew. The mean interval between start of preparation and storm's arrival for owners was 1.5 hours longer than that of renters (33.8 hours vs. 32.3 hours) in their study. They considered that this insignificant difference represented people's major concern about personal safety compared with protecting property. Moreover, Morrow (1997b) pointed out that owners are likely to have had relatives' help as well as help relatives in terms of preparing a disaster. The odds of homeowners receiving kin help are about twice as high as those of renters, possibly because homeowners "would have more preparation work to do, and, hence, would be more likely to need assistance than would renters (Morrow, 1997b, p.145)." In addition, the odds of homeowners helping other relatives are about 1.6 times as high as those of renters.

Impact Phase

The second phase is the impact phase that is "often the shortest, yet most dangerous" (Fischer, 1998, p. 8). During this phase, affordable housing for low-income

renters is more vulnerable due to low-quality construction (Greene, 1992; Katrakis, Knight, & Cavallo, 1994; Phillips, 1993; Rosenbaum, 1996) as well as their housing being located in hazardous areas (Bullard, Mohai, Saha, & Wright, 2008; Morrow, 1999; Phillips, 1993). Often earthquakes destroyed multi-family housing units (Comerio, 1997; Wu & Lindell, 2004) because of the poor housing quality and unsafe location (Bolin & Stanford, 1991). The Loma Prieta earthquake caused about 11,500 housing units to be destroyed or significantly damaged, and about 60% of them were rental units (Comerio, 1998). Similarly, the Northridge earthquake destroyed or severely damaged 60,000 housing units, 88% of which were multi-family housing (Comerio, 1997).

In terms of hurricanes, according to Comerio's study (1997) that reviewed residential losses in disasters, Hurricane Hugo destroyed or severely damaged 36,000 housing units and 11% of these were multi-family units. In the case of Hurricane Andrew, 80,000 housing units were destroyed or severely damaged and 29% of them were multi-family units (Comerio, 1997). In particular, most subsidized rental housing and all public housing in South Dade were destroyed (Morrow, 1997a). Hurricanes Katrina and Rita also severely affected rental housing. Approximately 56% of rental units in New Orleans were flooded by Hurricane Katrina (Muro, Liu, Sohmer, Warren, & Park, 2005), and low income housing was affected the most (National Low Income Housing Coalition, 2005). In addition, Hurricane Ike caused the greatest damage in the census tracts with high percentages of rental housing (Henneberger, 2009). Although most of the studies regarding on impact phase described mortality or housing damage, Morrow (1997b) considered perceptions of increased stress in various relationships

during Hurricane Andrew. The study showed that ownership did not have significant impact on the perception after controlling for major home damage, ethnicity, income, and being a single mother.

Emergency Response Phase

The third phase is the post-impact period, "typically including the first hours or days, perhaps up to one week, depending on the event" (Fothergill & Peek, 2004, p. 96). In this phase, people are looking for emergency shelters or temporary shelters (i.e., the first two phases of Quarantelli's disaster housing typology). Low-income renters have few shelter options due to their limited resources, thus they are more likely to stay in public or mass shelters (Mileti, Sorensen, & O'Brien, 1992; Morrow, 1999; Tierney, Lindell, & Perry, 2001). Morrow (1997b) found that evacuees selected their relative's homes as relocation places most frequently regardless of income level during Hurricane Andrew, but high-income households preferred to stay hotel or motel compared with low-income households. In addition, homeownership increased the odds of having relatives stayed with them after controlling income, ethnicity, and major damage (Morrow, 1997b). This might be because owners have security of their housing units, therefore it might be easier for owners to share their dwelling with their relatives compared with renters.

There are some studies regarding residents' evacuation behaviors. Gladwin and Peacock (1997) found that single-family housing residents as well as low-income and Black households who lived in the evacuation zone were less likely to evacuate during

Hurricane Andrew. According to these results, it is unclear whether ownership is associated with evacuation behavior, because single-family housing residents are likely to be owners, but low-income households are likely to be renters. They explained the possible reasons why low-income and Black households were less likely to evacuate were deficiency of transportation and affordable dwellings, which are more related to their financial issue rather than ownership itself. Similarly, Van Zandt and her colleagues (2012) pointed out that neighborhoods with higher proportions of renters had lower evacuation rates and they were more likely to have stayed later during Hurricane Ike. Elliott and Pais (2006) found that there was no significant difference in evacuation timing by ownership based on their survey results from the Hurricane Katrina survivors, but instead they found strong racial difference.

The transition time from sheltering to temporary housing is longer for low-income households compared to that of high-income households (Phillips, 1993) because of insufficient financial resources available to recover housing (Dash, Peacock, & Morrow, 1997). Elliott and Pais (2006) found that victims' post-Katrina sheltering situation was related to their homeownership. Their results showed that many owners had returned a month after Katrina's landfall, while renters and boarders were more likely to still stay in other's home, an apartment, hotel, or other temporary shelter.

Recovery & Reconstruction Phase

The final phase is the recovery and reconstruction phase. Recovery phase is the intermediate or restoration period during months or a year after a disaster (Fothergill &

Peek, 2004; Haas, Kates, & Bowden, 1977; Roberts, 1994). In this phase, people's life returns to fairly pre-disaster routine including services, utilities, and transportation, though they might live in temporary housing (Fothergill & Peek, 2004; Haas, Kates, & Bowden, 1977; Roberts, 1994). Reconstruction phase is the long-term recovery period that spans from one to many years after a disaster (Fischer, 1998; Fothergill & Peek, 2004; Roberts, 1994). During this phase, community services, homes, jobs and population are restored and replaced to pre-disaster conditions or possibly developed better; and people come back to their permanent housing (Fothergill & Peek, 2004; Haas, Kates, & Bowden, 1977).

During the recovery phase, low-income renters have problems finding affordable temporary housing (Quarantelli, 1995). Since there was a shortage of affordable housing before the disaster, it becomes worse afterward (Bates & Green, 2009; Bolin & Stanford, 1991; Bolton, Liebow, & Olson, 1993; Kreimer, 1980). Low-income households, particularly the poor, are more likely to be in temporary mobile homes, while high-income households usually prefer to get rental assistance rather than using a mobile home (Quarantelli, 1982). After disaster, rents often increased due to high demand of temporary housing for both owners and renters (Comerio, 1998; Quarantelli, 1982). Even with rental vouchers, it could be difficult for low-income displacees to find temporary housing (Green, Bates, & Smyth, 2007).

For low-income renters, planning their permanent housing (even whether or not they return to their original homes or communities) is another issue. After Hurricane Katrina, homeowners were more likely to plan to return to their original communities

than were renters (Elliott & Pais, 2006). Girard and Peacock (1997) also found that homeownership showed a negative relationship with relocation after Hurricane Andrew, and housing type is related to post-hurricane relocation; residents in single-family houses were less likely to relocate than residents of multi-family housing structures. One study that was conducted after the 1998 explosions in Israel, however, showed no significant relationship between tenure and relocation decisions (Kirschenbaum, 1996). Renters were apt to be displaced after a disaster (Peacock, Dash, & Zhang, 2007). Often, renters have no control over whether or when the property would be rebuilt. Thus, regardless of whether renters want to return to their original property, they might be forced to leave. At the same time, renters are less likely to secure their jobs after a disaster (Elliott & Pais, 2006) because of unstable employment of low-income workers (Morrow, 1999), which is one of the important factors in deciding their permanent housing location. Moreover, there is another possible barrier to returning to the original home: eviction. Some landlords may not want to receive returning displacees because they want higher rents, or alternative housing when they rebuild (Elliott & Pais, 2006). In the case of the Whittier-Narrows earthquake that occurred on October 1, the rent-due day, many renters were evicted because of failing to pay rent on time (Bolin, 1993 *cited in fothergill & peek, 2004*).

Rental housing has experienced a problem with much slower recovery compared to owner-occupied homes, particularly in low-income and minority neighborhoods (Zhang & Peacock, 2010). In the case of Hurricane Katrina, six months after landfall the population living in the New Orleans Metropolitan Area, as well as the proportion of

renters, was reduced from pre-Katrina levels (Frey & Singer, 2006). Two years after Hurricane Katrina, the speed of housing recovery in affluent neighborhoods was much faster than that in poor neighborhoods, e.g., Lakewood vs. Lower Ninth Ward (Jervis, 2007). There were about eight percent of housing loss in Lakewood and about 64 percent of housing loss in Lower Ninth Ward during the last decade (The Data Center, 2014a, 2014b). The homeownership rate of Lakewood decreased slightly to 88.4 percent in 2010, from 91.7 percent in 2000 and that of Lower Ninth Ward increased 66.4 percent in 2010, from 59 percent in 2000 (The Data Center, 2014a, 2014b). It may reflect that housing units in Lakewood have been restored regardless of housing tenure, but the restoration of rental housing in Lower Ninth Ward was much less or slower than that of owner-occupied housing. As a result, low-income renters might be forced to remain in temporary housing longer than owners or even be permanently unable to return to their original residence (Quarantelli, 1995).

Housing types are also significant factor for recovery speed. Apartments and duplex units have slower recovery speed compared to single family housings (Lu, Peacock, Zhang, & Dash, 2007; Peacock, Van Zandt, Zhang, & Highfield, 2014). Almost three years after the Northridge earthquake, less than two percent of housing construction permits for rebuilding were for apartment buildings although roughly 80 percent of the damaged housing units were multi-family housing and affordable rental housing (Wu & Lindell, 2004). Two years after the Loma Prieta earthquake, the single-family housing was almost rebuilt, however even after five years only half of the damaged multi-family housing was restored (Comerio, 1998). Within a couple of years

after Hurricane Andrew, single-family housing was restored in most cases; however, the rebuilding of multi-family housing lagged significantly (Comerio, 1997). Even after ten years, Miami-Dade County had many housing units that remained damaged (Kershaw & Mason, 2005). Likewise, the speed of public housing recovery has been very slow. Five years after Hurricane Ike, about 40 percent of homes had been restored, but no public housing unit had been rebuilt among the 569 public housing needs to be replaced (Wilder, 2013). In late 2014, six years after the storm, two new mixed-income (subsidized) developments were initiated to begin replacement of the lost public housing units.

One of the primary reasons for slow recovery of rental housing is the lack of financial resources for housing repairs or rebuilding (Cutter, Boruff, & Shirley, 2003; Dash, Peacock, & Morrow, 1997). In the aftermath of disasters, homeowners of single-family housing who rebuilt their housing used insurance, savings, and commercial loans as well as public resources (e.g., SBA, FEMA, and HUD) (Wu & Lindell, 2004). In contrast, owners of large apartment properties had little resources—either private or public. Comerio (1997) noted that these apartment property owners often have difficult situations because they lack money to repair the buildings due to high vacancy rates and falling property values, and getting repair loans from the government is usually difficult. For example, after the Northridge earthquake, most of single-family homeowners could repair damage as well as improve their homes using insurance and disaster assistance (Comerio, Landis, Firpo & Monzon, 1996 *cited in Comerio 1997*). By contrast, multi-family housing owners and renters were not adequately helped after a disaster (Comerio,

1997). As mentioned earlier, two years after Katrina, the recovery speed of housing in rich communities having private insurance and funds was much faster than that in poor communities which needs government assistance (Jervis, 2007). Thus, renters struggle to stay in adequate shelter or temporary housing until they are able to go back to their original dwelling, which usually takes longer than for owners to go back to their original dwelling.

Housing Tenure Variable and Social Vulnerability Studies By Disaster Phase

Housing tenure has often but not always been used as a study variable—including owner/renter, homeownership, and single family dwelling—in social vulnerability studies (see Table 2.1). Previous research mostly falls within four disaster phases: preparedness and warning, impact, emergency response, and recovery/reconstruction. For the preparedness and warning phase, three studies (Burby, Steinberg, & Basolo, 2003; Gladwin & Peacock, 1997; Morrow, 1997b) include housing tenure as an independent variable. For the impact phase, one study (Morrow, 1997b) used the housing tenure variable as an independent variable; alternatively, other studies did not use a housing tenure variable and described only mortality and damage. For the emergency response phase, of the five studies reviewed two studies used the interview method, one study did not use housing tenure as a variable, and only two studies (Elliott & Pais, 2006; Morrow, 1997b) used homeownership as an independent variable and a critical variable. Specifically, in terms of evacuation-related studies, according to Huang's dissertation (2014), 21 out of 35 studies used housing tenure as an independent

variable based on actual hurricane evacuation studies published from 1991 to 2012 (see Huang, 2014, Appendix A). The study found that homeownership is a strong and consistent predictor of a household's evacuation decisions, and also that homeowners are less likely to evacuate (Huang, 2014). Lastly, for the recovery and reconstruction phase, among the seven empirical studies, only five studies (Girard & Peacock, 1997; Elliott & Pais, 2006; Kirschenbaum, 1996; Lu, Peacock, Zhang, & Dash, 2007; Zhang & Peacock, 2010) used housing tenure as an independent variable.

Table 2.1. Summary of social vulnerability studies by disaster phase

Author (year)	Disaster (year)	Location	Analytical method	Dependent variable	Independent variables
Preparedness & Warning Phase					
Burby et al. (2003)	Joint natural & technological disaster	LA, CA	Regression	Disaster preparedness	**Tenure***, income, ethnicity, gender, children, marital status, length of residence, age, education, experience with hazard, perceived likelihood of disaster, knowledge of how to prepare, location in relation to refinery
Gladwin & Peacock (1997)	Hurricane Andrew (1992)	FL	T-test	Preparation time	**Tenure**
Morrow (1997b) Case a	Hurricane Andrew (1992)	FL	Regression	Relatives as source of help preparing	Have relatives in area, Black, Hispanic, income, single adult, couple, elder HH, widow, single mother, **own home**, evacuation zone
Impact Phase					
Morrow (1997b) Case b	Hurricane Andrew (1992)	FL	Regression	Perceptions of stress in relationships	Black, Hispanic, income, minor children, single mother, **own home**, live in South Dade, had major damage
Emergency Response Phase					
Elliott & Pais (2006) Case a	Hurricane Katrina (2005)	LA	Regression	Housing a month after the storm	Black/white, HH income & **ownership***, gender, age, parental status, condition of home

Note: Case a, b, or c indicates different study within one article or book (using different dependent variables or study areas). * indicates a critical variable; NB stands for neighborhood; HH stands for household.

Table 2.1. *Continued*

Author (year)	Disaster (year)	Location	Analytical method	Dependent variable	Independent variables
Emergency Response Phase					
Morrow (1997b) Case c	Hurricane Andrew (1992)	FL	Regression	Relocation to relatives	Have relatives in area, Black, Hispanic, income, **own home**, insured, live in South Dade, sustained major damage
O'Brlen & Mileti (1992)	Loma Prieta earthquake (1989)	CA	Regression	Public involvement in emergency response	Pre-event earthquake salience, pre-event earthquake experience, damage, community integration, roles of responsibility, age, ethnicity, gender, SES (education, income, occupation)
Katayama (1992)	Loma Prieta Earthquake (1989)	CA	Interview	NA	NA
Phillips & Ephraim (1992)	Loma Prieta Earthquake (1989)	CA	Documentation, in-depth interview	NA	NA
Recovery Phase					
Girard & Peacock (1997)	Hurricane Andrew (1992)	FL	Regression	Relocation patterns	Black, Hispanic, mobile home, multiple units, **owner**, low income/rent, insured owner, insured renter, moderate damage, major damage, totally destroyed, eye wall, eye
Elliott & Pais (2006) Case b	Hurricane Katrina (2005)	LA	Regression	Return decision	Black/white, HH income & **ownership***, gender, age, parental status, condition of home, New Orleans resident, evacuation timing, jobless
Kirschenbaum (1996)	Explosions (1988)	Israel	Chi-square	Relocation decision	Gender, age, ethnic, origin of father, immigration year, **apartment tenure**, previous residence, people in apartment, health, education, occupational status, employment, car ownership, model of car
Lu, Peacock, Zhang, & Dash (2007)	Hurricane Andrew (1992)	FL	Regression	Building value (housing recovery)	Year building value, bed room, bath room, building age, **ownership**, #of sales, damage NB median HH income, NB race/ethnic composition
Zhang & Peacock (2010)	Hurricane Andrew (1992)	FL	Regression	Appraised value (housing recovery)	Age, bedrooms, baths, hurricane damage, **tenure**, NB's income, ethnic/racial composition

Note: Case a, b, or c indicates different study within one article or book (using different dependent variables or study areas). * indicates a critical variable; NB stands for neighborhood; HH stands for household.

Table 2.1. *Continued*

Author (year)	Disaster (year)	Location	Analytical method	Dependent variable	Independent variables
Recovery Phase					
Bolin & Bolton (1986) Case a	Hurricane Iwa (1982)	HI	Path model	Family recovery	Damage to dwelling, weeks out of work, education, income, age, use of disaster assistance, use of informal aid, use of insurance, % losses covered, HH moves, race
Bolin & Bolton (1986) Case b	The Paris, Texas Tornado (1982)	TX	Regression	Economic recovery	Family size, SES, % damage, age, marital status, use of disaster assistance, primary group aid, insurance adequacy, aid adequacy, HH moves, race

Note: Case a, b, or c indicates different study within one article or book (using different dependent variables or study areas). * indicates a critical variable; NB stands for neighborhood; HH stands for household.

Policy Implications

As the literature review above makes clear, disasters make previously-existing housing problems more severe. Processes already in place in communities become magnified and hastened during disasters (Bates & Peacock, 1987; Kates, Colten, Laska, & Leatherman, 2006; Morrow & Peacock, 1997; Olshansky, Hopkins, & Johnson, 2012). Consequently, the outcomes can be generally predicted by pre-existing conditions (Peacock, Van Zandt, Zhang, & Highfield, 2014). However, it should be remembered that the rate of compression would differ between processes, which can distort the relationship between redevelopment and decision processes compared to that in normal times (Olshansky, Hopkins, & Johnson, 2012).

Low-income households experience shortages of affordable housing stock prior to a disaster, and then the stock is further reduced after a disaster (Bates & Green, 2009; Bolin & Stanford, 1991; Kreimer, 1980). As shown by Katrina, many counties have a

shortage of affordable housing issues prior to a disaster (Bates & Green, 2009; Popkin, Turner, & Burt, 2006). Low-income housing, and in particular multi-family housing, is more likely to be damaged during a disaster because of existing housing condition and location, therefore increasing the probability that low-income households will face problems after a disaster. Thus, during normal times housing policy needs to give more consideration to increasing—or at least maintaining—the amount of affordable housing stock as well as improving the physical condition of those buildings.

Immediately after a disaster, adequate shelters as well as temporary housings are needed. Among the options for temporary housing, people prefer rental assistance to a FEMA trailer. Naturally, low-income households have a problem paying for rent increases and dealing with the lack of housing stock after disasters (Bolin 1993 *cited in Fothergill et al., 1999*). After Katrina, home prices increased in areas other than the most-damaged ones, and rent prices also increased for the entire area (Liu, Fellowes, & Mabanta, 2006). Moreover, there were also issues related to the landlords' willingness to accept vouchers (Wilgoren, 2005). Thus, rent-control policies are needed for each municipality to prevent rental prices from escalating dramatically during the recovery and reconstruction phase (Fothergill, Maestas, & Darlington, 1999; Fothergill & Peek, 2004). Cities, which receive many evacuees, may issue emergency vouchers with funds from FEMA, HUD, or state as a temporary housing solution—for example Houston and Dallas during Hurricane Katrina (see Popkin, Turner, & Burt, 2006). Moreover, these cities may create a program to encourage landlords to admit these vouchers from the needy populations.

For disabled people in particular, more money should be spent on rent assistance because they require special accommodations that are more expensive than reflected by local Fair Market Rent levels (Fischer & Sard, 2006; Sard & Rice, 2005). Sard and Rice (2005) noted that rental assistance from FEMA and HUD was rarely covering the costs of utilities unless rental charge included utility. Thus, covering the costs of utilities is one way to help low-income households, and it is especially effective during summer and winter. Additionally, they suggested that assistance with housing search and also relocation assistance are other ways to reduce renters' burdens. Furthermore, renters' unmet needs need to be considered, and consistent and clear legal interpretations of rental assistance programs would be helpful (see detail in U.S. Senate, 2009).

For the temporary housing option, rental repair programs could be considered as an alternative to FEMA manufactured housing (U.S. Senate, 2009). FEMA trailers take time to be manufactured, which requires people to stay in a shelter longer (Davis et al., 2006). In contrast, rental repair programs could increase rental-housing stock that also serves as a good option for permanent housing; overall, it would be a cost-effective solution compared to manufactured housing (U.S. Senate, 2009).

According to Neal's (1997) study, after a disaster affects an area, some households passed from the emergency response phase to the recovery phase within a single month, while other households lagged and remained in the emergency response phase during that time. Previous studies show that owner-occupied housing experiences much faster recovery compared to rental housing (Zhang & Peacock, 2010), and renters and owners may even experience different disaster phases and activities concurrently.

Rental housing has often suffered from the lack of resources for repairs and rebuilding (Cutter, Boruff, & Shirley, 2003; Dash, Peacock, & Morrow, 1997; Girard & Peacock, 1997). Prior to a disaster, many large apartment buildings are already in bad condition. Owners of these buildings have inadequate or no insurance, insufficient money, and little support from government because of complex ownership arrangements that make them unable to get a Small Business Administration (SBA) loan (Comerio, 1997, p. 169). SBA loans and many FEMA assistance programs are often not applicable to renters (Bolin & Stanford, 1998; Comerio, 1998; U.S. Senate, 2009). Thus, relief agencies can provide financial aid and other forms of direct assistance to help renters and landlords deal with the challenges found within a disaster-stricken market (Burby, Steinberg, & Basolo, 2003).

Low-income affordable housing is rebuilt very slowly—or not rebuilt all—when compared to most other damaged housing. Prior to a disaster, there is usually not enough low-income housing, and yet post-disaster it is difficult to rebuild this housing stock even to the pre-disaster level. This slow (or lack of) recovery exacerbates renters' financial difficulty. While their original housing is rebuilt or repaired, they need money for temporary housing, not only rents and security deposits but also restoration of household goods. Considering that renters don't have enough resources and also that their housing recovery time takes longer, they often have severe problems paying for temporary housing. Therefore, solutions for displaced individuals and households, especially those who are unsubsidized renters (as opposed to federally-subsidized renters), are needed (see Popkin, Turner, & Burt, 2006). Also, housing subsidies for

other communities or cities that adopt some of these displacees are needed to account for people who resettle in other places (Lubell, 2005). More importantly, policy makers must plan for improving issues of housing affordability and quality even before a disaster as a fundamental solution.

Overall, the American housing system provides single-family housing well, and yet there are some shortcomings in what it provides for renters. During a normal period, housing policies (in particular the tax system) tend to favor owners over renters (Krueckeberg, 1999). Similarly, after a disaster, the current system serves single-family homeowners, particularly the middle-class, well in terms of disaster assistance to rebuild housing (Bolin & Stanford, 1991; Bolin & Stanford, 1998; Comerio, 1998). Likewise, a sufficient quantity of affordable housing stock for renters needs to be rebuilt in a reasonable time period and providing financial incentives could be one method to help ensure that it gets done (Zhang & Peacock, 2010). FEMA (2009) suggests another way to do this is to use funds from the Community Development Block Grant program and the HOME program to repair and rebuild this housing, in case of single-family rental housing, while having agreements that maintain rents at affordable levels to certain low-income residents. Overall, housing assistance programs need to focus more on renters' unmet needs (U.S. Senate, 2009, p.12) so that federal resources are distributed to the right place–for needy people.

