1.2 TRACKING AND EVALUATING U.S. BILLION DOLLAR WEATHER DISASTERS, 1980-2005

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ABSTRACT

About ten years ago, NOAA's National Climatic Data Center (NCDC) began tracking U.S. weather and climate events which individually resulted in at least $1 billion in overall damages and costs. The ensuing report, "Billion Dollar U.S. Weather Disasters," receives over 30,000 web hits per month, and has resulted in numerous news media interviews regarding its content. The report also links to more detailed reports and data concerning each event. During the 1980-2005 period, the U.S. sustained over $500 billion in overall inflation-adjusted damages/costs due to these extreme events. This paper describes the methodology in collecting the statistics, provides a list of the events, and illustrates the distribution of the events spatially and temporally.

1. INTRODUCTION

The NCDC report on billion dollar weather disasters has been one of the Center's more popular reports for many years. It provides readers with a snapshot of the major weather and climate events in the U.S. since 1980, and links (online) to more detailed information and data concerning each event. Events of this magnitude are very significant in that more than half of the annual damages and losses associated with weather events are typically the result of major events with over $1 billion in losses. Also, these are the events with the greatest impact to insurance companies and the economy as a whole.

2. METHODOLOGY

There is a "method to the madness" of collecting statistics for these events, though there is not a single government agency in charge of collecting all damage and fatality figures associated with weather events, in a truly scientific fashion. The loss and fatality statistics are often not fully known until several months (or longer) after the event occurs. The NOAA publication "Storm Data" uses information collected by National Weather Service offices after the end of the month, but there are frequently additional statistics available after this is published. Also, "Storm Data" information is generally compiled by city, county, and date, and does not readily provide an overall summation of damages and fatalities connected with a single event. This is especially true with major events with far-reaching affects.

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The methodology employed by NCDC in gathering statistics for "billion-dollar events" is to use the following sources of information to the greatest extent possible:

- State emergency management agencies – some are quite complete in their reports, but others do not provide detailed information. For those that provide complete information, we rely on the state emergency management agency as the leading source of data.
- Insurance information sources – this includes the Insurance Information Institute, which has a great deal of information available on its web site (www.iii.org). However, this generally does not provide figures for uninsured losses, which are often substantial.
- U.S. government agencies – this includes NOAA's National Weather Service, the Federal Emergency Management Agency (though not tasked with collecting these statistics), and other agencies.
- State and regional climate centers – this includes most states along with the six regional climate centers (funded by NOAA).
- News media sources – these are not used as primary sources, but as references to point to specific information. For example, a news media quote may lead to investigating the losses reported by a particular state from an event.

Therefore, these statistics are compiled from a wide variety of sources and represent, to the best of our ability, the estimated total costs of these events---that is, the costs in terms of dollars and lives that would not have been incurred had the event not taken place. Insured and uninsured losses are included in damage estimates, and direct plus indirect deaths (i.e., related to the event, would not have occurred otherwise) are included in fatality totals. Economic costs are included for wide-scale, long-lasting events such as drought.

3. THE 1980-2005 EVENTS

Following is a table of the 1980-2005 events which resulted in at least $1 billion in overall damages/costs at the time of the event. The total normalized (inflation-adjusted) losses for the 66 events are over $500 billion. Fifty-seven of these disasters occurred during the 1988-2005 period with total unadjusted damages/costs of over $370 billion. The events are listed beginning with the most recent. Two damage figures are given for events prior to 2002–the first figure represents actual dollar costs at the time of the event and is not adjusted for inflation. The value in parenthesis is the dollar costs normalized to 2002 dollars using a GNP inflation/wealth index. Standard state abbreviations are used for brevity

in the list, for events impacting multiple states. Statistics for 2005 events are based on information as of October 18, 2005.

