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Disaster Reporting in the United States

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This brief introduces the disaster reporting system in the United States administered by the Federal Emergency Management Agency (FEMA) and presents a quantitative summary of disaster experiences extending back to the 1950s. The summary highlights changes in the prevalence of wildfires, both their annual numbers and their place in the disaster reporting system. Also included is a summary of losses from major disasters, based on data from FEMA and data on billion-dollar disasters published by the National Oceanic and Atmospheric Administration (NOAA). The NOAA data are summarized in the aggregate and for seven categories of disasters. Finally, the brief describes the size of losses from major disasters in 2017 and 2018.

This brief has five main findings:

1. Disasters are becoming more frequent, with the annual increment averaging nearly one per year since the 1950s. The number of major disasters averaged about 13 per year in the 1950s but nearly 60 per year from 2010 to 2018.
2. Disasters exhibit wide annual variation.
3. Hurricanes (tropical cyclones) cause roughly half the economic losses from all disasters, even though they account for only one in six major disaster events.
4. Annual losses from disasters have trended upward, mainly because of increases in annual occurrences.
5. When all categories of major disasters are combined, they caused $1.7 trillion in economic losses between 1980 and 2018, or about 0.4 percent of real gross domestic product (GDP) for those years.

Disasters and Disaster Data

A disaster occurs when a hazard causes physical damage, injury or loss of life or assets, environmental degradation, disruption in the livelihoods and services of individuals and communities, and interruptions to social and economic activity. The United States has developed official definitions of disasters to classify and respond to them. The Robert T. Stafford Disaster Relief and Emergency Assistance Act (hereafter, the Stafford Act[1]) authorizes five categories of committed action either before a potential disaster occurs or in response to a disaster.[2] Three types of declarations can be made before a disaster occurs: fire management assistance declarations, the provision of defense resources, and a decision to pre-position resources and supplies. The president of the United States can issue two types of declarations after a disaster overwhelms the combined resources of local, county, and state jurisdictions: major disaster declarations and emergency declarations. Three types of disasters are declared and assigned incident numbers (major disasters, emergency declarations, and fire management declarations), but the provision of defense resources and the pre-positioning of resources and supplies do not have separate declarations.

The presidential disaster declaration process is firmly established in legislation. A major disaster is the result of a natural hazard or of an explosion, fire, or flood, regardless of the cause.[3] Once the president makes a major disaster declaration, federal resources are assembled for emergency relief and long-term recovery. Emergency declarations are more limited in scope, and certain long-term federal recovery benefits are not provided. Fire management assistance grants are provided for fires that pose a "threat of major disaster."

FEMA, part of the US Department of Homeland Security, administers the primary system for recording disasters.[4] Major disaster declarations have been recorded since 1953, emergency declarations have been recorded since 1974, and fire management declarations have been tracked since 1970. The disaster declaration process has remained largely unchanged, starting with a request from a governor to the president. Governors of affected states file application documents that describe the disaster and request federal assistance. The application identifies affected counties and the types of assistance needed. Federal assistance is available for the three numbered categories of disasters, and the flow of aid typically commences shortly after the request is approved. Disaster programs cover the 50 states, the District of Columbia, Puerto Rico, the Virgin Islands, and six island groups in the Pacific. When a disaster affects more than one state, there can be a declaration for each state (e.g., Hurricane Katrina in 2005 generated major disasters in Alabama, Florida, Louisiana, and Mississippi).

Table 1 identifies the three types of disaster declarations and summarizes milestones in the availability of data from FEMA related to disaster assistance. Individual counties included in disaster declarations were identified starting in 1965. For example, New York State experienced 73 major disasters between June 1953 and December 2018, and Schoharie County was affected in 16 of these 73 disasters. Flooding from rainstorms caused nine major disasters in Schoharie County, hurricanes were responsible for four, and winter storms caused two.

TABLE 1

Availability of Disaster Data

Year	Major disasters	Emergency declarations	Fire management declarations
First available year	1953	1974	1970
State identified	1953	1974	1970
County identified	1965	1974	1970
Public assistance: Yes or no[a]	1965	1974	1970
Individual assistance: Yes or no[b]	1965	NA	NA
Public assistance: Amount obligated	1999	1992	1990
Individual assistance: Amount obligated	2003	NA	NA
DUA payments[b]	1984	NA	NA

Source: Federal Emergency Management Agency.

Note: DUA = Disaster Unemployment Assistance; NA = not applicable, as this money is not available for this type of disaster.

[a] Money obligated for debris removal and infrastructure restoration.

[b] Money obligated for housing assistance and other individual assistance, including DUA.