Conclusions

This paper is focused on the difference between renters' and owners' housing needs before, during, and after a disaster. The previous studies showed that renters lack resources from prior to a disaster (preparedness) to post-disaster (recovery). Before a disaster, their resources were different, including financial resources, housing condition, and housing location. That is, renters' household, social, and physical resources prior to a disaster were limited compared to that of housing owners. Additionally, renters had more-severe damages during a disaster. Moreover, during a recovery, renters' limited financial resources (e.g., lack of insurance, and less governmental assistance) (Bolin & Stanford, 1998; Kunreuther & Roth, 1998 *cited in Peacock et al., 2007*) as well as limited social and political resources (i.e., less ability to make decisions regarding recovery) (Morrow, 1999) causes them to struggle harder and over a longer period of time.

Although housing tenure is an important vulnerability characteristic, the previous disaster-related studies were not much focused on it, but rather were more focused on race and income. Additionally, studies usually focused on a single disaster phase, whereas this study considers the larger picture of both rental and ownership housing needs before, during, and after disasters. This study offers an initial step in developing a framework based on housing tenure among social vulnerability studies.

There are a few suggestions for the future research. Although this paper provides theoretical evidence on the difference between renters' and owners' housing needs throughout a disaster, empirical study is also needed about how these differences of

housing needs by housing tenure change throughout various disaster phases. Thus, future study should focus on identifying and quantifying daily or weekly housing needs of renters and owners before, during, and after a disaster. This study will provide more advanced and detailed information to community planners and disaster managers regarding how to support renters and owners efficiently throughout various disaster phases, based on the understanding of what the specific needs are and when the needs peak. Notably, finding data on previous annual patterns (i.e., year-on-year changes) will be beneficial to identify/quantify a hurricane's impact on yearly needs. Furthermore, researchers could examine differences between owners and renters regarding which community characteristics are associated with their regions' housing needs before and after a disaster.

Future research should consider on analyzing housing needs over time and location by housing tenure from pre-disaster through recovery. It would be an interesting research to map hot-spots over time for specific type of needs (e.g., shelter needs and recovery needs). Finally, there is still little research related to housing recovery process following a disaster (Peacock, Dash, & Zhang, 2007), which is an important area that needs more attention.

CHAPTER III

HANDLING INCOMPLETE TERTIARY DATASETS: CASE OF 2-1-1 INFORMATION AND REFERRAL MISSING DATA

Introduction

Disasters such as Hurricane Sandy in 2012 and Hurricane Katrina in 2005 devastated coastal regions of the U.S. Policymakers want to know locations where services are needed during disasters and when the needs peak so that support can be most effective and efficient. For particular disasters, researchers need data that spans time and location; however, it is difficult to aggregate data from disparate sources. Even if these datasets could be compiled, they may have missing variables or different data collection methodologies (e.g., continuous vs. categorical, written detailed response vs. summary report).

Much has been written about methods to handle missing primary data; however, missing data in tertiary datasets remains problematic. Employing secondary data or tertiary data (i.e., data from published reports or the results of analysis; Blaikie, 2003) saves time and reduces both effort and the cost of research (Kiecolt & Nathan, 1985; Sørensen, Sabroe, & Olsen, 1996). According to these authors, it improves external validity because of the large study populations as compared to sample sizes typically collected in surveys or polls. Yet researchers may not take advantage of tertiary sources because of incomplete data. Finding a suitable method to handle missing data when merging tertiary datasets could increase the potential use of real-world datasets and

reduce bias in their analysis. In this study, we present a method to replace missing data for a key variable in one dataset to be merged with several other complete datasets.

Caller data from the Texas 2-1-1 Information & Referral (I&R) Network was used to investigate the missing data problem when merging tertiary data. Unlike 9-1-1 for emergency calls, the 2-1-1 phone service helps callers with non-emergency needs find health and social support services. The 2-1-1 caller data captured three key variables in real-time for analysis of unmet disaster needs over time and location: 1) caller unmet needs, 2) call date, and 3) locations where referrals were sought. The study covered a five-month period beginning in August, 2005, to capture data about unmet needs during Hurricanes Katrina and Rita evacuation, disaster response and recovery in Texas. The Texas 2-1-1 Network is comprised of 25 regional Area Information Centers (AICs) that share referral resource data statewide but maintain independent databases of caller unmet needs. Hence, merging these 25 caller databases enabled the investigation of unmet disaster needs longitudinally and spatially. However, call date was missing in the dataset submitted by the large Dallas metropolitan area call center. Hence, without call date, it was expected that there would be significant bias for longitudinal analysis of unmet needs by disaster phase unless there was a way to replace the missing data.

The specific merged dataset examined below was narrowed to callers requesting help for housing or shelter (N=180,601). This subset was about 28 percent of the total 2-1-1 calls during the study period (N=635,983) and represented the largest proportion of disaster needs when compared to health (18 percent), food (15 percent), or transportation (4 percent). Among the 25 AICs, the Dallas AIC lost their raw data and only had

summary reports listing volume of calls by county by type of need. The Dallas AIC served eight counties with a call volume of 124,435 during the 5-month study period, second only to Houston's AIC 2-1-1 call volume. Because the Dallas metropolitan area was a major evacuation destination during Hurricanes Katrina and Rita, their call data would be important to include in analysis of disaster needs over time. Thus, an accurate method was needed to replace the missing call date information.

This study involved four steps: 1) review types of missing data and existing techniques for handling missing data, 2) discuss missing data problems in the 2-1-1 tertiary datasets, 3) design a method for handling these incomplete datasets, and 4) apply the method to a real 2-1-1 dataset. Using this method, the volume of data for 2-1-1 datasets could be increased approximately 30 percent; therefore, the statistical validity increased. Moreover, this new approach for handling systematic missing data could be applied to other types of tertiary databases (e.g., 911, hospital records, school records, multiple service centers) that may have the similar dilemma of missing a variable in a subset of merged data.

Background

Types of Missing Data

Little and Rubin (1987, 2002) defined three types of missing data: missing completely at random (MCAR), missing at random (MAR), and not missing at random (NMAR). First, for MCAR data, "the probability of missing data on Y is unrelated to the value of Y itself or to the values of any other variables in the data set" (Allison, 2001, p.

3). For example, participants may be absent from a test due to random reasons not related to variables in the study, such as relocation or family tragedy (Peugh & Enders, 2004). Hence, this type of missing data is unbiased. Next, for MAR data, "the probability of missing data on Y is unrelated to the value of Y, after controlling for other variables in the analysis" (Allison, 2001, p. 4). For example, a male student may provide his test score while a female student doesn't, however within each gender category, the probability of a missing test score was not associated with test score itself. Finally, for NMAR, "the possibility that a variable value is missing depends on the missing data values themselves" (Newman, 2009, p. 10). For example, overweight people might avoid providing their weight data due to medical or social consequences, in which case this type of missing data is non-ignorable. Figure 3.1 is a flow chart that helps identify types of missing data.

In this study, the call date is MAR, because it is related to an exogenous variable and is not associated with the variable itself. In other words, the probability of call date data being missing depended on the regional call Area Information Center (AIC). Furthermore, within the AIC, the probability of having a missing call date was not related to the value of the call date.

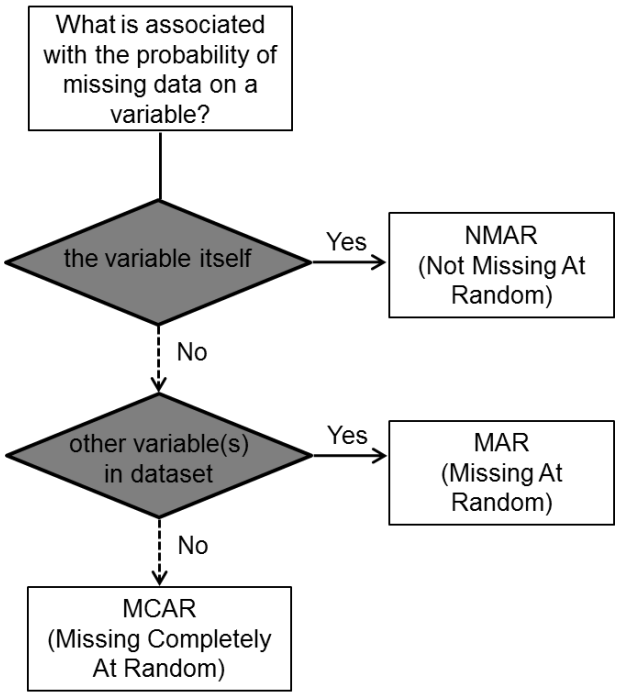


Figure 3.1. Determining the type of missing data

Methods of Handling Missing Data

To improve the value of analysis, it is necessary to identify missing data by type and then to use appropriate methods for handling these data. Some studies have used benchmark datasets (e.g., different amounts of missing data or different missing data types) to compare alternative methods for handling missing data (Buhi, Goodson, & Neilands, 2008; Chen & Åstebro, 2003; Farhangfar, Kurgan, & Dy, 2008; Newman, 2003; Scheffer, 2002; Sentas & Angelis, 2006). Others did not adequately consider missing data type or choose an appropriate method to manage missing data bias; whereas some studies disregarded bias imposed by missing data (for a review of reporting

missing data in educational research, see Peugh & Enders, 2004; in psychology literature, see Roth, 1994).

Table 3.1. Methods for handling the type of missing data

Type of missing data	Author	Recommend method[a]
MCAR	Roth (1994)[b]	Pairwise deletion, Regression imputation, Hot-deck imputation
	Allison (2001)	ML, MI, Listwise deletion
	Newman (2009)	ML, MI
MAR	Roth (1994)[b]	Hot-deck imputation, ML
	Allison (2001)	ML, MI
	Scheffer (2002)	MI works well. Single imputation methods work depending on the amount of missing.
	Chen & Åstebro (2003)	Listwise deletion is efficient; however if data loss is too much, Bayesian method is another solution.
	Sentas & Angelis (2006)	Multinomial logistic regression showed good performance for categorical missing data.
	Buhi, Goodson, & Neilands (2008)	Modern methods (ML, Bayesian estimation, MI) were better than ad hoc methods.
	Newman (2003, 2009)	ML, MI
MNAR	Roth (1994)[b]	ML
	Allison (2001)	ML, MI (possible method "if the chosen model is correct", see p.78)

Note. [a]ML = Maximum Likelihood; MI = Multiple Imputation.
[b]Amount of missing data is below 20 percent (see Roth 1994, p. 551).

Table 3.1 summarizes the recommended methods for handling missing data by type of missing data. The listwise deletion method has been widely used for MCAR and MAR types of missing data. Also, the hot-deck method is common in practice (Brown & Kros, 2003) and may be a viable alternative because the missing data are replaced using similar cases based on other variables related to respondents' characteristics (Roth, 1994). More recent studies, however, mostly agree that modern methods such as Maximum Likelihood (ML) or Multiple Imputation (MI) produce more robust estimates

compared to ad hoc methods under MAR (Buhi, Goodson, & Neilands, 2008; Fox-Wasylyshyn & El-Masri, 2005; Newman, 2003, 2009). Nevertheless, there is no single method that works for all types of missing data (Buhi, Goodson, & Neilands, 2008; Farhangfar, Kurgan, & Dy, 2008). Unfortunately, none of these methods were appropriate for the type of missingness encountered in our merged tertiary dataset. Thus, we needed an innovative approach to manage our missing data.

Data Issues of Texas 2-1-1 Information & Referral

The datasets from the 25 Texas AICs used a variety of recording systems. Two-thirds of the AICs had almost complete call records with both a dependent (housing-related need) and two key independent variables (location and call date) per caller. Essentially, their data were MCAR. Of the remaining AIC datasets, some had both need and location variables, whereas others had only need data not associated with location and call date variables. In the caller needs housing-related dataset, approximately 32 percent of call dates, a major variable of concern, were missing (Table 3.2).

Table 3.2. Numbers and percentages of missing data for key variables in 2-1-1 caller needs dataset (total calls vs. housing-related calls), fall 2005

Key variable	Total calls (N=635,983)		Housing-related calls (N=180,601)	
	Number of missing	Percentage of missing	Number of missing	Percentage of missing
Location	82,561	13.0	8,796	4.9
Call date	212,551	33.0	58,213	32.2
Need	2,799	0.4	0	0.0

The major source of missing call data was from the Dallas AIC call records. In the total dataset, Dallas data accounted for approximately 58.5 percent of call date missing overall and approximately 85 percent (N=49,614) of call date missing in the housing needs subset of data. Over 70 percent of 2-1-1 calls received by the Dallas AIC were from Dallas County that had about 10 percent of the Texas population in 2005. Hence, about 61 percent (N=35,638) of the housing-related dataset missing call dates came from Dallas County. Without Dallas County data from Dallas AIC, we would lose not only the disaster-related needs in this hurricane evacuation destination but also the routine needs of this major metropolitan area. Thus, a new method was needed to capture this valuable information.

Methods

Data Source

The study population was Texas 2-1-1 Network caller data from August 1 through December 31, 2005, for the 635,983 calls recorded from the 25 regional call centers. The data were in three forms: hand-written call logs, CDs of electronic data files, and summary reports from four call centers that had lost their raw data. After all caller identifiers were removed, the research team coded the data into a consistent database format and validated each step to minimize errors. Narrative descriptions of callers' needs were categorized into types of basic disaster needs – housing, health, food, transportation and other. In turn, these were subcategorized into specific variables for future analyses.

This study focused on the subset of data for housing needs (N=180,601) with location and call date variables. The category of housing-related needs consisted of seven types: shelter, rental housing, ownership housing, mobile home, group home, public housing, and housing unknown. Caller location was coded as the county where the caller was looking for help (N=254 Texas counties or state outside of Texas). Call date was recoded into 17 disaster phases, beginning with a 4-week baseline before Katrina and extending 14 weeks following Rita (Table 3.3).

Table 3.3. Study period of 2-1-1 tertiary data by disaster phase, fall 2005

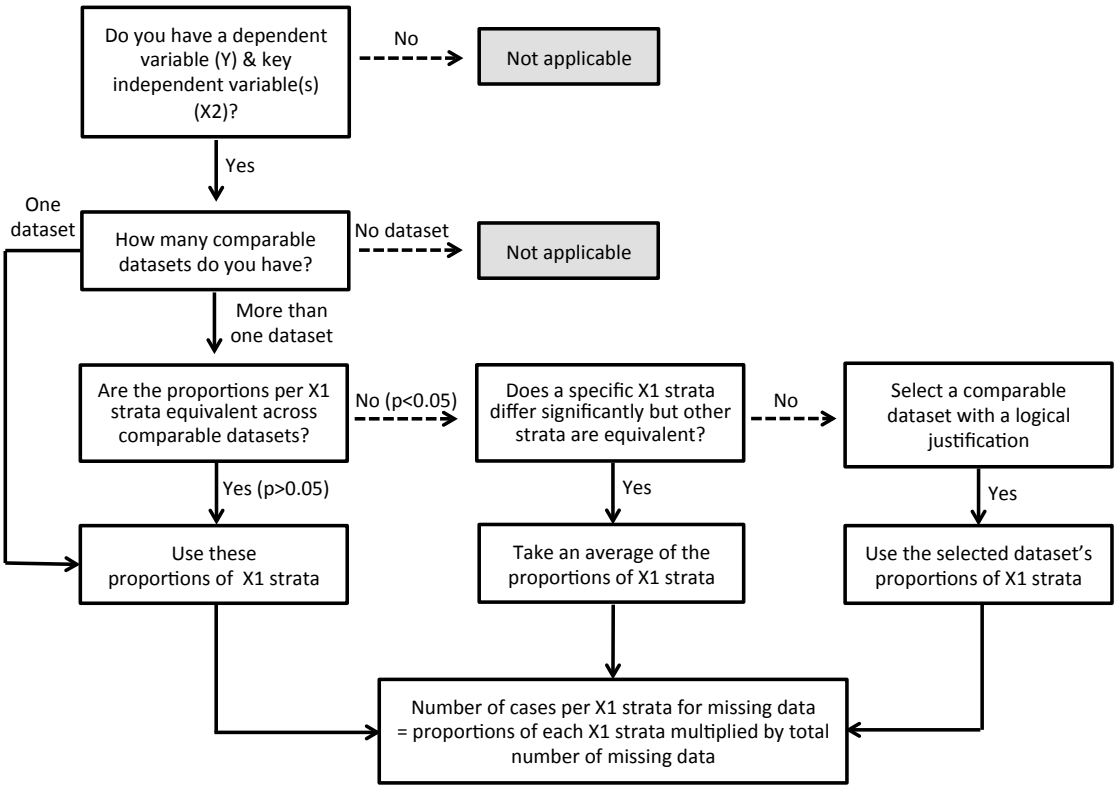
No.	Disaster phases	Date	Number of days	Duration
1	Baseline	8/1–25	25 days	4 weeks before Katrina landfall
2	Evacuation-K	8/26–28	3 days	1 to 3 days before Katrina landfall
3	Landfall-K	8/29	1 day	Katrina landfall
4	Immediate 1 to 3 days-K	8/30–9/1	3 days	1 to 3 days after Katrina landfall
5	Immediate 4 to 7 days-K	9/2–5	4 days	4 to 7 days after Katrina landfall
6	Intermediate 2 weeks-K	9/6–12	7 days	2 weeks after Katrina landfall
7	Intermediate 3 weeks-K	9/13–20[a]	8 days	3 weeks after Katrina landfall
8	Evacuation-R	9/21–23	3 days	1 to 3 days before Rita landfall
9	Landfall-R	9/24	1 day	Rita Landfall
10	Immediate 1 to 3 days-R	9/25–27	3 days	1 to 3 days after Rita landfall
11	Immediate 4 to 7 days-R	9/28–10/1	4 days	4 to 7 days after Rita landfall
12	Intermediate 2 weeks-R	10/2–8	7 days	2 weeks after Rita landfall
13	Intermediate 3 weeks-R	10/9–15	7 days	3 weeks after Rita landfall
14	Intermediate 4 weeks-R	10/16–22	7 days	4 weeks after Rita landfall
15	Recovery 5 to 8 weeks-R	10/23–11/19	28 days	5-8 weeks after Rita landfall
16	Recovery 9 to 12 weeks-R	11/20–12/17	28 days	9-12 weeks after Rita landfall
17	Recovery 13 to 14 weeks-R	12/18–31	14 days	13-14 weeks after Rita landfall

Note. [a]Phase has 8 days (7+1 extra day) because after that day, days overlap with Evacuation-R phase.
K = Katrina; R = Rita.

Procedures to Impute Missing Data

This study examined the case when missing values could be imputed for a key categorical variable missing from one of multiple merged data sources so that a particular dataset could be salvaged to use in analysis and to reduce bias. In this study, the Dallas AIC had complete data for the dependent variable (housing-related needs) and one other independent variable (location) but was missing 100 percent of call date information. Without replacing missing date information in the sizable dataset from Dallas, analysis of housing needs over time would be limited and bias would be introduced about shelter needs known to be important in this major evacuation destination.

The two known variables (need and location) could be used to find values for the missing date variable (disaster phase) when compared to dataset(s) from a comparable type of location(s) for the same study period. Of the 25 call center locations, Harris County (Houston) and Bexar County (San Antonio) were selected given their comparable city size, evacuation destination role in the hurricane disasters, 2-1-1 call center size and volume of calls. Although neighboring Fort Worth may have been comparable to Dallas, their database was missing two of the three key variables so missing data could not be imputed. The remaining Texas metropolitan area, Travis County (Austin), was excluded because this call center provided support services for the Statewide 2-1-1 headquarters so its call patterns and types of needs differed considerably during these hurricane disasters. This decision-making process of finding comparable sources of datasets is illustrated in Figure 3.2.

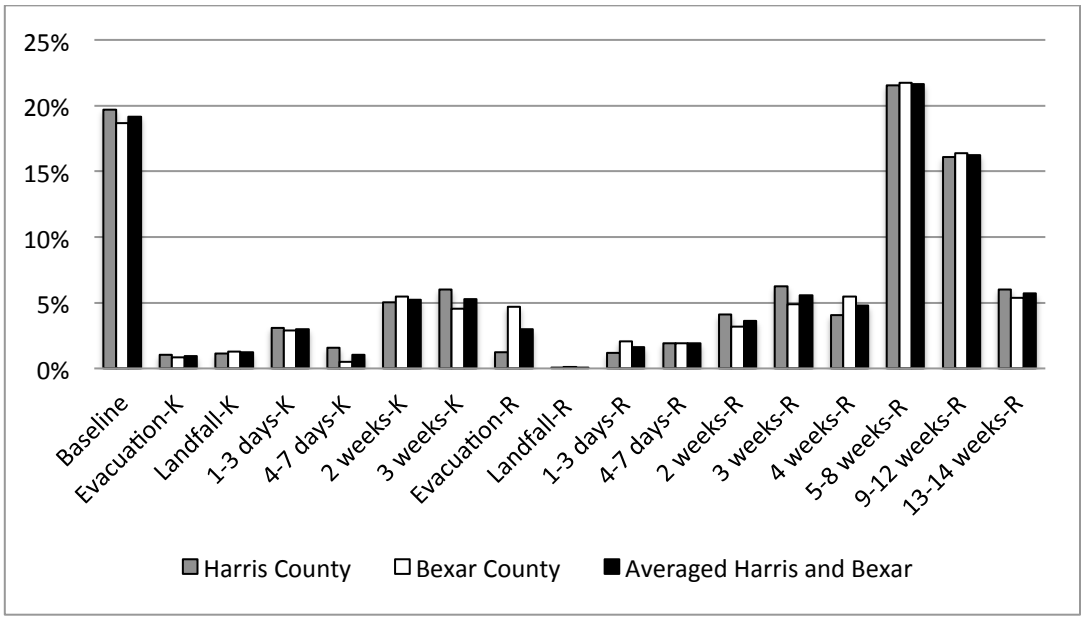


Note. X1 = Independent variable with missing categorical data = Disaster phase
X2 = Other key independent variable(s) with known data = County location
Y = Dependent variable(s) = Housing unmet need

Figure 3.2. Procedure for substituting categorical missing data using comparable dataset(s)

Figure 3.2 presents the decision process concerning how to most appropriately replace missing data for an independent categorical variable (X1: disaster phase). To begin, there must be sufficient complete data in the problem dataset for the dependent variable (Y: housing unmet need) and at least one other independent variable (X2: county location) that can be matched to determine proportions of Y per category of X1.

The second step is to determine comparable datasets using equivalent: a) unit of analysis, b) study period, c) key variables (X2), and d) exogenous considerations that logically would link the data sources. In this case, the exogenous considerations were comparable city size, major evacuation role in disaster, and 2-1-1 call center size for managing call data collection and recording.



Note. K = Katrina; R = Rita.

Figure 3.3. Percentages of calls for housing unmet needs by disaster phase for Harris, Bexar, and averaged percentages of these two counties, fall 2005

Table 3.4. Imputing Dallas 2-1-1 calls by disaster phase for housing unmet needs based on Harris and Bexar County data, fall 2005

Disaster phases	Harris County: 2-1-1 calls for housing needs by disaster phase		Bexar County: 2-1-1 calls for housing needs by disaster phase		Averaged % calls of Harris & Bexar	Dallas County imputed missing data: # housing calls of disaster phase data
	N	%	N	%	%	N
Baseline	5,945	19.7	1,743	18.7	19.2	6,834
Evacuation-K	316	1.0	79	0.8	0.9	337
Landfall-K	349	1.2	120	1.3	1.2	435
Immediate 1 to 3 days-K	935	3.1	272	2.9	3.0	1,071
Immediate 4 to 7 days-K	476	1.6	47	0.5	1.0	371
Intermediate 2 weeks-K	1,514	5.0	511	5.5	5.2	1,868
Intermediate 3 weeks-K	1,811	6.0	424	4.5	5.3	1,878
Evacuation-R	378	1.3	440	4.7	3.0	1,063
Landfall-R	6	0.0	12	0.1	0.1	26
Immediate 1 to 3 days-R	360	1.2	192	2.1	1.6	579
Immediate 4 to 7 days-R	584	1.9	177	1.9	1.9	682
Intermediate 2 weeks-R	1,233	4.1	295	3.2	3.6	1,290
Intermediate 3 weeks-R	1,884	6.2	455	4.9	5.6	1,980
Intermediate 4 weeks-R	1,226	4.1	511	5.5	4.8	1,698
Recovery 5 to 8 weeks-R	6,504	21.5	2,030	21.7	21.6	7,711
Recovery 9 to 12 weeks-R	4,855	16.1	1,530	16.4	16.2	5,784
Recovery 13 to 14 weeks-R	1,818	6.0	502	5.4	5.7	2,031
Total	30,194	100.0	9,340	100.0	100.0	35,638

Note. K = Katrina; R = Rita.

