WHAT IF HURRICANE CHARLEY MADE LANDFALL AT TAMPA BAY? MODELING THE IMPACTS

GRAHAM A. TOBIN, ERIN P. HUGHEY AND RAYMOND MILLER

Hurricane Charley

According to the National Weather Service (NWS), Hurricane Charley will go down in the record books as one of the most damaging hurricanes ever to hit South Florida. After developing as a Tropical Depression on August 9, 2004, the system grew into a powerful category 2 hurricane that pounded western Cuba a few days later. On August 13, Charley intensified into a category 4 hurricane with sustained winds reaching 145 mph (Pasch, Brown, & Blake, 2004). The projected path of Hurricane Charley took the storm along the west coast of Florida with the center of the cone running through the Tampa Bay metropolitan Area. While all areas within the cone are at risk, media attention focused on the 'direct-hit line,' of Tampa Bay (Johnson, 2004; Kaye, 2004; Stein, 2004). However, on August 13th Hurricane Charley veered several degrees to the east from the mid projection line, which put landfall not in Tampa Bay, but farther south in Charlotte Harbor. This presented serious problems for hazard managers since many people had evacuated to perceived safe areas inland.

The situation was further complicated because about twelve hours before landfall, the hurricane intensified from a category 2 at 1000 EDT to a category 4 only three hours later

Graham A. Tobin is professor of geography at the University of South Florida; Erin Hughey is Assistant at the Global Center for Disaster Management and Humanitarian Action; Ray Miller is a graduate student in geography at the University of South Florida.

(Gray & Klotzbach, 2004). The internal pressure fell 24 mb to 941 mb during this period (Pasch, Brown, & Blake, 2004), the eye shrank to 10 miles, and forward movement was estimated to be 23 mph (Thompson, 2004). Charley eventually made landfall at 1545 EDT near Cayo Costa just north of Captiva Island, and the eye passed over Punta Gorda around 1645 EDT. The hurricane then moved across central Florida on a north-northeastward track.

Hurricane Charley left a relatively narrow trail of destruction, about 30 miles wide, as it pushed through the state. It remained a hurricane as it sped north-northeastward, causing damage to virtually everything in its path including agricultural enterprises, residential homes and businesses in communities stretching from Boca Grande to Port Charlotte on the coast, through Arcadia, Lake Wales and the Orlando areas inland, then finally exiting Florida into the Atlantic near Daytona Beach just eight hours after initial landfall.

Although Tampa was spared the brunt of Hurricane Charley, it was more seriously impacted by Hurricanes Frances and Jeanne, while Hurricane Ivan was at one time projected to hit the metropolitan area all in a six week period in 2004. Nevertheless, the Tampa Bay area has not received a direct hit from a hurricane for many years although the probability remains high. Not surprisingly, then, the extensive destruction caused primarily from the strong winds of Hurricane Charley, left many asking "what if" landfall had occurred as once projected in the Tampa Bay metropolitan area. This research, therefore, explores these concerns by modeling the damage that could have been caused in the Tampa Bay area by a hurricane with similar physical characteristics as Hurricane Charley. The work focuses specifically on Hillsborough, Manatee, and Pinellas Counties as if Hurricane Charley had stayed on its initially projected middle path. This was part of a larger project undertaken to determine the aftermath of Hurricane Charley (Tobin et al. 2004).

Table 1. Defined Storm Track

Point	Latitude	Longitude	Max. Sustained Wind Speed (mph@10m)	Central Pressure
0	24.58	-83.43	110	970
1	24.98	-83.43	110	969
2	25.38	-83.43	110	970
3	25.88	-83.33	110	965
4	26.38	-83.03	127	964
5	26.68	-82.93	145	954
6	27.58	-82.73	140	941
7	28.38	-82.33	115	950
8	29.08	-81.93	92	965
9	29.78	-81.63	87	975

Methodology

The HAZUS-MH model was used to estimate socioeconomic impacts from a Hurricane Charley type storm hitting the Tampa Bay metropolitan area. This software, created by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS), is designed to assist in planning, response and recovery from hurricanes, flooding, and earthquakes. The hurricane model is particularly useful in Florida because the user can employ probabilistic, historic and user-defined scenarios to estimate economic losses including building damages, loss of structures and even anticipate physical damages such as downed trees. Furthermore, the data permit analyses to be made at state, county, and census tract levels with an accuracy of a factor of two or more (FEMA, 2003). Human displacement and potential short-term shelter needs can also be estimated by the number of households damaged. Thus, a storm with the same physical parameters as Hurricane Charley was tracked through Tampa Bay as shown in Figure 1 and Table 1. The physical parameters of the hurricane were obtained from UNiSYS and the National Oceanic and Atmospheric Administration (NOAA, 2004).

