

(Un)natural disaster: vulnerability, long-distance displacement, and the extended geography of neighborhood distress and attainment after Katrina

Corina Graif¹

Published online: 13 August 2015
© Springer Science+Business Media New York 2015

Abstract After Hurricane Katrina, socioeconomically vulnerable populations were slow to return to their poor and segregated pre-disaster neighborhoods. Yet, very little is known about the quality of their post-disaster neighborhoods. While vulnerable groups rarely escape neighborhood poverty, some Katrina evacuees showed signs of neighborhood improvement. The current study investigates this puzzle and the significance of long-distance moves for neighborhood change among participants in the Resilience in the Survivors of Katrina Project. Seven hundred low-income, mostly minority mothers in community college in New Orleans before Katrina were tracked across the country a year and a half later. The findings show that respondents' immediate and extended neighborhoods and metropolitan areas after Katrina were less disadvantaged, less organizationally isolated, and more racially and ethnically diverse compared to their pre-hurricane environments, and to the environments of those staying or returning home. Counterfactual analyses showed that more than within-neighborhood changes over time, between-neighborhood mobility and long-distance migration decreased respondents' exposures to distress in their neighborhood, extended geographic area, and metropolitan area.

Keywords Environmental risk · Socioeconomic vulnerability · Long-distance migration · Displacement · Residential mobility · Extended neighborhood · Attainment · Natural disaster · Hurricane Katrina

✉ Corina Graif
corina.graif@psu.edu

¹ Department of Sociology and Criminology, Population Research Institute, The Pennsylvania State University, 603 Oswald Tower, University Park, PA 16802-9976, USA

Introduction

In 2005, Hurricane Katrina prompted the largest abrupt population displacement in the USA since the Dust Bowl migration of the 1930s (Falk et al. 2006; Picou and Marshall 2007). Fourteen counties, a total of 2.5 million residents, experienced flooding or structural damage (Gabe et al. 2005), and about 1.7 million individuals found themselves scattered across towns and cities in all fifty states because of Katrina (FEMA 2007). By 2008, about a third of the pre-hurricane New Orleans residents had still not returned to the city. A few noteworthy studies investigated the consequences of dislocating large population masses after Katrina and other similar major disasters (Hori and Schafer 2010; Fussell et al. 2014). They highlighted the disproportionate displacement of the socioeconomically vulnerable, who returned home slower, if at all, due to flooding and housing damage (Campanella 2007; Fussell et al. 2010; Fussell and Harris 2014; Morrow-Jones and Morrow-Jones 1991). Overall, minorities have been shown to be more affected by disasters, net of income (Brunsma et al. 2007; Elliott and Pais 2006; Falk et al. 2006; Hunter 2005; Klinenberg 2003; Sharkey 2007; Hartman and Squires 2006; Tierney 2006; Wisner et al. 2004).

This body of work generates important questions about the extent to which the residential environments that the vulnerable evacuees are able to access after the hurricane are worse, the same, or improved compared to those they lived in before the hurricane. Understanding the residential outcomes of the vulnerable and the displaced is important because, even without hurricane-related trauma and losses, exposures to neighborhood disadvantage and segregation have been shown to contribute to a broad range of negative outcomes, including unemployment (Massey and Denton 1985), school dropout, teen parenthood (Harding 2003; Wodtke 2013), poor health (Auchincloss et al. 2007; Kling et al. 2007), and crime (Peterson and Krivo 2010; Sampson et al. 2002). Tremendous challenges in locating those who did not return home or who moved far from the affected areas (Sastry 2009) have, however, limited our understanding of their experiences and the quality of their receiving neighborhoods relative to their neighborhoods before the hurricane (Asad 2014).

The present study bridges this gap by investigating the post-evacuation neighborhoods of a sample of vulnerable families displaced by Katrina (which were tracked anywhere they moved across the country) compared to their neighborhoods before Katrina and the neighborhoods of those who returned or stayed behind. Studies of residential stratification and voluntary mobility have shown that low-income minority families are less likely than their higher-income non-minority counterparts to escape neighborhood disadvantage and segregation even when they are socioeconomically mobile (Crowder and Downey 2010; Sampson and Sharkey 2008; South et al. 2005). Additionally, exposures to neighborhood distress are durable over the life course and transmitted across generations (Sharkey 2008, 2012).

Lack of improvements in neighborhood quality among vulnerable populations has been attributed in large part to geographic immobility or mobility over short distances (Keels et al. 2005; Sampson 2008, 2012). Because disadvantage and

segregation tend to cluster in extended geographic areas that encompass multiple adjacent neighborhoods (Peterson and Krivo 2010), short-distance moves will greatly limit a vulnerable family's access to non-disadvantaged and integrated neighborhoods. Rare for low-income and minority groups, long-distance moves, such as moves away from the metro area of origin to other cities and metro areas, may contribute to reductions in neighborhood poverty, segregation (Sampson and Sharkey 2008; Sharkey 2012; South and Crowder 1997, 1998), and violence (Keels et al. 2005; Sharkey and Sampson 2010).

An important question that emerges in such studies is whether the link between moving long distance and neighborhood attainment exists beyond selection due to individual vulnerabilities and environmental risks like flooding. Families who voluntarily move farther from their origin area may be more educated, smaller in size, or may have adapted to diverse neighbors before. Such characteristics may shape their ability to move farther as well as their access to more affluent and diverse places, which may confound the direct effect of distance on the quality of place.

The main research question is thus what factors contribute to *neighborhood change* for vulnerable families after Katrina, focusing specifically on the effects of *long-distance migration* (to neighborhoods outside the New Orleans metro area) compared to immobility or *short-distance mobility* (within the metro area). The sampled respondents are low-income, mostly black, single mothers, New Orleans residents, and enrolled in community college before Katrina. Neighborhood distress after Katrina and *within-neighborhood* changes pre- to post-Katrina are compared between movers and stayers, focusing specifically on neighborhood disadvantage, organizational isolation, and racial–ethnic diversity.

In addressing these questions, understanding whether some Katrina evacuees are able to move to diverse neighborhoods in other US areas is especially important given New Orleans's high poverty and racial–ethnic segregation.¹ Progress on this topic is important in starting to rewrite our legacy of disadvantage and segregation (Sharkey 2012), whereby space and place cement race- and class-based exclusion and residential stratification.

This article makes the case that Hurricane Katrina afforded opportunities to socioeconomically vulnerable families by obliging them to choose among neighborhoods in which to settle and providing them with access to disaster-related assistance that alleviated mobility constraints due to poverty. This is important because socioeconomically vulnerable families typically have few residential choices and tend to remain stuck for years or even generations in socioeconomically distressed neighborhoods (Sharkey 2008; Black et al. 2013). The US Congress has recognized poverty's constraint on mobility and funded the Moving to Opportunity (MTO) program to help low-income families move from impoverished to non-poor neighborhoods. In contrast to voluntary and randomized mobility programs such as the MTO (Graif 2015; Ludwig et al. 2012; Orr et al. 2003), post-Katrina displacement was forced and non-randomized, following a traumatizing experience

¹ Indeed, the New Orleans city neighborhoods had on average 30 % poverty, higher than Chicago (22 %) and Baltimore (24 %). The average neighborhood share of black residents was about 63 %, higher than the average US tract (14 %), Chicago (42 %), or New York (27 %).

and tremendous losses. Despite its exceptional nature, such mobility may uncover mechanisms underlying the reproduction of individual and environmental risks. Alternatively, they may inadvertently open unique opportunities for neighborhood gains for vulnerable populations (Berube and Katz 2005; Briggs 2006).

The current study contributes to the literature in several ways. First, compared to prior Katrina studies focused on individuals who returned to the affected area, this study follows respondents wherever they moved across the country after Katrina. Second, while most studies were initiated after the hurricane, the present one includes information on prior exposures. Third, this article aims to contribute to the emerging literature on *long-distance displacement* by focusing on the neighborhood changes resulting from moves in general, or specifically, moves out of the New Orleans metro area, compared to staying behind or moving within the metro area. Fourth, it contributes to the emerging literature on *extended neighborhoods* by expanding the geographic focus beyond the immediate census tract of residence to the surrounding neighborhoods and metro areas.

The logic of the specific line of questioning is as follows. First, respondents were gauged on how their vulnerabilities associated with being flooded² and on whether their post-Katrina neighborhoods were differently distressed than before, without selection adjustments. Second, the relationship between pre- to post-Katrina neighborhood change and displacement was evaluated, while accounting for selection. Selection in this context could have contributed to either: (a) increased neighborhood distress, if Katrina displaced the most disadvantaged who would have stayed in place or moved downward even without the disaster; or (b) decreased distress, if Katrina displaced mostly those who would have moved to improved neighborhoods even without the disaster. In other words, Katrina may have simply accelerated otherwise typical mobility patterns rather than changed their nature. However, net of selection, the results show that respondents' moving and moving long distances decreased neighborhood distress.

Theoretical and empirical framework

Environmental risk, vulnerability, and post-disaster migration

Racial–ethnic minorities and low-income persons have been shown to be more likely to live in disadvantaged and environmentally risky neighborhoods (Crowder and Downey 2010) and to be disproportionately affected by major disasters (Brunsma et al. 2007; Elliott and Pais 2006; Falk et al. 2006; Hunter 2005; Klinenberg 2003; Sharkey 2007; Hartman and Squires 2006; Tierney 2006; Wisner et al. 2004). African Americans represented 76 % of the residents of “deeply and persistently” flooded areas after Katrina despite being 67 % of New Orleans city's population (Campanella 2007: 714). The displaced black residents of New Orleans

² While respondents are socioeconomically vulnerable overall, there are still important dimensions of variability: only half are unemployed; some have larger earnings, fewer children, and younger ages; some have more social support from spouses or other household members; and some live in less disadvantaged neighborhoods than others.

had lived in neighborhoods that were seriously flooded and damaged, and if they returned to the city, returned slower than whites (Fussell et al. 2010).

Studies also show that fewer residents returned to the high-disadvantage compared to low-disadvantage neighborhoods (Elliott et al. 2009; Pais and Elliott 2008; Tierney 2006). As McLeman and Hunter (2010 p. 453) note, “The overall picture that emerges from Katrina [is that] particular socioeconomic and demographic groups that were economically disadvantaged or marginalized were more likely to permanently relocate elsewhere [—which underscores] the importance of underlying socioeconomic conditions on migration outcomes following extreme events.” Beyond Katrina, major disasters have been shown to disproportionately displace low-income individuals, single-parent families, blacks, the less educated, and residents of poor and segregated areas (Morrow-Jones and Morrow-Jones 1991).

Thus, in the current study,

Respondents affected more profoundly by socioeconomic and demographic disadvantage, and living in greater neighborhood poverty and segregation pre-Katrina are expected to be more likely to a) be flooded by Katrina and b) move to a different neighborhood after Katrina (hypothesis 1).

Short-distance versus long-distance migration

Short-distance and temporary moves are common following regularly occurring environmental hazards such as annual floods and cyclones (Black et al. 2013; Zaman 1991; Hunter 2005). Migration over long distances or to non-distressed neighborhood is often not feasible for vulnerable households because of disrupted social ties and prohibiting costs of moving and housing (Hunter 2005; Chan 1995). Patterns of voluntary migration and residential mobility similarly show that when low-income minority families move, they do so over short distances: (a) within the same tract (South and Crowder 1997, 1998) or (b) within the same county, city, or metro area (Sampson and Sharkey 2008; Sharkey 2012; U.S. Census Bureau 2007).