2005 Hurricane Rita, September 2005. Category 3 hurricane hits Texas-Louisiana border coastal region, creating significant storm surge and wind damage along the coast, and some inland flooding in the FL panhandle, MS, LA, AR, and TX. Prior to landfall, Rita reached the third lowest pressure (897 mb) ever recorded in the Atlantic basin. Preliminary estimate of over $8 billion in damage/costs; 119 deaths reported—most being indirect (many related to evacuations).
Hurricane Katrina, August 2005. Category 4 hurricane initially impacts the U.S. as a Category 1 near Miami, FL, then as a Category 4 along the eastern LA-western MS coastlines, resulting in severe storm surge damage (maximum surge probably exceeded 25 feet) along the LA-MS-AL coasts, wind damage, and the failure of parts of the levee system in New Orleans. Inland effects included high winds and some flooding in the states of AL, MS, FL, TN, KY, IN, OH, and GA. Preliminary estimate of well over $100 billion in damage/costs, making this the most expensive natural disaster in U.S. history; over 1200 deaths—the highest U.S. total since the 1928 major hurricane in southern Florida.
Hurricane Dennis, July 2005. Category 3 hurricane makes landfall in western Florida panhandle resulting in storm surge and wind damage along the FL-AL coasts, along with scattered wind and flood damage in GA, MS, and TN. Preliminary estimate of over $2 billion in damage/costs; at least 12 deaths.
Midwest Drought, Spring-Summer 2005. Rather severe localized drought causes significant crop losses (especially for corn and soybeans) in the states of AR, IL, IN, MO, OH, and WI. Preliminary estimate of over $1.0 billion in damage/costs; no reported deaths.

2004 Hurricane Jeanne, September 2004. Category 3 hurricane makes landfall in east-central Florida, causing considerable wind, storm surge, and flooding damage in FL, with some flood damage also in the states of GA, SC, NC, VA, MD, DE, NJ, PA, and NY. Puerto Rico also affected. Estimate of over $6.9 billion in damage/costs; at least 28 deaths.
Hurricane Ivan, September 2004. Category 3 hurricane makes landfall on Gulf coast of Alabama, with significant wind, storm surge, and flooding damage in coastal AL and FL panhandle, along with wind/flood damage in the states of GA, MS, LA, SC, NC, VA, WV, MD, TN, KY, OH, DE, NJ, PA, and NY. Estimate of over $14 billion in damage/costs; at least 57 deaths.
Hurricane Frances, September 2004. Category 2 hurricane makes landfall in east-central Florida, causing significant wind, storm surge, and flooding damage in FL, along with considerable flood damage in the states of GA, SC, NC, and NY due to 5-15 inch rains. Estimate of approximately $9 billion in damage/costs; at least 48 deaths.
Hurricane Charley August 2004. Category 4 hurricane makes landfall in southwest Florida, resulting in major wind and some storm surge damage in FL, along with some damage in the states of SC and NC. Estimate of approximately $15 billion in damage/costs; at least 34 deaths.

2003 Southern California Wildfires, Late October-early November 2003. Dry weather, high winds, and resulting wildfires in Southern California. More than 743,000 acres of brush and timber burned, over 3700 homes destroyed; over $2.5 billion damage/costs; 22 deaths.
Hurricane Isabel, September 2003. Category 2 hurricane makes landfall in eastern North Carolina, causing considerable storm surge damage along the coasts of NC, VA, and MD, with wind damage and some flooding due to 4-12 inch rains in NC, VA, MD, DE, WV, NJ, NY, and PA; approximately $5 billion in damage/costs; 55 deaths.
Severe Storms and Tornadoes, Early May 2003. Numerous tornadoes over the midwest, MS valley, OH/TN valleys, and portions of the southeast, with a modern record one-week total of approximately 400 tornadoes reported; over $3.4 billion in damage/costs; 51 deaths.
Storms and Hail, Early April 2003. Severe storms and large hail over the southern plains and lower MS valley, with Texas hardest hit, and much of the monetary losses due to hail; over $1.6 billion in damage/costs; 3 deaths.

2002 Widespread Drought, Spring through Fall 2002. Moderate to extreme drought over large portions of 30 states, including the western states, the Great Plains, and much of the eastern U.S.; estimate of over $10 billion in damage/costs; no deaths reported.
Western Fire Season, Spring through Fall 2002. Major fires over 11 western states from the Rockies to the west coast, due to drought and periodic high winds, with over 7.1 million acres burned; over $2.0 billion in damage/costs; 21 deaths.

