Distinguishing Tropical Cyclone-Related Flooding in U.S. Presidential Disaster Declarations: 1965–1997

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Abstract: A problem exists in that the classifications used by the Federal Emergency Management Agency (FEMA) for weather-related disasters do not always allow analysts to clearly link declared disasters to their ultimate meteorological cause. This research focuses on those disasters related to flooding resulting from tropical cyclones. Neither FEMA nor the states that request federal disaster aid distinguish flood disasters by their meteorological origin, making it difficult to assess the contributions of various meteorological phenomena to the incidence and severity of Presidential Disaster Declarations (PDD). The data presented in this initial analysis indicate that the flood-related impacts of tropical systems are considerably broader and undoubtedly larger in economic magnitude than documented in the official records kept by FEMA.

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Introduction

A presidential declaration of a major disaster or emergency is the key action that makes federal disaster relief available to states, local governments, businesses, and individuals affected by disasters. Understanding temporal and spatial patterns in disaster declarations can help policymakers prioritize public research funding to generate useful information in setting disaster mitigation policies. However, a problem exists in that the classifications used by the Federal Emergency Management Agency (FEMA) for weather-related disasters do not always allow analysts to clearly link declared disasters to their ultimate meteorological cause.

To the extent that FEMA data are used by the scientific community as inputs to the setting of meteorological research priorities, a lack of precision in FEMA data can lead to inefficiencies in science policy decision making. For example, the physical processes that lead to inland flooding related to tropical cyclones differ from those that result in, say, large-scale flooding of the upper Mississippi river basin. Consequently, there will be different types of meteorological research implicated by a focus on the different types of floods. Priorities in meteorological research are established, to some degree, based on considerations of societal impacts of weather events. If data on societal impacts are misleading, then research priorities might be set inefficiently.

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This research focuses on those disasters related to flooding resulting from tropical cyclones (i.e., for our purposes, those storms which have at one time in their evolution reached tropical storm status. Note that "tropical storm" is a "tropical cyclone" of less than hurricane intensity but with winds of greater than 34 knots). Neither FEMA nor the states that request federal disaster aid distinguish flood disasters by their meteorological origin, making it difficult to assess the contributions of various meteorological phenomena to the incidence and severity of Presidential Disaster Declarations (PDD). Downton and Pielke (2001) examined broad trends in flood damage using a comprehensive database of flood-related disaster declarations from 1964 to 1998. Although FEMA revised its taxonomy of disaster declaration categories in 1999–2000 to eliminate some of the vagueness in its categorization, the issues associated with tropical cyclone-related flooding discussed in this paper were not resolved by the new taxonomy. This research is based on the dataset discussed by Downton and Pielke (2001) and presents the results of a preliminary attempt to distinguish tropical cyclone-related flood disasters in a 33-year record of PDDs.

Data and Taxonomical Methodology

The Disaster Relief Act of 1950 established a basis for systematically providing federal disaster assistance to states and local governments. Following a presidential declaration of a major disaster or emergency, one or more counties within a state are declared eligible for federal assistance. Since that time, federal response to disasters has expanded considerably, with billions of dollars in federal funds devoted to disaster assistance each year for disasters related to weather, earthquakes, fire, terrorism, and other causes (Burby 1991; Platt 1999).

This research utilizes a list of the counties included in all flood- or hurricane-related disaster declarations from December 24, 1964, through March 3, 1998, that was provided by FEMA (Downton and Pielke 2001). During this period, FEMA classified disaster declarations by 18 "primary incident types." The catego-

