Geographic Information Systems Supporting Disaster Response and Recovery

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This article reflects the views of the authors and does not necessarily reflect the views of the U.S. Department of Housing and Urban Development.

Abstract

Disasters do not comply with traditional geographic boundaries. Geographic Information Systems (GIS) enable policymakers and planners to overlay the impacted disaster areas over existing data sources to estimate the severity of the disaster on the area and to determine to what extent federal and local resources might be required to facilitate long-term recovery. GIS also enables policymakers to test the costs and benefits of policy options. In the aftermath of Hurricanes Katrina, Rita, and Wilma, the U.S. Department of Housing and Urban Development (HUD) used GIS more extensively than it had for any previous disaster to calculate risk of housing damage to HUD-assisted and HUD-insured housing and to estimate actual damage to all housing in the affected states. This analysis was critical for making decisions about how many resources for long-term recovery to use and where to target those resources. The analysis has also been critical for local officials in their design of programs that address the long-term recovery needs in their communities.

Introduction

Like clockwork, in August, September, and October 2005, a major hurricane struck the Gulf Coast States. The first and most devastating—Hurricane Katrina—stormed into Alabama, Louisiana, and Mississippi on August 29 and devastated portions of those states, including the metropolitan area of New Orleans, America's 35th largest metropolitan area. Less than a month later, on September

24, Hurricane Rita came ashore and caused serious damage in east Texas and western Louisiana. Finally, on October 24, Hurricane Wilma swept across Florida.

Although the U.S. Department of Housing and Urban Development (HUD)—America's housing agency—is not generally a "first responder" to disasters, it often plays a variety of roles in supporting the long-term recovery of communities following a disaster. The Office of Policy Development and Research (PD&R) at HUD provides information to senior policy officials and program office staff to support HUD's response to natural disasters. Among the core pieces of information PD&R provides are analyses of the extent of the housing damage and identification of the households most affected by the storms. Oftentimes PD&R is asked to obtain and analyze data to help the Secretary of HUD make allocation decisions about how much funding from Community Development Block Grant (CDBG) supplemental appropriations should be provided to individual jurisdictions or states to facilitate long-term disaster recovery.

After Hurricane Katrina (later followed by Hurricanes Rita and Wilma), the Secretary's Office at HUD asked PD&R to provide information on the magnitude of the disasters in terms of both the overall housing stock and the HUD-insured and HUD-assisted housing stock. This request was followed by a request from the White House Hurricane Katrina Task Force on Housing and Relocation Policy to provide a detailed analysis of how the storms affected the New Orleans metropolitan area specifically and to offer some thoughts on what major issues would affect its long-term recovery. Finally, after Congress appropriated $11.5 billion in December 2005 for the CDBG program to support long-term recovery, PD&R obtained data from the Federal Emergency Management Agency (FEMA) and the Small Business Administration (SBA) on the extent and type of housing damage the storms caused. This data enable PD&R to help the Secretary with his decision on how the funds should be divided among Alabama, Florida, Louisiana, Mississippi, and Texas. After a second supplemental appropriation of $5.2 billion in CDBG funds in June 2006, PD&R again provided data to the Secretary of HUD to help divide those funds among the five affected states. For all these activities, PD&R made extensive use of Geographic Information Systems (GISs).

Timeline and Overview

Over time, following Hurricanes Katrina, Rita, and Wilma, different types of data became available. Each new source of data enabled HUD to achieve a better understanding of the extent of damage, specifically where the damage was concentrated and which households were most affected by the storms. The table in exhibit 1 offers a brief timeline of when data became available in the context of when the hurricanes struck and when Congress provided supplemental appropriations for disaster recovery.

Declared Counties

The first type of data that became available after Hurricane Katrina struck was simply information about which counties and parishes were declared eligible for federal Individual Assistance (IA) and Public Assistance (PA) grants.

Exhibit 1

Timeline of Housing Damage Estimates

2005	
August	Hurricane Katrina makes landfall on August 29.
	President Bush declares 8 counties in Alabama, 31 parishes in Louisiana, and 49 counties in Mississippi as eligible for FEMA IA grants.
September	HUD prepares estimates on population and the number of housing units and HUD-assisted housing in disaster-affected counties.
	Hurricane Rita makes landfall on September 24. FEMA declares 22 counties in Texas and 22 parishes in Louisiana as eligible for IA grants.
	HUD obtains American Red Cross preliminary estimates of the total number of housing units damaged by Katrina.
	HUD obtains MAC remote sensing data from FEMA.
October	HUD links FEMA remote sensing data to Census 2000 Block Groups for demographic analysis.
	HUD obtains flood depth data (as of August 31) for Orleans Parish from NOAA.
	HUD links flood depth data to Census 2000 Blocks and Block Groups to calculate the number of units and other demographic characteristics by flood depth in Orleans Parish.
	Hurricane Wilma makes landfall in Florida on October 24. FEMA declares 13 counties eligible for IA grants.
November	HUD obtains updated American Red Cross estimates of housing damage by county and parish.
December	Congress appropriates $11.5 billion in CDBG funds to assist states impacted by Hurricanes Katrina, Rita, and Wilma with long-term recovery.
2006	
January	HUD obtains home inspection data and other registrant characteristics from FEMA and the SBA.
	HUD makes formula allocation to five states.
February	HUD obtains updated home inspection data from FEMA.
	President Bush requests an additional $4.2 billion in CDBG funds for recovery in Louisiana.
April	HUD and DHS release formal estimates of housing damage in Gulf Coast States based on FEMA home inspection data.
	The USACE prepares estimates of costs to repair and improve levees by hydraulic areas. HUD provides estimates on population and the number of housing units within hydraulic areas.
June	Congress makes an additional $5.2 billion CDBG appropriation for recovery in the Gulf Coast States.
July	HUD allocates $4.2 billion of CDBG funds for Louisiana.
August	HUD announces formula allocation to Alabama, Florida, Mississippi, and Louisiana using FEMA inspection data and data provided by the states on unmet needs.

CDBG = Community Development Block Grant.
DHS = U.S. Department of Homeland Security.
FEMA = Federal Emergency Management Agency.
HUD = U.S. Department of Housing and Urban Development.
IA = Individual Assistance (grants).
MAC = Mapping and Analysis Center (FEMA).
NOAA = National Oceanic & Atmospheric Administration.
SBA = Small Business Administration.
USACE = U.S. Army Corps of Engineers.

To show the total number of households that had been in harm's way, PD&R obtained data from the 2000 census and HUD administrative data systems on the affected counties. This information provided an estimate of the risk for HUD's assisted and mortgage-insured housing stock—public housing, Housing Choice Vouchers (HCVs), multifamily insured and assisted households, and the Federal Housing Administration (FHA) single-family insured portfolio. Because HUD maintains geographic information (latitude, longitude, state, county, tract) for each housing unit in its programs, the data could be linked quickly to the affected counties and aggregated. This information gave senior policymakers a quick picture of what portion of the HUD inventory had been in the paths of the storms.

American Red Cross Damage Data

The actual level of damage resulting from the storms would be less than the number of households in harm's way. HUD found that the best early source of data on the total number of damaged housing units was from the American Red Cross. The American Red Cross uses a combination of on-the-ground field staff and geospatial analysis of aerial photographs to estimate the number of damaged housing units. Almost immediately after the storms occurred, the American Red Cross assembled estimates of damage to determine where to deploy its staff to offer immediate disaster assistance. Over time, the American Red Cross refined its damage estimates. The table in exhibit 2 shows the October 2005 housing damage estimates for Hurricanes Katrina and Rita from the American Red Cross.[1]

The American Red Cross Disaster Assessment (ARC 30-3049) regulations for making damage assessments provides the following definitions:

- **Destroyed.** The dwelling is currently uninhabitable and cannot be made habitable without extensive repairs that would prove to be too costly (for example, total loss of structure or complete failure to major structural components).
- **Major Damage.** The dwelling is not currently habitable but can be made habitable with repairs (for example, substantial failure to structural elements such as floors, walls, or foundation).
- **Minor Damage.** The dwelling has sustained damage and will require repairs, but it is currently habitable whether or not the occupants have chosen to remain in the dwelling following the disaster event (for example, minor structural damage, damage to small section(s) of the roof, numerous broken windows, and missing roofing and siding).
- **Affected.** The dwelling has sustained "extremely minor" damage mostly considered nuisance damage (for example, a few shingles blown off, a couple of broken windows, debris in the yard or on or near the dwelling, and minor contents damage).
- **Inaccessible.** Access to the dwelling is impossible because of standing water, destroyed bridges, impassable roads, or other such conditions. This rating is also used for homes that have been evacuated because of an imminent threat (for example, mudslides, overflow of sewers, or inoperative basic utilities). (American Red Cross, 2003).