Short-distance moves are understood via several classic migration theories such as Wolpert’s (1966) stress threshold model, suggesting that families prefer to stay in a negative but familiar environment than to face the stress of long-distance migration. In Petersen’s (1958) classic migration typology, such moves are consistent with the “conservative” migration response intending to recreate the *status quo*. Further, immobility and short-distance moves are consistent with economic theories of migration (Graves 1983; Hunter 2005), which suggest that vulnerable families may accept environmental risks in exchange for affordable housing.

Migration theory and research have noted the importance of social capital and networks in shaping voluntary migration (Massey et al. 1993; Nord 1998). Immobility or short-distance mobility is thought to result from individuals’ dependencies on local kin and friends for emotional and childcare support which may facilitate staying in school or keeping a job (Cohn and Morin 2008). Similarly, after environmental hazards, short-distance moves may be related to temporarily moving in with nearby family or friends. Indeed, network ties have also been shown

to influence return patterns after post-disaster evacuations (Airriess et al. 2007; Li et al. 2010; McLeman and Hunter 2010) and environmental migration destinations (de Haas 2011; Black et al. 2011).

While less common, long-term relocation across longer distances may be unavoidable following rapid-onset disasters of large geographic scale such as Katrina. Katrina's flooding and structural damage affected about 77 % of Orleans parish's population, 96 % of St. Bernard's, 42 % of Plaquemines', 40 % of Jefferson's, and broadly 41 % of the state of Louisiana's population (Gabe et al. 2005). This likely decreased the availability of housing with friends or extended family nearby and increased evacuees' likelihood to move across great distances, away from a widely damaged city and metropolitan area. Slower returns of Katrina's evacuees to their old neighborhoods were observed and shown to be related to socioeconomic distress, racial–ethnic marginalization, and housing damage (Fussell et al. 2010; Fussell and Harris 2014; Groen and Povlika 2010; Stringfield 2009). Morrow-Jones and Morrow-Jones (1991) suggest that the poor are less likely to return home after disasters because of fewer resources to repair damages. Black et al. (2011, p. S7) also note that “displaced people may never return, because their home and livelihood have been completely destroyed, because of a fear of repeated events, or because new opportunities have arisen in their new location.” When the goal is to find a new environment of lower risk, long-distance relocation corresponds to an “innovative” migratory response in Petersen's (1958) classic migration typology. McLeman and Smit (2006) highlight migration as a complex adaptation to climate risk. In sum, the literature leads to two opposite expectations:

compared to respondents who were not flooded, those flooded are expected after Katrina to be more likely within the study's time scale to a) not move or move shorter distances or, alternatively, b) move and do so over longer distances (hypothesis 2).

The research on environmental vulnerability and post-disaster displacement tends to examine those who do not move or move short distances because of major challenges in tracking those who move long distance. Great emphasis has also been placed on local recovery after disasters, but much less work focuses on neighborhood changes experienced by those who did not return. Thus, integrating this literature with the scholarship on differential neighborhood attainment holds great potential for filling these gaps.

Restricted mobility and environmental dislocation

Spatial assimilation models of residential mobility indicate that gains in income, employment, marriage, and education increase the likelihood that families move from poor to non-poor neighborhoods (Alba et al. 1999; Massey and Denton 1985; South and Crowder 1997). For racial and ethnic minority groups, social mobility is also associated with moving from segregated to more diverse neighborhoods (Massey and Denton 1985; South and Crowder 1998).

Nonetheless, for vulnerable population groups, spatial assimilation is atypical. Disadvantaged groups move disproportionately to neighborhoods characterized by poverty, segregation, and organizational isolation. Models of place stratification (Alba and Logan 1993; Massey et al. 1994; Wilson 1987) have shown that low-earners, blacks, and women are less likely to move to non-poor, non-segregated neighborhoods and more likely to move to a different poor neighborhood, despite gains in education, employment, or income (South et al. 2005; Sharkey and Sampson 2010). Losing a job increases blacks' odds of moving from non-poor to poor tracts (South and Crowder 1997). Migration research and theories similarly highlight the differential mobility of the poor and non-poor, which results from, and reinforces, preexisting spatial differences in poverty concentration (Nord 1998).

Underlying restricted mobility patterns are systemic sociostructural barriers related to discriminatory practices in the housing and mortgage markets by landlords, real estate agents, lenders, or even neighbors (Logan and Alba 1993). Geographic exclusion further reinforces itself over time. The higher their neighborhood poverty, the lower is the likelihood of black residents to move from poor to non-poor neighborhoods. Moreover, a tract's percentage of blacks predicts blacks' lower chances of moving to mixed race or white neighborhoods (South and Crowder 1998). Hence, the restricted mobility and attainment perspective suggests that individuals' poverty and minority status predicts living in, or repeatedly moving to, poor segregated neighborhoods.

While this perspective has not been fully integrated with the post-disaster displacement literature, it makes sense that disaster-related damage compounds preexisting individual and neighborhood vulnerabilities. Thus, typical mechanisms of restricted mobility may become magnified after a hurricane, displacing evacuees to neighborhoods at least as poor and segregated as, if not worse than, their origin neighborhoods. Evidence shows that compared to other movers, disaster movers were more dissatisfied with their new housing (Morrow-Jones and Morrow-Jones 1991). Post-Katrina evacuees who re-settled in white communities in Colorado, Utah, and Texas reported racial prejudice and discrimination (GNOFHAC 2007; Hunt et al. 2009). Those who did not return to their state one year later were less likely to be employed (Zissimopoulos and Karoly 2010) and thus likely unable to afford housing in more affluent neighborhoods. Overall, this body of work suggests that

Flooded respondents will live in post-Katrina neighborhoods a) of as high, or higher disadvantage, segregation, and organizational isolation levels and b) less improving pre- to post-Katrina than the neighborhoods of the non-flooded (hypothesis 3).

Long-distance and extended neighborhood attainment

Studies show that Gulf Coast counties with lower (rather than higher) pre-hurricane proportions of disadvantaged residents experienced higher increases in population a year after Katrina (Myers et al. 2008). These findings suggest that displacement has the potential to impart neighborhood gains for some evacuees. A key driver of their

neighborhood gains may be long-distance moves, as suggested by studies of voluntary mobility.

Coulton et al.'s (2012) panel study of households in 10 US cities found that families with children who moved shorter distances (on average under two miles) did not gain in neighborhood amenities or satisfaction. Yet, those who moved greater distances (over five miles) improved their housing and neighborhood satisfaction. Clark et al. (2006, 2014) similarly found that compared to shorter-distance moves, longer-distance moves (e.g., to the suburbs or farther than 30 km) were associated with improvements in neighborhood quality. Furthermore, not moving or moving within the city has been associated with lower gains in neighborhood median income (Sampson and Sharkey 2008). Moving outside the city also decreased exposure to violence (Keels et al. 2005; Sharkey and Sampson 2010). When young adults, especially blacks, leave their county or city, they move to less poor and more racially integrated neighborhoods (Sharkey 2012). All racial and ethnic groups were found to gain in neighborhood quality as they move to less-segregated metro areas (South and Crowder 1998). Additionally, disadvantaged neighborhoods are often surrounded by other disadvantaged areas (Briggs 2006; Graif and Sampson 2009), suggesting that moving short distance reproduces neighborhood disadvantage, whereas moving farther away increases access to well-off neighborhoods.

Long-distance displacement after a major disaster may also affect neighborhood attainment through several mechanisms. First, moving farther from origin neighborhoods may open access to a wider range of neighborhood options that would not be available locally. Considering the high poverty and segregation of New Orleans, many other metro areas present better neighborhood options. Second, rental assistance and other financial and non-financial support from governmental and non-governmental organizations (McCarty et al. 2006) may enable evacuees to access housing in more distal and high-quality neighborhoods than they would be able to otherwise (U.S. Government Accountability Office 2005). Finally, the mass media's sustained attention to the hurricane's aftermath may have increased national sympathy for the flood victims, weakening housing barriers to non-distressed neighborhoods.

Extended neighborhoods If vulnerable populations typically face restricted access to affluent neighborhoods due to prohibitive housing costs or to discrimination in the housing search, an alternative choice for them may be to move to distressed yet affordable neighborhoods situated within walking distance to non-distressed and unaffordable neighborhoods. The emerging work on geographically extended neighborhoods shows great promise (Graif et al. 2014; Graif 2015; Morenoff 2003; Pattillo-McCoy 1999). For instance, Crowder and South (2008) suggest that families pay attention to the quality and demographic composition of the surrounding areas when they move from a neighborhood to another. Post-disaster evacuation may offer similar opportunities to those displaced. In sum,

Compared to similar stayers or metro-stayers, respondents who moved or left their metro area after Katrina, are expected on average a) to move to lower distress and b) to experience larger pre- to post-Katrina declines in distress at

all three geographic scales of interest—immediate and extended neighborhoods and metro areas (hypothesis 4).

Data, measures, and methods

Participants in the current study are low-income parents in New Orleans enrolled in community college in 2004–2005 before Katrina (Richburg-Hayes et al. 2009). At the time, they were between 18 and 34 years old, with at least one child, a family income below 200 % poverty level, and a high school diploma or GED. Many were African American women, and half were employed (see Table 1). For context, in

Table 1 Pre-Katrina individual and family characteristics of respondents by flooding status, moving post-Katrina, and moving out of the metro area

| | All | Non-flooded | Flooded | Non-mover | Mover | Stayed within metro | Moved out metro |
|---|-------------------|-------------------|-------------------|-------------------|-------------------|---------------------|-------------------|
| Age at the time of Katrina | 26.117 (4.468) | 26.419 (4.487) | 25.696 (4.418) | 26.296 (4.524) | 25.832 (4.423) | 26.125 (4.515) | 26.091 (4.400) |
| Male | .075 (.264) | .090 (.286) | .055 (.228) | .091 (.288) | .067 (.251) | .081 (.273) | .065 (.247) |
| Married | .191 (.393) | .220 (.415) | .147 (.355) | .204 (.404) | .160 (.367) | .197 (.398) | .178 (.383) |
| Number of children under 18 years old | 1.833 (1.056) | 1.830 (1.040) | 1.838 (1.078) | 1.819 (1.117) | 1.838 (1.036) | 1.817 (1.075) | 1.860 (1.027) |
| Household size | 3.669 (1.535) | 3.732 (1.597) | 3.581 (1.441) | 3.694 (1.522) | 3.643 (1.548) | 3.683 (1.552) | 3.649 (1.511) |
| Black | .851 (.356) | .780 (.415) | .953 (.212) | .798 (.402) | .887 (.317) | .826 (.379) | .894 (.308) |
| Hispanic | .024 (.153) | .034 (.181) | .010 (.102) | .032 (.177) | .017 (.128) | .030 (.170) | .015 (.121) |
| Speak another language at home | .071 (.257) | .071 (.256) | .072 (.258) | .072 (.260) | .065 (.246) | .067 (.250) | .078 (.269) |
| High school or GED | .967 (.180) | .964 (.186) | .970 (.171) | .975 (.156) | .956 (.205) | .967 (.179) | .966 (.182) |
| Currently employed | .515 (.500) | .530 (.500) | .494 (.501) | .533 (.500) | .501 (.500) | .519 (.500) | .507 (.501) |
| Monthly income at current or previous job | 992 (541) | 1014 (562) | 958 (508) | 1029 (572) | 951 (518) | 1006 (535) | 968 (552) |
| Income last month, if employed | 955 (497) | 977 (515) | 921 (467) | 983 (495) | 925 (512) | 964 (497) | 940 (499) |
| <i>N</i> | 960 | 558 | 401 | 362 | 505 | 606 | 352 |

The main cell values represent means or proportions. Standard deviations in parentheses

New Orleans city before Katrina, 26 % residents were in the same age group as this study's respondents 24 % of families were in poverty, 35 % of households had at least one child under 18, and 24 % had a high school diploma or equivalency. About 67 % of the population was African American, and 3 % was Hispanic. Nearly 36 % were married, and 52 % were employed.³ This study's respondents are thus not a representative sample of New Orleans population. Their baseline student status suggests higher aspirations for mobility than individuals traditionally included in residential mobility studies, limiting generalizability of the results. Nonetheless, the results will yield evidence on key factors that affected the mobility and neighborhood attainment of motivated yet vulnerable Katrina survivors.