2001 Tropical Storm Allison, June 2001. The persistent remnants of Tropical Storm Allison produce rainfall amounts of 30-40 inches in portions of coastal Texas and Louisiana, causing severe flooding especially in the Houston area, then moves slowly northeastward; fatalities and significant damage reported in TX, LA, MS, FL, VA, and PA; estimate of approximately $5.0 (5.1) billion in damage/costs; at least 43 deaths.
Midwest and Ohio Valley Hail and Tornadoes, April 2001. Storms, tornadoes, and hail in the states of TX, OK, KS, NE, IA, MO, IL, IN, WI, MI, OH, KY, WV, and PA, over a 6-day period; over $1.9 (1.9) billion in damage/costs, with the most significant losses due to hail; at least 3 deaths.

2000 Drought/Heat Wave, Spring-Summer 2000. Severe drought and persistent heat over south-central and southeastern states causing significant losses to agriculture and related industries; estimate of over $4.0 (4.2) billion in damage/costs; estimated 140 deaths nationwide.

Western Fire Season, Spring-Summer 2000. Severe fire season in western states due to drought and frequent winds, with nearly 7 million acres burned; estimate of over $2.0 (2.1) billion in damage/costs (includes fire suppression); no deaths reported.

1999 Hurricane Floyd, September 1999. Large, category 2 hurricane makes landfall in eastern NC, causing 10-20 inch rains in 2 days, with severe flooding in NC and some flooding in SC, VA, MD, PA, NY, NJ, DE, RI, CT, MA, NH, and VT; estimate of at least $6.0 (6.5) billion damage/costs; 77 deaths.
Eastern Drought/Heat Wave, Summer 1999. Very dry summer and high temperatures, mainly in eastern U.S., with extensive agricultural losses; over $1.0 (1.1) billion damage/costs; estimated 502 deaths.
Oklahoma-Kansas Tornadoes, May 1999. Outbreak of F4-F5 tornadoes hit the states of Oklahoma and Kansas, along with Texas and Tennessee, Oklahoma City area hardest hit; over $1.6 (1.7) billion damage/costs; 55 deaths.
Arkansas-Tennessee Tornadoes, January 1999. Two outbreaks of tornadoes in 6-day period strike Arkansas and Tennessee; approximately $1.3 (1.4) billion damage/costs; 17 deaths.

1998 Texas Flooding, October-November 1998. Severe flooding in southeast Texas from 2 heavy rain events, with 10-20 inch rainfall totals; approximately $1.0 (1.1) billion damage/costs; 31 deaths.
Hurricane Georges, September 1998. Category 2 hurricane strikes Puerto Rico, Florida Keys, and Gulf coasts of Louisiana, Mississippi, Alabama, and Florida panhandle, 15-30 inch 2-day rain totals in parts of AL/FL; estimated $5.9 (6.5) billion damage/costs; 16 deaths.
Hurricane Bonnie, August 1998. Category 3 hurricane strikes eastern North Carolina and Virginia, extensive agricultural damage due to winds and flooding, with 10-inch rains in 2 days in some locations; approximately $1.0 (1.1) billion damage/costs; 3 deaths.
Southern Drought/Heat Wave, Summer 1998. Severe drought and heat wave from Texas/Oklahoma eastward to the Carolinas; $6.0-$9.0 (6.6-9.9) billion damage/costs to agriculture and ranching; at least 200 deaths.
Minnesota Severe Storms/Hail, May 1998. Very damaging severe thunderstorms with large hail over wide areas of Minnesota; over $1.5 (1.7) billion damage/costs; 1 death.
Southeast Severe Weather, Winter-Spring 1998. Tornadoes and flooding related to El Nino in southeastern states; over $1.0 (1.1) billion damage/costs; at least 132 deaths.
Northeast Ice Storm, January 1998. Intense ice storm hits Maine, New Hampshire, Vermont, and New York, with extensive forestry losses; over $1.4 (1.5) billion damage/costs; 16 deaths.