Exhibit 2

Varying Estimates of Housing Damage—Hurricanes Katrina and Rita

	Number of Units in All Counties and Parishes	Number of Units in Orleans Parish	Number of Units in All Other Counties and Parishes
American Red Cross Estimates			
Destroyed	208,174	75,578	132,596
Major damage	145,857	51,870	93,987
Minor damage	183,480	35,092	148,388
Affected	209,891	64,083	145,808
Inaccessible	2,882	0	2,882
Subtotal	750,284	226,623	523,661
HUD Estimates Using FEMA Remote Sensing Data			
Catastrophic	22,244	183	22,061
Extensive	4,545	258	4,287
Moderate	18,151	629	17,522
Limited	78,008	3,839	74,169
Flooding	273,615	165,448	108,167
Subtotal	396,563	170,357	226,206
HUD Estimates for Orleans Parish Using Flood Depth			
Flooding of more than 7 feet	NA	19,829	NA
Flooding of 4 to 7 feet	NA	48,284	NA
Flooding of 2 to 4 feet	NA	35,399	NA
Subtotal	NA	103,513	NA
HUD Estimates Using FEMA Damage Inspections			
Severe damage	124,289	78,810	45,479
Major damage	157,621	26,345	131,276
Minor damage	651,004	29,189	621,815
Subtotal	932,914	134,344	798,570

FEMA = Federal Emergency Management Agency; HUD = U.S. Department of Housing and Urban Development; NA = not applicable.

FEMA Mapping and Analysis Center Remote Sensing Files

Although the American Red Cross estimates provided an excellent picture of the overall level of damage, they did not provide detailed information (by tenure, income, insurance status, and household type) about the specific households affected. The information also did not indicate how much of HUD's assisted or insured housing stock was likely damaged.

One early source of geographic data that can help provide this information is FEMA "remote sensing" data. During disaster response, the FEMA Mapping and Analysis Center (MAC) receives satellite imagery or aerial photography from the National Geospatial-Intelligence Agency. The MAC

uses this remotely sensed data, in conjunction with on-the-ground gross assessments, to produce files categorizing the type of damage an area sustained. The MAC is permitted to share these files with the public. The primary purpose for making these data available is to enable various businesses with vested interests in the data to apply them to their particular needs. FEMA's MAC has four designations for damage:

- **Catastrophic Damage.** Most solid and all light or mobile structures are destroyed.
- **Extensive Damage.** Some solid structures are destroyed and most sustain exterior and interior damage (for example, roofs are missing and interior walls are exposed); most mobile homes and light structures are destroyed.
- **Moderate Damage.** Solid structures sustain exterior damage (for example, missing roofs or roof segments); some mobile homes and light structures are destroyed and many are damaged or displaced.
- **Limited Damage.** Generally superficial damage to solid structures (for example, loss of tiles and roof shingles); some mobile homes and light structures are damaged or displaced.

In addition, FEMA's MAC identifies areas where flooding or ground saturation has occurred. These areas can overlap with one or more of the damage categories.

To identify HUD-insured and HUD-assisted properties in these damage areas and to examine demographic characteristics of households in the areas most affected by the storms, we overlaid the FEMA damage areas on Census 2000 Block and Block Group data and on the latitude and longitude of HUD's properties. The table in exhibit 2 shows HUD's estimates of the number of housing units in each of the FEMA damage areas for Hurricanes Katrina and Rita.

Flood Depth

One limitation of FEMA's remote sensing data was that most of the affected housing units were in areas designated only as "flooded." The FEMA MAC data provided no indication about the flooding depth—whether it was 1 foot or 10 feet. In October 2005, HUD received from the National Oceanic & Atmospheric Administration (NOAA) a file that showed flood depths for Orleans and St. Bernard Parishes. For those two parishes, we were able to overlay this file with both 2000 census data and HUD's administrative records to determine how many units were likely in areas of deep flooding versus shallow flooding.

FEMA Inspections

In December 2005, Congress appropriated $11.5 billion toward addressing unmet recovery needs in the five states affected by Hurricanes Katrina, Rita, and Wilma. To help the Secretary of HUD determine how to allocate the CDBG supplemental appropriation among the five states, HUD obtained FEMA data on registrants for its IA grant program. Included with this data was information reported from damage inspections conducted by FEMA contract inspectors. Because insurance may not cover all of an affected person's needs, most people register with FEMA for IA grants. FEMA conducts a housing inspection for most registrants. These data are a very direct measure of the extent of damage. Each unit is categorized into three levels of damage:

- **Severe.** The home is more than 50 percent damaged.
- **Major.** The cost to make the home habitable is more than $5,200 but the home is less than 50 percent damaged.
- **Minor.** The cost to make the home habitable is less than $5,200.

Moreover, because the FEMA IA data are at the registrant level and include information about the unit occupant, it was possible to estimate damage by type of damage (wind or flood), tenure, insurance status, income, and location (such as being inside or outside a flood zone). This information is very helpful when trying to allocate funds for unmet needs.

The table in exhibit 2 shows the number of units that sustained minor, major, or severe damage from Hurricanes Katrina and Rita based on HUD's analysis of a February 12, 2006, extract of FEMA IA data, the American Red Cross damage assessment data, and the result of overlaying Census 2000 data on the FEMA MAC remote sensing areas and the NOAA flood depth.

SBA Inspections

One downside to the FEMA direct inspection data is that the damage categories are very broad and do not take into account the varying costs to repair homes of different sizes. Inspections of homes by the SBA for individual owners who sought a low-interest disaster loan helped resolve some of the problems associated with the limited damage definitions from the FEMA inspections. SBA inspections provide detailed cost estimates of how much it would cost for a home to be repaired. Although far fewer SBA inspections are conducted than are FEMA inspections, it is possible to use SBA inspections to estimate how much it would cost to repair nearby housing units that FEMA had designated as having major or severe damage.

A combination of the FEMA and SBA data was used to inform the Secretary of HUD on likely unmet needs in the Gulf Coast States and guide the allocation of the $11.5 billion supplemental appropriation. These data also became the government's estimate of total damage. In April 2006, the U.S. Department of Homeland Security and HUD publicly released the aggregated data cross-tabulated by several need categories.[2]

Because FEMA damage data are based on direct inspections, they probably provide the most accurate and complete estimates. For early planning purposes, the American Red Cross estimates and the flood depth estimates for Orleans Parish proved to be reasonable estimates compared with the FEMA damage inspections. The remainder of this article provides details on how GIS was used in the activities described previously.

Counties Eligible for FEMA IA and PA

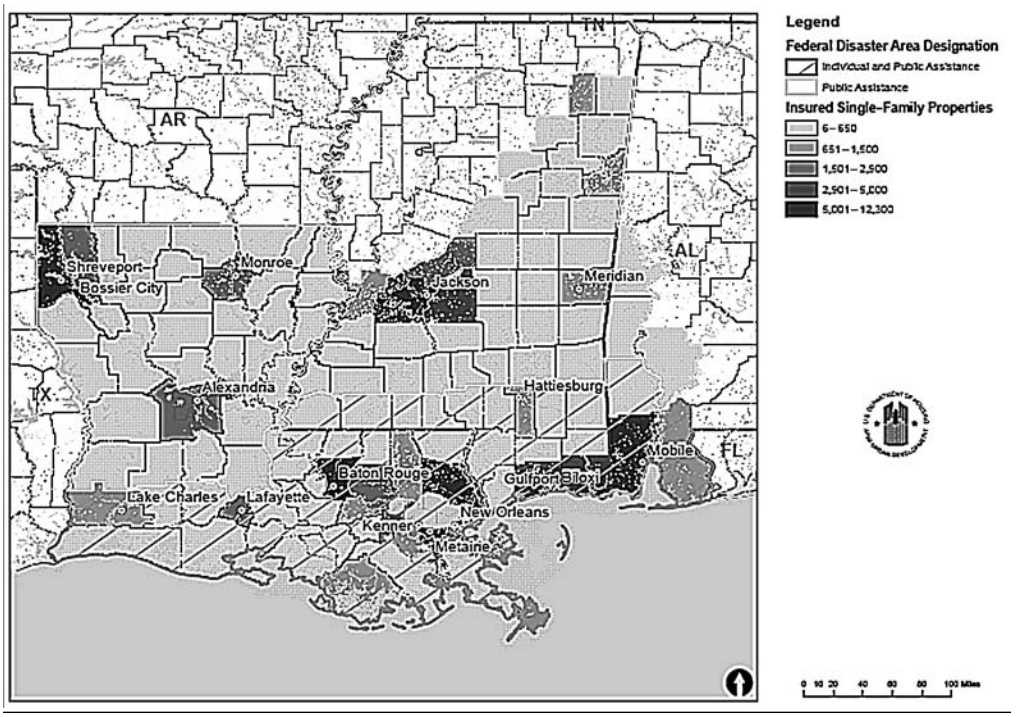
When a county is declared eligible for federal disaster assistance, it is generally declared as eligible for IA grants, PA grants, or both. Under the IA program, an individual whose home has been damaged or destroyed and whose losses are not covered by insurance may apply to FEMA for assistance with temporary housing, for small repair grants, and, sometimes, for other assistance, such as assistance to cover some medical costs. The PA program enables states, local governments,

