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R E P O R T



The Repopulation of New Orleans After Hurricane Katrina

Kevin McCarthy, D.J. Peterson, Narayan Sastry,
Michael Pollard



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PREFACE

What the future size and composition of the population of New Orleans will be in the aftermath of Hurricane Katrina is a topic of intense interest and discussion among current and displaced residents of the city; among policymakers in the City of New Orleans, the State of Louisiana, and the federal government; and within the general public. This report presents population estimates for New Orleans three months, six months, one year, and three years after Hurricane Katrina.

This report was prepared after consultation with New Orleans leaders in the aftermath of Hurricane Katrina and was done specifically to support the efforts of the Bring New Orleans Back Commission. Projections of the future population of New Orleans are essential to the work of the Commission's subcommittees for planning, infrastructure, and sustainability.

The work for this report was carried out between late November 2005 and early January 2006 and reflects the situation in New Orleans through that time. Changes and further developments in the situation since then are not reflected in this report.

The study was conducted through the RAND Labor and Population Program, which examines issues involving U.S. labor markets, the demographics of families and children, social welfare policy, the social and economic functioning of the elderly, and economic and social change in developing countries. This report is being released jointly by the Labor and Population Program and the RAND Gulf States Policy Institute. The research results from the RAND Corporation's continuing program of self-initiated research. Support for such research is provided, in part, by donors and by the independent research and development provisions of RAND's contracts for the operation of its U.S. Department of Defense federally funded research and development centers.

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SUMMARY

INTRODUCTION

Hurricane Katrina struck New Orleans, Louisiana, on August 29, 2005. The city suffered moderate damage from the hurricane, but substantially more harm from extensive flooding caused by breaks in several levees. Thousands of residents had fled the city in advance of the hurricane, and virtually all of the remaining residents were evacuated in the week following the hurricane. The city's population, estimated at 485,000 in 2000, was reduced to fewer than several thousand by the end of the first week of September 2005.

In November 2005, RAND was asked by New Orleans city leaders to estimate the repopulation of the city in the aftermath of Hurricane Katrina. The Bring New Orleans Back Commission needed estimates of the city's population in the immediate future (the next three to six months) and the near-term future (the next one to three years) to guide the redevelopment planning process. The study, completed in early January 2006, draws on the best available information at the time and documents extensively and in detail the methodology and assumptions used. Nevertheless, it was constrained by the urgent need for results, by limited data availability, and by the considerable uncertainty that surrounded the entire post-Katrina situation in New Orleans and the region.

APPROACH

Our estimates are guided by a conceptual framework based on the costs and benefits of migration and on the role of social networks and physical constraints. Damage to housing currently appears to be the most significant obstacle to repopulation, and the key assumption of our population estimates is that the rate of repair or reconstruction for flood-damaged dwellings will be the major determinant of the future population of New Orleans. There are likely to be substantial differences in housing habitability and the amount of time required to return damaged dwellings to a habitable state according to the depth and duration of flooding and characteristics of the dwelling. Other factors likely to shape the repopulation of New Orleans include the provision of basic services and infrastructure, storm protection and flood control, employment, schools and colleges, and social networks.

Given the determination that housing habitability is the key driver of the future population of New Orleans, we developed an equation that yields estimates of the future population of New Orleans for four points in time based on estimates of housing habitability. Those estimates are the product of the two terms in that equation: (1) an estimate of the pre-Katrina population by the condition of its housing *after* Katrina, organized into the four damage categories; and (2) an estimate of future repopulation rates for the four damage categories at the four points in time.

RESULTS

Pre-Katrina Population Estimates Based on Post-Katrina Housing Habitability

We assumed that flood damage to housing was directly related to the depth of the floodwater. We first classified all dwellings in New Orleans according to the extent of the damage they sustained based on the maximum depth of floodwater. Data on dwellings and population by block, for each of the 10,181 census blocks in New Orleans, was obtained from the 2000 Census. Blocks were classified into four categories based on floodwater depth: no flooding (no housing damage), less than 2 feet (minor damage), 2–4 feet (serious damage), and more than 4 feet (severe damage).

We calculated that approximately 25 percent of the pre-Katrina population of New Orleans was not exposed to flooding and their housing likely suffered little or no floodwater damage, while about 55 percent of the population experienced more than four feet of flooding, and their housing likely suffered severe damage.

Estimates of Repopulation Rates

We then estimated repopulation rates for each of the four flood/damage categories for four periods: three months post-flood (December 2005), six months post-flood (March 2006), one year post-flood (September 2006), and three years post-flood (September 2008).

A quantitative approach to estimating the repopulation rates was impossible because of the extremely limited data available on evacuees' current locations and circumstances and on the number and characteristics of current residents of New Orleans, and because of the lack of parallel past events that could be used to derive these rates. We determined that a qualitative approach to estimating the repopulation rates, based on a consensus process, was the best choice given the constraints we faced—in particular, given the short amount of time we had to produce estimates. As part of the consensus process, the authors of this report jointly agreed on a set of repopulation estimates after conducting a review and discussion of the available evidence and in consultation with various experts.

We gathered and used a wide array of primary and secondary information to develop our repopulation estimates, including media reports of the circumstances in, and recovery of, New Orleans; data gathered by local, state, and federal officials; post-Katrina data assembled and analyzed by organizations such as the Brookings Institution and the Urban Land Institute; telephone interviews with professionals in areas such as insurance, planning, architecture, building and inspections, real estate, business development, employment, and demography; and on-the-ground assessments of the recovery in New Orleans.

The repopulation rates arrived at through the consensus process are based on the flood-depth/housing-damage category and change by period, reflecting our assumptions that housing habitability will increase across all flooding and damage categories over time. Although our estimated

repopulation rates in the serious and severe damage categories also rise over time, the rate of increase is much slower and the repopulation rates substantially lower.

Estimates of the Future Population of New Orleans

Based on the pre-Katrina population and the estimated repopulation rates, the population of New Orleans in December 2005 was approximately 91,000. This figure is expected to rise rapidly to about 155,000 by March 2006, as basic repairs and stabilization of housing are completed, public services and infrastructure are restored, and schools and universities reopen. Subsequently, repopulation starts tapering off: One year after the storm, in September 2006, we estimate a population of about 198,000. Three years post-Katrina, we estimate that the New Orleans population will reach about 272,000—about 56 percent of the pre-Katrina population.

Spatial patterns of repopulation for New Orleans based on our results show that the population returning to the city in aftermath of Hurricane Katrina is initially concentrated in the high-elevation areas on either bank of the Mississippi River. Repopulation of other parts of the city proceeds very slowly, and even by September 2008 the density of population in Lakeview, Gentilly, and New Orleans East neighborhoods is far below what it was prior to Katrina.

Sensitivity Analyses

We conducted limited sensitivity analyses to examine how changing various assumptions would alter our population estimates. The most significant finding is that the estimates of the future New Orleans population for the near term are substantially more sensitive in relative terms—though not in absolute terms—to our assumptions than are the estimates for the more distant future. The sensitivity analyses also make it clear that the rate of progress in reconstructing the most severely flood-damaged areas of New Orleans will set the pace of repopulation of the city and will also determine, to a large extent, the city's total population in three years' time. The sensitivity analyses also point to the considerable uncertainty that surrounds our estimates of the future population of New Orleans and the entire repopulation process.

CONCLUSIONS AND NEXT STEPS

Our conceptual framework and analysis suggest that an important role for policymakers in shaping the repopulation process in New Orleans is to minimize the uncertainty faced by residents and businesses. Speeding up the reconstruction process would be an important way to achieve this reduction in uncertainty. This could be achieved by streamlining the process for obtaining permits to repair or to demolish and reconstruct housing in the city. Providing clearer and more comprehensive information about progress and the ultimate goals for restoring the levee system, reconstructing schools, hospitals, libraries, and other facilities, and the provision of public services such as public transportation and public safety may also increase the likelihood of former residents and new residents moving to the city.

As future research, the best way to understand how the repopulation process is unfolding in New Orleans is to collect better data on evacuees and current residents and to collect such data at regular intervals. Accurate population estimates from surveys would be perhaps the best gauge of how well the recovery process in New Orleans is proceeding. Detailed demographic data are also needed to plan public services, such as schooling and public safety. Nongovernmental and private-sector entities also need accurate data to assure proper provision of health care, services, and infrastructure.

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ABBREVIATIONS

BLS	Bureau of Labor Statistics
EOC	Emergency Operations Center
FEMA	Federal Emergency Management Agency
GIS	geographic information system

CHAPTER ONE INTRODUCTION

BACKGROUND

Hurricane Katrina struck New Orleans, Louisiana, on the morning of August 29, 2005. Although thousands of residents had fled the city in advance of the hurricane, following the mayor's order for a mandatory evacuation, many thousands of residents remained behind, either in their own homes or in one of the available hurricane shelters. The city suffered moderate damage from the hurricane itself, but substantially more damage from extensive flooding caused by breaks in several levees. In the week following the hurricane, virtually all the remaining residents were evacuated from the city. New Orleans, which had an estimated total population of 485,000 in 2000,¹ had been reduced to a city of fewer than several thousand people by the end of the first week of September 2005.²

In the subsequent weeks, the levee breaches were closed and water was drained from New Orleans. At the end of September 2005, the city began to allow former residents to return. Initially, only residents of areas that were not flooded were allowed to return. However, as water was pumped out of the flooded areas and basic services and infrastructure were restored, residents from more of the affected areas were allowed to return. Still, the depth of the floodwaters and the duration of flooding meant that most housing in the flooded areas suffered substantial damage and, for the most part, was not habitable.

One of the key questions facing policymakers is what the repopulation of New Orleans will look like and at what rate it will occur. Answering that question requires understanding myriad factors. There is the question of how extensive the damage to housing is. In addition, many evacuated residents quickly settled in other locations and found new jobs and enrolled their children in local schools. For these families, the decision to return to New Orleans involves more than just making a commitment to repairing or replacing a damaged house—it involves assessing the vitality of their former neighborhoods, the availability of schools and other local services and infrastructure, the rate at which businesses are reopening, and whether their jobs are likely to return.

¹U.S. Census Bureau (2001). The Census Bureau estimated that the population in New Orleans declined by about 20,000 between 2000 and 2004.

²In this document, we use the terms "City of New Orleans" and "New Orleans" interchangeably. Note that the incorporated limits of the City of New Orleans correspond precisely with the boundaries of Orleans Parish. The population of the City of New Orleans comprises almost half of the total population of 1,338,000 of the New Orleans-Metairie-Kenner Metropolitan Statistical Area. Furthermore, the City of New Orleans was the part of the metropolitan area hardest hit by Hurricane Katrina and flooding in its aftermath.

OBJECTIVES

The goal of this study is to estimate the future population of New Orleans.³ RAND was asked by city leaders of New Orleans to develop estimates of the repopulation of the city in the aftermath of Hurricane Katrina. This work was undertaken specifically to support the efforts of the Bring New Orleans Back Commission, which was established by New Orleans Mayor Ray Nagin. The Commission was faced with pressing decisions about the city's plan for recovery from Katrina and needed population estimates to inform its decisionmaking. In particular, having estimates of the future population of New Orleans in the immediate future (the next three to six months) and the near-term future (the next one to three years) is critical to the work of the Commission's subcommittees on planning, infrastructure, and sustainability and in guiding the city's redevelopment process.

Because the time frame for the effort was very constrained—work started in late November 2005 and concluded in early January 2006—we developed the population estimates in this report as quickly and as thoroughly as possible. Our report draws on the best available information at the time, and documents extensively and in detail the methodology and assumptions used. Nevertheless, it was constrained by the urgent need for results, by limited data availability, and by the considerable uncertainty that surrounded the entire post-Katrina situation in New Orleans and the region.

More specifically, although we know much about the characteristics of New Orleans residents prior to Hurricane Katrina, there has been very little systematic data collected on evacuees.⁴ Thus, we know little about evacuees' current locations and circumstances or about their characteristics, information that is essential for deriving the likelihood of their returning to the city.⁵ In addition, only limited data are available on the current population of New Orleans, including newcomers,⁶ and these data may not be reliable. Finally, there is little historical precedent on which to base estimates of the return of evacuees following a

³Traditionally, demographers distinguish between population estimates and projections. Population estimates refer to the current population and population projections apply to future populations. In this report, we use these two terms interchangeably. For a discussion of these terms see Shryock, Siegel, and Larmon (1973).