At baseline, 1019 individuals participated in the study in 2004–2005. Of these, 711 were located again in 2006–2007. Data were collected before and after Katrina, including information on socioeconomic status and experiences such as residential location, flooding, and evacuation. Respondents' addresses at both waves were standardized and matched in ArcGIS to an ESRI-Library file with street-level information for the USA. The unmatched addresses were geocoded manually in multiple steps using resources such as American Fact Finder. The matching success rate was 100 % of the baseline sample for pre-Katrina and 88 % for post-Katrina addresses.⁴ The geo-coordinates were next merged to polygon-shaped files of US census tracts. Respondents were assigned a FIPS code at each wave based on their positioning within a census tract. Neighborhood-level information was next merged to respondents' records. The census tract measures are derived from Decennial Census (DC) data, the Neighborhood Change Database (GeoLytics 2003), and the American Community Survey (ACS) 2006–2010 normalized to 2000 tract boundaries, using code by Logan et al. (2014).⁵

Neighborhood outcomes To assess core dimensions of neighborhood distress such as socioeconomic vulnerability and social and organizational isolation—all expected to increase environmental risk such as flooding—several measures were created. First, indices of poverty and concentrated disadvantage were used, the most prevailing and intuitive measures in neighborhood research. Concentrated disadvantage is a broad concept, which incorporates poverty as well as interrelated problems such as joblessness, welfare dependency, and family instability (Wilson 1987) measured as proportions of: persons in the civil labor force who are unemployed, households with public assistance, and female-headed households with children under 18 years old, respectively. In calculating the index, each item was weighted based on a principal component analysis (PCA) of all US census tracts (Sampson et al. 1997).

Second, the social distress dimension of neighborhood quality is represented by measures of racial and ethnic segregation—often related to discrimination in the

³ Decennial Census 2000—Social Explorer Tables T: 9, 14, 15, 21, 27, 40, 69, and 179.

⁴ The latter percentage was due to (a) challenges in finding people scattered all over the country, and (b) instances of incorrect, misspelled, or incomplete addresses, which made it difficult to identify the specific tract of residence.

⁵ Caution is important in interpreting differences between ACS and DC scores as their methodologies are different in sample size, question wording, collection date, multi-year averages for small areas, and the residence rule.

housing market (Massey and Denton 1988) and negative outcomes such as crime (Peterson and Krivo 2010). At the local level, neighborhood segregation has typically been assessed simply as a function of population proportions of specific racial and ethnic groups. This study uses a composite measure that incorporates information about all racial and ethnic groups in a neighborhood, *ethnic and racial diversity index*. This was calculated as a Herfindahl concentration index (Graif and Sampson 2009; Massey and Denton 1988) which equals one minus the sum of squares of the proportions of the neighborhood population made up by each and every one of six racial–ethnic groups: non-Hispanic whites, non-Hispanic blacks, Hispanics, Asians, Native Americans, and others. The measure indicates the probability of any two randomly drawn individuals from a neighborhood to belong to different population groups. Lower scores indicate severe neighborhood segregation where one group dominates the neighborhood, while higher values indicate residential integration, with multiple groups represented equally.

Additional neighborhood measures are based on data from the US Census Bureau's Longitudinal Employer Household Dynamics (LEHD). The LEHD program matches state-level administrative data on the universe of employers and employees with business and economic censuses. *Employment density* is the number of jobs held by tract residents (independent of the jobs' location) divided by the tract population. *Job concentration* is the number of jobs located within a census tract (independent of employees' residence) divided by the tract population.

Extended neighborhood indices corresponding to all of the above distress concepts are calculated as spatially weighted averages of scores of the four census tracts closest to respondents' immediate tract. The distance is assessed based on the geographic coordinates of census tract centroids.⁶ The measures were calculated for 2004 and 2007 for all US tracts and then matched to the geographic coordinates of participants in this study at their location before and after Hurricane Katrina.⁷

Counterfactual approaches and spatial selection

Similarities and differences in vulnerability between respondents' pre- and post-Katrina neighborhood exposures are assessed using *t* tests of mean differences for paired groups. However, in estimating how flooding and moving changed respondents' neighborhood distress levels compared to what they might have experienced otherwise, a key challenge emerges. Significant differences exist in pre-Katrina neighborhoods between the flooded versus non-flooded respondents, movers versus stayers, and metro-leavers versus metro-stayers. These non-random base differences may be responsible for the changes in respondents' outcomes post-

⁶ Neighborhood contexts are typically assessed as immediate tracts of residence or as large units like counties or ZIP codes. To understand the surrounding context within walking distance, the four nearby tracts were picked here as a first test of the concept. Four is nonetheless a necessarily arbitrary number because of the scarcity of work on extended neighborhoods in spatial mobility research. It will be valuable to explore other cutoffs in the future.

⁷ In a first step, the 2000 DC population count was used as denominators for pre-Katrina measures and the 2005–2009 ACS 5-year estimates for post-Katrina measures. ACS 5-year 2006–2009 tract population estimates were also used as denominator for post-Katrina measures, with little change in results.

Katrina, making it difficult to differentiate them from the direct locational effects of mobility after the hurricane.

To address this problem, a counterfactual methodology (Morgan and Winship 2007) was applied. The benefit of this approach compared to more standard approaches such as ordinary least squares regression is that the effects of mobility or a related treatment of interest are assessed by comparing outcomes only among respondents who are closely comparable based on baseline characteristics. Respondents who are not comparable are dropped from this analysis. Comparability was assessed based on propensity score analyses (Kuhn et al. 2011) applied in three sets of analyses, each corresponding to a different “treatment.” A first treated group is distinguished among respondents *flooded* during Katrina—in contrast to a *non-flooded* control group. The second treated group is identified among *movers*, respondents who moved out of their pre-hurricane neighborhood—in contrast to a control group of *stayers*, who did not move out or who returned to the baseline neighborhood within the study’s time span. The third treated group is *metro-leavers*, who moved out of the New Orleans metro area—in contrast to a control group of *metro-stayers*, who stayed in or moved within the metro area.

The first step of this methodology uses logistic regression to estimate the predicted probability of a respondent’s treatment as a function of observed covariates such as the baseline neighborhood’s disadvantage or poverty levels; population density; racial and ethnic diversity score; the pre-Katrina measure corresponding to the dependent variable; and a set of individual measures such as age, household size, race, ethnicity, gender, marital status, employment status, and earnings. When moving is the treatment, flooding is included as a control. These models estimate variations in the immediate and the extended neighborhoods of residence after Katrina.

In the second step, the treated observations are matched with the rest based on treatment probabilities estimated in the first step, using Stata’s *psmatch2* (Leuven and Sianesi 2014). The treated are matched one to one to the nearest neighbor, with replacement. The difference between the neighborhood characteristics of the treated compared to those of the control is the average effect of treatment on the treated. To examine the extent to which this procedure is successful in correcting the bias, covariate balance across treatment groups is assessed by calculating the percentage reduction in absolute standardized bias after matching compared to before (Rosenbaum 2002; Rosenbaum and Rubin 1985). If improvements in spatial context result from individual and contextual socioeconomic characteristics typically associated with geographic mobility, as the spatial assimilation perspective suggests, the effect of moving on neighborhood gains should wither away when comparing matched groups.

In brief, the analytical strategy is as follows. First, whether the most vulnerable families in this sample lived in environmentally risky neighborhoods flooded by Katrina and were mobile is explored; individual and family characteristics at baseline are compared without adjustments between the flooded and non-flooded, movers and stayers, and metro-leavers and metro-stayers (Table 1). Second, neighborhood change between pre- and post-Katrina locations of respondents is

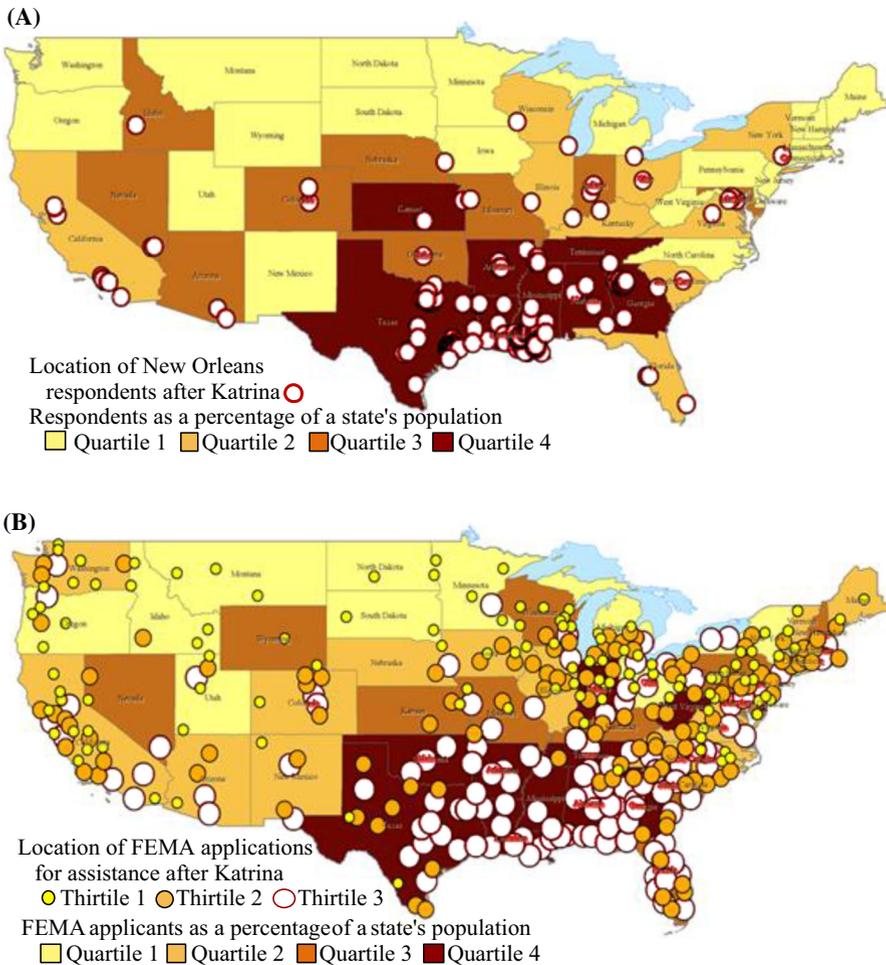


Fig. 1 **a** US spatial distribution of New Orleans respondents after Katrina. *Dots* represent respondents' post-Katrina locations. *Darker* shades represent higher quartiles of relocated respondents relative to the population of the relocation state. **b** US spatial distribution of individual applications for assistance from FEMA in 2007. The size of a *dot* reflects the number of applications per CBSA area. The larger the *dot*, the higher the number of applications. The *darker* the *polygon* shade, the higher the quartile of FEMA applications relative to the population of the relocation state

assessed (Table 2). Third, to investigate the extent to which flooding influenced outcomes, neighborhood changes over time are compared between the flooded and non-flooded (Fig. 2). Fourth, to assess whether any variation in mobility outcomes shaped by Katrina's flooding remained after adjusting for selection due to vulnerability, propensity score analyses are conducted in predicting: flooding, moving, and metro leaving (Table 3). These results are then used in counterfactual matching to estimate whether the effects of moving and moving longer distances on