1997 Northern Plains Flooding, April-May 1997. Severe flooding in Dakotas and Minnesota due to heavy spring snowmelt; approximately $3.7 (4.1) billion damage/costs; 11 deaths.
MS and OH Valleys Flooding & Tornadoes, March 1997. Tornadoes and severe flooding hit the states of AR, MO, MS, TN, IL, IN, KY, OH, and WV, with over 10 inches of rain in 24 hours in Louisville; estimated $1.0 (1.1) billion damage/costs; 67 deaths.
West Coast Flooding, December 1996-January 1997. Torrential rains (10-40 inches in 2 weeks) and snowmelt produce severe flooding over portions of CA, WA, OR, ID, NV, and MT; approximately $3.0 (3.4) billion damage/costs; 36 deaths.

1996 Hurricane Fran, September 1996. Category 3 hurricane strikes North Carolina and Virginia, over 10-inch 24-hour rains in some locations and extensive agricultural and other losses; over $5.0 (5.8) billion damage/costs; 37 deaths.
Southern Plains Severe Drought, Fall 1995 through Summer 1996. Severe drought in agricultural regions of southern plains--Texas and Oklahoma most severely affected; approximately $5.0 (6.0) billion damage/costs; no deaths.
Pacific Northwest Severe Flooding, February 1996. Very heavy, persistent rains (10-30 inches) and melting snow over OR, WA, ID, and western MT; approximately $1.0 (1.2) billion damage/costs; 9 deaths.
Blizzard of '96 Followed by Flooding, January 1996. Very heavy snowstorm (1-4 feet) over Appalachians, Mid-Atlantic, and Northeast; followed by severe flooding in parts of same area due to rain & snowmelt; approximately $3.0 (3.5) billion damage/costs; 187 deaths.

1995 Hurricane Opal, October 1995. Category 3 hurricane strikes Florida panhandle, Alabama, western Georgia, eastern Tennessee, and the western Carolinas, causing storm surge, wind, and flooding damage; over $3.0 (3.6) billion damage/costs; 27 deaths.
Hurricane Marilyn, September 1995. Category 2 hurricane devastates U.S. Virgin Islands; estimated $2.1 (2.5) billion damage/costs; 13 deaths
Texas/Oklahoma/Louisiana/Mississippi Severe Weather and Flooding, May 1995. Torrential rains, hail, and tornadoes across Texas – Oklahoma and southeast Louisiana - southern Mississippi, with Dallas and New Orleans areas (10-25 inch rains in 5 days) hardest hit; $5.0-$6.0 (6.5-7.1) billion damage/costs; 32 deaths.
California Flooding, January-March 1995. Frequent winter storms cause 20-70 inch rainfall and periodic flooding across much of California; over $3.0 (3.6) billion damage/costs; 27 deaths.

1994 Western Fire Season, Summer-Fall 1994. Severe fire season in western states due to dry weather; approximately $1.0 (1.2) billion damage/costs; death toll undetermined.
Texas Flooding, October 1994. Torrential rain (10-25 inches in 5 days) and thunderstorms cause flooding

across much of southeast Texas; approximately $1.0 (1.2) billion damage/costs; 19 deaths.
Tropical Storm Alberto, July 1994. Remnants of slow-moving Alberto bring torrential 10-25 inch rains in 3 days, widespread flooding and agricultural damage in parts of Georgia, Alabama, and panhandle of Florida; approximately $1.0 (1.2) billion damage/costs; 32 deaths.
Southeast Ice Storm, February 1994. Intense ice storm with extensive damage in portions of TX, OK, AR, LA, MS, AL, TN, GA, SC, NC, and VA; approximately $3.0 (3.7) billion damage/costs; 9 deaths.

1993 California Wildfires, Fall 1993. Dry weather, high winds and wildfires in Southern California; approximately $1.0 (1.3) billion damage/costs; 4 deaths.
Midwest Flooding, Summer 1993. Severe, widespread flooding in central U.S. due to persistent heavy rains and thunderstorms; approximately $21.0 (26.7) billion damage/costs; 48 deaths.
Drought/Heat Wave, Summer 1993. Southeastern U.S.; about $1.0 (1.3) billion damage/costs to agriculture; at least 16 deaths.
Storm/Blizzard, March 1993. "Storm of the Century" hits entire eastern seaboard with tornadoes (FL), high winds, and heavy snows (2-4 feet); $5.0-$6.0 (6.3-7.6) billion damage/costs; approximately 270 deaths.