The third step is to use the comparable datasets to calculate proportion of cases for Y (housing unmet need) per X1 strata (disaster phase). These proportions per X1 strata should be compared across the variety of comparable datasets to identify consistency. Differences in proportions per strata should then be tested statistically for "no significant difference" ($p > .05$) and visualized (Figure 3.3). If consistent, there

would be more confidence in imputing these proportions for missing values (see Table 3.4 for application example). If a specific strata differs significantly between comparable datasets but other strata are consistent, then an average of the strata proportions among the comparable datasets is used. If multiple X1 strata vary significantly between the comparable datasets, then the researcher would need to justify the logic of narrowing the selection of a comparable dataset(s). Again, limitations underlying the selection of fewer comparable datasets would need to be noted, much like the rejection of Ft. Worth's and Austin's datasets discussed previously.

To progress to the fourth step, differences in proportion of housing needs per disaster phase between two comparable datasets (Harris and Bexar Counties) are visualized in Figure 3.3. Both Harris County (Houston) and Bexar County (San Antonio) were comparable matches, except in two phases immediately before and after Hurricane Rita. Houstonians and Katrina victims had evacuated before Hurricane Rita veered northward for landfall; then they sought shelter, food and fuel before returning to Houston. Thus, based on Figure 3.3, it was decided that averaged proportions of these two counties were appropriate for allocating the number of calls in each disaster phase for Dallas County data (shown by the black bar).

The fourth step is to calculate the proportion of cases in each X1 strata used to replace the missing values. There are two strategies for doing this. The first would be to add the number of cases within a strata across the comparable datasets, then calculate a proportion of that strata per total cases among the comparable datasets. This approach assumes no significant difference between proportions of the comparable datasets and

equivalent number of cases within each strata per dataset. A second approach would be to use an average of the proportions of the comparable datasets for each X1 strata. This would "even out" minor variations between the strata proportions in each dataset and not have the subtle bias of one dataset being much larger than the other, thus possibly weighting the total proportion in a biased way.

In the fifth and last step, the proportion of cases per X1 strata calculated from the comparable databases is then used to impute the missing data per strata (see study example in Table 3.4). The number of cases for each X1 strata for the missing variable dataset is calculated using the proportions by each X1 strata (i.e., disaster phase) multiplied by total number of cases in that dataset with the missing variable.

For example:

Baseline phase in Dallas County =

[19.7% (from Harris County) + 18.7% (from Bexar County)]/2 =

19.2 % average proportion of calls for housing unmet needs.

Multiplied by: Total number of calls for housing unmet needs for Dallas County from Dallas 2-1-1 call center = 35,638

Thus: 19.2% × 35,638 = 6,834 for the baseline phase of Dallas County

This process is repeated for each X1 strata to impute missing disaster phase data for Dallas County.

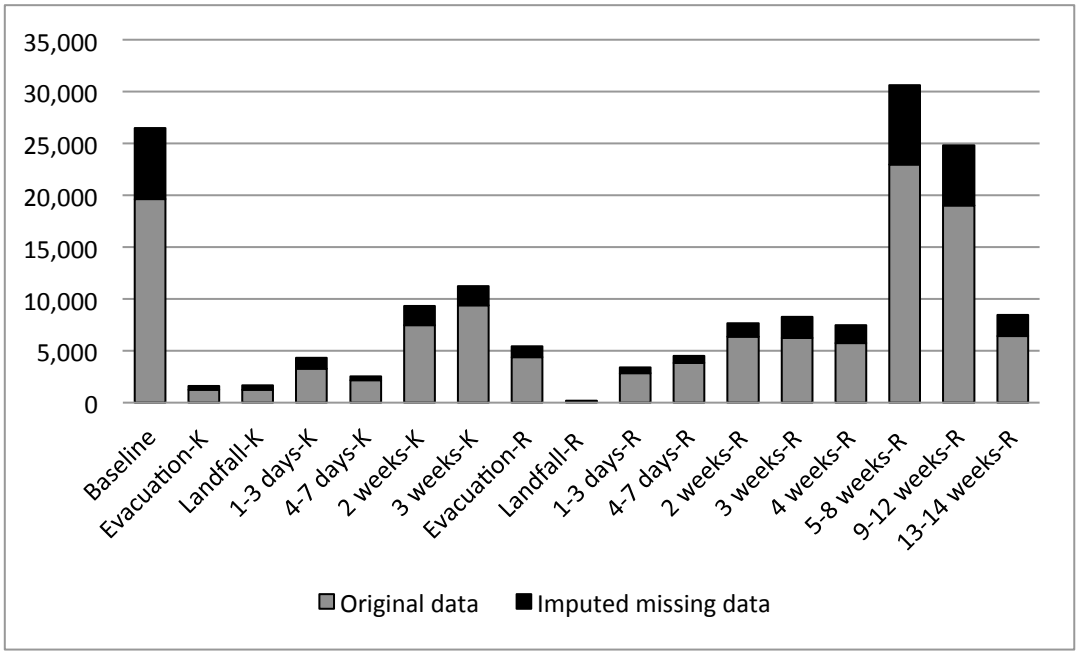
There are two strategies for assigning cases into each strata: 1) random selection without replacement and 2) systematic selection (choose every N^{th}) with a random start. When there is any systematic order in a dataset (e.g., alphabetical, time cycle, ranking),

random selection is preferred. In this study, random selection without replacement method was used. First, the strata order of disaster phases were randomized according to which strata of cases would be selected 1st, 2nd, i^{th}. Then, using a random number generator, the cases were selected per strata, being sure to go through the complete list of cases at least once. Although this method could introduce error, at least it would be randomized. For example, housing needs related to disaster sheltering could be assigned randomly to the pre-hurricane baseline phase. One would then need to review known key indicators in the dependent variable of housing needs (e.g., disaster sheltering, FEMA financing for repairs, "blue roof") for inappropriate placement into X1 strata to determine error frequency in the random assignment.

Effect of the Model to Impute Missing Data

Replacing missing Dallas County data by disaster phase significantly increased the number of cases (N=35,638) available for analysis of disaster unmet housing needs over time. In Figure 3.4, the original number of calls for housing unmet needs by disaster phase (gray) is compared to imputed Dallas data (black). As expected, the overall call pattern after replacing the lost Dallas County data (gray + black) was similar to the pattern shown before data replacement (gray). However, to understand state-level unmet housing needs during a disaster, it would be important for emergency managers and policymakers to know the more accurate volume of demand by disaster phase. The size of this demand would be significantly miscalculated without imputing missing Dallas County data. Thus, this information would help policymakers not only to

determine which disaster phases had high demand for housing unmet needs, but also to quantify those housing needs in order to more effectively and efficiently deliver emergency relief services.



Note. K = Katrina; R = Rita.

Figure 3.4. Numbers of state level calls for housing unmet needs by disaster phase in original data versus imputed missing data, fall 2005

Data Limitations

This data has several limitations. First, biases from other missing data were unknown. Calls were dropped during peak call volume. Surge of calls during landfall were not logged as staff and volunteers were too overwhelmed with call demand to enter data. The telephone system used by 2-1-1 dropped calls when volume exceeded peak

capacity. Although it seemed that only 0.4 percent of calls without need data (N= 2,799) were missing randomly, the information of these cases were excluded in this analysis of housing needs. Although call volume and needs would be underestimated, 2-1-1 staff reported that the types of needs were not expected to differ.

Potential socio-economic biases of the 2-1-1 caller population may be expected to bias the types of needs reported, but there were no demographic data available to test this. Also unknown was whether callers were local residents seeking help for routine needs or evacuees needing disaster assistance. These caller characteristics may also influence timing of when they needed help during the disaster phases. This dataset of all 2-1-1 calls statewide during the 5-month study period captured variation in type and volume of housing unmet needs. As every disaster is unique, generalizations would be recommendations for further policies to improve disaster response and recovery. Nevertheless, the strength of these recommendations is improved greatly by replacing 35,638 cases with missing data of housing and shelter needs in a major metropolitan evacuation destination.

Second, there were further limitations of this model to impute missing data. It could be applied to MAR type of missing data, but not for MNAR. However, the distinction of MAR versus MNAR may not be possible in many cases "because the values of the missing data are not available for comparison" (Newman, 2003, p. 358). For example, in this study, the probability of missing call date information depended on AICs where the data was collected, and within the AICs, the probability of having missing call date data was not related to the value of the call date, which shows MAR

type of missing data. Therefore, researchers would need to classify the type of missing data for their dataset before using this method.

Third, if a dataset has many key variables and part of the dataset has one missing variable, researchers may prefer other methods. For example, if this dataset had socio-economic characteristics of the 2-1-1 callers, hot-deck or multiple imputation method could be considered. However, the dataset did not have the additional information, so that this new method was needed. Thus, if the dataset has only a few key variables and part of the data has one missing variable (i.e., the datasets did not have enough predictors for the missing variable), then researchers can consider this method for salvaging tertiary data sources.

Finally, this missing variable (call date) was originally an interval variable (153 days); however, it was recoded and replaced as a categorical variable (17 disaster phases) because it could be more robust for future analysis. Thus, when researchers want to use this method, they may consider changing the type of their variable from interval to categorical.

Conclusions and Recommendations

Tertiary data have the advantage of saving considerable time and effort to collect a large dataset. Yet, researchers could be faced with difficulties to aggregate tertiary data from disparate sources. This is particularly problematic if one subset of data has systematically missing data in a key variable that may bias the findings. Ideally, one would set uniform criteria to be collected in a standardized way across database sources.

In reality, programs and agencies collecting large datasets have evolved their own preferences for collecting and coding their data (e.g., Census, NOAA, EPA, FEMA, Red Cross, CDC, 9-1-1). These differences become obvious when trying to merge datasets for more comprehensive understanding of trends over time and location. Although many authors have addressed a variety of missing data issues for primary datasets, no studies were found that examined this problem in merging tertiary datasets. The ability to salvage an important dataset enables researchers to explore a broader variety of tertiary data for more valid meta-analyses.

In this study, we developed a model to impute missing data for a key variable (disaster phase) in order to merge 25 different tertiary 2-1-1 datasets to analyze disaster unmet housing needs before, during and after Hurricanes Katrina and Rita throughout Texas. The approach developed a systematic algorithm within parameters of the nature of the missing data (random vs. systematic) and the logical sources of comparative data (e.g., collected from similar city or organizational size, disaster experience(s), socio-demographic characteristics). By applying this method, the amount of data available for analysis increased about 30 percent, thus significantly improving the validity of the findings.

A next step would be to replicate this method in a simulated dataset where the reliability and validity could be measured and tested. Errors were known to occur, for example assigning a case with unmet shelter or "blue roof" needs occurring prior to the hurricanes. Besides examining known disaster housing types of needs assigned to non-disaster time periods, other types of errors could not be identified. Hence, the error rate

could not be determined. Further refinement of this model could include adjusting replacement of missing data according to socio-demographic groups, e.g., replacement within matching gender, race/ethnicity, age groups. This refinement could not be used in this study of 2-1-1 data as demographic variables were not consistently nor reliably collected.

With growing research interest in employing tertiary data for studies, appropriate handling of missing data needs to be developed to merge these tertiary datasets. In this perspective, the method discussed in this study will contribute to better managing missing data in a key variable from tertiary datasets, and to improving statistical validity. Moreover, the practitioner who is dealing with a broader availability of tertiary data would benefit to investigate a more complete set of data collected from the growing variety of data sources.

CHAPTER IV

SHELTERING, RENTAL AND OWNERSHIP HOUSING UNMET NEEDS DURING HURRICANES KATRINA AND RITA IN TEXAS, 2005

Introduction

In 2005, the U.S. experienced fifteen hurricanes, making it one of the worst years in terms of natural disasters (NOAA, 2006). In late August, over a million people were moved from their homes because of Hurricane Katrina (Godoy, 2006). A month later, Hurricane Rita leveled homes in east Texas near the Louisiana border. The fresh memory of Katrina's devastation and mismanagement prompted mass evacuations along the Texas coast of an estimated 3.7 million people seeing shelter inland (Eskovitz, 2006). In the aftermath of these sequential disasters, recovery efforts to meet Katrina victims' needs for temporary housing were significantly compounded by housing needs of Rita victims as well.

Several studies have focused on sheltering and housing recovery after these hurricane disasters. However, few have examined the variation of housing issues over time, including before and during disasters and into the recovery phase. None have tracked *unmet* needs for disaster housing throughout disaster phases. Furthermore, shortcomings of Federal Emergency Management Agency (FEMA), Red Cross, and the U.S. Department of Housing and Urban Development (HUD) data present problems to accurately estimate variation in numbers, locations, and types of housing needs of disaster victims throughout disaster phases (Kromm & Sturgis, 2008). This makes it

difficult to understand timing and duration of specific housing needs and to prepare adequate disaster related policies, plans and programs. In the past, disaster planners and managers may have relied on assumptions that displaced people could go back to their original places (Lubell, 2005). Following experiences from Hurricanes Katrina and Rita, these assumptions have changed.

The purpose of this study was to identify and quantify unmet housing needs before, during, and after Hurricanes Katrina and Rita by housing type using Texas' 2-1-1 Information and Referral (I&R) caller data. Unmet housing needs were identified based on callers' requests for 2-1-1 that revealed access barriers using real-time data. Therefore, unmet housing needs arose when people were not able to meet housing needs with their own financial or information resources. It is important that planners and managers understand what unmet housing needs may exist during disasters, to then prepare adequate programs for accessible disaster management and relief. In this study, unmet housing needs were examined over time, ranging from a baseline of a month before Hurricane Katrina throughout three months following Hurricane Rita. Additionally, these housing needs were categorized by specific *housing types*: shelter, rental housing (including public housing), and ownership housing. The 2-1-1 data covered all 254 counties in Texas and included housing needs not only of disaster victims, but also from communities that hosted those evacuees along with routine needs of local residents.

Background

Housing Needs during Hurricanes Katrina and Rita

On August 29, 2005, Katrina made landfall in southeast Louisiana as a Category 3 hurricane (Knabb, Rhome, & Brown, 2005). One day before landfall, mandatory evacuation was ordered in New Orleans (DeLozier & Kamp, 2005); however, many remained by choice or had been stranded. Two days after landfall on August 31st, Louisiana Governor Blanco ordered total evacuation of New Orleans (DeLozier & Kamp, 2005). Hurricane Katrina caused about 1,833 deaths (Lott, Ross, Smith, Houston, & Shein, 2011) and damaged about 228,000 occupied housing units (Muro, Liu, Sohmer, Warren, & Park, 2005). The estimated damage from Hurricane Katrina was roughly $125 billion, the costliest natural disaster in the U.S. at that time (Lott, Ross, Smith, Houston, & Shein, 2011). Of more than one million Katrina evacuees sheltered throughout the nation, over 400,000 evacuees went to Texas (Community Affairs Department, 2006).

Just a few weeks after Hurricane Katrina's landfall, another category 3 hurricane came on September 24th. Hurricane Rita made landfall near the Texas and Louisiana border at Sabine Pass, Texas, and Johnson's Bayou, Louisiana (Knabb, Brown, & Rhome, 2006). Unlike the disastrous experiences with evacuation from Hurricane Katrina, Texas started Rita evacuation three days prior to landfall (Crawford & Company, 2005). With shelter needs already overburdened by Katrina evacuees, Hurricane Rita created more than three million displaced people and damaged or destroyed approximately 75,000 homes in Texas (Texas Low Income Housing

Information Service, 2007). Evacuees were reported in all 254 Texas counties, with exceptional housing and shelter demand throughout the state.

In 2006, hurricane victims in Texas were still housed in 3,403 travel trailers as temporary housing (FEMA, 2006a). By February 2006, FEMA had received 640,968 Individual Assistance applicants in Texas resulting from Hurricanes Katrina and Rita (FEMA, 2006b). FEMA continued to provide rental assistance to about 107,000 households in Texas as of August 2006 (FEMA, 2006c). Federal assistance in response to the 2005 Hurricanes Katrina, Rita, and Wilma amounted to $109 billion; with about half ($52 billion) allocated to temporary and long-term housing, e.g., flood insurance program, Community Development Block Grant (CDBG), temporary manufactured housing or temporary home repair (Fellowes & Liu, 2006).

Phases of Disaster Sheltering and Housing

Disaster phasing has been useful in coordinating disaster management activities and determining the scope of disaster research (Neal, 1997). Quarantelli (1982, 1995) defined four phases of disaster-related sheltering and housing: emergency sheltering, temporary sheltering, temporary housing, and permanent housing. In Quarantelli's first stage, disaster related emergency sheltering, "actual or potential disaster victims" (Quarantelli, 1995, p. 45) use schools, churches, or stadium arenas as emergency sheltering for a few hours or overnight (Quarantelli, 1995). During the second phase, temporary shelters are related to short-term displacement in friends/relative's house, hotel/motel, or public shelter (Quarantelli, 1995). Emergency shelters and temporary

shelters are distinguished in terms of "behavioral aspects" (Quarantelli, 1995, p. 45) related to food, clothing, or sleeping areas (Phillips, 2009). People with different socioeconomic status would seek different types of emergency or temporary shelter. When possible, evacuees would choose to stay at a friend's house or hotel instead of public shelter (Tierney, Lindell, & Perry, 2001). Those with affordability or availability barriers would be more likely to use mass shelters (Mileti, Sorensen, & O'Brien, 1992; Yelvington, 1997). Although many communities had the capacity to shelter and house evacuees, these sequential disasters required state and federal involvement to meet urgent sheltering needs for hundreds of thousands of evacuees displaced for weeks or even permanently (FEMA, 2009).

When the need for temporary shelter lasts more than a few days, people would be expected to seek interim housings or temporary housings such as rental units, or mobile homes (Quarantelli, 1982, 1995). In this third phase, evacuees needed alternative housing to reestablish a normal routine (cooking, sleeping, shopping, social activities, job, and school) until they would be able to acquire permanent housing (Quarantelli, 1982, 1995; Phillips, 2009). To utilize various temporary housing options, evacuees may need rental assistance. To qualify for disaster rental assistance, the rental property must be financially and physically appropriate and available (FEMA, 2009). If the supply of temporary housing did not meet community needs or was prohibitively expensive, individuals and families would be forced to relocate yet again to another neighborhood or community. Factory-built manufactured homes (e.g., mobile homes) and recreational vehicles were also used for temporary housing to supplement the shortage of rental units

(FEMA, 2009). Higher-income households usually preferred to supplement rental assistance to help pay for more traditional housing rather than use mobile homes (Quarantelli, 1982).

In the last phase, providing permanent housing, a disaster victim's original home would be repaired or rebuilt; otherwise new housing would be obtainable (Quarantelli, 1995). Some Katrina evacuees who had lost their homes chose to make their temporary housing permanent. During this phase, single-family homeowners were more likely to take advantage of government assistance programs than were owners of multi-family housing units (Comerio, 1997). Additionally, single-family homes were faster to recover than other types of dwellings in duplexes or apartment buildings (Lu, 2008).

Mitchell, Esnard, and Sapat (2012) summarized overall institutional timelines of sheltering and housing from their case study of Hurricanes Andrew, Katrina, and Ike. They pointed out that the time frame for providing emergency shelter by the American Red Cross was up to two weeks; temporary shelter was covered by FEMA up to three months, possibly extending up to 18 months; and FEMA provided for temporary housing up to 18 months. However, in the case of Hurricane Katrina, many displaced people stayed in emergency shelters up to seven weeks, and then moved to temporary shelter from three months up to two years (Mitchell, Esnard, & Sapat, 2012). Three months after Hurricane Katrina, FEMA started providing trailers and mobile homes to the victims as temporary housing (Mitchell, Esnard, & Sapat, 2012). It took six years until the last trailer left (Muskal, 2012). The U.S. Department of Housing and Urban Development (HUD) also offered housing assistance after Hurricane Katrina, then two

years later HUD created the Disaster Housing Assistance Program (DHAP-Katrina) that provided assistance to over 30,000 families (U.S. Senate 2009).

Although disaster phases are useful empirical tools for organizing disaster management, there are limitations resulting from an "overlap of phases" as noted by Haas, Kates, and Bowden (1977) and Quarantelli (1982, p. 280). Each phase is not expected to be mutually exclusive (Neal, 1997). Disaster managers may simultaneously provide sheltering needs as well as housing recovery needs (Quarantelli, 1995). This situation was unusually complex in the case of Hurricanes Katrina and Rita with the two disasters occurring so close in time and location, compounding housing and sheltering needs in both disaster sites as well as evacuation destinations.

The 2-1-1 Information and Referral (I&R) Service During Disasters

During disasters (e.g., hurricanes, flooding, wildfires, winter storms, H1N1), 2-1-1 has played an important role nationwide. In 2000, the Federal Communications Commission (FCC) approved the 3-digit number 2-1-1 for Information and Referral (I&R) telephone support regarding non-emergency services, similar to 9-1-1 for emergencies. In 2004, Texas completed its statewide 2-1-1 system network comprised of twenty-five autonomous regional call centers. Immediately following Hurricane Katrina evacuation in August 2005, this system was designated by the Texas Governor's Office of Emergency Management as a communication hub between disaster and community support services and callers with non-emergency needs. During and after Hurricanes Katrina and Rita, the Texas 2-1-1 statewide network was used "24/7" as a telephone

communication system to connect callers seeking help with available resources and services (United Way of America, n.d.). Hence, the Texas 2-1-1 Network was ready to provide statewide disaster coverage "24/7" to Katrina-Rita evacuees as well as communities hosting these evacuees throughout the state.

Methods

Study Population and Data Collection

The study population included all 2-1-1 calls from August 1 through December 31, 2005 (N=635,983 total calls), logged in "real time" by the twenty-five Area Information Centers (AICs) in Texas. Certified 2-1-1 staff recorded each call into a 2-1-1 database to match needs to appropriate information and/or available referral programs. During emergency phases of both Katrina and Rita, trained volunteers logged their calls into supplemental call records either on paper or electronically. Typically each AIC would handle calls from counties within their regional jurisdiction. During disasters, the 2-1-1 Texas I&R Network (TIRN) implemented its capability to have AICs function as a single I&R system sharing local resource databases statewide to serve caller demand with the next available staff regardless of location. Hence, if one AIC lost phone or power or had to evacuate, the other AICs would seamlessly manage all calls. Also, larger urban AICs could support smaller call centers to cope with call surges while providing rapidly updated disaster resource information. Because of this rollover capability, it was important to merge and analyze the twenty-five Texas AIC databases to determine needs within disaster areas and evacuation destinations. Moreover, all counties in Texas

reported evacuees from one or both storms, again highlighting the importance of a statewide analysis for all Texas 2-1-1 calls.