⁴The Federal Emergency Management Agency and the U.S. Postal Service both have assembled data on evacuees, but these data have not been released. The Gallup Organization conducted a small survey about one month after Hurricane Katrina among a sample of adults who applied to the American Red Cross for aid. For an analysis of the Gallup data, see Elliott and Pais (forthcoming).

⁵Data from evacuees about their *intentions* to return to their former homes have been collected in surveys, but are likely to be of limited use in predicting whether or not someone will move back. This is because people's attitudes unfold over time and are shaped not just by their intentions but also by competing opportunities, by various constraints, and by family and social dynamics—all of which also change with time. It is thus much more useful to base return probabilities on underlying social, demographic, and economic characteristics.

⁶The New Orleans Emergency Operations Center has conducted a series of rapid household surveys of current population of the city. We discuss some of their findings later in this report.

major, prolonged natural disaster. Together, these caveats mean that considerable uncertainty surrounds our estimates of the future population of New Orleans. We discuss these caveats throughout the report and return to them again in the final section.

ORGANIZATION OF THIS DOCUMENT

The report is organized as follows. The overall approach is outlined in Chapter Two, which considers the various factors shaping the decisions of former residents to return to New Orleans and of new residents to move to the city from elsewhere and how that informs our future population estimates. In Chapter Three, we describe the specific methods used to estimate the future population and present our results for the estimated population of New Orleans three months, six months, one year, and three years after Hurricane Katrina struck. These periods were chosen to correspond to what we believe will be the three major stages in the recovery and return process. The first stage (in the first six months following the storm) corresponds to the immediate recovery, during which individuals whose homes remained habitable decide to return to the city. The second stage (six months to one year after the storm) corresponds to the period in which individuals whose homes require minor repairs decide to return. The third stage (between one and three years after the storm) corresponds to the period in which individuals whose homes were seriously and severely damaged make the decision to undergo the reconstruction process and return to the city. We expect that the factors determining migration decisions at each of these stages will differ. The chapter also includes a discussion of the data and supporting information that shaped the estimates. In the final chapter, we summarize the results, discuss their implications, and provide an outline of essential follow-up research that is needed for obtaining more accurate and precise estimates of the future population of New Orleans.

CHAPTER TWO APPROACH TO THE PROBLEM

In this chapter, we describe our approach to estimating the future population of New Orleans. Following a discussion of a key definition of population size, we discuss the conceptual framework that guided our analysis. This framework describes the various factors that are expected to shape the population of New Orleans and the interrelationships among these factors. The framework, in turn, was used to motivate our estimation approach.

THE DEFINITION OF POPULATION SIZE

An important definition for this study concerns how people are classified according to their place of residence. The precise definition of “place of residence” that is chosen will shape the estimates of current and future population for the City of New Orleans.

The standard definition used by the U.S. Census Bureau is to classify a person as a resident of a particular place if that is where the person lives and sleeps “most of the time” (U.S. Census Bureau, 2002). A person’s place of residence may not be the same as the person’s legal residence or voting residence. The Census classifies people who are displaced because of a destroyed or damaged residence caused by a natural disaster as residing at that location. In other words, a person’s destroyed or damaged residence is considered by the Census Bureau to be his or her “usual residence.”

In this study, we use an alternative definition of residence. We consider people to be residents of New Orleans only if they are living and sleeping in the city most of the time. That is, we exclude people who are displaced from the city because their residences were damaged or destroyed. Like the Census Bureau, we do not specify precisely what “most of the time” means. However, we do exclude people who are in the city only during the day or only during the weekend, or those who are visiting the city but who have a usual place of residence elsewhere (even if they are pre-Katrina residents of the city).

CONCEPTUAL FRAMEWORK

Our conceptual framework merges the two main conceptual approaches that guide research on human migration, both of which are applicable to this study. The first approach is based largely on neoclassical economics (Sjaastad, 1962; Lee, 1966), and specifies that an individual (in this case, an evacuee from New Orleans) chooses to move (in this case, chooses to move back to the city) if the benefits from the move outweigh the costs. Individuals evaluate the current and future costs and benefits of moving, which typically differ by individual characteristics, such as age, sex, marital status, number of children, employment, occupation, and previous migration experience (Greenwood, 1975, 1985; Long 1992).

The second approach is based on new economics of migration and social network theory (Stark and Bloom, 1985), and suggests that people do not act on their own in evaluating costs and benefits from a move. Rather, they act collectively, with their decisions shaped by their family networks, ties with friends, neighbors, and co-workers, and characteristics of communities. Strong social network ties at a particular destination increase the likelihood that an individual will move there. Social networks affect migration decisions by demonstrating the feasibility of a move, providing information and resources that increase the expected benefits, and reducing the costs and uncertainty associated with a move (Massey, 1990; Stark, 1991; Taylor, 1986). A key insight from the social-network approach for studying migration is that the benefits from networks may be cumulative. That is, positive experiences may accumulate over time, as migrants who have had a successful experience share this information with others who are part of their social networks, which, in turn, further reduces costs and increases benefits from the move. Of course, the cumulative experience does not have to be positive—it may instead be negative and discourage further migration.

APPLYING THE CONCEPTUAL FRAMEWORK

We next apply the conceptual framework to estimating the future population of New Orleans. Our discussion of the factors shaping the repopulation of New Orleans considers the costs and benefits, as well as the role of social networks. The decision for evacuees about whether to return to New Orleans is a migration decision, and it is this decision that will largely determine the future population of the city. However, the future population of New Orleans will also be shaped by migration to the city of people who did not reside in the city when Katrina struck, but who moved to the city subsequently. New migrants will be influenced by a similar, though not identical, set of factors.

Factors Shaping the Decision to Move to New Orleans

The decision of evacuees from New Orleans about whether or not to return to the city depends on the costs and benefits associated with the move home. The main factors that are likely to shape these costs and benefits are housing, the provision of basic services and infrastructure, storm protection and flood control, employment, schools and colleges, and social networks—in particular, the decisions by family, friends, neighbors, and co-workers about whether to return to the city.⁷ We discuss each of these factors in turn.

Housing. In our judgment, housing availability is the factor that most limits the repopulation of New Orleans. Flood damage to housing was pervasive and widespread in the city, with only a few areas of

⁷Other factors that may play a role—but are likely to be less salient for most evacuees—include the availability of services and amenities such as stores, restaurants, and entertainment, and health care providers and hospitals.

higher ground escaping. There are likely to be substantial differences in housing habitability according to the depth and duration of flooding and characteristics of the dwelling. For example, raised houses and two-story houses were likely to face less flood damage, especially if the flood duration was short.

The rehabilitation of damaged housing is a long, slow, and expensive process that involves many steps, including gutting the dwelling of all flood-damaged material and furnishings, clearing away debris, remediating any environmental contamination, obtaining an insurance settlement, hiring a contractor and skilled tradespeople (e.g., electricians, plumbers, roofers) and finding necessary building supplies and equipment, obtaining flood insurance and loans or grants for reconstruction, and obtaining planning approval for repairs or demolition and reconstruction. There are likely delays at each step of the process, because of, for example, a shortage of construction workers (who themselves have no place to live), understaffing of the planning department, shortages of construction materials, and the huge backlog of properties needing inspection for insurance settlements. The availability of habitable housing in New Orleans is likely to be shaped considerably by the city's willingness and ability to fund adequately and manage appropriately the building permit and inspection process. The city's decisions will, in particular, shape the costs borne by individual homeowners and, ultimately, these costs may affect the repopulation rate.

Housing is likely to be the main impediment to the rapid return of former residents who want to move back to the city, because of the scale and scope of the damage to housing throughout New Orleans, the extensive demolition, repairs, and reconstruction that is required, and the likely slow pace of progress. Although temporary housing, such as trailers, may provide an interim solution for some people, they are unlikely to be a panacea for the overall housing problem that New Orleans faces.

A final consequence of the damage to dwellings in New Orleans is that reconstructed housing is likely to be substantially more expensive than housing of the equivalent size, quality, and location was in the past. This implies that fewer low-wage and nonworking people will live in New Orleans.

Provision of Basic Services and Infrastructure. Essential basic services include police and fire protection and emergency medical care; basic infrastructure includes passable roads, piped water and sanitation, electricity, gas, trash collection, telecommunications, and public transportation. The provision of these basic services and infrastructure is crucial for allowing most residents to return and to live in the city.⁸ Service levels are gradually being restored throughout much of New Orleans, with the exception of some of the areas hardest hit by flooding.⁹ Over the longer term, it is not yet clear what level of public services will

⁸More than 25 percent of the population did not have a car in their household and thus relied on the bus system for transportation for traveling to work, shopping, or school. As of December 7, 2005, only 10 percent of the New Orleans bus system was back in service (Katz, Fellowes, and Holmes, 2005).

⁹As of January 3, 2006, three-quarters of customers in New Orleans had access to electric power and gas in their neighborhoods (City of New Orleans, undated).

be available in various parts of the city, and proposals have been put forth to limit service provision in some areas to discourage redevelopment there.¹⁰ Uncertainty about services and infrastructure, therefore, is likely to impact some evacuees' decisions to return to the city, at least during the immediate and short-term recovery stages.

Storm Protection and Flood Control. The levee breaches that caused New Orleans to flood have now been closed, and the levees are expected to be restored initially to provide pre-Katrina levels of protection for the city. Whether the levees will be upgraded to provide protection against stronger storms than those for which the current system is designed is currently an open question. However, the high cost of providing protection against a category-four or -five hurricane—and the considerable time required for upgrading the levees—means that this is unlikely to happen any time in the near future.

Then again, residents of New Orleans probably understand well that the levees failed to meet their design specifications and that a commitment to upgrade the levees to meet their *original* specifications may be more important than upgrading the levees to protect against stronger storms. Furthermore, there may be more cost-effective alternatives for improving flood protection for New Orleans. One example is to construct secondary levees that divide the city, so that a single breach can be contained and does not flood the entire city. Another example is to close the canals that penetrate deep into the city and that increase its exposure to levee failures, and shift the pumping stations to where these canals meet Lake Pontchartrain.¹¹

Employment. The decision of evacuees from New Orleans about whether to return to the city is likely to be strongly influenced by employment. Employment levels are most likely to rebound for the industries in which New Orleans has a strong comparative advantage, including tourism, higher education, energy, and shipping—with employment prospects in the construction industry being particularly bright in the short and medium term. On the other hand, employment in industries that provide services to the local population are likely to lag if the rate of return to the city of former residents is slow. Overall, little is known about the extent of flood damage to local businesses and the effects of this flood damage on businesses reopening and future employment levels.

Businesses in areas least affected by flooding have started to reopen, but many are currently facing a shortage of workers, largely because few workers have a place to live in the city. In response, some employers, such as large hotels, have provided housing to employees. Other workers are commuting to New Orleans from the suburbs or from cities further away, such as Baton Rouge. In the short term, this weakens the tie between employment levels and the total population. However, workers appear to be sharing habitable dwellings at higher rates than in the past (New Orleans Emergency Operations Center,

¹⁰Various scenarios are noted by Russell and Donze (2005).

¹¹Canals that penetrate the city include the London Avenue Canal and the 17th Street Canal, both of which failed during Hurricane Katrina. The Mississippi River Gulf Outlet also has been blamed for channeling the storm surge into the city.

2005); at the same time, this means that there is less likelihood that nonworking spouses, seniors, or children will be living in the home.

In the longer term, the expected higher costs for flood insurance, labor, and reconstruction mean that employment is likely to decline in two ways. First, there is likely to be a relocation of businesses with a national or regional market for whom being in New Orleans is not essential. Second, fewer businesses will be needed to support a smaller population in the city. Even for businesses remaining in the city, employment is likely to be lower because of higher wage rates. Another effect of the higher costs for businesses in New Orleans is that these costs will be passed along to consumers; not only will housing be more expensive, but so, too, will many services and goods for local residents. This will also make it more difficult for poor and nonworking people to remain in the city.