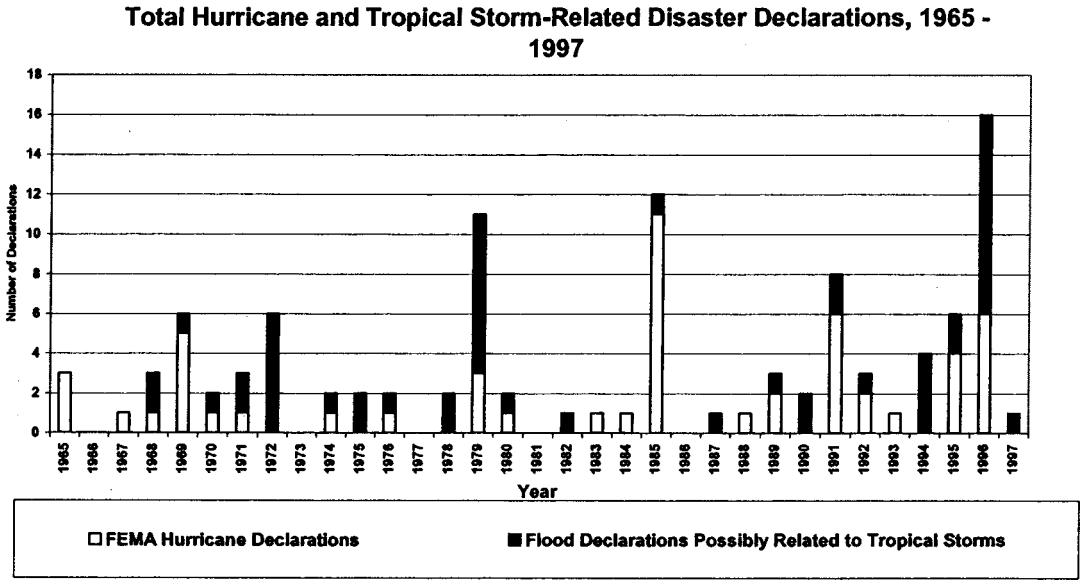

Fig. 1. Stacked bar graph showing annual number of hurricane-related disaster declarations using hurricane-related disaster declarations as classified by Federal Emergency Management Agency (FEMA) and flood-related declarations with origins in tropical systems resulting from this analysis.

ries "flood" and "flood and tornado" accounted for 56% of all presidential declarations and over 35% of federal disaster relief spending between May 1953 and May 1997 (Sylves 1998; Downton and Pielke 2001). Of the 720 flood-related declarations in our database, 84 (12%) involved just one county, 360 covered less than 15% of the counties in a state, and only 6 declarations covered an entire state. Some fraction of these are related to tropical cyclones but are not classified in any manner that allows such an identification to be made.

In the dataset, flood-related disasters include all declarations officially classified by FEMA as type "flood," "flood and tornado," "severe storm," "coastal storm," and "dam/levee break," because these incidents typically involve flooding as a major cause of damage. But, just as flood damage occurs in the category type "hurricane," lesser-strength tropical cyclones frequently cause flood-related disasters, often well inland, which are not classified as type "hurricane." These flood-related disasters can rival in magnitude and impact the effects of hurricanes. The origin of such disasters in tropical systems is not accounted for in the FEMA classification of disaster types, making it difficult to reliably estimate the inland impacts of tropical cyclones. The disaster declaration process is typically triggered by a request from a state's governor to the president. In many cases, it may be that the state fails to accurately describe the event and its origin, leading to imprecision in FEMA's final categorization. Thus, to better understand the contribution of tropical cyclones to U.S. flood disasters, the writers seek to distinguish that subset of flood-related PDDs originating in tropical systems that reached tropical storm strength at some point in their evolution.

Methodology for Identifying Tropical Cyclone-Related Disaster Declarations

To distinguish flood-related PDDs with their origin in systems that attained tropical storm status at some point in their lifetime, the writers used three sources of information:

1. The FEMA flood related disaster declaration database 1964–1998 (see, Downton and Pielke 2001).
2. A list of damaging hurricanes in the United States (see, Pielke and Landsea 1998).
3. Hurricane track maps by Neumann et al. (1993), supplemented by more recent hurricane track maps located on the National Hurricane Center (NHC) Web site (http://www.nhc.noaa.gov/). Although our analysis focuses on Atlantic systems and inland flooding in the continental United States, tropical cyclones from the Pacific have also led to flood-related PDDs in the islands of the Pacific as well as the continental United States (see, e.g., http://www.nssl.noaa.gov/headlines/century_ok.html)

With this information the writers found 53 flood-related disaster declarations in the FEMA database possibly related to a hurricane/tropical storm. This is 14% of the 378 total flood or hurricane-related PDDs in the 23 states affected by flood-related disaster declarations with a possible hurricane origin. Of course, this is likely an underestimate of the total impacts of tropical systems because the writers' analysis likely excludes some disasters from storms with tropical origins, but which never reached tropical storm status, as well as tropical systems with origins in the Pacific. In this study, data are compiled by federal fiscal year, for example, 1991 refers to October 1, 1990, through September 30, 1991. Disaster declarations are recorded by "action date," and are typically issued within a week or two after a major disaster because of strong pressure for an immediate public-sector response, but PDDs have in some instances been issued months after the triggering event.

