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THE DEADLIEST, COSTLIEST, AND MOST INTENSE UNITED STATES HURRICANES OF THIS CENTURY (AND OTHER FREQUENTLY REQUESTED HURRICANE FACTS)

Paul J. Hebert, WSFO, Miami, Florida
Robert A. Case, NHC, Miami, Florida

National Hurricane Center
Miami, Florida
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UNITED STATES
DEPARTMENT OF COMMERCE
Robert A. Mosbacher, Secretary

National Oceanic and Atmospheric Administration
John A. Knauss
Under Secretary and Administrator

National Weather Service
Elbert W. Friday
Assistant Administrator

PREFACE

This version of the Deadliest, Costliest, and Most Intense United States Hurricanes of This Century is an update through the 1989 hurricane season.

Hurricane Hugo, the first category 4 or 5 hurricane to strike the United States since 1969, has led to revisions of many of the tables. In addition three new tables have been added. These are Tables 12a through 12c, which rank deaths and unadjusted and adjusted damages by annual totals. Adjusted dollar damage estimates in the tables have been made based on 1989 dollars. Much of the text remains unchanged. Page 11 has the most significant changes.

Deaths and dollar damage estimates for Hugo and the remainder of the 1989 tropical cyclones to affect the United States should be considered preliminary. They are expected to be close to the final figures in the 1989 Atlantic hurricane season articles issued by the National Hurricane Center.

Finally, the end of the decade of the eighties allows some interesting comparisons in trends from recent seasons and previous decades.

THE DEADLIEST, COSTLIEST, AND MOST INTENSE UNITED STATES HURRICANES OF THIS CENTURY (AND OTHER FREQUENTLY REQUESTED HURRICANE FACTS)

by

Paul J. Hebert, Weather Service Forecast Office
& Robert A. Case, National Hurricane Center
National Weather Service
Miami, Florida

ABSTRACT

Lists of United States hurricanes which have caused 25 or more deaths and more than one hundred million dollars in damages (unadjusted) during this century have been compiled from all data sources available at the National Hurricane Center (NHC). In addition, all major[1] hurricanes which have made landfall in the United States during this century are listed. Some additional statistics on United States hurricanes of this century and tropical cyclones in general are also presented.

1. INTRODUCTION

Numerous requests are received at the National Hurricane Center for statistical information on deaths, damages, and severity of hurricanes which have affected the United States. In the past, this has required searching through various reference materials, depending on the nature of the individual request. Different sources gave different estimates of these statistics so that decisions had to be constantly made as to which information should be given out by NHC as "official" from the National Hurricane Information Center (another function of NHC). Requests to other Weather Service Offices posed the same dilemma. These lists are being published in the hope of presenting a single source of the best currently available estimates of deaths, damages, and intensity of major U.S. hurricanes which have made landfall in this century. In some instances, data in these lists present revised estimates for individual hurricanes based on more complete information received after earlier published values, including the previous versions of this technical memorandum.

There are other frequently asked questions about hurricanes. What is the average number of hurricanes per year? What year(s) had the most and least hurricanes? What hurricane had the longest life? When did the earliest and latest hurricane occur? What was the most intense Atlantic hurricane? What was the largest number of hurricanes in existence on the same day? When was the last time a major hurricane or any hurricane hit a given community directly[2]? Answers to these and several other questions are provided in Section 3.

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[1]A major hurricane is a category 3, 4, or 5 on the Saffir/Simpson Hurricane Scale (see references), and is comparable to a Great Hurricane in other publications. Table 1 gives the criteria used.

[2]A direct hit means experiencing the core of strong winds and high tides (approximately 50 miles along the coastline) of a hurricane.

Table 1. Saffir/Simpson Hurricane Scale Ranges.

Scale Number (Category)	Central Pressure (Millibars)	(Inches)	OR Winds (Mph)	OR Surge (Feet)	Damage
1	≥980	≥28.94	74-95	4-5	Minimal
2	965-979	28.50-28.91	96-110	6-8	Moderate
3	945-964	27.91-28.47	111-130	9-12	Extensive
4	920-944	27.17-27.88	131-155	13-18	Extreme
5	<920	<27.17	>155	>18	Catastrophic

2. CRITERIA

The statistics in most of the tables and figures in this publication depend directly on the criteria used in preparing another study, Hurricane Experience Levels of Coastal County Populations-Texas to Maine (Hebert, Taylor, and Case, 1984). The primary purpose of that study was to demonstrate, county by county, the low hurricane experience level of a large majority of the population. Statistics show that the largest loss of life and, for the most part, property occur in locations experiencing the core of a category 3 or higher hurricane. Unless a given population has experienced this core, or direct hit, with its very strong winds and high tides, it would defeat the primary purpose of the study on hurricane experience levels to so categorize it.

The central pressure ranges of hurricanes on the Saffir/Simpson scale will usually agree quite well with the wind ranges in that category. In the absence of other information, this is normally the best estimate of a hurricane's winds. However, some hurricanes which have developed from winter-type or subtropical low pressure systems occasionally have a minimum central pressure lower than the corresponding observed winds would suggest. In this instance, the wind criteria are used.

On the other hand, the surge is strongly dependent on the slope of the continental shelf (shoaling factor). This can change the height of the surge by a factor of two for a given central pressure and/or maximum wind.

Heavy rainfall associated with a hurricane is not one of the criteria for categorizing it.

The subjective determination of which category number to assign to a hurricane, as well as its direct or indirect[3] effect, is made on a county by county basis with the intent of the study on hurricane experience levels foremost in mind. However, state and United States lists will include direct hits even though a county might only have a footnote reference to such a hit.

As with the assignment of scale numbers, a certain amount of subjectivity was inescapable at times in determining which counties received direct or indirect hits during the various hurricane situations. However, certain arbitrary guidelines for these classifications as used in Hurricane Experience Levels, etc., are indicated below:

Direct Hit - When the innermost core region or "eye" moved over a county, it was counted as a direct hit. Using "R" as the radius of maximum winds in a hurricane (the distance in miles from the storm's center to the circle of maximum winds around the center), all or parts of counties falling within approximately 2R to the right and R to the left of a storm's landfall point were considered to have received a direct hit. (This assumes an observer at sea looking toward the shore). On the average, this direct hit zone extended about 50 miles along the coastline (R≈15 miles). Of course, some hurricanes were smaller than this and some, particularly at higher latitudes, were much larger. Cases were judged individually, and many borderline situations had to be resolved.

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[3]Indirect means experiencing at least wind gusts of hurricane force and/or tides of 4 to 5 feet or more above normal from a nearby hurricane.

Indirect Hit - These were based primarily on a hurricane's strength and size, and on the configuration of the individual county coastline. Here again, much subjectivity was necessary in many cases which were complicated by storm paths and geography. Generally, those areas on either side of the direct hit zone which received hurricane force winds and/or tides of 4 to 5 feet or more above normal were considered to have had an indirect hit.

It is realized that the effect of an indirect hit by a large category 4 hurricane might be greater than that of a small category 1 affecting the same county. However, trying to account for these differences would hopelessly complicate the use of this system.

The study by Simpson and Lawrence (1971) gives climatological probabilities of the total number of storms and hurricanes to affect the U.S. coastline by fifty-mile wide coastal segments, as well as only hurricanes, and major (or great) hurricanes. While this 50 miles approximates that of the "core" used for direct hits, there are some differences. In the Simpson and Lawrence study, a storm/hurricane/great hurricane was counted in the segment where it crossed the coast plus the next segment to the right. As indicated earlier, the "core" used in Hebert, Taylor, and Case (1984) can be smaller or larger than 50 miles, and could also affect one of the segments in Simpson and Lawrence to the left of a coastline crossing which that study would not count.

The foregoing two studies and their associated criteria are climatological with their primary purpose being for use in assessing risk based on past experience. On the other hand, the National Weather Service's Hurricane Probability Program has as its purpose the assessment of risk based on a present hurricane threat to the United States coastline. It does this by arbitrarily defining a "strike" as the center of a hurricane moving through a zone within approximately 50 nautical miles to the right or 75 nautical miles to the left of the site of interest (Sheets, 1984). The asymmetry is to allow for the strongest winds in a hurricane frequently being further to the right of the center than the left-a consideration reflected also in the earlier studies discussed. This 125 nautical mile diameter circle approximates the region of hurricane force winds for a "typical" hurricane. It will usually be larger than the "core", and is fixed, like the segments in Simpson and Lawrence. HURRICANE STRIKE PROBABILITIES HAVE NO RELATION TO HURRICANE INTENSITY. Users of these probabilities must take this into account when assessing risk, based on the forecast time before landfall and strength. The reader is urged to refer to The National Weather Service Hurricane Probability Program (Sheets, 1984) for a more thorough explanation of forecast probabilities.

Statistics on total storm/hurricane activity in the North Atlantic Ocean (which includes the Gulf of Mexico and the Caribbean Sea) can be found in Neumann, Jarvinen, Pike, and Elms (1987). A detailed breakdown of hurricanes by category which have affected coastal counties of the Gulf of Mexico and North Atlantic Ocean both directly and indirectly can be found in Hebert, Taylor, and Case (1984), which has been updated where necessary for this technical memorandum. The best source of how a hurricane affected individual localities or states can be found in the annual articles on the hurricane season in the Monthly Weather Review (1990) and Storm Data tabulation (1990) for the individual states, respectively.

3. DISCUSSION

Part I

(1) What have been the deadliest hurricanes of this century in the United States?

Table 2 lists the 31 deadliest hurricanes to strike the U.S. in this century. Three hurricanes prior to 1900 as well as a tropical storm which affected southern California in 1939 are listed as an addendum because of their large death tolls.

(2) What have been the costliest hurricanes of this century in the United States?

Table 3 lists the 31 costliest hurricanes to strike the U.S. in this century. Figures are unadjusted for inflation.

Table 3a re-orders some of these plus several other hurricanes after adjusting to 1989 dollars[4].

(3) What have been the most intense hurricanes to strike the United States during this century?