Schools and Colleges. Very few local schools and colleges were operating in the months after Katrina struck, but several schools and colleges, such as Tulane University, Xavier University, and Loyola University, planned to open in January 2006. Most school-aged children who evacuated from New Orleans enrolled in local schools elsewhere. Many parents apparently plan to keep their children enrolled in these schools—at least until the end of the current school year—which has reduced the demand for local schools in New Orleans to reopen quickly.¹²

Public schools in New Orleans faced many challenges prior to Katrina, and after the storm, the public school system was liquidated and reorganized. This is likely to slow the reopening of public schools.¹³ Some schools plan to reopen for the new school year in the fall of 2006, which will probably coincide with the return of many families with school-aged children. Then again, parents who enrolled their children in schools where they evacuated often found the new schools to have better discipline and instruction. They may be reluctant to return their children to New Orleans' troubled schools, which may affect their likelihood of settling outside the city or remaining in the areas where they evacuated.

Social Networks. The conceptual framework described previously indicates that the decision for each individual or family about whether to relocate back to New Orleans will not be made independently on the basis of the costs and benefits that they themselves expect from the move. Rather, decisions are likely to be strongly shaped by what friends, co-workers, family members, and neighbors decide to do. Information about positive experiences of individuals and families that return early will be shared with

¹²Only 4,000 students were expected to be enrolled in New Orleans public schools in January 2006. Public school enrollment prior to the storm was 60,000. Enrollment in the city's Catholic schools was estimated at 12,000–13,000 in January 2006, compared with a pre-Katrina level of roughly 18,000 (Russell, 2006).

¹³Of 118 public schools operating prior to Hurricane Katrina, only two New Orleans public schools (Benjamin Franklin Elementary School and McMain Senior High School) and 15 charter schools were approved for operations in January 2006. Several more schools have been approved to open in August 2006 (City of New Orleans, 2006).

people in their social networks, increasing the likelihood that others will return. Conversely, if early returnees experience a difficult time and find that few members of their social network have committed to return to the city, the overall effect will be to reduce the likelihood of others returning and may make it more likely that the returnees decide to leave the city again, this time for good.

Interdependencies. The process of rebuilding New Orleans is not linear in nature and is not comprised of independent processes. Rather, there are substantial interactions and interdependencies among the different factors described previously; furthermore, there is the possibility of negative, deleterious cycles or positive, virtuous cycles.

As an example of a negative, deleterious cycle, delays or shortfalls in a single area, such as federal funding for repairing or upgrading the levies, underwriting flood insurance, and subsidizing reconstruction, could result in delays in businesses reopening, which would lead to fewer workers and their families returning to the city; this lower rate of return, in turn, may justify still lower levels of federal investment, which starts a new round of the cycle. The net result would be substantially lower rates of population return than might otherwise be expected.

As an example of a positive, virtuous cycle, the faster that people move back to the city, the quicker services and infrastructure, employment, and schools will be restored. This would, in turn, make the city a more attractive place for displaced residents who would consequently be more likely to return. Thus, positive feedback effects are also possible. The presence of these interdependencies and feedback effects makes it important that policy decisions at all levels are made quickly and correctly.

Our Approach to Estimating the Future Population of New Orleans

Based on the conceptual framework outlined previously and available evidence on the various factors shaping the decision to move to New Orleans, we hypothesized that the availability of housing was likely to be the most critical constraint shaping the pace of repopulation for New Orleans in the wake of Hurricane Katrina. In particular, our population estimates are based on the key assumption that the rate of repair or reconstruction for flood-damaged dwellings will be the major determinant of the future population of New Orleans. The amount of work required to return damaged dwellings to a habitable state, it was further assumed, would be principally determined by the amount of flood damage that was sustained and by the amount of repairs and the time it would take to complete them.

Given this, we assumed that flood damage to housing was directly related to the depth of the floodwater. Our first step was thus to classify all dwellings in New Orleans according to the depth of the floodwater and hence the extent of the damage they sustained. Table 2.1 shows the four categories we used to describe the damage to dwellings. In Chapter Three, we provide more detail on how and why we derived these four categories.

Table 2.1
Categories for Floodwater Depth and Housing Damage

Flood-Depth/Housing-Damage Category	Mean Depth of Floodwater	Housing Damage
1	No flooding	None
2	< 2 feet	Minor
3	2–4 feet	Serious
4	> 4 feet	Severe

Based on the distribution of the total population from the 2000 Census across the four flood/damage categories shown in Table 2.1, we estimated the future population of New Orleans by applying various repopulation rates to the following periods: three months post-flood (December 2005), six months post-flood (March 2006), one year post-flood (September 2006), and three years post-flood (September 2008).

We assumed that the population in areas of flood damage category i at time period t , P_{it} , is related to the initial pre-Katrina population, P_{i0} , according to the following model:

$$P_{it} = P_{i0} \times R_{it}, \quad (1)$$

where R_{it} represents the repopulation rate or the fraction of the base population that lives in areas of flood damage category i at time t . The selection of the repopulation rates was based on the following principles: First, the rates cannot be negative ($R_{it} \geq 0$); second, there is some unspecified upper bound that R_{it} cannot exceed; third, the repopulation rate increases monotonically over time ($R_{it} \geq R_{i(t-1)}$); and finally, the change in population rates ($R'_{it} = R_{it} - R_{i(t-1)}$) is a parameter of interest that was examined separately and in conjunction with the repopulation rates.

The challenge of using this model—or any other similar model—to estimate the repopulation of New Orleans in the aftermath of Hurricane Katrina is in obtaining reasonable estimates of the repopulation rates, R_{it} . The range of possible approaches to estimating the repopulation rates is greatly constrained by the fact there are extremely limited data available on evacuees' current location and circumstance and on the number and characteristics of current residents of New Orleans.¹⁴ Furthermore, there are few, if any, parallel events from the past that could be used to derive these rates. As a consequence, it is difficult or impossible to use a quantitative approach to estimate the repopulation rates. The alternative in these circumstances is to use a qualitative approach. We discuss the qualitative approach we took, along with all the key assumptions underlying it, in Chapter Three, when we present the results of that approach.

¹⁴In analyzing the demographic effects of other natural disasters—such as Hurricane Andrew, which struck Florida in 1992—researchers have fielded new population surveys, after concluding that virtually all other data sources have significant shortcomings (Smith, 1996; Smith and McCarty, 1996).

CHAPTER THREE

ESTIMATES OF THE FUTURE POPULATION OF NEW ORLEANS

The culmination of the approach presented in Chapter Two is an equation that yields estimates of the future population of New Orleans for four points in time based on estimates of housing habitability. Those estimates are the product of the two terms in Equation 1: (a) an estimate of the pre-Katrina population by the condition of its housing *after* Katrina, organized into the four damage categories; and (b) an estimate of future repopulation rates for the four damage categories at the four points in time.

In this chapter, we present our results for the estimates of the future population of New Orleans, preceded by our results for the two terms of the equation that yield those estimates. We also explain how we arrived at those results. Finally, we present the results of some limited sensitivity analyses.

PRE-KATRINA POPULATION ESTIMATES ORGANIZED BY POST-KATRINA HOUSING HABITABILITY

The Approach

Housing in New Orleans suffered two kinds of assault from Hurricane Katrina: wind damage and flood damage. Given the extensive flooding, most housing damage was caused by flooding of brackish water that poured through broken levees or surged over them (Bachman, 2005). Accordingly, we assumed that the habitability of a housing unit was determined first by the amount of flood damage it received, and second by the likely pace of repair and rebuilding.

As discussed briefly in Chapter Two, we divided New Orleans into four categories of flood damage. Here, we discuss those categories in more detail:

1. **No Damage:** Housing in this category largely suffered from wind damage, such as leaking roofs, broken windows, and fallen trees. We assumed that most of these structures could feasibly be stabilized (e.g., with blue tarps) or repaired and lived in almost immediately. Such dwellings were clustered along the natural levee of the Mississippi in the Garden District, French Quarter, and in Algiers. These areas also were among the first to have water and power restored and among the first to see local businesses and services reopen—making these neighborhoods the most attractive for early repopulation.¹⁵
2. **Minor Damage:** Housing located in areas with less than 2 feet of flooding was considered to have minor damage. If the house was elevated on some form of foundation or slab and remained above the peak flood stage, it might not have suffered from any flood damage at

¹⁵This hypothesis is supported by the findings of the New Orleans Emergency Operations Center (2005).

all. If flooding did occur, we assumed that the owner would have to hire craftspeople to do discrete repair work and to get the work inspected and approved by the city. Reestablishing an electric power hookup might also require an inspection. According to our calculations, about 63,000 households out of a total of 188,000 households (34 percent) were subject to flood levels of less than 2 feet or were not in areas that flooded at all.¹⁶

3. **Serious Damage:** Housing units in locations with 2–4 feet of standing water were considered to have suffered serious damage. We assumed that on the ground floor the brackish water would have irreparably damaged floors and the lower portion of interior walls; electrical, heating, and central air conditioning systems; large appliances; and furniture. Walls with insulation would have to be opened up and dried out over a period of time. We assumed that structures in this category suffered damage equal to 51 percent or more of their value.¹⁷ According to National Flood Insurance Program guidelines (the so-called “50-Percent Rule”), upon repair, such structures must be raised above the FEMA Base Flood Elevation for that location. Accordingly, we assumed that the owner would have to hire a contractor to manage repair and reconstruction work and the owner would have to obtain building permits and get the work inspected and approved by the city. According to our calculations, about 31,500 households (almost 15 percent of the total) were subject to serious flooding.
4. **Severe Damage:** Houses in locations with more than 4 feet of flooding were assumed to have severe structural and integrity damage.¹⁸ In the worst case, this classification includes structures that were moved off their foundations. We assumed that the owner would have to hire a contractor to manage partial or complete demolition and reconstruction or rebuilding

¹⁶Of 215,091 housing units, a total of 26,840 (12 percent) were vacant. Housing vacancy rates were higher in blocks with no damage (16 percent, or 9,695 vacant households out of a total of 62,413 households), minor damage (15 percent, or 1,194 out of 12,448), and serious damage (15 percent, or 4,601 out of 31,499). In contrast, vacancy rates were under 10 percent (10,630 vacant households out of a total of 108,731 households) in areas with severe damage.

¹⁷This hypothesis is consistent with the large number of structures inspected and found to have partial structural damage (i.e., yellow-tagged) by the U.S. Army Corps of Engineers and Shaw Group (final inspections data cited by the Emergency Operations Center, 2005).

¹⁸According to the U.S. Army Corps of Engineers, flooding of more than three feet typically produces severe structural or integrity damage (Pace, 1988). However, there is disagreement on this point by some local engineers and architects, who report that historical evidence and current core samples indicate no structural damage to wood soaked by water for prolonged periods (discussion at forum on “Building Solutions: Hurricanes Hugo and Katrina,” 2005; panelists included Richard Gruber, Director, Ogden Museum; David Houston, Chief Curator, Ogden Museum; Errol Barron, Barron and Toups Architects, New Orleans; Reed Kroloff, Dean, Tulane University School of Architecture; and Ray Huff, Huff+Gooden Architects, LLC, South Carolina).

and that the owner would have to obtain permits and have the work inspected and approved by the city. We also assumed that structures in this category, if repaired, would have to be raised above the base flood elevation. Given the intensity and extent of damage in severely flooded neighborhoods, we assumed that they would be the last to undergo initial clearing of debris and restoration of basic services and infrastructure, which is necessary to begin any assessment, planning and design, or construction efforts. Areas in the severe damage category include Lakeview, Gentilly, and the Lower Ninth Ward. According to our calculations, about 108,000 households (50 percent of the total) were affected by severe flooding.

Estimates of the effects of flooding on the housing stock in New Orleans vary greatly. For example, only 5,529 structures (about 4.3 percent) inspected by the Army Corps of Engineers and Shaw Group have been red-tagged (i.e., deemed unsafe to enter and occupy).¹⁹ Many of these houses were probably structurally unsound before the storm (Russell, 2005). The city has asserted that a red tag does not necessarily mean that demolition is required (City of New Orleans, undated). Structural engineers and building professionals have noted that homes suffering serious and even severe damage could be rehabilitated after removing the interior contents and finishes (such as wallboard) and drying out the structure. Older homes, which typically have higher-quality wood and lack insulation, and which constitute a large portion of the housing stock, are likely to be easier to salvage (Avegno, 2005; Barter, 2005; Shalett, 2005). And, given the large number of culturally and architecturally significant structures in the city, it is expected that special efforts will be made to restore them.

