2007 Metropolitan Disaster Planning

Analytical Support of the American Housing Survey

U.S. Department of Housing and Urban Development
Office of Policy Development and Research

2007 Metropolitan Disaster Planning Analytical Support of the American Housing Survey

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Executive Summary

During the time leading up to a disaster and in the immediate aftermath, one of the most valuable of commodities for disaster planners and emergency responders is information. Task C of the Analytical Support of the American Housing Survey, Fiscal Year 2008 workplan explores how the Department of Housing and Urban Development (HUD) and federal government agencies may be able to make use of the American Housing Survey (AHS) in disaster planning and response activities and/or survey additional data for this purpose.

The Econometrica-ICF team performed a literature review (included as Appendix 1) of research related to the field of disaster recovery and found that the AHS can help fill a critical gap in the emergency response preparedness planning literature. While research related to disaster response and recovery is plentiful and covers a diverse range of topics, there is limited research available regarding data needs in disaster recovery. One common topic throughout the available literature is the need of disaster planners and responders to have detailed information about community vulnerability in pre-disaster planning and post-disaster response and recovery activities. The detailed information required, however, does not typically reside in one organization or one system but instead requires integrating various authoritative sources to more comprehensively understand disaster planning and response needs.

In this deliverable, the Econometrica-ICF team documents the information included in the AHS provides a rich and granular foundation for disaster planning-related analyses, particularly those related to housing issues in the surveyed areas. This information allows disaster planners to evaluate community resilience, housing stock vulnerability, and potential housing issues that might arise in the aftermath of a disaster event. While the primary focus of the AHS is on the housing unit, the survey also includes valuable information that can be used in disaster planning activities beyond housing, such as the distribution of short-term emergency response resources.

Additionally, the Econometrica-ICF team performed a disaster simulation case study on the Miami-Ft. Lauderdale, FL Metropolitan Statistical Area (MSA) to illustrate how AHS data can be used to evaluate the vulnerability of the geographic areas within an MSA. The analysis shows that the Miami-Ft. Lauderdale, FL MSA is highly sensitive to disturbances in housing stock availability. Even under conservative assumptions, serious housing deficits arise when more than 30 percent of the MSA is affected.

While the literature search, AHS variable analysis, and simulation exercise demonstrate the potential value of the AHS in pre-disaster planning and post-disaster response, the AHS data are limited in some respects. For instance, there is limited information regarding language barriers and tenure in the region, both of which are considered important characteristics in describing a community's vulnerability.[1] Limitations such as these, however, can be readily overcome by integrating the data in the AHS with other data sources and/or through AHS survey modification.

The AHS, as a preeminent source of housing characteristic information for the U.S. housing stock, is a data source that in isolation or when integrated provides valuable authoritative housing stock and other demographic information that can assist local governments in planning pre-disaster and post-disaster recovery, whether they are natural, large industrial accidents, or major terrorist attacks.

Introduction

Developing community resilience and reducing vulnerability requires detailed knowledge of the social, economic, and infrastructural characteristics of a community. Data that address housing stocks are a critical component of this knowledge base because it allows disaster planners and responders to identify and allocate resources to locations where an emphasis is warranted in both the short term and long term. In the short term, it provides responders with guidance regarding triaging and emergency housing actions. In the long term, it can assist planners in developing measures that minimize individual losses,

[1] Previous editions of the AHS contained limited information pertaining to disability statuses of household members. Questions addressing disability status are included in the 2009 AHS.

shorten permanent housing reconstruction trajectories, and overall, minimize foregone economic activity.

The Econometric-ICF team performed a detailed literature review (included as Appendix 1) in search of research relevant to data needs in disaster preparedness, response, and recovery. While the literature is plentiful, there is limited research available regarding data needs in disaster recovery. One common topic throughout the available literature is the need of disaster planners to evaluate community vulnerability. Vulnerability, however, is a multi-dimensional concept incorporating many social, economic, and infrastructure variables.

Knowledge of the demographic and economic characteristics of a region's occupants prior to disasters can aid responders in the allocation of resources to areas where an increased response is warranted in both the short term and the long term. These characteristics include age, race, gender, family structure, disability status, English-language proficiency, and tenure in the area, among others. For example, an area with large percentages of elderly or disabled residents will require additional resources in a major disaster event to assist the pre-disaster evacuation process. In the long term, detailed knowledge of the distribution of race and family structures, such as single-parent households, across a region can aid in housing stock recovery planning.

Economic characteristics also provide disaster planners with valuable information in disaster settings. These factors include occupation, household income, individual savings, poverty status, and access to finance, among others. For instance, a region with relatively lower household incomes, lower individual savings, and limited access to finance will face longer housing stock reconstruction trajectories than other areas.

Many authors note that one of the most important characteristics in the long-term economic recovery of a region is the recovery of the housing stock. Knowledge of infrastructure and housing stock characteristics, combined with knowledge of the region's residents, can aid planners in pre- and post-disaster recovery planning. These characteristics include the distribution of housing unit types, unit quality, unit values, and vacancy rates, among others. For example, an area with high percentage of multi-family housing relative single-family housing will have a longer housing stock recovery trajectory than other areas. In addition, areas with large percentages of rental housing, housing with frequent sales, and housing located in predominantly minority areas, especially non-Hispanic Black populations, tend to have slower recovery trajectories.

This analysis explores the valuable data included in the 2007 American Housing Survey (AHS) data collected by the U.S. Census Bureau for the Department of Housing and Urban Development (HUD).[2] These data focus on the housing unit as the unit of observation and provide a rich and granular base for analyses. In particular, they address many important data requirements for policy development and disaster recovery planning related to housing stock issues.

The AHS data are limited in some respects. While we are able to subdivide the data by geographic zone, there are no data that address the geospatial characteristics of each zone.[3] These data are valuable for examining area-specific factors such as population density, building density, and elevation, among others. To negate this limitation, the Econometrica-ICF team requested and received internal geospatial data from HUD and incorporated it into the dataset.

In this document the Econometrica-ICF team begins by presenting AHS variables that can be used in disaster planning situations, and we explain their potential use. This is followed by a presentation of summary statistics of calculations derived from AHS data that are useful in housing recovery planning and describe how they could be used to evaluate community vulnerability. Next, the analysis illustrates the use of several calculations derived from AHS data in a disaster simulation in which the zone-specific housing stocks in the Miami-Ft. Lauderdale, FL MSA are destroyed or rendered

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[2] AHS metropolitan data can be downloaded at http://www.huduser.org/datasets/ahs/ahsmetro_07.html
[3] *Zone* is a geographic identification variable that subdivides metropolitan statistical areas included in the AHS. We discuss the rationale behind its use in the following sections.

unlivable. Finally, the Econometrica-ICF team evaluates the results of this simulation through a sensitivity analysis and offers recommendations and concluding remarks.

Because this research is exploratory, the emphasis is on how AHS data could be used in disaster planning situations. Additional analyses are required before the results of this research are operationalized for use.

Data

The AHS is actually two separate surveys – a national survey and a metropolitan survey – which have changed many times since the inception of the AHS. The national survey represents data for approximately 55,000 housing units across the United States every 2 years. The metropolitan survey, on the other hand, gathers information for 47 metropolitan areas. The surveys for these metropolitan areas are not conducted simultaneously. Instead, the Bureau of the Census collects data for about 14 metropolitan areas on even numbered years until all metropolitan areas have been surveyed.[4,5]

Disaster Planning-Related Variables

In this section, we highlight variables included in the AHS that are useful in disaster planning situations and discuss their potential use. Calculations for the variables included in Table 1 conducted across the 2007 AHS national survey and metropolitan survey, are included in Appendix 2 and Appendix 3, respectively.