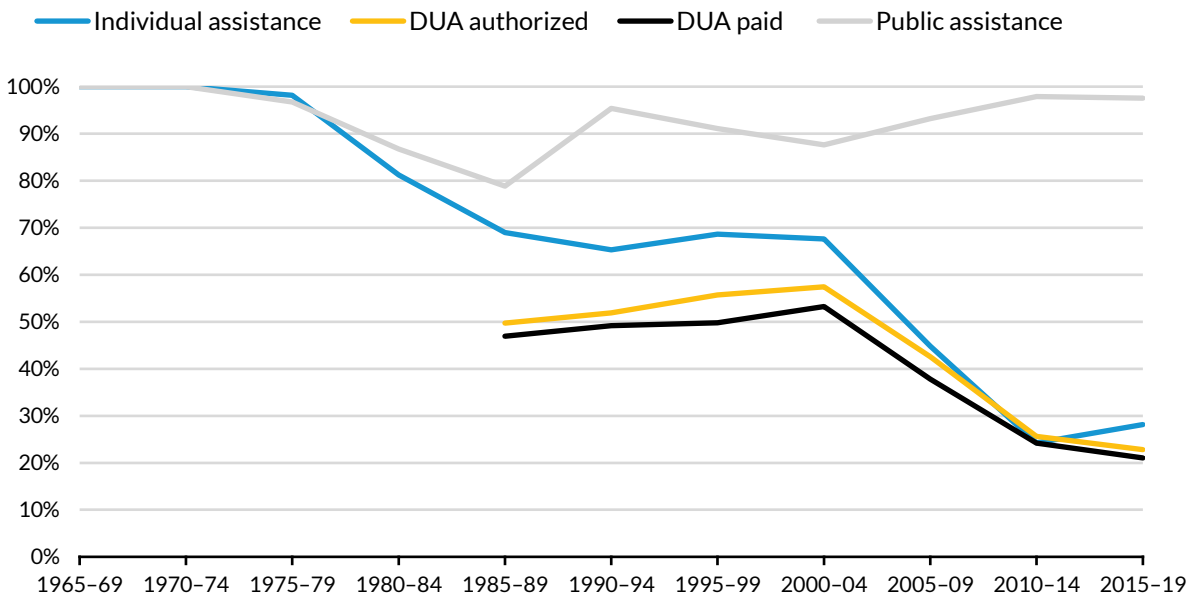
Public assistance (PA) is almost always available in disaster-affected counties. This assistance covers emergency trash and debris removal as well as infrastructure repair and restoration (for highways and bridges, water and sewer systems, schools, public buildings, and parks). Disaster counties where PA and individual assistance (IA) are available have been identified since 1965. The largest category of IA is housing assistance, but other assistance can be made available to individuals and families.[5] If a disaster causes people to miss work, assistance can be paid to unemployed people through Disaster Unemployment Assistance (DUA), a program administered by state unemployment insurance agencies. But the state must request DUA, and affected individuals must first apply for unemployment insurance.

Data on the dollar amounts of PA and IA authorizations for major disasters are available only in recent years (PA data since 1999 and IA data since 2003). From 1965 to 1978, PA and IA were available following all major disaster declarations. While PA has continued to have nearly universal availability, IA has become less available. In 2016, only 18 of the 46 major disaster declarations authorized IA payments, and only 14 made DUA payments. In contrast, PA was available following all 46 major disasters.[6]

Figure 1 summarizes the availability of disaster program cash payments since 1965. It shows the share of major disaster declarations where the indicated types of cash payments were available during five-year periods starting with 1965–69. There are two series for the DUA program: one for authorizations and one for payments to the unemployed.

FIGURE 1

Share of Major Disasters with Benefits, 1965–2018 (Five-Year Averages)



Source: Author's calculations based on data for individual major disasters published by the Federal Emergency Management Agency.
Note: DUA = Disaster Unemployment Assistance.

Figure 1 has three noteworthy features. First, public assistance payments have been widely available. The share of disasters with PA payments from 1965 to 1969 was 100 percent and was 98 percent from 2015 to 2018.[7] Second, the availability of IA and DUA benefits has decreased significantly. Between 2000–04 and 2010–14, each of the three shares for IA and DUA in figure 1 deceased 29 percent or more. In recent years, IA and DUA benefits have been available for only 20 to 30 percent of disasters. Individual assistance payments are now made in approximately one in four major disasters. The decline in IA and DUA payments after 2004 may reflect a change in eligibility or a change in state requests for assistance. To receive IA benefits, a state must request these benefits. To receive DUA benefits, the claimant must first apply for unemployment insurance and be found previously ineligible for unemployment insurance before receiving DUA. Third, for major disasters where IA payments are available, DUA benefits are also usually available.

Although DUA benefits are paid in most disasters when IA payments are made, the comparative scale of these payments needs to be recognized. In 2016, for example, IA authorizations totaled $1.3 billion while DUA payments totaled only $3.7 million. Most IA payments to individuals and families compensate for property damage and do little to make up for unemployment caused by major disasters.

Disaster Annual Time Series

The three disaster declaration series in table 1 display distinct time series patterns. Though all three exhibit wide year-to-year variability, emergency declarations are the most variable and major disasters are the least variable. Table 2 illustrates the contrasts displaying means (annual counts), standard deviations, and coefficients of variation for the three series over their periods of availability.[8] On average, there are roughly as many major disasters each year as emergency declarations plus fire management declarations combined. But because major disasters cause larger economic losses per event, they generate larger total financial consequences.

In table 2, the emergency declarations exhibit the largest relative variability of the three series (coefficient of variation, ratio of the standard deviation to the mean). In years with frequent emergency declarations, they have been mostly a single type of event. For example, hurricanes made up 52 of 68 events in 2005, droughts made up 24 of 33 events in 1977, and hurricanes made up 16 of 29 events in 2011. All three types of disasters exhibit wide year-to-year variability, but the relative variability is greatest for emergency declarations.

TABLE 2

Relative Variability of Three Disasters: Annual Series

	Major disasters	Emergency declarations	Fire management declarations
Mean	34.6	8.7	26.1
Variance	370.1	135.5	769.2
Standard deviation	19.2	11.6	27.7
Coefficient of variation	0.56	1.34	1.06

Source: Federal Emergency Management Agency disaster reports.