The writers defined a PDD classified as flood-related to be "possibly related" to a hurricane/tropical storm if the storm occurred within the same state as the declaration and within a reasonable time before the declaration (in no instance more than 4 months, usually days or weeks). Out of the total of 53 declarations that the writers identified as being possibly related to tropical cyclones, FEMA's brief description of the event indicated 13

Table 1. Federal Emergency Management Agency's (FEMA) Original Classification of Hurricane-Related Disaster Declarations and Number of Tropical Storm-related Declarations Added by the Present Analysis

Year	Number of tropical storm-related disaster declarations	Number of FEMA hurricane disaster declarations
1965	0	3
1966	0	0
1967	0	1
1968	2	1
1969	1	5
1970	1	1
1971	2	1
1972	6	0
1973	0	0
1974	1	1
1975	2	0
1976	1	1
1977	0	0
1978	2	0
1979	8	3
1980	1	1
1981	0	0
1982	1	0
1983	0	1
1984	0	1
1985	1	11
1986	0	0
1987	1	0
1988	0	1
1989	1	2
1990	2	0
1991	2	6
1992	1	2
1993	0	1
1994	4	0
1995	2	4
1996	10	6
1997	1	0
Total	53	53

were related to a hurricane/tropical storm, although they were not officially classified as such.

Table 2. Number of Counties Included in Federal Emergency Management Agency's (FEMA) Original Classification of Hurricane-Related Disaster Declarations and Number of Counties Included in Tropical Storm-Related Declarations Added by Our Analysis

Year	Number of counties involved in tropical storm-related declarations	Number of counties involved in FEMA official hurricane declarations
1965	0	54
1966	0	0
1967	0	29
1968	16	14
1969	1	62
1970	15	7
1971	22	20
1972	229	0
1973	0	0
1974	1	10
1975	20	0
1976	8	3
1977	0	0
1978	4	0
1979	25	32
1980	2	12
1981	0	0
1982	4	0
1983	0	9
1984	0	6
1985	52	72
1986	0	0
1987	10	0
1988	0	3
1989	1	53
1990	21	0
1991	12	36
1992	7	38
1993	0	1
1994	78	0
1995	18	107
1996	57	150
1997	3	0
Total	606	718

Results

Fig. 1 shows the annual number of hurricane-related disaster declarations using two categories: hurricane-related disaster declarations as classified by FEMA and flood-related declarations with origins in tropical systems resulting from this analysis. Table 1 shows the data and indicates that flooding related to tropical cyclones results in disaster declarations as often as those officially classified as hurricane related by FEMA. The writers' analysis doubles the number of declarations in the database (official, plus those resulting from our analysis) related to tropical cyclones to 106 (or, 28% of the 378 total PDDs).

It is important to note that the FEMA data set used does not include information on the costs of the individual PDDs. Thus, it is not possible, with the FEMA dataset, to estimate the additional damage costs related to floods with origins as tropical cyclones, although in some cases, they may be large (e.g., Hurricane Agnes in 1972, for a discussion, see Pielke and Pielke 1997).

Fig. 2 shows the number of counties covered by the disaster declarations, and Table 2 shows the annual data. Over the period 1965–1997, PDDs officially related to hurricanes covered 718 counties; our analysis finds an additional 606 counties that received PDDs for flood-related declarations with origins in tropical cyclones.

Table 3 shows the percentage by state of all flood-related and hurricane-related PDDs that were classified as type "hurricane." It also shows the percentage of all flood-related and hurricane-related PDDs that were flood-related declarations with origins in tropical cyclones identified in our analysis, in combination with those officially classified as type hurricane.