[4] http://www.census.gov/prod/2004pubs/ahsr04-1.pdf

[5] This information became obsolete in 2007. In 2011, HUD will implement a new methodology that includes surveying 60 metropolitan areas over a 4-year cycle.

Table 1: Disaster Planning-Related Variables

Planning Focus	Category	Associated AHS Variables (source module in parentheses)
Households at Risk	Age (elderly & children)	age (person)
	Household type	age (person), sex (person), per (newhouse), mar (person), rel (person), par (person), spos (person), zadult (newhouse)
	Persons per room	per (newhouse), rooms (newhouse)
	Vehicles available	cars (newhouse), trucks (newhouse)
	Non-English speaking/Recently Arrived in US	inusyr (person), span (person), natvty (person)
	Household income	zinc2 (newhouse)
	Housing costs as a percent of income	zsmhc (newhouse), zinc2 (newhouse)
	Households below poverty line	zinc2 (newhouse)
	Households with mortgages	mg (newhouse)
	Households with homeowner's insurance	buyi (newhouse)
	Persons living in public housing units	per (newhouse), proj (newhouse)
Units Affected	Unit value	value (newhouse)
	Size	rooms (newhouse), bedrms (newhouse), unitsf (newhouse)
	Structure type	nunit2 (newhouse)
Susceptibility of Unit to Damage	Flood plain/proximity to water	floodpln (newhouse)
	Physical problems	zadeq (newhouse)
	Manufactured homes built prior to wind standards	nunit2 (newhouse), built (newhouse)
Absorption Capacity	Rental vacancy rate	vacancy (newhouse)
	Non-rental vacancy rate	vacancy (newhouse), tenure (newhouse)
Special Issues	Source for water & sewage displacement	sewdis (newhouse)
	Heating/cooling equipment	hequip (newhouse), air (newhouse), airsys (newhouse)
	Cooking fuel	cfuel (newhouse)

Households at Risk

Age: The *age* variable allows disaster planners and responders to evaluate the number of elderly individuals and children who reside in an area. These individuals may require additional resources in disaster settings, such as specialized medical care, specialized dietary requirements, or evacuation assistance.

Household type: By combining several AHS variables, disaster planners are able to create detailed descriptions of household types. Some household types, such as single-parent households or elderly households, may require substantial assistance in disaster settings. In the long term, knowledge of the household type distribution across a disaster area can assist planners in evaluating the vulnerability of an area's housing stock.

Persons per room: Disaster planners can use calculations of the persons per room to guide the allocation of emergency housing resources within a disaster area. In addition, the variable *per* can also describe an area's population density when combined with geospatial data.

Vehicles available: Knowledge of the number of vehicles available can assist responders in determining mandatory evacuation times, suggesting evacuation routes, and allocating evacuation resources, such as buses and personnel.

Non-English speaking/Recently arrived in the US: Emergency planners and responders cite language barriers as a difficulty encountered in communicating with increasingly diverse populations. While there are no data in the AHS that directly address language barriers, there is data related to country of birth and year of immigration to the U.S.[6] These data can be used by planners to evaluate what cultural and linguistic resources might be needed in emergency situations and where they should be allocated within an MSA. In addition, the data can inform the decisions of planners regarding the development of pre-disaster communications.

Household income: Households with lower incomes may be less willing to evacuate in a possible disaster situation, fearing the repercussions that a disruption in income might create. In the long term, knowledge of household incomes is valuable to disaster planners because areas with lower incomes and less access to finance face longer permanent housing reconstruction trajectories.

[6] The 2009 AHS will include a flag that indicates whether the interview was conducted using the Spanish-language instrument. This flag is intended to document the survey procedure rather than specifically determine the language spoken in the housing unit.

Households with mortgages: Households with mortgages face significant financial difficulties in the aftermath of a disaster, especially if the disaster causes business closures or job losses, or both. Information about the percentage of households with mortgages can assist planners in evaluating where financial assistance might be required.

Households with/without homeowner's insurance: Households without homeowner's insurance face significant financial losses if their housing units are destroyed in a major disaster event. Knowledge about the percentage of households with homeowner's insurance can assist disaster planners in evaluating where additional evacuation resources and financial assistance might be required in both the short term and the long term.

Persons living in public housing units: Persons living in public housing units may choose not to return to an area if the public housing units are destroyed. In addition, damages to public housing units incur costs to the local government instead of a private party. Knowledge of the number of public housing units in a given area allows planners to evaluate expected public housing losses due a disaster event.

Units Affected

Unit value: If a housing unit is destroyed in a disaster, the homeowner is faced with a significant loss, especially if the owner does not have homeowner's insurance. If the owner does have homeowner's insurance, then the financial loss in whole or part is transferred to the insurance company. When a major disaster strikes, insurance companies may not be financially able to provide compensation for the all insured and damaged housing units. Knowledge of unit values allows planners to evaluate these potential losses and examine the ability of insurance companies to meet insurance claim obligations.

Size: In the aftermath of a disaster, households will be displaced if their housing unit is destroyed or severely damaged. In the short term, information about the size of housing units allows planners to evaluate how much emergency housing may be required to house displaced residents. In the long term, it allows planners to determine where acceptable vacant units exist for permanent household moves.

Structure type: Knowledge of the types of structures in an area assists responders in the deployment of resources to areas with large concentrations of multi-unit structures. In addition, this information allows planners to evaluate where acceptable vacant units exist for long-term housing solutions.

Susceptibility of Unit to Damage

Floodplain/proximity to water: Housing units in floodplains or close to bodies of water are more susceptible to damage in disaster events when flooding occurs. Disaster planners can use this information to determine what areas of a disaster zone may need additional evacuation or emergency housing resources.

Physical problems: Housing units with significant physical problems are more likely to be rendered unlivable by disasters. Knowledge of the prevalence of such problems can assist responders in the deployment of evacuation or emergency housing resources.

Manufactured homes built prior to wind standards: Manufactured homes built prior to the current wind standards are more susceptible in disaster events involving high wind speeds. Information about the distribution of manufactured and mobile homes can assist responders in the deployment of evacuation or emergency housing resources.

Absorption Capacity

Rental vacancy rate/Non-rental vacancy rate: In the aftermath of a major disaster, households living in housing units will be displaced if their housing unit is destroyed or severely damaged. Knowledge of the rental and non-rental vacancy rates outside of the disaster area can assist planners evaluate where acceptable vacant units may exist.

Special Issues

Source for water & sewage displacement: In environmental situations with substantial flooding, sewage system overflow can cause the release of hazardous waste, particularly in areas with high population growth and older sewage systems. This can cause substantial problems if the released hazardous wastes enter the potable water system. Disaster planners can use information about sewage system types to evaluate which areas of a devastated region should be evacuated and the order of evacuations.

Heating/cooling equipment: Heat-related conditions can be devastating, as illustrated by the European heat wave of 2003.[7] The AHS contains data that address primary heating and cooling equipment as well as secondary sources. This information, in combination with the ages of unit occupants, can be used by disaster planners to allocate emergency resources to areas with vulnerable populations during periods of intense environmental conditions.

Cooking fuel: In some disaster settings, a disruption to primary cooking fuels (e.g., electricity, gas) can eliminate households' ability to prepare food. This information can be used by disaster responders to allocate additional emergency food supplies where cooking fuel disruptions are more likely to occur.

