Trends in Hurricane Impacts in the United States

by Roger A. Pielke, Jr., National Center for Atmospheric Research

Editor's Note: This article is taken from information distributed at the Workshop on the Social and Economic Impacts of Weather held April 2-4, 1997, in Boulder, CO. You can find more information on this workshop on the World Wide Web at http://www.dir.ucar.edu/esig/socasp/weather1.

Hurricane related damages have risen dramatically in recent years. The 1990s have already seen as much damage as the combined total of the 1970s and 1980s (even after adjusting for inflation). From the 1950s through the 1980s, hurricane related deaths decreased each decade, however, midway through the 1990s it appears that this downward trend has stalled.

The Challenge of Impact Assessment: Assessing Damages

In the aftermath of any extreme event, there is a demand for a bottom-line measure of damages in dollars. There are many valid ways to measure the costs of a hurricane. Any assessment of impacts resulting in an estimate of total damages associated with disaster must pay explicit attention to assumptions guiding the analysis in order to facilitate interpretation of the estimate. The analyst needs to pay attention to five factors that can undermine damage assessment: Contingency, quantification, attribution, aggregation and comparison.

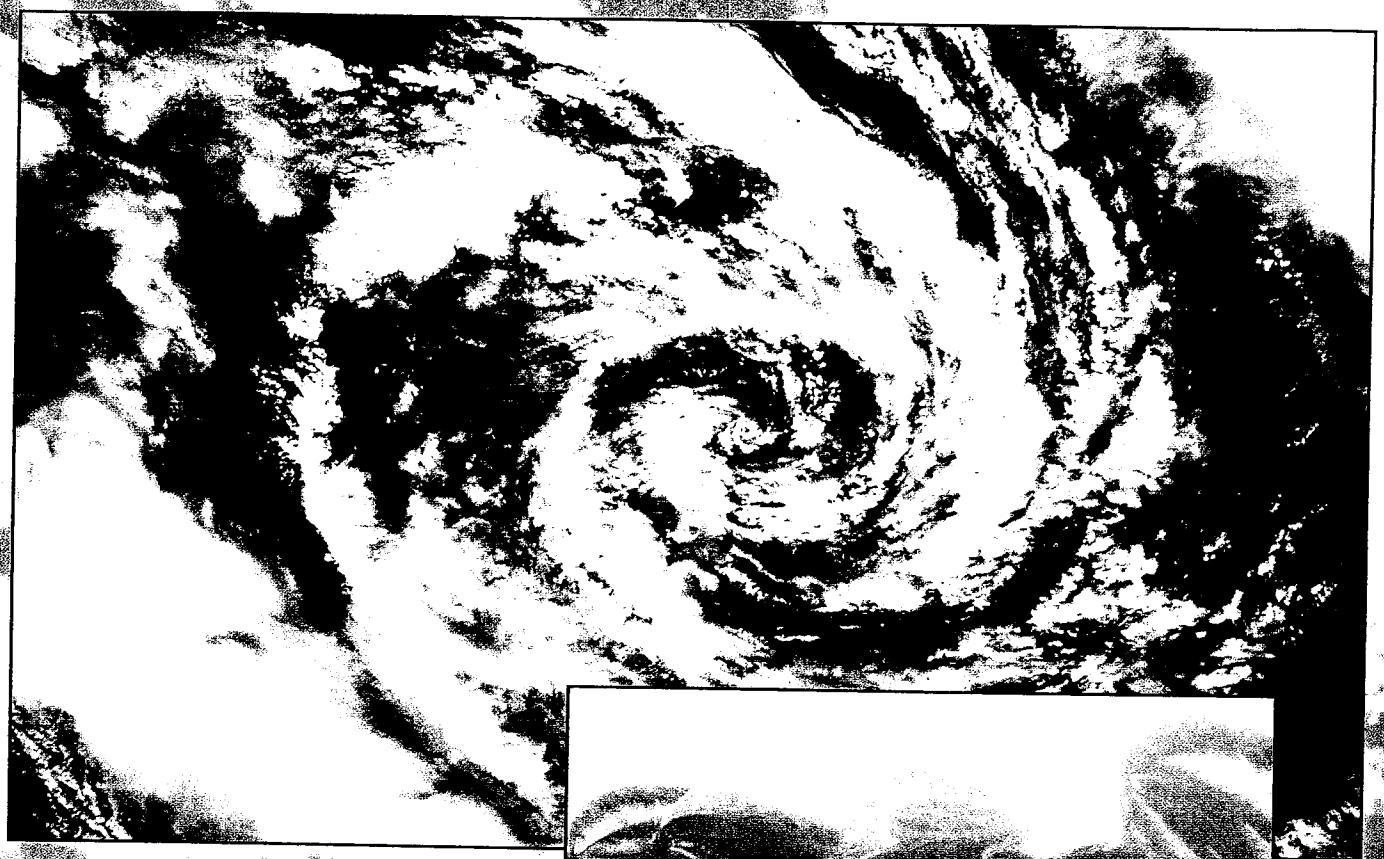
Contingency: The Problem of Multiple-Order Impacts