Table 4 lists the 60 major hurricanes which have struck the U.S. during this century. Hurricanes are ordered by the lowest estimated central pressure and/or highest category to affect the United States at time of landfall

A look at the lists of deadliest and costliest hurricanes of this century reveals several striking facts: (1) The twelve deadliest hurricanes were all the equivalent of a category 4 or higher, if the excessive forward speed is considered as raising the category of a hurricane by one. (2) All but four of the thirty-one deadliest hurricanes were major hurricanes. Two were the inland flood-producing hurricanes Agnes and Diane. These large death totals were primarily a result of the 15 to 20 feet or more rise of the ocean (storm surge) associated with these major hurricanes. (3) A large portion of the damage in three of the eleven costliest hurricanes (Table 3) resulted from inland flooding caused by torrential rainfall in mountainous areas. (4) Nearly three-fifths of the deadliest hurricanes were the equivalent of a category four or higher, but only two-fifths of the costliest hurricanes (Table 3) met this criterion. (5) Only one of the deadliest hurricanes has occurred during the past twenty years in contrast to about half of the costliest hurricanes.

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[4]Adjusted to 1989 dollars on basis of U.S. Department of Commerce composite construction cost indexes.

Table 2. The deadliest United States hurricanes of this century.

DEADLIEST HURRICANES, UNITED STATES 1900-1989
(25 or more deaths)

	HURRICANE	YEAR	CATEGORY	DEATHS
1.	TX (Galveston)	1900	4	6000
2.	FL (Lake Okeechobee)	1928	4	1836
3.	FL (Keys)/S TX	1919	4	600#
4.	New England	1938	3*	600
5.	FL (Keys)	1935	5	408
6.	AUDREY (SW LA/N TX)	1957	4	390
7.	NE U.S.	1944	3*	390@
8.	LA (Grand Isle)	1909	4	350
9.	LA (New Orleans)	1915	4	275
10.	TX (Galveston)	1915	4	275
11.	CAMILLE (MS/LA)	1969	5	256
12.	FL (Miami)	1926	4	243
13.	DIANE (NE U.S.)	1955	1	184
14.	SE FL	1906	2	164
15.	MS/AL/Pensacola	1906	3	134
16.	AGNES (NE U.S.)	1972	1	122
17.	HAZEL (SC/NC)	1954	4*	95
18.	BETSY (SE FL/SE LA)	1965	3	75
19.	CAROL (NE U.S.)	1954	3*	60
20.	SE FL/LA/MS	1947	4	51
21.	DONNA (FL/Eastern U.S.)	1960	4	50
22.	GA/SC/NC	1940	2	50
23.	CARLA (TX)	1961	4	46
24.	TX (Velasco)	1909	3	41
25.	TX (Freeport)	1932	4	40
26.	S TX	1933	3	40
27.	HILDA (LA)	1964	3	38
28.	SW LA	1918	3	34
29.	SW FL	1910	3	30
30.	CONNIE (NC)	1955	3	25
31.	LA	1926	3	25

* Moving more than 30 miles per hour.
# Over 500 of these lost on ships at sea; 600-900 estimated deaths
@ Some 344 of these lost on ships at sea.

ADDENDUM

LA	1893	-	2000
SC/GA	1893	-	1000-2000
GA/SC	1881	-	700
SOUTHERN CALIFORNIA	1939		45

Table 3. The costliest United States hurricanes of this century.
(Unadjusted)

COSTLIEST HURRICANES, UNITED STATES 1900-1989
(More than $100,000,000 damage)

	HURRICANE	YEAR	CATEGORY	DAMAGE (U.S.)
1.	HUGO (SC)	1989	4	$7,000,000,000
2.	FREDERIC (AL/MS)	1979	3	2,300,000,000
3.	AGNES (NE U.S.)	1972	1	2,100,000.000
4.	ALICIA (N TX)	1983	3	2,000,000,000[1]
5.	JUAN (LA)	1985	1	1,500,000,000
6.	CAMILLE (MS/AL)	1969	5	1,420,700,000
7.	BETSY (SE FL/SE LA)	1965	3	1,420,500,000
8.	ELENA (MS/AL/NW FL)	1985	3	1,250,000,000
9.	GLORIA (Eastern U.S.)	1985	3*	900,000,000
10.	DIANE (NE U.S.)	1955	1	831,700,000
11	ALLISON (N TX)	1989	T.S.@	500,000,000
12	ELOISE (NW FL)	1975	3	490,000,000
13.	CAROL (NE U.S.)	1954	3*	461,000,000
14.	CELIA (S TX)	1970	3	453,000,000
15.	CARLA (TX)	1961	4	408,000,000
16	CLAUDETTE (N TX)	1979	T.S.@	400,000,000
17.	DONNA (FL/Eastern U.S.)	1960	4	387,000,000
18.	DAVID (FL/Eastern U.S.)	1979	2	320,000,000
19.	New England	1938	3*	306,000,000
20.	KATE (FL Keys/NW FL)	1985	2	300,000,000
21.	ALLEN (S TX)	1980	3	300,000,000
22.	HAZEL (SC/NC)	1954	4*	281,000,000
23.	DORA (NE FL)	1964	2	250,000,000
24.	BEULAH (S TX)	1967	3	200,000,000
25.	AUDREY (LA/N TX)	1957	4	150,000,000
26.	CARMEN (LA)	1974	3	150,000,000
27.	CLEO (SE FL)	1964	2	128,500,000
28.	HILDA (Central LA)	1964	3	125,000,000
29.	FL (Miami)	1926	4	112,000,000
30.	SE FL/LA/MS	1947	4	110,000,000
31.	NE U.S.	1944	3*	100,000,000+

* Moving more than 30 miles per hour.
@ Only of Tropical Storm intensity, but included because of high damage amount.

[1]Alicia was mistakenly listed as $200,000 in the previous version of this Technical Memorandum.

Table 3a. The costliest United States hurricanes of this century.
(Adjusted to 1989 dollars) **

COSTLIEST HURRICANES, UNITED STATES 1900-1989
(More than $400,000,000 damage)

	HURRICANE	YEAR	CATEGORY	DAMAGE (U.S.)
1.	HUGO (SC)	1989	4	$7,000,000,000
2.	BETSY (FL/LA)	1965	3	6,321,225,000
3.	AGNES (NE U.S.)	1972	1	6,279,000,000
4.	CAMILLE (MS/AL)	1969	5	5,128,727,000
5.	DIANE (NE U.S.)	1955	1	4,108,598,000
6.	New England	1938	3*	3,515,940,000
7.	FREDERIC (AL/MS)	1979	3	3,427,000,000
8.	ALICIA (N TX)	1983	3	2,340,000,000[1]
9.	CAROL (NE U.S.)	1954	3*	2,318,830,000
10.	CARLA (TX)	1961	4	1,884,960,000
11.	DONNA (FL/Eastern U.S.)	1960	4	1,784,070,000
12.	JUAN (LA)	1985	1	1,635,000,000
13.	CELIA (S TX)	1970	3	1,526,610,000
14.	HAZEL (SC/NC)	1954	4*	1,413,430,000
15.	ELENA(MS/AL/NW FL)	1985	3	1,362,500,000
16.	FL (Miami)	1926	4	1,286,880,000
17.	DORA (NE FL)	1964	2	1,132,500,000
18.	ELOISE (NW FL)	1975	3	1,058,400,000
19.	GLORIA (Eastern U.S.)	1985	3*	981,000,000
20.	NE U.S.	1944	3*	905,000,000
21.	BEULAH (S TX)	1967	3	826,000,000
22.	SE FL/LA/MS	1947	4	688,600,000
23.	AUDREY (LA/N TX)	1957	4	681,000,000
24.	CLAUDETTE (N TX)	1979	T.S.@	596,000,000
25.	CLEO (SE FL)	1964	2	582,105,000
26.	SW FL/NE FL	1944	3	570,150,000
27.	HILDA (LA)	1964	3	566,250,000
28.	SE FL	1945	3	527,400,000
29.	ALLISON (N TX)	1989	T.S.@	500,000,000
30.	DAVID (FL/Eastern U.S.)	1979	2	476,800,000
31.	IONE (NC)	1955	3	434,720,000
32.	ALLEN (S TX)	1980	3	402,000,000
	N TX (Galveston)	1915	4	1,152,400,000[2]
	N TX (Galveston)	1900	4	691,440,000[3]

[1]Not in this list in previous version-see footnote in table 3.
[2]Considered too high in 1915 reference.
[3]Using 1915 cost adjustment base - none available prior to 1915.

* Moving more than 30 miles per hour.
@ Only of Tropical Storm intensity, but included because of high damage.

** Adjusted to 1989 dollars on basis of U.S. Department of Commerce composite construction cost indexes. Revision of previous indexes has caused a switch in rank of AGNES/BETSY and ELENA/HAZEL.

Table 4. The most intense United States hurricanes of this century (at time of landfall).

MOST INTENSE HURRICANES, UNITED STATES 1900-1989
(At time of landfall)

	HURRICANE	YEAR	CATEGORY	MILLIBARS	INCHES
1.	FL (Keys)	1935	5	892	26.35
2.	CAMILLE (LA/MS)	1969	5	909	26.84
3.	FL (Keys)/S TX	1919	4	927	27.37
4.	FL (Lake Okeechobee)	1928	4	929	27.43
5.	DONNA (FL/Eastern U.S.)	1960	4	930	27.46
6.	TX (Galveston)	1900	4	931	27.49
7.	LA (Grand Isle)	1909	4	931	27.49
8.	LA (New Orleans)	1915	4	931	27.49
9.	CARLA (TX)	1961	4	931	27.49
10.	HUGO (SC)	1989	4	934	27.58
11.	FL (Miami)	1926	4	935	27.61
12.	HAZEL (SC/NC)	1954	4*	938	27.70
13.	SE FL/LA/MS	1947	4	940	27.76
14.	N TX	1932	4	941	27.79
15.	GLORIA (Eastern U.S.)	1985	3*&	942	27.82
16.	AUDREY (LA/N TX)	1957	4#	945	27.91
17.	TX (Galveston)	1915	4#	945	27.91
18.	CELIA (S TX)	1970	3	945	27.91
19.	ALLEN (S TX)	1980	3@	945	27.91
20.	New England	1938	3*	946	27.94
21.	FREDERIC (AL/MS)	1979	3	946	27.94
22.	NE U.S.	1944	3*	947	27.97
23.	SC/NC	1906	3	947	27.97
24.	BETSY (SE FL/SE LA)	1965	3	948	27.99
25.	SE FL/NW FL	1929	3	948	27.99
26.	SE FL	1933	3	948	27.99
27.	S TX	1916	3	948	27.99
28.	MS/AL	1916	3	948	27.99
29.	DIANA (NC)	1984	3+	949	28.02
30.	S TX	1933	3	949	28.02
31.	BEULAH (S TX)	1967	3	950	28.05
32.	HILDA (Central LA)	1964	3	950	28.05
33.	GRACIE (SC)	1959	3	950	28.05
34.	TX (Central)	1942	3	950	28.05
35.	SE FL	1945	3	951	28.08

Continued on next page

* Moving more than 30 miles per hour.
& Winds and tides did not justify 4.
# Classified 4 because of extreme tides.
@ Reached Cat. 5 intensity three times along its path through the Caribbean and Gulf of Mexico. The lowest pressure reported was 899 mb (26.55 in.) at 1742 UTC 8/7/80 off the northeastern tip of the Yucatan Peninsula.
\+ Cape Fear, NC area only; was a 2 at final landfall.