The AHS variables included in Table 1 are a representative sample intended to illustrate the breadth of applicability of AHS data in common disaster planning and response settings. In the following section, we continue this exploration by evaluating the use of many of these variables in a housing stock recovery-related setting for the Miami-Ft. Lauderdale Metropolitan Statistical Area (MSA).

Housing Stock Recovery-Related Variables

The 2007 AHS metropolitan survey contains records for the following seven MSAs: Baltimore, MD; Boston, MA; Houston, TX; Miami-Ft. Lauderdale, FL; Minneapolis-St. Paul, MN; Tampa-St. Petersburg-Clearwater, FL; and Washington, DC-MD-VA. We use the Miami-Ft. Lauderdale, FL MSA in the exploratory analysis below but have also included summary variable statistics for each of the seven MSAs in Appendix 3.

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[7] http://www.usatoday.com/weather/news/2003-09-25-france-heat_x.htm

The data in the AHS provide a wealth of information useful in characterizing the various geographic zones in an MSA. In particular, they can be used by disaster planners to evaluate the vulnerability of communities and housing stocks for both short-term and long-term planning.

The data for the Miami-Ft. Lauderdale, FL MSA contain more than 2,600 records and 2,700 variables. An appropriate exploration of AHS value in disaster recovery planning requires the ability to subdivide the survey data into geographic areas. Three of the variables included in the AHS subdivide metropolitan data into geographic areas using county, zone, and Census tract identifiers.[8] To protect confidentiality, pseudo-Census tracts are used that do not readily correspond to actual Census tracts. This aspect of the data renders the pseudo-Census tracts unusable for the current analysis and as such, we use an alternative geographic identifier - the *zone* variable. For the Miami-Ft. Lauderdale, FL MSA, there are 25 zones included in the AHS. We obtained a Census tract-to-zone key from the HUD website and identified each zone by visually locating the real Census tracts on regional maps.

The Econometrica-ICF Team present calculations derived from AHS data that are relevant for housing stock recovery after a major disaster in Table 2 below. Because this is an exploratory analysis, summary statistics are presented only for Zone 101 (the City of Miami's shorefront), Zone 105 (central inland Miami), and the MSA as a whole. Equivalent descriptive statistics can be readily calculated for the remaining zones in the MSA.

[8] A zone is defined as a socio-economically homogeneous area of more than 100,000 people.

Table 2: Housing Stock Recovery-Related Statistics

Variable	Zone 101	Zone 105	SMSA Total
Population	81,039	363,457	4,847,913
Area (Square Miles)	31.3	147.7	5,472.9
Population Density	2,589	2,461	886
Average Household Size	1.6	3.2	2.5
Householders ≥ 65 years old	13,265 (15.3%)	21,848 (17.7%)	461,021 (19.1%)
Single Parent Householders	1,105 (2.2%)	5,621 (5.0%)	96,284 (5.0%)
Minority Householders	38,629 (44.4%)	45,536 (36.9%)	898,833 (37.2%)
Non-Hispanic Black Householders	2,177 (3.4%)	34,305 (29.7%)	309,487 (20.3%)
Median Household Income	$ 36,000	$ 48,000	$ 43,097
Households Below Poverty Line[9]	14.3%	7.8%	13.3%
Homeownership	25.2%	65.1%	54.5%
Households with Mortgages	8.3%	43.7%	34.4%
Households with Homeowner's Insurance	36.9%	55.2%	61.8%
Units In Floodplain	56.1%	10.9%	18.4%
Elevation (meters above sea level)[10]	0.4	1.0	2.7
Median Market Value of Unit	$ 400,000	$ 250,000	$ 285,000
Median Rent	$ 900	$ 1,020	$ 900
Median Year Built	1960	1975	1975
Total Housing Units	86,976	123,544	2,419,711
One-unit attached or detached	15.2%	63.4%	57.3%
2 to 4 units	3.9%	4.5%	6.1%
5 to 9 units	6.3%	2.9%	4.7%
10 to 19 units	11.1%	6.1%	6.4%
20 or more units	63.5%	19.8%	21.8%
Manufactured/mobile home	0.0%	3.3%	3.6%
Housing Unit Density	2,779	836	442
Units in Condominiums/Cooperatives	72.9%	29.5%	34.3%
Median Square Footage, One-Unit Attached or Detached	2,375	1,500	1,758
Median Square Footage, Others	950	900	972
Rental Vacancy Rate	14.2%	17.7%	16.3%
Median Months Vacant, One-Unit Attached or Detached	0.5	3.0	2.0
Median Months Vacant, Others	3.0	2.0	2.0
Vacant Space, Year-Round Units (square feet)[11]	106,989,988	186,436,513	3,396,490,223

[9] We use the poverty guidelines specified in Federal Register, Vol. 72, No. 15, January 24, 2007, pp. 3147–3148

[10] Digital elevation models (DEMs) were used to extract the elevation of each zone. The DEMs used for this study were part of the NED (National Elevation Dataset), provided by the USGS. Using GIS, the elevation for each zone was estimated at the approximate center of zone.

[11] "Vacant" is defined here as all non-seasonal, non-migratory vacant units. This differs from the vacancy definition used in the simulation.

Zone 101 Profile

The population of Zone 101 is relatively small compared to the remaining zones in the MSA – approximately 2 percent of the entire MSA resides in Zone 101 – but it has a high population density of roughly 2,600 persons per square mile. More than 38,000 of the householders are minorities, which amounts to approximately 44 percent of the population. Of these, 6 percent are classified as non-Hispanic black householders. The average household size is 1.6 persons, and approximately 61 percent of households have only one resident. In addition, more than 13,000 (15 percent) householders in Zone 101 are at least 65 years old.

The median household income of Zone 101 is $36,000, more than $7,000 less than the MSA-wide median, and more than 14 percent of households are beneath the poverty line. The percentage of homeowners with mortgages is small - only 8 percent of households have outstanding mortgages, substantially less than the MSA-wide 34 percent. This is primarily due to the low rate of homeownership in Zone 101 relative to the entire MSA.

The housing stock of Zone 101 consists predominantly of rental housing with more than 63 percent of the units in high-rise structures with 20 or more units. The rental vacancy rate is lower than the MSA-wide rate, but the median months vacant for non-single-family housing (i.e., not one-unit attached or detached housing) is higher than the city-wide median. This is possibly the result of the high percentage of units that are condominiums or cooperatives that require more time on the market. The median months vacant for single-family housing, on the other hand, is approximately one-half of a month, which is substantially less than the same calculation for the entire MSA. This is likely due to the limited supply of single-family properties in Zone 101.

Zone 105 Profile

Zone 105 differs from Zone 101 in its social, economic, and infrastructural characteristics. It has approximately 364,000 residents (7.5 percent of the MSA total) with a population density equal to more than 2,400 persons per square mile. Approximately 22,000 of Zone 105's householders are at least 65 years old, which amounts to about 18 percent of the zone's total. In addition, Zone 105 has more than 45,000 (37 percent) minorities, 75 percent of whom are classified as non-Hispanic black householders.

The residents of Zone 105 have a median household income of $48,000, approximately $12,000 more than Zone 101 and $4,000 more than the city-wide median. Less than eight percent of the households in Zone 105 are beneath the poverty line. Unlike Zone 101, a large proportion of the households have outstanding mortgages (43 percent). This is mainly due to the relatively high rate of homeownership in Zone 105 compared to the rest of the MSA.

