Facts about FEMA Household Disaster Aid: Examining the 2008 Floods and Tornadoes in Missouri

CAROLYN KOUSKY

Resources for the Future, Washington, D.C.

(Manuscript received 18 November 2012, in final form 7 May 2013)

ABSTRACT

Very little empirical work has been done on disaster aid in the United States. This paper examines postdisaster grants to households from the Federal Emergency Management Agency in the state of Missouri in 2008, when the state experienced flooding, storms, and tornadoes. The paper answers the following questions: What was the aid for? How much was given? How many people applied for aid? How many households received aid and how many were denied? Why were some applicants denied aid? Is there any relationship between aid received and socioeconomic or demographic characteristics of communities? The paper finds that the majority of aid grants are for very small amounts of money, on the order of a few thousand dollars. Over half of aid applications are denied, often because of ineligible or insufficient damage. The paper provides some important basic information on the nature of disaster grants to households and also generates several hypotheses for future research.

1. Introduction

Many media stories and scholarly treatments of federal disaster aid to individuals and households in the United States presume that it is generous and available. This often leads to concerns about the (dis)incentives federal disaster aid creates regarding investments in risk reduction (e.g., Lichtenberg 1994; Niehaus 2010). Direct grants to individuals to repair or replace damaged homes or property, however, are limited in amount and are associated with strict eligibility requirements (Kousky and Shabman 2012). With very little empirical work on disaster aid—even a basic understanding of who receives it, how much is given, and for what—it is impossible to determine if theoretical arguments have much predictive power in real-world settings.

In the United States, postdisaster grants to homeowners are available from the Federal Emergency Management Agency's (FEMA's) Individual Assistance (IA) program if the president authorizes such aid through a disaster declaration (this process is discussed in detail in section 2). While other types of disaster aid are available to homeowners, such as low-interest loans from the Small Business Administration or charity from nongovernmental organizations, this paper is focused on grants disbursed directly to households from FEMA in response to damage they sustained from a disaster.

The paper examines all FEMA IA grants to the state of Missouri in 2008. These data, generally not available to researchers, were obtained through a Freedom of Information Act request. In 2008, Missouri was hit by severe storms, flooding, and tornadoes, resulting in six presidential disaster declarations. These were damaging events for the state, but not unprecedented in magnitude; while terrible events, they did not approach the status of a national tragedy. They thus make a good case analysis of federal aid for "average" disasters (as opposed to truly catastrophic events, such as Hurricane Katrina).

Analyzing the IA data, this paper answers a series of questions about federal aid to individuals in Missouri in 2008: What was the aid for? How much was given? How many people applied for aid? How many households received aid and how many were denied? Why were some applicants denied? Is there any relationship between the aid received and socioeconomic or demographic characteristics of communities? While providing insight into the nature of federal aid, the answers to these questions also generate many hypotheses for future work, grounded in a detailed examination of federal aid data.

Corresponding author address: Carolyn Kousky, Resources for the Future, 1616 P Street NW, Washington, DC 20036.
E-mail: kousky@rff.org

DOI: 10.1175/WCAS-D-12-00059.1

I find that the vast majority of aid grants are for small amounts of money. The average IA grant in Missouri in 2008 was a little over $2000. A large number of applications for aid are denied. Across the 2008 disaster declarations, the denial rate was always over 50%, indicating that many individuals apply for aid when they are ineligible to receive it. The largest proportions of applications are denied for reasons of ineligible damage, suggesting that homeowners may not be aware of the eligibility criteria to receive funds. Exploratory regression analysis indicates that aid is less likely in higher income areas and more likely as the percent of housing units that are owner occupied increases. There is no statistically significant relationship between insurance take-up rates and disaster aid. More aid is given in areas with greater insured losses, likely because it is correlated with uninsured damages. For a 1% increase in the percent of the population that is African American, the number of approved applications as a proportion of total housing units increases by a little over 1%, but average amounts given decrease by roughly 0.4%.

The paper proceeds as follows. Section 2 provides details on the disaster declaration process and on FEMA's IA program. Section 3 turns to analysis of the IA grants in Missouri in 2008, examining both housing assistance and other needs assistance—two subtypes of IA grants. This section also provides some initial comparisons of aid given with damages from the disasters. Section 4 presents the results of econometric analyses designed to generate hypotheses about the determinants of federal disaster aid. Section 5 concludes the paper.

2. Background on disaster aid

The Robert T. Stafford Disaster Relief and Emergency Assistance Act, passed in 1988 and later amended, provides the current authority for federal disaster relief in the United States. Before federal dollars can be disbursed after a disaster, the president must issue either a major disaster declaration or an emergency declaration. In brief, the disaster declaration process is composed of the following steps:

1) A disaster occurs.
2) A governor[1] requests a declaration.
3) FEMA conducts an assessment and recommends to the president whether to approve the request.
4) The president makes a decision.
5) If a disaster is declared, then FEMA dispenses aid from the Disaster Relief Fund (DRF).
6) If more aid than is available in the DRF is needed, then the U.S. Congress must authorize and appropriate additional funding.

To request a presidential declaration after a disaster, a governor must send a request to the president through the FEMA regional director. [Since FEMA has been folded into the Department of Homeland Security (DHS), the request now also goes through the secretary of DHS before going to the president.] Governors will usually consult with state emergency managers, and local governments may petition the governor to issue a request (Sylves and Búzás 2007). Before making a request, the governor must have activated the state emergency plan and ensured that state and local action is underway (Beauchesne 2001).

In most cases, a preliminary damage assessment is undertaken by FEMA and local officials. FEMA then makes a recommendation to the president about whether to grant a declaration [the Government Accountability Office (GAO) has recently reported on how FEMA's process for recommendations should be improved; see GAO 2012]. For very extreme events where aid is clearly needed, the preliminary assessment may not be finished before a disaster is declared (GAO 2001). Upon receiving FEMA's recommendation, the president decides whether to declare a disaster, an emergency, or do nothing. A GAO analysis of declarations issued in 1988 and 1989 found that the White House followed FEMA's recommendation every time except one (GAO 1989). Another GAO analysis of declaration requests between 2004 and 2011 found that the president approved 86% of requests over that time period (GAO 2012).

Once a president makes a declaration, FEMA decides how much money to disburse from the DRF. For emergencies, the federal response is limited to immediate and short-term assistance, and expenditures by FEMA may not exceed $5 million (U.S. dollars; GAO 2001). The focus in this paper is disaster declarations and there is no spending limit for these. Each year, funds are appropriated into the DRF, where they remain until spent. For very extreme events, or years in which multiple events occur and require more aid than is in the fund, Congress must pass supplemental legislation appropriating more funds.