and certain nonprofit organizations to obtain supplemental federal disaster grant assistance for the repair, replacement, or restoration of disaster-damaged, publicly owned facilities and the facilities of certain private nonprofit groups. In the early stages after a disaster, PA funds are used extensively for debris removal.

Counties eligible for the IA program are usually the hardest hit counties where homes were more likely to experience significant damage. In its analysis of housing damage caused by Hurricane Katrina, HUD generally focused its attention on the IA counties. A total of 2,421,132 housing units were in the Katrina-related IA counties. Among the housing units in the affected IA counties were 106,945 homes with FHA single-family mortgage insurance. The map in exhibit 3 illustrates the type of information provided shortly after Katrina struck[3] to demonstrate the concentration of FHA single-family insured homes in the counties declared eligible for federal disaster assistance.

Exhibit 3

FHA Single-Family Insured Properties Affected by Hurricane Katrina



FHA = Federal Housing Administration.

American Red Cross

As noted previously, the American Red Cross uses GIS technology for a variety of tasks to better target its resources before, during, and after a disaster (ESRI, 2005). The American Red Cross has teams of staff and trained volunteers who begin working before a disaster and collect information

throughout the disaster to help the teams decide where to provide services. The teams immediately follow their decision by identifying where most of the damage is centered and which housing units are most affected (Hallman, 2004). When feasible, the American Red Cross bases its damage estimates on external physical assessments of units and collects this information on a block-by-block basis. For large disasters, such as Hurricanes Katrina and Rita, the American Red Cross identifies areas based on the likely level of damage and uses GIS to determine the number of housing units in the area. For Hurricanes Katrina, Rita, and Wilma, the American Red Cross supplemented its on-the-ground assessments with remote sensing data from the FEMA MAC. A comparison of the American Red Cross estimates of damage, which are available shortly after the disaster, with the direct inspection data from FEMA, available many months after the disaster, shows the aggregate damage totals from the American Red Cross data to be reasonably similar to the totals from the FEMA inspections. This observation tends to validate the reliability of the American Red Cross damage estimates as a good source of data to base early planning decisions for long-term recovery.

FEMA Remote Sensing Data

HUD's first major use of GIS to better understand the scope of the disaster and how HUD's insured and assisted units might be affected was with data obtained from FEMA's MAC. The FEMA MAC data used satellite imagery and "boots-on-the-ground" information to make assessments of areas impacted by the hurricanes.

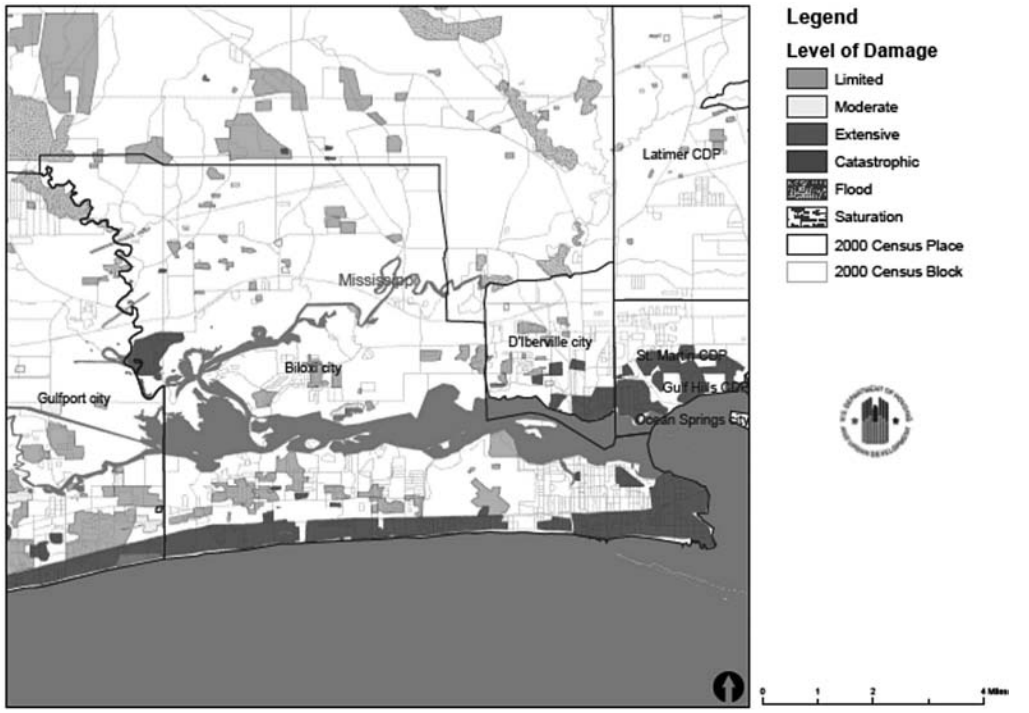
The map of Biloxi, Mississippi, in exhibit 4 shows the areas defined as damaged under the various categories. To calculate the number of housing units within each of those damage areas, we overlaid the damage areas with Census 2000 Blocks. If a damage area represented only a fraction of the block, we had to decide what fraction of the housing units in that block should be counted in each of the categories of damage. We considered three options:

1. Including of the housing units for that block.
2. Apportioning the data for the block by the percentage of the block represented by the damage area (for example, if the damage area represented 1 acre in a 10-acre block, then the number of housing units in the block would be multiplied by 1/10).
3. Adding in the street grid for the block and assuming the housing units are located near the streets. By "placing" the housing units in the block, we can then see how many of the housing units fall within the damage areas. The Oak Ridge National Laboratory conducted this analysis for HUD using a methodology developed as part of previous research for HUD.

Although the third option is probably the most accurate, it required many hours of data processing to accomplish. It did, however, lead us to a hybrid approach: for rural areas, all housing units in a damaged block are considered damaged (approach 1), while for urban areas, housing units are apportioned by area (approach 2). This hybrid approach yields nearly the same result as the third approach. As a result, for most of this analysis, we used the hybrid approach to estimate the number of homes in each of the FEMA remote-sensing damage areas.

Exhibit 4

Hurricane Katrina Damage Assessment, Biloxi, Mississippi, September 2005



To get detailed demographic information that is available only at the block group level, we aggregated the number of homes in each damage category from the block level to the block group level and assumed that the demographics of those households experiencing damage in a block group would be the same as the demographics of those not experiencing damage within a block group. This assumption resulted in tables such as the one in exhibit 5, which shows by income and tenure the number of households that lived in areas defined as having different levels of damage. The table in exhibit 5 shows this information for Biloxi, Mississippi, but similar tables were developed for the disaster areas as a whole and for each of the hardest hit communities.

Estimating damage to HUD's owned, insured, and assisted housing stock was considerably easier to do because HUD maintains a distinct point location for each property. All we needed to determine the damage to each property was a simple "point-in-polygon" overlay procedure, otherwise known as a "spatial join." After a damage category was assigned to each property, maps and reports were generated to inform HUD principal staff on the type and extent of damage to expect. (See exhibit 6.)