1992 Nor'easter of 1992, December 1992. Slow-moving storm batters northeast U.S. coast, New England hardest hit; $1.0-$2.0 (1.3-2.6) billion damage/costs; 19 deaths.
Hurricane Iniki, September 1992. Category 4 hurricane hits Hawaiian island of Kauai; about $1.8 (2.4) billion damage/costs; 7 deaths.
Hurricane Andrew, August 1992. Category 4 hurricane hits Florida and Louisiana, high winds damage or destroy over 125,000 homes; approximately $27.0 (35.6) billion damage/costs; 61 deaths.

1991 Oakland Firestorm, October 1991. Oakland, California firestorm due to low humidities and high winds; approximately $2.5 (3.5) billion damage/costs; 25 deaths.
Hurricane Bob August 1991. Category 2 hurricane--Mainly coastal North Carolina, Long Island, and New England; $1.5 (2.1) billion damage/costs; 18 deaths.

1990 Texas/Oklahoma/Louisiana/Arkansas Flooding, May 1990. Torrential rains cause flooding along the Trinity, Red, and Arkansas Rivers in TX, OK, LA, and AR; over $1.0 (1.4) billion damage/costs; 13 deaths.

1989 Hurricane Hugo, September 1989. Category 4 hurricane devastates South and North Carolina with ~ 20 foot storm surge and severe wind damage after hitting Puerto Rico and the U.S. Virgin Islands; over $9.0 (13.9) billion damage/costs (about $7.1 (10.9) billion in Carolinas); 86 deaths (57--U.S. mainland, 29--U.S. Islands).
Northern Plains Drought, Summer 1989. Severe summer drought over much of the northern plains with significant losses to agriculture; at least $1.0 (1.5) billion in damage/costs; no deaths reported.

1988 Drought/Heat Wave, Summer 1988. 1988 drought in central and eastern U.S. with very severe losses to agriculture and related industries; estimated $40.0 (61.6) billion damage/costs; estimated 5,000 to 10,000 deaths (includes heat stress-related).

1986 Southeast Drought/Heat Wave, Summer 1986. Severe summer drought in parts of the southeastern U.S. with severe losses to agriculture; $1.0-$1.5 (1.8-2.6) billion in damage/costs; estimated 100 deaths.

1985 Hurricane Juan, October-November 1985. Category 1 hurricane--Louisiana and Southeast U.S.–severe flooding; $1.5 (2.8) billion damage/costs; 63 deaths.
Hurricane Elena, August-September 1985. Category 3 hurricane—Florida to Louisiana; $1.3 (2.4) billion damage/costs; 4 deaths.
Florida Freeze, January 1985. Severe freeze central/northern Florida; about $1.2 (2.2) billion damage to citrus industry; no deaths.

1983 Florida Freeze, December 1983. Severe freeze central/northern Florida; about $2.0 (4.0) billion damage to citrus industry; no deaths.
Hurricane Alicia, August 1983. Category 3 hurricane--Texas; $3.0 (5.9) billion damage/costs; 21 deaths.
Western Storms and Flooding, 1982 - Early 1983. Storms and flooding related to El Nino, especially in the states of WA, OR, CA, AZ, NV, ID, UT, and MT; approximately $1.1 (2.2) billion in damage/costs; at least 45 deaths.
Gulf States Storms and Flooding, 1982 - Early 1983. Storms and flooding related to El Nino, especially in the states of TX, AR, LA, MS, AL, GA, and FL; approximately $1.1 (2.2) billion in damage/costs; at least 50 deaths.

1980 Drought/Heat Wave, June-September 1980. Central and eastern U.S.; estimated $20.0 (48.4) billion damage/costs to agriculture and related industries; estimated 10,000 deaths (includes heat stress-related).

4. SPATIAL AND TEMPORAL ILLUSTRATIONS

The figures below provide graphical illustrations of the spatial and temporal distribution of these events. As one would expect, the number of "billion-dollar" events has increased over time, due to inflation and the increasing population in disaster-prone areas (e.g., along the coasts). We expect this trend to continue.