Table 2 Characteristics of respondents' neighborhoods of residence before and after Katrina^a

| | Pre-Katrina neighborhoods | Post-Katrina neighborhoods | Paired difference |
|--|---------------------------|----------------------------|-------------------|
| Neighborhood socioeconomic indicators | | | |
| Median family income | 33,694 (13,834) | 38,312 (15,927) | 4438 (16,675)** |
| Prop. of persons in poverty | .260 (.145) | .218 (.142) | -.040 (.143)** |
| Unemployment rate | .101 (.061) | .087 (.055) | -.014 (.059)** |
| Prop. female-headed families with kids | .463 (.177) | .399 (.179) | -.061 (.175)** |
| Prop. households with public assistance | .139 (.080) | .110 (.080) | -.029 (.086)** |
| Concentrated disadvantage | | | |
| Disadvantage index | 1.089 (1.158) | .648 (1.155) | -.426 (1.190)** |
| Poverty less than 20 % | .411 (.492) | .536 (.499) | .119 (.505)** |
| Poverty more than 40 % | .145 (.352) | .107 (.310) | -.043 (.349)** |
| Disadvantage in upper 5 % of US tracts | .211 (.408) | .136 (.343) | -.073 (.376)** |
| Ethnic and racial composition | | | |
| Prop. non-Hisp whites | .301 (.280) | .392 (.286) | .087 (.273)** |
| Prop. non-Hisp blacks | .626 (.314) | .477 (.320) | -.142 (.328)** |
| Prop. Hispanics | .042 (.043) | .086 (.119) | .043 (.122)** |
| Prop. first-generation immigrants | .048 (.049) | .085 (.097) | .035 (.100)** |
| Ethnic and racial diversity index | .344 (.199) | .417 (.195) | .067 (.206)** |
| Neighborhood size | | | |
| Total population (a) | 4350 (2009) | 4918 (3299) | 553 (3559)** |
| Population density (a) | 6880 (5569) | 4560 (3399) | -2321 (5445)** |
| Educational structure | | | |
| Prop. with a college degree or higher | .153 (.109) | .179 (.127) | .026 (.132)** |
| Employment density | | | |
| Employment density | .412 (.063) | .421 (.091) | .009 (.101)* |
| Extended neighborhood employment density | .433 (.468) | .490 (.634) | .065 (.724)** |
| Job concentration | | | |
| Job concentration | .374 (1.191) | .436 (1.072) | .049 (1.541) |
| Extended neighborhood job concentration | .526 (1.262) | 3.556 (43.131) | 3.020 (43.17)* |

$p < .10$; * $p < .05$; ** $p < .01$

^a Main cell values represent averages. Standard deviation in parentheses

decline in neighborhood and metropolitan distress exist above and beyond selection. Between-group differences in neighborhood, extended, and metro area outcomes after Katrina are assessed (Tables 4, 6) as are within-individual differences in outcomes pre- to post-Katrina (Table 5).

Findings

Respondents were widely distributed across New Orleans before the hurricane and exposed to a range of neighborhood poverty levels. About 40 % were flooded by Katrina. Analyses of their post-disaster dispersion across the country (Fig. 1) show a wide geographic distribution across the USA which overlaps proportionally well with the spatial distribution of applicants for Katrina-related FEMA assistance (2007). Of the 1.7 million FEMA applications, over 75 % were from metropolitan areas (CBSAs) with at least 50,000 residents. Many were from states such as Texas, Mississippi, Alabama, Georgia, Florida, and California, and metro areas such as Baton Rouge, Gulfport-Biloxi, Houston, Atlanta, Los Angeles, Chicago, and New York.

How do respondents fare on neighborhood distress levels after Katrina compared to before Katrina? Within-individual comparisons over time show that respondents’

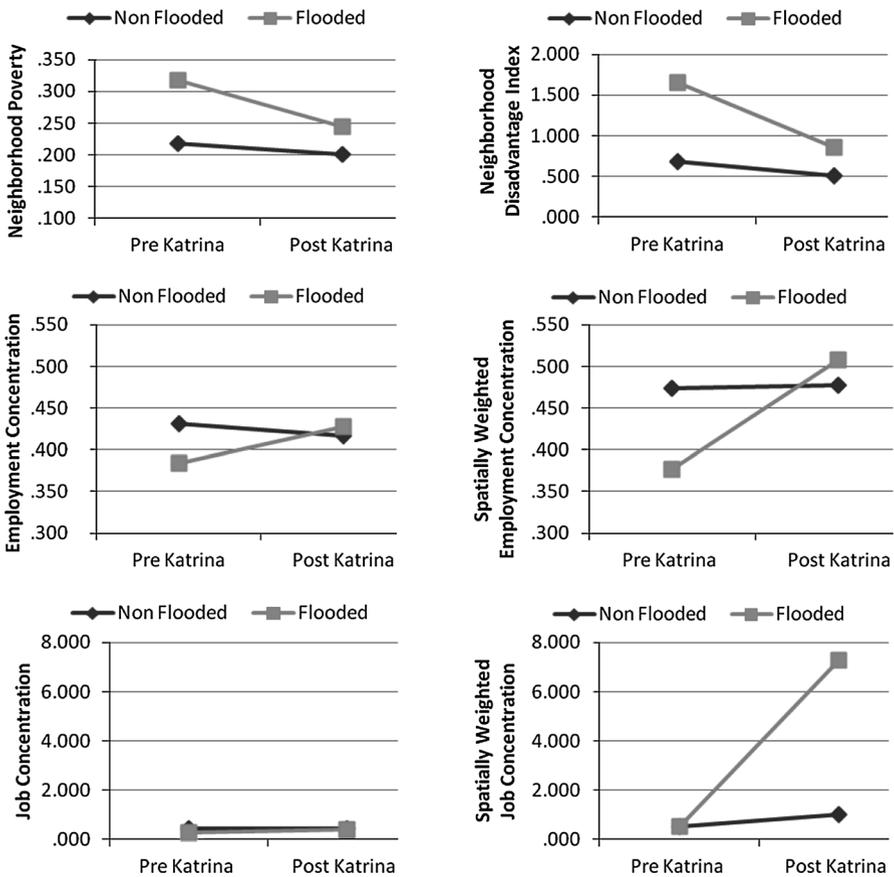


Fig. 2 Respondents’ scores on immediate and extended (spatially weighted) neighborhood indices of poverty, concentrated disadvantage, neighborhood employment, and job concentration before and after Katrina (whether they moved or not across the country after Katrina)

post-Katrina neighborhoods were on average significantly less poor, have a higher median family income, are more densely populated, and have a lower unemployment rate than pre-Katrina (Table 2). Respondents still lived in predominantly minority areas; yet, the destination neighborhoods were more racially and ethnically diverse—with about nine percentage points more non-Hispanic whites, 14

Table 3 Logistic regression analyses of flooding during Katrina, moving away from the pre-Katrina neighborhood, and moving to a neighborhood outside the New Orleans metropolitan area

| | Flooded | Moved | Moved out of metro |
|-----------------------------------|------------------------------|------------------|--------------------|
| Individual characteristics | | | |
| Gender | −.071 (.419) | −.021 (.304) | −.042 (.325) |
| Hispanic | −1.222 (1.306) | .085 (.550) | −.258 (.695) |
| Black | 1.790** (.446) | .559* (.253) | .425 (.286) |
| Age at the time of Katrina | .004 (.024) | −.002 (.019) | .015 (.019) |
| Household size pre-Katrina | −.084 (.076) | −.007 (.054) | .011 (.056) |
| Marital status pre-Katrina | .167 (.289) | −.279 (.210) | −.176 (.223) |
| Employment status pre-Katrina | −.403 [#] (.220) | −.081 (.164) | −.179 (.168) |
| Earnings pre-Katrina ^a | −.155 (.219) | −.246 (.156) | −.249 (.167) |
| Flooded during Katrina | | .609** (.215) | .633** (.214) |
| Neighborhood contexts pre-Katrina | | | |
| Population density ^a | .295** (.033) | .025 (.019) | .001 (.019) |
| Concentrated disadvantage | −.110 (.128) | −.213* (.095) | .036 (.098) |
| Racial and ethnic diversity | −6.456** (.702) | −.668 (.535) | .173 (.557) |
| Constant | −1.192 (.824) | .362 (.601) | −1.398* (.631) |
| Log likelihood | −275.571 | −445.009 | −428.436 |
| Pseudo <i>R</i> -squared | .395 | .042 | .034 |

Standard errors in parentheses

[#] $p < .10$; * $p < .05$; ** $p < .01$

^a Coefficients and standard errors multiplied by 1000

Table 4 Counterfactual estimations of respondents' neighborhood characteristics after Katrina as a function of flooding, moving, and moving out of the metro area

| | Neighborhood poverty | | Concentrated disadvantage | | Racial and ethnic diversity | | Employment density | | Job concentration | |
|--|----------------------|---------|---------------------------|---------|-----------------------------|---------|--------------------|---------|-------------------|--------------------|
| | Unmatched | Matched | Unmatched | Matched | Unmatched | Matched | Unmatched | Matched | Unmatched | Matched |
| <i>Post-Katrina immediate neighborhood</i> | | | | | | | | | | |
| Flooding ^a | | | | | | | | | | |
| Flooded | .249 | .249 | .893 | .893 | .366 | .366 | .425 | .425 | .400 | .400 |
| Non-flooded | .200 | .289 | 1.280 | .506 | .446 | .303 | .416 | .370 | .475 | .356 |
| Difference | .049** | -.040 | -.387 | .387** | -.079** | .064 | .009 | .055** | -.075 | .044 |
| Cov. lbiasl reduction | 50.50 % | | 43.30 % | 43.30 % | | | 60.2 % | 60.2 % | 56.0 % | 56.0 % |
| Moving ^b | | | | | | | | | | |
| Movers | .192 | .192 | .398 | .398 | .447 | .447 | .424 | .424 | .451 | .451 |
| Stayers | .255 | .269 | 1.084 | 1.013 | .370 | .319 | .413 | .422 | .441 | .351 |
| Difference | -.063** | -.076** | -.687** | .615** | .077** | .128** | .012 [#] | .003 | .010 | .099 |
| Cov. lbiasl reduction | 48.10 % | | 69.90 % | 69.90 % | | | 68.4 % | 68.4 % | 67.0 % | 67.0 % |
| Moving out of metro ^b | | | | | | | | | | |
| Metro-leavers | .171 | .171 | .151 | .151 | .472 | .472 | .429 | .429 | .445 | .445 |
| Metro-stayers | .245 | .266 | 1.097 | .930 | .384 | .349 | .415 | .406 | .447 | .474 |
| Difference | -.074** | -.095** | -.946** | .779** | .088** | .123** | .014* | .023* | -.002 | -.028 |
| Cov. lbiasl reduction | 62.90 % | | 68.80 % | 68.80 % | | | 72.9 % | 72.9 % | 57.0 % | 57.0 % |
| <i>Post-Katrina extended neighborhood</i> | | | | | | | | | | |
| Flooded ^a | | | | | | | | | | |
| Flooded | .226 | .226 | .731 | .731 | .347 | .347 | .530 | .530 | 9.548 | 9.548 |
| Non-flooded | .176 | .235 | .808 | .328 | .417 | .417 | .447 | .408 | .486 | .487 |
| Difference | .050** | -.008 | -.078 | .403** | -.069 [#] | -.073** | .082 [#] | .122* | 9.061* | 9.061 [#] |
| Cov. lbiasl reduction | 74.40 % | | 91.20 % | 91.20 % | | | 82.7 % | 82.7 % | 35.0 % | 35.0 % |