Exhibit 5

Income and Tenure Characteristics of Households in FEMA Damage Areas in Biloxi, Mississippi, by Number and Percentage of Households

Damage Category and Area Median Income Range	Owner	Renter	Total
Moderate, extensive, or catastrophic damage and/or flooding	**2,233**	**3,278**	**5,511**
0–30% AMI*	8%	19%	14%
31–50% AMI	9%	13%	11%
51–80% AMI	15%	23%	20%
81–95% AMI	8%	11%	10%
96% AMI plus	61%	35%	45%
Limited damage	**1,238**	**1,319**	**2,557**
0–30% AMI	4%	16%	10%
31–50% AMI	5%	13%	9%
51–80% AMI	8%	24%	16%
81–95% AMI	6%	10%	8%
96% AMI plus	77%	37%	56%

**Area median income as determined by HUD.*

Exhibit 6

HUD-Insured and HUD-Assisted Housing Units in Areas Damaged by Hurricane Katrina, by Geographic Area, September 23, 2005

Geographic Area and Type of HUD-Assisted and/or HUD-Insured Housing	Total Housing Units (no.)	Federally Declared Disaster Areas		Areas Eligible for Individual Assistance		In FEMA-Designated Damage Areas[a]		In FEMA-Designated Flood Areas[b]	
		Units (no.)	% of State Stock	Units (no.)	% of State Stock	Units (no.)	% of State Stock	Units (no.)	% of State Stock
Alabama									
LIHTC	15,547	4,452	29	2,577	17	0	0	0	0
Public housing	42,734	15,630	37	7,232	17	0	0	0	0
HCV	23,745	11,819	50	5,923	25	0	0	0	0
Multifamily insured and assisted	29,502	12,399	42	7,407	25	0	0	0	0
FHA single-family insured	77,876	33,599	43	15,097	19	60	0	1	0
Total	**189,404**	**77,899**	**41**	**38,236**	**20**	**60**	**0**	**1**	**0**

FEMA = Federal Emergency Management Agency; FHA = Federal Housing Administration; HCV = Housing Choice Voucher Program; LIHTC = low-income housing tax credit.

[a] FEMA-designated damage areas include categories of limited damage, moderate damage, extensive damage, catastrophic damage, flooding, and saturation.

[b] FEMA-designated flood areas do not indicate the extent of flooding. This designation, therefore, does not necessarily indicate units were under water. Federally declared disaster areas are as of September 10, 2005.

Notes: Data include only units with complete, verifiable addresses. Therefore, state totals may not be strictly comparable with other data sources. LIHTC data are as of 2003; public housing data are as of March 31, 2005; HCV data are as of June 30, 2005; single-family insurance data are as of September 7, 2005; and multifamily program data are as of September 13, 2005. Multifamily housing includes HUD-insured and HUD-assisted properties, Section 202 and Section 811 units, and HUD-held properties.

Exhibit 6

HUD-Insured and HUD-Assisted Housing Units in Areas Damaged by Hurricane Katrina, by Geographic Area, September 23, 2005 (continued)

Geographic Area and Type of HUD-Assisted and/or HUD-Insured Housing	Total Housing Units (no.)	Federally Declared Disaster Areas		Areas Eligible for Individual Assistance		In FEMA-Designated Damage Areas[a]		In FEMA-Designated Flood Areas[b]	
		Units (no.)	% of State Stock	Units (no.)	% of State Stock	Units (no.)	% of State Stock	Units (no.)	% of State Stock
Louisiana									
LIHTC	21,733	21,733	100	12,101	56	2,135	10	2,135	10
Public housing	29,672	29,672	100	19,631	66	8,383	28	8,383	28
HCV	31,365	31,365	100	20,752	66	7,297	23	7,287	23
Multifamily insured and assisted	33,918	33,918	100	21,783	64	6,160	18	6,160	18
FHA single-family insured	75,243	75,243	100	57,629	77	12,708	17	11,611	15
Total	**191,931**	**191,931**	**100**	**131,896**	**69**	**36,683**	**19**	**35,576**	**19**
New Orleans									
LIHTC	2,796	2,796	13	2,796	13	2,103	10	2,103	10
Public housing	10,420	10,420	35	10,420	35	8,247	28	8,247	28
HCV	8,066	8,066	26	8,066	26	6,657	21	6,652	21
Multifamily insured and assisted	6,464	6,464	19	6,464	19	4,767	14	4,767	14
FHA single-family insured	12,259	12,259	16	12,259	16	8,169	11	8,108	11
Total	**40,005**	**40,005**	**21**	**40,005**	**21**	**29,943**	**16**	**29,877**	**16**
Mississippi									
LIHTC	13,774	13,774	100	9,279	67	72	1	0	0
Public housing	14,933	14,933	100	10,158	68	162	1	0	0
HCV	14,820	14,820	100	10,927	74	286	2	12	0
Multifamily insured and assisted	29,827	29,827	100	20,595	69	752	3	0	0
FHA Single-family insured	49,714	49,714	100	34,219	69	1,306	3	51	0
Total	**123,068**	**123,068**	**100**	**85,178**	**69**	**2,578**	**2**	**63**	**0**
Grand Total	**504,403**	**392,898**	**78**	**255,310**	**51**	**39,321**	**8**	**35,640**	**7**

FEMA = Federal Emergency Management Agency; FHA = Federal Housing Administration; HCV = Housing Choice Voucher Program; LIHTC = low-income housing tax credit.

[a] FEMA-designated damage areas include categories of limited damage, moderate damage, extensive damage, catastrophic damage, flooding, and saturation.

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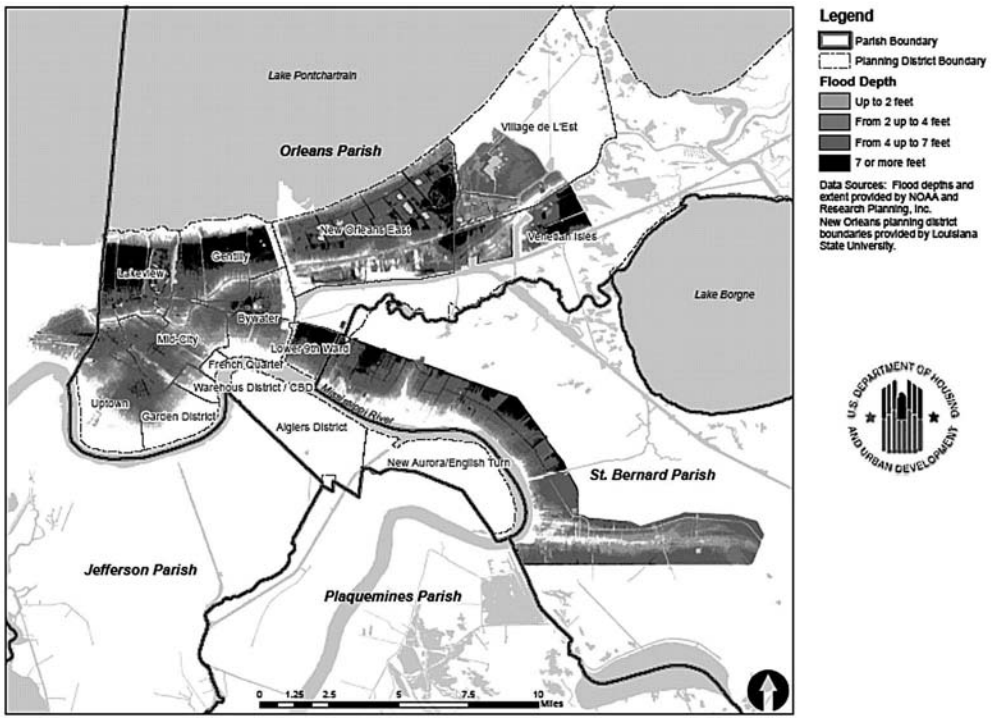
NOAA Flood Depths

The New Orleans metropolitan area had the highest concentration of households affected by Hurricane Katrina and was of special interest to HUD in understanding early on the extent of challenge that lay ahead. Unfortunately, as mentioned previously, the FEMA remote-sensing data showed only the areas that flooded, not the depth of the flooding. To get a better understanding of the extent of damage due to flooding, HUD obtained a flood-depth grid file from NOAA that showed the depth of the floodwaters on August 31, 2005. For the purpose of estimating damage, we attempted to categorize the severity of flooding as less than 2 feet, 2 to 4 feet, 4 to 7 feet, and more than 7 feet. Our hypothesis was that flooding of less than 2 feet was likely to cause minimal damage, whereas flooding of more than 7 feet would likely result in the demolition of the unit. The creation of the 2-to-4-foot and 4-to-7-foot categories of flooding was an attempt to distinguish moderate from severe flood damage.