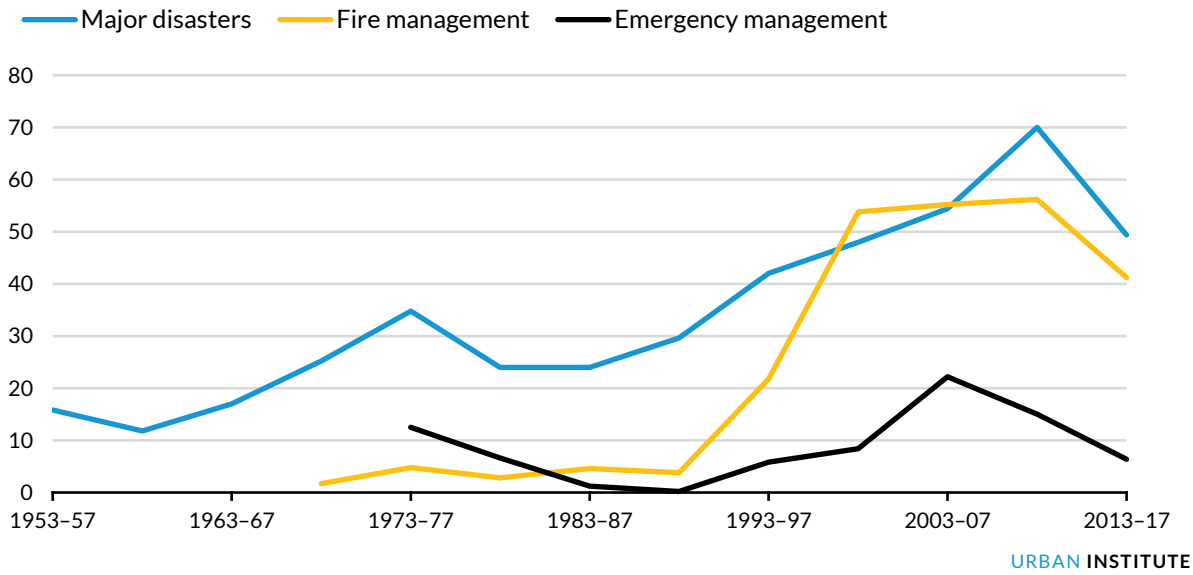
Notes: Summary statistics refer to years of availability: 1953–2018 for major disasters, 1974–2018 for emergency declarations, and 1970–2018 for fire management declarations. The coefficient of variation, the ratio of the standard deviation to the mean, is a common measure of relative variability.

Major disasters show the greatest year-to-year stability but are highly variable. To illustrate this variability, a simple regression of current-year major disasters on one-year-lagged major disasters explains only 56 percent of the time series variation, and the slope on lagged disasters is only 0.75. All three disaster series are highly variable.

The three categories of disasters introduced in table 1 display distinct time series patterns. Figure 2 illustrates the contrasts, displaying five-year averages.

FIGURE 2

Annual Disaster Declarations, Five-Year Averages



Source: Federal Emergency Management Agency disaster reporting system.

Major disasters have the highest averages except from 1998 to 2007. But the most dramatic change has been the increase in fire management declarations, increasing from 3.8 annual declarations from 1988 to 1992 to 21.8 from 1993 to 1997 and then to 53.8 from 1998 to 2002. The five-year average has topped 40 in all later periods. Since 1998, there have been nearly as many fire management declarations as declarations of major disasters. Finally, emergency management declarations have been low in all periods, with just one five-year average (2003–07) exceeding 20 per year.

Table 3 displays descriptive regressions that summarize these time series patterns, emphasizing data trends and shifts. Regressions 1 and 2 describe major disasters, and both indicate a strong upward trend between 1953 and 2018. The trend coefficient in equation 1 shows an average increase of about 0.8 major disasters per year over the full data period. Two subperiods with below-average numbers of major disasters are identified. In equation 2, the coefficients on the categorical (0–1 dummy) variables for 1980–95 and 2012–18 are negative, sizeable, and statistically significant. During these two subperiods, major disasters occurred less frequently than would have been expected based on a simple projection from a linear trend for the full 66 years.

TABLE 3

Descriptive Regressions of Annual Disaster Declarations

	Major disasters (1)	Major disasters (2)	Fire management declarations (3)	Fire management declarations (4)	Emergency management declarations (5)
Constant	8.159 (2.7)	7.663 (3.0)	4.923 (1.5)	4.034 (0.7)	4.430 (1.2)
Trend 1953	0.789 (10.0)	0.983 (12.9)			
Trend 1970				0.066 (0.2)	
Trend 1974					0.187 (1.4)
D 1980–95		-15.995 (5.5)			
D 1996–18			46.816 (10.0)	45.202 (4.8)	
D 2012–18		-20.017 (4.2)			
Adjusted R^2	0.604	0.747	0.676	0.669	0.021
Standard error	12.19	9.75	16.280	16.449	11.719
Mean	34.590	34.590	26.898	26.898	8.733
Years	1953–2018	1953–2018	1970–2018	1970–2018	1974–2018

Source: Federal Emergency Management Agency disaster reporting system.

Notes: D = dummy variable. Explanatory variables are linear trends and 0–1 dummy variables. Beneath each coefficient is the absolute value of its *t* ratio. *T*s of 2.0 or larger indicate significance.

The second subperiod, 2012–18, includes 2017, the year with the largest number of large-scale major disasters in more than a decade. Hurricanes Harvey, Irma, and Maria delivered the most destructive one-two-three punch since Hurricanes Katrina, Rita, and Wilma in 2005. Note the size of the trend 1953 coefficients in equations 1 and 2. Over the long run, major disasters have been increasing at a rate of 0.8 to 1.0 event per year. Based on the trend 1953 slope coefficients in regressions 1 and 2, the number of major disasters to be expected in 2019 should be between 11 and 15 more than expected in 2005.