Table 4 continued

| | Neighborhood poverty | | Concentrated disadvantage | | Racial and ethnic diversity | | Employment density | | Job concentration | |
|---------------------------------|----------------------|---------|---------------------------|---------|-----------------------------|---------|--------------------|---------|-------------------|--------------------|
| | Unmatched | Matched | Unmatched | Matched | Unmatched | Matched | Unmatched | Matched | Unmatched | Matched |
| Moved ^b | | | | | | | | | | |
| Movers | .177 | .177 | .301 | .301 | .414 | .414 | .514 | .514 | 6.513 | 6.513 |
| Stayers | .222 | .252 | .737 | .952 | .361 | .314 | .431 | .439 | .485 | .453 |
| Difference | -.044** | -.075** | -.437** | -.652** | .053** | .100** | .082 [#] | .075* | 6.028 | 6.060 [#] |
| Cov. lbiasl reduction | 63.00 % | | 75.10 % | | 56.10 % | | 80.4 % | | 75.0 % | |
| Moved out of metro ^b | | | | | | | | | | |
| Metro-leavers | .157 | .157 | .067 | .067 | .448 | .448 | .541 | .541 | 10.420 | 10.420 |
| Metro-stayers | .217 | .243 | .711 | .894 | .361 | .340 | .445 | .423 | .482 | .724 |
| Difference | -.060** | -.087** | -.643** | -.827** | .087** | .109** | .095* | .117* | 9.939* | 9.696 [#] |
| Cov. lbiasl reduction | 68.80 % | | 70.70 % | | 76.50 % | | 66.4 % | | 37.0 % | |

[#] $p < .10$; * $p < .05$; ** $p < .01$

^a Propensity scores are based on respondents' neighborhood characteristics at baseline: concentrated disadvantage (or poverty), population density, and ethnic and racial diversity; on respondents' characteristics: age, gender, marital status, household size, racial and ethnic status, employment status, and income; and on the baseline values of the dependent variable

^b Propensity scores are based on the same covariates as in a plus flooding status

Table 5 Counterfactual estimates of change in neighborhood attributes between pre- and post-Katrina locations of respondents, before and after propensity score matching

| | Sample | Treated | Controls | Difference |
|--|-----------|---------|----------|---------------------------|
| <i>Change in poverty</i> | | | | |
| Immediate neighborhood | | | | |
| Flooded versus non-flooded | Unmatched | -.061 | -.016 | -.045 (.012)** |
| | Matched | -.061 | -.107 | .045 (.032) |
| Movers versus stayers | Unmatched | -.050 | -.011 | -.039 (.012)** |
| | Matched | -.050 | .006 | -.056 (.014)** |
| Metro-leavers versus metro-stayers | Unmatched | -.065 | -.017 | -.048 (.012)** |
| | Matched | -.065 | -.026 | -.039 (.017)* |
| Extended neighborhood | | | | |
| Flooded versus non-flooded | Unmatched | -.068 | -.001 | -.067 (.009)** |
| | Matched | -.068 | -.060 | -.008 (.022) |
| Movers versus stayers | Unmatched | -.041 | -.007 | -.035 (.009)** |
| | Matched | -.041 | -.008 | -.033 (.010)** |
| Metro-leavers versus metro-stayers | Unmatched | -.060 | -.009 | -.052 (.009)** |
| | Matched | -.060 | -.020 | -.040 (.013)** |
| <i>Change in disadvantage</i> | | | | |
| Immediate neighborhood | | | | |
| Flooded versus non-flooded | Unmatched | -.845 | -.357 | -.488 (.090)** |
| | Matched | -.845 | -.784 | -.061 (.247) |
| Movers versus stayers | Unmatched | -.705 | -.321 | -.383 (.089)** |
| | Matched | -.705 | -.308 | -.396 (.103)** |
| Metro-leavers versus metro-stayers | Unmatched | -.841 | -.383 | -.458 (.092)** |
| | Matched | -.841 | -.587 | -.254 (.132) [#] |
| Extended neighborhood | | | | |
| Flooded versus non-flooded | Unmatched | -.806 | -.298 | -.508 (.069)** |
| | Matched | -.806 | -.794 | -.012 (.162) |
| Movers versus stayers | Unmatched | -.620 | -.317 | -.303 (.069)** |
| | Matched | -.620 | -.323 | -.297 (.076)** |
| Metro-leavers versus metro-stayers | Unmatched | -.780 | -.337 | -.443 (.071)** |
| | Matched | -.780 | -.291 | -.489 (.095)** |
| <i>Change in ethnic and racial diversity</i> | | | | |
| Immediate neighborhood | | | | |
| Flooded versus non-flooded | Unmatched | -.011 | .024 | -.035 (.009)** |
| | Matched | -.011 | .082 | -.093 (.026)** |
| Movers versus stayers | Unmatched | .002 | .024 | -.023 (.009)* |
| | Matched | .002 | .029 | -.027 (.012)* |
| Metro-leavers versus metro-stayers | Unmatched | .009 | .011 | -.002 (.009) |
| | Matched | .009 | .005 | .004 (.013) |
| Extended neighborhood | | | | |
| Flooded versus non-flooded | Unmatched | .146 | .052 | .094 (.013)** |
| | Matched | .146 | .186 | -.040 (.039) |

Table 5 continued

| | Sample | Treated | Controls | Difference |
|------------------------------------|-----------|---------|----------|---------------|
| Movers versus stayers | Unmatched | .127 | .035 | .092 (.013)** |
| | Matched | .127 | .015 | .112 (.013)** |
| Metro-leavers versus metro-stayers | Unmatched | .176 | .041 | .135 (.012)** |
| | Matched | .176 | .061 | .114 (.017)** |

Standard errors in parentheses. Estimates are based on Decennial Census 2000 for pre-Katrina neighborhood estimates and ACS 2006–2010 normalized to 2000 boundaries for post-Katrina estimates

$p < .10$; * $p < .05$; ** $p < .01$

percentage points fewer non-Hispanic blacks, and four percentage points more Hispanics according to 2000 Census data. Respondents' neighborhoods post-Katrina exhibited median family incomes of \$4400 higher than pre-Katrina, the equivalent of the median family in the neighborhood earning a month and a half of extra income each year. Additionally, the concentrated disadvantage exposure dropped by almost half a standard deviation. Pre-Katrina, about 14.5 % of the respondents lived in neighborhoods of extreme poverty (poverty rate over 40 %), while after Katrina, 11 % lived in such neighborhoods. Before Katrina, more than 21 % of the respondents lived in neighborhoods in the upper 5 % of disadvantage of US tracts, yet 7 percentage points fewer did so post-Katrina. In other words, out of over 200 families in this study who lived in extremely disadvantaged neighborhoods before Katrina, about 70 escaped exposures to extreme disadvantage after Katrina. The average poverty rate dropped from 26 % to about 22 %. This indicates that on average, respondents lived around about 200 fewer neighbors in poverty.⁸ The improvement in the spatially weighted employment density in the *extended neighborhoods* of over 6.5 % is even larger than in the immediate neighborhoods. Similarly, the job concentration in the extended neighborhoods increases to over 3.5 local jobs per resident, despite nonsignificant immediate neighborhood changes. Overall, the pre- to post-Katrina declines in neighborhood disadvantage, organizational isolation, and segregation, while sometimes small, are significant ($p < .01$) and wide-ranging.

How was flooding associated with pre- to post-Katrina neighborhood changes? The flooded families improved their neighborhoods post-Katrina on multiple dimensions. They shed on average five percentage points more in neighborhood poverty than the non-flooded families, narrowing the neighborhood poverty gap between the flooded and non-flooded from 10 percentage points pre-Katrina to four percentage points after Katrina. A similar pattern emerges with respect to declines in neighborhood disadvantage. While the flooded respondents had lower employment concentration in their immediate and surrounding neighborhoods before Katrina compared to the non-flooded, they close the gap after Katrina. Additionally, while no difference in immediate job concentrations among the two groups exists before and after Katrina, the job concentration in the flooded respondents' post-

⁸ Average 4 % difference in poverty rate \times average 5000 tract residents = about 200 fewer poor neighbors.

Katrina extended neighborhoods becomes six times larger compared to the non-flooded (Fig. 2). These findings inform the third and fourth hypotheses, suggesting that, while some immediate neighborhood distress factors (e.g., job concentration) did not change much with Katrina's flooding, improvements occurred within walking distance in the surrounding environments.

Socioeconomic vulnerabilities and environmental hazard impact

How are respondents' socioeconomic vulnerabilities associated with Katrina's flooding? Simple paired comparisons indicate that before the hurricane, the flooded lived in neighborhoods that were considerably more crowded, disadvantaged, and racially segregated, consistent with the first hypothesis. For example, before Katrina, the neighborhoods of the flooded respondents had 32 % residents in poverty and about 85 % non-Hispanic blacks while those of the non-flooded had on average 10 percentage points fewer residents in poverty and about 38 percentage points fewer non-Hispanic blacks. Logistic regression analyses (Table 3) similarly showed that non-Hispanic black respondents, those unemployed before Katrina, and those living in dense and segregated neighborhoods at baseline were more likely to be flooded by Katrina. The significant relationship between neighborhood disadvantage and flooding documented in Fig. 2 weakened after controlling for neighborhood racial and ethnic composition.

A similar pattern emerges when estimating the probability of respondents moving to a different neighborhood after Katrina and not returning to their pre-Katrina neighborhood during the study. When flooding is controlled, the roles of employment and neighborhood racial and ethnic status are weakened to nonsignificance, while the role of neighborhood disadvantage becomes significant in predicting mobility. Flooding is robust to controls in predicting moving and moving outside the metro area, consistent with the second version of hypothesis 2.

The findings are thus consistent with prior work showing that flooding did not occur randomly across space. Are, then, the effects of flooding and subsequent mobility on respondents' neighborhood outcomes robust after accounting for spatial selection bias? If people live in poor neighborhoods because they cannot afford housing in other neighborhoods, the post-Katrina neighborhood outcomes of flooded respondents are expected to look the same as those of the non-flooded, if not worse. Propensity score matching is implemented to adjust for a battery of possible individual and neighborhood selection factors pre-Katrina. Logistic regression (Table 3) is used to balance the covariates to match comparable controls with those who were flooded, moved, or moved away from the metro area of New Orleans, respectively. The median reduction in absolute bias varies between 43 and 91 % in estimating post-hurricane poverty, disadvantage, and racial and ethnic diversity and between 35 and 82 % in estimating employment density and job concentrations in the immediate or extended neighborhoods.⁹ Based on similar propensity score

⁹ Matching yielded 683 observations in the region of common support and reduced significantly the individual and neighborhood differences between the treatment and control groups. For instance, the average pre-Katrina neighborhood poverty became 32 % for the flooded, no different from the non-

models, movers were also matched to equivalent stayers and metro-leavers with equivalent metro-stayers.