Table 4 continued.

	HURRICANE	YEAR	CATEGORY	MILLIBARS	INCHES
36.	FL (Tampa Bay)	1921	3	952	28.11
37.	CARMEN (Central LA)	1974	3	952	28.11
38.	EDNA (New England)	1954	3*	954	28.17
39.	SE FL	1949	3	954	28.17
40.	ELOISE (NW FL)	1975	3	955	28.20
41.	KING (SE FL)	1950	3	955	28.20
42.	Central LA	1926	3	955	28.20
43.	SW LA	1918	3	955	28.20
44.	SW FL	1910	3	955	28.20
45.	NC	1933	3	957	28.26
46.	FL (Keys)	1909	3	957	28.26
47.	EASY (NW FL)	1950	3	958	28.29
48.	N TX	1941	3	958	28.29
49.	NW FL	1917	3	958	28.29
50.	N TX	1909	3	958	28.29
51.	MS/AL	1906	3	958	28.29
52.	ELENA (MS/AL/NW FL)	1985	3	959	28.32
53.	CAROL (NE U.S.)	1954	3*	960	28.35
54.	IONE (NC)	1955	3	960	28.35
55.	ALICIA (N TX)	1983	3	962	28.41
56.	CONNIE (NC/VA)	1955	3	962	28.41
57.	SW FL/NE FL	1944	3	962	28.41
58.	Central LA	1934	3	962	28.41
59.	SW FL/NE FL	1948	3	963	28.44
60.	NW FL	1936	3	964	28.47

* Moving more than 30 miles per hour.

DIRECT HITS BY HURRICANES
U.S. GULF & ATLANTIC COASTS
1900-1989

Category 5:	2
4:	14
3:	44
2:	34
1:	57
TOTAL	151

Major hurricanes (categories 3, 4, 5) 60

This means that during the period 1900-1989, an average of 2 major hurricanes every 3 years made landfall somewhere along the U.S. Gulf or Atlantic coast. (All categories combined average about 5 hurricanes every 3 years for the same period.)

One of the greatest concerns of the National Weather Service's (NWS) hurricane preparedness officials is that the statistics in tables 1-4 will mislead people into thinking that no more large loss of life will occur in a hurricane because of our advanced technology. Dr. Robert Sheets, spokesman for the NWS hurricane warning service and Director of NHC, as well as former Director, Dr. Neil Frank, have repeatedly emphasized the great danger of a catastrophic loss of life in a future hurricane if proper preparedness plans for vulnerable areas are not formulated.

The study by Hebert, Taylor, and Case (1984), updated with 1985 population estimates, showed that as of 1985 almost 75% of U.S. coastal residents from Texas to Maine have never experienced a direct hit by a major hurricane. Many of those 43 million residents had moved to coastal sections during the past twenty-five years. Even the landfall of Hugo has not lessened an ever increasing concern brought by the continued increase in coastal populations.

A look at Table 5 which lists hurricanes by decades in this century shows that during the twenty year period 1960-1979 both the number and intensity of landfalling U.S. hurricanes decreased sharply! Based on 1900-1959 statistics from the same study, the expected number of hurricanes and major hurricanes during the period 1960-1979 was 36 and 15, respectively. In fact, only 27 or 75% of the expected number of hurricanes struck the U.S. with only 10 major hurricanes or 67% of that expected number. Did the decade of the eighties show a change in this trend?

Hurricane Hugo became the first category 4 or 5 hurricane to strike the U.S. since Camille in 1969-a period of 20 years. On the average a category 4 or greater hurricane strikes the U.S. once every 6 years.

Fewer hurricanes do not necessarily mean a lesser threat of disaster, however. The 1919 hurricane which was both the third deadliest and third most intense of this century to strike the U.S. occurred in a year which had a total of only three storms/hurricanes. The most intense U.S. hurricane of record in 1935 and the seventh costliest in 1965 (Betsy) occurred in years which had a total of only six storms/hurricanes.

The conclusions are obvious. A large death toll in a U.S. hurricane is still possible. The decreased death totals in recent years may be as much a result of lack of major hurricanes striking the most vulnerble areas as they are of any fail-proof forecasting, warning, and observing systems. Continued coastal growth and inflation will almost certainly result in every future major landfalling hurricane (and even weaker hurricanes and tropical storms) replacing one of the current costliest hurricanes. If warnings are heeded and preparedness plans developed, the death toll can be reduced, but large property losses are inevitable.

PART II

In addition, to information about U.S. hurricanes, this section will also include statistics on total tropical storm and hurricane activity.

(1) What is the average number of hurricanes per year?

Table 6 gives the average number of tropical cyclones which reached storm strength and hurricane strength for various time periods. A total of ten tropical cyclones reaching storm strength with six of these becoming hurricanes appears to be the best averages to use based on the past 40 to 50 year time period. The averages of eight tropical cyclones and five hurricanes for the longer 104-year period is a reflection of less detection and fewer actual storms prior to 1930.

Table 5. Number of hurricanes of various categories to strike the United States each decade. Updated from Hebert, Taylor, and Case (1989).

	CATEGORY					ALL	MAJOR
DECADE	1	2	3	4	5	1,2,3,4,5	3,4,5
1900-1909	5	5	4	2		16	6
1910-1919	8	3	5	3		19	8
1920-1929	6	4	3	2		15	5
1930-1939	4	5	6	1	1	17	8
1940-1949	7	8	7	1		23	8
1950-1959	8	1	7	2		18	9
1960-1969	4	5	3	2	1	15	6
1970-1979	6	2	4			12	4
1980-1989	9	1	5	1		16	6
1900-1989	57	34	44	14	2	151	60

Note: Only the highest category to affect the U.S. has been used.

Table 6. Average number of tropical cyclones which reached storm strength and hurricane strength for various time periods. Updated from Neumann, et al (1987).

	NUMBER	AVERAGES (PER YEAR)	
PERIOD	OF YEARS	TROPICAL CYCLONES[1]	HURRICANES
1886-1989	104	8.4	4.9
1940-1989	50	9.7	5.6
1950-1989	40	9.7	5.8
1960-1989	30	9.4	5.4
1970-1989	20	9.4	5.1
1975-1989	15	9.3	5.3
1980-1989	10	9.3	5.2

[1]Includes subtropical storms after 1967

(2) What year(s) have had the most and least hurricanes?
Table 7 shows the years of maximum and minimum tropical cyclone and hurricane activity for the entire Atlantic Ocean.

The only years when a hurricane failed to strike the U.S. coast were 1902, 1905, 1907, 1914, 1922, 1927, 1930, 1931, 1937, 1951, 1958, 1962, 1973, 1978, 1981, and 1982. Note that only twice has the U.S. gone as long as two years without a hurricane. The most hurricanes to strike the U.S. in one year were six in 1916 and 1985. There were five in 1933, and four in 1906, 1909, and 1964. Three hurricanes have struck the U.S. in one year a total of fifteen times. Ten of these fifteen times occurred during the period 1944-1959!

In this century three or more hurricanes have struck the U.S. an average of once every four years! See Table 13. A chronological list of all hurricanes to strike the U.S. during this century through 1982 including month, category by states affected, and minimum sea level pressure at landfall can be found in Hebert, Taylor, and Case (1984). This list will be updated in the next version of that publication (probably in 1991), but the information is available at the National Hurricane Center.

(3) When did the earliest and latest hurricane occur?
The hurricane season is defined as June 1 through November 30. An early hurricane can be defined as occurring in the three months prior to the start of the season, and a late hurricane can be defined as occurring in the three months after the season. With these criteria the earliest observed hurricane in the Atlantic was on March 7, 1908, while the latest observed hurricane was on December 31, 1954.
The earliest hurricane to strike the U.S. in this century was Alma which struck northwest Florida on June 9, 1966.
The latest hurricane to strike the U.S. was late on November 30, 1925 near Tampa, Florida.

(4) What were the longest-lived and shortest-lived hurricanes?
Ginger in 1971 holds the record for both the most number of days as a hurricane (20) and tropical cyclone (31). There have been many tropical cyclones which attained hurricane intensity for periods of 12 hours or less.

(5) What were the strongest and weakest Atlantic hurricanes? To strike the United States?
In terms of central pressure (and probably winds), the strongest observed hurricane in the Atlantic basin was Gilbert in 1988 with a pressure of 888 millibars while located in the northwest Caribbean. The 1935 Labor Day hurricane in the Florida Keys with a pressure of 892 millibars was the strongest hurricane to strike the U.S. Numerous hurricanes have reached only the minimum wind speed of 74 miles per hour and struck the U.S.

(6) How many hurricanes have there been in each month?

Table 8 adapted from Neumann, et al (1987) shows the total and average number of tropical cyclones and those which became hurricanes by months for the period 1886-1989. In addition, the monthly total and average number of hurricanes to strike the U.S. in this century (updated from Hebert, et al, (1989) are given.

Table 7. Years of maximum and minimum tropical cyclone and hurricane activity in the North Atlantic Ocean, Caribbean Sea, and Gulf of Mexico during the period 1871-1989 (from Neumann, et al, 1987).

MAXIMUM ACTIVITY

TROPICAL CYCLONES[1]		HURRICANES[2]	
NUMBER	YEAR(S)	NUMBER	YEAR(S)
21	1933	12	1969
18	1969	11	1916, 1950
17	1887	10	1887, 1893, 1933
16	1936	9	1955, 1980

MINIMUM ACTIVITY

TROPICAL CYCLONES[1]		HURRICANES[2]	
NUMBER	YEAR(S)	NUMBER	YEAR(S)
1	1890, 1914	0	1907, 1914
2	1925, 1930	1	1890, 1905, 1919, 1925
		2	1895, 1897, 1904, 1917, 1922, 1930, 1931, 1982

[1]Includes subtropical storms after 1967. See Neumann, et al (1987).
[2]After 1885.