Another noteworthy feature of equations 1 and 2 is the scale of the unexplained variation in major disaster occurrences. Although both equations display highly significant upward trends, both equations exhibit large errors for within-sample data points, with standard errors of 12.19 and 9.75, respectively.[9] It is another illustration of the wide annual swings in the number of major disasters. Interestingly, though 2017 had a historic hurricane season, with Hurricanes Harvey, Irma, and Maria causing damage that is still being repaired, the number of major disaster declarations in 2017 was not unusually large. There were 55 major disaster declarations across the 50 states and the District of Columbia plus 4 in Puerto Rico and the Virgin Islands. The projections for 2017 from equations 1 and 2 are 59.9 and 51.5 declarations, respectively, both deviating less than 1 standard error from 55, the 2017 major disaster count.

In contrast to major disasters, fire management declarations were essentially trendless from 1970 to 1995 but then increased sharply. The dummy variable for 1996 and later years in equation 3 shows an upward shift of 46.8 declarations per year. Between 1970 and 1995, there were only 116 fire management declarations, an average of 4.5 per year. Since 1996, the annual average has been 50.5. The coefficients for the shift dummy variables in equations 3 and 4 capture this large shift while equation 4 shows no significant additional long-term trend between 1970 and 2018.

Regression equation 5 in table 3 does not capture the time series variation in emergency management declarations using a linear trend. The adjusted R^2 is 0.021. This reflects the concentration of certain common events such as hurricanes and droughts in specific years. Tests with categorical (0–1 dummy) variables for subperiods also do not yield significant additions to explained variation. The largest annual number of emergency declarations was 68 in 2005, but nearly all the declarations were linked to Hurricane Katrina. Between 1974 and 2018, the number of emergency declarations averaged 8.7 per year.

Wildfires and Major Disasters

Since the 1990s, the annual number of fire management declarations has often approached the number of major disasters. Table 4 illustrates the increase in the number of fire management declarations with data from 1953 to 2018. Because fire management declaration reporting commenced in 1970, column 2 displays only four 11-year summaries. The change between 1975–85 and 2008–18 was huge, increasing from 43 to 538. As a share of major disasters, fire management declarations increased dramatically from 0.152 in 1975–1985 to 0.993 in 1997–2007 and 0.828 in 2008–2018.

TABLE 4

Wildfires in the FEMA Disaster Reporting System

	Major disasters (1)	Fire management declarations (2)	Major disaster wildfires (3)	Fire management/ all majors = (2)/(1) (4)	Major wildfires/fire management = (3)/(2) (5)	Major wildfires/all majors = (3)/(1) (6)
1953–1963	156	NA	4	NA	NA	0.026
1964–1974	282	NA	2	NA	NA	0.007
1975–1985	283	43	3	0.152	0.070	0.011
1986–1996	360	134	8	0.372	0.060	0.022
1997–2007	552	548	10	0.993	0.018	0.018
2008–2018	650	538	20	0.828	0.037	0.031

Source: Data for columns 1, 2, and 3 come from FEMA's disaster reporting system.
Note: All majors = all major disasters; FEMA = Federal Emergency Management Agency; NA = not available.

Although fire management declarations have increased sharply, the number that have become major disasters has been low and has increased only modestly (table 4, column 3). Of the 538 fire management declarations during 2008–18, only 20 became major disasters, representing only 3.7

percent of fire management declarations (column 5). As a share of all major disasters, these declarations have varied modestly across the six periods in column 6 (e.g., between 0.7 percent and 3.1 percent). Few fire management declarations cause sufficient damages to qualify as major disasters.

The comparatively small economic losses from fire management declarations in FEMA data is reinforced by loss estimates from the NOAA billion-dollar disaster data. Between 1980 and 2018, NOAA estimates that wildfires caused 16 billion-dollar disasters. The average loss across these 16 events was just $4.9 billion, and only 4 of the 16 had losses that exceeded $5 billion.[10] The wildfire average is measurably smaller than the overall average of $6.9 billion for all billion-dollar disasters over the 39 years. Wildfires cause large losses for affected individuals and businesses but affect few entities.

Accompanying the increase in the number of fire management declarations has been a change in their distribution across the months of the year. Table 5 shows the mean, variance, and standard deviation of the declaration month for the 85 declarations between 1970 and 1992 and the 1,143 declarations between 1993 and 2017. The mean declaration date changed from July 11 between 1970 and 1992 to June 16 between 1993 and 2017.[11] The mean declaration date from 1993 to 2017 was 25 days earlier in the year than the mean declaration date from 1970 to 1992. Fire season starts earlier in the year than in the past.

TABLE 5

Mean and Variance of Monthly Fire Management Declaration Dates, 1970–2017

	Fire management declarations	Mean month of year	Variance of months	Standard deviation of months
1970–1992	85	7.36	2.54	1.59
1993–2017	1,143	6.53	6.28	2.51
1970–2017	1,228	6.58	6.06	2.46

Source: Author's calculations based on data from the Federal Emergency Management Agency disaster reporting system.
Note: Statistics are based on the month when each fire management declaration was made between 1970 and 2017.

The data also show that the fire management declarations have become more widely dispersed within the year. The variance in declaration dates increased from 2.54 months between 1970 and 1992 to 6.28 months between 1993 and 2017. The change across the two subperiods shows an evolutionary increase in the within-year variability of fire management declaration dates.

Summarizing the evolution of fire management declarations between 1970 and 2017, three points are noteworthy. First, the annual number of declarations has increased. Annual fire management declaration counts now rival the counts of major disasters. Second, the mean declaration date has moved to earlier in the year, from July 11 to June 16. Third, the within-year variability of fire management declaration dates has increased. The standard deviation of the declaration date from 1993 to 2017 (2.51 months) was 58 percent larger than the 1.59-month standard deviation from 1970 to 1992.