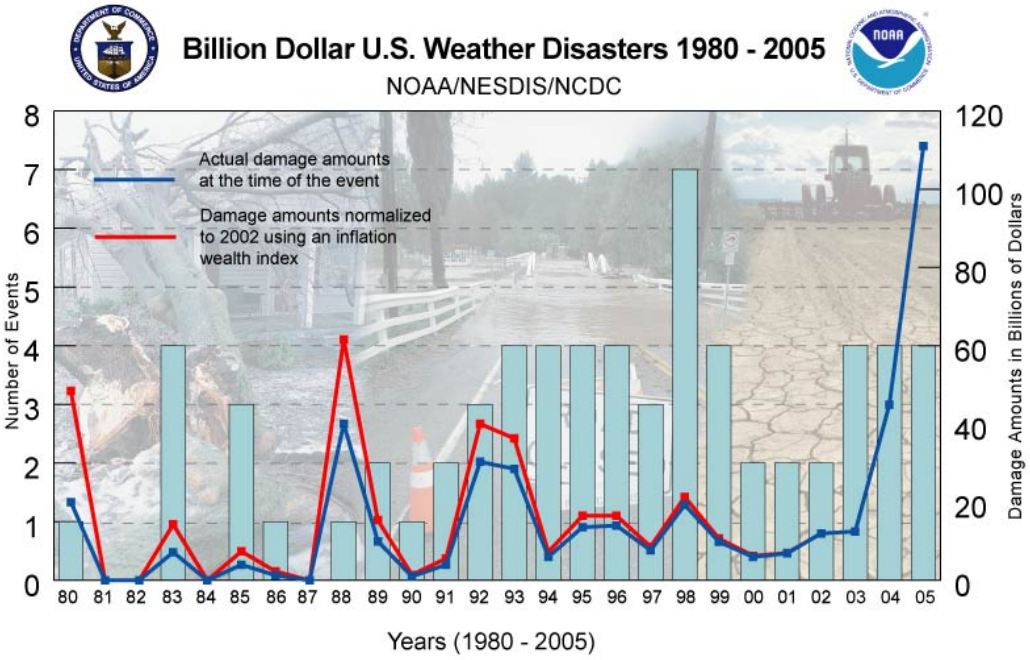
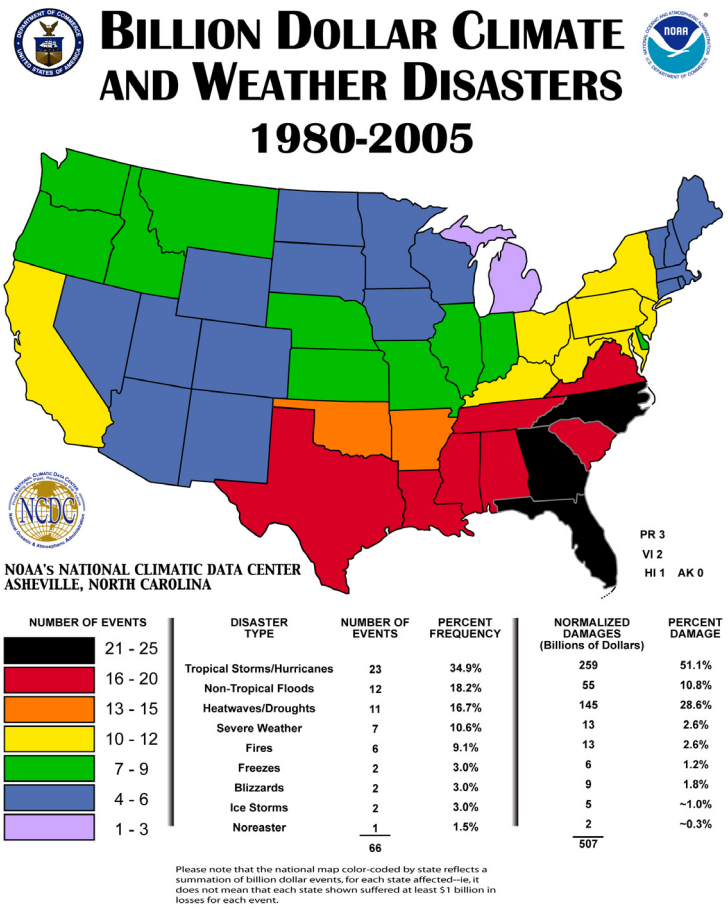


Figure 1. Time Series Graph Showing Number of Events and Dollar Costs by Year.