Several political science papers have documented that politics plays a role in the issuance of disaster declarations and the amount of aid given. These papers have found that there are more disaster declarations in election years (Downton and Pielke 2001; Sylves and Búzás 2007) and in states with more electoral importance

[1] In addition to the governors of all 50 states, the mayor of Washington, D.C., and the heads of U.S. trust or commonwealth territories may also request declarations. For ease of discussion, I will simply use the term "governor."

(Garrett and Sobel 2003). This work also suggests that states with members on the relevant oversight committees in Congress receive higher payments (Garrett and Sobel 2003). A working paper suggests that political influence in the declaration process is a more recent phenomenon, perhaps beginning at the end of the 1980s (Reeves 2009).

FEMA provides disaster relief through three channels: (i) the IA program; (ii) the Public Assistance program, which aids state, local, and tribal governments; and (iii) the Hazard Mitigation Program, which gives extra funding to states to help communities implement measures to reduce future damages (GAO 2001). The president can approve either IA or PA alone, or both. The focus of this paper is the IA grants (see Kousky and Shabman 2012 for an overview). This is divided into housing assistance (HA) and other needs assistance (ONA). HA provides for temporary housing, or repair and replacement of damaged housing. ONA reimburses disaster-related, nonhousing expenses, such as replacing damaged household items or disaster-related medical expenses. HA and ONA are grants to individuals that do not need to be repaid, but they are capped at an amount indexed to inflation. For disaster declarations issued between 1 October 2007 and 30 September 2008, the cap was $28,800 per household for combined HA and ONA payments. For declarations between 1 October 2008 and 30 September 2009, the maximum amount was increased to $30,300. Interestingly, numerous FEMA documents for the public fail to mention this cap. For those documents that do state that there is a limit, the amount of the cap is often not given (e.g., FEMA 2008), and it is not available on the main FEMA disaster aid web pages. This may contribute to a lack of understanding about the limited amounts of disaster aid grants.

The average aid for repair of a damaged home is just over $4000 (McCarthy 2010). Receiving such aid is tied to certain eligibility requirements. Not only must a presidential disaster declaration have been made, but the individual or household must have first exhausted other sources to cover the loss, such as insurance or a Small Business Administration (SBA) loan. The applicant must be a U.S. citizen, noncitizen national, or qualified alien. For HA, the home must be the applicant's primary residence (secondary and vacation homes are not eligible for aid). Finally, if the homeowner lives in a 100-year floodplain and the community is not participating in the National Flood Insurance Program,[2] aid will not be given for the home; however, a homeowner could qualify for rental assistance or for aid for items not covered by flood insurance, such as some categories of ONA. The purchase of flood insurance is often a requirement of receiving an IA grant. HA is funded entirely by FEMA, but ONA has a 25% state cost share.

While the focus of this paper is FEMA grants to households, it should be noted that the federal government provides other forms of aid for individuals. The first line of assistance is an SBA loan. Disaster losses can also be deducted from federal taxes. The U.S. Department of Agriculture (USDA) offers relief programs for farmers. The U.D. Department of Housing and Urban Development (HUD) has mortgage and rental assistance programs. There are also, of course, nongovernmental sources of disaster aid to individuals. Surveys undertaken of victims of Hurricane Katrina, for example, found that religious organizations, friends, and family are the predominant sources of disaster aid for individuals, not the government (Chappell et al. 2007).

3. 2008 disaster aid in Missouri

a. Overview of the data

In response to a Freedom of Information Act request, FEMA supplied information on all IA grants made in the state of Missouri in 2008 (data available from author). For privacy reasons, the exact address of each awardee was removed; the finest spatial resolution available in the data is the zip code (the county is also given). For each grant, the data include the particular disaster declaration with which it is associated, the type of assistance, whether assistance was approved, the reason for denial if assistance was not granted, and the amount given if assistance was granted.

In 2008, the state of Missouri received six presidential disaster declarations. For two of the declarations only public assistance was authorized.[3] This paper focuses on the four declarations for which individual assistance was authorized.[4] The first declaration with individual assistance was issued on 19 March (declaration number 1749) for severe storms and flooding. The second was issued 23 May (declaration number 1760) for severe storms

[2] Flood insurance is generally not available on the private market, but residents of participating communities can purchase a policy through the federally run National Flood Insurance Program.

[3] There were over 5000 public assistance projects funded by FEMA, totaling over $134 million for the six 2008 and one 2007 disaster declarations (FEMA 2012).

[4] Including a winter 2007 disaster declaration along with the six 2008 declarations, there were over 11 million home loans and over 8 million business loans made by the SBA to Missourians (FEMA 2012).

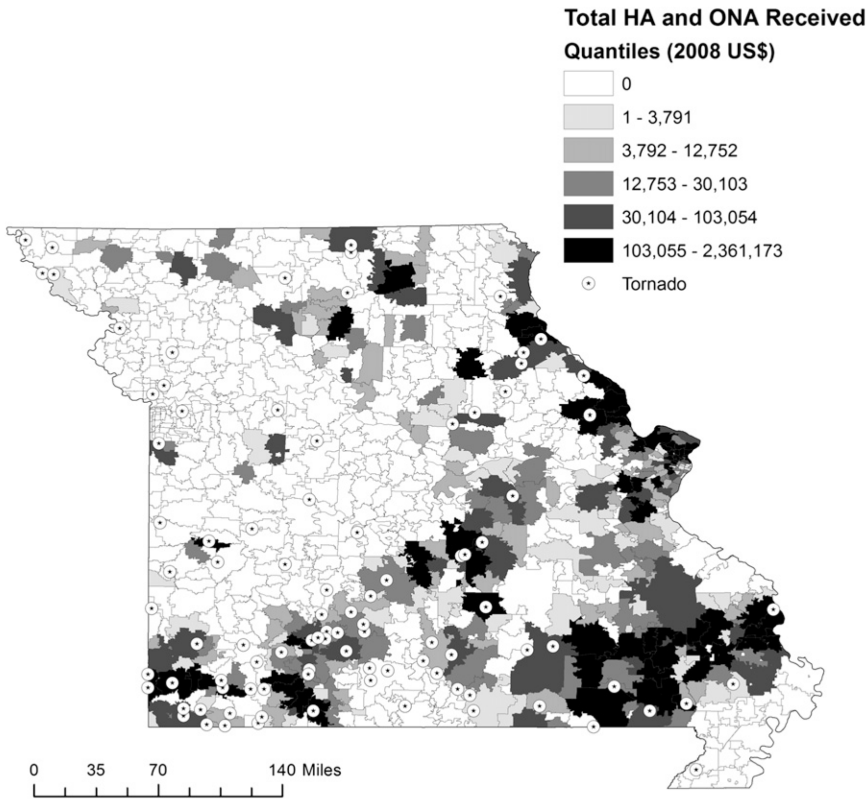

FIG. 1. Total HA and ONA received by zip code.

and tornadoes. The third was issued 25 June (declaration number 1773) for severe storms and flooding. The final declaration in 2008 for Missouri was issued November 13 (declaration number 1809) for severe storms, flooding, and tornadoes. The November declaration, however, was for September flooding associated with the remnants of Hurricane Ike; clearly, the process for federal aid can sometimes move very slowly (Hampel 2008). The other declarations were made much closer to the timing of the actual event.