The five-month study period encompassed a four-week baseline prior to Hurricane Katrina through three months of recovery after Hurricane Rita landfall. In winter of 2006, the 2-1-1 call data from the study period were collected from each AIC and stored at TIRN headquarters. Upon project funding in 2008 by the Department of Homeland Security, any identifying information was deleted from the AIC datasets then released to the researchers. The data were coded from the original electronic and paper data sources into a uniform file format, validated at 100%, then merged.

Study Variables

Three variables were consistently collected throughout the 2-1-1 dataset: 1) call date, 2) caller's location by county, and 3) description of caller's unmet need(s). Call date was logged by 2-1-1 staff and volunteers for AICs recording on paper forms or notes, particularly prevalent during the surge of calls during evacuation and the emergency period following landfall. Electronic call data had an automatic default to document call date. Call dates were then aggregated into six disaster phases (Table 4.1). There was a four-week baseline phase prior to Hurricane Katrina. Next, an emergency phase for each hurricane included landfall and the subsequent week where acute and urgent needs would be addressed. Three-day evacuation prior to Rita was included in this emergency phase as well. An intermediate phase was set to include 3 weeks post emergency phase, i.e., the first month post disaster when victims assessed damage and

took care of crises so they could begin to resume work, school, and community activities. Katrina's intermediate phase was cut short by the arrival of Hurricane Rita. The ten-week recovery phase in this study began after one month post-Rita landfall until the end of the calendar year. Recovery needs of both Katrina and Rita victims would be reflected during this phase.

Table 4.1. Study period of Texas 2-1-1 data by disaster phase, fall 2005

No.	Disaster phase	Date	Number of days	Duration
1	Baseline (Base)	8/1–28	28 days	4 weeks before Katrina landfall
2	Emergency-Katrina (E-K)	8/29–9/4	7 days	1 week after Katrina landfall
3	Intermediate-Katrina (I-K)	9/5-20	16 days	2 to 3 weeks after Katrina landfall
4	Emergency-Rita (E-R)	9/21-30	10 days	3 days before and 1 week after Rita landfall
5	Intermediate-Rita (I-R)	10/1-21	21 days	2 to 4 weeks after Rita landfall
6	Recovery	10/22–12/31	71 days	5 to 14 weeks after Rita landfall

Note. * Emergency-Rita phase includes 3 days evacuation before the landfall.

Location was recorded by the AICs as city, zip code, and/or county of the caller and of the recommended agency(s) or program(s) where the caller was seeking help. The researchers recoded location as the destination where the caller sought help for housing or shelter needs, i.e., the location of the referral organization, program, or service. Location data were aggregated to the county level (N=254 Texas counties) to preserve anonymity as well as enable comparisons to census measures of population size to control for urban/rural bias.

In this study, unmet needs relating to housing and shelter were used for analysis (N=180,601). Within the set of housing-related unmet needs, seven kinds of housing needs were empirically identified from the raw data: shelter (N=20,007), rental housing (N=35,267), ownership housing (N=6,542), mobile home (N=36), group home (N=1,324), public housing (N=4,021), and housing need with no further information about type (N=113,884). Note that shelter needs were not always mutually exclusive from other housing types as well as financial aid for rent and mortgage were coded together. Because of the small number of cases of group homes and mobile homes, these types were deleted from the longitudinal analysis as well as excluding calls where specific types of housing were not identified. Needs related to public housing were incorporated into the rental category.

Data Analysis

Analysis of 2-1-1 caller unmet needs was conducted for each of the three major housing types: shelter, rental housing, and ownership housing. First, a qualitative description was presented of the most frequent types of unmet needs within each housing type. Second, the volume of unmet needs was graphed for the number of calls daily per housing type over the five-month study period, illustrating variation in the pattern of unmet needs within and between the different disaster phases. The high volume of unmet needs showed that there was a lack of access to resources. Last, the weekly total number of unmet needs by housing type was overlaid on a single graph to show the differences in weekly patterns and volume over time.

Limitations of the Data

It should be noted that the number of 2-1-1 callers were expected to be underestimated. During disaster call surges, 2-1-1 staff and volunteers could not keep up with documenting each call as well as calls were disconnected from the automated phone system or dropped if callers did not hold until 2-1-1 personnel were able to answer. However, it would not be expected that the nature of caller needs not documented would be different than calls recorded during these peak times. Data missing specific type of housing need would also contribute to underestimating the volume of demand by housing type, but again, were not expected to differ from the overall trends found in the detailed data according to 2-1-1 staff recollections of their data collection during the disasters.

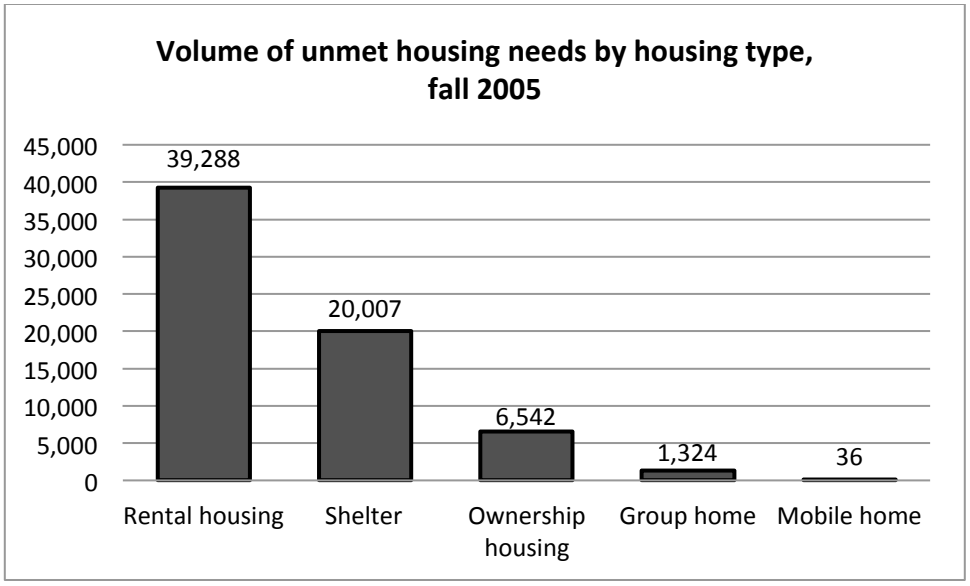
Representativeness of 2-1-1 callers compared to other evacuees or community residents was unknown as demographic data were not reliably collected. The 2-1-1 callers were motivated to seek help to overcome access barriers to meet their non-emergency needs. Callers may have been familiar with this service through prior experience encountering access barriers to community support services, via recommendations of community programs or family/friends, and from Texas disaster management's promotion of 2-1-1 as a gateway to community disaster support services. But comparisons to other disaster victims, service or program users, or county demographics would be inappropriate. Hence, this remains a case study of Texas 2-1-1 callers throughout disaster phases of Hurricanes Katrina and Rita. Nevertheless, the study's volume of unmet needs reported in real-time, broad geographic scope, and

extended time span through all disaster phases provides a unique portrayal of a vulnerable population's housing needs during disaster and recovery.

Results

Volume of Unmet Needs by Housing Type

A total of 635,983 Texas 2-1-1 calls were logged during the five-month study period encompassing four weeks baseline prior to Hurricane Katrina through three months of recovery following Hurricane Rita. Calls related to housing and shelter needs totaled N=180,601 during this period. The proportion of housing-related unmet needs was the highest (28%) compared to calls for other basic disaster unmet needs for food (15%), medical (18%), and transportation (4%). Sixty-three percent (N=113,884) of the housing-related needs did not have a housing type identified. Of the remainder (N=66,717), five housing types were empirically determined—unmet housing needs regarding: rental housing, shelter, owner housing, group homes, and mobile homes (Figure 4.1). Another type, public housing (N=4,021), was aggregated with rental housing (N=35,267) as the specific nature of their unmet needs were similar. The number of unmet needs by housing type did not sum to the total because 2-1-1 data entry included shelter needs recorded along with other housing types as well as overlapping rental and ownership financial aid needs.



Note. *Excluding number of calls without specific housing type information (N=113,884).
** Housing types were not mutually exclusive; total = 66,717.

Figure 4.1. Volume of unmet housing needs by housing type, fall 2005

The volume of rental housing unmet needs, including public housing, was 22% of all housing needs and was the largest group (59%) among the housing types documented. Shelter-related unmet needs were almost half of the volume of rental housing related needs, making up 11% of all housing needs and 30% of the housing types. Ownership housing needs were approximately a third of shelter-related needs; comprising 4% of all housing-related needs and 10% of housing types. Unmet needs regarding group and mobile homes were unexpectedly small; both less than 1% of overall housing-related needs. Unmet needs related to group living comprised 2% of housing types and mobile homes at 0.05%. Because of the small number of calls for group and mobile home unmet needs, these were deleted from further analysis.

Qualitative Analysis of Unmet Needs by Housing Type

The 2-1-1 call centers documented caller needs using the nationwide 2-1-1 taxonomy; however, the degree of specificity varied by call center as well as by when the call was received according to demands of call surge or staffing per shift. The researchers aggregated needs to adjust for redundancies inherent within the taxonomy. Further adjustments were made for volunteers' narrative coding to group similar terms with those of the need taxonomy. For example, "Homeless Shelter" included homeless drop-in centers, shelter-homeless, homeless help, shelter for homeless. In Tables 4.2–4.4, specific needs encountered during the study period were itemized by housing type.

The majority (59%) of unmet housing needs concerned rental issues (Table 4.2). Over three-quarters (78%) of the unmet rental housing needs were problems accessing financial assistance for rent and/or deposit. Another 11% were also financially-related problems for help to access public housing, low income or subsidized housing, and Section 8 housing. Almost 5% of callers sought help with housing authorities and another 2% needed help handling landlord/tenant issues. It was likely that evacuees and community residents had direct access to other housing, real estate, and community social service resources to help locate housing for specific needs. Less than 1% of callers with rental needs sought access to housing for special needs such as disabled, elderly, and assisted living. Another 0.6% needed help to find available rental housing, boarding houses, or single room occupancy. Only 0.3% of rental calls were documented as disaster-related as the 2-1-1 taxonomy did not differentiate disaster-related from routine rental needs.

Table 4.2. Specific unmet rental housing needs in Texas, fall 2005

Unmet rental housing needs	Frequency	Percent of unmet rental housing needs
Rent/rental deposit assistance	30,557	77.8%
Public housing	2,119	5.4%
Housing authorities	1,845	4.7%
Low income/subsidized rental housing	1,707	4.3%
Landlord/tenant	796	2.0%
Section 8	596	1.5%
Assisted living facilities	224	0.6%
Rental housing/apartment	117	0.3%
Disaster specific rent assistance	111	0.3%
Rooming/boarding houses	81	0.2%
Single room occupancy housing	56	0.1%
Elderly/disabled home rental listings	5	0.01%
Other (If number of specific need < 2)	1,074	2.7%
Total	**39,288**	**100.0%**

Unmet shelter needs were 30% of 2-1-1 housing-related calls by type (Table 4.3). Disaster shelters comprised almost half (47%) of the specific needs for those looking for access to transitional shelter, mass shelter care, disaster shelter, emergency shelter, post-disaster housing, and shelter from bad weather. Only an additional 1.4% of shelter-related calls were for information on hotels, motels and vouchers for these that were supplementing shelter beds in evacuation destinations. It was assumed that 6% of calls were non-disaster related for access to community special needs shelters such as domestic violence, family crisis, runaway, and women's shelters. Forty percent of shelter-related requests were undifferentiated and simply coded as shelter or homeless shelter without identifying whether disaster-related or not. Hence, the greatest proportion

of unmet shelter needs was for access to disaster shelters, along with general sheltering help.

Table 4.3. Specific unmet shelter needs in Texas, fall 2005

Unmet shelter needs	Frequency	Percent of unmet shelter needs
Homeless shelter	4,137	20.7%
Shelter	3,152	15.8%
Transitional shelter	2,544	12.7%
Mass shelter care	2,502	12.5%
Disaster shelter	2,481	12.4%
Emergency shelter	1,216	6.1%
Domestic violence shelter	822	4.1%
Community shelter	646	3.2%
Post disaster housing	494	2.5%
Family crisis shelters	309	1.5%
Hotels/motels	156	0.8%
Homeless motel vouchers	118	0.6%
Bad weather shelters	71	0.4%
Runaway shelter	70	0.3%
Women's shelter	53	0.3%
Other (If number of specific need < 2)	1,236	6.2%
Total	**20,007**	**100.0%**

Unmet needs for those who owned their own home were approximately 10% of the housing types analyzed (Table 4.4). This lower percentage of unmet needs did not compare to ownership rate (65.9% from U.S. Census Bureau 2005) in Texas communities; hence it was speculated that there were many fewer access barriers to routine help as well as disaster-related assistance for homeowners than for renters.

Table 4.4. Specific unmet ownership housing needs in Texas, fall 2005

Unmet ownership housing needs	Frequency	Percent of unmet ownership housing needs
Mortgage assistance	2,688	41.1%
Home rehabilitation/repair services	2,625	40.1%
Home rehabilitation/repair grants/loans	180	2.8%
Heat the Town	161	2.5%
Housing down payment/purchase loans	121	1.8%
Homeowner/home purchase counseling	108	1.7%
Home modifications	78	1.2%
Ramp construction	62	0.9%
Disaster specific home repairs	55	0.8%
Plumbing repair	55	0.8%
Roof repair	41	0.6%
Sweat equity programs	34	0.5%
Weatherization	24	0.4%
Other (If number of specific need < 2)	310	4.7%
Total	**6,542**	**100.0%**

Almost half (47%) of homeowner unmet needs related to access for financial assistance, namely, mortgage assistance, home rehabilitation/repair grants or loans, and down payment or purchase loans. An equivalent amount (47%) was for help meeting home repair or rehabilitation needs, including services and grants or loans for repair, as well as home modifications, ramp construction, plumbing and roof repair. Less than 1% of 2-1-1 calls for home ownership type were recorded as disaster specific repairs, again underestimating these types of needs due to limitations of the 2-1-1 software constraints for differentiating disaster-related needs. Heat the Town was a program in some Texas communities in late fall of 2005 to help with utility bills and installations for home heating. A small number of homeowner calls (N=24) were for help with home

weatherization. This type of need may be classified with financial aspects, repair, and disaster-related help for homeowners.

Longitudinal Patterns of Unmet Housing Needs by Housing Type

Longitudinal patterns of unmet needs by housing type were measured as the distribution of 2-1-1 calls per day per housing type plotted over the five-month study period (Figures 4.2–4.4). Patterns of 2-1-1 call volume for unmet housing needs had weekly cycles, typically with a peak in call volume at the beginning of the week then tapering off to a considerable drop over the weekend despite 24/7 availability of 2-1-1 services. It was speculated by 2-1-1's leadership that this low level of weekend use reflected callers demand during operating hours of social service agencies, with higher use early in the week from pent-up demand for unmet needs over the weekend. This overall weekly pattern differed during evacuation and disaster response phases, then resumed during recovery except during Thanksgiving and Christmas holidays.

The longitudinal pattern of unmet rental housing needs was slightly higher at the beginning of each month and followed the typical weekly cycle except during emergency response phase immediately after landfall (E-K, E-R) and during the holidays (Figure 4.2). There were higher levels of unmet rental housing needs during intermediate disaster response phases (I-K, I-R), otherwise the pattern for rental-related needs were consistent during the five-month study period, reaching up to 325 to 358 calls per day during the weeks prior to Hurricane Katrina and during recovery. There was a precipitous drop in unmet rental needs after landfall for each hurricane while sheltering,

then a sudden increase the following week. Further increases followed in the subsequent few weeks during the intermediate disaster response phase for both Hurricanes. Unmet rental housing needs were highest in the intermediate response phase after Katrina, spiking to 462 calls per day for help with rental housing-related needs. Perhaps disaster victims were seeking rental assistance to meet temporary housing needs. This phase also included unmet public housing needs that surged between Katrina and Rita, likely given that many Katrina evacuees were unable to promptly qualify for Texas public housing. The weekly cycle also varied during the recovery phase in preparation for the holidays as well as seeking help for rental assistance as the weather turned colder.

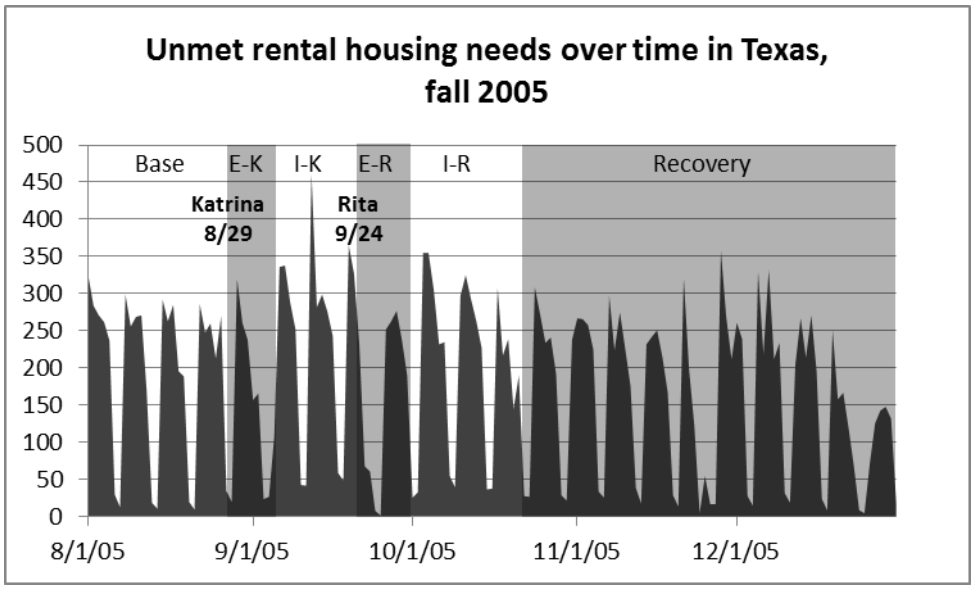


Figure 4.2. Unmet rental housing needs over time in Texas, fall 2005

The overall pattern of 2-1-1 calls for shelter-related unmet needs was a clear portrait of demand during emergency response post-landfall (E-K, E-R) (Figure 4.3). Before Hurricane Katrina, there were about 60 shelter related calls per day throughout the state. The volume of calls first peaked a few days after Katrina made landfall when Katrina evacuees were sent to Texas shelters. However, Katrina victims still maintained a high level of unmet shelter needs during the second week post-landfall as temporary housing access was problematic and they could not return home. Unmet shelter needs for Rita peaked with acute requests for available beds, compounding Katrina victims with east Texan evacuees as well as two million of Houston and Galveston area residents evacuating early before Hurricane Rita shifted northward into the Texas-Louisiana border area (National Weather Service, n.d.). Texas residents were able to return home or to friends/families nearby, but Katrina victims still required sheltering until they could seek temporary housing, as shown in the surge of unmet rental housing needs 3 weeks post-landfall (Figure 4.2). Following this extended sheltering period, the number of unmet shelter needs returned close to baseline levels throughout recovery. Ongoing access to sheltering before and after disaster response seemed to have minimal access barriers and unmet needs, thus it was assumed to be handled successfully by routine community resources.

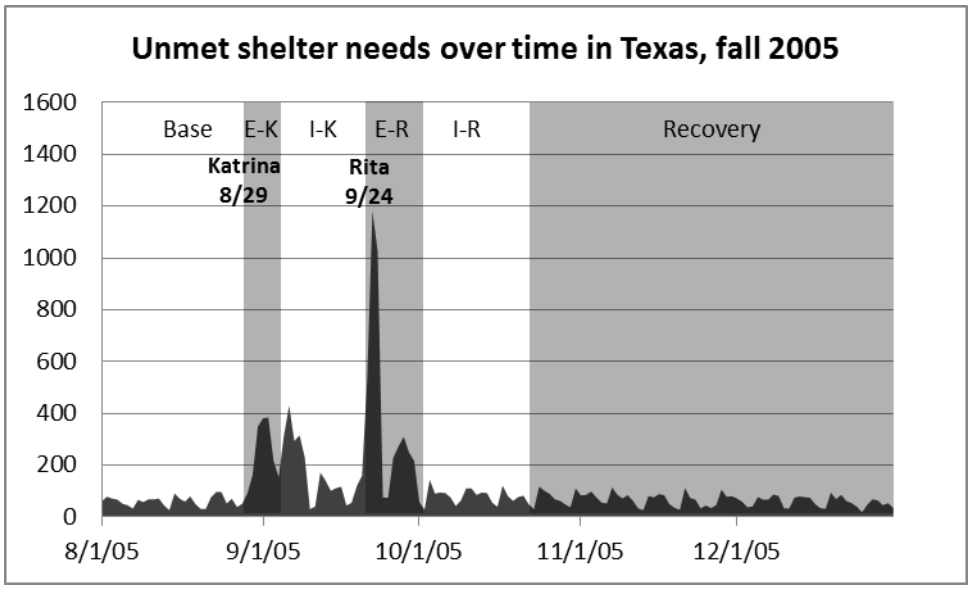


Figure 4.3. Unmet shelter needs over time in Texas, fall 2005

The number of unmet ownership housing needs dropped slightly following Hurricane Katrina emergency phase (Figure 4.4), perhaps with Texan housing financial and maintenance services preoccupied with helping Katrina victims' transition into temporary housing. After a week post-Katrina, these unmet needs returned to baseline levels. During emergency response for Hurricane Rita there was a considerable drop in unmet ownership housing needs corresponding to a peak in seeking shelter. After the week following Rita landfall, unmet ownership housing needs continued to rise weekly until they peaked a month post-landfall. Likely, there was a rise in disaster-related repair and financial needs and winter season-related needs. By year-end, calls were lower than the pre-storm levels.

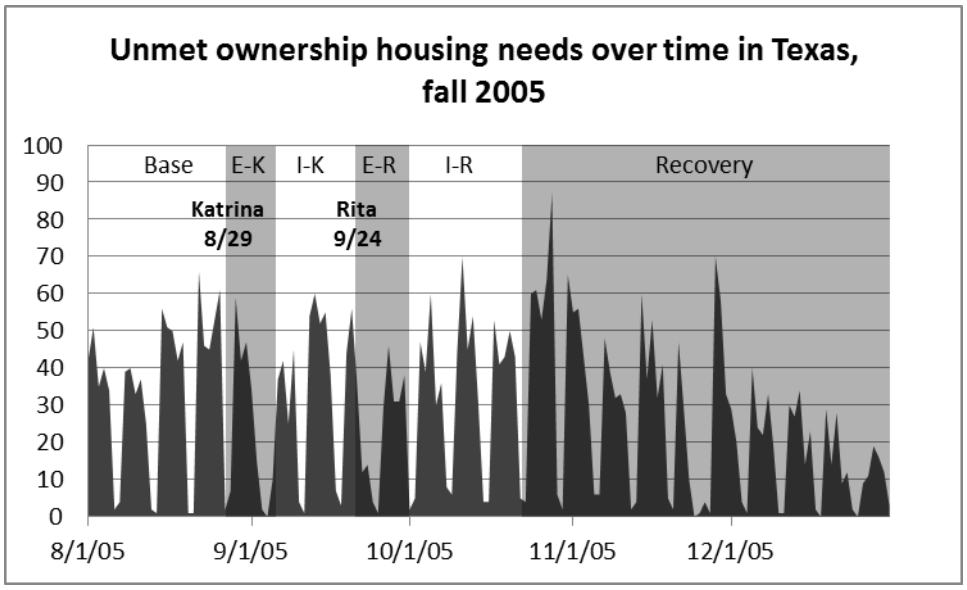


Figure 4.4. Unmet ownership housing needs over time in Texas, fall 2005

The number of 2-1-1 calls per week was plotted to compare volume and patterns of the three major housing types throughout the 5-month study period (Figure 4.5). As expected, unmet rental housing needs were remarkably higher than other housing types, indicating more encounters with access barriers in seeking financial help and locating resources. Only during holidays (Thanksgiving and Christmas) was there a reduction in requests for rental housing unmet needs. Unmet rental needs fluctuated inversely with shelter needs during the emergency response phases. It was speculated that renters comprised a significant component of those encountering access barriers to seeking shelter, compounded with the influx of Katrina evacuees overwhelming sheltering resources in Texas. In turn, the rise in unmet rental needs coincided with evacuees seeking temporary housing as shelters began to close. The volume of unmet needs

related to both rental housing and shelter returned to baseline levels following the seven weeks of emergency and intermediate response for both hurricanes.