DISASTER TYPE	NUMBER OF EVENTS	PERCENT FREQUENCY	NORMALIZED DAMAGES (Billions of Dollars)	PERCENT DAMAGE
Tropical Storms/Hurricanes	23	34.9%	259	51.1%
Non-Tropical Floods	12	18.2%	55	10.8%
Heatwaves/Droughts	11	16.7%	145	28.6%
Severe Weather	7	10.6%	13	2.6%
Fires	6	9.1%	13	2.6%
Freezes	2	3.0%	6	1.2%
Blizzards	2	3.0%	9	1.8%
Ice Storms	2	3.0%	5	~1.0%
Noreaster	1	1.5%	2	~0.3%
	66		507	

Figure 2. National Map Showing Spatial Distribution of Events by State.

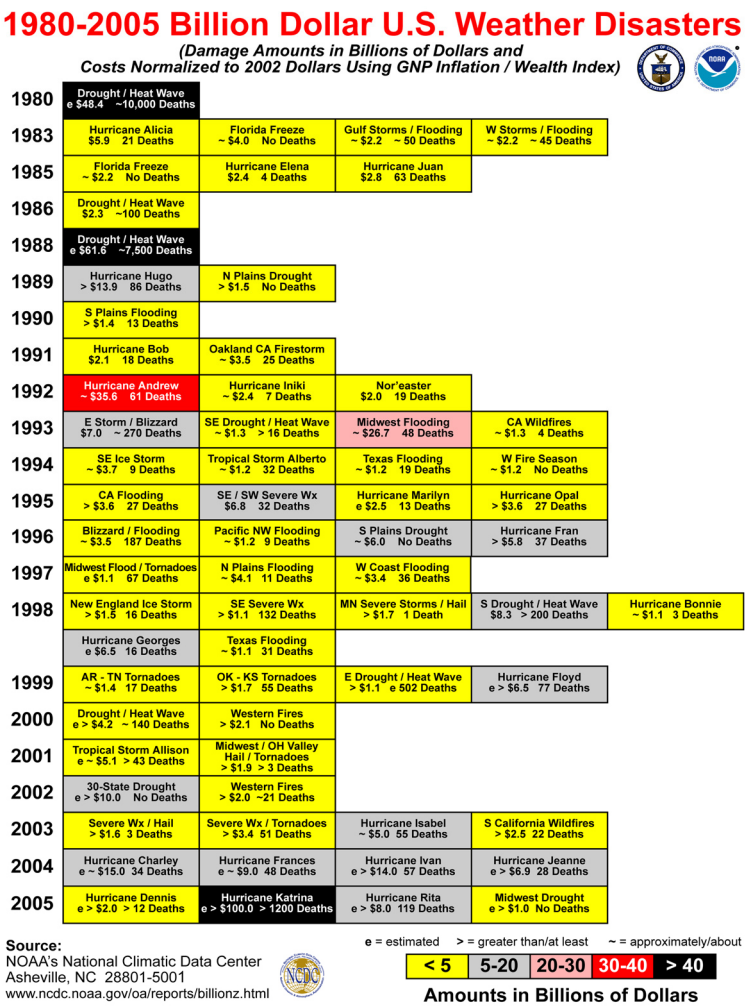


Figure 3. Chronology of Events for 1980-2005, with Brief Synopsis of Each Event.

5. CONCLUSION

We have provided a brief synopsis of major weather disasters in the U.S. since 1980, along with our methodology for collecting statistics for these events. The report does not account for an event producing some gains that may occur in one sector of the economy to partly offset the losses – e.g., rains beneficial to agriculture, from a hurricane. However, the overall damages and costs are generally much greater than any short to intermediate term gains. Also, we have not attempted economic analyses of longer-term effects, such as a "boom" in the local construction industry following a severe event.

NCDC encourages each state, and in particular, the state emergency management agencies, to collect damage and fatality statistics for major weather events. Also, the state and regional climate centers could serve as focal points for collection of these data (from the states) for NOAA. NCDC will continue to update this report as new information becomes available. The WWW version of this report (http://www.ncdc.noaa.gov/reports/billionz.html accessible via the NCDC homepage) includes links to detailed climatological reports on many of these events.