For the four 2008 declarations, there were 31 022 total applications for assistance (note that the same household could have applied for both HA and ONA). There were 7864 applications for only HA and 459 for only ONA. Not all of the applications were approved, as discussed more in sections 3b and 3c on HA and ONA grants specifically.

Figure 1 shows the total amount (in 2008 dollars) of HA and ONA aid received by zip code in 2008, shaded by quantile. Damages are generally—although not always—higher along the Mississippi River, which borders the state in the east, and where the tornadoes touched down (also shown on Fig. 1). More detail on individual grants is discussed in the next two sections. In zip codes that received some amount of HA or ONA aid, the median total amount for the entire zip code was only $17,299. The zip code with the lowest positive amount received only $55, and the zip code with the highest total amount received $2,361,173. The number of approved applications in zip codes that received aid ranges from 1 to 587. Across these zip codes, the average HA grant ranges from $55 to $28,800, with a mean of $3072 and a median of $2352. Average ONA grants ranged slightly more modestly from $80 to $10,594, with a mean of $1507 and a median of $1014.

b. *Housing Assistance*

HA summary statistics are provided in Table 1 for the four declarations in which individual assistance was granted. As can be seen in the table, the most applications were for 1749, associated with spring storms and flooding, followed by 1809, which was the late issuance of a declaration for the remnants of Hurricane Ike passing through Missouri. The number of counties with at least one approved application gives some indication of how widespread the damage was from each disaster event, from very localized for the declarations with tornadoes (1760 and 1809) to more widespread for the flooding and storm declarations. Table 1 also shows that the mean payment varies by disaster. It suggests that

TABLE 1. Summary statistics for HA grants by disaster.

Disaster code	1749	1760	1773	1809
Number of applications	10 331	841	3447	6408
Applications approved (%)	43	23	48	34
Number of counties with at least one approved application	35	3	27	18
Mean HA payment ($; if payment received)	2752	6591	2963	2314
Standard deviation of HA payment ($; if payment received)	5058	9970	5190	3134

while disaster 1760 was fairly localized, the damage was more severe, as indicated by the higher average grant amounts. This would be consistent with tornado damage.

Table 1 also shows that the percentage of approved applications varies across the disasters. In no case is the approval rate over 50%. This suggests that many households are applying for disaster aid when they are not actually eligible. Either people hope to get aid anyway, or there is widespread lack of awareness on the conditions for receiving HA. This is worthy of further investigation.

There are limited data available on how these approval percentages compare with other disasters. A GAO report on Hurricanes Katrina and Rita found that for those events, the approval rating for HA was around 67%, but it was only 38% for hurricanes in 2004 and 46% for hurricanes in 2003 (GAO 2006). Putting aside the outlier event of Hurricane Katrina, it appears from this comparison that HA approval rates in Missouri in 2008 were fairly typical.

There are many reasons why HA applications are ruled ineligible. Interestingly, about 40% of all the applications marked ineligible for these four disasters were given an ''INR'' code by FEMA. This code indicates the applicant told FEMA that he/she will not move from the home while repairs are being made and so he/she is ineligible for rental assistance. The exact wording from FEMA for this code is, ''Based on FEMA records, the applicant told the FEMA inspector that he/she is not going to move from his/her damaged home while repairs are being made. Since the applicant does not plan to move, he/she is not eligible for FEMA rental assistance at this time.'' It seems surprising that households would seek rental assistance when they are staying in their home, but the data provide no further insight. Do households apply and then decide not to move? Do they hope to get funds anyway? Are they confused about eligibility requirements? This is certainly another area for future research.

Another 13% of applications are marked ineligible because of insufficient damage as determined by a FEMA inspection. It is important to note that FEMA HA is just to make the house safe and livable again. As FEMA notes, the aid ''is not intended to restore your damaged property to its condition before the disaster'' (FEMA 2008). If the house is deemed safe, then aid will not be given. Many individuals may believe aid is available to restore property to its predisaster condition, but FEMA documents on HA explicitly state that this is not the case (FEMA 2008). It is not clear if this is well advertised or explained immediately postdisaster.

Finally, another just under 13% of denied applications are marked ineligible because the home is covered by insurance. Damages from disasters are to be covered by insurance first, and aid is only given for damages the insurance company will not cover. Individuals cannot choose aid over filing a claim with their respective insurance companies.

HA is provided in five different categories. The first is assistance in which FEMA provides temporary housing (e.g., trailers) directly but does not provide a cash payment. This type of assistance was not given in Missouri in 2008. The four other categories are all cash payments to individuals to cover certain types of expenses. These categories are as follows:

1) Home repair: covers the costs of home repairs to make a home safe, sanitary, and functional.
2) Replacement housing: covers the costs of replacement housing for homeowners whose home is destroyed.
3) Rental assistance: covers rental assistance for housing while repairs are being completed on a home.
4) Transient accommodations: covers lodging expenses needed during an evacuation or while a home was not accessible.

Figure 2 shows the number of approved HA applications in each of these categories across all four disasters. The majority of grants were for home repairs, followed by rental assistance. Very few grants were given for replacement housing or transient accommodations.