Table 8. Total and average number of tropical cyclones and hurricanes in the North Atlantic Ocean, Caribbean Sea, and Gulf of Mexico by month of origin for the period 1886-1989 (from Neumann, et al, 1987), and for hurricanes striking the U.S. coast in this century (updated from Hebert, Taylor, and Case, 1989).

	TROPICAL CYCLONES[1]		HURRICANES		U.S. HURRICANES[2]	
MONTH	TOTAL	AVG.	TOTAL	AVG.	TOTAL	AVG.
JAN-APRIL	3	*	1	*	0	0.0
MAY	14	0.1	3	*	0	0.0
JUNE	56	0.5	23	0.2	11	0.1
JULY	65	0.6	34	0.3	16	0.2
AUGUST	210	2.0	148	1.4	36	0.3
SEPTEMBER	298	2.9	187	1.8	61	0.6
OCTOBER	181	1.7	91	0.9	23	0.2
NOVEMBER	42	0.4	21	0.2	4	*
DECEMBER	6	0.1	3	*	0	0.0
YEAR	875	8.4	511	4.9	151	1.5

[1]Includes subtropical storms after 1967. See Neumann, et al (1981) for details.
[2]1900-1989.

* Less than 0.05.

(7) What was the largest number of hurricanes in existence in the Atlantic Ocean at the same time?

According to information on the master data tape of Neumann, et al (1987), there have never been four hurricanes in existence in the North Atlantic at the same time in this century. On August 22, 1893 four hurricanes co-existed, one of them being the hurricane which killed an estimated 2,000 people in Georgia-South Carolina several days later.

On September 11, 1961 three hurricanes and possibly a fourth existed. The only other years in this century with three hurricanes on the map at the same time were 1950 and 1967.

(8) How many direct hits by hurricanes of various categories have affected each state?

Table 9, updated from Hebert, Taylor, and Case (1989), shows the number of hurricanes (direct hits) affecting the U.S.and individual states. The table shows that on the average close to two hurricanes per year strike the U.S., while two major hurricanes cross the U.S. coast somewhere every three years.

Other noteworthy facts, updated from Hebert, Taylor, and Case (1989), are: 1.) Thirty-six percent of all U.S. hurricanes hit Florida; 2.) Seventy-five percent of category 4 or higher hurricanes have hit either Florida or Texas; 3.) Approximately one out of every two hurricanes is a major one along the middle Gulf coast, southern Florida, and New York and southern New England.

(9) When are the major hurricanes likely to strike given areas?

Table 10 shows the incidence of major hurricanes by months for the U.S. and individual states. For the United States as a whole, September has had more major hurricanes than all other months combined. Only in Texas and Louisiana are August major hurricanes almost an equal threat. Most major October hurricanes occur in southern Florida.

However, three of the most devastating hurricanes did not occur in September--AUDREY (1957) in June, CAMILLE (1969) in August, and HAZEL (1954) in October.

(10) How long has it been since a major hurricane directly hit a given community? Any hurricane? Indirectly?

Table 11 summarizes the occurrence of the last major hurricane or of any hurricane to directly hit the more populated coastal communities from Brownsville, Texas to Eastport, Maine. In addition, if a hurricane indirectly affected a community after the last direct hit, it is listed in the last column of the table.

Table 9. Number of hurricanes (direct hits) affecting the U.S. and individual states 1900-1989 according to Saffir/Simpson scale. Updated from Hebert, Taylor, and Case, (1989).

AREA	CATEGORY NUMBER					ALL	MAJOR HURRICANES (≥3)
	1	2	3	4	5		
U.S. (Texas to Maine)	57	34	44	14	2	151	60
Texas	12	9	9	6	0	36	15
(North)	7	3	3	4	0	17	7
(Central)	2	2	1	1	0	6	2
(South)	3	4	5	1	0	13	6
Louisiana	8	5	7	3	1	24	11
Mississippi	1	1	5	0	1	8	6
Alabama	4	1	5	0	0	10	5
Florida	17	15	16	5	1	54	22
(Northwest)	9	7	6	0	0	22	6
(Northeast)	1	7	0	0	0	8	0
(Southwest)	6	3	5	2	1	17	8
(Southeast)	4	10	7	3	0	24	10
Georgia	1	4	0	0	0	5	0
South Carolina	6	4	2	2	0	14	4
North Carolina	10	3	8	1*	0	22	9
Virginia	2	1	1*	0	0	4	1*
Maryland	0	1*	0	0	0	1*	0
Delaware	0	0	0	0	0	0	0
New Jersey	1*	0	0	0	0	1*	0
New York	3	0	5*	0	0	8	5*
Connecticut	2	2*	3*	0	0	7	3*
Rhode Island	0	1*	3*	0	0	4*	3*
Massachusetts	2	1*	2*	0	0	5	2*
New Hampshire	1*	1*	0	0	0	2*	0
Maine	5	0	0	0	0	5	0

* Indicates all hurricanes in this category were moving greater than 30 mph.

Note: State totals will not equal U.S. totals and Texas and Florida sectional totals will not necessarily equal state totals.

Table 10. Incidence of major hurricanes (direct hits) by months to affect the United States and individual states (1900-1989) according to the Saffir/Simpson Scale (updated from Hebert, Taylor, and Case, 1989).

	MONTH					
AREA	JUNE	JULY	AUG.	SEPT.	OCT.	ALL
U.S. (Texas to Maine)	2	3	13	35	7	60
Texas	1	1	7	6		15
(North)	1	1	3	2		7
(Central)			1	1		2
(South)			3	3		6
Louisiana	2		3	5	1	11
Mississippi		1	1	4		6
Alabama		1		4		5
Florida		1	1	15	5	22
(Northwest)		1		5		6
(Northeast)						0
(Southwest)				5	3	8
(Southeast)			1	7	2	10
Georgia						0
South Carolina				3	1	4
North Carolina			1	7	1	9
Virginia				1		1
Maryland						0
Delaware						0
New Jersey						0
New York			1	4		5
Connecticut			1	2		3
Rhode Island			1	2		3
Massachusetts				2		2
New Hampshire						0
Maine						0

Note: State totals will not equal U.S. totals and Texas and Florida sectional totals will not necessarily equal state totals.

Table 11. Last occurrence of a direct or indirect hit by any hurricane and/or by a major hurricane at the more populated coastal communities from Texas to Maine (updated from Hebert, Taylor, and Case, 1989). Category is in parentheses.

		DIRECT				INDIRECT	
STATE	CITY	LAST MAJOR		LAST ANY		LAST ANY	
Texas	Brownsville	1980(3)	Allen	1980(3)	Allen		
	Corpus Christi	1970(3)	Celia	1971(1)	Fern	1980(3)	Allen
	Port Aransas	1970(3)	Celia	1971(1)	Fern	1980(3)	Allen
	Matagorda	1961(4)	Carla	1971(1)	Fern	1983(3)	Alicia
	Freeport	1983(3)	Alicia	1983(3)	Alicia		
	Galveston	1983(3)	Alicia	1989(1)	Jerry		
	Houston	1941(3)		1989(1)	Jerry		
	Beaumont	<1900		1986(1)	Bonnie		
Louisiana	Cameron	1957(4)	Audrey	1985(1)	Danny	1985(1)	Juan
	Morgan City	1974(3)	Carmen	1985(1)	Juan		
	Houma	1974(3)	Carmen	1985(1)	Juan		
	New Orleans	1965(3)	Betsy	1965(3)	Betsy	1969(5)	Camille
Mississippi	Bay St. Louis	1985(3)	Elena	1985(3)	Elena		
	Biloxi	1985(3)	Elena	1985(3)	Elena		
	Pascagoula	1985(3)	Elena	1985(3)	Elena		
Alabama	Mobile	1985(3)	Elena	1985(3)	Elena		
Florida	Pensacola	1926(3)		1926(3)		1979(3)	Fred-
	Panama City	1975(3)	Eloise	1985(2)	Kate		eric
	Apalachicola	1985(3)	Elena	1985(2)	Kate		
	Homosassa	1950(3)	Easy	1968(2)	Gladys		
	St. Petersburg	1921(3)		1946(1)		1968(2)	Gladys
	Tampa	1921(3)		1946(1)		1968(2)	Gladys
	Sarasota	1944(3)		1946(1)		1966(2)	Alma
	Fort Myers	1960(3)	Donna	1960(3)	Donna	1966(2)	Alma
	Naples	1960(4)	Donna	1964(2)	Isbell	1965(3)	Betsy
	Key West	1948(3)		1987(1)	Floyd		
	Miami	1950(3)	King	1964(2)	Cleo	1965(3)	Betsy
	Fort Lauderdale	1950(3)	King	1964(2)	Cleo	1965(3)	Betsy
	West Palm Beach	1949(3)		1979(2)	David		
	Stuart	1949(3)		1979(2)	David		
	Fort Pierce	1933(3)		1979(2)	David		
	Vero Beach	<1900		1979(2)	David		
	Cocoa	<1900		1979(2)	David		
	Daytona Beach	<1900		1960(2)	Donna	1979(2)	David
	St. Augustine	<1900		1964(2)	Dora		
	Jacksonville	<1900		1964(2)	Dora		
	Fernandina Beach	<1900		1928(2)		1964(2)	Dora
Georgia	Brunswick	<1900		1928(1)			
	Savannah	<1900		1979(2)	David		
South	Hilton Head	1959(3)	Gracie	1979(2)	David	1985(1)	Bob
Carolina	Charleston	1989(4)	Hugo	1989(4)	Hugo		
	Myrtle Beach	1954(4*)	Hazel	1954(4*)	Hazel	1989(4)	Hugo
North	Wilmington	+1960(3*)	Donna	1984(2)	Diana		
Carolina	Morehead City	1960(3*)	Donna	1960(3*)	Donna	1985(3*)	Gloria
	Cape Hatteras	1985(3*)	Gloria	1986(1)	Charley		

+ Cape Fear only - Direct 3.

Table 11 continued.