To determine potential economic losses and building damages for Hillsborough, Manatee, and Pinellas Counties, demographic data were obtained from the 2000 census and building

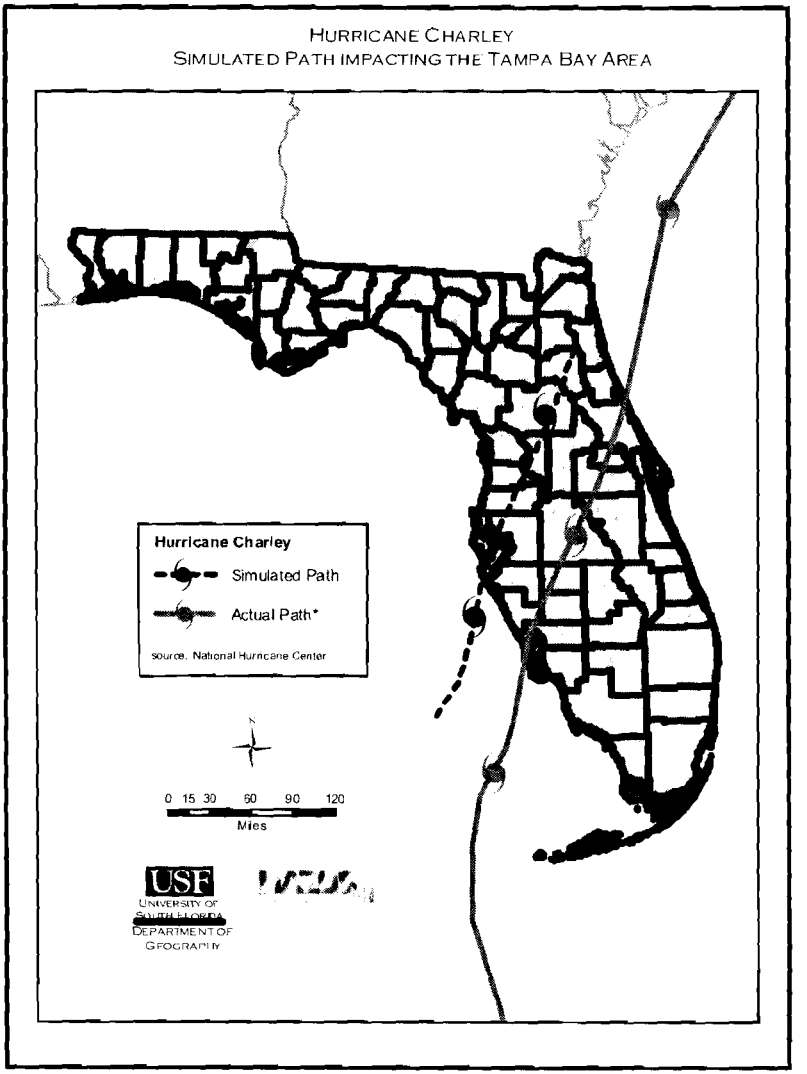
HURRICANE CHARLEY
SIMULATED PATH IMPACTING THE TAMPA BAY AREA
Hurricane Charley
Simulated Path
Actual Path*
source: National Hurricane Center
0 15 30 60 90 120
Miles
USF
UNIVERSITY OF
SOUTH FLORIDA
DEPARTMENT OF
GEOGRAPHY

Figure 1.

Table 2. Regional Population and Building Value Data

Florida County	Population	Building Value ($000)		
		Residential	Non-Residential	Total
Hillsborough	998,948	$ 54,466,284	$ 11,761,451	$ 66,227,735
Manatee	264,002	$ 15,750,781	$ 2,377,747	$ 18,128,528
Pinellas	921,482	$ 56,245,286	$ 9,393,852	$ 65,639,138
Total	2,184,432	$ 126,462,351	$ 23,533,050	$ 149,995,401

Table 3. Expected Building Damage by Severity and Occupancy

Occupancy	Moderate Damage	Severe Damage	Destroyed
Agriculture	8	6	2
Commercial	1,392	1,092	49
Education	28	11	0
Government	29	41	0
Industrial	162	159	10
Religion	42	35	2
Residential	94,347	40,934	21,734
Total	96,008	42,278	21,795

data were estimated from FEMA and NIBS. These data showed that there was approximately $150 billion worth of property in the hazard area (Table 2).

Results

If a storm with the magnitude of Hurricane Charley tracked through Tampa Bay there would be extensive losses to buildings and critical facilities throughout Hillsborough, Manatee, and Pinellas Counties. For instance, it is estimated that 160,081 residential buildings would be at least moderately damaged, over 20 percent of the total number of residential buildings in the region, and 21,795 residential buildings completely destroyed (Table 3). Such losses would necessitate a strong push for additional long-term housing accommodation. The HAZUS model also provides an estimate of households that would be expected to be displaced due to the hurricane and the number of displaced people that would require accommodations in temporary public shelters. It is projected that 67,968 households would be displaced due to such a hurricane. Of these, 17,989 people (out of a total population of 2,184,432) would probably seek temporary shelter

Table 4: Expected Damage to Essential/Critical Facilities

Facility Type	Total Number of Facilities	Probability of at Least Moderate Damage > 50%
Emergency Operation Centers	2	1
Fire Stations	38	13
Hospitals	34	17
Police Stations	48	21
Schools	610	191
Total	732	243

in public facilities. Again, this information is critical to local authorities and aids in planning and response activities.