The distribution of payments in each category varies. This is shown in Fig. 3 (again, in 2008 dollars) for all approved HA applications. Each box shows the 25th–75th percentiles and the line indicates the median value. The dots represent outliers. Note that in no category are there grants given in excess of the 2008 limit on disaster aid of $30,300 (recall the cap also includes ONA payments received). The majority of the payments for the home repair category are very skewed, with the majority of approved applications receiving relatively modest amounts of a few thousand dollars, but with some payments stretching into the tens of thousands of dollars. The median payment for this category is $1455. The grants to cover either rental assistance or transient

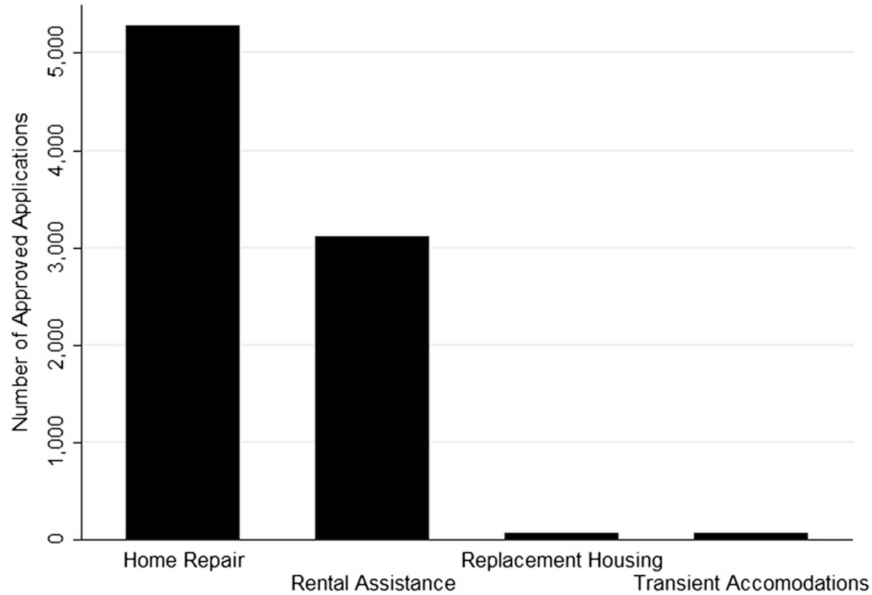

FIG. 2. Number of approved HA applications by category.

accommodations show smaller amounts of variation and are all under $4000. As would be expected, the payments for replacement housing are greater on average than for anything else, with many clustered close to the aid limit. Table 1 had shown that the mean grant for disaster 1760 was higher, perhaps because of the nature of tornado damage. Consistent with this, the percentage of approved applications for replacement housing are also greater for this disaster, at a little over 4%, while for the others the percentage is always below 0.5%.

c. *Other Needs Assistance*

Table 2 shows summary statistics for the ONA grants in Missouri in 2008. Like HA (see Table 1), there were more applications for both 1749 and 1773 than the other disasters. The numbers of ONA applications are smaller than the number of HA grants, though, across all

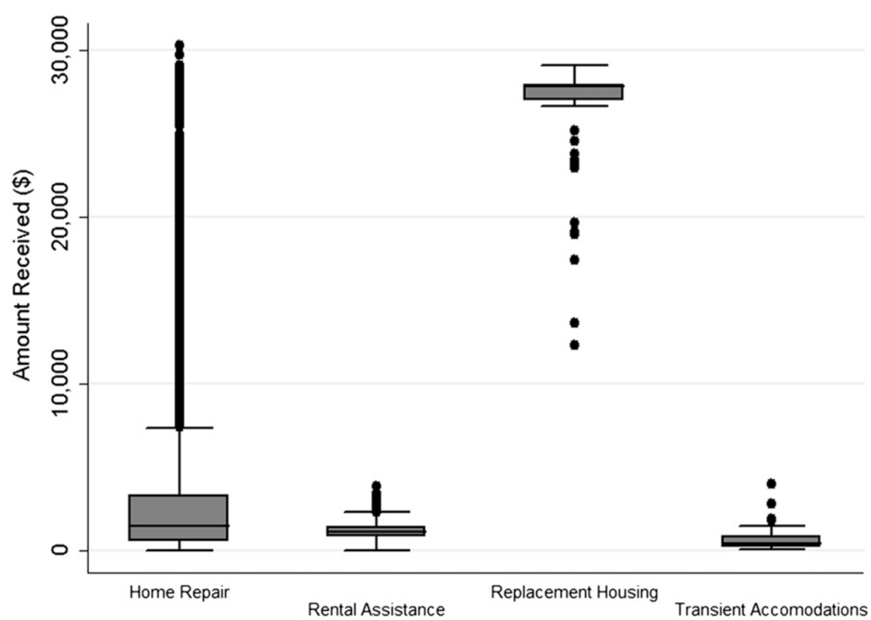

FIG. 3. Distribution of HA payments by category (2008 U.S. dollars, $).

TABLE 2. Summary statistics for ONA grants by disaster.

Disaster code	1749	1760	1773	1809
Number of applications	4269	584	1393	3749
Applications approved (%)	23	15	21	30
Number of counties with at least one approved application	33	3	25	15
Mean HA payment ($; if payment received)	1668	4034	1516	1604
Standard deviation of HA payment ($; if payment received)	1967	4479	1794	1756

disasters. The number of counties with at least one approved application is similar to HA. Mean payments are all somewhat smaller than HA, as expected.

Interestingly, the approval rates for ONA are quite a bit lower than those for HA. These approval ratings are also quite a bit lower than those found for hurricanes by a GAO analysis. The GAO reported that for hurricanes in 2003, the approval rating for ONA was 50%, for hurricanes in 2004 it was 65%, and for Hurricanes Katrina and Rita it was 41% (GAO 2006). In contrast, the approval ratings here never go above 30%. It is likely that approval rates will vary across disasters depending on insurance take-up rates, other resources available for victims, how aggressively aid is advertised, and the type of damage caused, so it may not be appropriate to make such comparisons. Still, the approval rates here are notably lower.

The vast majority of ONA applications rated ineligible in Missouri in 2008—around 61%—are because of insufficient damage. After insufficient damage, the next most common reason for ineligibility, although at only just over 7% of ineligible applications, is for failure to submit substantiation of claims.

ONA is grouped into the following seven categories:

1) Personal property: funds to repair or replace property damaged or destroyed by the disaster (e.g., clothing, household items).
2) Dental: dental expenses related to the disaster.
3) Funeral: funeral and burial costs related to the disaster.
4) Medical: medical expenses related to the disaster.
5) Moving: moving and storage expenses related to the disaster.
6) Transportation: funds for repairing or replacing a primary means of transportation that cannot be used as a result of the disaster.
7) Other: other expenses, such as purchasing a National Flood Insurance Program (NFIP) policy or purchasing needed fuel.