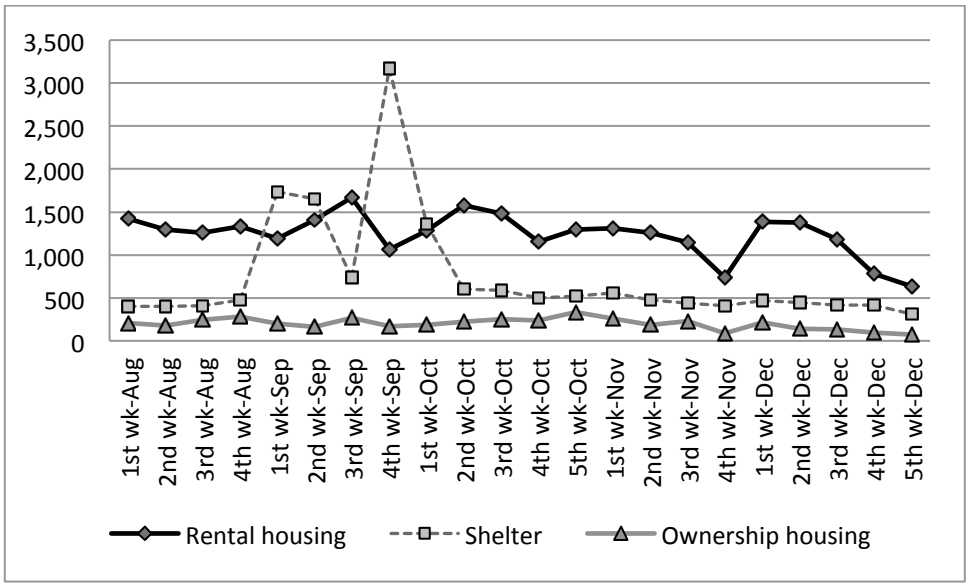


Figure 4.5. Comparing number of 2-1-1 calls per week for unmet needs by housing type, fall 2005

In contrast, unmet needs for ownership housing were minimal and varied little throughout the disaster phases, perhaps indicating their encountering the fewest access barriers. There was a slight drop in unmet ownership needs during emergency response to Hurricane Rita, corresponding with the rise in unmet sheltering needs. These needs dropped during the holidays as well. The rise in unmet ownership needs after one month post-Rita did not correspond to unmet need patterns of the other housing types. On one hand, owners may have been seeking to finally initiate repairs and winter preparation.

On the other hand, this rise in unmet needs may have been driven by FEMA or insurance funding deadlines for disaster repairs.

Summary and Conclusions

This study addressed two questions: 1) What are the types of unmet housing needs most frequently encountered after a disaster? and 2) When is assistance needed, according to housing type, across the various disaster phases? An analysis of Texas 2-1-1 data enabled this investigation of unmet needs in 254 Texas counties before, during, and after Hurricanes Katrina and Rita (a five month study period). This large geographic scope captured the unmet needs not only in the disaster areas, but also in evacuation host locations. Analyzing the volume of 2-1-1 calls regarding unmet housing needs was a way to use unique, real-time data to track the various access barriers faced by vulnerable populations. If the volume of unmet needs was high, it meant there were a greater number of access barriers to the available resources. If the volume of unmet needs was low, then those needs were met directly in the vulnerable populations' respective communities by available programs and services.

The greatest proportion of 2-1-1 calls recorded during the study period was for unmet housing needs (28%). Of the callers who identified their type of housing, renters comprised the largest group (59%), followed by those encountering barriers seeking shelter (30%), then homeowners with unmet needs (10%). Financial problems related to rental housing was the most frequent barrier. The volume of unmet needs related to rental housing fluctuated throughout the various disaster phases, however a consistent

pattern occurred for both hurricane events; the volume of renters' unmet needs increased during the intermediate disaster phases, times when evacuees needed to move out of shelters and into temporary housing.

Shelter-related unmet needs comprised almost half the volume of rental housing unmet needs, indicating that shelter dwellers or individuals who sought a shelter had fewer experiences with access barriers despite the extraordinary demand for disaster shelters by Katrina victims (a problem which was later compounded by Rita evacuees). Although the total number of community shelter beds is not known, the number of routine unmet needs in shelters was consistently low, perhaps indicating that these needs were addressed directly in local communities and with minimal access barriers. In contrast, unmet needs for disaster-related shelters in Texas were considerable during the evacuation and emergency response phases for both Hurricanes Katrina and Rita. During the Rita emergency phase there was a large spike in calls seeking help to find shelter, a problem which was compounded by individuals already in shelters due to Katrina and the large number who evacuated early from Houston. The comparatively larger number of unmet needs in shelters extended into the intermediate phase following Hurricane Katrina, especially for evacuees who had no place to which they might return. This same pattern of an increased number of extended needs for shelter occurred in the week following Hurricane Rita, beyond the time when shelters began closing. The number of unmet needs subsided to a more routine level of community shelter needs for abuse victims, runaways, the homeless, and special needs crises after the third week post-Rita, and continued throughout the remainder of the study period.

The volume of ownership housing-related unmet needs was much less than that of rental housing or shelter-related needs, reflecting that homeowners encountered fewer access barriers in directly seeking support services. Of the barriers experienced, about half of the unmet ownership needs were related to financial issues and the other half were related to getting help for repairs and other home modifications. There was a slight dip in homeowners' unmet needs during the emergency response phases of both hurricanes. During the respective recovery phases, however, the volume of unmet needs for ownership housing increased, with individuals seeking help with disaster-related repairs and winter preparations. In addition, help was requested regarding the deadlines for homeowners seeking to file disaster damage claims with their insurance companies and FEMA.

Overall, unmet shelter needs clearly showed different patterns of demand according to the associated disaster phase, as compared with more subtle changes in the volumes of unmet rental and ownership housing needs. As expected, unmet shelter needs spiked during emergency response phases and fell almost back to a normal baseline after two weeks post-landfall. Renters' needs rose as shelters closed, with displaced disaster victims encountering access barriers to temporary housing and in qualifying for public housing assistance. The volume of unmet needs for ownership housing varied little over time, but did rise one month post-Rita, when the volumes of the unmet needs of other housing types decreased to their baseline levels.

Comparisons with the Literature and Contributions

The study results support the previous literature regarding patterns related to disaster housing (see Quarantelli, 1982, 1995). Furthermore, this study showed the lengths of time for peaks in unmet housing needs according to each housing type, from before a disaster to 14 weeks after a disaster. Decades ago Haas, Kates, and Bowden (1977) presented their disaster model of recovery activities and Quarantelli (1982, 1995) specified a disaster sheltering and housing typology. However, little research has empirically illustrated these theoretical longitudinal patterns of how shelter and housing needs change during disasters, and how long it might take to become normal. In this study of unmet housing needs during hurricane disasters, the peaks in unmet shelter needs occurred right before and at hurricane landfall, as expected, but extended to two weeks after landfall. This extension was due to problems with moving evacuees into temporary housing, since they were not able to return home. Unmet shelter needs quickly returned to nearly baseline levels for local shelters that normally served as refuge for the homeless and/or abused. Then the volume of unmet needs related to rental housing increased; shelter needs became easier to meet once the evacuees seeking temporary housing in shelters began to leave and seek more permanent housing elsewhere (i.e., from a week after the landfall through another two weeks beyond). In contrast, there was a rise in unmet ownership housing needs one month post-Rita. These patterns indicate when the temporary housing phases and the permanent housing phases began. They also indicate that each disaster housing phase is not mutually exclusive, as has also been stated in the previous literature (Quarantelli, 1982, 1995). Before the

sheltering phase ended, even during the time when unmet shelter needs peaked, unmet rental housing needs began to increase. Additionally, when unmet ownership housing needs peaked, the volume of unmet shelter needs was still higher than it was before the disaster, which indicated the "overlap of phases". Furthermore, among the three housing types, the most vulnerable housing type after a disaster was the shelter. On the other hand, rental housing was vulnerable both before and after a disaster, as compared to ownership housing. This also shows that renters and owners may experience different levels of difficulty during different periods of time. This study provides empirical evidence that can support the theoretical model of housing-related disaster phases based on real-time data.

Recommendations for Disaster Managers and Communities

The volume of unmet rental housing needs indicated that community planners and policy makers needed to address high demand for rental housing assistance, as well as to lower financial barriers for disaster victims (in particular, rent and deposit assistance and support for public housing eligibility, low income/subsidized rental housing, and Section 8 financial assistance). Homeowners seemed to have significantly fewer access barriers than the individuals trying to meet rental and shelter housing unmet needs.

An unexpected barrier confronted by Texas communities hosting Katrina evacuees were conflicts in eligibility for subsidized public housing, as well as eligibility for other state-subsidized support services including Medicaid, food programs, and

employment services. The evacuees who lived in unsubsidized rental housing also faced difficulties regarding the gaps in housing cost between their original and host areas. For example, as of 2005 the monthly area median income of Louisiana was $548 lower than that of Texas; additionally, the fair market price to rent a two-bedroom apartment in Louisiana was $103 lower than that of Texas (Wardrip, Pelletiere, & Crowley, 2005). These interstate differences became problematic not during the emergency response phase when federal funds supported the housing relief, but rather when individuals sought temporary and permanent housing because their original homes and neighborhoods had been devastated. Thus, disaster planning and policy making should consider mechanisms to facilitate interstate criteria and emergency funds to bridge the gap in eligibility for financial support and housing programs.

Policy makers need to consider extending services for a longer period of time. The length of the assistance should differ depending on the extent of the disaster. The American Red Cross usually provides emergency shelter for up to two weeks, but evacuees needed to stay in emergency shelters for up to seven weeks during Hurricane Katrina (Mitchell, Esnard, & Sapat, 2012). Although the study results indicated that unmet shelter needs were critical up to two to three weeks after each hurricane, until about ten weeks after the hurricanes the volume of unmet shelter needs was still higher than it was prior to the disasters. It is possible that the volume of unmet rental and ownership housing needs might also surge later or consist at some different level of volume during long-term recovery, but this study's results only examined unmet housing needs through three months of recovery phase.

Moreover, policy makers should also consider improving assistance for evacuee host areas in the case of catastrophic disaster. Although Hurricane Katrina did not directly affect Texas, many evacuees came to Texas (e.g., Houston, Dallas) to seek shelter. Aid directed toward meeting temporary housing needs was essential for evacuees who were not able to return to their original homes. The study results showed an increase in rental housing needs in Texas after Hurricane Katrina. In the case of Hurricane Katrina, many of the evacuees were low income (Texas Health and Human Services Commission, 2006); thus, disaster relief efforts must also include the support of affordable housing programs. Furthermore, evacuee host areas must also serve the everyday needs of residents in addition to the special needs of evacuees, which stretches what are often limited budgets (Bame et al., 2012). As a result, host areas might also require additional resources.

Recommendations for Future Research

In order to better predict and plan for unmet housing needs, future research is needed to analyze the temporal and spatial changes that have occurred in shelter and housing needs, especially in terms of tracking unmet needs by disaster phase and location. Analyzing this information according to the different units of analysis (county, city, ZIP code, or neighborhood level) could be a way to develop comprehensive strategies for policy makers and disaster managers. Comparisons between urban and rural areas could offer implications for certain allocations of resources. In this study, shelter and housing needs included not only routine needs for residents, but also

emergency needs for evacuees. Research should consider differences in the volume of needs pre- and post-disaster. Moreover, exploring specific needs of shelter and housing over time—public shelter vs. motel/hotel, or subsidized rental housing vs. market-rate rental housing— can provide better suggestions for policy makers and emergency managers hoping to effectively allocate resources in anticipation of a future disaster. These real-time 2-1-1 data snapshots taken before, during, and after disasters provide an excellent understanding of unmet needs over time in broad geographic areas.

CHAPTER V

COMMUNITY FACTORS ASSOCIATED WITH THE HOUSING NEEDS OF OWNERS VS. RENTERS DURING A DISASTER: A CASE STUDY OF HURRICANES KATRINA AND RITA IN TEXAS

Introduction

Low income households, and in particular low income renters, suffer from disproportionately severe circumstances during disaster recovery (Quarantelli, 1995). In the beginning of the 21st century, the U.S. struggled with a lack of affordable housing, in particular for renters (Belsky, Goodman, & Drew, 2005; Belsky & Drew, 2007). Low income households often have little choice in the quality and location of housing because of a limited number of affordable housing options (Schwartz, 2006). As a result, they have a greater chance of living in poor housing conditions (Belsky & Drew, 2007; Kreimer, 1980; Morrow, 1999; Peacock & Girard, 1997) and in unsafe locations (Morrow, 1999; Phillips, 1993), which lead to higher losses after a disaster. Along with housing issues prior to a disaster, the inequality of recovery leads to more complex housing issues after a disaster, including finding affordable temporary housing. The purpose of this study is to test a model of community factors known to affect housing needs during normal times in order to determine the relationship and significance of these factors under disaster conditions. A further aim is to differentiate this model for owners versus renters, as well as to examine variation throughout disaster phases.

Researchers have determined that housing needs are affected by affordability, availability, and quality of housing during normal times. However, in disaster situations the housing needs model would require additional factors such as how the location relates to a disaster site (i.e., areas directly affected by the disaster vs. evacuation destinations), or how the time relates to the disaster (e.g., before, during, or after a disaster). This study modified the housing needs model to examine how significant factors during normal times would be associated during disaster with housing needs of owners and of renters using data from the Texas 2-1-1 caller dataset of actual housing needs over time and location. The Texas 2-1-1 caller dataset was provided by the 2-1-1 Texas Information and Referral Network (TIRN), which contained call records relating to non-emergency needs. This unique real-time dataset offered a comprehensive assessment of housing needs within a broad geographical area—Texas's entire 254 counties, including both disaster areas and major/minor evacuation destinations—throughout Hurricanes Katrina and Rita disaster phases, fall 2005.

The results of this study provide valuable information for disaster planning by identifying a more complete portrayal of actual housing needs. In this study, the housing needs emerging from the two extensive hurricane disasters—Katrina and Rita—were analyzed by disaster phase in broad geographical areas. Also, the study area covers both evacuation host communities from Hurricane Katrina and disaster affected communities from Hurricane Rita. Thus, community leaders and policymakers could use this study to help them understand how to manage assistance efficiently during the preparation, emergency management, and early recovery phases of a disaster. Also, planners and

researchers could use the information presented here to assist them in better understanding which community factors are associated with housing needs, and how these relationships change when the temporal aspects of a disaster are considered, in particular for both owners and renters.

Background

Conceptual Framework of Housing Needs

Previous housing needs models can be grouped into two types based on distinct time periods: current housing needs (e.g., Heumann, 1976) and future housing needs (e.g., Holmans, 1995; Myers, Pitkin, & Park, 2002). This study's model is adapted from a current housing needs model (i.e., the Illinois housing model) and HUD's "worst case housing needs" model. The Illinois housing model has three key elements: substandard housing units, overcrowding, and excessive housing costs (Heumann, 1976). HUD's "worst case housing needs" model uses three categories to classify the stock of affordable housing: 1) affordable; 2) affordable and available; and 3) affordable, available, and adequate (Steffen et al., 2011, p. 13). The conceptual model tested in this study is illustrated in Figure 5.1, with three major dimensions used to account for likelihood of housing needs: affordability, availability, and quality. This standard model is then modified according to disaster phase and disaster site designated locations. Two types of housing needs are examined—those of renters and of homeowners.

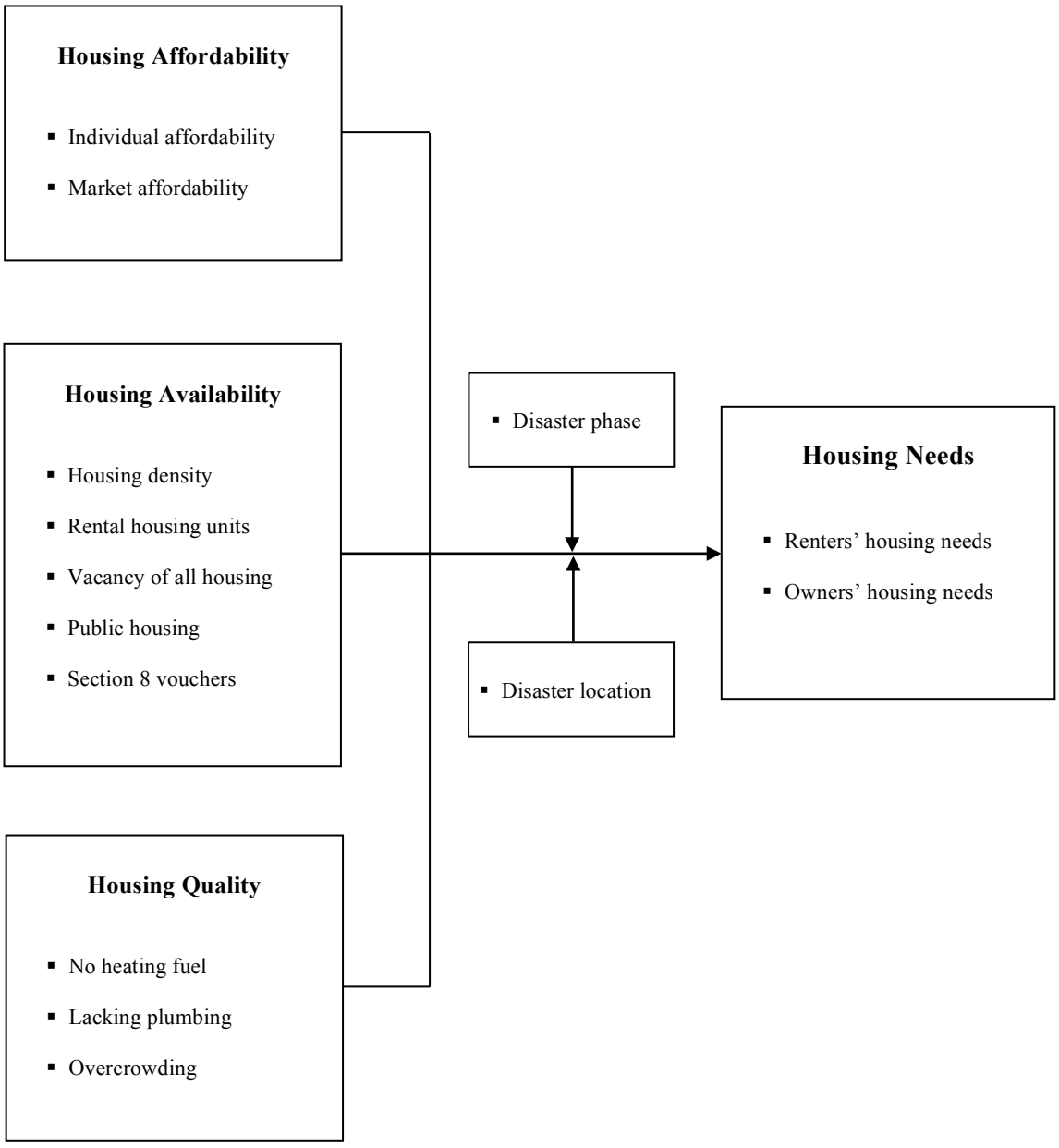


Figure 5.1. Model of community factors associated with owner vs. renter housing needs adjusted by disaster phase and location

Previous research found that renters endured greater affordability problems than owners. Moreover, low income renters often had very little opportunity to select their housing location due to limited number of affordable and available housing units (Schwartz, 2006). Renters also struggle with inadequate housing quality and overcrowding conditions, as compared with owners (see detail in U.S. Census Bureau, 2011). In rental housing units, including multifamily housing, little can be done by renters to prepare for a disaster such as installing shutters or other types of window protection (Morrow 1999). Also, housing units for low income are often located in hazardous areas (Morrow, 1999; Phillips, 1993). Multifamily housing units were found more likely to be affected than single family housing units during the Loma Prieta and Northridge earthquakes (Comerio, 1997). A great deal of low income rental housing was destroyed or severely damaged during Hurricanes Andrew, Katrina, and Ike (Morrow, 1997a; National Low Income Housing Coalition, 2005; Henneberger, 2009). Moreover, it takes more time for multifamily housing units to recover from disasters than it does single family housing (Lu, 2008). Multifamily housing units, many of which are rental housing units, are not easily restored to be the same as they were pre-disaster. This means that some renters need to relocate permanently, and may even need to move to another city, county, or state.

Housing Affordability

Housing affordability is one of the major housing issues faced during normal, non-disaster times. Among the various indices of housing affordability (e.g., HUD,

NAR, housing wage, etc.), the HUD affordability index is a conventional measure that is most commonly used (Jewkes & Delgadillo, 2010). The HUD affordability index (the ratio of housing costs to income) indicates a cost burden if the ratio is over 30 percent (Belsky, Goodman, & Drew, 2005). Recently, Tang (2012) and Bramley et al. (2010) used multiple housing affordability measurements for more reliable results. Consequently, this study considered using two aspects measuring housing affordability: individual affordability and market affordability. Following the definition provided by Jewkes and Delgadillo (2010), individual affordability is considered here to be "how much a household can afford on mortgage payments without facing a housing cost burden" (p. 48). They explain that market affordability is "the general affordability of a given area as measured by the median home price in that area" (p. 48). In this study, individual affordability is measured by the percentage of households spending 30 percent or more of their income on gross rent or monthly owner costs, by county. Market affordability is calculated as a price-to-income ratio of a given county (i.e., a county's median gross rent or median monthly owner mortgage cost divided by the county's monthly median household income).

Housing Availability

Housing availability has been used to evaluate housing needs for state and federal-level reports (e.g., 2013 State of Texas low income housing plan and annual report, HUD's worst case housing needs 2009). There are certain gaps between demand for housing units and available housing units. The housing market cannot guarantee a

housing unit at a price less than 30 percent of a household's income, generally considered to be the standard for housing affordability. This study used five measures of housing availability: housing density, percent of rental housing units, vacancy, public housing, and Section 8 vouchers. In order to measure potential loss and recovery needs, researchers often use 'density' and 'renter-occupied units.' High-density areas are more likely to have greater loss (Cutter, Boruff, & Shirley, 2003; Mitchell, 1999), and evacuation difficulties (Cova & Church, 1997) during disasters. Hence, high-density areas (i.e., urban areas) will possibly have many needs relating to evacuation and recovery. In particular, catastrophic disasters have a significant impact on high-density areas, not only those directly affected by the disaster, but also those that serve as evacuee hosts areas (as the disaster will result in many shelter and temporary housing needs). Renters are especially vulnerable during disasters (Morrow, 1999). For example, they have little choice when searching for affordable shelter as well as often lack information resources to inform them about financial assistance (Cutter, Boruff, & Shirley, 2003).