More pessimistic scenarios about the plight of housing have also been put forth. Some have noted that newer housing, such as in New Orleans East and Parkview, was typically one story (thus, more of the building was potentially flooded) and constructed of lower-quality materials, which may require razing due to cost considerations (Manning, 2005; Eskew, 2005). Because of the presence of widespread and persistent poverty among New Orleans residents, many housing units were likely in poor condition. Low property values and a weak rental market also may make such properties more likely candidates for demolition than rehabilitation.²⁰ Environmental hazards caused by mold and polluted floodwaters may add cost, complexity, time, and uncertainty to the recovery and rebuilding process and it may deter some residents from returning (Centers for Disease Control and Prevention and U.S. Environmental Protection Agency, 2005; Tanneer, 2005). Some city officials have reportedly estimated that out of 188,000

¹⁹Final inspections data cited by New Orleans Emergency Operations Center (2005).

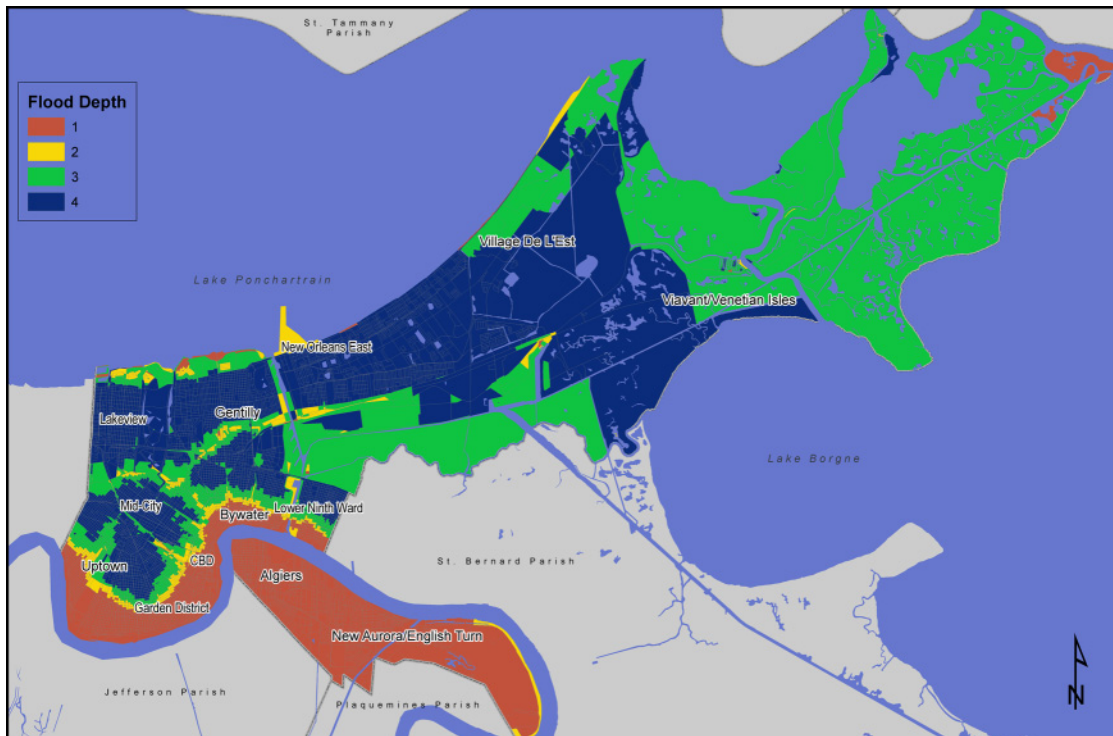
²⁰The median rent in many of the flooded areas was under \$315 per month (GCR and Associates, Inc., 2005).

habited housing units in New Orleans, 50,000 (27 percent) may have to be razed (Marsh and McLennan Companies, 2005).

To implement this four-level classification scheme, we obtained detailed block-level information for the entire city of New Orleans on the number of housing units and total population corresponding to each of the four categories of flood-depth and housing damage.

Information on the depth of the floodwater was derived from remote sensing data on the extent of flooding in New Orleans on September 10, 2005—a day of near-maximum flooding.²¹ The floodwater depth was calculated using a geographic information system that included detailed topographic information for the city.²² We obtained these data at the block, tract, and neighborhood levels.²³ Figure 3.1 shows the mean depth of floodwater, by category, for all blocks in New Orleans. Flooding was most severe in the

Figure 3.1
Flood-Depth Category by Census Block for New Orleans



SOURCE: Flood depth calculated by GCR and Associates, Inc., from FEMA data on water levels for September 10, 2005.
 NOTE: Flood-depth categories: (1) no flooding; (2) less than 2 feet; (3) 2–4 feet; (4) more than 4 feet.
 RAND TR369-3.1

²¹These data were made available by the Federal Emergency Management Agency (2005).

²²These data were provided to us by GCR and Associates, Inc.

²³Block and tract boundaries are established by the U.S. Census Bureau, while neighborhood boundaries are established by the City of New Orleans.

low-lying areas near Lake Pontchartrain and in the mid-city area, while neighborhoods situated on the natural levees on both sides of the Mississippi River had no flooding. Blocks along several natural ridges that cross the city and areas along the shore of Lake Pontchartrain also escaped major flooding.

We used block-level data to calculate the number of housing units and population in each of the four damage categories. The City of New Orleans is divided into a total of 10,181 census blocks. For each of these areas, we obtained data on the following:

- Total population
- Housing (total housing units; the number of vacant units, and housing units by tenancy that distinguishes owner-occupied and renter-occupied units)
- Flooding (classified by depth of floodwater to the nearest foot).

We used this information to calculate, for all blocks in the city, the total number of housing units and population in each of the four flood-depth/housing-damage categories.

The Results

Table 3.1 presents our results, which show that approximately one-quarter of the pre-Katrina population of New Orleans was not exposed to flooding based on their block of residence and that their housing likely suffered little or no floodwater damage.²⁴ Then again, about 55 percent of the population experienced more than an average of 4 feet of flooding in their neighborhoods, and their housing most probably suffered severe damage.

Table 3.1
New Orleans Population and Housing Affected by Flooding Due to Hurricane Katrina

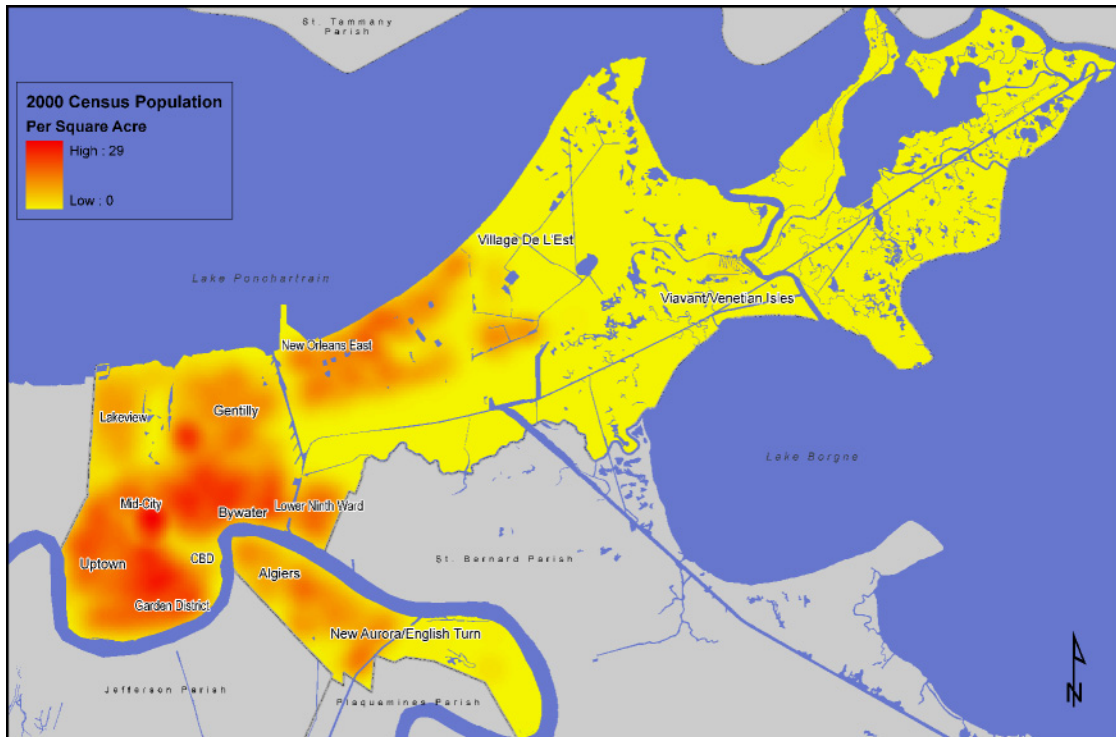
Flood-Depth/Housing-Damage Category	Population	Percent of Total Population	Households	Percent of Total Households
1	122,073	25.2	52,718	28
2	26,617	5.5	10,534	6
3	67,853	14.0	26,898	14
4	268,131	55.3	98,101	52
Total	484,674	100.0	188,251	100

SOURCE: Authors' calculation based on 2000 U.S Census block-level data on population and housing and estimates of mean floodwater depth provided by GCR and Associates, Inc.

²⁴Their houses may have suffered from direct or indirect damage from wind; however, wind-related damage was not extensive.

In Figure 3.2, we show the spatial distribution of the New Orleans population based on block-level data from the 2000 Census. The city's population in 2000 was concentrated around the central business district. Less densely settled residential areas include neighborhoods near Lake Pontchartrain and on the West bank of the Mississippi River.

Figure 3.2
Population Density for New Orleans in 2000



SOURCE: Block-level population counts from the 2000 U.S. Census.
RAND TR369-3.2

ESTIMATES OF REPOPULATION RATES

The Approach

As noted in Chapter Two, given the study time constraints and the lack of available data, we were unable to calculate repopulation rates quantitatively. Thus, we opted for a qualitative approach. Qualitative approaches to estimating future trends have been widely used in situations where there are no historical data, complete and accurate information on the current circumstances are missing, and the entire situation is outside the range of past experience. More formal and elaborate qualitative approaches include the Delphi method (see, for example, Linstone and Turoff, 1977), developed by RAND researchers in the 1950s as a technique for drawing on the knowledge of a group of experts with a range of backgrounds to arrive at a consensus. A simpler technique is a consensus approach, in which a group of knowledgeable

individuals, through a review and discussion of the available evidence and consultation with various experts, jointly agree upon a set of estimates.²⁵ We adopted the latter approach for this study, using a consensus panel comprising of the four authors of this report to obtain estimates of the repopulation rates. We concluded that this was the best choice given the constraints we faced.

The consensus approach has several strengths, as well as certain weaknesses. The main strength of the consensus approach is that it is quick and straightforward to apply and the method is easy to understand. Hence, it is easy to replicate in other settings and with other panel members. Moreover, the consensus approach is likely to provide reasonable estimates in circumstances in which quantitative techniques cannot be applied, such as those facing New Orleans—in particular, it is unlikely to produce extreme estimates that lack immediate “face” validity.

The weaknesses of the consensus approach are that it appears ad hoc and may be biased by myriad factors. Biases may arise from reliance on readily available information, groupthink or the spiral of silence,²⁶ political pressure to meet certain targets, or selective perceptions. In applying the consensus approach to estimating repopulation rates, we worked to mitigate the disadvantages of this technique by documenting as completely and comprehensively as possible all of the information that we assembled and reviewed on the extent of flooding, the damage to housing caused by the flooding, and the prospects for housing reconstruction and by identifying our main underlying assumptions. Nevertheless, another team of experts given the same information may have arrived at different results. This type of replication would be valuable because the results could be used to generate error bounds for the estimates that reflect uncertainty in deriving the model parameters that are otherwise obscured by the deterministic, rather than stochastic, nature of our single set of estimates of the future population of New Orleans.

Here, we lay out in detail the assumptions underlying the estimates of repopulation rates. We gathered and used a wide array of primary and secondary information to characterize the population situation in New Orleans and to develop our population projections. This background information included the following:

- Local and national media reports on housing, employment, and related developments concerning the recovery of New Orleans
- Data gathered by local, state, and federal officials, such as the Louisiana State Department of Labor and the Federal Emergency Management Agency (FEMA)

²⁵Consensus methods have been used extensively in government and planning, business and industry, and in medicine and public health (e.g., see Fink et al., 1984).