Major Disasters and Direct Compensation by FEMA

The economic losses from major disasters experienced by households, businesses, and governments are partially offset by FEMA's direct compensation benefits. FEMA makes cash payments of individual assistance and public assistance benefits to families, businesses, and governments directly affected by major disasters. This section briefly summarizes payments by FEMA of PA and IA benefits.[12]

All three categories of disasters (i.e., major disasters, emergency declarations, and fire management declarations) disburse PA benefits that pay to restore damaged infrastructure, while major disasters also pay IA benefits. Most IA benefits finance the restoration of household residences and other buildings. Table 1 identified the first full year for which IA and PA benefit data are available for individual disasters. IA benefit data are available starting in 2003, while PA data are available for major disasters starting in 1999, emergency declarations starting in 1992, and fire management declarations starting in 1990.

Table 6 summarizes FEMA's disaster-related cash payments from 2003 to 2017, when data for all four types of assistance benefits are available and complete.[13] When the PA and IA payments in 2009 dollars from major disasters are considered together, they averaged $109 million per disaster from 2003 to 2017. Emergency management PA payments averaged $7.6 million, while fire management PA payments averaged $1.7 million.

TABLE 6

Cash Payments by the Federal Emergency Management Agency for Disasters, 2003–17

	Major disasters, individual assistance	Major disasters, public assistance	Emergency management public assistance	Fire management, public assistance
Number of events	869	869	219	762
Total (current dollars)	$21.85 billion	$71.45 billion	$1.56 billion	$1.43 billion
Total (2009 dollars)	$11.49 billion	$71.83 billion	$1.67 billion	$1.32 billion
Average (2009 dollars)	$25.88 million	$82.66 million	$7.61 million	$1.73 million

Source: Author's calculations based on data from the Federal Emergency Management Agency disaster reporting system.
Notes: The number of events is the total for each category during 2003–17. The amounts in 2009 dollars are calculated using the gross domestic product deflator.

Payments per event associated with fire management declarations are the smallest across the three disaster categories. From 2003 to 2017, major disasters accounted for 97 percent of all cash benefit payments from FEMA's disaster reporting system. Given the wide variability in the underlying disaster events, it is not surprising that the four data series in table 6 vary widely.

Table 7 displays simple regression equations that summarize annual payouts for each of the four categories of FEMA-administered cash benefits from table 6. The top four regressions address total annual benefit payments, while the bottom four examine average payments.[14] All series are measured in 2009 dollars to remove the effects of inflation. The data series all end in 2017 to exclude the effects of payment lags that affect the 2018 data.

TABLE 7

Annual Real Expenditure Regressions with Data to 2017

	Intercept	Linear trend	Adjusted R^2	Standard error	Mean	Data period
Total benefit payments						
IA major disasters	2.255 (2.2)	-0.098 (0.7)	-0.046	2.225	1.470	2003–2017
PA major disasters	6.129 (1.7)	-0.176 (0.5)	-0.060	6.452	4.728	1999–2017
PA fire management	0.013 (0.7)	0.0035 (3.2)	0.257	0.047	0.064	1990–2017
PA emergency management	0.120 (1.6)	-0.0020 (0.4)	-0.034	0.189	0.092	1992–2017
Mean benefit payments						
IA major disasters	93.999 (1.4)	-2.540 (0.3)	-0.067	122.89	73.676	2003–2017
PA major disasters	68.476 (1.0)	-1.444 (0.2)	-0.055	138.25	82.917	1999–2017
PA fire management	1.051 (2.2)	0.055 (1.9)	0.087	1.25	1.851	1990–2017
PA emergency management	10.163 (3.6)	-0.214 (1.2)	0.013	7.08	7.276	1992–2017

Source: Author's calculations based on data from the Federal Emergency Management Agency disaster reporting system.
Notes: IA = individual assistance; PA = public assistance. All regression equations are simple regressions that test for a linear time trend. Total benefits are in billions of 2009 dollars using the gross domestic product (GDP) deflator. Mean benefits are in millions of 2009 dollars using the GDP deflator. The sample periods are shown in the right-hand column. Beneath each coefficient is the absolute value of its *t* ratio.

For each of the four categories of benefit payments, a simple regression with only a linear trend was fitted. As a group, the fits are poor, with negative adjusted R^2s in five of eight regressions. The only significant trends in table 7 are for fire management declarations, which trended significantly upward between 1990 and 2017.

Table 7 also illustrates the overwhelming importance of major disasters in the FEMA direct benefit payment totals. The means for IA and PA total real benefits in the top panel are $1.5 billion and $4.7 billion, respectively. The comparable means for emergency management and fire management declarations are $92 million and $64 million, respectively. Major disasters accounted for 97 percent of FEMA-supported direct payments during these 15 years. Removal of years with large hurricane payouts from the data eliminated the largest residuals from the table 7 regressions, but the fits were still poor. All three categories of disasters exhibit wide annual variation.

The preceding analysis of postdisaster real annual IA and PA payments by FEMA indicates high variability from year to year, and only fire management declarations exhibited a significant upward trend in the years covered in tables 6 and 7. These data also show the overwhelming importance of hurricane-related IA and PA payments. Only the devastation from Hurricane Katrina in 2005 caused real state-level IA payments to exceed $1 billion.[15] Of the eight major disasters where PA payments

exceeded $1 billion, six were hurricanes. The two exceptions are the September 2001 terrorist attacks on New York City and the severe storms and flooding in Iowa in May 2008.

Disasters in 2017 and NOAA Data

2017 was the most expensive year for major disasters in the data. Since 1980, the National Oceanic and Atmospheric Administration has published data on billion-dollar disasters. Between 1980 and 2018, NOAA identified 239 billion-dollar disasters in the 50 states and the District of Columbia and 2 others in Puerto Rico. Unlike the major disaster data series from FEMA, the NOAA data combine information from individual states for multistate disasters. Thus, the total losses from Hurricane Sandy, as estimated by NOAA, were $72.2 billion and were treated as a single event, whereas in FEMA's reporting system, Sandy caused 13 separate state-level major disasters.