Figure 4 shows a bar chart of the number of approved ONA applications in each of the seven categories. The vast majority are for repairing and replacing personal property. The small medical, dental, and funeral claims indicate that while the disasters in Missouri in 2008 caused property damage, they did not, for the most part, lead to high levels of injury or mortality. There were some, however; the Missouri State Emergency Management Agency reported 25 deaths across all four declarations.[5]

Figure 5 shows the distribution of payments for each ONA category. When examining this graph, it should be kept in mind that the bulk of payments is for personal property, as in Fig. 4. Three-quarters of personal property payments are below $2740, but there is a long tail, with a few payments above $10,000. Transportation payments are clustered on a few values because of the state-recommended caps for transportation expenses. For the state of Missouri in 2008, these were $580 for vehicle repair (an amount received by 71 applicants) and $5764 for vehicle replacement (an amount received by 40 applicants) (A. Prenger, Missouri State Emergency Management Agency, 2012, personal communication). While only a few grants were given in the remaining categories, average amounts were lowest for moving costs, which might be expected, and highest for funeral expenses.

d. *Comparing aid with damages*

It is difficult to compare the amounts of federal aid given to households with actual damage amounts. The United States does not keep systematic records in one location of losses associated with natural hazards. Many experts have called for such a database to be developed and maintained by the federal government (e.g., National Research Council 1999), but thus far it has not occurred. One source of disaster data is the Spatial Hazard Events and Losses Database for the United States (SHELDUS), maintained by the Hazards and Vulnerability Research Institute at the University of South Carolina. SHELDUS is a compilation of data from many different sources and can be queried by presidential disaster declaration number. It is freely downloadable (http://webra.cas.sc.edu/hvri/products/sheldus.aspx).

The SHELDUS estimates of total property damage[6] can be compared with the total amount of HA and ONA given for each event. This is shown in Fig. 6. Interestingly, FEMA aid varies from not even 4% of total estimated

[5] The Missouri State Emergency Management Agency has a summary of every disaster declaration for the state on its website.

[6] Note that SHELDUS also indicates crop damage for disasters 1773 and 1809, but agricultural aid is not covered in this paper and as such, these numbers are not included in Fig. 6.

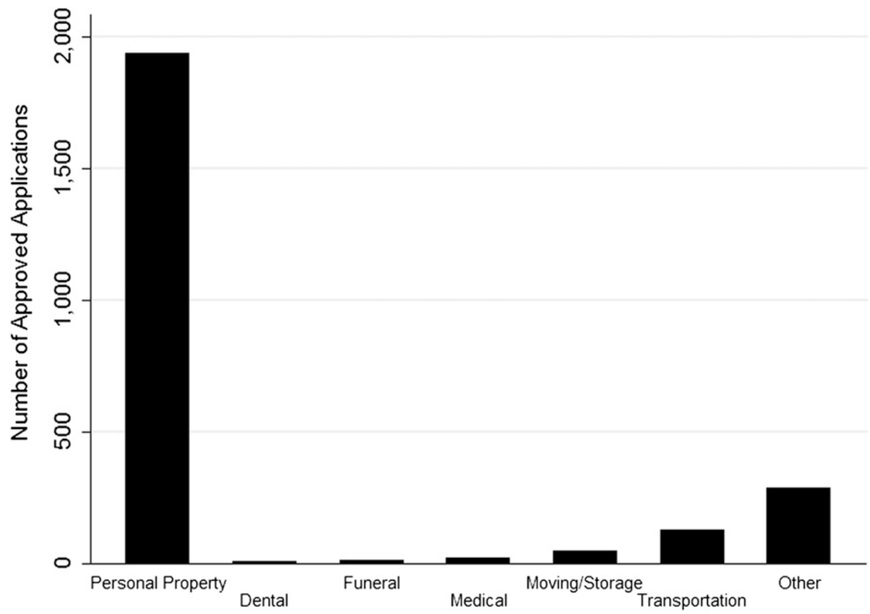

FIG. 4. Number of approved ONA applications by category.

property damage (disaster 1760) to over 100% (disaster 1809). This is in part indicative of the difficulty in obtaining accurate estimates of the damages from disaster events. The SHELDUS estimates of property damage for 1809 are most likely underestimates of total damage. IA grants—given the caps and other limitations—should not exceed total property damage. The Missouri State Emergency Management Agency notes that more homes were destroyed in disaster 1760 (over 150 homes) than in disaster 1809 (12 homes), but many more homes were damaged in disaster 1809 (over 1200 homes) than in disaster 1760 (316 homes).

The damage from all four declarations was from severe storms, flooding, and/or tornadoes. Comparing average FEMA individual assistance amounts per zip code with total precipitation data for 2008 from the National

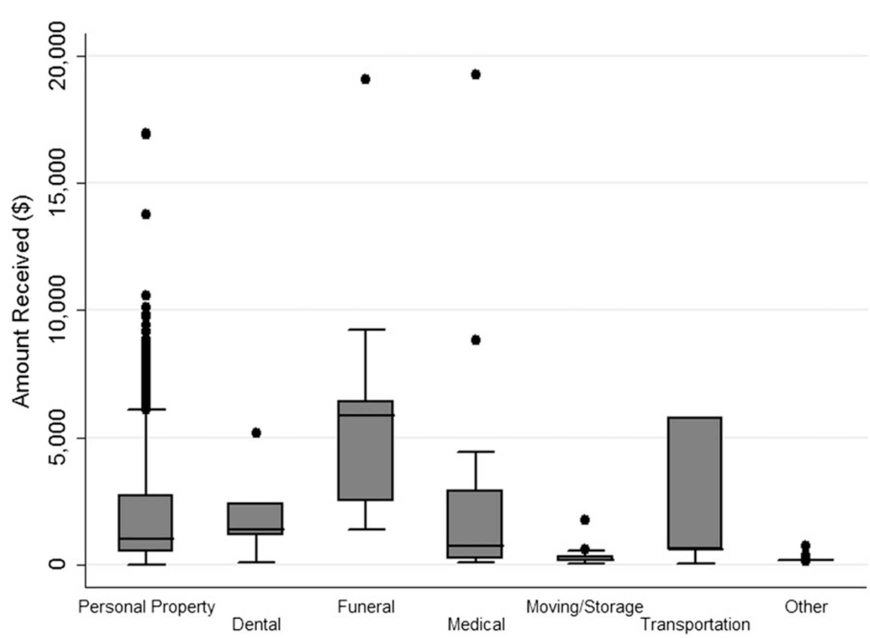

FIG. 5. Distribution of ONA grants by category (2008 U.S. dollars, $).