The majority of householders in Zone 105 are homeowners of single-family units, more than half of whom have homeowner's insurance. The median unit value is $250,000, approximately $35,000 less than the MSA-wide value. The prevalence of condominiums is also less than in Zone 101 and the entire MSA. Unlike Zone 101, the rental vacancy rate is higher than the MSA-wide rate and the median months vacant for single-family homes is greater than that for non-single-family homes. This is likely due to excess supply of single-family homes relative to non-single-family homes.

Example Vulnerability Findings

Disaster planners can use these types of calculations to determine that Zone 101 is a more vulnerable zone than Zone 105. As noted in the disaster planning literature, poorer areas with high percentages of minorities exhibit longer reconstruction trajectories than more affluent areas. In addition, rental housing, condominiums, and multi-family housing tend to have longer reconstruction trajectories than single-family housing. Zone 101 has a high percentage of minorities, a large portion of rental properties, and substantially more multi-family housing than single-family housing. These issues are compounded by the fact that only 37 percent of the homeowners in Zone 101 have homeowner's insurance, more than 56 percent of the units are in a floodplain, and the center of the zone is only 0.4 meters above sea level. In addition, the housing unit density is approximately 2,779 units per square mile. Hurricanes or major flooding could cause massive economic losses to Zone 101 where the median market value of units is $150,000 higher than the city-wide median. In addition, the housing stock is relatively older and likely more susceptible to damages.

Zone 105 is not without vulnerable characteristics. Numerous studies in the disaster planning literature note that single parents encounter more difficult situations in post-disaster situations because of limited financial resources, among other reasons. Approximately 5,600 (5 percent) of the householders in Zone 105 are single parents, which is more than five times the number in Zone 101. In addition, the percentage of non-Hispanic black householders is higher in Zone 105 than in the rest of the MSA. While both of these factors indicate a higher level of vulnerability, the negative effects might be offset by households' relatively higher incomes. The housing units in Zone 105 are also approximately 15 years younger than those in Zone 101, will likely meet newer building codes, and are in better condition and more capable of limiting the residents' exposure to natural hazards in a major disaster event. In addition, the housing unit density is almost twice that of the MSA-wide density, and the elevation is only 1 meter above sea level. Even though there are approximately 36,000 more housing units in Zone 105 than in Zone 101, the total market value of the housing stock is more than $8 billion less than that of Zone 101 because of the lower market value of units.

Disaster Simulation Case Study – Miami-Ft. Lauderdale, FL

A critical component of regional recovery in the wake of major disasters is the recovery of the housing stock. In many cases, significant damage to housing structures requires residents to move elsewhere. In this section, the Econometrica-ICF team illustrates how AHS data can be used to simulate a major disaster in the Miami-Ft. Lauderdale, FL MSA. Specifically, use of the AHS data on unit vacancy, the number of rooms in housing units, the square footage of housing units, and the number of people per unit describes how the distribution of available housing changes when particular zones are affected. This type of analysis can be used to examine the potential of regional housing stocks to absorb displaced people after major disasters.

Approach to Simulation

A central determinant in the total living space available in a metropolitan area after a disaster is the geographic range of the disaster event. Within this range, a fraction of the housing units might be destroyed or damaged to the point of condemnation. It is not possible to determine from the AHS data which units will be actually damaged by a major disaster or the extent of the damages so it is assumed that the disaster renders all housing units within the affected areas unlivable. The residents of these units, therefore, must move elsewhere while housing reconstruction takes place. In this simulation, affected areas are referred to as "devastated zones" and the areas to which the displaced individuals could potentially move as "absorption zones".

The Miami-Ft. Lauderdale, FL MSA was subdivided into geographic areas using the *zone* variable included in the AHS. A major disaster is then simulated in Zone 101 because it is the shorefront of the City of Miami. The number of vacant rooms required to house the displaced persons is calculated as the vacant rooms, by number of rooms per unit, in the absorption zones. The vacant space, in square feet, required to house the displaced persons is calculated as the vacant space available in the absorption zones.[12] The size of the total devastated area is increased by adding affected zones iteratively, moving outward and inland from the shorefront of the City of Miami at each iteration. For this example, the order of devastated zones is as follows: 101, 1, 2, 102, 3, 106, 103, 104, 108, and finally, 107.

This approach requires several assumptions beyond the order of zone devastation. It is assumed that households will move into vacant housing units in the absorption zones that have the same number of rooms as their previous residence. If no housing units with the same number of rooms are available, the displaced households will be forced to move into units of a different size or share housing units with other households, or both. It is also assumed that the vacant space required by displaced individuals can be scaled down by one-half. That is, we assume that a person displaced by a disaster is willing and able to

[12] "Vacant" is defined as year-round housing units that are for rent only or units that are for sale or for rent.

live in a space equivalent to one-half of that person's residential space in the devastated zone. This scaling method is inappropriate for individuals already living in very small housing units. Because of this, the minimum vacant space required is set at 300 square feet. We evaluate the scaling assumption further in the sensitivity analysis below.

Simulation Results

Table 3 below presents the number of available units by number of rooms in the absorption zones as the hypothetical devastated area is iteratively expanded to include more zones of the MSA.

The first zone devastated in the Miami-Ft. Lauderdale, FL MSA is Zone 101, which houses more than 81,000 residents in approximately 44,000 housing units. As shown in Table 3, there are a sufficient number of vacant rental units by number of rooms to house the displaced households except for households living in 9- or 11-room units.[13] In other words, 1,780 displaced households will have to live in housing units with fewer rooms than their previous residences. Using the base scenario that assumes that these individuals would be willing and able to live in one-half of their previous residential space, the vacant space required to house them in the other zones of the MSA (i.e., absorption zones) is approximately 61 million square feet. Since we assume that all housing units in Zone 101 are destroyed by the disaster event, this leaves 116 million square feet of available space in which to house the displaced people, almost twice that which is required.

[13] "Vacant rental units" are those are "for rent only" or "for rent or for sale". We performed an equivalent analysis to the one above using all vacant units, including those "for sale only", and the results are not substantially different. While the latter method increases the number of vacant housing units, we determined that displaced households will almost exclusively move into rental units while damaged or destroyed units are repaired or rebuilt. In any case, vacant units "for sale only" can be considered an additional source of vacant housing.

Table 3: Available Rental Unit Balance Remaining Post-Disaster

	Devastated Zones				
Number of Rooms	101	101, 1	101, 1, 2	101, 1, 2, 102	101, 1, 2, 101, 3
1	1,930	-239	-1,251	-2,370	-2,370
2	1,778	-2,516	-4,592	-4,592	-5,711
3	13,748	-7,768	-22,640	-43,209	-59,275
4	32,114	18,180	-6,621	-21,302	-28,879
5	6,582	803	-6,091	-13,072	-26,015
6	13,536	11,267	7,882	-3,664	-10,722
7	1,778	-609	-609	-5,386	-7,806
8	460	460	-684	-684	-4,149
9	-565	-1,780	-1,780	-4,296	-4,296
10	0	0	0	0	-1,170
11	-1,215	-1,215	-1,215	-1,215	-2,430

Table 4: Vacant Space Analysis, Base Scenario

Devastated Area	Vacant Space Required	City-wide Vacant Space Post-Disaster	Net
Zone 101	60,556,541	116,149,878	55,593,337
+ Zone 1	95,875,264	114,471,075	18,595,811
+ Zone 2	129,835,837	113,398,788	**-16,437,049**
+ Zone 102	191,080,461	109,344,548	-81,735,913

The second zone devastated by the hypothesized disaster event is Zone 1, an area that houses more than 99,000 residents living in approximately 50,500 households. The lack of units with the appropriate number of rooms will cause more than 14,000 households to either share housing units or move into units of a different size than their previous units. Almost 75 percent of these households come from 1- to 3-room housing units, and more than 30,000 housing units with 4 to 6 rooms are still available after the disaster so such a transition should be feasible. The displaced individuals, under the base scenario, require approximately 35 million square feet of space in the absorption zones in the MSA that, after the disaster has affected both Zone 101 and Zone 1, now has approximately 115 million square feet available. Since the displaced people of Zone 101 and 1 require a total of 96 million square feet of space, there is still sufficient housing space in the absorption zones to house them, even with more than 14,000 households sharing units or moving into units of a different size.