Loss estimates in the NOAA data include compensated and uncompensated losses. Losses are measured both in current-year price levels and in 2018 prices adjusted for the Consumer Price Index (CPI). In 2018 dollars, losses between 1980 and 2017 totaled $1.7 trillion. In the 39 years of available billion-dollar loss estimates, 2017 had the highest annual losses at $313 billion. This estimate primarily reflects losses from three major hurricanes: Harvey, Irma, and Maria. NOAA estimates their respective losses at $128 billion, $51 billion, and $92 billion, for a combined total of $270 billion, which is 26 percent larger than the 2005 total from the hurricane trio of Katrina, Rita, and Wilma ($215 billion).[16]

Losses from wildfires were also at a historic maximum in 2017 and again in 2018. Western wildfires were extensive during the second half of 2017, most notably in northern California's Napa County, destroying more than 15,000 homes, business, and other buildings. NOAA estimated these wildfire losses at $18.4 billion, three times its next-highest previous wildfire loss estimate of $6.2 billion from the Oakland firestorm of 1991.[17]

Wildfires again caused large losses in California in 2018. The city of Paradise, near Sacramento, suffered extensive damage, as did areas near Los Angeles. NOAA estimated total 2018 wildfire losses in California at $24 billion. Before 2017, the average loss for 14 earlier billion-dollar wildfires was $2.6 billion. Adding the losses of 2017 and 2018 increased the average for 16 wildfire events to $4.9 billion.

The responses to the major disasters of 2017 severely exceeded FEMA's budget for the year. Emergency additions were made to FEMA's budget in late 2017 and early 2018, and budgetary issues related to Harvey and Maria continue into 2019.

Table 8 summarizes estimated losses from billion-dollar disasters for the 39 years from 1980 to 2018. The table's seven-category taxonomy was devised at the Urban Institute and reflects classification decisions made when the NOAA description included two or more loss categories used in the table. Often at issue were three categories: severe storm, flood, and tornado. Generally, the first category listed in NOAA's description was used to classify each event. The categories winter freeze, drought, hurricane, and wildfire typically posed few classification problems. Estimated losses include

both compensated losses (e.g., payments from insurance and disaster programs) and uncompensated losses.

Five features of table 8 are worth noting. First, losses from hurricanes dominate the statistics, accounting for about one-sixth of billion-dollar events (42 of 241) but about half of total losses ($919.7 billion of $1.7 trillion). Average losses from hurricanes are more than three times the overall average ($21.9 billion / $6.9 billion = 3.2), and all five events with losses above $50 billion were hurricanes. Second, drought is the only other disaster category with above-average losses per event ($9.4 billion versus $6.9 billion). Third, the most common of the seven disaster categories is severe storms and severe weather (69 events), but their average losses are the smallest ($2.2 billion). Fourth, a wide variety of events can cause a billion-dollar disaster. Six of the seven loss categories in table 8 had between 16 and 42 events between 1980 and 2018. Finally, hurricanes and droughts are responsible for the greatest number of deaths, with the highest average mortality per event at 115 and 155 people, respectively.

TABLE 8

Billion-Dollar Disasters: Total Losses and Losses by Category, 1980–2018

Loss category	Number	Total losses	Average loss	Total deaths	Average deaths
Winter freeze	24	$72.9 billion	$3.0 billion	1,187	50
Drought	26	$244.3 billion	$9.4 billion	2,993	115
Hurricane[a]	42	$919.7 billion	$21.9 billion	6,487	155
Severe storms or weather	69	$149.1 billion	$2.2 billion	605	9
Flood	28	$116.7 billion	$4.2 billion	558	20
Tornado	36	$89.1 billion	$2.5 billion	1,014	28
Wildfire	16	$78.8 billion	$4.9 billion	344	22
Total	**241**	**$1.7 trillion**	**$6.9 billion**	**13,188**	**55**

Source: "Billion-Dollar Weather and Climate Disasters: Table of Events," National Oceanic and Atmospheric Administration, National Centers for Environmental Information, accessed July 24, 2019, https://www.ncdc.noaa.gov/billions/events/US/1980-2018.

Note: Losses are in billions of Consumer Price Index–adjusted 2018 dollars.

[a] Includes four events the National Oceanic and Atmospheric Administration classified as tropical storms.

Table 9 provides a second summary of losses by disaster type. It shows the distribution of billion-dollar losses for the same seven loss categories as in table 8 but displays the distribution of losses across six size categories. Hurricanes accounted for all five disasters with losses above $50 billion and five of the nine with losses between $25 and $50 billion. Droughts caused three of the other four events, with losses between $25 and $50 billion. At the other end of the distribution, 184 of the 241 disasters (three-fourths) had losses below $5 billion. All but 2 of the 69 severe weather or storms disasters had losses below $5 billion.

TABLE 9

Billion-Dollar Disasters by Type and Size of Losses, 1980–2018

Size of losses ($billions)	Hurricane	Drought	Wildfire	Flood	Winter freeze	Tornado	Severe weather	Total
50+	5	0	0	0	0	0	0	5
25–49.9	5	3	0	1	0	0	0	9
10–24.9	9	3	2	2	0	2	0	18
5–9.9	8	8	2	1	4	0	2	25
2–4.9	8	11	5	12	11	14	24	85
1–1.9	7	0	7	12	9	20	43	99
Total	42.0	26.0	16.0	28.0	24.0	36.0	69.0	241.0
Mean	21.9	9.4	4.9	4.2	3.0	2.5	2.2	6.9
Median	8.7	3.6	2.3	2.1	2.2	2.3	1.6	2.3

Source: National Oceanic and Atmospheric Administration.