²⁶Groupthink occurs when the consensus-forming process leads people to reinforce each other’s views and not consider all alternatives, while the “spiral of silence” occurs when those with dissenting views are increasingly unwilling to express their views.

- Post-Katrina data and analyses generated by organizations such as the New Orleans Emergency Operations Center (EOC), the American Planning Association, the Brookings Institution, and the Urban Land Institute
- Telephone interviews with professionals in areas such as insurance, planning, architecture, building and inspections, real estate, business development, employment, and demography
- Data and analysis provided by a New Orleans-based planning and consulting firm, GCR and Associates, Inc.

Based on these data, we determined that key issues driving those assumptions were insurance and financing, construction and rebuilding, and willingness and ability to return. We discuss each below.

Insurance and Financing. Insurance is likely to be a critical factor driving the pace of rebuilding and repopulation of New Orleans. We assume that housing in the areas not flooded or that experienced minor flooding will be repaired using payments by insurance companies for insured losses (e.g., under wind and flood policies) or owners' existing credit and cash reserves. In areas characterized by serious or severe damage, we assume that housing repairs and rebuilding will be funded by insurance payments, federal assistance available for raising structures above the base flood elevation,²⁷ borrowing, and cash reserves. Nevertheless, we believe that recovery and rebuilding in areas suffering serious and severe flooding could be slowed or impeded by several factors.

On average, about half of all losses from natural disasters are uninsured (Seeman, 2005). This proportion appears to hold in the case of New Orleans. According to one early estimate, of an estimated \$170 billion in losses, \$100 billion are uninsured (Kline, 2005). Roughly 80 percent of homes in New Orleans were located in a FEMA-designated flood zone at the time Katrina hit, but, according to FEMA, only 40 percent of housing units in New Orleans were covered by flood insurance. In other words, a significant share of housing units that received serious or severe flood damage were unlikely to have flood-insurance coverage. The maximum federal flood policy coverage in effect at the time of Katrina was \$200,000 for the structure and \$60,000 for contents. The average policy coverage (\$152,000) was roughly equal to the median home price at the time of the storm. This means that even if a house were insured, the average flood policy may not be sufficient to repair serious or severe damage, as well as the loss of contents. Moreover, flood insurance does not cover the loss of the use of a home. Many evacuees have received housing allowances by FEMA, but these are due to expire by early 2006. Thus, many

²⁷The National Flood Insurance program offers policy holders Increased Cost of Compliance assistance of up to \$30,000 to raise a structure above the base flood elevation. This money may also be used to demolish a structure (Shalett, 2005).

displaced families have had to draw down their savings that they might have dedicated to rebuilding to obtain temporary shelter and to replace lost personal belongings.²⁸

Looking forward, it is not clear that private insurers will be ready to write wind-damage policies for dwellings being rebuilt in New Orleans—at least in the short term.²⁹ According to Marsh Risk Consulting, a risk analysis and advisory firm, Hurricanes Katrina and Rita “revealed vulnerabilities and failures in the catastrophe models that insurers and reinsurers use to analyze their exposures to loss” (Marsh and McLennan Companies, 2005, p. 1). Property-insurance providers have been severely affected by Hurricanes Katrina and Rita, and Marsh concluded that “[t]here are strong indications that insurers will be more discriminating in their choice of policyholders and that they will be increasing rates” (Marsh and McLennan Companies, 2005, p. 1). Revised risk models are expected in early 2006 (Muir-Wood, 2005). It is conceivable that evolving risk models will lead to increases in the cost of insurance and greater caution by insurers. Efforts by regulators to put caps on insurance rates may motivate some insurers to exit the market.³⁰

According to flood-insurance program regulations, all residential structures that are located in a flood zone and have mortgages issued by federally regulated lenders must be insured. The flood maps developed by FEMA for parishes surrounding Lake Pontchartrain are 5–25 years old and were in the process of being updated prior to Katrina. It is likely that significant changes will now be made that would expand the area designated as a flood zone, as well as increase the base flood elevations (the height to which severely damaged building must be raised and new structures must be built). FEMA has noted that “the strength and extent of Hurricane Katrina’s wind field resulted in a storm surge greater than historical maximums” (FEMA, 2005a), creating the need to develop new maps. FEMA has reported that its flood maps of the area are in some stage of restudy. This has yet to occur in Louisiana, but the agency notes that “[a]dditional analyses may be needed as a result of Katrina, because the hurricane affected some areas in significant ways. If so, the scheduled release [of new flood maps] will be delayed in order to incorporate the new data” (FEMA, 2005b, p. 2). As of mid-December 2005, FEMA had not yet issued its advisory base flood elevations. This means that property owners, city planners, insurers, and other interested parties lack critical guidance on codes and standards that building must meet.³¹ Recommendations have been made that the city adopt stricter building codes that include a freeboard provision that calls for elevating

²⁸In testimony to Congress, Louisiana Governor Kathleen Blanco asserted that without significant federal assistance, homeowners “will have not money to rebuild” (“State Officials Defend Katrina Response,” 2005)

²⁹The federal government offers flood insurance—but not insurance from damage from wind or other factors—and is obligated to provide such insurance to qualifying households.

³⁰This scenario occurred in California following the 1994 Northridge earthquake.

³¹FEMA issued Advisory Base Flood Elevations in mid-November for coastal Mississippi.

structures an additional increment above the FEMA base flood elevation. This would mitigate uncertainties in flood studies and earn a reduction in flood insurance rates.³²

Many property owners will choose not to build and lenders and insurers are unlikely to back rebuilding efforts unless adequate flood protection can be provided. The U.S. Army Corps of Engineers has stated that category-three storm protection will be in place by June 2006, the start of the next hurricane season. The federal government has not made a commitment to provide category-five storm protection and does not appear to be in a position to make such a commitment in the near future.

Construction and Rebuilding. A recent survey of U.S. architecture firms by the American Institute of Architects indicated that the rebuilding period after a natural disaster typically lasts 2–5 years. An important determinant of the pace of rebuilding (both of existing housing and new housing) is the availability of labor and materials.

Katrina destroyed an estimated 275,000–300,000 individual housing units in the Gulf region and probably damaged an equivalent number. A large number of commercial and government structures were also damaged or destroyed (Baker, undated). The large-scale rebuilding required is likely to place significant upward pressure on the cost of construction materials—in a market environment where the cost of some building materials had already seen “significant price increases” as a result of a regional construction boom and rising world market prices for key materials such as steel and concrete.³³ For example, Economy.com noted a 2.5-percent increase in the price of concrete and a 5.5-percent increase in the price of wallboard and other gypsum products in the two-month period after Katrina struck. From early 2005 to the end of 2008, Economy.com forecasts a producer price escalation of 5.8 percent for lumber and wood products, a 12.9-percent increase for gypsum products and cement, and a rise of more than 7 percent for plumbing fixtures and heating equipment as a consequence of post-hurricane rebuilding. Economy.com also indicated that local shortages of some building supplies may appear.³⁴ Energy price hikes after hurricanes Katrina and Rita have added to price escalation and disruptions in supplies of building materials (Stundza, 2005). As a consequence, the cost of housing construction per square foot may rise dramatically in the immediate post-hurricane period. Escalation in construction costs will create a disincentive for property owners to rebuild or it may encourage them to delay rebuilding in the hopes that construction costs will fall at some time in the future (Nossiter, 2005; Shalett, 2005). Furthermore, insurance payments and savings may not be sufficient to cover the increased costs of construction.

³²The State of Louisiana also is expected to implement new, stricter building codes (American Planning Association, 2005.)

³³Economy.com research (cited by Baker, undated); Andrews (undated).

³⁴Economy.com (cited by Baker, undated). Economy.com predicted that escalation in the prices for building materials may ease if the nationwide boom in home building cools off.

In contrast to much of the rest of the South and the Gulf Coast, metropolitan New Orleans in recent years has had a relatively slow housing construction market. On average over the past decade, only about 8,000 new housing units were produced per year (Ragas, 2005). Therefore, the area will have to expand significantly its capacity for planning and inspections, its number of construction firms, its labor, and its building-supply networks. By all local accounts, in the months immediately after the storm, the ability of residential and commercial property owners to find qualified construction contractors and craftspeople—for demolition and to perform triage and repairs—has been extremely difficult. For example, if a property owner did not have a preexisting project or relationship with a contractor, he or she likely would have to wait in line until the first wave of projects was completed—a six-month proposition (Gist, 2005; Barter, 2005). Moreover, because New Orleans was flooded with brackish water, all electrical systems and mechanical systems that were flooded will have to be replaced. This will require electricians to perform the work, as well as qualified inspectors to examine and approve the work after it is completed. Individuals in New Orleans report a shortage of building and electrical inspectors as a result of layoffs by the city and the electrical utility, Entergy New Orleans, because of their financial distress.³⁵ Reconstruction will take even longer than normal and cost more as workers themselves have limited living quarters.³⁶

Based on this evidence, we assumed that most repairs to housing that was not flooded could be returned to habitability almost immediately. For houses suffering minor damage, we estimated the repair time to be six months to one year. For seriously or severely damaged homes *that are intended to be repaired*, we add an assessment and decisionmaking period of six months to one year, and estimate construction to last up to three years. For structures that are razed and new structures that are built, we estimate that the assessment, financing, planning and design, and construction period might last as long as 5–10 years.³⁷ To this point, the American Institute of Architects concluded that of the estimated 250,000 units lost in Louisiana, only about 100,000 units would be replaced by 2008 (Baker, undated).

Willingness and Ability to Return. We considered other factors that may affect individuals' willingness and ability to return and reoccupy housing and to assume or resume employment. Although we assumed that 100 percent of the housing stock in areas not subjected to flooding was habitable by mid-November 2005 (as shown below), we did not assume that all previously occupied housing units will be reoccupied. Based on telephone interviews and media reports, we see several scenarios whereby people

³⁵By the end of November, only 64 percent of Orleans Parish had restored electricity and 50 percent had gas service (Katz, Fellowes, and Mabanta, 2006). New Orleans Mayor Ray Nagin stated on December 3, 2005, that full power would not be resuming until January 2006 (Tanneer, 2005).

³⁶Holtz-Eakin (2005). While New Orleans and the state and federal governments resolve critical issues, such as what level of flood protection they will be able to provide, other communities in the region are moving forward with building, attracting labor and resources to those areas first.

³⁷The American Institute of Architects estimates that an average assessment and construction period for a generic rebuilding project is six months to three years.

with habitable homes choose not to return to them. Such scenarios include individuals with medical conditions and seniors who choose to stay away because of a perceived cutbacks in services, such as healthcare and public safety;³⁸ unemployed individuals who have found employment or more favorable living conditions outside the parish;³⁹ lack of adequate schools;⁴⁰ and impoverished individuals who were evacuated to distant locations and who may find it difficult to return.⁴¹ The 2000 Census indicates that nearly half of the housing units in New Orleans were rental units; relative to homeowners and those with mortgages, we expect that these people are substantially less likely to return to their original residences if the units were damaged or if they evacuated to another location.

Looking further into the future, other factors likely will affect individuals' willingness to return or move to New Orleans. These factors include evacuees' age and economic status; evacuees' distance of relocation from New Orleans; the availability and quality of schooling; and measures to protect the city from future natural disasters. Employment prospects in New Orleans are likely to play an important role in shaping people's willingness and ability to live in the city. Rebuilding the area's economy will depend not only on the available labor supply but also on repairs to the region's infrastructure, the availability of private and public investment, and a host of other factors. A recent survey by Economy.com suggests that economic recovery in the Gulf region will proceed more slowly in Louisiana than in any of the other states affected by Hurricane Katrina. Indeed, Economy.com suggests that economic recovery in the state will not occur until 2008—three years after the storm (Baker, undated). Because the New Orleans metropolitan region and the city in particular were damaged even more heavily than the state as a whole, we expect that employment recovery in the city will also lag. Research indicates that the service and trade sectors are the most vulnerable to disaster impacts (Kroll et al., 1990), and are the slowest and least likely to make a long-term recovery (Webb, Tierney, and Dahlhamer, 2002). These vulnerable sectors are the primary

³⁸Medical services are greatly restricted throughout New Orleans post-Katrina: Only two of the eight hospitals in the city were open in late November and they were at reduced capacity (Thomas, 2005). Less than one third of the city's restaurants had reopened by November 2005 (Katz, Fellowes, and Mabanta, 2006).