The next zone affected by the disaster event is Zone 2, an area with almost 130,000 inhabitants. The disaster will result in the displacement of more than 45,000 households, and since there are only approximately 7,900 6-bedroom units available, the vast majority of the displaced households will have to share housing units or move into units of a different size than their previous units, or both. The total vacant space required by all displaced persons from Zones 101, 1, and 2 equals almost 130 million square feet while only 114 million square feet are available, yielding a net vacant space deficit of more than 16 million square feet. Both the unavailability of units with the appropriate number of rooms as well as the space available indicate that sufficient housing will not be available in the absorption zones of the MSA if the disaster event significantly affects more than Zone 101, Zone 1, and a minimal fraction of Zone 2. Otherwise, the demand for housing by displaced persons will exceed supply.

The simulation exercise above uses the assumption that individuals are willing and able to live in one-half of the residential space of their now destroyed unit. This scaling factor may be excessive so we evaluate the results of the simulation in the sensitivity analysis below.

Sensitivity Analysis

The Econometrica-ICF team evaluated the results of the simulation using alternative scaling assumptions for the vacant space calculation. The results of these excursions are shown in Table 5 below. The Base Scenario results are the results from the simulation conducted above. In Scenario 2, we scale the space required by displaced persons by 0.25 instead of by 0.5. That is, it is assumed that displaced persons are willing and able to live in one-fourth of the residential space of their previous residence. Similarly, the space required is scaled by 0.10 for Scenario 3. Finally, we use the American Red Cross minimum space required per person for emergency sheltering, 50 square feet, in Scenario 4.[14] While this assumption is unrealistic for long-term housing solutions, it can be

[14] http://www.region4a-mrc.org/documents/2009march/AMERICAN%20RED%20CROSS%20GUIDE%20FOR%20SHELTER%

thought of as the absolute minimum housing requirement for displaced persons. For all of the scenarios considered, the majority of households would have to move into housing units of a different size or share housing units if Zones 101, 1 and 2 were all devastated.

Table 5: Residential Space Balance Post-Disaster

Devastated Area	Base Scenario (Space Required Scaled by 0.5)	Scenario 2 (Space Required Scaled by 0.25)	Scenario 3 (Space Required Scaled by 0.10)	Scenario 4 (American Red Cross Minimum)
Zone 101	55,593,337	80,208,918	88,272,840	112,097,933
+ Zone 1	18,595,811	55,511,173	69,231,736	105,466,276
+ Zone 2	**-16,437,049**	30,942,007	47,865,784	97,912,485
+ Zone 102	-81,735,913	**-8,205,963**	18,795,609	87,101,728
+ Zone 3	-127,820,960	-37,432,605	**-3,814,751**	78,010,190
+ Zone 106	-205,425,836	-84,038,084	-35,049,578	60,604,456
+ Zone 103	-278,033,724	-128,671,661	-66,074,535	48,147,491
+ Zone 104	-324,693,898	-157,331,279	-89,128,714	36,491,392
+ Zone 108	-404,061,449	-205,016,625	-125,925,844	17,125,889
+ Zone 107	-603,174,762	-314,601,156	-200,341,717	**-17,376,104**

As noted previously, a disaster event impacting more than Zone 101, Zone 1, and a minimal fraction of Zone 2 will result in a net deficit of space for the MSA. If the scaling factor is reduced to 0.25 (Scenario 2), then the results show that there will be sufficient space available as long as no more than Zone 101, Zone 1, Zone 2, and a minimal fraction of Zone 102 are affected. If we assume that people are willing and able to live in approximately one-tenth of the space of their previous residence, then there will be adequate space available if the event affects no more than the first four zones and a minimal fraction of Zone 3. In Scenario 4 in which we use the American Red Cross minimum, there will be sufficient space available as long as the event does not affect more than the first nine zones in the table above. The results of this scenario show that there will not be sufficient housing available post-disaster if the event affects more than 30 percent of the zones in the MSA.

20MANAGERS.htm. The American Red Cross provides the minimum housing guideline of 40 to 60 square feet of sleeping space per person, so the average is used here.

Concluding Remarks

As the explorations presented above illustrate, the data included in the AHS provide a rich and granular foundation for disaster planning and response related analyses. They allow disaster planners to evaluate community resilience, housing stock vulnerability, and potential housing issues that might arise in the aftermath of a disaster event. For example, our simulation analysis shows that the Miami-Ft. Lauderdale, FL MSA is highly sensitive to disturbances in housing stock availability. Even under the most unrealistic of assumptions, serious housing deficits, both in available units with the appropriate number of rooms and in vacant space available, arise when more than 30 percent of the MSA is affected by a disaster. The majority of displaced households will be forced to live in housing units of a different size, share units with other households, or move out of the MSA.

Our analysis focuses on the available units by number of rooms and vacant space available of a relatively small sample of zones in the Miami-Ft. Lauderdale, FL MSA, but this methodology could be applied in a similar manner across all zones of the MSA and all disaster-prone MSAs included in the AHS. At each iteration, disaster planners can evaluate disaster-related variables and critical components of the housing stock to evaluate what would happen if individual or multiple zones are affected by a major disaster.

The simulation presented above is not meant to be conclusive, but instead, as an illustrative exploration of how the AHS data could be used to evaluate issues that may arise for displaced persons regarding long-term housing. Additional analyses are required before the results of this research are operationalized for use.

Recommendations

The AHS data are limited regarding geographic information. While we are able to subdivide the data by geographic zone, there are no publicly available data that address the geographic area within each zone. Many valuable descriptive statistics can be derived from this information, such as population density and housing unit density. In addition, no data address the elevation of housing units. Such information could be helpful in disaster situations because it would allow planners and responders to examine areas of greater risk in disasters involving serious flooding. We recommend that geospatial area and elevation data be added or integrated to the AHS data set.

The AHS does not include information that directly addresses language barriers. While we are able to create proxies for possible language barriers, they are likely highly inaccurate. We recommend that the AHS include questions that ask respondents what language is spoken at home and if they face language barriers outside of the home.

The AHS does not include information that represents a household's tenure in the area/region. This is important for planning purposes because households with less time in an area are less likely to remain in that area if a disaster strikes. We recommend that the AHS include a question regarding the total amount of time that the household has lived in the area/region.

Appendix 1: Literature Review

Executive Summary

We conducted a detailed literature review in search of research relevant to data needs in disaster recovery. While the literature for disaster recovery is plentiful, there is limited research available regarding data needs in disaster recovery. The majority of literature focuses on how to best utilize the data that is already available.

Our literature review illustrates that the American Housing Survey (AHS) can help fill a critical gap in the emergency response preparedness planning literature. As the preeminent source of housing characteristic information for the U.S. housing stock, AHS provides a wealth of information that can aid local governments in planning for and responding to disasters.

Literature Review

We performed a literature review of research related to the field of disaster recovery including detailed searches for research related to housing issues, disaster recovery lessons learned, and vulnerability reduction. Throughout this search process, we paid particular attention to articles addressing the issue of data needs in disaster planning.