The counterfactual estimates indicate that, in contrast to the significant unadjusted differences, comparisons of flooded with non-flooded respondents matched for similarity at baseline reveal no significant differences in post-Katrina exposure to neighborhood poverty, concentrated disadvantage, or immediate neighborhood diversity (Table 4). These findings indicate that the significant unadjusted differences in means between the flooded and the non-flooded are explained by self-selection into the most environmentally risky neighborhoods. Even more, the matched flooded respondents compared to the non-flooded exhibit 5.5 and 12.2 % higher employment densities post-Katrina in the immediate and extended neighborhoods and marginally higher job concentration in the extended neighborhood. Overall, the results indicate that the gaps in neighborhood distress before Katrina between the flooded and the non-flooded become narrow to nonsignificant after Katrina, and in many respects, neighborhoods improve for the flooded. These patterns are inconsistent with the third hypothesis (which predicted a negative effect of flooding on post-Katrina neighborhood quality and change over time). Given that flooding contributed to moving, this surprising flooding effect may be related to a positive effect of moving on neighborhood quality.

Indeed, when comparing movers with equivalent stayers, moving led to significantly lower immediate neighborhood poverty and disadvantage, and marginally higher population diversity. Moving also contributed to exposures to lower *extended* neighborhood poverty, disadvantage, segregation, and higher employment density, as well as statistically marginal increases in extended job concentrations (Table 4). Moving to neighborhoods outside the metro area contributed to even larger neighborhood gains post-Katrina compared to those who moved or stayed within the New Orleans metro area. These findings are consistent with hypothesis 4.

To also account for *within-neighborhood change*, measures based on normalized ACS 2006–2010 data were next used to characterize post-Katrina locations. While differences between groups were somewhat smaller with ACS estimates compared to only using DC, the results (not shown) indicate the same patterns.

Are neighborhood changes between the pre- and post-Katrina for the flooded, movers, and metro leavers larger compared to their matched counterparts? Table 5 shows results from matching estimations of the pre- to post-Katrina neighborhood changes by treatment category. For the flooded, the pre- to post-neighborhood changes tend to be nonsignificantly different from their matched counterparts, inconsistent with the restricted mobility hypothesis 3, with the exception of immediate racial and ethnic diversity. The pre- to post-Katrina improvements remain significantly and consistently higher for movers and metro-leavers compared to stayers and metro-stayers, respectively—in line with the fourth hypothesis.

Footnote 9 continued

flooded. Similarly, post-matching differences were nonsignificant in neighborhood income, disadvantage, female-headed households, households with public assistance, and percent college graduates. The difference in racial and ethnic diversity by flooding narrowed considerably but did not disappear. Importantly, matching movers with stayers, and metro-leavers with metro-stayers, reduced to nonsignificant differences in neighborhood socioeconomic as well as racial–ethnic characteristics.

Exploring mechanisms of attainment

What are some of the factors contributing to post-Katrina neighborhood improvements? One important possible mechanism of attainment is improvement in the range of neighborhood options as a result of moving long distance. People who moved to a new metropolitan area may have encountered wider choices of neighborhoods than available in New Orleans. Indeed, the results show that respondents' metro areas post-Katrina were significantly improved on all dimensions of distress (poverty, disadvantage, segregation, employment density, and job concentration) for movers and metro-leavers compared to stayers and metro-stayers, respectively. This is the case before and after propensity score matching adjustments and independent of the data source used (Decennial Census 2000 or ACS 2006–2010) (Table 6). Similarly, supplementary analyses show that compared to metro-stayers, the metro-leavers are more likely to move post-Katrina into a lower poverty quartile of metro neighborhoods (41 vs. 21 %) and less likely to stay in the same poverty quartile (33 vs. 44 %) or to move into a higher quartile (27 vs. 35 %) (results available per request).

Another possible mechanism of attainment was housing assistance. While the survey responses on FEMA assistance are limited to less than half of the respondents, they indicate that respondents who moved or moved out of the metro area after Katrina did indeed receive more support (money, including for living expenses) from FEMA and non-FEMA organizations. Nonetheless, net of assistance (amount of money, any money received, or weeks of assistance), the results (not included) still show neighborhood gains, suggesting that disaster assistance works in combination with other key factors such as long-distance moves. Gaining employment was a next obvious suspect, but results (not shown) indicate that the neighborhood attainment occurred despite *losing* employment after Katrina.

Discussion

This study investigated the factors that affected neighborhood change for vulnerable respondents displaced from New Orleans by Hurricane Katrina. The results suggest important effects of long-distance mobility on neighborhood attainment after the shock of the disaster. Four main patterns emerged. First, the analyses showed that respondents' experience of flooding was associated with socioeconomic and environmental vulnerability, consistent with the study's first hypothesis. The highest likelihood of flooding in this sample was seen among African Americans and the unemployed respondents who lived in densely populated neighborhoods with low racial and ethnic diversity. While African American and low-income families were overrepresented in this study's sample, sufficient variation exists to identify meaningful patterns. These findings are consistent with prior research on Katrina (Brunsma et al. 2007; Falk et al. 2006; Sharkey 2007), on other environmental disasters (Hunter 2005; Hartman and Squires 2006; Tierney 2006; Wisner et al. 2004), and on residential attainment (Crowder and Downey 2010). They highlight

Table 6 Counterfactual estimates of respondents' metropolitan area attributes post-Katrina after propensity score matching on individual and neighborhood characteristics at baseline

| | Sample | Treated | Controls | Difference |
|--|---------|---------|----------|----------------|
| <i>Metropolitan average neighborhood poverty</i> | | | | |
| Decennial Census 2000 | | | | |
| Flooded versus non-flooded | Matched | .183 | .197 | -.014 (.007)* |
| Movers versus stayers | Matched | .174 | .211 | -.037 (.002)** |
| Metro-leavers versus metro-stayers | Matched | .147 | .212 | -.065 (.002)** |
| American Community Survey 2006–2010 | | | | |
| Flooded versus non-flooded | Matched | .183 | .188 | -.004 (.003) |
| Movers versus stayers | Matched | .180 | .191 | -.012 (.001)** |
| Metro-leavers versus metro-stayers | Matched | .171 | .192 | -.021 (.002)** |
| <i>Metropolitan average neighborhood disadvantage</i> | | | | |
| Decennial Census 2000 | | | | |
| Flooded versus non-flooded | Matched | .267 | .372 | -.106 (.047)* |
| Movers versus stayers | Matched | .208 | .456 | -.249 (.016)** |
| Metro-leavers versus metro-stayers | Matched | .003 | .468 | -.465 (.013)** |
| American Community Survey 2006–2010 | | | | |
| Flooded versus non-flooded | Matched | .148 | .196 | -.048 (.031) |
| Movers versus stayers | Matched | .116 | .234 | -.118 (.013)** |
| Metro-leavers versus metro-stayers | Matched | .000 | .246 | -.246 (.013)** |
| <i>Metropolitan average neighborhood ethnic and racial diversity</i> | | | | |
| Decennial Census 2000 | | | | |
| Flooded versus non-flooded | Matched | .348 | .331 | .017 (.011) |
| Movers versus stayers | Matched | .356 | .311 | .045 (.004)** |
| Metro-leavers versus metro-stayers | Matched | .388 | .311 | .078 (.005)** |
| American Community Survey 2006–2010 | | | | |
| Flooded versus non-flooded | Matched | .390 | .373 | .016 (.011) |
| Movers versus stayers | Matched | .399 | .354 | .045 (.003)** |
| Metro-leavers versus metro-stayers | Matched | .431 | .353 | .078 (.005)** |
| <i>Metropolitan average employment density</i> | | | | |
| Longitudinal employer household dynamics 2007 and ACS 2006–2010 | | | | |
| Flooded versus non-flooded | Matched | .451 | .446 | .006 (.004) |
| Movers versus stayers | Matched | .453 | .448 | .005 (.002)** |
| Metro-leavers versus metro-stayers | Matched | .457 | .448 | .009 (.003)** |
| <i>Metropolitan average job concentration</i> | | | | |
| Longitudinal employer household dynamics 2007 and ACS 2006–2010 | | | | |
| Flooded versus non-flooded | Matched | 1.287 | .891 | .396 (.244) |
| Movers versus stayers | Matched | 1.429 | .841 | .588 (.212)** |
| Metro-leavers versus metro-stayers | Matched | 1.801 | .850 | .951 (.354)** |

Standard errors in parentheses. ACS 2006–2010 estimates are normalized to 2000 boundaries

$p < .10$; * $p < .05$; ** $p < .01$

the unnatural consequences of “natural disasters,” which affect socioeconomically vulnerable individuals and communities most profoundly (Campanella 2007).

Second, the results show that Katrina’s flooding led respondents to move away from their neighborhood of origin and outside the New Orleans metro area where they were found between one and one and a half years after the disaster. That flooding significantly increased the chances of all respondents and their families to move, even those living in disadvantaged neighborhoods, suggests that it displaced families that may not have moved otherwise (or would not have moved out of neighborhood disadvantage). Still, higher pre-Katrina levels of neighborhood disadvantage made it less likely that respondents would move after the hurricane.

Third, the analyses showed evidence that, after Katrina, respondents who moved during the duration of the study did so to better quality neighborhoods than they originally lived in or they may have moved to otherwise. The neighborhood changes are similar to those in the MTO intervention (Ludwig et al. 2008). The counterfactual approach adjusted for individual and spatial risk factors and restricted the analyses to closely similar groups. Yet, the positive locational outcomes were retained. The new neighborhoods of residence remained significantly less disadvantaged and situated in closer proximity to higher employment densities. While, generally, counterfactual analyses require caution as the covariate balance is based only on observed measures, overall, the results are robust in indicating that neighborhood moves and long-distance moves lead to spatial gains.

Fourth, the results showed that moving, especially long-distance moving (out of the metro area), contributed to lower distress levels and larger declines in *extended neighborhood* distress compared to those who stayed behind, returned, or moved a short distance within the metro area. Change due to moving and change within place were simultaneously assessed in the current analyses. The levels and increases in neighborhood quality factors in these *extended neighborhoods* are comparable to, and in some cases (e.g., disadvantage declines, diversity gains) larger than, those in the immediate neighborhoods. These results contribute to the literature by highlighting the importance of not treating neighborhoods as isolated units, as they typically are in neighborhood mobility research. It is notable, therefore, that the extended areas are found to fare better on local jobs’ presence than the immediate neighborhoods. This indicates that, as low-income families move, even when unable to access neighborhoods where jobs are located, they benefit significantly in geographic proximity to job hubs. The results relate to an emerging line of work on the importance of surrounding areas (Crowder and South 2008; Graif 2015; Graif et al. 2014; Morenoff 2003; Sampson 2012). They further advance the field by also showing a wide range of declines in extended neighborhood and metropolitan distress levels among a vulnerable population group.