The map in exhibit 7 shows the extent of flooding in Orleans Parish, St. Bernard Parish, and, to a small extent, Jefferson Parish according to these flood categories.

Exhibit 7

Estimated Extent and Depth of Hurricane Katrina Flooding, New Orleans, Louisiana, August 31, 2005



To estimate the number of housing units in each flood category, we employed a classic GIS overlay function called a union. First, a planning district was assigned to each census block. Because

planning districts and blocks tend to share boundaries, it was not difficult to determine the correct planning district to assign the block to. Flooded areas, however, do not follow block boundaries as neatly, so we had to employ an area-based allocation methodology to estimate the number of housing units in each block that were affected by flooding. A union of the census blocks and flood grid enabled us to calculate the percentage of the block area in each flood category. That percentage was then used as a weighting factor in the allocation of demographic attributes—in this case, housing units—to the damage area. This approach operates under the tenuous assumption that the demographic being studied is homogeneously distributed across the landscape. We selected the census block, the smallest level of census geography available, in an attempt to minimize the distortion caused by this assumption. The table in exhibit 8 provides an example of what this method told us about the number of housing units likely affected by the flooding.

Exhibit 8

Number of Housing Units by Area and Flood Depths of More Than 2 Feet in New Orleans City Planning District and St. Bernard Parish

Area	Flooding of 2 to 4 Feet	Flooding of 4 to 7 Feet	Flooding of More Than 7 Feet	Total Units With Flooding of More Than 2 Feet	Total Number of Units in District
Algiers District	0	0	0	0	20,053
Bywater	3,583	4,467	685	8,735	18,027
French Quarter	0	0	0	0	3,505
Garden District	2,964	1,558	2	4,524	24,000
Gentilly	2,691	4,679	6,792	14,162	17,343
Lakeview	1,116	2,949	5,648	9,713	11,722
Lower 9th Ward	1,131	2,332	2,721	6,184	7,138
Mid-City	12,519	10,745	386	23,651	35,582
New Aurora/English Turn	0	0	0	0	1,227
New Orleans East	5,387	14,013	2,625	22,025	27,986
Uptown	4,823	7,018	577	12,418	29,853
Venetian Isles	23	38	34	95	1,397
Village de L'Est	1,017	288	296	1,601	3,445
Warehouse District/CBD	56	1	0	57	1,183
No district defined	91	195	63	349	12,641
City of New Orleans total	**35,399**	**48,284**	**19,829**	**103,513**	**215,101**
St. Bernard Parish total	**5,738**	**9,310**	**2,371**	**17,420**	**26,790**

CBD = Central Business District.
Source: HUD overlay of National Oceanic & Atmospheric Administration August 31, 2005, data on flood depths over Census 2000 Block count data

We also overlaid the location of HUD's housing stock to estimate how many of these units were likely affected by the flooding. These procedures led to the creation of tables such as the one in exhibit 9, which shows the flood depths for households in the various assisted housing programs and indicates the number of properties covered by each of those programs and the number of units within those properties.

Exhibit 9

HUD-Assisted, LIHTC, and HUD Multifamily Units and Projects/Buildings by Flood Depths of More Than 2 Feet in the City of New Orleans

Type of Housing	Flooding of 2 to 4 Feet	Flooding of 4 to 7 Feet	Flooding of More Than 7 Feet	Total Units With Flooding of More Than 2 Feet	Total Number of Units
Individual units					
HCV	1,840	2,469	672	4,981	8,066
Public housing[a]	2,552	3,787	222	6,561	10,420
Multifamily assisted	894	2,058	0	2,952	5,485
LIHTC	289	1,057	108	1,454	2,796
Multifamily insured	152	765	56	973	1,774
Total	**5,727**	**10,136**	**1,058**	**16,921**	**28,541**
Properties, projects, and/or buildings					
Public housing	239	397	55	691	1,055
Multifamily assisted	11	11	0	22	43
LIHTC projects	8	6	1	15	37
Multifamily insured	2	4	1	7	19
Total	**260**	**418**	**57**	**735**	**1,154**

HCV = Housing Choice Voucher Program; HUD = U.S. Department of Housing and Urban Development; LIHTC = low-income housing tax credit.

[a] The actual number of public housing units under management by the New Orleans Housing Authority at the time Katrina struck was 8,279. The City of New Orleans had demolished units before Katrina that were still included in the "point" data file used to calculate the number of units by flood depth. As a result, the actual number of impacted public housing units is probably fewer than the number shown in exhibit 8.

Source: HUD data on property location with overlay of National Oceanic & Atmospheric Administration August 31, 2005, data on flood depths

FEMA and SBA Inspection Data

The early analysis described above was useful in framing the discussion about the breadth of long-term rebuilding needs. In late December 2005, President George W. Bush signed a supplementary appropriation into law that included $11.5 billion for the Community Development Block Grant program to provide "disaster relief, long-term recovery, and restoration of infrastructure in the most impacted and distressed areas" of the five states impacted by Hurricanes Katrina, Rita, and Wilma. HUD was charged with dividing the funds among Alabama, Florida, Louisiana, Mississippi, and Texas with the caveat that no state could receive more than 54 percent of the $11.5 billion.

HUD has received supplemental appropriations in the past to address long-term recovery needs. HUD's past experience identified a standard approach to developing a funding formula that can be quickly implemented to get the funds to the affected areas expeditiously.[4] HUD's approach has been to acquire detailed data from FEMA IA, FEMA PA, and the Small Business Administration Disaster Loan program to estimate the extent of needs not being met by these programs. The unmet needs are then summed up for each state and the allocation generally is made proportionally to that need, with some unmet needs getting higher priority for funding than others.

For a "normal" federally declared disaster, the primary sources of funding for long-term recovery of housing and businesses are (1) insurance, (2) SBA low-interest disaster loans, and (3) FEMA IA home-repair grants for owner-occupied housing and IA personal property grants for renters and owners. Recovery options for individuals who lack adequate insurance, are unable to qualify for an SBA disaster loan, and live in housing that has sustained more damage than what a FEMA home-repair grant would cover are limited to what state and local government or nonprofit groups may provide in the way of assistance. When Congress provides a supplemental appropriation of CDBG funds for long-term recovery activities, however, a fourth source of very flexible funding becomes available to address long-term recovery needs. Congress generally makes these allocations when the extent of the disaster is so large it has clearly overwhelmed the local capacity to fill in the "gaps" not addressed by the three other options. Congress usually states in the legislation its priority for funding, but that priority is nearly always associated with unmet housing, business, and infrastructure needs to facilitate long-term recovery.

HUD's allocation methodology is driven both by legislative direction and by the data available. In response to the supplemental appropriation, HUD assembled the most current data available on the extent of damage in each of the five hurricane-affected states. In addition to acquiring the data noted above, HUD obtained from FEMA its file of IA registrants, which included registrant characteristics and results of the home inspections conducted through December 31, 2005.[5] For most properties, FEMA contract inspectors make a direct assessment of housing unit damage. For some of the units impacted by Hurricane Katrina, FEMA did not do direct inspections but instead assumed a level of damage based on the flood depth.[6]

FEMA inspects properties to determine eligibility for real property and personal property assistance. FEMA real property assistance is determined as the cost to make a home habitable. If a home is less than 50 percent damaged, FEMA will provide up to $5,200 in repair assistance for damage not covered by insurance. If damage is greater than 50 percent, FEMA will provide $10,500 in repair assistance for damage not covered by insurance. FEMA will make similar assessments for personal property damage.

Because FEMA provides reimbursement at only three levels (less than $5,200, $5,200, and $10,500), for the table in exhibit 10 HUD categorized the inspection results into three categories of damage.

Minor Damage:

- Property inspection was conducted and found damage of less than $5,200; or
- If no real property inspection was conducted but an inspection of personal property was conducted and found damage of less than $5,195.76; or
- If no direct inspection was conducted but remote sensing finds water depth of 6 inches to 1 foot (for portions of Orleans, St. Bernard, and Jefferson Parishes).

Major Damage:

- Property inspection was conducted and finds damage of greater than or equal to $5,200 and less than $30,000; or

- If real property inspection was conducted and the inspector used the inspection default of $5,200 to indicated damage in excess of $5,200 but the property was less than 50 percent damaged overall; or
- If no real property inspection was conducted but a personal property inspection was conducted finding damage of greater than or equal to $5,195.76 but less than $30,000; or
- If no real property inspection was conducted but personal property damage inspection was conducted and the inspector used the inspection default of $5,195.76 to indicate personal property damage in excess of $5,195.76 but the property was less than 50 percent damaged overall; or
- If no direct inspection was conducted but remote sensing finds water depth of 1 foot to 2 feet (for portions of Orleans, St. Bernard, and Jefferson Parishes).