³⁹The Housing Authority of New Orleans, which managed 20,000 public housing and Section 8 housing units, had not reopened its housing because of security and safety concerns as of the end of 2005. Bureau of Labor Statistics (BLS) statistics indicate that two-thirds of the Katrina evacuees from all areas (and 50 percent of black evacuees) that had not returned to their homes in October were already employed (Bernstein, 2005).

⁴⁰Only one of the 116 public schools in New Orleans was open by December (Katz, Fellowes, and Holmes, 2005). Orleans Parish public schools were not planning to reopen any East Bank campuses until at least summer 2006 (Moran, 2005).

⁴¹Poorer people tended to be evacuated to more distant locations in the wake of Katrina (Tizon and Smith, 2005). A BLS survey released February 3, 2006, found that more than 26 percent of Katrina evacuees who had yet not returned home were classified as unemployed compared with a national unemployment rate of 4.7 percent (El Nasser and Overberg, 2006).

sources of employment in the New Orleans metropolitan area (U.S. Department of Labor, undated). Ed Durabb, the Jefferson Parish planning director, suggests that many people, especially those on public assistance, will be able to find better economic and educational opportunities in their new locations and will, thus, have little incentive to return to New Orleans (Moran, 2005).

One longer-term concern faced by residents and businesspeople, lenders, and insurers is the feasibility and timeline of repair and improvement to the city's levee system. While Mayor Nagin has indicated that the levees will be rebuilt to withstand a category-three hurricane by the 2006 hurricane season, adequately strengthening the levees and addressing other future flood prevention remedies will take several years at a minimum (Bohannon and Enserink, 2005). This, combined with the other concerns, such as decisions about where redevelopment can proceed, and the performance of the public school system and public safety, will likely slow the return of evacuees and influx of new immigrants. Disaster research, for example, has indicated that parents are reluctant to expose children to threatening circumstances, even when they do not feel threatened themselves (Kirschenbaum, 1996). Deep uncertainties about these issues and the complexity of modeling decisions based on these factors make long-term population projections exceedingly difficult (Warner, 2005).

The Results

Based on these assumptions, Table 3.2 presents the repopulation rates at which we arrived through the consensus process. The rates differ by flood-depth/housing-damage category and generally change by period. A summary of the assumptions underlying the rates shown in the table is included in the final column. To illustrate how the information in Table 3.2 summarizes our results, consider the first row in the table. This row shows we estimated that the repopulation rate for areas with no flooding in December 2005, three months after Hurricane Katrina struck, would be about 65 percent of the base population of full-time residents.⁴² This estimate is based on the following evidence: (1) The houses in this area suffered wind damage but no flood damage and, with minor repairs, could be occupied by early returnees; (2) utilities were reconnected quickly for most households; (3) vacant houses in these areas were not occupied immediately; and (4) no families with children returned during this early period. The subsequent rows show that we estimated repopulation rates of about 20 percent in areas with moderate housing damage (less than 2 feet of flooding), 5 percent in areas with serious damage (2–4 feet of flooding), and 1 percent in areas with severe damage (more than 4 feet of flooding).

The repopulation rates shown in Table 3.2 for subsequent periods (three months, one year, and three years after the storm) reflect our assumptions that housing habitability will increase across all flooding and

⁴²This figure is consistent with the results of unpublished rapid surveys conducted on November 12–13, 2005, and December 3–4, 2005 (EOC, 2005).

damage categories. We believe it is possible that the population in census blocks that did not experience flooding will be higher in 2006 than in 2000 because vacancy rates will decline and the average size of households in those areas will increase as more people crowd into the limited supply of available and safe housing.⁴³ Over the longer term, housing redevelopment is likely to be concentrated in these areas too—already, there is evidence that property prices have risen rapidly in these “high and dry” areas of New Orleans (Rivlin, 2006). Accordingly, we assume that, after one year, the repopulation rates in nonflooded areas could rise to more than 100 percent of pre-Katrina levels. In areas that suffered minor damage, we assume that repopulation rates rise to 75 percent one year after Katrina and to 100 percent after two more years. Although our estimated repopulation rates in the serious and severe damage categories also rise over time, the rate of increase is much slower and the repopulation rates substantially lower: We expect repopulation rates of 45 percent in the serious-damage category and of 30 percent in the severe-damage category after three years.⁴⁴ Myriad factors are likely to be responsible for this expected trend: limited or lack of savings among homeowners; property abandonment and mortgage foreclosures; lack of adequate insurance coverage; regulations and codes that raise the cost of repairs and construction; escalation in construction costs; uncertainty about the level of flood protection; and resistance by insurers and lenders to service perceived high-risk areas.

It is important to note that the estimates of repopulation rates reflect not only the habitability of dwellings, but also other factors. For example, the average household in New Orleans contained about 2.6 persons prior to Katrina. Anecdotal evidence suggests that friends and family members are currently sharing scarce housing: The EOC (2005), based on a limited survey, estimated that habited housing units on the West Bank had about 3.2 individuals on the weekends in early December 2005. Our estimates also assume gradual repopulation by people living in temporary travel trailers provided by FEMA, but they do not include persons living in hotels or cruise ships.⁴⁵

⁴³For instance, according to our calculations, 11,600 housing units in areas with less than 2 feet of flooding were listed as vacant prior to the storm. On the West Bank, 13 percent of housing units were vacant at the time of the 2000 Census. A significant share of vacant properties likely will be occupied post-Katrina.

⁴⁴The occupancy of severely damaged dwellings is projected to have begun within three months of Katrina, not because houses will have been reconstructed in that short time, but because some residents are stabilizing their homes and “rouging it” (e.g., by not using the ground floor). Other residents have qualified for and obtained the temporary housing trailers provided by FEMA, and some are pursuing a mix of these strategies (Rigamer, 2005). The performance of government efforts to provide trailer housing will affect the March 2006 and one-year population estimates.

⁴⁵About 18,000 FEMA trailers were expected to be delivered to New Orleans by early 2006 (Russell, 2006). The cruise ship and hotel populations were estimated at 18,000 and 4,500 respectively on December 3, 2005 (EOC, 2005).

Table 3.2
Estimated Repopulation Rates for New Orleans and Supporting Evidence and Assumptions

Period	Flood-Depth/ Housing-Damage Category	Repopulation Rate (%)	Supporting Evidence and Assumptions
December 2005	No flooding/none	65	<ul style="list-style-type: none"> • Wind-damaged houses repaired easily, occupied by early returnees • Utilities available • Vacant houses not yet occupied • Few families with children or without jobs return
	<2 feet/moderate	20	<ul style="list-style-type: none"> • Only residents with established contractor relationships able to schedule repairs • Repairs begun but few completed • Many households lacking utilities
	2–4 feet/serious	5	<ul style="list-style-type: none"> • Residents are “roughing it” or living in temporary trailers • Demolition and repairs barely begun • Limited availability of utilities
	>4 feet/severe	1	<ul style="list-style-type: none"> • Very few residents, who are “roughing it” or living in temporary trailers • First stages of reconstruction (demolition, gutting) slowed by lack of laborers and inspection/permitting delays • Very limited availability of utilities
March 2006	No flooding/none	100	<ul style="list-style-type: none"> • Vacant houses are rented • Increase in average household size • Repairs underway, or completed
	<2 feet/moderate	35	<ul style="list-style-type: none"> • Utilities largely restored • Repairs planned or underway
	2–4 feet/serious	15	<ul style="list-style-type: none"> • Few repairs begin due to uncertainties and delays with insurance and planning and permitting process • Gutting in preparation for reconstruction begun • Many households lacking utilities
	>4 feet/severe	5	<ul style="list-style-type: none"> • Increasing number of temporary housing trailers • Many homeowners unable to finance housing repairs • Very few homeowners begun gutting and preparations for reconstruction
September 2006	No flooding/none	110	<ul style="list-style-type: none"> • Further decline in housing vacancy rates • Increase in average household size • “High and dry” areas continue to be most attractive places to live
	<2 feet/moderate	75	<ul style="list-style-type: none"> • Return of families with children • Housing repairs planned or under way
	2–4 feet/serious	25	<ul style="list-style-type: none"> • Few families with children return • Gutting underway and reconstruction begun • Utilities restored
	>4 feet/severe	10	<ul style="list-style-type: none"> • Further increase in temporary housing trailers • Very few families with children return • Reconstruction limited by high costs and financial hardship of homeowners • Continuing shortage of construction workers, skilled tradespeople, inspectors, and building materials
September 2008	No flooding/none	110	<ul style="list-style-type: none"> • Same factor as in previous period
	<2 feet/moderate	100	<ul style="list-style-type: none"> • Decrease in vacancy rates • Increase in average household size • Virtually all reconstruction and repairs completed
	2–4 feet/serious	45	<ul style="list-style-type: none"> • Reconstruction limited by high costs and financial hardship of homeowners • Some reconstruction completed • Many families with children return
	>4 feet/severe	30	<ul style="list-style-type: none"> • Shortages of construction workers, skilled tradespeople, inspectors, and building materials continuing • Some reconstruction completed • Financial hardship of homeowners continues to constrain reconstruction

ESTIMATES OF THE FUTURE POPULATION OF NEW ORLEANS

The previous two chapters have provided estimates for the two terms to the right of Equation 1 shown in Chapter Two. Here, we provide the results for the product of those two terms. Specifically, in Table 3.2, we present our estimates of the future population of New Orleans in the aftermath of Hurricane Katrina. We estimate that the population of New Orleans in December 2005 was approximately 91,000. This figure is expected to rise rapidly to about 155,000 by March 2006, as basic repairs and stabilization of housing is completed, public services and infrastructure are restored, and schools and universities reopen. Subsequently, repopulation starts tapering off: One year after the storm, in September 2006, we estimate a population of about 198,000. Three years post-Katrina, we estimate that the New Orleans population will reach about 272,000—about 56 percent of the pre-Katrina population. Although we recognize that there are hopes in the New Orleans community that the population will bounce back faster than we project, we believe that because so many New Orleanians lived in areas that experienced serious or severe flood damage, the challenges of rebuilding place a strong damper on the population recovery potential.

In Figure 3.3, we show the spatial patterns of repopulation for New Orleans based on our results. These maps—which present the population density in December 2005, March 2006, September 2006, and September 2008—show that the population returning to the city in aftermath of Hurricane Katrina is initially concentrated in the high-elevation areas on either bank of the Mississippi River. Repopulation of other parts of the city proceeds very slowly; even by September 2008, the density of population in Lakeview, Gentilly, and New Orleans East neighborhoods is far below what it was prior to Katrina. Note that these maps assume that population will be spatially distributed in the post-Katrina period in direct proportion to the spatial distribution prior to Katrina. However, this is unlikely to occur, particularly in areas with housing severely damaged by the flooding, where it is far more likely that only certain areas will be redeveloped while the remaining residential areas will be converted to other land uses.

SENSITIVITY ANALYSIS OF FUTURE POPULATION ESTIMATES OF NEW ORLEANS

We conducted a sensitivity analysis to assess the extent to which our population estimates for New Orleans are shaped by several major assumptions that underlie our approach. Although the sensitivity analysis shows how population estimates would be altered as a result of making specific changes in the assumptions underlying our method, it does not provide confidence intervals or upper or lower bounds to our baseline estimates.

We varied two sets of assumptions for the sensitivity analysis. First, we considered the effects of damage to housing at each floodwater depth category being more severe and less severe than in our baseline estimates presented previously. Specifically, we examined the effects of moving the flood damage

Table 3.3
New Orleans Population Estimates Based on Housing Habitability

Mean Depth of Floodwater	December 2005		March 2006		September 2006		September 2008	
	Repopulation Rate (%)	Estimated Population	Repopulation Rate (%)	Estimated Population	Repopulation Rate (%)	Estimated Population	Repopulation Rate (%)	Estimated Population
No flooding	65	79,347	100	122,073	110	134,280	110	134,280
<2 feet	20	5,323	35	9,316	75	19,963	100	26,617
2-4 feet	5	3,393	15	10,178	25	16,963	45	30,534
>4 feet	1	2,681	5	13,407	10	26,813	30	80,439
Total		90,744		154,974		198,019		271,870

categories up and down by one foot.⁴⁶ Second, we examined the effects of varying the repopulation rates for housing at each floodwater depth, by increasing and decreasing the repopulation rates by five percentage points and by ten percentage points.