We found a diverse array of literature related to disaster recovery. Many articles assess business continuity in disaster planning and lessons learned from Hurricanes Andrew, Katrina, and Rita. The majority of these focus on disaster planning for financial operations such as banks and credit unions. We also found many articles pertaining to business continuity planning for the health care sector, particularly the ability to meet mental health needs following a natural disaster. Several articles also address the importance of disaster planning for insurance carriers.

Our search also returned many articles related to communications in disaster scenarios, particularly internet communications. Several of these articles focus on continuity of communication capabilities. Central to disaster planning is the presence of interoperable communications, which are necessary in the coordinating emergency responses. In addition, technology such as Geographic Information Systems (GIS) must be available to identify the locations of disaster response resources.

Rooney and White (2007) assess disaster preparedness and the difficulties faced by persons with mobility impairments. Their qualitative study draws upon interviews with 56 persons with disabilities who have experienced a catastrophic event. The study highlights the lack of knowledge in the communities about the special needs of the disabled people in an emergency situation and lack of proper community evacuation plans that would account for those needs.

Benitez and Rodriguez (2008) highlight the vulnerability of individuals with limited-English proficiency in disaster situations. The authors evaluate several recent natural disasters and the emergency responses offered to the Latino and immigrant communities and find that governments and charitable organizations are not well prepared to serve those populations. It is imperative, the authors assert, that all future programs and policies developed by the governments to respond to large-scale catastrophic events address the issues that vulnerable Latino and immigrant residents face.

Several papers highlight the importance of triaging in emergency response situations. Combining knowledge on the housing stock characteristics and the characteristics of the home occupants prior to the disaster with the information on its severity could aid the first responders in identifying and allocated resources to those locations where an increased response is warranted.

There is substantial research on the definition and assessment of vulnerable populations in various disaster scenarios. Mayunga (2007) notes that developing community resilience and reducing vulnerability are important characteristics of successful disaster management. This requires the participation of both the public and private sector as well as all levels of government. Reducing vulnerability requires knowledge of the characteristics of a community. Vulnerability, however, is a multi-dimensional concept incorporating many social, economic, and infrastructure variables. For example, important variables in the evaluation of vulnerability are age, poverty, race, gender, ethnicity, occupation, family structure, as well macro-variables such as housing stock and tenure in area. Miller and Nigg (1993) provide an evaluation of disaster recovery from a social class standpoint. In particular, the authors argue that vulnerability arises from living in densely-populated urban areas in substandard housing units. These substandard housing units increase individuals' exposure to harmful effects caused by the disaster. Similarly, Comerio (1997) evaluates housing issues prevalent after hurricanes and earthquakes. The author examines the housing issues faced after urban area disasters in the United States, Mexico, and Japan. A central result of this study is that stark differences exist between housing recoveries in urban versus rural areas. In particular, urban housing losses are worse not only because of greater housing density, but also because of the damage to the urban infrastructure.

Short-term and long-term housing solutions are central components to disaster response. In their analysis of the Hurricane Katrina response and recovery effort, Berke and Campanella (2006) show the critical importance of short-term, emergency housing actions and long-term permanent housing reconstruction in policy planning. Bolin and Stanford (1991) discuss various issues related to emergency sheltering, housing, and reconstruction after the earthquakes in California in the 1980s. In particular, they address access to shelters and housing after natural disasters by social class as well as the relationship between post-disaster shelter and housing recovery. The authors also discuss the aspects of disaster recovery related to the provision of housing aid post-disaster. In particular, the authors find that environmental emergencies magnify pre-disaster social inequalities. In addition, they note that rational planning pre-disaster is limited due to the pressure to rapidly respond to disaster victims. In order to maximize the planning that is performed, disaster planning must involve local citizen groups, government agencies at all levels, and individuals from the private sector. However, Johnson (2007) argues that poor pre-disaster strategic planning is not the central problem related to temporary housing programs, but instead, poor *ad hoc* tactical planning for reconstruction. Based on this analysis, the author also proposes a dynamic framework for temporary housing planning activities that identifies available resources before the disaster and allows for disaster-specific modifications.

Levine et al. (2007) evaluate long-term disaster recovery in coastal communities. The authors discuss the provision of temporary housing and transition to permanent housing, the decisions of households to return to the disaster area, and housing reconstruction processes. It is important for emergency managers to develop knowledge of temporary displacement and land development issues. In addition, it is critical to identify appropriate accommodation types for the displaced population.

Williams et al. (2009) examine a wide array of environmental emergencies in an effort to provide guidance to state housing agencies in Australia. With increased population growth and migration to urban areas throughout the country, more people are at risk. When an environmental emergency occurs, the most costly impacts are damages to buildings. The authors note that the vulnerability of individuals is based on socio-economic and demographic factors, the quality of the housing structure in which the individuals reside, and the amount of exposure to natural hazard. The authors suggest better disaster management systems, such as risk-assessment protocols, building codes, and early warning technologies such as GIS. The authors also state that successful disaster planning and management must be a coordinated effort between all levels of government. For housing, it is important to understand the processes behind emergency sheltering, evacuations, the transition to permanent housing, as well as the underlying socio-economic and political influences that appear during that transition.

Chen et al. (2007) evaluate issues and policies related to condominium housing reconstruction after the Taiwan 921 earthquake. The authors find that condominium housing recovery is much slower than other types of reconstruction due to multiple property ownership and collective decision making. In addition, limited finances of most individuals post-disaster made them ineligible for government loans so the majority of post-disaster reconstruction finances were individual savings. Wu et al. (2007) add to this analysis in their case study of the same earthquake. The authors find the speed of condominium reconstruction is directly affected by household income. The speed of reconstruction, however, is not related to household size, race, age, marital status, or physical and mental obstacles. In addition, the authors suggest that condominium reconstruction was approximately two years longer than for single-family housing.

Comerio (1998) shows that multi-family housing tends to recover at a slower pace than single family housing due to recovery programs that focus on single-family, owner-occupied housing. Lu et al. (2007) extend this analysis in their assessment of long-term recovery for single family housing, duplexes, and apartment buildings following Hurricane Andrew in 1992. The authors find that duplexes and apartment buildings have slower recovery speeds than single-family housing. In addition, rental housing, housing with frequent sales, and housing located in predominantly minority areas, especially non-Hispanic Black populations, have slower recovery trajectories.

Several authors provide alternative approaches to risk management using modified building codes and new technologies in early warning systems, land-use planning (e.g., GIS) and engineering. Marrow (199) encourages emergency planners and policy-makers to identify vulnerable populations and incorporate this information into GIS systems where feasible.

Conclusion

Research related to disaster response and recovery is plentiful and covers a diverse range of topics. The majority of available literature focuses on how to best utilize the data that is already available as opposed to additional data needs for disaster response management.

Research related to housing issues in disaster recovery is available but limited. Topics covered include disaster response preparation, issues related to population displacement, the role of governments and community organizations, socio-economic differences and how they related to post-disaster recovery, among others.

From our literature review, it is clear that AHS can help in bridging an important data gap in the emergency response preparedness planning. As the preeminent source of housing characteristic information for the U.S. housing stock, AHS provides a wealth of information that can assist local governments in planning for and responding to disasters, whether they be natural, large industrial accidents, or major terrorist attacks.