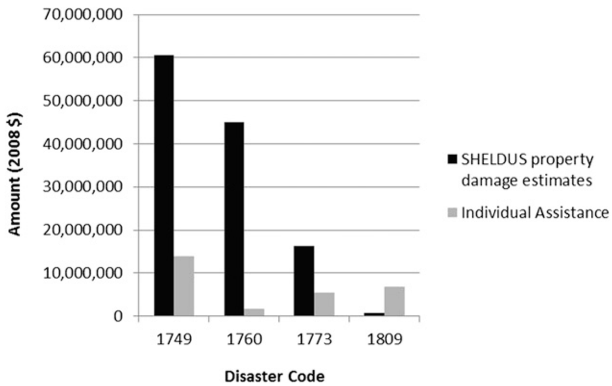

FIG. 6. Comparing property damage estimates and individual assistance grants.

Oceanic and Atmospheric Administration (http://water.weather.gov/precip/download.php)[7] generates a small, positive correlation of 0.12. While this is the direction that would be expected, it is small in magnitude. This could be due to a number of factors, such as flooding damage not correlating perfectly with precipitation, since it is influenced by elevation, upstream conditions, structural flood protection, protective measures, and antecedent conditions. In addition, exposure and social vulnerability (Cutter et al. 2003) interact with a hazard to determine disaster losses. Further, some of the FEMA grants were for tornadoes and the data do not differentiate these from grants for flood- or storm-related damage.

4. Determinants of aid

This section explores the question of the determinants of federal IA grants. One other paper has examined this question. Examining federal aid following the Northridge earthquake, Kamel and Loukaitou-Sideris (2004) find that zip codes with higher concentrations of renter-occupied units and low-income households were associated with more assistance for repairing property and less assistance for rehabilitating homes. This can be explained by many of the eligibility requirements of federal disaster aid. They also find that higher concentrations of African Americans were associated with higher levels of FEMA grants, while higher concentrations of Hispanics were negatively associated with FEMA housing grants.

Who receives aid will be a function of where disasters hit, who applies, the extent to which aid requirements are adhered to, and any FEMA discretion in approving applications. Because of data limitations, results in this section should only be interpreted as suggestive. This exercise is undertaken as exploratory in nature and done to generate hypotheses for future work, not to identify causal relationships. Because of the privacy restrictions on the release of the IA data, they must necessarily be aggregated to the zip code level.

The many zip codes with zero amounts of aid require the use of a corner solution model. The Tobit model is one common choice; however, it restricts the marginal effect of a given variable on the probability of there being any aid to have the same sign as the marginal effect of the variable on the intensity of aid given. A hurdle model is thus preferred. It combines a probit model on the binary variable of whether any aid was given to the zip code with an ordinary least squares (OLS) regression for zip codes that received a positive amount of aid. The linear regression model is run with two dependent variables: the average IA grant per application and the number of approved applications normalized by the number of housing units in the zip code.

Data from several sources were combined with the IA grants. Summary statistics of all variables at the zip code level are given in Table 3 (zip code boundaries in GIS format are available from the U.S. Census Bureau's Topologically Integrated Geographic Encoding and Referencing (TIGER) page at http://www.census.gov/geo/maps-data/data/tiger.html). Total 2008 observed precipitation was obtained from the National Weather Service (http://water.weather.gov/precip/download.php). This is reported as inches averaged over 16-km^2 grid cells. Using a geographical information system (GIS), the average of these values for a given zip code was calculated. Elevation data at a resolution of ⅓ arc-second (approximately 10 m) was obtained from the U.S. Geological Survey's National Elevation Dataset (http://ned.usgs.gov/). The average elevation for each zip code was then calculated in GIS. These elevation data were entered as their own explanatory variables and also interacted with the precipitation data, since low-lying areas may suffer more flooding for a given precipitation amount. Using a shapefile of tornado touchdowns from the Storm Prediction Center (shown in Fig. 1), zip codes within 0.5 miles of a tornado touching down in 2008 were identified (http://nationalatlas.gov/mld/tornadx.html). Using a shapefile of major surface waters (scale: 1:2 000 000, from 2005) from the U.S. Geological Survey, I identified those zip codes crossed by or bordered by one of the major rivers in Missouri: the Mississippi, Missouri, or Meramec (http://nationalatlas.gov/mld/hydrogm.html). While not perfect, it is hoped these spatial variables will

[7] These are observed precipitation data. They are measured in inches over roughly 16-km^2 grid cells. As explained in section 4, these values were averaged for each zip code.

TABLE 3. Summary statistics for zip codes in Missouri.

Variable	Mean	Std dev	Min	Max
Aid yes/no	0.3712	0.4834	0	1
Average aid per application (2008 $)	1017	1842	0	14 175
Average total precipitation (in. 16 km^{-2})	56.53	7.334	36.54	72.98
Tornado touched down in 2008	0.1104	0.3135	0	1
Located on Missouri, Mississippi, or Meramec Rivers	0.1602	0.3670	0	1
Mean elevation (m)	252.8	73.94	74.00	470.7
Insured loss in 2008 (2008 $)	1 020 000	2 417 000	0	2.98×10^7
Total housing units (100 s)	27.02	43.36	0.03	276.3
Insurance exposures in 2008 over total housing units	0.4039	0.2098	0.002 551	1
Population not a citizen (%)	0.0070	0.0148	0	0.1526
Owner occupied housing units (%)	76.62	11.63	0	99.1
Population with at least a high school degree ($)	76.80	9.78	13.5	100
African American (%)	3.803	11.65	0	97.1
Median age	41.58	5.491	20	60.6
Median year built	1968	11.78	1940	1997
Median income in 1999 ($)	34 300	11 530	10 490	126 500

partially control for the extent of damage in a zip code. Other controls were taken from the 2010 U.S. Census, including the total number of housing units, median income (latest available data is from 1999), percent owner-occupied housing units, percent of population self-identifying as African American or Hispanic, median age of the population, median year housing units were built, percent of the population with a high school degree or higher, and the percent of the population that is not a citizen (these last three variables are taken from the 2000 Census, since the 2010 data were not yet available at a zip code level for Missouri) (http://www.census.gov/main/www/access.html).

One concern is the inability to control for insurance take-up rates, a variable that theoretically would influence the amount of aid given. To address this, additional data were obtained from Missouri Department of Insurance, Financial Institutions and Professional Registration. The department provided ''exposure'' counts that are equal to one for one home insured for one year. This is not quite counts of insurance policies, but very close. These data did not include renters policies, mobile homes policies, or farm policies. The data also included information on the total insured losses in a zip code in 2008. This variable is also included as another potential control for disaster damages. Mean insured losses, as shown in Table 3, are $1,020,000—much higher than mean aid amounts, as would be expected.