A summary of the results from the sensitivity analysis is presented in Table 3.3. Several main findings emerged from this analysis. The most significant finding is that the estimates of the future New Orleans population for the near term are more sensitive in relative terms to our assumptions than are the estimates for the more distant future. The sensitivity analysis suggests that moderate changes in our assumptions could lead to a December 2005 population estimate as low as 30,467 (65 percent lower than the baseline population estimate of 90,744) or as high as 139,212 (53 percent higher than the baseline estimate). However, our population estimates for New Orleans for September 2008 are much less influenced by our assumptions. The estimates of total population three years after Hurricane Katrina ranges from a low of 223,403 (18 percent below the baseline population estimate of 271,870) to a high of 320,338 (18 percent above the baseline estimate).

Table 3.4
Results of Sensitivity Analysis of Estimates of New Orleans Population Based on Housing Habitability

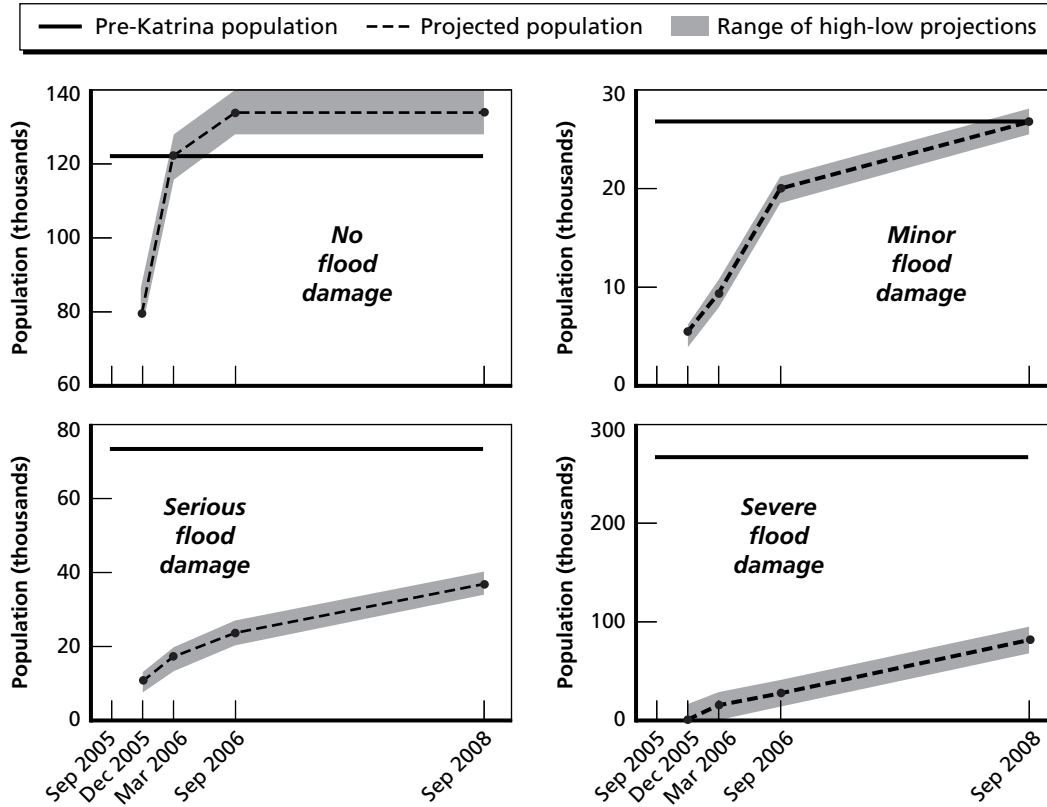
Scenario	Estimated Total Population			
	December 2005	March 2006	September 2006	September 2008
Baseline	90,744	154,974	198,019	271,870
More damage at floodwater depth	30,467	66,920	136,911	239,949
Less damage at floodwater depth	109,266	182,680	229,749	298,647
Occupancy rates 5 points lower	77,237	130,739	173,787	247,637
Occupancy rates 5 points higher	114,978	179,208	222,254	296,105
Occupancy rates 10 points lower	69,802	119,913	149,552	223,403
Occupancy rates 10 points higher	139,212	203,441	246,487	320,338

Further insights into the sensitivity of the results to our assumptions is provided in Figure 3.4, which plots the baseline population projections together with the range based on increasing and decreasing repopulation rates by 10 percentage points. The results are presented in four panels, which correspond to the four damage categories. The graphs show that the population of areas with no flood damage stabilizes rapidly. The population of areas with minor and serious damage is small enough that changing the parameters does not have a major effect on the results. However, the large population in areas with severe

⁴⁶Moving the flood-damage categories down by one foot assumes that there is less damage to housing at each flood depth; moving them up by one foot assumes that there is more housing damage at each flood depth.

flood damage means that even moderate changes in the assumptions result in large shifts in total population. These results make it clear that it is the rate of progress in reconstructing the most severely flood-damaged areas of New Orleans that will set the pace of repopulation of the city and will also determine to a large extent the city's total population in the three years' time.

Figure 3.4
Results of Sensitivity Analysis of Estimates of New Orleans Population Based on Housing Habitability



RAND TR369-3.4

CHAPTER FOUR CONCLUSIONS AND NEXT STEPS

CONCLUSIONS

In this report, we presented an analysis of the repopulation of New Orleans in the wake of the tremendous devastation brought about by levee breaches and flooding from Hurricane Katrina. In particular, we drew on expert opinion, news reports, and various extant data sources to estimate the New Orleans population in December 2005 (roughly three months after Hurricane Katrina struck), in March 2006 (six months after Katrina), and in September 2006 and 2008 (respectively, one and three years after the hurricane and floods). We estimated that the population of New Orleans will be about 155,000 in March 2006 and will grow to 198,000 in September 2006 and to 272,000 in September 2008.

Our results are subject to a considerable number of qualifications and caveats. First, these estimates are based on limited data on circumstances in New Orleans, considerable uncertainties about the rebuilding process and the level of government and private investment and support, and limited historical experience with a natural disaster of this magnitude. Second, very limited primary data have been collected in the aftermath of Hurricane Katrina, either on evacuees from the city or on current city residents (including new migrants to the city) or on commuters who work in the city but live elsewhere. Not knowing the current status and circumstances of evacuees and residents introduces additional uncertainty into our population estimates. Third, the analysis had to draw on a significant number of assumptions. These assumptions, which have been documented extensively in this report, are subject to error and are often not based on hard data or confirmed experience, since there are few historical parallels on which to draw. Finally, our results included a limited sensitivity analysis to examine how our estimates change as a number of key assumptions are altered.

Despite these qualifications and caveats, our results provide some important insights into the current and future population of New Orleans. In particular, the results suggest that the rebuilding process in the most severely devastated areas of the city—which together accounted for 55 percent of the pre-Katrina population of the city—will largely determine the future population of New Orleans in the medium term and beyond. This is because areas that suffered no damage or only minor damage will in all likelihood be rapidly resettled, and there is only a small population in areas that suffered serious damage. The difference between high and low estimates from our sensitivity analysis was driven primarily by the situation in the severely flooded areas.

An important point about our estimates of the future population of New Orleans is that they are based on an equilibrium process—a process in which the number of people moving back to the city matches the housing reconstruction process and the return of jobs, schools, services, and infrastructure. In other words, they are mid-range estimates and, in particular, do not reflect either the upper bound for

housing and population that might be achieved, or the lower bound. The equilibrium process could be altered for the better if additional outside resources were made available for reconstruction. This would lead to the supply of housing being expanded, which would keep housing costs down and encourage people to return. Then again, uncertainties about the future of the city could lead to people delaying their return to the city, which might, in turn, dramatically slow down the repopulation of the city.

This suggests an important role for policymakers shaping the repopulation process in New Orleans. In particular, there are factors they can influence or even control that could increase the likelihood of positive feedback effects. Among the factors likely to have the greatest impact on the repopulation rate are policies and procedures to streamline the process for obtaining permits to repair or demolish and reconstruct housing in the city. Policies that reduce uncertainty for residents and business are also likely to have a positive effect on the repopulation process. For example, there is considerable uncertainty about planned repairs and upgrades to the levee system, the plans for reconstructing schools, hospitals, libraries, and other facilities, and the provision of public services, such as public transportation and public safety. Providing clearer and more comprehensive information about progress and the ultimate goals for restoring these systems and services may increase the likelihood of former residents and new residents moving to the city.

NEXT STEPS

The best way to understand how the repopulation process is unfolding in New Orleans is to collect better data on evacuees and current residents and to collect such data at regular intervals. Accurate population estimates from surveys would be perhaps the best gauge of how well the recovery process in New Orleans is proceeding. Detailed demographic data is also needed to plan public services, such as schooling and public safety. Nongovernmental and private-sector entities also need accurate data to assure proper provision of health care, services, and infrastructure.

Of foremost importance is collecting detailed individual-level data on the current residents of New Orleans and on the evacuated residents of the city. These data will be of tremendous value in understanding the circumstances of the current and former residents of New Orleans and in assessing their likelihood of returning to the city. These data will also be useful for undertaking more detailed analyses that consider, for example, the return rates to New Orleans of different populations. It is of considerable interest to many to know how return rates to the city will vary according to race, socioeconomic status, family structure, number of children, and other key demographic factors.

New Orleans before Hurricane Katrina was a poor city that was highly segregated by race and socioeconomic status (Brookings Institution, 2005). As the hurricane approached, poor residents—who were predominately African American—had more difficulty evacuating the city due to low rates of car ownership (Berube and Raphael, 2005). The stratification of the city became highly visible to the country as images were broadcast of most poor and mostly African-American residents stranded on their rooftops and

in the Superdome. Lack of transportation will also make it difficult for poor evacuees to travel back to the city to evaluate the condition of their former residences and either to begin the process of repairing their homes or to find a new place to live. Furthermore, many poor residents were tenants who, on average, paid extremely low rents. In the aftermath of Katrina, these people may no longer be able to afford the higher rents that are likely to be demanded for reconstructed dwellings in New Orleans. Finally, poor residents continue to have poor employment prospects. For these reasons, there are likely to be major demographic and socioeconomic disparities in the repopulation of New Orleans. Understanding the differences in repopulation rates by race and socioeconomic status is an important topic for future research.

Future work should also analyze the business sector and its redevelopment as a critical factor affecting the demand for labor and employment prospects for residents of New Orleans that, in turn, will shape the future population of the city. For example, a rigorous analysis of future demand could be based on the situation of, and prospects for, firms that are exporters—including first the tourism-related sector that provides goods and services to residents outside the city. These export businesses will be among the most significant drivers of the overall economic regrowth and labor demand. Other work should focus on past and present commuting patterns and the likelihood that labor demand in the city is met by hiring workers who live outside the city of New Orleans.

Finally, future work should focus on developing improved assumptions to guide the population projections. Some assumptions could no doubt be quantified better. And, of course, as time passes, we will have better insights into just how many people are returning to the city and into how employment is increasing and the reconstruction process is unfolding.