When a hurricane strikes a community, it leaves an obvious path of destruction. As a result of high winds and water from a storm surge, homes, businesses and crops may be destroyed or damaged, public infrastructure may also be compromised and people may suffer injuries or loss of life. Such obvious impacts can be called "direct impacts" because of the close connection between event and damages. The costs associated with direct impacts are generally easiest to assess because they come in discrete quantities. Federal insurance payouts are one measure of direct impacts, as are federal aid, public infrastructure reconstruction and debris removal. Table 1 shows the direct impacts associated with Andrew's landfall in south Florida in August 1992.

Table 1. Current dollar estimates of $30 billion in damages directly related to Hurricane Andrew in south Florida.

TYPE OF LOSS	AMOUNT ($ BILLIONS)
Common Insured Private Property	16.5
Uninsured Home	0.35
Federal Disaster Package	6.5
Public Infrastructure	0.050
State	0.287
County	0.060
City Schools	1.0
Agriculture	
Damage	1.04
Lost Sales	0.48
Environment	2.124
Aircraft	0.02
Flood Claims	0.096
Red Cross	0.070
Defense Department	1.412

Secondary impacts are those that are related to the direct impacts of a hurricane. Generally, secondary impacts result in the days and weeks following a hurricane's passage. For



example, a hurricane may destroy a water treatment plant. The direct impact is the cost associated with rebuilding the plant; secondary impacts might include the costs associated with providing fresh water for local citizens. In general, such secondary impacts are more difficult to assess because they require estimation and are part of an existing social process; e.g., estimating the costs of providing fresh water in lieu of that which would have been provided by the plant requires some sense of what would have occurred without the hurricane's impact.

Further order impacts on time scales of months and years occur and can easily be imagined. For example, a hurricane may destroy a number of businesses in a community resulting in a decrease in tourist visits, which in turn leads to a shortfall in a sales tax collection. As a result, community services that had been funded from sales tax revenues may suffer, leading to further social disruption and thus additional costs. Estimation of the costs associated with such impacts is difficult to accomplish with much certainty because of numerous confounding factors. In short, a hurricane serves as a shock to a community that leaves various impacts which reverberate through the social system for short and long periods. Pulling the signal of the reverberations from the noise of ongoing social processes becomes increasingly difficult, as the impact becomes further removed in time and in causation from the event's direct impacts.

Attribution: The Problem of Causation

Related to contingency is attribution. In the aftermath of a natural disaster, people are quick to place blame on nature: The *hurricane* caused billions of dollars in damages. However, it is often the case that natural disasters are a consequence of human failures. Damage is often a result of poor decisions of the past and inadequate preparation rather than simply the overwhelming forces of nature. It is often at the intersection of extreme events and poor preparation that a disaster occurs. An important aspect of learning from a hurricane is to understand what damages and casualties might have been preventable and which were not. Gross tabulations of damages neglect the question of why damage occurred, and often implicitly place blame on nature rather than ourselves.

Quantification: The Problem of Measurement

How much is a life worth? Or put in practical terms; how much

public money are people willing to pay to save one more life in the face of an environmental hazard? According to a review by Fischer, Chestnut and Violette entitled "The value of reducing risks of death: A note on new evidence", the public assigns between $2 million and $10.9 million as the value of a human life (these figures are adjusted to 1993 dollars). The difficulties associated with assigning an economic value to a human life is representative of the more general problem of assessing many of the costs associated with a hurricane's impact. Similar questions might include: What is the value of a lost ecosystem, park or unrecoverable time in school, etc.? What are the costs associated with psychological trauma? The difficulties in quantifying the cost of a life are representative of the more general problem of placing a dollar value on damages that are not directly economic in nature.

A hurricane impacts many aspects of society that are not explicitly associated with an economic measure (e.g., well being). As a consequence, any comprehensive economic measurement of a hurricane's impact necessitates the quantification of costs associated with subjective losses. Therefore, the assumptions that one brings to assessment of value can affect the bottom line. Care must be taken to make such assumptions explicit in the analysis.

Aggregation: The Problem of Benefits and Spatial Scale

Hurricanes are not all costs; however, estimates of impacts rarely consider benefits. Consider the following example: Following a hurricane that severely damages agricultural productivity in a region, commodity prices rise nationwide. Thus, while farmers in the effected region see losses, farmers outside of the region may actually see significant benefits due to the hurricane. At a national level, the hurricane may thus have net economic benefits.