STATE	CITY	DIRECT LAST MAJOR	DIRECT LAST ANY	INDIRECT LAST ANY
Virginia	Virginia Beach	1944(3*)	1986(1) Charley	
	Norfolk	<1900	1955(1) Connie	1985(3*) Gloria
Maryland	Ocean City	<1900	<1900	1985(3*) Gloria
	Baltimore	<1900	<1900	1954(2*) Hazel
Delaware	Rehoboth Beach	<1900	<1900	1985(3*) Gloria
	Wilmington	<1900	<1900	<1900
New Jersey	Cape May	<1900	1903(1)	1985(3*) Gloria
	Atlantic City	<1900	1903(1)	1985(3*) Gloria
New York	New York City	<1900	1903(1)	1976(1) Belle
	Westhampton	1985(3*) Gloria	1985(3*) Gloria	
Connecticut	New London	1938(3*)	1972(1) Agnes	1985(2*) Gloria
	New Haven	1938(3*)	1985(2*) Gloria	
	Bridgeport	1954(3*) Carol	1985(2*) Gloria	
Rhode Island	Providence	1954(3*) Carol	1985(2*) Gloria	
Massachusetts	Cape Cod	1954(3*) Edna	1954(3*) Edna	1985(2*) Gloria
	Boston	<1900	1960(1*) Donna	1985(2*) Gloria
New Hampshire	Portsmouth	<1900	1985(2*) Gloria	
Maine	Portland	<1900	1985(1*) Gloria	
	Eastport	<1900	1969(1) Gerda	1985(1*) Gloria

* Moving more than 30 miles per hour. <1900 means before 1900

Perhaps the most illustrative example of the uncertainty of when a hurricane might strike a given locality is Pensacola, Florida. Although Dunn (1967) listed Pensacola as the city with the second highest frequency of hurricane force winds in the United States (1 in 10), it has been more than 60 years since any hurricane directly struck Pensacola!

In order to obtain the same type of information listed in Table 11 for the remaining coastal communities, the reader is referred to Hebert, Taylor, and Case (1984).

(11) What is the total U.S. damage (unadjusted and adjusted) and death toll for each year of this century?

Table 12 summarizes this information. Tables 12a-c rank the years. In most years the death and damage totals are usually the result of a single, major hurricane. Gentry (1966) gives damages adjusted to 1957-59 costs as a base for the period 1915-1965. For the most part, death and damage totals for the period 1915-1965 were taken from Gentry's paper, and for the remaining years from the Monthly Weather Review. Adjusted damages were calculated to 1989 dollars by the same factors as used in Table 3a.

(12) Are there hurricane cycles?

Figures 1 through 9 show the landfalling portion of the major hurricanes which have struck any portion of the United States during this century.

Table 12. Estimated annual deaths and damages (unadjusted and adjusted[1]) in the United States for each year of this century.

YEAR	DEATHS	DAMAGE ($ MILLIONS)		YEAR	DEATHS	DAMAGE ($ MILLIONS)	
		UNADJUSTED	ADJUSTED			UNADJUSTED	ADJUSTED
1900	6000+	30	(689)[2]	1945	7	80	703
1901	10	1	*	1946	0	5	37
1902	0	Minor	Minor	1947	53	136	851
1903	15	1	*	1948	3	18	103
1904	5	2	*	1949	4	59	337
1905	0	Minor	Minor	1950	19	36	202
1906	298	3+	*	1951	0	2	10
1907	0	0	0	1952	3	3	15
1908	0	0	0	1953	2	6	30
1909	406	8	*	1954	193	756	3803
1910	30	1	*	1955	218	985	4866
1911	17	1+	*	1956	19	27	126
1912	1	Minor	Minor	1957	400	152	690
1913	5	3	*	1958	2	11	50
1914	0	0	0	1959	24	23	106
1915	550	63	1448[3]	1960	65	396	1826
1916	107	33	657	1961	46	331	1529
1917	5	Minor	Minor	1962	3	2	9
1918	34	5	65	1963	10	12	54
1919	287	22	253	1964	49	515	2333
1920	2	3	27	1965	75	1445	6430
1921	6	3	34	1966	54	15	64
1922	0	0	0	1967	18	200	826
1923	0	Minor	Minor	1968	9	10	39
1924	2	Minor	Minor	1969	256	1421	5130
1925	6	Minor	Minor	1970	11	454	1530
1926	269	107	1229	1971	8	213	671
1927	0	0	0	1972	121	2100	6279
1928	1836	25	287	1973	5	3	8
1929	3	1	11	1974	1	150	353
1930	0	Minor	Minor	1975	21	490	1058
1931	0	0	0	1976	9	100	208
1932	0	0	0	1977	0	10	19
1933	63	47	638	1978	36	20	34
1934	17	5	62	1979	22	3045	4537
1935	414	12	149	1980	2	300	402
1936	9	2	25	1981	0	25	31
1937	0	Minor	Minor	1982	0	Minor	Minor
1938	600	300	3447	1983	22	2000	2340
1939	3	Minor	Minor	1984	4	66	75
1940	51	5	60	1985	30	4000	4360
1941	10	8	89	1986	9	17	18
1942	8	27	260	1987	0	8	8
1943	16	17	154	1988	6	9	9
1944	64	165	1493	1989	56	7670	7670

[1]Adjusted to 1989 dollars on basis of U.S. Department of Commerce composite construction cost indexes.
[2]Using 1915 cost adjustment base - none available prior to 1915.
[3]Considered too high in 1915 reference.

* Not available

Table 12a. Estimated deaths in the United States for each year of this century ranked according to annual total.

RANK	YEAR	TOTAL	RANK	YEAR	TOTAL
1	1900	6000+	37	1911	17
2	1928	1836	37	1934	17
3	1938	600	39	1943	16
4	1915	550	40	1903	15
5	1935	414	41	1970	11
6	1909	406	42	1901	10
7	1957	400	42	1941	10
8	1906	298	42	1963	10
9	1919	287	45	1936	9
10	1926	269	45	1968	9
11	1969	256	45	1976	9
12	1955	218	45	1986	9
13	1954	193	49	1942	8
14	1972	121	49	1971	8
15	1916	107	51	1945	7
16	1965	75	52	1921	6
17	1960	65	52	1925	6
18	1944	64	52	1988	6
19	1933	63	55	1904	5
20	1989	56	55	1913	5
21	1966	54	55	1917	5
22	1947	53	55	1973	5
23	1940	51	59	1949	4
24	1964	49	59	1984	4
25	1961	46	61	1929	3
26	1978	36	61	1939	3
27	1918	34	61	1948	3
28	1910	30	61	1952	3
28	1985	30	61	1962	3
30	1959	24	66	1920	2
31	1979	22	66	1924	2
31	1983	22	66	1953	2
33	1975	21	66	1958	2
34	1950	19	66	1980	2
34	1956	19	71	1912	1
36	1967	18	71	1974	1

Note 1: There were 18 years in which no deaths occurred...1902,1905,1907, 1908,1914,1922,1923,1927,1930,1931,1932,1937,1946,1951,1977,1981,1982, 1987.

Note 2: Death totals in this table do not agree with those in table 2 because the latter included deaths on ships at sea.

Table 12b. Estimated damages (unadjusted) in the United States for each year of this century ranked according to annual total.

RANK	YEAR	DAMAGE ($ millions)	RANK	YEAR	DAMAGE ($ millions)
1	1989	7670	37	1959	23
2	1985	4000	38	1919	22
3	1979	3045	39	1978	20
4	1972	2100	40	1948	18
5	1983	2000	41	1943	17
6	1965	1445	41	1986	17
7	1969	1421	43	1966	15
8	1955	985	44	1935	12
9	1954	756	44	1963	12
10	1964	515	46	1958	11
11	1975	490	47	1968	10
12	1970	454	47	1977	10
13	1960	396	49	1988	9
14	1961	331	50	1909	8
15	1938	300	50	1941	8
15	1980	300	50	1987	8
17	1971	213	53	1953	6
18	1967	200	54	1918	5
19	1944	165	54	1934	5
20	1957	152	54	1940	5
21	1974	150	54	1946	5
22	1947	136	58	1906	3+
23	1926	107	59	1913	3
24	1976	100	59	1920	3
25	1945	80	59	1921	3
26	1984	66	59	1952	3
27	1915	63	59	1973	3
28	1949	59	64	1904	2
29	1933	47	64	1936	2
30	1950	36	64	1951	2
31	1916	33	64	1962	2
32	1900	30	68	1911	1+
33	1942	27	69	1901	1
33	1956	27	69	1903	1
35	1928	25	69	1910	1
35	1981	25	69	1929	1

Note 1: Eleven years had minor damage...1902,1905,1912,1917,1923,1924, 1925,1930,1937,1939,1982.

Note 2: Seven years had no damage...1907,1908,1914,1922,1927,1931,1932.

Table 12c. Estimated damages (adjusted to 1989 dollars)[1] in the United States for each year of this century ranked according to annual total.

RANK	YEAR	DAMAGE ($ millions)	RANK	YEAR	DAMAGE ($ millions)
1	1989	7670	33	1976	208
2	1965	6430	34	1950	202
3	1972	6279	35	1943	154
4	1969	5130	36	1935	149
5	1955	4866	37	1956	126
6	1979	4537	38	1959	106
7	1985	4360	39	1948	103
8	1954	3803	40	1941	89
9	1938	3447	41	1984	75
10	1983	2340	42	1918	65
11	1964	2333	43	1966	64
12	1960	1826	44	1934	62
13	1970	1530	45	1940	60
14	1961	1529	46	1963	54
15	1915	1511[2]	47	1958	50
16	1944	1493	48	1968	39
17	1926	1229	49	1946	37
18	1975	1058	50	1921	34
19	1947	851	50	1978	34
20	1967	826	52	1981	31
21	1900	719[3]	53	1953	30
22	1945	703	54	1920	27
23	1957	690	55	1936	25
24	1971	671	56	1977	19
25	1916	657	57	1986	18
26	1933	638	58	1952	15
27	1980	402	59	1929	11
28	1974	353	60	1951	10
29	1949	337	61	1962	9
30	1928	287	61	1988	9
31	1942	260	63	1973	8
32	1919	253	63	1987	8

Note 1: Eleven years with minor damage...1902,1905,1912,1917,1923,1924, 1925,1930,1937,1939,1982.

Note 2: Seven years with no damage...1907,1908,1914,1922,1927,1931,1932.

Note 3: Eight years prior to 1915 not adjusted...1901,1903,1904,1906,1909, 1910,1911,1913.

[1]Adjusted to 1989 dollars on basis of U.S. Department of Commerce composite construction cost indexes.
[2]Considered too high in 1915 reference.
[3]Using 1915 cost adjustment base - none available prior to 1915.