BIBLIOGRAPHY

- Avegno, Ashton, Jr., structural engineer, telephone communication, New Orleans, La., November 21, 2005.
- Andrews, Marcellus, *"Demand Surge" After Hurricanes Katrina and Rita*, New York: Insurance Information Institute, undated. Online at http://server.iii.org/yy_obj_data?binary/746643_1_0/Demand_Surge.pdf as of March 3, 2006.
- Baker, Kermit, *Economic and Construction Outlook in the Gulf States After Hurricane Katrina*, Washington, D.C.: American Institute of Architects, undated. Online at http://www.aia.org/SiteObjects/files/AIA_katrina_econ_report.pdf as of March 3, 2006.
- Barter, Mark, structural engineer, telephone communication, Mobile, Ala., November 22, 2005.
- Bachman, J., American Insurance Association, Washington, D.C., telephone communication, November 23, 2005.
- Bernstein, Jared, "Katrina Evacuees Face Extreme Levels of Joblessness," Washington, D.C.: Economic Policy Institute, November 9, 2005. Online at http://www.epi.org/content.cfm/webfeatures_snapshots_20051109 as of March 3, 2006.
- Berube, Alan, and Steven Raphael, *Access to Cars in New Orleans*, Washington, D.C.: Brookings Institution, 2005. Online at http://www.brookings.edu/metro/20050915_katrinacarstables.pdf as of March 3, 2006.
- Bohannon, John, and Martin Enserink, "Hurricane Katrina: Scientists Weigh Options for Rebuilding New Orleans," *Science*, Vol. 309, September 16, 2005, pp. 1808–1809. Online at <http://www.sciencemag.org/cgi/reprint/309/5742/1808.pdf> as of March 3, 2006.
- Brookings Institution, *New Orleans After the Storm: Lessons from the Past, a Plan for the Future*, Washington, D.C.: Metropolitan Policy Program, Brookings Institution, 2005. Online at http://www.brookings.edu/metro/pubs/20051012_NewOrleans.pdf as of March 3, 2006.
- "Building Solutions: Hurricanes Hugo and Katrina," forum, New Orleans, La.: The Ogden Museum of Southern Art, January 8, 2005.
- Centers for Disease Control and Prevention and U.S. Environmental Protection Agency, *Hurricane Katrina Response: Initial Assessment*, Environmental Health Needs and Habitability Assessment Joint Taskforce, Centers for Disease Control and Prevention and U.S. Environmental Protection Agency, 2005. Online at <http://www.bt.cdc.gov/disasters/hurricanes/katrina/pdf/envassessment.pdf> as of March 3, 2006.
- City of New Orleans, "City of New Orleans Expedited Permitting Process," undated Web page. Online at <http://www.cityofno.com/portal.aspx?portal=1&tabid=57> as of March 3, 2006.

- — —, "Situation Report for New Orleans," press release, New Orleans, La., January 3, 2006. Online at <http://www.cityofno.com/portal.aspx?portal=1&load=~PortalModules/ViewPressRelease.ascx&itmid=3365> as of March 3, 2006.
- Costa, Fernando, *Charting the Course for Rebuilding a Great American City: An Assessment of the Planning Function in Post-Katrina New Orleans*, Chicago, Ill.: American Planning Association, 2005. Online at <http://www.planning.org/katrina/pdf/rebuildingreport.pdf> as of March 3, 2006.
- Elliott, James R., and Jeremy Pais, "Race, Class and Hurricane Katrina: Social Differences in Human Response to Disaster," *Social Science Research*, forthcoming.
- El Nasser, Haya, and Paul Overberg, "Katrina Evacuees Who Can't Go Home Opt to Hang Close; Months After the Hurricane, Many Head Back to Gulf Coast," *USA Today*, February 6, 2006, p. 4A.
- EOC. See New Orleans Emergency Operations Center.
- Eskew, Allen, Director, Eskew, Dumez, Ripple, personal communication, Santa Monica, Calif., December 11, 2005.
- Federal Emergency Management Agency, *About Hurricane Katrina*, Washington, D.C.: Federal Emergency Management Agency, 2005a. Online at http://www.fema.gov/hazards/floods/recoverydata/katrina_about.shtm as of March 3, 2006.
- Federal Emergency Management Agency, *Frequently Asked Questions: Flood Map Modernization*, Washington, D.C.: Federal Emergency Management Agency, 2005b. Online at http://www.fema.gov/pdf/press/katrina_after/map_mod_faqs.pdf as of March 3, 2006.
- FEMA. See Federal Emergency Management Agency.
- Fink, A., J. Kosecoff, M. Chassin, and R. H. Brook, "Consensus Methods: Characteristics and Guidelines for Use," *American Journal of Public Health*, Vol. 74, No. 9, 1984, pp. 979–983.
- GCR and Associates, Inc. "NORA: Using What We Know to Build Strategies for the Future," unpublished data, New Orleans, La., November 21, 2005.
- Gist, Karen Taylor, "No Quick Fixes; Home Repairs Are Requiring More Time and More Money," *Times-Picayune (New Orleans)*, November 19, 2005, p. 1.
- Greenwood, Michael J., "Research on Internal Migration in the United States: A Survey," *Journal of Economic Literature*, Vol. 13, No. 2, 1975, pp. 397–433.
- — —, "Human Migration: Theory, Models, and Empirical Studies," *Journal of Regional Science*, Vol. 25, No. 4, 1985, pp. 521–544.
- Holtz-Eakin, Douglas J., "Statement of Hon. Douglas J. Holtz-Eakin, Director, Congressional Budget Office," in "After the Hurricanes: Impact on the Fiscal Year 2007 Budget: Hearing Before the Committee on the Budget, House of Representatives, One Hundred Ninth Congress, First Session, Washington, D.C., October 6, 2005. Online at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_house_hearings&docid=f:23486.pdf as of March 3, 2006.

- Katz, Bruce, Matt Fellowes, and Nigel Holmes, "The State of New Orleans," *The New York Times*, December 7, 2005, p. 33.
- Katz, Bruce, Matt Fellowes, and Mia Mabanta, *Katrina Index: Tracking Variables of Post-Katrina Reconstruction*, Washington, D.C.: Brookings Institution, 2006. Online at http://www.brookings.org/metro/pubs/200603_KatrinaIndex.pdf as of March 3, 2006.
- Kirschenbaum, A., "Residential Ambiguity and Relocation Decisions: Population and Areas at Risk," *International Journal of Mass Emergencies and Disasters*, Vol. 14, No.1, 1996, pp. 79–96.
- Kline, Robert W., Director, "Dividing Katrina's Tab," presentation at American Enterprise Institute, Washington, D.C., October 3, 2005.
- Kroll, Cynthia, John D. Landis, Qing Shen, and Sean Stryker, "Economic Impacts of the Loma Prieta Earthquake: A Focus on Small Business," *Berkeley Planning Journal*, Vol. 5, No. 1, 1990, pp. 39–58.
- Lee, Everett S., "A Theory of Migration," *Demography*, Vol. 3, No. 1, 1966, pp. 47–57.
- Linstone, Harold A., and Murray Turoff, eds., *The Delphi Method: Techniques and Applications*, Reading, Mass.: Addison-Wesley Pub. Co., 1977.
- Long, Larry, "Changing Residence: Comparative Perspectives on Its Relationship to Age, Sex, and Marital Status," *Population Studies*, Vol. 46, No. 1, 1992, pp. 141–158.
- Manning, Raymond, principal, Manning Architects, personal communication, Santa Monica, Calif., December 11, 2005.
- Marsh and McLennan Companies, *The Impact of Nature: The Aftermath of Hurricanes Katrina and Rita*, New York: Marsh and McLennan Companies, 2005.
- Massey, Douglas, "Social Structure, Household Strategies, and the Cumulative Causation of Migration," *Population Index*, Vol. 56, No. 1, 1990, pp. 3–26.
- Muir-Wood, Robert, executive vice president, Risk Management Solution Limited, personal communication, Santa Monica, Calif., December 13, 2005.
- Moran, Kate, "Shrinking City; No One Disputes That Katrina Will Reduce the Population of the New Orleans Area, But Just How Much Is Unclear," *Times-Picayune (New Orleans)*, October 23, 2005, p. 1.
- New Orleans Emergency Operations Center, *Rapid Population Estimate Survey: December 3–4, 2005*, New Orleans, La.: New Orleans Emergency Operation Center, December 19, 2005.
- Nossiter, Adam, "Thousands of Demolitions Near, New Orleans Braces for New Pain," *The New York Times*, October 23, 2005, Section 1, p. 1.
- Pace, Carl E., *Flood Proofing Tests: Tests of Materials and Systems for Flood Proofing Structures*, Springfield: National Technical Information Service, 1988.
- Ragas, Wade, real estate consultant, New Orleans, La., e-mail communication, November 29, 2005.
- Rigamer, Greg, principal, GCR and Associates, Inc., telephone communication, December 22, 2005.

- Rivlin, Gary, "In New Orleans, Housing Sales Are Bright Spot," *The New York Times*, January 1, 2006, Section 1, p. 1.
- Russell, Gordon, "2,000 Homes Face Possible Razing; But Qualifications of Inspectors Questioned," *Times-Picayune (New Orleans)*, November 5, 2005, p. 1.
- — —, "Comeback in Progress: Formal Numbers Are Hard to Come by, But One Thing's Certain: New Orleans' Population Is Coming Back More Quickly Than Expected," *Times-Picayune (New Orleans)*, January 1, 2006, p. 1.
- Russell, Gordon, and Frank Donze, "Proposal: Let Residents Decide; Well-Populated Areas Wouldn't Get Buyout," *Times-Picayune (New Orleans)*, December 19, 2005, p. 1.
- Seeman, Bruce Taylor, "Uninsured Losses Complicate Disaster Recovery," *Newhouse News Service*, October 11, 2005.
- Shalett, Karen Sommer, "To Raise or to Raze . . . That Is the Question; Experts Look at the Issues Involved in Homeowners' Decisions," *Times-Picayune (New Orleans)*, December 10, 2005, p. 1.
- Shryock, Henry S., Jacob S. Siegel, and Elizabeth A. Larmon, *The Methods and Materials of Demography*, 2nd printing, rev., Washington, D.C.: U.S. Bureau of the Census, 1973.
- Sjaastad, Larry A., "The Costs and Returns of Human Migration," *The Journal of Political Economy*, Vol. 70, No. 5, 1962, pp. 80–93.
- Smith, Stanley K., "Demography of Disaster: Population Estimates After Hurricane Andrew," *Population Research and Policy Review*, Vol. 15, Nos. 5–6, 1996, pp. 459–477.
- Smith, Stanley K., and Christopher McCarty, "Demographic Effects of Natural Disasters: A Case Study of Hurricane Andrew," *Demography*, Vol. 33, No. 2, 1996, pp. 265–275.
- Stark, Oded, *The Migration of Labor*, Cambridge, Mass.: B. Blackwell, 1991.
- Stark, Oded, and David E. Bloom, "The New Economics of Labor Migration," *The American Economic Review*, Vol. 75, No. 2, 1985, pp. 173–178.
- "State Officials Defend Katrina Response," *Reuters*, December 14, 2005, 21:53:30 GMT.
- Stundza, Tom, "Analysts: Virtually All Commodities Are Impacted," *purchasing.com*, October 6, 2005. Online at <http://www.purchasing.com/article/CA6261055.html> as of March 3, 2006.
- Tanneeru, Manav, "Atlanta's Katrina Evacuees Wary About Return Home," *CNN.com*, December 4, 2005, 7:58 a.m. EST (12:58 GMT). Online at <http://www.cnn.com/2005/US/12/03/katrina.townhall/index.html> as of March 3, 2006.
- Taylor, J. Edward, "Differential Migration, Networks, Information and Risk," *Research in Human Capital and Development*, Vol. 4, 1986, pp. 147–171.
- Thomas, Cathy Booth, "New Orleans Today: It's Worse Than You Think," *Time*, Vol. 166, No. 22, 2005, p. 30.
- Tizon, Tomas Alex, and Doug Smith, "Evacuees of Hurricane Katrina Resettle Along a Racial Divide," *Los Angeles Times*, December 12, 2005, p. A1.

- U.S. Census Bureau, Census 2000 Summary File 1 [Louisiana], 2001.
- — —, Census 2000 Technical Documentation, 2002.
- U.S. Department of Labor, Bureau of Labor Statistics, "Metropolitan Area at a Glance: New Orleans-Metairie-Kenner, LA," undated Web page. Online at http://www.bls.gov/eag/eag.la_neworleans_msa.htm as of March 3, 2006.
- Warner, Coleman, "Demographer Says Many Residents Want to Return; But Firm Numbers Are Hard to Come By," *Times-Picayune (New Orleans)*, November 12, 2005, p. 1.
- Webb, Gary R., Kathleen J. Tierney, and James M. Dahlhamer, "Predicting Long-Term Business Recovery from Disaster: A Comparison of the Loma Prieta Earthquake and Hurricane Andrew," Newark, Del.: University of Delaware Disaster Research Center, Preliminary Paper 328, 2002. Online at http://www.udel.edu/DRC/Preliminary_Papers/PP328-PredictingLong-Term.pdf as of March 3, 2006.