Housing Quality

Improving housing quality was an important issue during the last century (Belsky, Goodman, & Drew, 2005). Researchers used physical characteristics to measure housing quality, such as: lack of plumbing, heating, electrical systems or maintenance (HUD's "worst case housing needs"; Steffen et al., 2011, p. 1), lack of plumbing, heating, electricity, or upkeep (U.S. Census Bureau 2011, p. A-21), and lack of kitchen and plumbing facilities (Texas Department of Housing and Community

Affairs, 2013). This study used three measures of housing quality: no heating fuel, a lack of plumbing facilities, and overcrowding. Since residents living in overcrowded conditions often experience substandard housing conditions, the housing quality category includes overcrowding. Overcrowding could also indicate a lack of affordable housing options, because people are being forced to choose smaller-sized houses than might be appropriate for their household size in order to reduce their housing cost burden. The standard used for overcrowding has gone through several changes; for this study, the standard of overcrowding is more than one person per room.

Housing Needs by Phase of Disaster and Location of Disaster

To use the housing needs model in disaster situations, two additional factors have been included: the phase of the disaster and the location of the disaster. Housing needs in disaster-related literature centered on shelter and temporary housing (Johnson, 2007; Mitchell, Esnard, & Sapat, 2012), relocation (Elliott & Pais, 2006; Girard & Peacock, 1997; Morrow, 1997a), and housing recovery (Comerio, 1997; Zhang & Peacock, 2010; Lu, Peacock, Zhang, & Dash, 2007; Mukherji, 2010). These previous studies focused primarily on a single disaster phase. Additionally, their study locations usually involved areas directly affected by a disaster in order to examine housing damage and recovery. There has been little study of evacuation destinations such as neighboring counties or states. In cases of catastrophic disasters such as Hurricane Katrina, not only areas directly affected by the disaster but also evacuation destinations faced housing issues relating to that disaster. In this study, housing needs were examined statewide, including

Texas counties designated by FEMA as Hurricane Rita disaster areas as compared evacuation destinations where every Texas county reported receiving evacuees from Hurricanes Katrina and Rita.

The volumes and types of housing needs for owners versus renters are different prior to a disaster, as well as post-disaster (see Chapter IV). Previous studies relating to housing tenure focused on a certain period before or after a disaster, such as: preparedness (Burby, Steinberg, & Basolo, 2003), post-disaster sheltering situations (Elliott & Pais, 2006), and housing recovery (Comerio, 1997; Zhang & Peacock, 2010; Mukherji, 2010). Yet few studies have examined the housing needs of owners and renters throughout the various disaster phases.

Hurricane Katrina and Rita in Texas and Texas 2-1-1

In 2005, Texas experienced unprecedented housing and sheltering needs due to sequential disasters—Hurricanes Katrina and Rita. Hurricane Katrina, the costliest hurricane in U.S. history to date (Lott, Ross, Smith, Houston, & Shein, 2011), made landfall in Louisiana on August 29, 2005. Of the 1.3 million evacuees, over 400,000 came to Texas (Community Affairs Department, 2006) and required both shelter and temporary housing, particularly in the large urban areas (e.g., Dallas, Houston, and San Antonio). Less than a month later, Hurricane Rita arrived on the Texas and Louisiana borders. Hurricane Rita caused about 111 deaths in Texas, including 90 deaths related to the mass evacuation process (Zachria & Patel, 2006), displaced over three million people (Eskovitz, 2006), and damaged about 75,000 homes in Texas (Texas Low Income

Housing Information Service, 2007). Many of the Katrina evacuees in the Houston area were required to evacuate a second time, and find other shelters and temporary housing facilities.

The 2-1-1 three-digit phone number is a contact number for non-emergency needs in normal times. The 2-1-1 Texas Information and Referral Network is a communication hub for callers asking for help and for information regarding available resources and services. As 2-1-1 has assisted in meeting disaster-related needs during the H1N1 and various wildfire crises, Texas 2-1-1 helped to address disaster-related needs (as well as routine, non-emergency community needs) after Hurricanes Katrina and Rita. During these crisis times, 2-1-1 calls surged; as a result, many unmet disaster-related needs were recorded at the 2-1-1 call centers (Bame et al., 2012).

Methods

Data Sources and Variables

This study drew from three data sources merged by county to examine what aggregated housing characteristics were associated with 2-1-1 callers' unmet housing needs in that county: 1) U.S. Census data aggregated to Texas county-level, 2000; 2) HUD data of subsidized households per county, 2005; and 3) Texas 2-1-1 caller data aggregated to county-level, 2005. The scope of 2-1-1 data included each of Texas' 254 counties from August 1 through December 31, 2005 covering the period before, during, and after Hurricanes Katrina and Rita. The databases were merged with county as the

unit of analysis. The variables tested in the model were summarized in Table 5.1, along with the operational definitions.

Table 5.1. Variable names and definitions of housing needs associated with community factors and disaster characteristics

Variable names	Definitions	Data sources	References
Housing needs			
Owner housing needs	If a county received a call relating to unmet ownership housing needs	Texas 2-1-1 data	
Renter housing needs	If a county received a call relating to unmet rental housing needs	Texas 2-1-1 data	
Housing affordability			
Individual affordability–owner	Owner occupied units who pay 30% or more income in mortgage and owner costs (%)	U.S.Census 2000 Summary file 3	Dacquisto & Rodda (2006); Jewkes & Delgadillo (2010)
Individual affordability–renter	Renter occupied units who pay 30% or more income in gross rent (%)	U.S.Census 2000 Summary file 3	Dacquisto & Rodda (2006); Jewkes & Delgadillo (2010); Bramley et al. (2010)
Market affordability–owner	Median mortgage payment/Median household income (%)	U.S.Census 2000 Summary file 3	Jewkes & Delgadillo (2010)
Market affordability–renter	Median gross rent/Median household income (%)	U.S.Census 2000 Summary file 3	Jewkes & Delgadillo (2010)
Housing availability			
Housing density	Number of housing units/Square miles	U.S.Census 2007 & U.S.Census 2000	Cutter et al. (2003); Finch et al. (2010)
Rental housing units	Renter-occupied housing units/Total occupied housing units (%)	U.S.Census 2000 & American Community Survey (ACS) 2005	Cutter et al. (2003); Finch et al. (2010); Van Zandt et al. (2012)
Vacancy of all housing	Vacant housing units/Total housing units (%)	U.S.Census 2000 Summary file 3	Ganapati et al. (2012); Van Zandt et al. (2012)
Public housing	Households reported receiving public housing/Total households (%)	HUD 2005 & TSDC 2005	Texas Department of Housing & Community Affairs (2013)
Section 8 vouchers	Households reported receiving Section 8 vouchers/Total households (%)	HUD 2005 & TSDC 2005	Texas Department of Housing & Community Affairs (2013)

Table 5.1. *Continued*

Variable names	Definitions	Data sources	References
Housing quality			
No heating fuel	Occupied housing units-no heating fuel (%)	U.S.Census 2000 Summary file 3	Steffen et al. (2011)
Lacking plumbing	Occupied housing units-lacking complete plumbing facilities (%)	U.S.Census 2000 Summary file 3	Heumann (1976); Steffen et al. (2011)
Overcrowding	Occupied housing units-person per room is 1.01 or more (%)	U.S.Census 2000 Summary file 3	Heumann (1976); Myers et al. (2002)
Disaster characteristics			
Disaster Area	1: disaster area (n=22 counties); 0: non-disaster area; evacuation destination (n=232 counties)	FEMA 2005	
Disaster Phases	See detail in Table 5.2		

Notes. TSDC (Texas State Data Center at the University of Texas at San Antonio); U.S. Census 2007: Annual estimates of housing units for counties in Texas (HU-EST2006-04-48); HUD 2005: Picture of subsidized households

The 2000 U.S. Census Summary File 3 was used to identify the variables of county housing characteristics: a) housing affordability (individual affordability for owners vs. renters, market affordability for owners vs. renters); b) housing availability (housing density, rental housing units, housing vacancy); and c) housing quality (no heating, lacking plumbing, overcrowding). The 2005 HUD database was used to determine two housing availability characteristics related to subsidized households per county: proportion of public housing and of Section 8 vouchers per total households.

The 2005 Texas 2-1-1 caller database contained three variables: a) location (county and FEMA designated disaster area), b) call date (disaster phases), and c) unmet housing needs (renter vs. owner). Caller location data were aggregated to the county level, triangulating city, zip code and county information collected for where the caller was seeking information or referral help. The variable "Disaster Area" was determined according to FEMA's disaster declaration of October 20, 2005 defined as "individual

assistance and/or public assistance" (Categories A and B) (FEMA, 2005). Twenty-two counties in eastern Texas were designated by FEMA as disaster areas from Hurricane Rita: Angelina, Brazoria, Chambers, Fort Bend, Galveston, Hardin, Harris, Jasper, Jefferson, Liberty, Montgomery, Nacogdoches, Newton, Orange, Polk, Sabine, San Augustine, San Jacinto, Shelby, Trinity, Tyler, and Walker (Figure 5.2). Although certain cities were designated as major evacuation destinations for both Katrina and Rita victims, all Texas counties reported receiving some evacuees. Thus, no separate designation was made for disaster evacuation location.

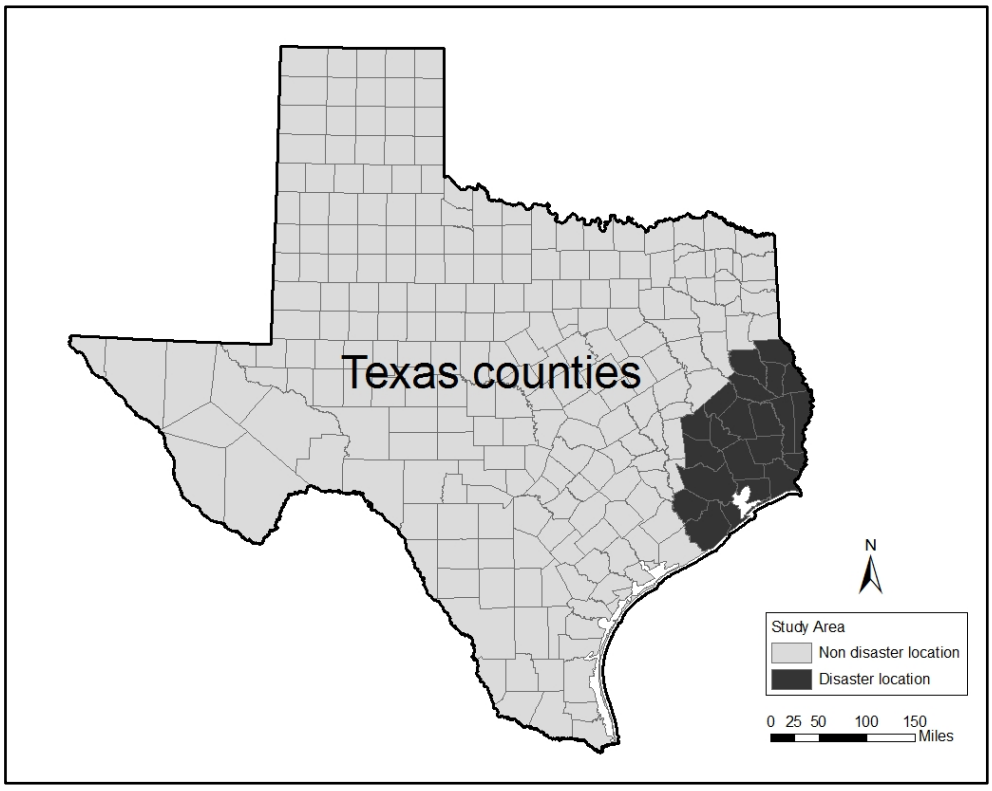


Figure 5.2. FEMA declaration of Hurricane Rita disaster area in Texas as of 10/20/2005

Date of the 2-1-1 call was aggregated into four disaster phases (Table 5.2). The pre-disaster phase included a baseline period of four weeks prior to Hurricane Katrina's landfall in Louisiana. The second phase, Katrina-emergency, included Hurricane Katrina landfall, evacuation and sheltering until the declared evacuation for Hurricane Rita three weeks later. The third phase of Hurricane Rita-emergency included evacuation, sheltering and immediate recovery up through four weeks post-Rita landfall. The fourth phase was recovery from one month post-Rita up to the end of the study period, 14 weeks after Hurricane Rita's landfall.

Table 5.2. Disaster phases of Hurricanes Katrina and Rita, August 1–December 31, 2005

Disaster phase	Date	Number of days	Duration
Pre-disaster	8/1–8/28	28 days	4 weeks before Katrina landfall
Hurricane Katrina	8/29–9/20[†]	23 days	Katrina landfall to 3 weeks after, until start of evacuation for Rita
Hurricane Rita	9/21-10/21[††]	31 days	3 days before and 4 weeks after Rita landfall
Short-term recovery	10/22–12/31[†††]	71 days	5 to 14 weeks after Rita landfall

Note. [†] Hurricane Katrina phase starts from landfall, 8/29 (Knabb, Rhome, & Brown, 2005).
[††] Hurricane Rita phase includes 3 days evacuation (Crawford & Company, 2005) before landfall, 9/24 (Knabb, Brown, & Rhome, 2006).
[†††] Short-term recovery phase is up to 14 weeks (3 months) following Rita landfall in this study.

All 2-1-1 calls were assumed to be *unmet* needs, reflecting callers motivated to seek information or referral (I&R) to available and/or affordable community support services. Without encountering access barriers, callers would be connecting directly with community support services, with no reason to contact 2-1-1 I&R services. For this study, unmet housing needs were enumerated from other types of unmet needs (e.g.,

health, food, transportation). These housing unmet needs (N=180,601) were then categorized according to housing types according to the nature of the caller's need or type of referral documented: shelter, rental housing, ownership housing, public housing, group homes, and mobile homes. Public housing needs were included in the rental category as the narrative descriptions were similar to those of renters. Unmet shelter needs were not related to the purpose of this study and the other housing types were negligible, and thus, not included in the analysis. Unfortunately, 63% (N=113,884) of housing-related needs had no information about type of housing, and thus, could not be used for this analysis.

Data Analysis

Logistic regression was used to test what characteristics in the multivariate model of housing affordability, availability, and quality were significant factors in whether or not unmet housing needs were experienced in a county by owners compared to renters according to disaster phase, adjusting for disaster location. The odds ratio and level of significance $p \leq 0.05$ were calculated using STATA 11.2 (StataCorp, College Station, TX). If the odds ratio was < 1.0 then the relationship was negative; if > 1.0, the relationship was positive. If the odds ratio was = 1, there was no relationship. To code dichotomous unmet housing needs by renter vs. by owner per disaster phase per county, eight dependent variables were created: any call per county by owner-type vs. by renter-type for each of the four disaster phases = 1; no calls for that type during that phase per county = 0. The independent operational measures were defined above in Table 5.1.

Comparing and contrasting the eight models accounting for the likelihood of unmet housing needs encountered in counties determined differences and similarities in significant factors over disaster phases for either renters or homeowners or both.

Limitations

The total number of calls was expected to be underestimated during each hurricane's landfall because of 2-1-1's difficulty in handling overwhelming call surges. However, these types of calls may be expected to be more concerned with evacuation and sheltering rather than other types of renter or owner housing needs. In addition, it should be noted that the number of calls relating to both ownership and rental housing was underestimated because of data missing regarding the type of housing specified; however, many of these calls were related to utility bills. Thus, the findings here might have unknown biases in this regard.

As stated above, the study population did not include people who met their needs using their own resources, knew where they should seek help, and had access to available and affordable services. Hence, the study population was more likely to be made up of vulnerable populations who had needs but encountered access barriers. Unfortunately, no socio-demographic or economic data were collected in the 2-1-1 database so that comparisons to underlying census population characteristics could not be made. Nevertheless, these analyses would be useful for policy makers and community managers seeking location and timing of unmet needs in high-risk, vulnerable populations during disasters.

Although this model of housing characteristics associated with community disaster resiliency is well known in the literature, no previous analyses have been found that investigate differences in comparing the significance of these factors across disaster phases. Moreover, this study's analysis compared and contrasted the significance of those factors that accounted for unmet housing needs for renters as opposed to homeowners. Hence, this extensive analysis provided unique evidence of community housing factors that were significantly associated with *unmet* housing needs over time and across disaster phases as well as evacuation locations.

Results

Description of Unmet Housing Needs

During the five-month study period, 635,983 total 2-1-1 calls were recorded by the Texas Information & Referral Network. Approximately 28 percent (N=180,601) of the total calls were related to unmet housing and shelter needs. This was the largest proportion in comparison to other basic needs of health/safety (18%), food/water (15%), and transportation/fuel (4%). These needs were not independent, however, as callers presented with multiple types of needs and overlapping categories (e.g., shelter and food, transportation to medical facility).

The set of housing-related needs were categorized into housing types to identify the context of those needs and availability of referral services: 1) Rental housing (19.5%; N=35,267), 2) Shelter (11.1%; N=20,007), 3) Ownership housing (3.6%; N=6,542), 4) Public housing (2.2%; N=4,021), 5) Group homes (0.7%; N=1,324), 6) Mobile homes

(0.02%; N=36), and 7) Housing-related needs with no information about type (63.1%; N=113,884). Rental housing type was merged with public housing as the nature of these needs were similar, resulting in a total of 21.8% (N=39,288) in this category. Owner housing needs were much less, comprising 4% of unmet housing needs (N=6,542). Unmet shelter needs were not related to the purpose of this study and the other housing types were negligible, and hence, not included in the analysis.

Table 5.3. Number and proportion of Texas counties with any housing needs of owners vs. renters by disaster phase (N=254 counties)

Housing needs	**Disaster phase**	**Having any housing needs**[†]		**No housing needs**[††]	
		# of counties	% of counties[†††]	# of counties	% of counties[†††]
Any housing needs (Owner or Renter)	Pre-disaster	110	43.3%	144	56.7%
	Katrina	107	42.1%	147	57.9%
	Rita	135	53.1%	119	46.9%
	Short-term recovery	146	57.5%	108	42.5%
	All phases	181	71.3%	73	28.7%
Owner housing needs	Pre-disaster	67	26.4%	187	73.6%
	Katrina	74	29.1%	180	70.9%
	Rita	85	33.5%	169	66.5%
	Short-term recovery	94	37.0%	160	63.0%
	All phases	134	52.8%	120	47.2%
Renter housing needs	Pre-disaster	98	38.6%	156	61.4%
	Katrina	96	37.8%	158	62.2%
	Rita	121	47.6%	133	52.4%
	Short-term recovery	127	50.0%	127	50.0%
	All phases	163	64.2%	91	35.8%

Note. [†] The county had at least one call during the disaster phase.
[††] The county had no call record during the disaster phase.
[†††] % of counties is the ratio of # of counties over the total number of Texas counties (N=254)
The number of days during each disaster phase is different (see Table 5.2).

The distribution of any housing needs by type and phase per county is summarized in Table 5.3. Seventy-one percent of Texas counties had at least one unmet housing need during the five-month study period. Of those 181 counties, 74% had an owner-related need and 90% had a renter-related need. The number of counties reporting any housing-related need increased as the disaster phases progressed. Approximately a quarter of Texas counties had any owner-related housing needs during the month prior to Hurricane Katrina, increasing to over a third of counties with any owner-related needs during recovery. Almost 40% of counties had any renter-related needs during the baseline phase, increasing to 50% of counties during recovery.

Models Accounting for Likelihood of Any Unmet Housing Need by Owner vs. Renter across Disaster Phases

All logistic regression models had housing factors that significantly ($p \leq 0.05$) accounted for the likelihood of owner and of renter unmet housing needs per county across all disaster phases (Table 5.4). Overall, the significant factors of the conceptual model differed by owner vs. renter unmet housing needs according to disaster phase. Affordability factors were significant during the baseline pre-disaster phase for both owners and renters. However, affordability was significant for just renters during both Hurricane Katrina's and Rita's emergency periods. During recovery, no significant affordability factors were found to account for likelihood of any unmet housing needs per county for either owners or renters. Availability factors were significantly related to likelihood of unmet housing needs of both owners and renters for all disaster phases.

Table 5.4. Logistic regression models predicting having unmet housing needs by ownership during four disaster phases (N= 254), odds ratios

	Pre-disaster		Katrina		Rita		Short-term Recovery	
	Ownership housing	Rental housing	Ownership housing	Rental housing	Ownership housing	Rental housing	Ownership housing	Rental housing
Affordability								
Individual affordability-owner/renter	.936	1.186***	1.104	1.018	1.001	1.092*	1.057	1.006
Market affordability-owner/renter	1.214*	1.140	1.037	1.414*	1.060	1.096	1.116	1.081
Availability								
Housing density	1.012*	1.010	1.023**	1.052**	1.035***	1.039*	1.008	1.182***
Rental housing units	.939	.965	.987	.958	1.062	.987	.989	1.006
Vacancy of all housing	.911**	.901***	.875***	.816***	.945*	.936*	.927**	.902**
Public housing	.897	.770	.976	.904	1.015	.906	.655**	.979
Section 8 vouchers	.928	.540*	.860	.920	.797	.819	1.014	.767
Quality								
No heating fuel	.829	.787	1.795	1.423	.929	1.137	1.934	.743
Lacking plumbing	1.068	1.010	1.287	1.295	1.222	1.195	.879	1.318
Overcrowding	.964	.974	.926	.877	.912	.902	.919	.920
Disaster Area	1.663	.490	2.420	2.185	16.598***	8.497*	2.791	.659
LR χ^2	61.87***	111.57***	99.34***	157.55***	108.56***	118.26***	72.12***	164.94***
Pseudo R^2	.211	.329	.324	.468	.335	.336	.215	.468

Note. * $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$

It was interesting to find that no housing quality factors were significant in testing the model. As expected, whether or not a county was in the FEMA designated disaster area was significant for Hurricane Rita's emergency phase for both owners and renters. However, it was surprising that this factor was not significant for determining unmet housing needs during the recovery phase, particularly in the disaster area.

In Table 5.5, the degree of significance and direction of the significant relationships are indicated for each variable to more easily compare and contrast the patterns of specific relationships for the eight logistic models. Within affordability, a greater likelihood of renters having unmet housing needs was associated with individual affordability during the baseline prior to Hurricane Katrina and during Hurricane Rita's emergency phase when renters were perhaps looking to afford temporary housing or having to relocate. During Katrina's emergency phase, renters' likelihood of unmet housing needs was directly related to greater market affordability of rental costs. Market affordability of mortgage costs was significantly associated with homeowners' unmet housing needs during the baseline phase only. No other affordability measure was related to owner's likelihood of unmet housing needs. Hence, renters were more vulnerable to both individual and market affordability barriers throughout the disaster phases except during recovery. In contrast, homeowners were more likely to have unmet housing needs in higher priced mortgage markets during the baseline period but affordability barriers did not play a role in their housing needs thereafter during the disaster phases.

Table 5.5. Comparing significant factors across models by phase and by owner vs. renter unmet housing needs

	Pre-disaster		Katrina		Rita		Short-term Recovery	
	Ownership housing	Rental housing	Ownership housing	Rental housing	Ownership housing	Rental housing	Ownership housing	Rental housing
Affordability								
Individual affordability-owner/renter		+++				+		
Market affordability-owner/renter	+			+				
Availability								
Housing density	+		++	++	+++	+		+++
Rental housing units								
Vacancy of all housing	- -	- - -	- - -	- - -	-	-	- -	- -
Public housing							- -	
Section 8 vouchers		-						
Quality								
No heating fuel								
Lacking plumbing								
Overcrowding								
Disaster Area					+++	+		

	Odds Ratio >1.0: Positive relationship	Odds Ratio <1.0: Negative relationship
$p \leq .05$	+	-
$p \leq .01$	++	- -
$p \leq .001$	+++	- - -

Housing availability measures were significant in accounting for likelihood of unmet housing needs for both owners and renters throughout all disaster phases. Housing density, as a measure of city size, was a significant factor for homeowners' likelihood of unmet housing needs during the baseline period and emergency phase of each hurricane but not during recovery. Homeowners in the larger cities were more likely to report unmet housing needs than those in smaller towns or rural areas. Once the disasters started, renters were significantly prone to experience housing needs in larger cities throughout the disaster phases, including recovery.