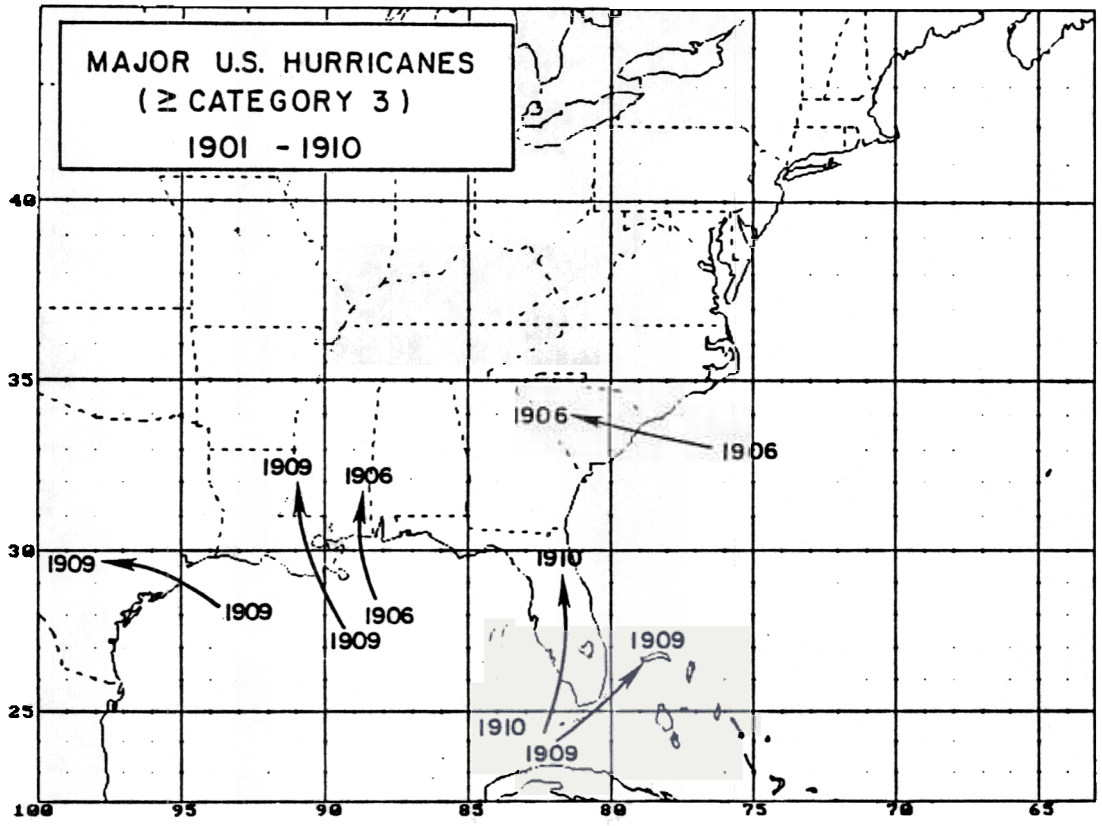

Figure 1. Major landfalling United States hurricanes (greater than or equal to a category 3) during the period 1901-1910.

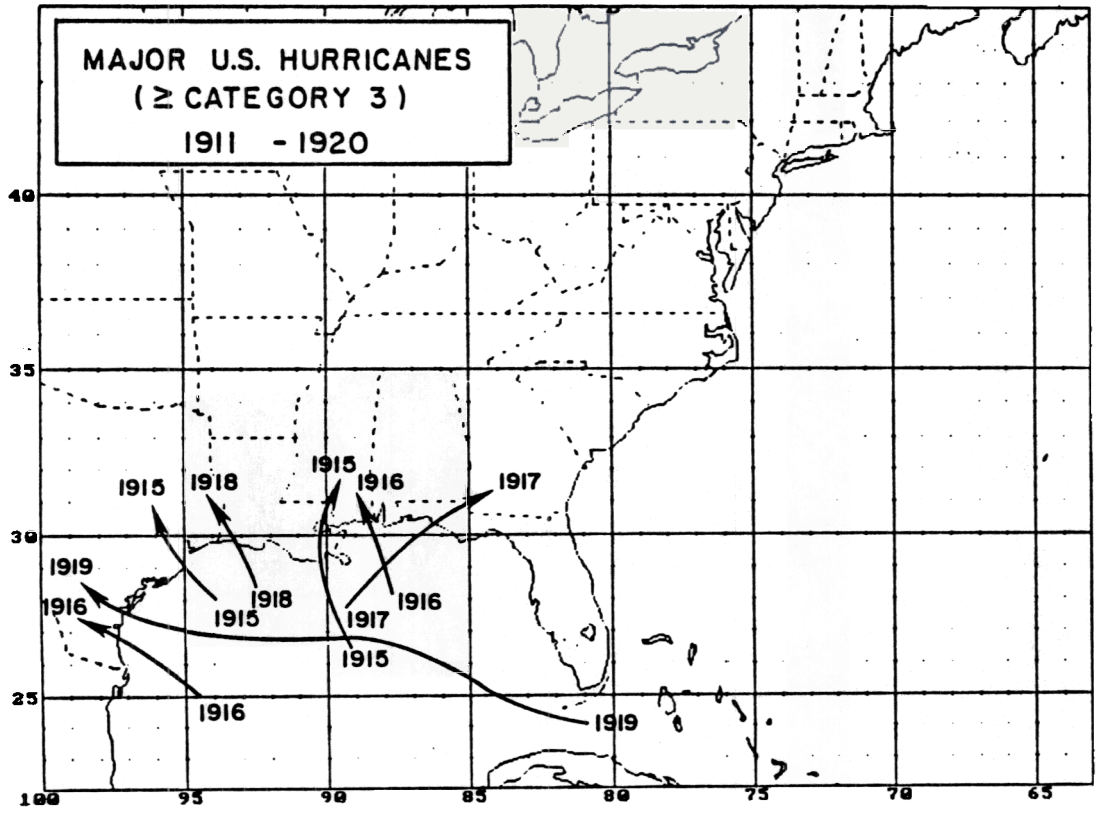

Figure 2. Major landfalling United States hurricanes (greater than or equal to a category 3) during the period 1911-1920.

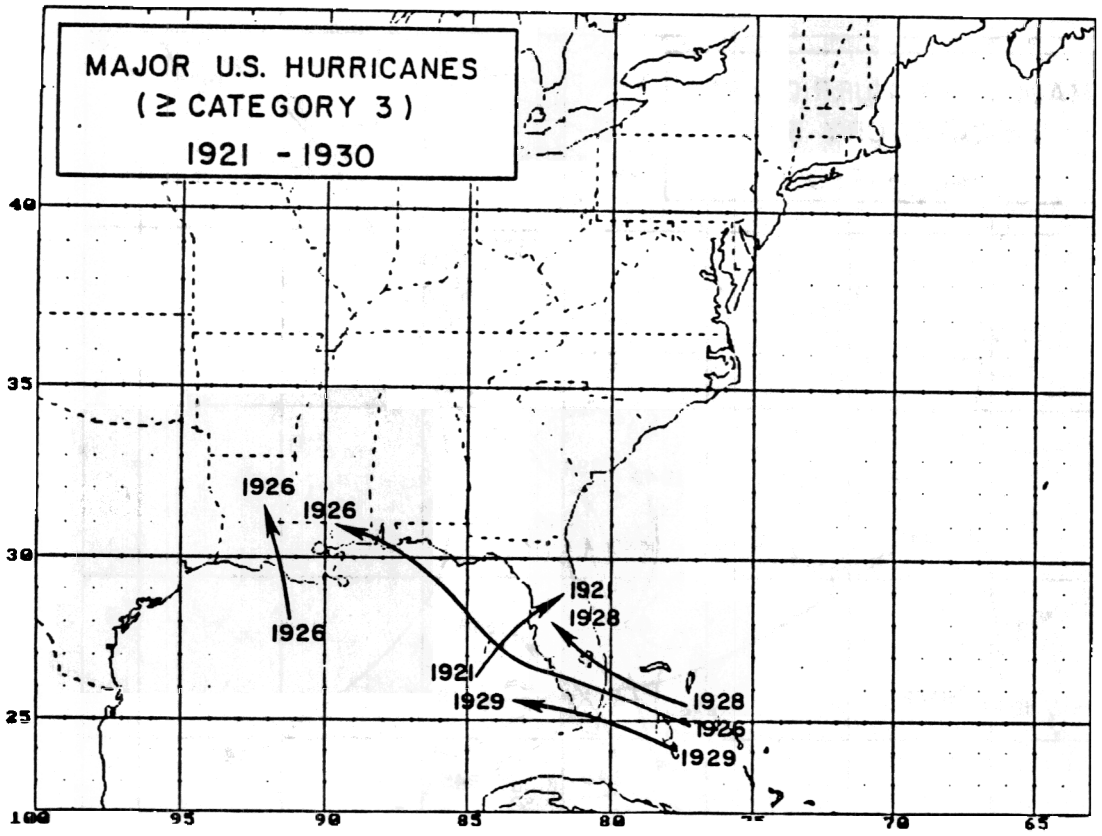

Figure 3. Major landfalling United States hurricanes (greater than or equal to a category 3) during the period 1921-1930.