The example of farmers seeing gains or losses, depending upon where they farm, points to two sorts of issues: benefits and spatial scale. Arguably, following every disaster, some individuals and groups realize benefits in some way from the event. Should such benefits be subtracted from a hurricane's total impact? Further, the picture of damages depends upon the scale of the analysis. For the same event, a county may experience complete devastation, the state moderate impacts and the nation positive benefits. The transfer of wealth through disaster aid further complicates the picture. Because there are multiple valid spatial scales from which to view a hurricane's impacts, careful attention must be paid to the purposes of loss estimates. Furthermore, it is important to remember that impacts go beyond those things that can be expressed in dollars. Suffering and hardship are losses independent of scale.

Comparison: The Problem of Demographic Change

As a consequence of the challenges facing meaningful impact assessment, comparing hurricane impacts across time and space is problematic. Past intense hurricanes of the past would certainly leave a greater legacy had they occurred in more recent years. Yet, damage statistics often go into the historical record noting only the event and economic damage (usually adjusted only for inflation). Such statistics can lead to mistaken conclusions about the significance of trends in hurricane damage. Because population and property at risk to hurricanes has changed dramatically this century, such statistics may grossly underestimate our vulnerability. Therefore, care must be taken in the use of bottom line damage estimates to reach policy conclusions.

The Bottom Line: Apples with Apples, Oranges with Oranges

There are many ways in which to measure the costs associated with a hurricane. There is no one right way. The method chosen for measurement of the costs of damages depends upon the purposes for which the measurement is made, and therefore must be determined on a case by case basis. No matter what method is employed when assessing or using the costs associated with a hurricane s impact, the analyst needs to ensure at least two things. First, the analyst needs to make explicit the assumptions that guide the assessment. What is being measured, how and why. Second, compare apples with apples and oranges with oranges. If the purpose is to compare the impacts of a recent hurricane with a historical hurricane to an earthquake, the methods employed ought to result in conclusions that are meaningful in a comparative setting.

Trends: Economic Losses, Casualties and Hurricane Frequencies

In the United States alone, after adjusting for inflation, hurricanes were responsible for an annual average of $1.6 billion for the period 1950-1989, $2.2 billion over 1950-1995 and $6.2 billion over 1989-1995. For comparison, China suffered an average of $1.3 billion (unadjusted) in damages related to typhoons over the period 1986-1994. Significant tropical cyclone damages are also experienced by other countries including those in southeast Asia, along the Indian Ocean (including Australia), islands of the

continued on page 18

Hurricane Impacts

continued from page 10

Caribbean and Pacific and in Central America (including Mexico). While a full accounting of these damages has yet to be documented and made accessible, it is surely in the billions of dollars, with a reasonable estimate of about $10 billion annually (1995 dollars). Other estimates range to $15 billion.

In the United States, 196 people lost their lives related to hurricanes over the period 1986-1995. Experts have estimated that worldwide, tropical cyclones result in approximately 12,000 to 23,000 deaths. Tropical cyclones have been responsible for a number of the largest losses of life due to a natural disaster. For instance, in April 1991, a cyclone made landfall in Bangladesh resulting in the loss of more than 140,000 lives and disrupting more than 10 million people (and leading to $2 billion in damages). A similar storm resulted in the loss of more than 250,000 lives in November 1970. China, India, Thailand and the Philippines have also seen loss of life in the thousands in recent years.

The increase in hurricane damages over recent decades has almost entirely taken place during an extended period of decreasing hurricane frequencies and intensities. This means that fewer storms are responsible for the increased damages and these storms are, on average, no stronger than those of past years. Rather than the number of and strength of storms being the primary factor responsible for the increase in damages, it is the rapid population growth and development in vulnerable coastal locations.

Conclusion

Society has become more vulnerable to hurricane impacts. The trend of increasing losses during a relatively quiet period of hurricane frequencies should be taken as an important warning. When hurricane frequencies and intensities return to levels observed earlier this century, then losses are sure to increase to record levels unless actions are taken to reduce vulnerability.

Inhabitants along the U.S. Atlantic and Gulf Coasts are fortunate in that hurricane watches and warnings are readily available as are shelters and well-conceived evacuation routes. However, this should not give reason for complacency. Disaster planners have developed a number of scenarios that result in a large loss of life here in the United States. For instance, imagine a situation of gridlock as evacuees seek to flee the Florida Keys on the only available road. Or imagine New Orleans, with much of the city below sea level, suffering the brunt of a powerful storm, resulting in tremendous flooding to that low-lying city. Scenarios such as these require constant attention to saving lives. Because the nature of the hurricane problem is constantly changing as society changes, the hurricane problem can never be said to be solved. TODAY