Severe Damage:

- Property inspection finds damage greater than or equal to $30,000; or
- If real property inspection was conducted and the inspection default of $10,500 was used to indicated property damage in excess of 50 percent; or
- If no real property inspection was conducted but a personal property damage inspection was conducted showing damage of greater than or equal to $30,000; or
- If no real property inspection was conducted but a personal property damage inspection was conducted and inspector used the inspection default of $10,391.51 to indicate the property was more than 50 percent damaged; or
- If no direct inspection occurred but remote sensing finds water depth of 2 feet or greater (for portions of Orleans, St. Bernard, and Jefferson Parishes).

Unfortunately, as is true with almost every source of data, data quality issues needed to be addressed with these otherwise extremely useful data. Because it was possible for multiple individuals to register for FEMA housing assistance for the same housing unit, we implemented a complicated set of procedures to identify individual housing units. For example, if a husband and wife both registered, or if an owner and his or her tenant both registered for the housing unit, we attempted to count the housing unit only once. The procedures we used, which depended heavily on geocoding the addresses, included the following:

- We included only records with a FEMA inspection. If the inspection was based on flood depth, we included only cases in which a grant was provided or the FEMA data indicated that the owner or renter had flood insurance.
- If we recorded duplicate registrant numbers with the same address, we retained the record with highest FEMA damage rating.
- If we recorded multiple registrants for the same address of a single-family property, then we retained the record with highest FEMA damage rating. If one registrant was an owner and the other was a tenant, we retained the owner registrant. We considered single-family records to be

duplicates for the same property if the U.S. Postal Service ZIP Code + 4 in combination with the delivery point bar code (DPBC) were the same (this is also referred to as the ZIP Code + 6). The ZIP Code + 6 proved to be the most valuable tool for identifying multiple records for the same address. For most single-family properties, the ZIP Code + 6 gives each property a unique numerical code, something similar to a Social Security number for a house. That is, each single-family home in the United States has its own unique 11-digit numerical code. This code turns out to be a powerful tool because it allows for easy identification of multiple registrants for the same address.

The challenge with the DPBC is to determine when it is used for a single-family home instead of a multifamily or mobile home. Fortunately, the DPBC for single-family homes is simply the last two numbers of the house address. Because the ZIP Code + 4 represents the block the house is on, the extra two digits pinpoint the DPBC at the house. If the DPBC matches the last two digits of the property address, we categorize the home as a single-family house. If not, we categorized the home as a multifamily or mobile home.

- Because many of the addresses for registrants who were living in apartments or mobile homes did not have apartment or lot numbers, it was not possible to use the ZIP Code + 6 method to limit those registrants to a single unit. Instead, multifamily and mobile home records were considered to have multiple registrants if the last names and addresses were the same.

Even with these procedures, double-counted units likely remained in the file. These units may have been offset, however, by likely undercounting. The data do not count vacant homes or second homes. They also do not include properties that had not yet had a FEMA inspection or reinspection as of February 12, 2006. If an individual did not register with FEMA, his or her damage would not be counted. In addition, our procedures to reduce multiple registrants for a single unit to one record may actually eliminate legitimate cases of independent units that were damaged.

A subset of FEMA registrants with real property damage applied to the SBA for loans to help repair their properties. If the applicants met some income and credit thresholds, SBA would have a contract inspector make a detailed assessment of the real property loss resulting from the disaster (referred to as "verified loss"). This verified loss is usually a more precise estimate than FEMA's estimate of what it would actually cost to repair the property.

Following Hurricanes Katrina, Rita, and Wilma, SBA conducted 184,361 inspections as of May 31, 2006. Because the FEMA data are more comprehensive in coverage—more than 1.3 million inspections—and the SBA data are more specific on dollar amount of the damage, they are linked together for this analysis. The units with both FEMA and SBA inspections are used to develop an estimate of the dollar amount of the damage for units inspected by FEMA but with no SBA inspection.

Basically, this estimation works as follows. At the census block level, the average SBA damage amount for a FEMA-designated "severe" damage property is applied to all the properties in the block with severe damage ratings from FEMA. The same process is repeated for properties with "major" damage ratings. The assumption here is that a property without an SBA inspection in the same block and same level of damage as determined by the FEMA inspection is likely to be of a similar structure type, value, and SBA damage level as a property with an SBA inspection. As a

Exhibit 10

Damage Estimates for Hurricanes Katrina and Rita Using February 12, 2006, FEMA Inspection Data, by Number of Units

	Owner-Occupied Housing Units				Renter-Occupied Housing Units	Total
	Insurance Status					
	Hazard & Flood	Hazard Only	No Insurance	Owner Subtotal		
Homes with flood damage						
Homes in FEMA 100-year flood plain						
Minor damage	5,272	2,108	1,465	8,845	8,386	17,231
Major damage	25,325	7,280	4,952	37,557	22,262	59,819
Severe damage and/or destroyed	36,286	7,640	8,014	51,940	35,338	87,278
Subtotal	66,883	17,028	14,431	98,342	65,986	164,328
Homes outside FEMA 100-year flood plain						
Minor damage	1,541	3,505	1,621	6,667	5,977	12,644
Major damage	7,098	13,128	3,623	23,849	14,514	38,363
Severe damage and/or destroyed	7,511	5,539	3,706	16,756	10,803	27,559
Subtotal	16,150	22,172	8,950	47,272	31,294	78,566
Homes with damage, but no flood damage (generally wind damage)						
Minor damage	51,262	231,450	160,327	443,039	178,090	621,129
Major damage	5,493	19,633	14,065	39,191	20,248	59,439
Severe damage and/or destroyed	792	1,619	3,581	5,992	3,460	9,452
Subtotal	57,547	252,702	177,973	488,222	201,798	690,020
Total	**140,580**	**291,902**	**201,354**	**633,836**	**299,078**	**932,914**
Summary totals						
Minor damage	58,075	237,063	163,413	458,551	192,453	651,004
Major damage	37,916	40,041	22,640	100,597	57,024	157,621
Severe damage and/or destroyed	44,589	14,798	15,301	74,688	49,601	124,289

FEMA = Federal Emergency Management Agency.

result, the property without an SBA inspection is assigned the same cost to repair as the property with the SBA inspection in that census block. If an SBA inspection did not occur in the block, then the next level of geography average (first census tract, then county) is used. Exhibit 11 provides the estimated per-unit amount to repair homes with major or severe damage, organized by the same categories as those in exhibit 10. A per-unit amount is not provided for minor damage because only a relatively small percentage of individuals whose properties sustain minor damage seek out SBA assistance.

Beyond providing the basic inspection data, the FEMA registrant file and other data available to HUD that could be matched to the FEMA registrant file provided useful information for understanding not only how much damage was incurred but also by which households. This information included the following:

Tenure

Owner-Occupied Housing Units and Renter-Occupied Housing Units

When individuals registered for FEMA assistance, they were asked if they were renters or owners. In approximately 10 percent of these cases, no tenure was indicated. Exhibits 10 and 11 assume that those individuals not indicating tenure were owner-occupants.

Type of Damage

The tables in exhibits 10 and 11 break out damage into two categories: homes with any flood damage and homes with no flood damage. If a home had flood damage and other types of damage, it is categorized as having flood damage. Most homes without flood damage had damage related to wind. Flood damage was determined if FEMA inspectors indicated damage was due to flooding or if the damage estimate was from remote sensing (which based damage on flood depth).

Exhibit 11

Per-Unit Repair Cost for Damage From Hurricanes Katrina and Rita Using March 30, 2006, SBA Data (in dollars)

	Owner-Occupied Housing Units			Owner- and Renter-Occupied Housing Units		
	Insurance Status					
	Hazard & Flood	Hazard Only	No Insurance	Owner Subtotal	Renter Occupied	Total
Homes with flood damage						
Homes in FEMA 100-year flood plain						
Major damage	81,210	72,789	69,744	78,214	81,355	79,567
Severe damage and/or destroyed	147,266	132,214	114,909	139,541	107,409	125,871
Homes outside FEMA 100-year flood plain						
Major damage	84,048	69,789	67,071	73,832	82,860	78,321
Severe damage and/or destroyed	149,050	119,433	103,677	127,975	116,477	123,731
Homes with damage, but no flood damage (generally wind damage)						
Major damage	44,499	36,225	32,827	36,876	47,670	39,382
Severe damage and/or destroyed	145,720	90,579	67,058	87,118	88,777	87,428
Summary average cost to repair						
Major	69,875	45,911	42,619	53,459	70,401	59,284
Severe	147,497	113,442	90,980	124,377	107,740	118,250

FEMA = Federal Emergency Management Agency; SBA = Small Business Administration.