Housing vacancy rate was a significant factor in accounting for unmet housing needs for both homeowners and renters for the baseline period, emergency phase of each hurricane, and recovery phase. The lower the proportion of vacancies per total households the greater the likelihood of unmet housing needs. Hence, this measure was consistently significant for determining availability barriers in meeting housing needs whether during disasters or normal times.

Other availability barriers associated with unmet housing needs were subsidized housing factors. However, the type of measure and phase of significant association differed for owners vs. renters. During the baseline period, renters' unmet housing needs were more likely in counties with lower proportions of available Section 8 vouchers. This factor was not significant for renters after the disasters started. In contrast, analysis of homeowners' unmet housing needs was significantly associated with availability to public housing during recovery when their unmet housing needs were more likely in counties with less public housing available.

Thus, renters' unmet housing needs were more likely as they spent a greater proportion of their income on their housing as well as more vulnerable to housing unmet needs in higher-rent markets. Owners were also more likely to have unmet housing needs in higher-priced housing markets, but were not as vulnerable to variations during disaster phases. Neither renters nor owners had affordability factors during recovery, perhaps reflecting outside financial support for hurricane victims and evacuation communities during recovery from these two devastating disasters. Both renters and homeowners in larger cities reported a greater likelihood of unmet housing needs throughout the disaster emergency phases and continuing into recovery for renters. The most consistent factor throughout the study for both homeowners and renters was a greater likelihood of unmet housing needs as vacant available housing options decreased. A decrease in the proportion of public housing was associated with greater housing needs for homeowners and less Section 8 voucher availability was associated with renters' greater likelihood of unmet housing needs. Both renters and homeowners had significantly greater unmet housing needs in Hurricane Rita's disaster area; however, this diminished as they phased into recovery.

Discussion

Three dimensions have been found to be related to housing needs–affordability, availability, and quality. In this study, measures of each dimension were analyzed according to unmet housing needs for homeowners compared to renters over a five-month study period that encompassed a month baseline phase, emergency phases of two

sequential hurricanes, and over three months of recovery following Hurricane Rita. The findings of multivariate logistic analysis testing this model is discussed below according to each dimension in comparison to previous research findings in testing this model.

Market affordability was only related to homeowners during the baseline period, with no relationship to affordability measures affecting homeowners during disaster phases. As would be expected, typical higher average market home prices were associated with greater unmet housing needs reported by homeowners. But during disaster, this homeowner population was perhaps more resilient to find help to meet their own housing needs. In contrast, housing affordability was found to be an important issue for renters throughout the disaster phases analyzed in this study except for recovery. The greater proportion of income spent on rental housing, the more likely unmet needs were encountered. Market rental rates were a significant problem during Katrina's emergency phase, perhaps indicating Katrina evacuees' problems with Texas' rental prices as they sought temporary housing. No significant relationships between affordability and unmet housing needs were found during recovery phase may indicate successful federal, state, and charitable support given to help hurricane victims' housing needs in Texas.

In the U.S., the number of renters who suffered from housing cost burdens reached approximately 50 percent in 2011, including renters with severe cost burdens (27.6 percent) (Alexander et al., 2013b, Table A-3). Compared to renters, the number of owners who suffered from housing cost burdens was approximately 30 percent in 2011, including owners with severe cost burdens (12.6 percent) (Alexander et al., 2013b, Table A-3), indicating that renters' levels of affordability are far below those of owners.

Housing costs as a share of income increased from 26.6 percent to 32.2 percent from 1990 to 2010, as the median renter income decreased, and gross rent increased (see Alexander et al., 2013a, Table A-1).

Housing availability was a key dimension related to the likelihood of unmet housing needs in this study, regardless of disaster phase or whether the 2-1-1 caller was a homeowner or renter. First, counties with greater housing density experienced greater likelihood of unmet housing needs. Hence, the larger urban areas were more at risk for vulnerability to housing problems, especially during the emergency phases of disasters and for renters during the recovery phase included in the study. Interestingly, this relationship did not hold for owners during recovery. As found above regarding affordability, perhaps the owners were more resilient and better able to navigate support help to meet their housing needs.

Regardless of disaster phase, vacancy was negatively related to both owner and renter unmet housing needs, implying that increasing the available housing stock could help reduce unmet housing needs. A more simple approach may be to implement free or low cost locator services to help the rental population meet their housing needs. However, in the U.S., a shortage in affordable housing stock has remained an issue, especially for lower income renters. According to the American Community Survey (ACS), in 2009 affordable and available housing units were 78 units per 100 very low income renters (30 to 50 percent of Area Median Income), but were only 41 units per 100 extremely low income renters (30 percent of Area Median Income) (Collinson, 2011, p. 88). In addition, low-priced rental housing stock has been removed at higher

rate compared with those of higher priced rental stocks from 2001 to 2011: 12.8 percent for housing units where the rent level was under $400, versus 3.0 percent for housing units where the rent level was $800 and greater (Alexander et al., 2013a, Table A-4). Although new construction has been one of the ways to fill the gap between demand and supply in affordable housing stock, the price of the new units would likely be too expensive for low income renters (Alexander et al., 2013b, p. 25). In 2010, the gross rent for existing units was $873, but asking price for new apartments was $1,134, which meant that housing costs as a share of income was 32.2 percent for existing stock, but that number increased to 41.8 percent for new stock (Alexander et al., 2013a, p. 42). Thus, policy makers need a strategy for increasing lower-priced affordable housing units and providing additional rental housing assistance particularly for disaster victims.

One of the unexpected results of this study was that the proportion of assisted housing in a community (public housing and Section 8 vouchers) had no relationship with unmet rental housing needs during disaster phases. However, greater availability of public housing units was significantly related to lower unmet housing needs of homeowners during the early recovery period. Perhaps greater access to low-income housing helped to reduce competition for lower priced housing, hence significantly reduced unmet housing needs for homeowners.

Although housing quality would be relatively important parameter in determining housing needs during normal times, none of the housing quality variables was associated with either owners' or renters' unmet housing needs throughout the disaster phases. Nor were these measures significant during the baseline period. On one hand, this may

indicate an improvement in or satisfaction with housing quality in Texas communities. On the other hand, people may consider quality-related housing needs to be less urgent, particularly during disasters, or they may exchange inadequate conditions for a reduction in their financial burden. The Department of Housing and Urban Development (HUD) has published a report of worst case housing needs for very low income renters using data from the American Housing Survey. This report showed that the number of worst case needs has increased sharply, mostly due to a high rent to income ratio (Steffen et al., 2011). The major housing needs of very low income renters were related to severe rent burdens (about 93.8 percent of housing needs as a sole reason); the remaining housing needs (6.3 percent) were related to severely inadequate housing or both problems together (Steffen et al, 2011). Lastly, housing quality variables may be a significant factor in housing needs at the individual level, but not when measured at the aggregate level as found in this study using counties as the units of analysis.

Disaster area was added as a factor in determining likelihood of unmet housing needs simply as a logical way to control for disproportionate housing risk due to hurricane damage. As expected, this factor had a significant relationship with both unmet owners' and renters' housing needs during the emergency phase of Hurricane Rita. Interestingly, it had much stronger relationship with homeowners' unmet needs than those reported by renters. However, it was a surprise that neither owners' nor renters' housing vulnerability for unmet needs differed during recovery. Previous research has shown that rental housing takes more time to recover as compared to

ownership housing (Comerio, 1997, 1998; Peacock, Dash, & Zhang, 2007; Zhang & Peacock, 2010).

There were several reasons hypothesized why homeowners in the Hurricane Rita disaster area were significantly more likely to have unmet owner needs as compared with renters' housing needs. First, the number of rental housing units damaged by Hurricane Rita was approximately 26 percent of the total damaged housing units, a relatively small number as compared to owned housing units (though this is not an insignificant percentage of the rental housing stock). Second, if there were no available rental housing units in a disaster-affected area, victims who were renters must find housing units in other areas. A significant number of Katrina evacuees went to metro areas in Texas (e.g., Houston, Dallas) (Ericson, Tse, & Wilgoren, 2005). Victims who were owners before the disaster were more likely to come back to their original homes earlier than their renter counterparts. Thus, the impact of the disaster area on homeowners' needs would logically be greater. Third, rental housing needs were addressed later by disaster management organizations. Homeowner needs increased in terms of house repair as soon as the owners came back home. Alternatively, renters may be more likely to stay in temporary shelters during the same period of time, because they could not control whether or when they would go back to their original homes. For example, about nine months after Hurricane Katrina, 12 percent of evacuees were still living in someone else's home or at temporary shelters (Texas Health and Human Services Commission, 2006). Thus, it is possible that there was another surge in rental

housing needs later than measured in this study, or that renters settled in other places permanently.

Summary and Conclusions

In summary, this study tested a conceptual framework for understanding homeowners' and renters' unmet housing needs before, during, and following a disaster. Considerable research has examined models to explain housing needs in normal times; however, no previous study has investigated the factors associated with variations in unmet housing needs by disaster vs. evacuation areas and throughout disaster phases. Texas 2-1-1 caller data were used to identify unmet housing needs reported in real time within a broad geographical area (Texas's 254 counties) ranging from four weeks before Hurricane Katrina through 14 weeks after Hurricane Rita landfall. These findings suggested that housing affordability and availability factors had substantial relationships on the likelihood of owners' and renters' unmet housing needs (Tables 5.4 and 5.5). Greater affordability barriers were related to significantly greater renters housing needs before and during the emergency phases but not during recovery. In contrast, homeowners had significant affordability issues prior to the Hurricanes but none were significant after the disaster phases started.

Availability characteristics were significantly related to the likelihood of unmet housing needs throughout the disaster phases for both homeowners and renters. Larger cities were more likely to have both homeowner and renter unmet housing needs during the emergency phases; however, only renters in larger urban areas continued to have

significantly greater likelihood for unmet housing needs during recovery. The greater proportion of availability of vacancies for both homeowners and renters, the less likely they were to have unmet housing needs during both normal times and all disaster phases. A greater proportion of public housing was associated with lower likelihood of homeowners' unmet needs during the short-term recovery; whereas the proportion of housing available via Section 8 vouchers seemed to have no effect on renters' unmet needs during disaster phases.

Surprisingly, housing quality measures were found to have no relationship with unmet housing needs over time or location for either homeowners or renters during this study period. As expected, unmet housing needs were significantly more likely for those in the declared disaster areas when Hurricane Rita hit Texas. However, location was not associated with housing needs during any of the other disaster phases. Thus, it seems that federal and state disaster financial support helped meet housing needs for both homeowners and renters during recovery, but limited vacancies were significantly problematic for both renters and owners before, during and following these compound Hurricane disasters, particularly more likely for those in larger cities.

Comparing Factors Accounting for Housing Unmet Needs During Disasters

There were two unexpected results of this study as compared to models found in previous research that suggest consideration of housing policies throughout disaster phases. First, assisted housing variables (public housing and Section 8 vouchers) rarely showed a relationship with unmet rental housing needs throughout the study period. This

may be linked to the influx of Katrina evacuees in Texas who were supported by federal housing funds. Further, the percent of households receiving public housing or Section 8 vouchers only reflected Texas residents and would not include Katrina evacuees, hence, interfering with relationships between assisted housing availability and unmet rental housing needs during other disaster phases. Thus, this result might suggest that assisted housing-related programs may need more funding in evacuation destinations as well as financial support for housing in disaster locations.

A second unexpected finding was that during Hurricane Rita's emergency phase, counties in disaster areas had a stronger significant relationship with unmet housing needs of homeowners than renters. Based on previous research, it was hypothesized that disaster areas would have much a more significant association with rental housing and for longer periods of time. The reasons why this study showed different results may be hypothesized as follows: 1) a comparatively smaller proportion of rental housing units than houses were damaged by Hurricane Rita, 2) evacuee host areas were likely to have increasing rental housing needs because of the significant number of evacuees that relocated, and 3) there may have been a surge in rental housing needs later in recovery beyond the scope of time in this study, as many renters remained in temporary housing in other areas due to unrepaired housing and/or no affordable alternative housing in their original place of residence.

Other than those two findings of this study, the significant factors largely supported the proposed model accounting for housing unmet needs; however, with some variation through disaster phases for renters vs. homeowners. This model was consistent

with previous housing needs models in the literature examined during normal times. The only factor consistently related to unmet housing needs for both renters and owners throughout the baseline and disaster phases was an inverse relationship with vacancy—the lower the vacancy rate the greater the likelihood of unmet housing needs.

Rental housing was the more vulnerable housing type. More counties struggled with unmet rental housing needs than with unmet needs of homeowners. In our study, renters in larger cities had significantly greater likelihood of having unmet housing needs throughout disaster phases, whereas urban homeowners had significantly greater likelihood of housing needs during the emergency phases of both Hurricanes Katrina and Rita but not during recovery.

As previous research has focused on rental housing affordability (Belsky & Drew, 2007; Belsky, Goodman, & Drew, 2005; Collinson, 2011; Tang, 2012), this study showed that housing affordability was a significant problem for renters through the various disaster phases but not for homeowners. Policy makers should consider increasing the affordable housing stock as well as supporting locator services for low cost rental availability along with greater access to rental housing financial assistance. The results show that housing quality issues were less urgent types of needs. Yet, it should be remembered that other studies had found that people usually trade off these types of quality issues in order to reduce housing cost burdens (Belsky & Drew, 2007; Belsky, Goodman, & Drew, 2005). Among housing assistance programs, public housing and Section 8 vouchers have been essential for low income households. Funding from the federal government has been insufficient with regards to public housing; only 25

percent of eligible low income families were served by this program (Rice & Sard, 2007). The Section 8 Housing Choice Vouchers program provided rent assistance to 2.1 million low-income people in 2012, but the budget sequestration in 2013 forced a cut of about 50,000 vouchers (Rice, 2014). Thus, more funding for these housing assistance programs should be reconsidered.

During and immediately following disasters, homeowner and renter housing needs would require different policies and programs because of the different factors that affected the variation in housing needs that occurred during each disaster phase. During the emergency phase including immediate response and early recovery, homeowner needs increased with regards to mitigation and management issues of housing damage in disaster-affected areas, unless owners were to relocate permanently to other areas as experienced with Katrina victims. First, owners housing needs in disaster-affected areas were likely related to the repair or rebuilding of damaged housing units. Previous research has pointed out that disaster recovery programs and policies assist middle class, single-family homeowners best (Bolin & Stanford, 1991; Bolin & Stanford, 1998; Comerio, 1998). Thus, housing recovery programs would need to expand to encompass low income households, particularly in minority neighborhoods where the speed of recovery was found to be slower (Zhang & Peacock, 2010).

Second, rental housing needs in disaster-affected areas may be categorized into two types: the recovery of damaged rental housing units, and the provision of temporary housing. Rental housing needs related to housing recovery usually require more time than ownership housing needs. After the Northridge earthquake, owners of multifamily

housing units, and large buildings in particular, faced greater difficulties such as poor financial status due to a lack of cash flow and equity, as well as the limited availability of assistance programs due to complex ownership (Comerio, 1997). Three years after Hurricane Katrina, only 11 percent of the rental housing stock was available for occupancy among the 24,600 rental housing units that were allocated to be repaired with recovery assistance (Rose, Clark, & Duval-Dlop, 2008). Thus, strategies would be needed to reduce recovery times for renters who need household repairs. Until their rental units are repaired or rebuilt, disaster victims looked for temporary housing near their original home locations, which might result in increased rent near disaster-affected areas. Renters in New Orleans struggled much more with housing costs than did homeowners; more than half of the renters were paying more than 35 percent of their income in housing costs more than five years after Hurricane Katrina (Plyer, Ortiz, Horwitz, & Hobor, 2013). In addition, public housing residents have been struggling. For example, five years after Hurricane Ike in 2008, rebuilding or rehabilitation of public housing was still a complicated matter (Wilder, 2013).

Third, rental housing needs in evacuee host areas should be considered in cases of catastrophic disaster. If victims cannot find temporary housing units near their original homes, victims may need to travel to a different city or state, often attracted to larger cities where there are more available rental units and job opportunities. Then they may face additional barriers, such as higher costs of living. For example, Katrina evacuees sent to Austin found that rent was much higher and there were less available public housing units as compared to Louisiana (Lein et al., 2006, p. 15). Moreover,

previous public housing residents faced difficulties when attempting to transfer to different public housing accommodations (Lein et al., 2006, p. 15). Nine months after Hurricane Katrina, about 84 percent of evacuees stayed in rental housing, and only three percent had bought a condo or house in Texas (Texas Health and Human Services Commission, 2006). Without housing assistance, many of Katrina's evacuees struggled with their housing costs. Thus, disaster housing policy makers need strategies for disaster areas that deal with the recovery of damaged rental housing units as well as for evacuation destinations that deal with displaced victims, in particular those individuals who will have difficulties due to housing price gaps between their previous and current locations.

Recommendations for Disaster Managers and Communities

To reduce the housing cost burden of disasters, recommendations would be to not only increase affordable housing stock, but also provide more funding for rental housing assistance. Thus, a strategy would be needed for expanding the stock of available lower-priced affordable housing units and for providing additional rental housing assistance. Even before a disaster, the stock of affordable housing may already be insufficient, then access barriers compounded by losses during a disaster. Policymakers should understand that the types of factors affecting unmet needs for homeowners vs. renters would likely be different, depending on the type and disaster phase. Hence, different strategies and programs would be needed during the different time periods surrounding a disaster and should be targeted to different vulnerable population groups.

Disaster-related homeowner needs occurring in disaster areas would usually involve repair or rebuilding damaged housing units. Disaster-related rental housing needs, however, occur not only in disaster areas, but also in evacuation destinations. In disaster areas, recovery programs would be needed for both ownership housing and rental housing inhabitants, and in particular for low income households (see Zhang & Peacock, 2010). The recovery speed for rental housing has been shown to be slower than for ownership housing; thus, strategies are needed to reduce recovery times for rental housing. In addition, disaster areas, as well as evacuee host areas, would need to provide temporary housing at an affordable price for renters who need a place to stay until their housing units are repaired or rebuilt. And specifically, evacuee destinations need financial disaster support to bridge the housing price differences between the evacuees' original and current locations.

Recommendations for Future Research

This investigation of homeowners vs. renters unmet housing needs was successful in demonstrating that different factors affected these different groups varying according to disaster phase. This laid the groundwork to generate hypotheses about what kinds of housing needs occurred for whom and when. In future studies, researchers should also examine differences according to disaster areas compared to evacuation destinations in order to examine variations in factors affecting housing needs. Further, distinguishing unmet needs with regards to whether or not they were specifically disaster-related, researchers could better organize findings and recommendations

according to disaster-related needs versus local community needs. This would be especially helpful for mitigating the impact of evacuation of large urban areas into destinations with community resources already stressed by previous disaster(s) or other economic or social upheaval. Lastly, this study may provide a template for future research using 2-1-1 data to examine unmet needs in real time over time for other types of disasters and responses that reduce risk for these vulnerable populations in other communities throughout the U.S.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The purpose of this study was to examine unmet housing needs during disasters, investigating the case of Hurricanes Katrina and Rita experiences in Texas over a five-month study period, fall 2005. Using the Texas 2-1-1 Information and Referral Network's (TIRN) dataset, information was captured about unmet needs of callers in "real time" throughout the state's 254 counties. The dissertation is a compellation of four manuscripts for publication, recognizing that these working papers are in various stages of finalizing for submission. These papers cover the typical aspects included in a dissertation, i.e., literature review, methods, descriptive findings, and multivariate findings. The first chapter was an introduction to the organization of the dissertation and a brief overview of the background of the study.

Summary of Key Findings and Conclusions

Chapter II, "Differences between Renters' and Owners' Housing Needs During Disasters," focused on reviewing the literature of previous research regarding differences between renters' and owners' housing needs before, during, and after disasters. Prior to a disaster, renters' household, social, and physical resources have typically been limited compared to those of homeowners. When recovering from severe damage from a disaster, renters struggle harder and over a longer period of time. Thus, housing

assistance program need to focus more on renters' needs during a normal period as well as after disasters.

Chapter III, "Handling Incomplete Tertiary Datasets: Case of 2-1-1 Information and Referral Missing Data," was written about a new method developed to handle missing data when merging multiple tertiary datasets. The purpose was to test a model for imputing missing data for a key variable in order to conduct multivariate analyses. This method was developed in collaboration with Dr. Michael Longnecker and Dr. Sherry Bame to solve the problem of missing date information encountered in the Texas 2-1-1 caller dataset in order to combine the 25 different tertiary Texas 2-1-1 datasets for analysis. The approach used a systematic algorithm within the parameters of the missing data in comparison to logical assumptions of the comparative data. By applying this method, the amount of data available for analysis increased approximately 30 percent, thus significantly improving the validity of the findings. Thus, this method may enhance opportunities to employ tertiary data for research and management studies, at the same time increasing the validity of the findings for more appropriate planning and policies.

Chapter IV, "Sheltering, Rental and Ownership Housing Unmet Needs During Hurricanes Katrina and Rita in Texas, 2005," addressed two issues: the types of unmet housing needs most frequently encountered and the time period in which victims need the most assistance, according to housing type. As expected, the most vulnerable type of unmet housing need during and immediately after a disaster was shelter. Unmet needs for rental housing were the most frequent type of needs both before and after the emergency phases. The most frequent barriers related to rental housing needs were

financial problems. Homeowners encountered fewer access barriers relating to financial issues and getting help for repairs as well as other home modifications. Conclusions emphasized the importance of addressing unmet housing needs, particularly those of renters, for considerably longer than the immediate disaster phase in order to accommodate demands for evacuees' temporary housing as well as routine housing needs of residents in evacuation destinations.

This study also provided empirical evidence based on real-time data to support Quarantelli's theoretical model of disaster sheltering and housing (1982, 1995). Findings of the longitudinal analysis portrayed peaks in unmet shelter needs occurring right before and at hurricane landfall. Before the sheltering phase ended, unmet rental housing needs began to increase. Unmet ownership housing needs peaked during the early recovery phase. Perhaps shelter needs became easier to meet once evacuees started seeking temporary housing or sought more permanent housing to relocate. Until one month post-Rita, the volume of unmet shelter needs was still higher than it was before the disaster. This may indicate that disaster sheltering and housing phases are 'mutually inclusive', as has also been stated in the previous literature (Quarantelli, 1982, 1995; Neal, 1997).

Chapter V, "Community Factors Associated with the Housing Needs of Owners vs. Renters During a Disaster: A Case Study of Hurricanes Katrina and Rita in Texas," provided a conceptual framework and quantitative multivariate evidence for understanding homeowner and renter unmet housing needs before, during, and following hurricane disasters. The model used measures of affordability, availability, and quality

dimensions found to be significant in previous research examining housing needs during normal times. The unmet housing needs, location, and time data were obtained from the 2005 Texas 2-1-1 dataset and the independent measures were developed from the Texas Census and Housing and Urban Development (HUD) public access databases. This comprehensive model was tested for renters vs. homeowners over time, including a baseline month and three disaster phases covering two hurricanes and 14 weeks post-landfall of Hurricane Rita.

The multivariate logistic regression findings suggested that housing affordability and availability factors had a significant impact on homeowner and renter unmet housing needs, whereas housing quality had no significant relationship during the disaster study period. In the case of unmet rental housing needs, greater affordability barriers were associated with greater unmet needs of renters for all disaster phases except recovery, where it was hypothesized that federal and state disaster assistance may have helped to afford temporary rental housing as well as relocation expenses. Interestingly, housing market affordability barriers were significant for homeowners during the baseline period but none were significant during the disaster phases. Hence, homeowners may have been more resilient to meet their own housing needs or had greater access to disaster financial support programs.