Notes: Losses are in billions of 2018 dollars adjusted with the all-items Consumer Price Index. The category for hurricanes includes four tropical storms that caused more than $1 billion in losses.

Comparing Disaster-Related Losses and Compensation

The following paragraphs compare economic losses from disasters with compensation payments to affected people, businesses, and governments. This analysis is not comprehensive because support payments from important programs and institutions are not included, such as payments from charities and religious organizations, state and local governments, agricultural insurance programs, and some private insurance programs, as well as Small Business Administration loans. The intent here is to compare the economic losses from disasters with payments made by three federal disaster relief programs.

Table 10 displays information from four data series: losses estimated by NOAA's billion-dollar disaster data and compensation data from three programs: FEMA payments of IA and PA that follow disaster declarations, payments from the National Flood Insurance Program (NFIP), and federal wildfire suppression costs as estimated by the National Interagency Fire Center (NIFC). All data refer to the 15 years from 2003 to 2017. Losses and compensation are measured in current dollars of the year of their occurrence and in constant dollars to remove the effects of inflation. The estimates in real terms use the 2018 all-items CPI in all four panels to enhance comparability with the NOAA data.

Panel A shows total compensated plus uncompensated losses from NOAA's estimates of billion-dollar disasters. Annual updates of the NOAA series use the CPI from the most recent year. For the 39 years from 1980 to 2018, NOAA's estimate of total losses is $1.7 trillion in 2018 dollars, of which $1.1 trillion occurred from 2003 to 2017.

The NOAA loss estimates for billion-dollar disasters in panel A are shown only in 2018 dollars because of an unusual feature of its measurement system. When the current-year CPI is used to update

NOAA's annual loss estimates, it affects the disaster counts from earlier years. For example, there were 220 billion-dollar disasters through 2017 but 241 through 2018. But only 14 of the 21 added disasters occurred in 2018, while 7 occurred earlier. The earlier 7 did not reach $1 billion when measured in 2017 dollars, but they did reach $1 billion when measured in 2018 dollars. For these earlier events, NOAA did not publish current-dollar estimates because the losses fell below $1 billion when measured in current dollars in their year of occurrence. Hence, current-dollar loss estimates for the 241 disasters are not shown in panel A of table 10 because estimates were never published for all 241.

TABLE 10

Billion-Dollar Disaster Losses and FEMA Compensation, 2003–2017

	Current dollars	2018 dollars
Panel A: NOAA Billion-Dollar Disasters		
Total losses		$1.1 trillion
Panel B: FEMA Direct Payments		
Major disasters: IA	$21.8 billion	$25.8 billion
Major disasters: PA	$71.4 billion	$83.2 billion
Emergency management declarations: PA	$1.6 billion	$2.0 billion
Fire management declarations: PA	$1.4 billion	$1.6 billion
Total	$96.3 billion	$112.6 billion
Panel C: National Flood Insurance Program		
All floods	$53.4 billion	$62.1 billion
Paid losses	931,000	
Significant flood events	$44.3 billion	$52.1 billion
Paid losses	684,000	
All other floods	$9.1 billion	$10.0 billion
Paid losses	247,000	
Panel D: National Interagency Fire Center		
Federal firefighting costs	$25.2 billion	$28.8 billion
All wildfires	1.07 million	
Acres burned	10.62 million	
Big wildfires	149	
Acres burned	3.36 million	
Other wildfires	10.68 million	
Acres burned	7.26 million	

Sources: FEMA documents and National Interagency Fire Center documents.

Notes: FEMA = Federal Emergency Management Agency; IA = individual assistance; NOAA = National Oceanic and Atmospheric Administration; PA = public assistance. All data refer to the 15 years from 2003 to 2017. Amounts in 2018 dollars are derived using the 2018 all-items Consumer Price Index.

Panel B of table 10 summarizes direct payments from FEMA to people, businesses, and governments for major disasters, emergency management declarations, and fire management declarations. Three points stand out. First, most payouts are occasioned by major disasters. In 2018 dollars, major disasters accounted for $109 billion of $112.6 billion (or 96.8 percent) of direct payments between 2003 and 2017. Second, public assistance benefits make up the majority of assistance payments from major disasters: $83.2 billion of $109 billion, or 76.3 percent of the 2003–17 total. Third, direct payments from FEMA compensated for 10.2 percent of total billion-dollar disaster-related losses between 2003 and 2017 ($112.6 billion of $1.1 trillion).

People and businesses insured by the National Flood Insurance Program receive substantial flood insurance payments. From 2003 to 2017, NFIP payments totaled $53.4 billion in current dollars and $62.1 billion in 2018 dollars (panel C). Payments were made to 931,000 policyholders. Eighty-three percent of NFIP payouts from 2003 to 2017 were related to significant flood events, such as those where 2,500 or more policyholders were compensated. NFIP payouts during these years (panel C) totaled about half the direct payments made by FEMA (panel B).

Between 2003 and 2017, the US experienced 1.1 million wildfires that burned 106.2 million acres. The federal budget costs for fighting wildfires during these years totaled $25.2 billion in current dollars during those years and $28.2 billion in 2018 dollars. The budgets of the two federal firefighting agencies (the US Forest Service and the Bureau of Land Management) respectively made up about 79 and 21 percent of the total. Additionally, state firefighting costs sometimes approach federal costs in budget outlays, but state budget data are less readily available.[18] Total acres burned in what the National Interagency Fire Center calls "big" fires (that burn more than 100,000 acres) accounted for 31.6 percent of total acres burned during these 15 years.