Flood Plain Status

Using GIS, we performed an overlay operation known as a spatial join with the FEMA-registered housing units and the FEMA digital Q3 Flood Data (vector files developed by scanning the Flood Insurance Rate Map [FIRM] hard copy) to determine which units were inside (or outside) a FEMA 100-year flood zone.

Insurance Status

Insurance status was determined from FEMA data if the registrant indicated having hazard or flood insurance. In very few cases, no information on insurance status was recorded and "no insurance" was assumed.

Income Level

Income level was calculated by comparing the income and household size reported to FEMA at the time of registration with HUD's published income limits for the county in which the damaged property was located.

Assisted Housing

Assisted housing information is based on matching the FEMA registrants to HUD data on program participants in HUD's public housing, Housing Choice Voucher, and project-based Section 8 programs.

Geographic Identifiers

All the housing units were geocoded to include geographic identifiers of interest, including political divisions, such as county or place; congressional districts, so HUD could provide estimates to congressional staff; and the Orleans Planning Districts, so HUD could provide Orleans Parish the same identifiers as those used for the flood depth estimates described previously to provide estimates by planning district.

All this information was used to both facilitate the CDBG formula allocations and create detailed tables such as the one in exhibit 10, which shows the total number of units that sustained different types of damage, and the one in exhibit 11, which uses the SBA data to estimate the per-unit cost to repair housing units that sustained major and severe damage. Tables such as the one in exhibit 10 were produced for many different areas, including the most impacted counties and subareas of counties (such as Orleans Planning Districts). The tables are publicly available[7] and have been very helpful to the five states as they plan for long-term recovery of their housing stock (U.S. Department of Homeland Security and U.S. Department of Housing and Urban Development, 2006).

These data were also a key piece of information that the U.S. Department of Homeland Security's Office of the Federal Coordinator for Gulf Coast Rebuilding used in preparing its request to Congress in February 2006 for an additional $4.2 billion in CDBG funds for long-term recovery in Louisiana.

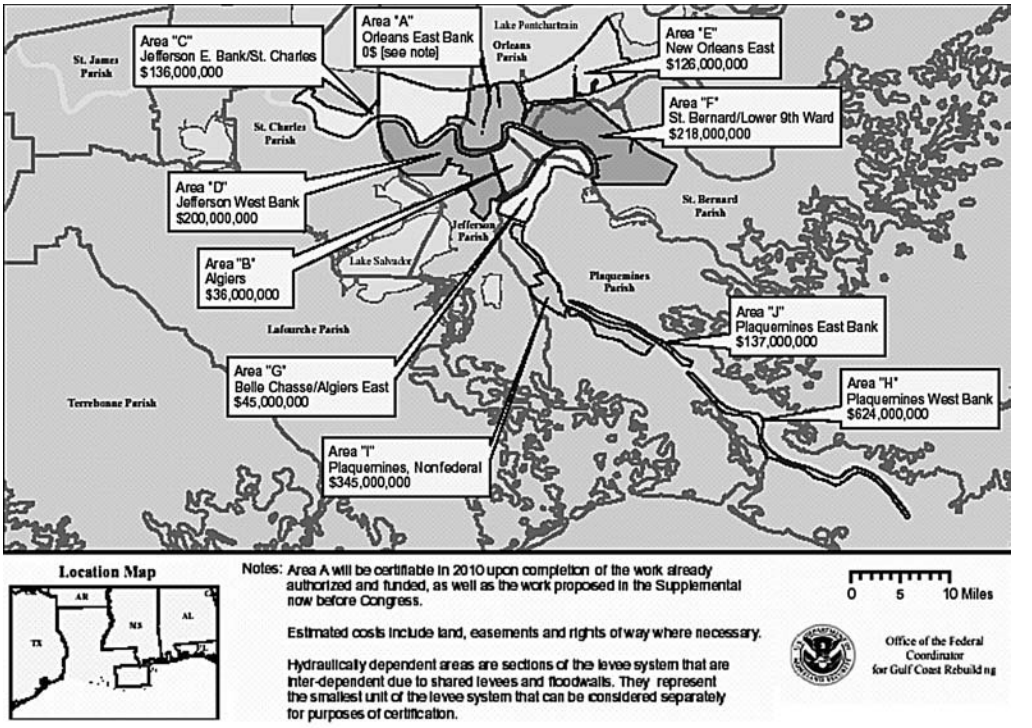
Hydraulic Areas and FEMA Base Flood Elevations

HUD also provided data support to the Office of the Federal Coordinator for Gulf Coast Rebuilding as the Office studied the cost to rebuild the levees in the New Orleans metropolitan area. The map in exhibit 12 shows hydraulic areas, each of which represents a basin protected by a series of levees. If any of the levees surrounding a hydraulic area fails, the basin will fill. The Office had received from the U.S. Army Corps of Engineers (USACE) the cost to repair or improve the levees so that the levees could be certified to protect against the 1-percent-annual-chance (100-year) flood. The Office wanted to know how many people lived in each of these basins and asked HUD to overlay the basin geography on the Census 2000 Block data to develop the estimate.

At the same time, the National Flood Insurance Program provided much-anticipated Advisory Base Flood Elevations (ABFEs). If the ABFEs are adopted by the local governments, a newly constructed home or a repaired home that had sustained more than 50 percent damage would be required to be elevated above the ABFE requirements or not be eligible for flood insurance. The ABFEs depend on the USACE's certifying the levees against a base flood. Without that certification, the ABFEs would be much higher. The ABFEs assume that the certified levees will hold and that any flooding is due to rainfall only, not levee failure.

Exhibit 12

Costs to Certify Levee Systems by Hydraulic Area



Source: U.S. Department of Homeland Security (http://www.dhs.gov/interweb/assetlibrary/GulfCoast_LeveeCosts.pdf)

For areas in a parish located within existing levees, FEMA has determined that "new construction and substantially damaged homes and businesses within a designated FEMA floodplain should be elevated to either the Advisory Base Flood Elevation (BFE)[8] or at least 3 feet above the highest adjacent existing ground elevation at the building site, whichever is higher; and new construction and substantially damaged homes and businesses not located in a designated FEMA floodplain should be elevated at least 3 feet above the highest adjacent existing ground elevation at the building site." (USDHS FEMA, 2006).

BFEs represent how many feet above sea level a home should be elevated to be safe from likely flooding. Regarding BFE, the Office of the Federal Coordinator for Gulf Coast Rebuilding asked a policy question: How many homes would have to be elevated and by how much? To make this estimate required converting the ABFEs and the U.S. Geological Survey topographical maps into vector format, overlaying them on each other and with Census 2000 Block data. The combined data were overlaid with the locations of the homes with severe damage (those that would likely be expected to be elevated because of damage greater than 50 percent). This analysis resulted in the creation of several tables similar to the one in exhibit 13.

Exhibit 13

Severely Damaged Owner-Occupied and Single-Family Renter-Occupied Housing by Parish, Hydraulic Area, and Advisory Base Flood Elevations From Ground Level[a] for Homes in 100-Year Flood Plains or Levee-Protected Areas, April 25, 2006

Parish and Hydraulic Area	2000 Census		Owner-Occupied and Single-Family Rental Units With Severe Damage[b]				
	Total Population	Number of Occupied Housing Units	Number of Units With Severe Damage[c]	Number of Units To Be Elevated 3 Feet	Number of Units To Be Elevated 4 to 6 Feet	Number of Units To Be Elevated More Than 6 Feet	Total Number of Units to be Elevated
Jefferson Parish							
Hydraulic Area A (part)	5,523	2,362	84	39	0	0	39
Hydraulic Area C	106,634	35,609	389	82	127	133	342
Hydraulic Area D (part)	83,515	30,290	169	17	102	29	148
Hydraulic Area K (part)	251,978	105,166	2,549	687	17	1,796	2,500
Damage data not block geocoded			215	0	0	0	0
Outside hydraulic areas	7,816	2,807	151	0	0	0	0
Subtotal	455,466	176,234	3,557	825	246	1,958	3,029

[a] Elevation levels are calculated by subtracting the average NAVD88 (North American Vertical Datum of 1988) ground level elevation from the Advisory Base Flood Elevation (ABFE). If the result is less than 3 feet, the elevation is set at 3 feet per the advisory.