Appendix 2: National Data Statistics

Disaster Planning-Related Variables, National Data Statistics

Planning focus	Category	Value
Households at Risk	Elderly (Age ≥ 65)	12.3%
	Children (Age < 5)	6.5%
	Household type	
	Single males living alone	12.2%
	Single females living alone	14.9%
	Husband and wife only	21.8%
	Husband, wife, children only	17.0%
	Single parent with children only	5.1%
	Other household arrangements	29.0%
	Median persons/room	0.4
	Households with at least one vehicle available	92.2%
	Hispanic immigrant householders arrived since 2004	3.0%
	Median household income	$ 47,619
	Housing costs as a percent of income	22.9%
	Households below poverty line	13.1%
	Percentage of households with mortgages	40.8%
	Percentage of households with homeowner's insurance	72.5%
	Public housing units	1.8%
Units Affected	Median unit value	$ 191,638
	Size (median square feet)	1,808
	Structure type	
	1 unit attached or detached	70.1%
	2 to 4 units	7.9%
	5 to 9 units	4.6%
	10 to 19 units	4.2%
	20 or more units	6.9%
	Manufactured/mobile homes	6.2%
Susceptibility of Unit to Damage	Units in floodplain	2.3%
	Units with selected physical problems	
	Moderate	3.6%
	Severe	1.6%
	Manufactured/mobile homes built prior to wind standards	30.4%
Absorption Capacity	Rental vacancy rate	9.8%
	Non-rental vacancy rate	2.6%

Planning focus	Category		Value
Special Issues	Non-public utility water & sewage displacement		20.1%
	Primary heating equipment		
		Forced warm-air furnace	62.9%
		Steam or hot water-based system	11.5%
		Electric heat pump	11.7%
		Electric baseboard or coil heating	4.4%
		Pipeless furnace	4.5%
		Other	5.0%
	Households with air conditioning		86.7%
	Primary cooking fuel		
		Electricity	59.9%
		Gas or propane	39.9%
		Other	0.02%

Appendix 3: Metropolitan Area Data Statistics

Disaster Planning-Related Variables: Baltimore, MD

Planning Focus	Category	Value	Planning Focus	Category	Value
Households at Risk	Elderly (Age ≥ 65)	13.7%	*Units Affected*	Median unit value	$300,000
	Children (Age < 5)	8.1%		Size (median square feet)	2,194
	Household type			Structure type 1 unit attached or detached	78.4%
	Single males living alone	11.4%		2 to 4 units	3.9%
	Single females living alone	16.6%		5 to 9 units	3.8%
	Husband and wife only	20.3%		10 to 19 units	7.2%
	Husband, wife, children only	15.7%		20 or more units	4.9%
	Single parent with children only	5.4%		Manufactured/mobile homes	1.8%
	Other household arrangements	30.7%	*Absorption Capacity*	Rental vacancy rate	12.0%
	Median persons/room	0.33		Non-rental vacancy rate	1.5%
	Households with at least one vehicle available	89.0%	*Special Issues*	Non-public utility water & sewage displacement	13.5%
	Hispanic immigrant householders arrived since 2004	5.3%		Primary heating equipment	
	Median household income	$ 61,624		Forced warm-air furnace	64.1%
	Housing costs as a percent of income	22.1%		Steam or hot water-based system	14.0%
	Households below poverty line	10.0%		Electric heat pump	17.7%
	Percentage of households with mortgages	45.4%		Electric baseboard or coil heating	2.1%
	Percentage of households with homeowner's insurance	79.8%		Pipeless furnace	1.3%
	Public housing units	2.3%		Other	0.8%
Susceptibility of Unit to Damage	Units in floodplain	1.9%		Households with air conditioning	96.8%
	Units with selected physical problems			Primary cooking fuel	
	Moderate	2.7%		Electricity	50.6%
	Severe	1.7%		Gas or propane	49.4%
	Manufactured/mobile homes built prior to wind standards	20.2%		Other	0.08%

Disaster Planning-Related Variables: Boston, MA

Planning Focus	Category	Value	Planning Focus	Category	Value
Households at Risk	Elderly (Age ≥ 65)	14.4%	*Units Affected*	Median unit value	$300,000
	Children (Age < 5)	5.7%		Size (median square feet)	2,199
	Household type			Structure type 1 unit attached or detached	54.5%
	Single males living alone	12.5%		2 to 4 units	22.9%
	Single females living alone	17.5%		5 to 9 units	5.8%
	Husband and wife only	20.3%		10 to 19 units	5.2%
	Husband, wife, children only	15.4%		20 or more units	11.0%
	Single parent with children only	4.4%		Manufactured/mobile homes	0.5%
	Other household arrangements	29.9%	*Absorption Capacity*	Rental vacancy rate	8.7%
	Median persons/room	0.4		Non-rental vacancy rate	2.0%
	Households with at least one vehicle available	86.5%	*Special Issues*	Non-public utility water & sewage displacement	17.0%
	Hispanic immigrant householders arrived since 2004	5.5%		Primary heating equipment	
	Median household income	$ 67,314		Forced warm-air furnace	35.9%
	Housing costs as a percent of income	25.2%		Steam or hot water-based system	53.2%
	Households below poverty line	10.9%		Electric heat pump	1.9%
	Percentage of households with mortgages	40.0%		Electric baseboard or coil heating	5.9%
	Percentage of households with homeowner's insurance	70.2%		Pipeless furnace	1.9%
	Public housing units	3.4%		Other	1.2%
Susceptibility of Unit to Damage	Units in floodplain	2.7%		Households with air conditioning	86.1%
	Units with selected physical problems			Primary cooking fuel	
	Moderate	5.3%		Electricity	49.1%
	Severe	2.2%		Gas or propane	50.6%
	Manufactured/mobile homes built prior to wind standards	65.1%		Other	0.3%

Disaster Planning-Related Variables: Houston, TX

Planning Focus	Category	Value	Planning Focus	Category	Value
Households at Risk	Elderly (Age ≥ 65)	8.0%	*Units Affected*	Median unit value	$ 129,078
	Children (Age < 5)	7.9%		Size (median square feet)	1,979
	Household type			Structure type 1 unit attached or detached	70.2%
	Single males living alone	10.9%		2 to 4 units	2.9%
	Single females living alone	12.9%		5 to 9 units	5.8%
	Husband and wife only	19.1%		10 to 19 units	8.5%
	Husband, wife, children only	21.9%		20 or more units	6.6%
	Single parent with children only	5.4%		Manufactured/mobile homes	6.1%
	Other household arrangements	29.8%	*Absorption Capacity*	Rental vacancy rate	18.1%
	Median persons/room	0.4		Non-rental vacancy rate	4.0%
	Households with at least one vehicle available	94.8%	*Special Issues*	Non-public utility water & sewage displacement	7.6%
	Hispanic immigrant householders arrived since 2004	3.2%		Primary heating equipment	
	Median household income	$ 49,352		Forced warm-air furnace	82.3%
	Housing costs as a percent of income	22.2%		Steam or hot water-based system	0.1%
	Households below poverty line	12.3%		Electric heat pump	7.6%
	Percentage of households with mortgages	38.0%		Electric baseboard or coil heating	0.4%
	Percentage of households with homeowner's insurance	67.5%		Pipeless furnace	1.8%
	Public housing units	0.5%		Other	7.9%
Susceptibility of Unit to Damage	Units in floodplain	3.0%		Households with air conditioning	98.8%
	Units with selected physical problems			Primary cooking fuel	
	Moderate	7.3%		Electricity	56.9%
	Severe	1.5%		Gas or propane	42.8%
	Manufactured/mobile homes built prior to wind standards	28.7%		Other	0.3%