Availability barriers affected unmet housing needs for both renters and homeowners. Unmet housing needs of both were significantly greater in larger urban areas during the emergency response phases, with renters still struggling during recovery. Controlling for city size, lower vacancy rates for both ownership homes and

rental units were significantly associated with greater reports of unmet housing needs for both homeowners and renters throughout the study period. Less availability of public housing was related to homeowners greater unmet housing needs during the short-term recovery, whereas fewer Section 8 vouchers was related to renters' unmet needs only during the baseline phase prior to the hurricanes.

During Hurricane Rita's emergency phase, homeowners in the declared disaster area had significantly greater likelihood for unmet housing needs than did renters. Perhaps this was due to longer delays in disaster locations to recover rental housing (Zhang & Peacock, 2010) and/or a tendency of renters to relocate (Peacock, Dash, & Zhang, 2007), particularly if their employment was disrupted by the disaster. Alternatively, there may have been a surge in rental housing needs beyond the scope of the early recovery phase in this study, as many renters remained in temporary shelters or were housed in other areas due to unrepaired housing and/or no affordable alternative housing in their original place of residence.

Recommendations for Planning, Policy, and Future Research

Community planners and policymakers should address affordability barriers for rental housing needs during disasters. If the stock of affordable housing is already insufficient before disasters, both homeowners and renters will experience significantly greater unmet housing needs throughout disaster phases not only in the disaster areas but also in evacuation destinations. In disaster areas, as well as evacuation host locations, temporary housing may need to be provided at affordable prices, especially for renters

until units in the disaster locations are repaired or rebuilt. Evacuees who lived in unsubsidized rental housing faced difficulties from the gap in housing cost between their original and host areas. Additional barriers for Katrina victims encountered in Texas communities hosting evacuees were ineligibility for subsidized public housing and other subsidized support services requiring state residency. These interstate differences became problematic not during the emergency response phase when disaster-related funding supported housing relief, but rather when individuals sought temporary and permanent housing because their original homes and neighborhoods had been devastated. Thus, disaster planning and policy making should consider mechanisms to facilitate interstate eligibility criteria and emergency funds in order to bridge the gap for financial support and housing programs.

Policymakers should consider that the types of unmet housing needs for homeowners compared to renters are often different, and hence, different strategies and programs would be needed. Furthermore, these differences vary during different time periods surrounding a disaster. Disaster-related ownership housing needs occurring in disaster areas usually involve the repair or rebuilding of damaged housing units. Disaster-related rental housing needs, however, occur not only in disaster areas, but also in evacuee host areas for temporary housing or relocation. In disaster areas, recovery programs would be needed for both homeowners and renters, and in particular for low income households in larger urban areas.

The results of this study suggest topics for future research. Analyses according to disaster area versus other areas may examine differences in disaster-related housing

needs for disaster sites as well as for evacuation host communities. Comparisons between urban and rural areas could offer implications for allocating resources, especially for rural communities with limited availability of resources and programs. In order to better predict and plan for unmet housing needs, future research is needed to analyze the temporal and spatial changes that occur for sheltering and temporary housing, especially in terms of tracking unmet needs by disaster phase and location. Exploring specific sheltering and housing needs over time can enable more timely and focused interventions by emergency managers hoping to more effectively and efficiently allocate resources. The importance of also investigating evacuation destination community needs would help to enhance community resiliency in supporting disaster victims while maintaining support and services for their own residents. Lastly, repeating this research approach using 2-1-1 data of other types of disasters in other locations would enable greater understanding of factors affecting housing unmet needs in an all-hazards model.

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APPENDIX A

CODING INSTRUCTIONS FOR PAPER DATA: Excel Files

- NEW FILE FOR EACH AIC
- HAVE HIGHLIGHTER AND STICKY-NOTE FOR QUESTIONS
- **ALL CAPS ONLY**
- LEFT TOP OF PAPER: CODER 3-INITIALS & DATE
- RIGHT TOP OF PAPER: VALIDATER 3-INITIALS & DATE
- SET FOR ' WRAP TEXT"
- FILE NAME: INITIALS_AIC_PAPER_DATE.XLS (E.G.: SIB_SOUTH-TX_PAPER_8_29_08.XLS}
- SEPARATE MULTIPLE INFORMATION WITH A SEMICOLON [;]
- Log all questions & your decisions so we can go over at team meetings.
- If demographic information available on more than one client, please see SIB
- Use "DK" ONLY if the staff or caller stated that on the data record
- **NO BLANK CELLS: USE "MISS" IF DATA MISSING FOR ANY VARIABLE**
- Put "XX" if you & others have a question about the information: write what you think it is & we will search for XX to validate.
- USE "NA" IF NOT APPROPRIATE TO HAVE DATA IN THAT CELL [e.g., if not validated put NA in validation columns]
- Use "ILLEG" if illegible, if you & others cannot figure out what was written.

Coding instructions for paper data

COLUMN	VARIABLE	HOW	COMMENT	9/2/08 UPDATE	9/7/08 UPDATE
A	CODER	3-INITIALS	AMD=Aatmaja; A2G=Abha; A3G=Andrew; AMS=Ashley; CNP=Courtney; DKF=Dayna; ENH=Erin; JYL=JeeYoung; MTK=Tiffany; RJB=Robyn; TMD=Tasha		
B	CODE_ DATE	M/D/YR			
C	MODE	P / E / A / O	P=paper/ E=Excel/ A=Alliance-Access/ other-> write out		If OTHER -- write out what other format it is
D	AIC	Area Information Center Name	Can abbreviate, then Find/Replace		
E	CALLER_ID	Use caller ID number available. If NONE, start at 1 & continue sequentially for all that you code for that AIC.	We will reassign ID after validate per AIC.	Start at 1 & number sequentially, NO DUPLICATE NUMBERS PER INITIALS	**If data sheet has its own caller numbers, put" AIC-#'s" [e.g., S-TX-190]**
F	CALL_ MO	Call month: 1-12			You do not need "0#" if single digit
G	CALL_DAY	Call date: 1-31			You do not need "0#" if single digit
H	COUNTY	NAME / MISS	**DELETE:** If out of state, list LOCATION, STATE OR COUNTRY IN THIS COLUMN	Location: COUNTY NAME OR MISS for WHERE THE NEED IS	
I	CITY	NAME / MISS	If more than one location, list all that are there.	Log where the need or referral should be.	
J	ZIP	##### / MISS			

Continued

COLUMN	VARIABLE	HOW	COMMENT	9/2/08 UPDATE	9/7/08 UPDATE
K	INFO_LOCATION	ANY COMMENTS RE: LOCATION		LOG ANY LOCATION INFORMATION OTHER THAN WHERE THE NEED IS. INCLUDE ESPECIALLY IF INFO RE: WHERE FROM. Include broader location info, e.g., Sugarland coded in city & Houston area coded in INFO_LOCATION	
L	DIZ	EVACUEE= written that hurricane evacuee; DIZ=disaster related but not written if evacuee; NO=only if written that NOT disaster call; MISS=no information available	If you don't know how to code, please check w/ Team Leaders or SIB	Code DIZ if yes. Find/replace if already coded with Y or YES.	ADD "EVACUEE" if listed in the data, so: DIZ; or EVACUEE or MISS 9/23: "Shelter"= EVACUEE [not homeless shelter]
M	K-R	K=Katrina related / R=Rita / MISS=Information missing /If OTHER type of disaster -- write it out	DELETE: Check w/ SIB if not clear. IF LOCATION has Louisiana, then list Katrina.	Code only what's written. Do NOT make any assumptions of which disaster unless "evacuee" & city fits K or R.	Can code more than one hurricane &/or other disaster. Separate by semicolon ";" 9/23: "Hurricane"
N	NEEDS	WORDS OR PHRASES AS WRITTEN	Explain as close to original wording. Include donations. Use referral info if need not clear.	Include in NEED -- VOLUNTEER or DONATION and any further information of what they are giving.	
O	EST_NUM_NEEDS	# OF NEEDS LISTED			
P	AGE	YEARS OLD	If birthdate listed, convert to age in 2005 (see cheat-sheet); If > 1 listed, include all with";"	If more than one caller/client -- list all info given separated by ";"	

Continued

COLUMN	VARIABLE	HOW	COMMENT	9/2/08 UPDATE	9/7/08 UPDATE
Q	GENDER	M / F / O / MISS	Male / Female / Other (explain) / Missing	If more than one caller/client -- list all info given separated by ";"	
R	RACE	W / B / H / A / O / MISS	White / Black / Hispanic / Asian / Other (explain) / MISS		
S	HSE_SIZE	# IN HOUSEHOLD	# kids / # adults if listed, or total	Use + if some listed but not sure how many total.	
U	HOH	FHOH=Female head of household; M=Male HOH; DK; MISS			
T	EMPLOYMENT	FT / PT / SP / UN / RT / DSB / MISS	FT=Full time/ PT=Part time/ SP=Sporadic or seasonal/ UN=Unemployed/ RT=Retired/ DSB=Disabled/ MISS=Missing		List detailed information re: disability.
V	ECON	Write in info re: economic data, e.g., income, food stamps, welfare			
W	OTHER	Write in other relevant info: Check w/ SIB about if should include			
X	VALIDATOR	3 INITIALS	Put only in cases you validate or make changes (XX questions); else put "NA"		Validate every 10th OR questions (XX), which ever comes first.
Y	V-DATE	M/D/Y			
Z	V-COMMENTS	write out any comments, changes, decisions or questions for future re-coding			

APPENDIX B

INFORMATION FOR VALIDATING PAPER CODING

Purpose: To represent data as closely as possible to what was recorded
To make coding decisions consistent

1) Take file of other person
   Other validater
   Other coder
2) SAVE filename AS CURRENT DATE -- do NOT change original initials
   Put V_ at front of filename to identify that it is validated: V_SIB_SOUTH-TX_PAPER_M_D_YY.XLS
3) FIND-REPLACE for the whole file:
   Search for BLANK cells
      Validate what it should be
      Report to SB & the original coder
   Search for EVACUEE
      If evacuee coded anywhere, change DIZ to DIZ-EVACUEE
   Search for ABBREVIATIONS as you run across them & change to full names in the whole file [eg, S-TX or STX -> SOUTH-TX; M -> MISS vs. ok if male].
   Log these & notify SB
      Careful to not change within text-- Whole cells only.
      Let us know of any other abbreviations to check
4) Search for XX -- fix questionable coding. ASK others & SIB !
      If illegible, code "ILLEG" rather than MISS
      If location confusing, check w/ SB
      If needs confusing, check w/ SB
5) Start w/ #1 & then check every 10th case carefully for accuracy.
      Ask re: any problems & make post-its to discuss w/ SIB
      Notify SIB of any problems found for other coder or differences from your coding
6) Search for any more ?'s ("?-" or "?^ (space)" or ?? Or whatever they used) & fix or consult w/ SB
7) If find needs not included, show SB & we'll inform the group of how to decide in these cases
8) Identify any DISABILITY-related information & write details in EMPL (DSB-wheelchair, DSB-parkinsons). Ask SB if any questions re: this.
9) Put validater INITIALS at end of case record; Column X
   Put DATE validated in Column Y
   Put any COMMENTS or decisions made about that case in Column Z
10) Put NA in X & Y & Z if NOT validated or checked by validater

APPENDIX C

CODING HOUSING NEEDS

PREPARING FOR HOUSING CODING

DONE – JYL 7/9/09

A) SET UP NEEDS-PIVOT TABLE SORTING

1) • In JYL_PIVOT_NEEDS_7_9_09.xls, each worksheet has each AIC's pivot.
   • Make two worksheets: one is for electric files, the other is for paper and report files.
   • Column A: name of AIC, Column B: needs, and Column C: number of needs
2) Sort NEEDS coding alphabetically.

B) SET UP FILES FOR HS CODING: DSB_AIC_*INITIALS*_M_D_YY

1) ***Save as*** HS_AIC_M_D_YY.xlsx

2) Label the file's ***tab as*** **HS-FILE**

3) ***Delete*** the following COLUMNS / VARIABLES from right to left:
   [NOTE: THE COLUMN LETTER WILL CHANGE IF YOU DELETE LEFT TO RIGHT]
   • EVERYTHING TO RIGHT OF Q (ANY_DSB),
   i.e., INCLUDING R (DSB-COPY) → AF (DSB_CODE_DATE)

FILE VARIABLE ORDER

A =	MERGE_ID
B =	CALL_DATE
C =	CODER
D =	CODE_DATE
E =	MODE
F =	AIC
G =	CALLER_ID
H =	CODE_CO
I =	DIZ
J =	K-R
K =	NEED
L =	NUM_NEEDS
M =	DSB
N =	FEMA

O = RED-CROSS
P = SALVATION-ARMY
Q= ANY_DSB

2) ***Labels new FOR HOUSING Variable w/ Columns***

R * HS

* = ***Copy & Insert*** NEED (column K) & relabel the variable names in Row 1
Code NONE, if there is no need related to housing.
Keep MISS, if the need is MISS.

S ** ANY_HS
T ** HS-COPY

** = ***Copy & Insert*** HS (column R) & relabel the variable names in Row 1

U*** HS-DIZ

*** = ***Copy & Insert*** DIZ (column I) & relabel the variable names in Row 1

V SHELTER
W RENTAL-HS
X OWN-HS
Y MOBILE-HS
Z GROUP-HS
AA PUBLIC-HS
AB NO-INFO
AC LOW-INCOME
AD DISABLED
AE ELDERLY
AF HOMELESS
AG CHILDREN
AH POP-MISC
AI LOCATION
AJ HS-REHAB
AK FINANCIAL
AL HS-INFO
AM UTILITY
AN HS-GOODS
AO HS-MISC
AP HS_CODER
AQ HS_CODE_DATE

C) *Save* the prep'd base files ***in separate folder*:**

→ **HS_AIC_JYL_M_D_YY.xlsx**

HOUSING CODING – STEP I: ANY_HS (Column S)

A) ***SORT*** whole file (highlight upper left diamond then sort) by **ANY_HS** [COLUMN S] in ascending order – be sure "HEADER ROW" is highlighted.

1) ***Write*** the word "HS" in first cell of ANY_HS: Row 2, Column Q
   Copy the word "HS" over everything that is **NOT:**
   → **MISS**
   → **NONE**

2) In large files, do this down several hundred rows, save, then continue scrolling down several hundred rows, save, etc.

   Thus, will have only 3 codes in ANY_HS:
   - HS
   - MISS
   - NONE

SAVE

HOUSING CODING – STEP II: HS-COPY & GROUP CAT (Column U-AO)

1) ***Highlight*** all MISS in HS-COPY column.

2) Without releasing cursor, go to lower right corner of last MISS cell that is highlighted and hold until you get a plus sign ✚

3) ***Drag right*** the whole set of highlighted MISS through column AO: HS-MISC.
   - This will fill in the set of cases with MISSING HS for all HS variables.
   - Check the bottom of the set to make sure all copied and no more than should.

4) Go to the top and ***Highlight*** the whole HS-COPY column.
   - ***Find / Replace All:*** MISS with a number 1 in just the HS-COPY column.

*** * * REPEAT < 1 - 4 > FOR "NONE" * * ***

[Remember, HS-COPY is alphabetical, so all "MISS" should be together, and the same for all "NONE".]

STOP HERE UNTIL ALL XX_FILES (GROUP 1 & 2) ARE PREP'D

- Do pivot table on ANY_HS to get count of HS / NONE / MISS.
- Save pivot table in new tab worksheet in this file.
- Total must = total # cases (MERGE_ID)

HS CODING – STEP III: CODING HOUSING BY GROUP CATEGORY

HS Coding on all X_Group 1 & X_Group 2 files. These should be finished with STEP I: a) set into HS File format, and b) ANY_HS coded.

A) HS Coding Set-up

1) Open HS_AIC_*your initials*_M_D_YY.xlsx. Now ***save*** this file with new date and adding your initials to **left** of existing initials – even if they were yours:
Save as HS_AIC_***Your Initials***_former initials_M_D_YY.xlsx

2) Leave your file sorted as in STEP-I. You will be using **HS-COPY** that should be sorted in alphabetical order.

3) HS_CATEGORIES: Open file **JYL_HS_CODE-CAT_8_15_09.xlsx**
a) There are 21 HS categories (variables) in this CODE_CAT file:

	DISASTER		HOUSING TYPE
1	HS-DIZ	2	SHELTER
		3	RENTAL-HS
		4	OWN-HS
		5	MOBILE-HS
		6	GROUP-HS
		7	PUBLIC-HS
		8	NO-INFO
	SPECIAL POPULATION		**TYPE OF ASSISTANCE**
9	LOW-INCOME	15	LOCATION
10	DISABLED	16	HS-REHAB
11	ELDERLY	17	FINANCIAL
12	HOMELESS	18	HS-INFO
13	CHILDREN	19	UTILITY
14	POP-MISC	20	HS-GOODS
		21	HS-MISC

b) There are 3 worksheet tabs in this CODE_CAT file (per 8/15/09):

→ HS-CATEGORY:
- List of housing categories and variables.

→ HS-CAT. LOGIC:
- Word or phrase describing the types of needs included in the HS_category.
- Alphabetical listing.
- This listing is not all inclusive, so if you have suggestions please notify Jee Young & copy Dr. Bame.

→ JYL_HS-CODE-CAT_8.15.09:
- List of all possible HS needs in HS_AIC files categorized to date (8/15/09).
- The needs are listed alphabetically *exactly* as they appear in the datafiles, with spacing and spelling errors.

4) Files ready to code HS_CAT per 8/16/09:

AIC	X_Group	Type	Number of Merge ID
1) ALAMO	1	electronic	38,549
2) BRAZOS	1	electronic	12,112
3) COASTAL BEND	1	electronic	8,259
4) DALLAS A & B	2	report	64,007 & 60,428
5) DEEP EAST	1	report	1,747
6) EAST TX	1	electronic	15,331
7) FT. WORTH	1	report	38,435
8) HEART OF TX	2	electronic	6,280
9) HOUSTON x 5	1	electronic	28,841, 29,502, 34,624, 42,983, 36,566
10) NORTH EAST	1	electronic	5,135
11) NORTH TX	1	paper/report	1,556
12) PERMIAN BASIN	2	electronic	25,320
13) SOUTH EAST TX	1	electronic	863
14) SOUTH PLAINS	2	paper	64
15) TEXOMA	1	electronic	4,020
16) TIP-of-TX	1	electronic	25,708

B) HS-Needs Coding: 6-step process: (See below for detailed instructions per step.)

1) ***Copy*** **(Ctrl + C)** HS need in column "**HS-COPY"** in your new HS datafile.

2) ***Find*** **(Ctrl + F)** the category group for that need in HS_CODE-CAT file.

3) ***Paste*** **(Ctrl + V)** that need into the appropriate variable column in new HS datafile for all those cases with that need.

4) ***Delete*** that need in the HS-COPY column by typing a "1"

5) ***Find*** *blank* (cursor against far left) in each category column and ***Paste*** "**NO**", i.e., there are no HS needs for that category.

6) If HS-DIZ is "DIZ", copy HS-COPY column and paste into HS-DIZ column.

1) ***Copy*** HS need in column "**HS-COPY"** in your new HS datafile.

a) In your file, HS_AIC_*Your Initials*_former initials_M_D_YY.xlsx, start alphabetically in column T: **HS-COPY:**
- ***Copy*** the HS-need then go to the HS_CODE-CAT file.
- You will know where you need to go back to for the next need as you finish up one need and change it to a "1" (Step 4)

Semicolon(s):
- Whether more than one need is separated by semicolon(s) or not, ***Copy*** the whole need.

NOTE: Paper files had many needs with semicolons but electronic files rarely did.

-- If you do not find that exact need, the combination of needs may be listed together. ***Find*** a portion of that need, reading the listings carefully in the HS_CODE-CAT file. Then ***Paste*** that revised version from HS_CODE-CAT file into the HS datafile in that case's cell under the appropriate category.

-- OR, that need may have been excluded from HS_CAT because it was not housing related.

2) *Find* the category group for that need in HS_CODE-CAT file.

a) Sort by AIC & HS-NEED
Find what group category that HS-need item is in the CODE-CAT file.

- Identify the Variable Category's name at the top (Row 1) where that HS-item is found.
- **Do NOT take any categorizing for granted –** search out each HS-need item and the appropriate Category Variable.

b) *Copy* that HS-need item in the CODE-CAT file in your HS-need database file. (Easier to just copy again when you ***find*** because sometimes Excel will drop what was copied if there are any intervening steps before *paste*.)

3) *Paste* that HS-need item into the appropriate variable category column in your new HS datafile **for all those cases with that need.**

a) ***Paste*** the word/phrase into the appropriate category's column for that cell (row) in your HS-need datafile.
Be careful. Many of the HS-needs have MORE than one category.

- When you toggle back to your HS-need datafile, you should end up in the cell for that need in the HS-COPY column.

- Use the right arrow to move curser over to the correct column so you stay in the same row.

b) Because the HS-COPY column in your HS-need datafile is alphabetical, you should be able to just ***copy-down*** in the appropriate Category column for all cases (rows) that have that same HS-need item.

4) *Delete* that need item in the HS-COPY column by typing a number 1

a) Use the arrow to go back to the HS-COPY column for that case (row) for that need item.

b) ***Delete*** that need item by typing a "1" in that cell in the HS-COPY column.

c) If there are more than one row of that exact same need item, ***copy/paste*** a number 1 into each of those cells. [Don't "copy down" because the 1 will change to 2 then 3, etc.]

d) At the end of coding this file, summing the HS-COPY column will = the number of cases in the file (i.e., the last MERGE_ID). This is one of the key steps in checking your coding.

5) ***Find*** *blank* (cursor against far left) in each category column and ***Paste*** "**NO**", i.e., there were no HS needs for that category.

a) Fill in blank cells for each HS category column:
[Recommend you do one column at a time, especially for the big files.]
- ***Find " "*** – keep this *blank*, i.e., curser to far left
- ***Paste*** "NO"

[NOTE: NONE means that there was no need coded for that case for any of the HS-need variables vs. NO means that the specific HS variable did not have any needs in that category.]

b) All cells must be filled in with either the word/phrase of the HS item **/** MISS **/** NONE **/** *or* NO.

6) If HS-DIZ is "DIZ", copy HS-COPY column and paste into HS-DIZ column.

C) Check your HS coding when finished

1) Check for ***blank*** cells
- ***Find " "*** – keep this *blank*, i.e., curser to far left
- Fix your mistake.

2) Check that all HS-needs are coded: ***Sum*** the HS-COPY column [sum($R2:$R*i*)] or ***Highlight*** the HS-COPY column, you can see the total at the bottom
= total number of cases for that file (i.e., the last MERGE_ID #).
= the last row number minus one.

→ If NOT the same total, then there is something that was not coded. Scroll and "eyeball" to find it to fix.

D) Code your *INITIALS* (HS_CODER: Column AP) and *DATE* (HS_CODE-DATE: Column AQ) for those rows that you code.

- Keep this up to date if you stop before finished. Even if you stop just for a break.
- If you do all coding in one sitting, then you can put your initials & date in first 2 rows, highlight, put curser at lower right and double-click.

- Scroll down to see if all cells filled in and stopped at the last case.
- In the case of MISS and NONE, I already put my initials & date. Leave as it is.
- Also check to make sure the date did not change while copying.

E) Finished

1) ***SAVE*** with current date.
2) Send back HS-CODED FILE to Jee Young & copy Dr. Bame.
3) Files will be validated after the first set is coded.
4) Be sure to save frequently and to have your files backed up. This is a lot of effort and would not like to have you repeat it all because lost a file or corrupted.
5) Please send any feedback &/or suggestions re: the coding or ways that may work better.