A core underlying process of residential attainment highlighted by the findings is related to improving opportunities when respondents moved farther from their origin neighborhoods. The high levels of poverty and segregation in New Orleans make long-distance moves important for improving neighborhood conditions. Still, the results are also consistent with research in other areas of the country which shows that, when low-income minority families leave their neighborhoods of origin

and their city or county, they experience lower neighborhood poverty and higher diversity (Sampson and Sharkey 2008; Sharkey 2012; South and Crowder 1998).

Several other factors, such as assistance from FEMA and non-FEMA organizations, mattered. The resources, information, and a wide range of public support mobilized by various organizations after Katrina (McCarty et al. 2006; U.S. Government Accountability Office 2005) enabled evacuees to move to improved locations farther away from their origin neighborhoods. Yet, assistance did not fully explain the observed neighborhood gains.

Heightened public awareness about Katrina might have also temporarily weakened discrimination in housing. Still, many evacuees experienced racial prejudice in their destination communities (Asad 2014; Hunt et al. 2009). Considering the current findings that movers and stayers experienced increases in neighborhood diversity pre- to post-Katrina and that many low-income African Americans had rarely encountered immigrants in New Orleans before Katrina, an important question for future research is *how well do African American evacuees fare when moving to areas characterized by high levels of Latino immigration?*

Analyses here also show that neighborhood gains from mobility occurred despite respondents' low employment post-Katrina—also shown in other studies (Zissimopoulos and Karoly 2010)—perhaps due to discrimination or disrupted networks (Asad 2014). Nonetheless, the finding here that extended job densities improved with geographic mobility suggests optimism about possible improving odds of respondents' employment over time as well.

Several limitations should be noted. The sampling design limits the generalizability of the findings. Participants' student status at baseline suggests that they may be more motivated to seek resources and opportunities for improvement than the average low-income population. It would be valuable to investigate whether locational gains found here extend to other population groups in future research. The short time between waves in this study leaves unanswered questions about longer-term changes. More time would be needed for benefits to outweigh disaster-related losses. Mobility programs such as the MTO show that gains in neighborhood quality, while smaller than expected, are possible without a disaster, are sustainable, and result in further benefits especially related to health and safety (Keels et al. 2005; Graif 2015; Ludwig et al. 2012). Kirk (2009) similarly found that neighborhood change after Katrina led to less recidivism among ex-prisoners. Additional benefits may emerge over the longer run among those displaced.

Implications

Because of global warming, hurricanes of Katrina-like intensity occur twice as often compared to a few decades ago. Before the end of the century, this number may double again (Holland 2012). The findings here contribute to understanding post-disaster displacement by uncovering locational gains among a sample of vulnerable families displaced by Katrina. Broadly, the robust improvements in neighborhoods and broader spatial contexts found here suggest that the neighborhood poverty traps in which many vulnerable families find themselves (Crowder and South 2005;

Sampson and Sharkey 2008; Sharkey 2012) may be escaped through long-distance moves. Such gains are surprising from the constrained residential mobility standpoint, but are consistent with the migration scholarship, as long-distance migration has been historically associated with greater returns. The results advance our understanding of spatial mobility pathways among disadvantaged minority evacuees and integrate core insights from the scholarships on post-disaster migration, vulnerability, environmental effects, and residential stratification.

The decreases in neighborhood poverty found here parallel those observed in voluntary residential mobility programs like the MTO and suggest that refining such programs to encourage long-distance moves may contribute to broader neighborhood gains. The findings also suggest that in order to help socioeconomically vulnerable survivors of environmental hazards retain their neighborhood gains and translate them into further benefits (Kirk 2009; Sharkey and Sampson 2010), future programs would do well to (a) prepare movers to capitalize on new resources at different geographic scales, from their immediate and extended neighborhoods to their metro area (and relatedly, assist with public or private transportation access); (b) expand housing access and affordability (Fussell and Harris 2014); (c) strengthen communication between movers and groups with different cultural norms in receiving areas; (d) mitigate the disaster's psychological and financial tolls (Asad 2014; Bourque et al. 2006); and (e) Help evacuees overcome employment obstacles, from interrupted education, discrimination, disrupted networks, to prohibitive childcare costs.

Acknowledgments I am very grateful to Mary Waters, Jean Rhodes, Chris Paxson, Lori Hunter, Jenny Van Hook, Michelle Frisco, and Barry Lee for valuable feedback and support for this project. I thank Andy Gladfelter for research assistance. I thank Mary Waters and the Harvard RISK project team for providing access to the data. I am also grateful for support from the Robert Wood Johnson Foundation Health and Society Scholars Program at the University of Michigan, the Population Research Institute at Pennsylvania State University (NICHD award # R24 HD041025), and the National Science Foundation. The contents of this paper are my own views and do not necessarily reflect the views or policies of NSF, NICHD, the U.S. Government, or of any of the other supporting institutions.

References

- Airriess, C. A., Li, W., Leong, K. J., Chen, A. C.-C., & Keith, V. M. (2007). Church based social capital, networks, and geographical scale: Katrina evacuation, relocation, and recovery in a New Orleans Vietnamese American community. *Geoforum*, 39(3), 1333–1346.
- Alba, R. D., & Logan, J. R. (1993). Minority proximity to whites in suburbs: An individual-level analysis of segregation. *American Journal of Sociology*, 98(6), 1388–1427.
- Alba, R. D., Logan, J. R., Stults, B. J., Marzan, G., & Zhang, W. (1999). Immigrant groups in the suburbs: A reexamination of suburbanization and spatial assimilation. *American Sociological Review*, 64(3), 446–460.
- Asad, A. L. (2014). Contexts of reception, post-disaster migration, and socioeconomic mobility. *Population and Environment*, 36(3), 1–32.
- Auchincloss, A. H., Roux, A. V. D., Brown, D. G., O'Meara, E. S., & Raghunathan, T. E. (2007). Association of insulin resistance with distance to wealthy areas the multi-ethnic study of atherosclerosis. *American Journal of Epidemiology*, 165(4), 389–397.
- Berube, A., & Katz, B. (2005). Katrina's window: Confronting concentrated poverty across America. *The Brookings Institution*. <http://www.brookings.edu/research/reports/2005/10/poverty-berube>

- Black, R., Adger, W. N., Arnell, N. W., Dercon, S., Geddes, A., & Thomas, D. S. G. (2011). The effect of environmental change on human migration. *Global Environmental Change*, 21S, S3–S11.
- Black, R., Arnell, N. W., Adger, W. N., Thomas, D., & Geddes, A. (2013). Migration, immobility and displacement outcomes following extreme events. *Environmental Science & Policy*, 27S, S32–S43.
- Bourque, L. B., Siegel, J. M., Kano, M., & Wood, M. M. (2006). Weathering the storm: The impact of hurricanes on physical and mental health. *The Annals of the American Academy of Political and Social Science*, 604(1), 129–151.
- Briggs, X. S. (2006). After Katrina: Rebuilding places and lives. *City and Community*, 5(2), 119–128.
- Brunsmma, D. L., Overfelt, D., & Picou, J. S. (2007). *The sociology of Katrina: Perspectives on a modern catastrophe*. Lanham, Maryland, USA: Rowman & Littlefield Publishers.
- Campanella, R. (2007). An ethnic geography of New Orleans. *The Journal of American History*, 94(3), 704–715.
- Chan, N. W. (1995). Choice and constraints in floodplain occupation: The influence of structural factors on residential location in Peninsular Malaysia. *Disasters*, 19(4), 287–307.
- Clark, W., Deurloo, M., & Dieleman, F. (2006). Residential mobility and neighborhood outcomes. *Housing Studies*, 21(3), 323–342.
- Clark, W. A., van Ham, M., & Coulter, R. (2014). Spatial mobility and social outcomes. *Journal of Housing and the Built Environment*, 29(4), 699–727.
- Cohn, D., & Morin, R. (2008). *American mobility: Who moves? Who stays put? Where's home?* Washington, DC: Pew Research Center.
- Coulton, C., Theodos, B., & Turner, M. A. (2012). Residential mobility and neighborhood change: Real neighborhoods under the microscope. *Cityscape*, 14(3), 55–89.
- Crowder, K., & Downey, L. (2010). Inter-neighborhood migration, race, and environmental hazards: Modeling micro-level processes of environmental inequality. *American Journal of Sociology*, 115(4), 1110.
- Crowder, K., & South, S. J. (2005). Race, class, and changing patterns of migration between poor and nonpoor neighborhoods. *American Journal of Sociology*, 110(6), 1715–1763.
- Crowder, K., & South, S. J. (2008). Spatial dynamics of white flight: The effects of local and extralocal racial conditions on neighborhood out-migration. *American Sociological Review*, 73(5), 792–812.
- de Haas, H. (2011). The internal dynamics of migration processes: A theoretical inquiry. *Journal of Ethnic and Migration Studies*, 36(10), 1587–1717.
- Elliott, J. R., Hite, A. B., & Devine, J. A. (2009). Unequal return: The uneven resettlements of New Orleans' uptown neighborhoods. *Organization and Environment*, 22(4), 410–421.
- Elliott, J. R., & Pais, J. (2006). Race, class, and Hurricane Katrina: Social differences in human responses to disaster. *Social Science Research*, 35(2), 295–321.
- Falk, W. W., Hunt, M. O., & Hunt, L. L. (2006). Hurricane Katrina and New Orleanians' sense of place: Return and reconstitution or "gone with the wind"? *Du Bois Review*, 3(01), 115–128.
- Federal Emergency Management Agency (FEMA). (2007). *Reported mailing addresses of Katrina IA Applicants from Louisiana, Mississippi, and Alabama DR#s 1603-05 as of 07-31-2007*. Washington, DC: Disaster Assistance Support Center Analysis, Reporting, and Technology Solutions.
- Fussell, E., Curtis, K. J., & DeWaard, J. (2014). Recovery migration to the City of New Orleans after Hurricane Katrina: A migration systems approach. *Population and Environment*, 35(3), 305–322.
- Fussell, E., & Harris, E. (2014). Homeownership and housing displacement after Hurricane Katrina among low-income African-American mothers in New Orleans. *Social Science Quarterly*, 95(4), 1086–1100.
- Fussell, E., Sastry, N., & VanLandingham, M. (2010). Race, socioeconomic status, and return migration to New Orleans after Hurricane Katrina. *Population and Environment*, 31(1–3), 20–42.
- Gabe, T., Falk, G., McCarty, M., & Mason, V. W. (2005). *Hurricane Katrina: Social-demographic characteristics of impacted areas*. Washington DC: Congressional Research Service, Library of Congress.
- GeoLytics. (2003). *Census CD neighborhood change database*. East Brunswick, NJ: GeoLytics.
- GNOFHAC (Greater New Orleans Fair Housing Action Center). (2007). *For rent, unless you're black: An audit report and study on race discrimination in the Greater New Orleans Metropolitan Rental Housing Market*. New Orleans: Greater New Orleans Fair Housing Action Center.
- Graif, C. (2015). Delinquency and gender moderation in the moving to opportunity intervention: The role of extended neighborhoods. *Criminology*, 53(3), 1–32.
- Graif, C., Gladfelter, A. S., & Matthews, S. A. (2014). Urban poverty and neighborhood effects on crime: Incorporating spatial and network perspectives. *Sociology Compass*, 8(9), 1140–1155.