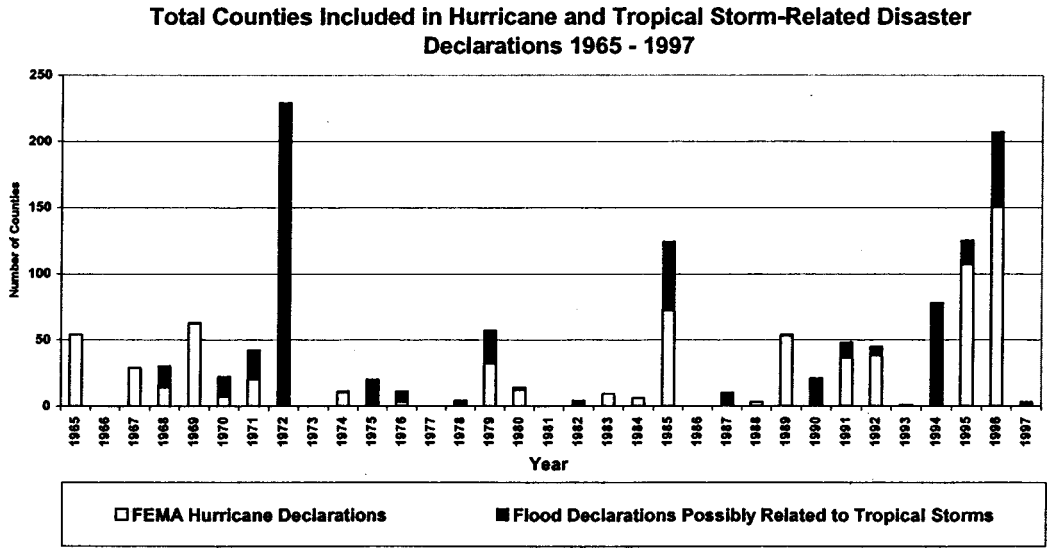

Fig. 2. Stacked bar graph showing annual number of counties covered by hurricane-related disaster declarations using hurricane-related disaster declarations as classified by Federal Emergency Management Agency (FEMA) and flood-related declarations with origins in tropical systems resulting from this analysis.

Table 3. Percentage of All Declarations by State Included in Federal Emergency Management Agency's (FEMA) Original Classification of Hurricane-Related Disaster Declarations and Percentage of Declarations When Adding to FEMA's Tabulation of Tropical Storm-Related Declarations

State	FEMA hurricane declarations as a percentage of all hurricane and flood-related disaster declarations	FEMA hurricane and tropical storm-related flood declarations as a percentage of all hurricane and flood-related disaster declarations
Okla.	0	4
Ky.	0	5
Ariz.	0	6
Ind.	0	8
W.V.	11	16
N.H.	10	20
N.J.	11	22
Miss.	20	20
Md.	0	22
N.Y.	14	23
Me.	6	25
Tex.	12	24
Ala.	15	26
Pa.	10	29
Ga.	8	33
La.	20	33
Conn.	40	40
Va.	12	41
Mass.	22	56
Fla.	33	71
N.C.	56	78
S.C.	67	100
R.I.	100	100

Conclusions and Implications

The data presented in this initial analysis indicate that the impacts of tropical systems are considerably broader, and undoubtedly larger, than documented in the official record kept by FEMA for the causes of Presidential Disaster Declarations. This analysis is consistent with that by Rappaport (2000) who found that the vast majority of deaths related to tropical cyclones occur because of inland flooding.

Although the immediate beneficiaries of disaster declarations are not affected by event categorization, imprecision in data collection can lead to longer term inefficiencies in decision making. Specifically, if meteorological research priorities are to be effectively aligned with their potential to contribute useful information to decision makers, then it is important that data on societal impacts of weather be collected in a manner that enhances such contributions. Specifically, it would be relatively straightforward for FEMA to include representatives of the meteorological community, e.g., from the National Weather Service, in the development of a more robust and sophisticated taxonomical methodology in order to more clearly distinguish the meteorological events that contribute to PDDs. FEMA should not rely on individual states to categorized the origins of meteorological-related disasters because not all states have such expertise available, and when they do, they may not always apply a consistent method to categorization. With respect to the impacts of tropical cyclones, the taxonomical approach used by FEMA hides rather than clarifies their broad societal impacts.

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