[b] Some of the structures may have been elevated to or above the advisory elevations before the event occurred.

[c] Severe damage is a rough approximation of 50 percent damage. It is based on Individual Assistance inspections or flood depths, not substantial damage data. Local building code officials determine the actual number of units with substantial damage for purposes of the National Flood Insurance Program. Recent data suggest that local officials have designated far fewer homes as more than 50 percent damaged than is shown in this chart.

[d] Orleans Parish requires homes be elevated 18 inches above the road crown. Because of this requirement, homeowners in Orleans Parish, are asked to elevate their homes another 18 inches.

Note: Because some addresses are not geocoded to the block level and determination of elevation requirements is made based on the ABFE and elevation of a census block, it was not possible to estimate the need for elevation.

Exhibit 13

Severely Damaged Owner-Occupied and Single-Family Renter-Occupied Housing by Parish, Hydraulic Area, and Advisory Base Flood Elevations From Ground Level[a] for Homes in 100-Year Flood Plains or Levee-Protected Areas, April 25, 2006 (continued)

Parish and Hydraulic Area	2000 Census		Owner-Occupied and Single-Family Rental Units With Severe Damage[b]				
	Total Population	Number of Occupied Housing Units	Number of Units With Severe Damage[c]	Number of Units To Be Elevated 3 Feet	Number of Units To Be Elevated 4 to 6 Feet	Number of Units To Be Elevated More Than 6 Feet	Total Number of Units to be Elevated
Orleans Parish[d]							
Hydraulic Area A (part)	312,007	127,244	45,615	21,822	18,883	1,878	42,583
Hydraulic Area B	94,820	32,830	17,383	12,436	3,895	16	16,347
Hydraulic Area D (part)	55,635	20,310	126	49	3	0	52
Hydraulic Area E (part)	19,515	6,802	4,569	2,076	104	0	2,180
Hydraulic Area G (part)	1,147	375	13	11	0	0	11
Damage data not block geocoded			1,260	0	0	0	0
Outside hydraulic areas	1,550	690	484	0	0	0	0
Subtotal	484,674	188,251	69,450	36,394	22,885	1,894	61,173
Plaquemines Parish							
Hydraulic Area D (part)	837	313	2	2	0	0	2
Hydraulic Area F	1,812	463	214	149	0	0	149
Hydraulic Area G (part)	9,011	3,087	19	8	0	0	8
Hydraulic Area H	10,457	3,578	1,996	1,863	60	63	1,986
Hydraulic Area J	2,526	827	154	89	18	4	111
Damage data not block geocoded			1,222	0	0	0	0
Outside hydraulic areas	2,114	753	355	288	40	0	328
Subtotal	26,757	9021	3,962	2,399	118	67	2,584
St. Bernard Parish							
Hydraulic Area E (part)	66,092	24,698	11,908	4,425	2,323	457	7,205
Damage data not block geocoded			374	0	0	0	0
Outside hydraulic areas	1,137	425	315	0	0	0	0
Subtotal	67,229	25,123	12,597	4,425	2,323	457	7,205

[a] Elevation levels are calculated by subtracting the average NAVD88 (North American Vertical Datum of 1988) ground level elevation from the Advisory Base Flood Elevation (ABFE). If the result is less than 3 feet, the elevation is set at 3 feet per the advisory.

[b] Some of the structures may have been elevated to or above the advisory elevations before the event occurred.

[c] Severe damage is a rough approximation of 50 percent damage. It is based on Individual Assistance inspections or flood depths, not substantial damage data. Local building code officials determine the actual number of units with substantial damage for purposes of the National Flood Insurance Program. Recent data suggest that local officials have designated far fewer homes as more than 50 percent damaged than is shown in this chart.

[d] Orleans Parish requires homes be elevated 18 inches above the road crown. Because of this requirement, homeowners in Orleans Parish, are asked to elevate their homes another 18 inches.

Note: Because some addresses are not geocoded to the block level and determination of elevation requirements is made based on the ABFE and elevation of a census block, it was not possible to estimate the need for elevation.

Next Steps

Because GIS can link data from multiple sources, it has been a very important tool to inform policymakers and planners on the extent and concentration of housing damage, the cost to repair, and the design of long-term recovery strategies.

GIS should have a continued important role in long-term recovery. HUD is currently exploring the use of GIS technology to help identify problem spots that may be holding back individual neighborhood recovery. For the most affected states—Mississippi and Louisiana—their current housing recovery strategies are demand driven, because they depend on the demand by individuals who require assistance with rebuilding their homes and who apply to the state for assistance that is funded through HUD's CDBG Disaster Recovery assistance.

As recovery progresses, however, it is likely that long-term recovery will have to be considered not only as assistance to individuals but also as assistance to neighborhoods. It is also quite likely that, for some reason, many property owners will not repair their homes. Although home repair is an individual choice, a tendency for property owners not to repair their homes could have serious negative consequences for other proximate property owners who do wish to repair their homes. The challenge will be identifying those properties where no effort is being taken to repair damage and determining a strategy to return those properties to productive use so they are not a nuisance for neighboring properties.

The Office of Policy Development and Research is exploring whether it would be possible to link the FEMA damage inspection data by address to local parcel data in order to more accurately pinpoint the location of the damaged properties. After locating the properties, PD&R would set up a mapping system that could be linked to data on loans and grants provided for home repairs, and local data on building permits so local officials could track neighborhood recovery.

The idea is for local officials to look at a block and quickly see for each home that was damaged, which homes are under repair (using local permit data), and from this know which properties have no activity. For those with no activity, officials could see if a grant or loan was provided. If not, the state or local government could proactively seek out the property owner and find out what his or her plans are for that property. The state or local government could then use a variety of tools to determine what is preventing that property from being returned to productive use.

Conclusions

Disasters do not comply with traditional geographic boundaries. GIS permits policymakers and planners to overlay the impacted areas of a disaster over existing data sources to estimate the impact of a disaster and judge to what extent federal and local resources might be required to facilitate long-term recovery. GIS also permits policymakers to test the costs and benefits of policy options. With the aftermath of Hurricanes Katrina, Rita, and Wilma, HUD used GIS more extensively than it had for any previous disaster to calculate risk of housing damage to HUD-assisted and HUD-insured housing and to estimate actual damage to all housing in the affected states. This analysis was critical for making decisions about how many resources for long-term recovery to use and where to target them. The analysis has also been critical for local officials in their design of programs that address their long-term recovery needs.

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Notes

1. Later comparison of the American Red Cross's October 2005 estimates with direct inspection data by the Federal Emergency Management Agency (which was not available until several months later) shows the Red Cross estimates of housing units damaged to be reasonably reliable, at least for doing initial recovery planning.
2. See http://www.dhs.gov/xlibrary/assets/GulfCoast_HousingDamageEstimates_021206.pdf.
3. Note that this map was based on preliminary disaster designations made by FEMA; the final designations are somewhat different.
4. For example, in 1997, Congress was motivated by the damage caused by floods in the upper Midwest and Hurricane Fran to appropriate $500 million toward disaster recovery of individual communities impacted by any disaster that had occurred in the prior 13 months. The U.S. Department of Housing and Urban Development (HUD) made 110 grants using a formula. In 2004, motivated by the four hurricanes striking Florida and affecting dozens of other states, Congress appropriated $150 million to address disasters that had affected any states in the prior fiscal year. As a result of these funding appropriations, HUD made 10 grants.
5. The data reflected only occupants of housing units eligible for Federal Emergency Management Agency housing assistance. As such, the data do not reflect other types of damaged housing units, such as predisaster vacant units and summer homes or second homes.
6. These assumptions of damage were most often made for homes in Orleans, St. Bernard, and Jefferson Parishes in Louisiana. A smaller number of homes in Mississippi were assumed destroyed based on their proximity to the storm surge.

7. See http://www.huduser.org/publications/pdf/GulfCoast_HsngDmgEst.pdf.
8. An Advisory Base Flood Elevation is not required. Local officials must adopt the advisory elevations before they become the official Base Flood Elevations under which the National Flood Insurance Program will issue flood insurance.

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