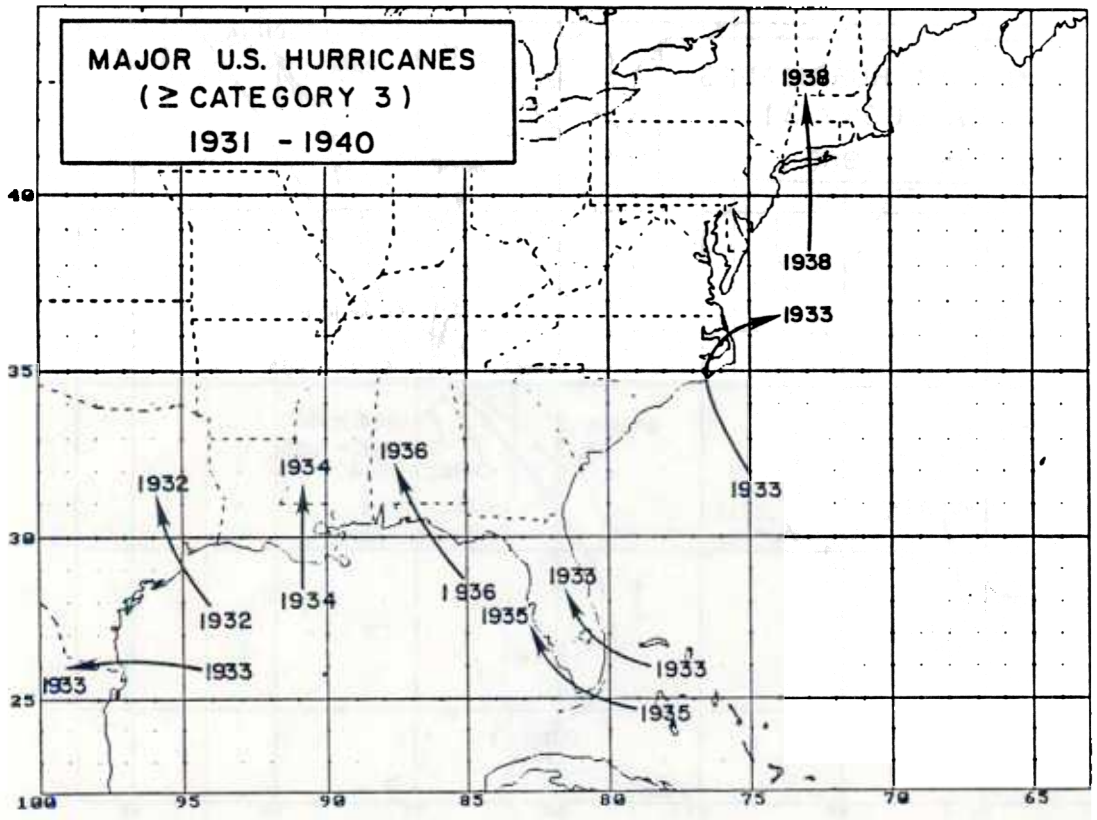

Figure 4. Major landfalling United States hurricanes (greater than or equal to a category 3) during the period 1931-1940.

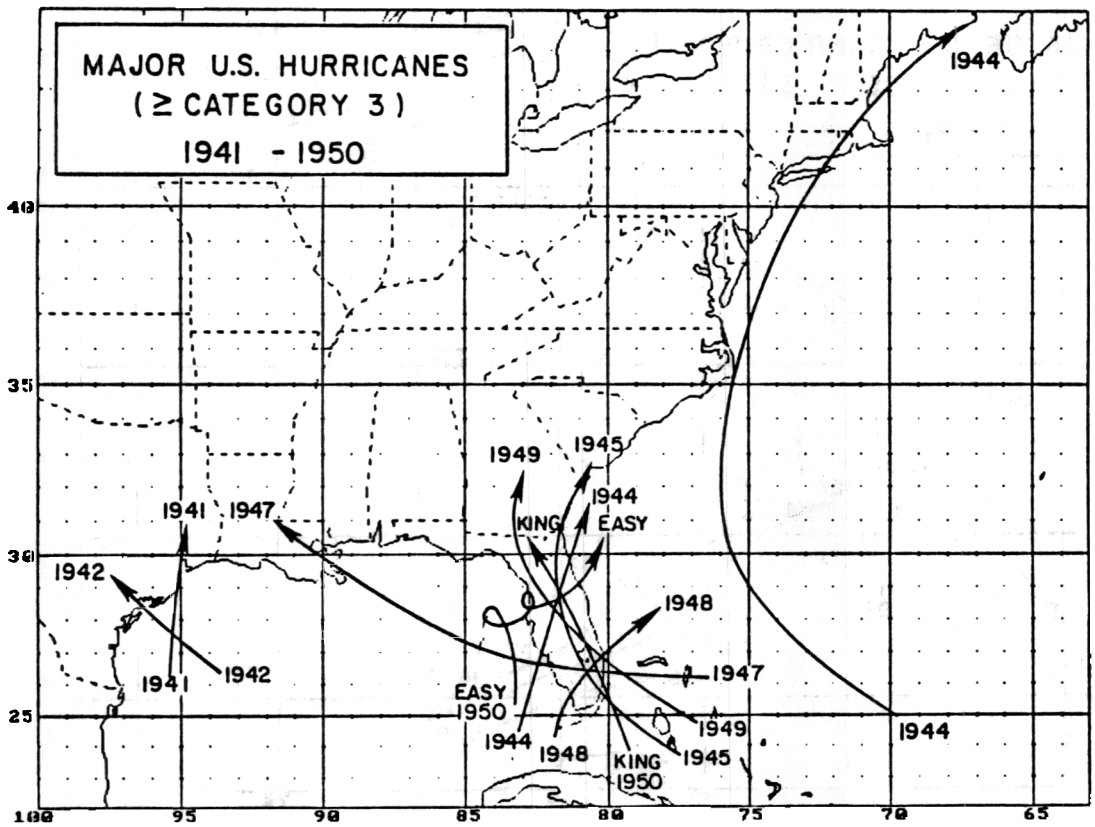

Figure 5. Major landfalling United States hurricanes (greater than or equal to a category 3) during the period 1941-1950.

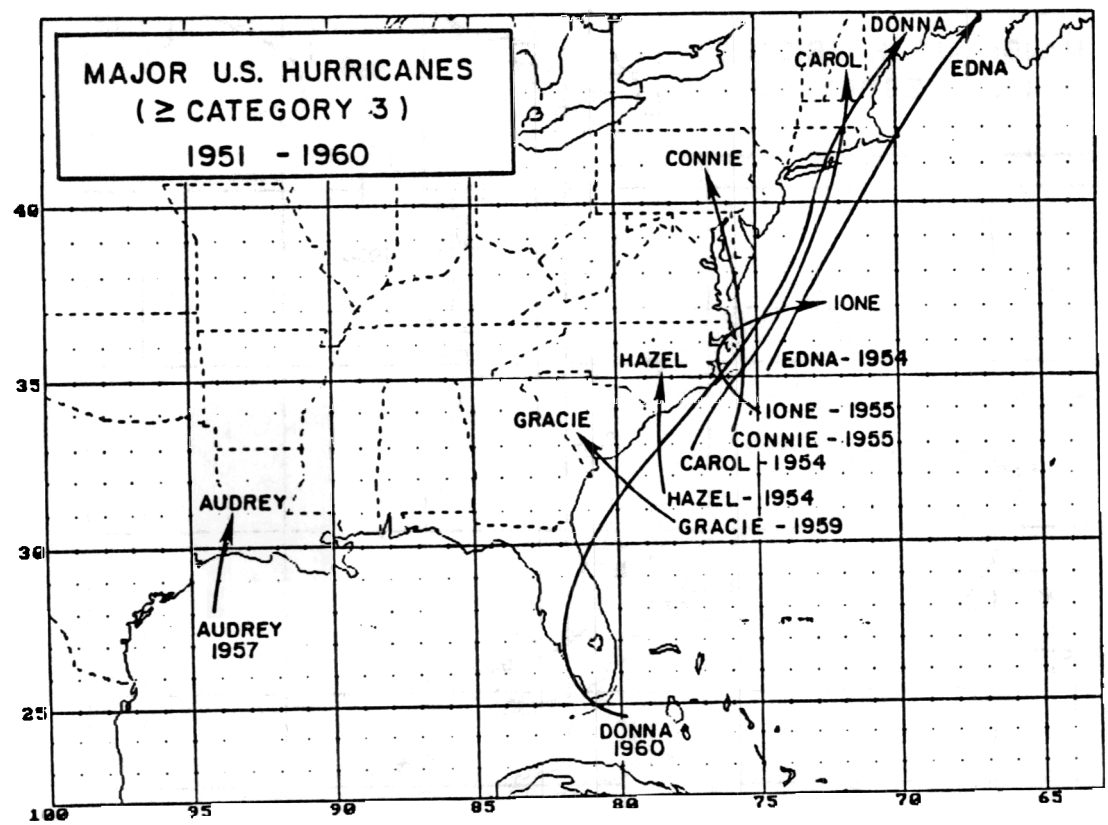

Figure 6. Major landfalling United States hurricanes (greater than or equal to a category 3) during the period 1951-1960.

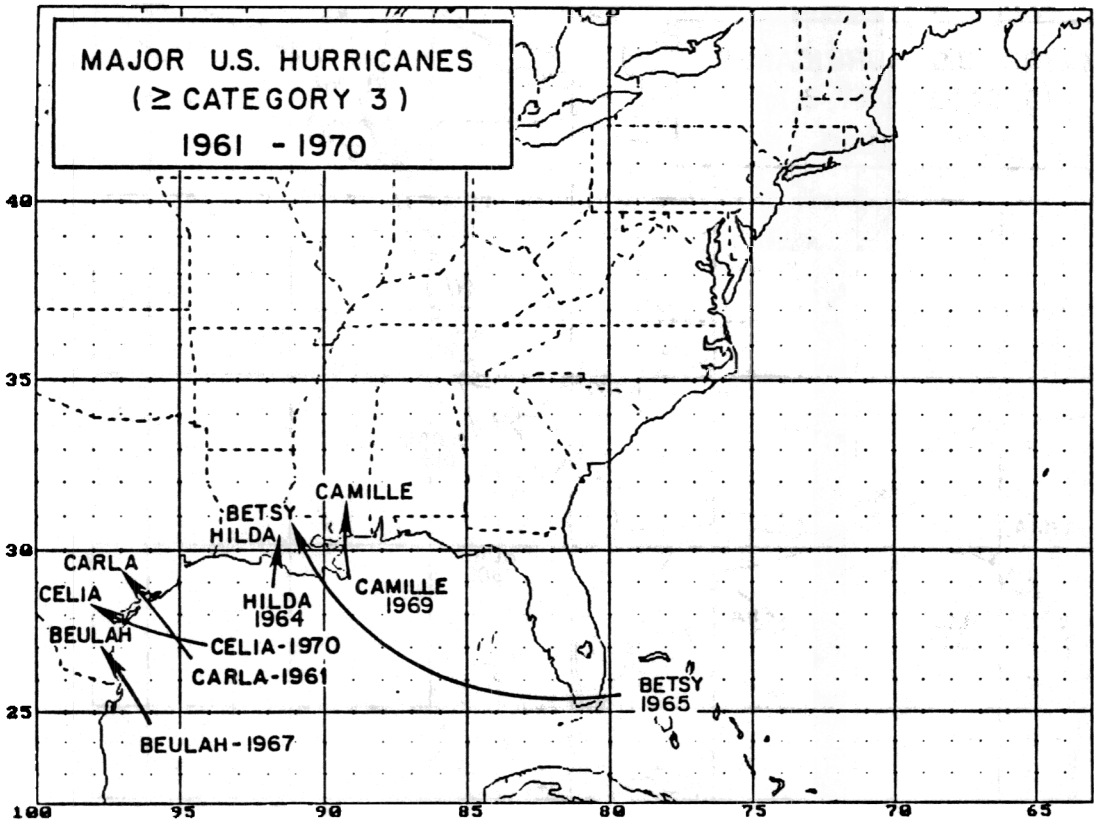

Figure 7. Major landfalling United States hurricanes (greater than or equal to a category 3) during the period 1961-1970.