Coefficients and robust standard errors from the hurdle model are shown in Table 4. Columns 1 and 4 show the results of the probit model. Columns 2 and 5 present the results of ordinary least squares (OLS) regression with the natural log of the average IA grant per approved application as the dependent variable, and columns 3 and 6 present the results of OLS regression with the natural log of the number of approved applications normalized by the number of housing units in the zip code as the dependent variable. Columns 1–3 include only a basic set of controls, while columns 4–6 expand the control set.

Looking first at the results of the probit regressions, I find that total precipitation, as expected, leads to a greater probability of the zip code receiving any IA aid in the first specification (column 1). When elevation and the interaction of elevation are included as additional covariates, however, none of the three variables is statistically significant, as shown in column 4. Being near a tornado touchdown appears to make aid more likely, although this loses significance when more controls are added to the model. The dummy variable for being located on a major river is never significant. Insured losses increase the likelihood of aid in both specifications 1 and 4, presumably because insured losses are correlated with total damage and uninsured damage. As expected, more housing units make aid more likely, as do more owner-occupied housing units. Specification 4 also finds that as the percent of the population with more education increases, as the median age increases, and as the median income increases, the likelihood of aid falls, suggesting IA may be targeted at more vulnerable populations.

Next, I look at the results of OLS regressions on the sample of zip codes that had at least one IA grant. The total explanatory power of these regressions is very low. Still, they suggest some findings worthy of deeper examination. When looking at the specifications with an average IA grant given as the dependent variable, being located on a major river decreases the amount of the grant by a little over 30%. This is likely because the tornados caused higher levels of damage in 2008 and were

TABLE 4. Hurdle model of determinants of IA grants. Numbers in parentheses are robust standard errors.

	Probit	OLS regression (when total aid > 0)		Probit	OLS regression (when total aid > 0)	
	(1)	(2)	(3)	(4)	(5)	(6)
	Aid yes/no	ln(average aid)	ln(No. approved/ housing units)	Aid yes/no	ln(average aid)	ln(No. approved/ housing units)
Average total precipitation (in. 16 km^{-2})	0.0158[a] (0.0063)	0.0097 (0.0073)	−0.0098 (0.0113)	0.0022 (0.0241)	−0.0027 (0.0270)	−0.1094[a] (0.0467)
Tornado touched down in 2008	0.2661[b] (0.1427)	0.2069 (0.1297)	0.1742 (0.2071)	0.2233 (0.1484)	0.1554 (0.1310)	0.0448 (0.2071)
Located on Missouri, Mississippi, or Meramec Rivers	−0.0521 (0.1228)	−0.3157[c] (0.1194)	0.2070 (0.2649)	−0.0793 (0.1392)	−0.3318[a] (0.1378)	0.0170 (0.2662)
ln of insured loss in 2008	0.0865[c] (0.0284)	0.0168 (0.0249)	−0.0802[b] (0.0444)	0.0851[a] (0.0391)	0.0710 [a] (0.0345)	0.0608 (0.0582)
Total housing units (100 s)	0.0058[c] (0.0014)	−0.0017[a] (0.0008)	−0.0096[c] (0.0021)	0.0095[c] (0.0017)	−0.0014[b] (0.0008)	−0.0065[c] (0.0022)
Mean elevation (m)				−0.0063 (0.0051)	−0.0042 (0.0058)	−0.0312[c] (0.0098)
Interaction of precipitation and elevation				0.0001 (0.0001)	0.0001 (0.0001)	0.0005[c] (0.0002)
Exposures as a percent of total housing units				0.5026 (0.4346)	−0.5392 (0.4484)	−0.5209 (0.7020)
Population not a citizen (%)				−1.2014 (3.5897)	−4.4346 (3.0077)	−5.3585 (5.6622)
Owner-occupied housing units (%)				0.0283[c] (0.0075)	0.0035 (0.0077)	0.0411[a] (0.0163)
Population with at least HS degree (%)				−0.0121[b] (0.0069)	0.0000 (0.0070)	0.0009 (0.0140)
African American (%)				−0.0020 (0.0046)	−0.0041[b] (0.0024)	0.0112[a] (0.0056)
Median age				−0.0283[c] (0.0107)	−0.0123 (0.0116)	−0.0114 (0.0203)
Median year built				0.0080 (0.0051)	−0.0086 (0.0054)	0.0007 (0.0099)
ln of income in 1999				−0.8765[c] (0.2947)	−0.0490 (0.2666)	−1.9845[c] (0.5664)
Constant	−2.4107[c] (0.4866)	6.9461[c] (0.4959)	−3.4003[c] (0.8419)	−8.0134 (9.9028)	25.0884[a] (10.5821)	18.4494 (19.3012)
Observations	881	342	342	878	340	340
R-squared		0.0626	0.1696		0.0923	0.3105
Log likelihood	−540.3353	−410.6503	−613.8506	−510.1900	−402.7711	−576.7079

[a] $p < 0.05$.
[b] $p < 0.10$.
[c] $p < 0.01$.

thus associated with larger grants. The insured loss variable is again positive, and statistically significant in specification 5. As the percent of the population that is African American increases in specification 5, the average aid amount declines by a very small amount; however, while these specifications control for income, they do not control for the value of structures, which may be correlated with socioeconomic variables. Very few of the other coefficients are statistically significant.

Finally, specifications 3 and 6 look at the number of applications approved divided by total housing units in the zip code as the dependent variable. Precipitation is insignificant in specification 3 and is surprisingly negative in specification 6, while the interaction with elevation is positive. It is very likely these physical variables are not fully capturing damage levels in the zip code. A higher percentage of African Americans slightly increases the proportion of approved grants and a 1% increase in income decreases the number of applications approved by almost 2%. This is again consistent with IA grants targeting disadvantaged communities.

Perhaps surprisingly, in specifications 4–6, insurance policies (as measured by exposures) as a percentage of housing units are never statistically significant, although in the OLS specifications (5 and 6) they are negative. A stronger relationship may have been expected since if more homes have insurance, then there presumably would be less need for aid. There may simply not be enough power to identify this relationship. It could also be that an omitted variable is biasing the coefficients. For example, there are plausibly higher take-up rates for insurance in riskier areas, particularly to the extent that the mandatory purchase requirement of the National Flood Insurance Program is enforced, and also more aid is given in these locations (assuming the spatial variables do not fully capture ''riskiness''). Or, alternatively, it could be that those with insurance are also savvier about getting reimbursement for uninsured damages. A 2006 report that examined the link between disaster aid and flood insurance at a state level found that higher levels of insurance penetration only slightly reduced the probability of a state receiving aid in a given year (Dixon et al. 2006). This suggests aid may often cover uninsured losses.