Disaster Planning-Related Variables: Miami-Ft. Lauderdale, FL

Planning Focus	Category	Value	Planning Focus	Category	Value
Households at Risk	Elderly (Age ≥ 65)	14.3%	*Units Affected*	Median unit value	$288,413
	Children (Age < 5)	5.5%		Size (median square feet)	1,922
	Household type			Structure type — 1 unit attached or detached	63.3%
	Single males living alone	12.2%		2 to 4 units	6.3%
	Single females living alone	14.6%		5 to 9 units	4.4%
	Husband and wife only	19.1%		10 to 19 units	5.7%
	Husband, wife, children only	15.0%		20 or more units	16.6%
	Single parent with children only	5.0%		Manufactured/mobile homes	3.7%
	Other household arrangements	34.1%	*Absorption Capacity*	Rental vacancy rate	16.3%
	Median persons/room	0.4		Non-rental vacancy rate	5.8%
	Households with at least one vehicle available	92.3%	*Special Issues*	Non-public utility water & sewage displacement	6.6%
	Hispanic immigrant householders arrived since 2004	5.1%		Primary heating equipment	
	Median household income	$ 44,554		Forced warm-air furnace	23.0%
	Housing costs as a percent of income	30.7%		Steam or hot water-based system	0.3%
	Households below poverty line	13.3%		Electric heat pump	64.9%
	Percentage of households with mortgages	43.5%		Electric baseboard or coil heating	1.3%
	Percentage of households with homeowner's insurance	61.8%		Pipeless furnace	2.0%
	Public housing units	1.3%		Other	8.4%
Susceptibility of Unit to Damage	Units in floodplain	16.2%		Households with air conditioning	98.9%
	Units with selected physical problems			Primary cooking fuel	
	Moderate	2.8%		Electricity	91.9%
	Severe	1.1%		Gas or propane	8.1%
	Manufactured/mobile homes built prior to wind standards	56.9%		Other	0.1%

Disaster Planning-Related Variables: Minneapolis-St. Paul, MN-WI

Planning Focus	Category	Value	Planning Focus	Category	Value
Households at Risk	Elderly (Age ≥ 65)	9.8%	*Units Affected*	Median unit value	$ 257,353
	Children (Age < 5)	5.6%		Size (median square feet)	2,169
	Household type			Structure type 1 unit attached or detached	74.9%
	Single males living alone	12.8%		2 to 4 units	4.3%
	Single females living alone	14.2%		5 to 9 units	1.6%
	Husband and wife only	21.6%		10 to 19 units	3.7%
	Husband, wife, children only	20.2%		20 or more units	13.1%
	Single parent with children only	5.0%		Manufactured/mobile homes	2.4%
	Other household arrangements	26.2%	*Absorption Capacity*	Rental vacancy rate	12.4%
	Median persons/room	0.4		Non-rental vacancy rate	1.6%
	Households with at least one vehicle available	93.9%	*Special Issues*	Non-public utility water & sewage displacement	11.1%
	Hispanic immigrant householders arrived since 2004	5.2%		Primary heating equipment	
	Median household income	$ 65,849		Forced warm-air furnace	77.5%
	Housing costs as a percent of income	23.5%		Steam or hot water-based system	17.4%
	Households below poverty line	7.4%		Electric heat pump	0.4%
	Percentage of households with mortgages	52.8%		Electric baseboard or coil heating	2.8%
	Percentage of households with homeowner's insurance	83.7%		Pipeless furnace	1.0%
	Public housing units	1.6%		Other	0.9%
Susceptibility of Unit to Damage	Units in floodplain	0.8%		Households with air conditioning	95.5%
	Units with selected physical problems			Primary cooking fuel	
	Moderate	1.5%		Electricity	57.8%
	Severe	1.6%		Gas or propane	42.1%
	Manufactured/mobile homes built prior to wind standards	50.4%		Other	0.10%

Disaster Planning-Related Variables: Tampa-St. Petersburg, FL

Planning Focus	Category	Value	Planning Focus	Category	Value
Households at Risk	Elderly (Age ≥ 65)	14.8%	*Units Affected*	Median unit value	$ 209,216
	Children (Age < 5)	4.5%		Size (median square feet)	1,662
	Household type			Structure type 1 unit attached or detached	65.8%
	Single males living alone	13.6%		2 to 4 units	4.6%
	Single females living alone	17.0%		5 to 9 units	3.8%
	Husband and wife only	24.0%		10 to 19 units	5.4%
	Husband, wife, children only	12.5%		20 or more units	7.3%
	Single parent with children only	4.5%		Manufactured/mobile homes	13.1%
	Other household arrangements	28.5%	*Absorption Capacity*	Rental vacancy rate	16.9%
	Median persons/room	0.4		Non-rental vacancy rate	5.0%
	Households with at least one vehicle available	94.1%	*Special Issues*	Non-public utility water & sewage displacement	13.0%
	Hispanic immigrant householders arrived since 2004	2.9%		Primary heating equipment	
	Median household income	$ 43,217		Forced warm-air furnace	26.2%
	Housing costs as a percent of income	25.1%		Steam or hot water-based system	0.1%
	Households below poverty line	11.9%		Electric heat pump	65.9%
	Percentage of households with mortgages	41.4%		Electric baseboard or coil heating	1.5%
	Percentage of households with homeowner's insurance	71.0%		Pipeless furnace	1.7%
	Public housing units	0.7%		Other	4.7%
Susceptibility of Unit to Damage	Units in floodplain	10.8%		Households with air conditioning	98.6%
	Units with selected physical problems			Primary cooking fuel	
	Moderate	1.7%		Electricity	91.6%
	Severe	1.6%		Gas or propane	8.3%
	Manufactured/mobile homes built prior to wind standards	45.6%		Other	0.1%

Disaster Planning-Related Variables: Washington, DC-MD-VA

Planning Focus	Category	Value	Planning Focus	Category	Value
Households at Risk	Elderly (Age ≥ 65)	9.8%	*Units Affected*	Median unit value	$ 300,000
	Children (Age < 5)	5.2%		Size (median square feet)	2,453
	Household type			Structure type 1 unit attached or detached	70.6%
	Single males living alone	12.8%		2 to 4 units	2.3%
	Single females living alone	16.5%		5 to 9 units	4.5%
	Husband and wife only	19.1%		10 to 19 units	9.4%
	Husband, wife, children only	18.0%		20 or more units	12.2%
	Single parent with children only	4.0%		Manufactured/mobile homes	1.0%
	Other household arrangements	29.5%	*Absorption Capacity*	Rental vacancy rate	10.9%
	Median persons/room	0.3		Non-rental vacancy rate	2.5%
	Households with at least one vehicle available	91.0%	*Special Issues*	Non-public utility water & sewage displacement	9.3%
	Hispanic immigrant householders arrived since 2004	5.6%		Primary heating equipment	
	Median household income	$ 79,361		Forced warm-air furnace	66.9%
	Housing costs as a percent of income	23.2%		Steam or hot water-based system	9.6%
	Households below poverty line	6.8%		Electric heat pump	19.2%
	Percentage of households with mortgages	51.3%		Electric baseboard or coil heating	1.9%
	Percentage of households with homeowner's insurance	77.7%		Pipeless furnace	1.5%
	Public housing units	1.3%		Other	0.9%
Susceptibility of Unit to Damage	Units in floodplain	0.8%		Households with air conditioning	98.8%
	Units with selected physical problems			Primary cooking fuel	
	Moderate	2.4%		Electricity	51.8%
	Severe	1.4%		Gas or propane	48.0%
	Manufactured/mobile homes built prior to wind standards	49.5%		Other	0.2%