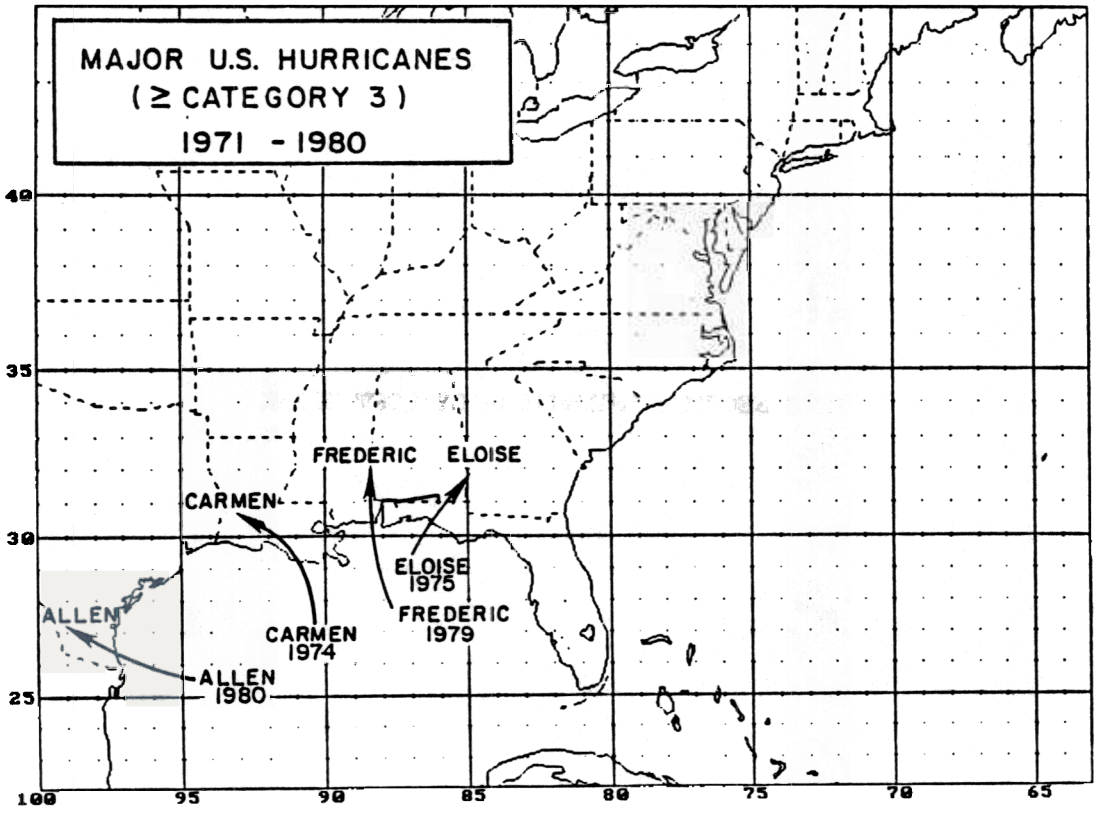

Figure 8. Major landfalling United States hurricanes (greater than or equal to a category 3) during the period 1971-1980.

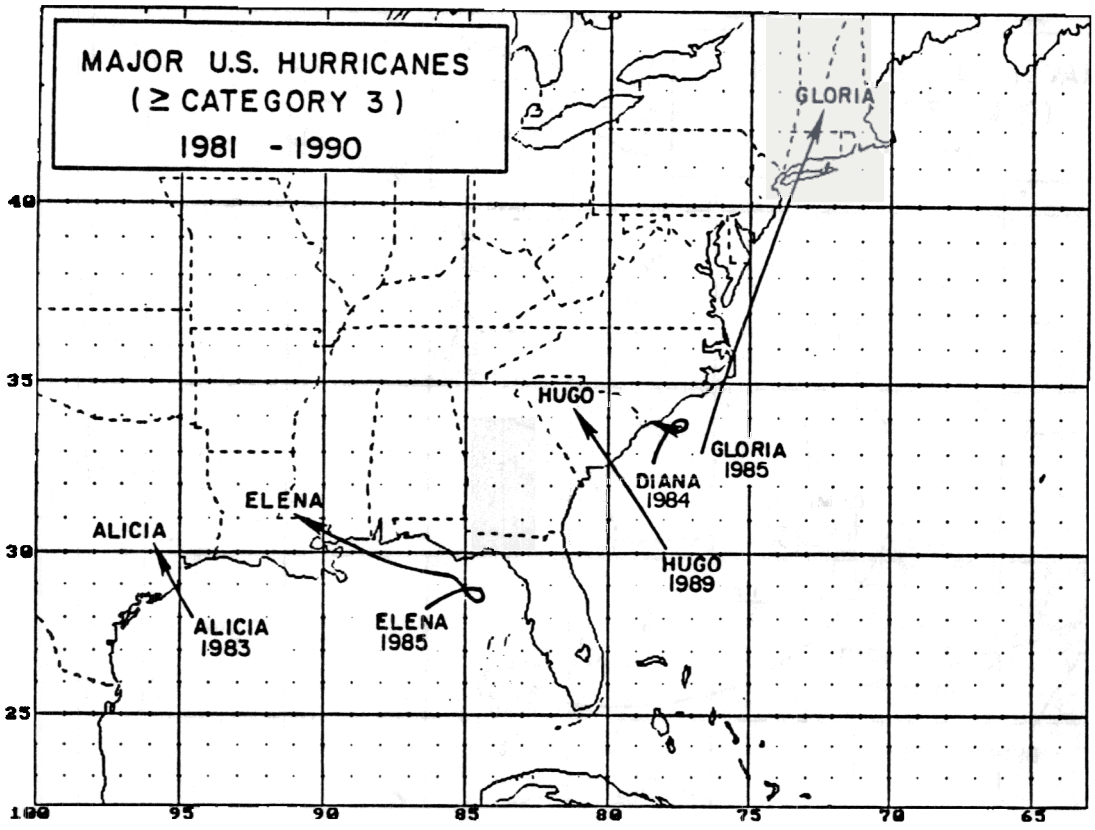

Figure 9. Major landfalling United States hurricanes (greater than or equal to a category 3) during the period 1981-1989.

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The reader might note the tendency of the major hurricanes to cluster in certain areas during certain decades. Another interesting point is the general tendency for this clustering to occur in the latter half of individual decades in one area and in the first half of individual decades in another area. During the very active period of the thirties this clustering is not apparent.

A comparison of twenty-year periods beginning in 1900 indicates that the major hurricanes tended to be in the western Gulf Coast states at the beginning of the century, shifting to the eastern Gulf Coast states and Florida during the next twenty years, then to Florida and the Atlantic Coast states during the forties and fifties, and back to the western Gulf Coast states in the sixties and seventies. Does figure 9 indicate a shift to the eastern Gulf Coast states, Florida, and the Atlantic Coast states in the eighties and nineties?

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(13) Are there hurricane cycles evident in certain years regardless of category or geographical area?

Table 13 gives a tabulation of hurricanes of all categories to affect the U.S. by individual years within each decade.

Table 13. Major and all category landfalling hurricanes in the United States by individual years.

MAJOR

	00	01	02	03	04	05	06	07	08	09	TOTAL
1900-09	1						2			3	6
1910-19	1					2	2	1	1	1	8
1920-29		1					2		1	1	5
1930-39			1	3	1	1	1		1		8
1940-49		1	1		2	1		1	1	1	8
1950-59	2				3	2		1		1	9
1960-69	1	1			1	1		1		1	6
1970-79	1				1	1				1	4
1980-89	1			1	1	2				1	6
TOTAL 1990-99	7	3	2	4	9	10	7	4	4	10	60

ALL

	00	01	02	03	04	05	06	07	08	09	TOTAL
1900-09	1	2		2	1		4		1	4	15
1910-19	2	2	2	2		3	6	1	1	1	20
1920-29	2	2		1	2	1	3		2	2	15
1930-39			2	5	2	2	3		2	1	17
1940-49	2	2	2	1	3	3	1	3	3	3	23
1950-59	3		1	3	3	3	1	1		3	18
1960-69	2	1		1	4	1	2	1	1	2	15
1970-79	1	3	1		1	1	1	1		3	12
1980-89	1			1	1	6	2	1	1	3	16
TOTAL 1990-99	14	12	8	16	17	20	23	8	11	22	151

Figures 1 through 9 certainly support the existence of a cyclical nature of major hurricanes affecting given regions Table 13 is also suggestive of preferred periods. However, it is left to the reader to decide what weight should be given to these statistics.

4. SUMMARY

In virtually every coastal city of any size from Texas to Maine, both present Director, Dr. Robert Sheets, and former Director, Dr. Neil Frank, have stated that the United States is building toward a hurricane disaster. The population growth versus low hurricane experience levels indicated in Hebert, Taylor, and Case (1984), together with updated statistics presented in the discussion section of this paper, form the basis for their statements. Stated simply, the areas of the United States where 9 out of 10 persons have lost their lives by drowning from the storm surge during hurricanes (along the immediate Gulf of Mexico and Atlantic shorelines) are the very areas where the most dramatic increases in population have occurred in recent years. This situation, in combination with continued building on low coastal elevations, will lead to serious problems for many areas in future hurricanes. Since it is likely that people will always live along the immediate shoreline, a pleasant way of life, the solution to the problem lies in education and preparedness.

The message to coastal residents is this: Become familiar with what hurricanes can do, and when a hurricane threatens your area, increase your chances of survival by moving away from the water until the hurricane has passed! Unless this message is clearly understood by coastal residents through a thorough and continuing preparedness effort, a future disaster is inevitable.

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