All these findings, as already noted, should be interpreted with a high amount of caution. Table 4 should be considered a hypothesis-generating procedure. The specifications are likely afflicted by omitted variable bias, have a limited sample, and are aggregated at a fairly high level. Still, consistent with other work, disadvantage communities do appear to be perhaps receiving more aid. Also, they demonstrate, as found in previous research, that the hazard does not fully capture damage due to mediating influences. The results also raise questions on the degree to which insurance can or does fully replace aid.

5. Conclusions

To date there has been little empirical examination of federal disaster aid in the United States, largely because the data are not readily available. This paper took a step toward improving our understanding of federal disaster aid by examining actual FEMA aid data for a representative disaster year in the state of Missouri. The goal of this work was to answer some basic questions about aid, as well as to generate hypotheses for future research.

It was found that IA grants to individuals are fairly modest in amount. This could be in part due to the requirement that aid only be given to make homes safe and inhabitable again, not to restore them to predisaster conditions. This paper examined storm and tornado events in Missouri in 2008. A report by the Congressional Research Service suggests that the low average grant levels may be more widely applicable to other areas and disaster events (McCarthy 2010), as well. Such low grant levels suggest moral hazard may be less of a problem than is often suggested. To further explore that issue, it would be useful to combine these findings with a survey of those located in risky locations about their expectations of aid amounts, as expectations would be driving predisaster investments in risk reduction.

Survey results would also be useful to shed more light on the finding that many people who apply for aid are denied it, often for reasons of ineligible damage. This deserves further research: Why are so many applicants denied aid? Is it due to a lack of understanding about the requirements for aid? Answers to these questions would presumably have implications for communications efforts regarding federal aid programs.

Another important area for future research is the relationship between insurance and disaster aid. On the one hand, it seems intuitive that higher take-up of insurance could reduce the amount of aid needed. On the other hand, the current caps on aid and the limitation that it only be to make a home safe, as opposed to return it to predisaster conditions, suggests IA grants and insurance may not be substitutes. It could be that aid is filling in holes in insurance coverage by compensating homeowners for below-deductible damage or for items not covered by insurance, and as such, there is not a strong negative relationship between insurance take-up rates and aid given.

Finally, the analysis in this paper is limited by the lack of availability of consistent and reliable disaster damage data. Damage information also does not appear to be collected by FEMA for grant recipients. It is thus impossible to say what percentage of individual damages IA grants cover and whether this varies along any dimensions, such as type of property.

Acknowledgments. I would like to thank Alan Prenger at the Missouri State Emergency Management Agency for the helpful information and Brent Kabler at the Missouri Department of Insurance, Financial Institutions and Professional Registration for providing data. I would also like to thank Leonard Shabman for the helpful conversations on these topics and the anonymous referees for their very insightful feedback. Remaining errors are, of course, my own.

REFERENCES

Beauchesne, A. M., 2001: *Natural Disasters.* Vol. 1, *A Governor's Guide to Emergency Management*. National Governors Association, 67 pp.

Chappell, W. F., R. G. Forgette, D. A. Swanson, and M. V. Van Boening, 2007: Determinants of government aid to Katrina survivors: Evidence from survey data. *South. Econ. J.,* **74,** 344–362.

Cutter, S. L., B. J. Boruff, and W. L. Shirley, 2003: Social vulnerability to environmental hazards. *Soc. Sci. Quart.,* **84,** 242–261.

Dixon, L., N. Clancy, S. A. Seabury, and A. Overton, 2006: The National Flood Insurance Program's market penetration rate: Estimates and policy implications. RAND Corporation, 116 pp.

Downton, M. W., and R. A. J. Pielke, 2001: Discretion without accountability: Politics, flood damage, and climate. *Nat. Hazards Rev.,* **2,** 157–166.

FEMA, 2008: Help after a disaster: Applicant's guide to the Individuals and Households Program. Federal Emergency Management Agency Publ. FEMA P-545, 29 pp.

——, cited 2012: Federal assistance from seven disaster declarations tops $180 million. Federal Emergency Management Agency. [Available online at http://www.fema.gov/news-release/2009/03/26/federal-assistance-seven-disaster-declarations-tops-180-million.]

GAO, 1989: Disaster assistance: Timeliness and other issues involving the major disaster declaration process. Government Accountability Office Rep. GAO/RCED-89-138, 12 pp.

——, 2001: Disaster assistance: Improvement needed in disaster declaration criteria and eligibility assurance procedures. Government Accountability Office Rep. GAO-01-837, 37 pp.

——, 2006: Hurricanes Katrina and Rita: Unprecedented challenges exposed the Individuals and Households Program to fraud and abuse; Actions needed to reduce such problems in future. Government Accountability Office Rep. GAO-06-1013, 110 pp.

——, 2012: Improved criteria needed to assess a jurisdiction's capability to respond and recover on its own. Government Accountability Office Rep. GAO-12-838, 89 pp.

Garrett, T. A., and R. S. Sobel, 2003: The political economy of FEMA disaster payments. *Econ. Inquiry,* **41,** 496–508.

Hampel, P., 2008: President declares region disaster area. *St. Louis Post-Dispatch,* 14 November, 3rd ed., C1.

Kamel, N. M. O., and A. Loukaitou-Sideris, 2004: Residential assistance and recovery following the Northridge earthquake. *Urban Stud.,* **41,** 533–562.

Kousky, C., and L. A. Shabman, 2012: The realities of federal disaster aid: The case of floods. Resources for the Future Issue Brief 12-02, 16 pp.

Lichtenberg, E., 1994: Sharing the challenge? An economist's view. *Water Resour. Update,* **97,** 39–43.

McCarthy, F. X., 2010: FEMA disaster housing: From sheltering to permanent housing. Congressional Research Service 7-5700, R40810, 28 pp.

National Research Council, 1999: *The Impacts of Natural Disasters: A Framework for Loss Estimation.* The National Academies Press, 80 pp.

Niehaus, G., 2010: Comment on ''Federal financial exposure to natural catastrophe risk.'' *Measuring and Managing Federal Financial Risk,* D. Lucas, Ed., University of Chicago Press, 93–96.

Reeves, A., 2009: *Political Disaster? Presidential Disaster Declarations and Electoral Politics.* Boston University, 40 pp.

Sylves, R., and Z. I. Búzás, 2007: Presidential disaster declaration decisions, 1953–2003: What influences odds of approval? *State Local Gov. Rev.,* **39,** 3–15.