Because wildfires occur primarily on public lands, they cause limited losses for private homeowners, landowners, and governments. NOAA estimates the costs of wildfires that cause billion-dollar disasters. Between 2003 and 2017, NOAA identified 10 billion-dollar wildfires with total losses of $41.4 billion in 2018 dollars. But the NOAA methodology does not attempt to estimate dollar losses of uncut timber or other potential wood products. It focuses on damage to residences, businesses, and public infrastructure. The loss estimation methodologies FEMA and NOAA use do not attempt to estimate all actual and potential economic losses from wildfires. Thus, although the NIFC estimates that 1.1 million wildfires occurred between 2003 and 2017, FEMA made only 763 fire management disaster declarations and only 21 wildfire-related major disaster declarations.

The economic losses from disasters were $1.1 trillion from 2003 to 2017. But the size of the US economy also needs to considered. GDP in 2018 totaled $20.5 trillion, while the cumulative GDP total for 2003–17 was $275.4 trillion (in 2018 dollars). Though losses from major disasters over the 15 years are large in absolute value, they are tiny relative to the scale of the US economy: 0.4 percent of GDP from 2003 to 2017.

Summary

Major disasters are becoming more frequent, averaging 13 per year in the 1950s and nearly 60 per year now. Fire management declarations have also increased, from less than 5 per year in the 1970s to nearly 50 per year now. All three categories of disasters (major disasters, emergency declarations, and fire management declarations) experience wide variation in annual occurrences.

Since the 1950s, the disaster reporting system FEMA oversees has evolved to provide more complete information. Individual disaster counties have been identified since 1965, fire management declarations since 1970, emergency declarations since 1974, billion-dollar disasters since 1980, and

individual disaster–specific IA and PA amounts for the past 20 years. Data on individual disasters have become increasingly available.

Hurricanes stand out as the most consistently destructive. They accounted for one in six billion-dollar disasters between 1980 and 2018 but caused about half of disaster-related economic losses, compensation, and deaths. Floods, tornadoes, winter freezes, severe storms, and wildfires all cause severe hardships but have smaller aggregate consequences than hurricanes.

When all categories of major disasters are combined, NOAA estimates they caused $1.7 trillion in losses (in 2018 CPI-adjusted dollars) between 1980 and 2018. Annual losses have trended upward largely because of increased numbers of disasters. Fire management declarations are the only one of FEMA's three main categories of disasters where losses per disaster have trended upward. In the past 20 years, average losses per disaster have increased for fire management declarations, but average losses have not increased significantly for major disasters or emergency declarations. The main reason for increases in disaster-related losses is their increased frequency.

Notes

1 Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988, Pub. L. No. 100-707, 102 Stat. 4689 (1988).

2 The Stafford Act of 1988 amended the Disaster Relief Act of 1974 (Pub. L. No. 93-288). The legislation establishes the statutory authority for most federal disaster response and recovery activities, especially as they relate to FEMA and its programs. This brief focuses on disasters covered by the Stafford Act and events tracked by the FEMA disaster reporting system. Disaster declarations made by the Small Business Administration and the US Department of Agriculture are not examined. Data from billion-dollar disasters as estimated by NOAA are examined in a later section.

3 Section 102 (2) of the Stafford Act defines *major disaster* as "any natural catastrophe (including any hurricane, tornado, storm, high water, wind-driven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snow storm, or drought), or regardless of cause, any fire, flood, or explosion in any part of the United States, which in the determination of the president causes damage of sufficient severity and magnitude to warrant major disaster assistance under this chapter to supplement the efforts and available resources of state, local governments, and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby."

4 Before FEMA was created, state or tribal and local governments worked with separate disaster-related federal agencies. In 1979, President Carter centralized the federal emergency functions into one agency. In 2003, FEMA became part of the US Department of Homeland Security.

5 Individual assistance obligations for housing assistance totaled $13.2 billion between 2003 and 2016, while other individual assistance totaled $4.7 billion.

6 This brief does not examine the reasons for the decreased use of IA and DUA benefits.

7 The dip to 79 percent from 1985 to 1989 was heavily influenced by 1988 data, when PA was available for four of the eight major disaster declarations. When 1988 is removed from the five-year average, the average for the other four years rises to 86 percent, close to the 87 percent average from 1980 to 1984.

8 The coefficient of variation is the ratio of the standard deviation to the mean. It is the common measure of relative variability for a statistical series.

[9] The standard error of the regression equation is the average distance between the regression line and the actual number of declarations.

[10] Losses for each disaster in the NOAA data between 1980 and 2018 are measured in billions of 2018 dollars.

[11] The calculations are as follows: 7.36 is 0.36 percent of the way through July, or July 11, and 6.53 is 0.53 percent of the way through June, or June 16.

[12] For a broad analysis of the effects of disasters on family well-being, see Ratcliffe and coauthors (2019)

[13] After a disaster is declared, lags that extend for months or years can follow decisions authorizing and approving benefit payments. Hence, the data exhibit lags. For example, IA benefits from major disasters in 2017 totaled $3.4 billion when measured in February 2018 but $4 billion when measured in February 2019.

[14] The FEMA data do not show support payments for all disasters. The means and totals examined here pertain only to disasters where dollar amounts of support payments are recorded.

[15] The IA and PA data used here extend to 2016 but not to 2017. When complete 2017 information becomes available, it will add another year when expenditures exceed $1 billion.

[16] The estimated totals for 2005 and 2017 were measured in 2018 prices using the all-items CPI. For a description of NOAA's methodology in estimating losses in billion-dollar disasters, see Smith and Katz (2013).

[17] Totals in CPI-adjusted 2018 prices. Only 4 of the 16 billion-dollar wildfires had losses exceeding $5 billion.

[18] State-level firefighting costs totaled $6.5 billion in 1998, 2002, 2004, 2006, and 2008. Federal firefighting costs for the same five years totaled $6.9 billion. See Cleetus and Mulik (2014, table 4.5).

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