- Graif, C., & Sampson, R. J. (2009). Spatial heterogeneity in the effects of immigration and diversity on neighborhood homicide rates. *Homicide Studies*, 13(3), 242–260.
- Graves, P. E. (1983). Migration with a composite amenity: The role of rents. *Journal of Regional Science*, 23(4), 541–546.
- Groen, J. A., & Povlika, A. E. (2010). Going home after Hurricane Katrina: Determinants of return migration and changes in affected areas. *Demography*, 47(4), 821–844.
- Harding, D. J. (2003). Counterfactual models of neighborhood effects: The effect of neighborhood poverty on dropping out and teenage pregnancy. *American Journal of Sociology*, 109(3), 676–719.
- Hartman, C. W., & Squires, G. D. (Eds.). (2006). *There is no such thing as a natural disaster: Race, class, and Hurricane Katrina*. London: Taylor & Francis.
- Holland, G. J. (2012). Hurricanes and rising global temperatures. *Proceedings of the National Academy of Sciences*, 109(48), 19513–19514.
- Hori, M., & Schafer, M. J. (2010). Social costs of displacement in Louisiana after Hurricanes Katrina and Rita. *Population and Environment*, 31(1–3), 64–86.
- Hunt, J. S., Armenta, B. E., Seifert, A. L., & Snowden, J. L. (2009). The other side of the diaspora: Race, threat, and the social psychology of evacuee reception in predominantly white communities. *Organization and Environment*, 22(4), 437–447.
- Hunter, L. M. (2005). Migration and environmental hazards. *Population and Environment*, 26(4), 273–302.
- Keels, M., Duncan, G. J., DeLuca, S., Mendenhall, R., & Rosenbaum, J. (2005). Fifteen years later: Can residential mobility programs provide a long-term escape from neighborhood segregation, crime, and poverty. *Demography*, 42(1), 51–73.
- Kirk, D. S. (2009). A natural experiment on residential change and recidivism: Lessons from Hurricane Katrina. *American Sociological Review*, 74(3), 484–505.
- Klinenberg, E. (2003). *Heat wave: A social autopsy of disaster in Chicago*. Chicago: University of Chicago Press.
- Kling, J. R., Liebman, J. B., & Katz, L. F. (2007). Experimental analysis of neighborhood effects. *Econometrica*, 75(1), 83–119.
- Kuhn, R., Everett, B., & Silvey, R. (2011). The effects of children's migration on elderly kin's health: A counterfactual approach. *Demography*, 48(1), 183–209.
- Leuven, E., & Sianesi, B. (2014). *PSMATCH2: Stata module to perform full Mahalanobis and propensity score matching, common support graphing, and covariate imbalance testing*. Statistical Software Components S432001, Boston College Department of Economics.
- Li, W., Airriess, C. A., Chen, A. C. C., Leong, K. J., & Keith, V. (2010). Katrina and migration: Evacuation and return by African Americans and Vietnamese Americans in an eastern New Orleans suburb. *The Professional Geographer*, 62(1), 103–118.
- Logan, J. R., & Alba, R. D. (1993). Locational returns to human capital: Minority access to suburban community resources. *Demography*, 30(2), 243–268.
- Logan, J. R., Xu, Z., & Stults, B. J. (2014). Interpolating U.S. Decennial Census tract data from as early as 1970 to 2010: A longitudinal tract database. *The Professional Geographer*, 66(3), 412–420.
- Ludwig, J., Duncan, G. J., Gennetian, L. A., Katz, L. F., Kessler, R. C., Kling, J. R., et al. (2012). Neighborhood effects on the long-term well-being of low-income adults. *Science*, 337(6101), 1505–1510.
- Ludwig, J., Liebman, J. B., Kling, J. R., Duncan, G. J., Katz, L. F., Kessler, R. C., et al. (2008). What can we learn about neighborhood effects from the moving to opportunity experiment? *American Journal of Sociology*, 114(1), 144–188.
- Massey, D. S., Arango, J., Hugo, G., Kouaouci, A., Pellegrino, A., & Taylor, J. E. (1993). Theories of international migration: A review and appraisal. *Population and Development Review*, 19(3), 431–466.
- Massey, D. S., & Denton, N. A. (1985). Spatial assimilation as a socioeconomic outcome. *American Sociological Review*, 50(1), 94–106.
- Massey, D. S., & Denton, N. A. (1988). The dimensions of residential segregation. *Social Forces*, 67(2), 281–315.
- Massey, D. S., Gross, A. B., & Shibuya, K. (1994). Migration, segregation, and the geographic concentration of poverty. *American Sociological Review*, 59(3), 425–445.
- McCarty, M., Perl, L., & Foote, B. E. (2006). *HUD's response to Hurricane Katrina*. Washington, DC: Congressional Research Service. http://assets.opencrs.com/rpts/RS22358_20060105.pdf

- McLeman, R. A., & Hunter, L. M. (2010). Migration in the context of vulnerability and adaptation to climate change: Insights from analogues. *Climate Change*, 1(3), 450–461.
- McLeman, R. A., & Smit, B. (2006). Migration as an adaptation to climate change. *Climatic Change*, 76(1–2), 31–52.
- Morenoff, J. D. (2003). Neighborhood mechanisms and the spatial dynamics of birth weight. *American Journal of Sociology*, 108(5), 976–1017.
- Morgan, S. L., & Winship, C. (2007). *Counterfactuals and causal inference: Methods and principles for social research*. Cambridge: Cambridge University Press.
- Morrow-Jones, H. A., & Morrow-Jones, C. R. (1991). Mobility due to natural disaster: Theoretical considerations and preliminary analyses. *Disasters*, 15(2), 126–132.
- Myers, C. A., Slack, T., & Singelmann, J. (2008). Social vulnerability and migration in the wake of disaster: The case of Hurricanes Katrina and Rita. *Population and Environment*, 29(6), 271–291.
- Nord, M. (1998). Poor people on the move: County-to-county migration and the spatial concentration of poverty. *Journal of Regional Science*, 38(2), 329–351.
- Orr, L., Feins, J. D., Jacob, R., Becroft, E., Sanbonmatsu, L., Katz, L. F., et al. (2003). *Moving to opportunity interim impacts evaluation: Final report*. Washington, DC: U.S. Department of Housing and Urban Development.
- Pais, J. F., & Elliott, J. R. (2008). Places as recovery machines: Vulnerability and neighborhood change after major hurricanes. *Social Forces*, 86(4), 1415–1453.
- Pattillo-McCoy, M. (1999). *Black picket fences: Privilege and peril in the black middle class neighborhood*. Chicago: University of Chicago Press.
- Petersen, W. (1958). A general typology of migration. *American Sociological Review*, 23, 256–266.
- Peterson, R. D., & Krivo, L. J. (2010). *Divergent social worlds: Neighborhood crime and the racial-spatial divide*. New York: Russell Sage Foundation.
- Picou, J. S., & Marshall, B. K. (2007). Katrina as paradigm shift: Reflections on disaster research in the twenty-first century. In D. L. Brunson, D. Overfelt, & J. S. Picou (Eds.), *The sociology of Katrina: Perspectives on a modern catastrophe* (pp. 1–20). Lanham, MD: Rowman and Littlefield.
- Richburg-Hayes, L., Brock, T., LeBlanc, A., Paxson, C., Rouse, C. E., & Barrow, L. (2009). *Rewarding persistence: Effects of a performance-based scholarship program for low-income parents*. New York: MDRC.
- Rosenbaum, P. R. (2002). *Observational studies* (2nd ed.). New York: Springer.
- Rosenbaum, P. R., & Rubin, D. B. (1985). Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. *The American Statistician*, 39(1), 33–38.
- Sampson, R. J. (2008). Moving to inequality: Neighborhood effects and experiments meet social structure. *American Journal of Sociology*, 114(1), 189–231.
- Sampson, R. J. (2012). *Great American city: Chicago and the enduring neighborhood effect*. Chicago, IL: The University of Chicago Press.
- Sampson, R. J., Morenoff, J. D., & Gannon-Rowley, T. (2002). Assessing ‘neighborhood effects’: Social processes and new directions in research. *Annual Review of Sociology*, 28(1), 443–478.
- Sampson, R. J., Raudenbush, S. W., & Earls, F. (1997). Neighborhoods and violent crime: A multilevel study of collective efficacy. *Science*, 277(5328), 918–924.
- Sampson, R. J., & Sharkey, P. (2008). Neighborhood selection and the social reproduction of concentrated racial inequality. *Demography*, 45(1), 1–29.
- Sastry, N. (2009). Tracing the effects of Hurricane Katrina on the population of New Orleans: The Displaced New Orleans Residents Pilot Study. *Sociological Methods and Research*, 38(1), 171–196.
- Sharkey, P. (2007). Survival and death in New Orleans: An empirical look at the human impact of Katrina. *Journal of Black Studies*, 37(4), 482–501.
- Sharkey, P. (2008). The intergenerational transmission of context. *American Journal of Sociology*, 113(4), 931–969.
- Sharkey, P. (2012). Temporary integration, resilient inequality: Race and neighborhood change in the transition to adulthood. *Demography*, 49, 889–912.
- Sharkey, P., & Sampson, R. J. (2010). Destination effects: Residential mobility and trajectories of adolescent violence in a stratified metropolis. *Criminology*, 48, 639–681.
- South, S. J., & Crowder, K. D. (1997). Escaping distressed neighborhoods: Individual, community, and metropolitan influences. *American Journal of Sociology*, 102, 1040–1084.
- South, S. J., & Crowder, K. D. (1998). Leaving the ‘hood’: Residential mobility between black, white, and integrated neighborhoods. *American Sociological Review*, 63, 17–26.

- South, S. J., Crowder, K. D., & Chavez, E. (2005). Exiting and entering high-poverty neighborhoods: Latinos, Blacks, and Anglos compared. *Social Forces*, *84*(2), 873–900.
- Stringfield, J. D. (2009). Higher ground: An exploratory analysis of characteristics affecting populations after Hurricane Katrina. *Population and Environment*, *31*, 43–63.
- Tierney, K. (2006). Social inequality, hazards, and disasters. In R. J. Daniels, D. F. Kettl, & H. Kunreuther (Eds.), *On risk and disaster: Lessons from Hurricane Katrina* (pp. 109–128). Philadelphia: University of Pennsylvania Press.
- U. S. Census Bureau. (2007). *Current Population Survey historical geographical mobility/migration tables*. Suitland, MD: U.S. Census Bureau.
- U.S. Government Accountability Office. (2005). *Hurricanes Katrina and Rita: Provision of charitable assistance*. Washington, DC: U.S. Government Accountability Office.
- Wilson, W. J. (1987). *The truly disadvantaged: The inner city, the underclass, and public policy*. Chicago: University of Chicago Press.
- Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2004). *At risk: Natural hazards, people's vulnerability, and disasters* (2nd ed.). London and New York: Routledge.
- Wodtke, G. T. (2013). Duration and timing of exposure to neighborhood poverty and the risk of adolescent parenthood. *Demography*, *50*, 1765–1788.
- Wolpert, J. (1966). Migration as an adjustment to environmental stress. *Journal of Social Issues*, *22*(4), 92–102.
- Zaman, M. Q. (1991). The displaced poor and resettlement policies in Bangladesh. *Disasters*, *15*(2), 117–125.
- Zissimopoulos, J., & Karoly, L. A. (2010). Employment and self-employment in the wake of Hurricane Katrina. *Demography*, *47*(2), 345–367.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.