The total economic loss for structures in the Tampa Bay Area is estimated at $19,682,700,000 dollars, which represents 13.12 percent of the total replacement value of the region's buildings. This overall cost does not take into consideration other expenses and economic burdens that would affect the area. Overtime for city and county workers as well as the loss of jobs would all have a significant impact on the ability of the community to respond and recover quickly and effectively from such a disaster. The spatial pattern of building damage, shown in Figure 2, adds another dimension. Substantial losses would have accrued throughout the bay area although some individual census tracts would have experienced losses in excess of $600,000.

Table 4 highlights the damage that could have occurred to essential/critical facilities such as schools, police and fire stations and hospitals. Of particular note is the potential impact of the storm on the number of available hospital beds. According to the data, the Tampa Bay region has about 9,000 hospital beds; on the day of the hurricane, only 2,226 hospital beds, or just 25 percent, would be available for use. After one week 26 percent of the beds would be in service, and after a month 37 percent of the beds would be operational. In other words, hospitals would be so severely damaged that the ability of emergency responders to do their jobs would be compromised. Even after a month, conditions

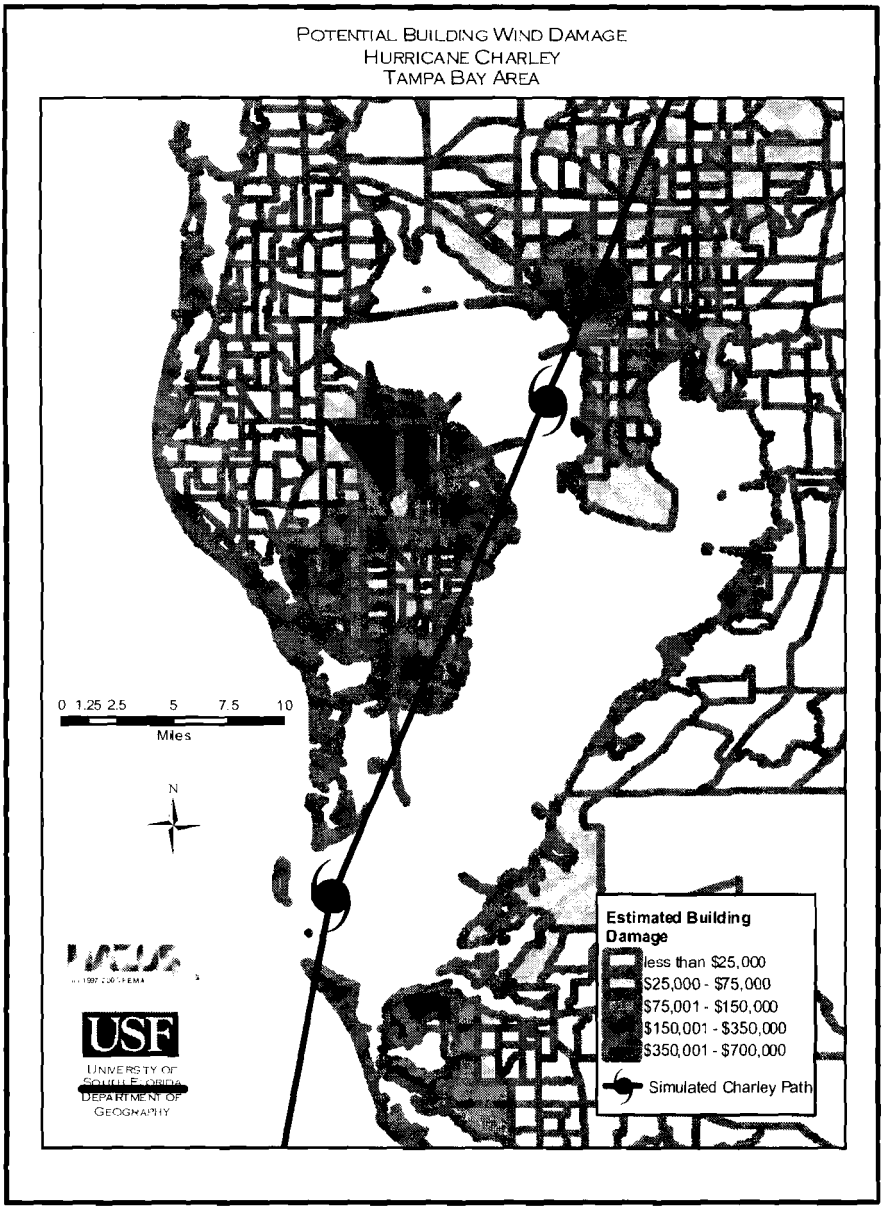
POTENTIAL BUILDING WIND DAMAGE
HURRICANE CHARLEY
TAMPA BAY AREA
0 1.25 2.5 5 7.5 10
Miles
N
USF
UNIVERSITY OF SOUTH FLORIDA
DEPARTMENT OF GEOGRAPHY
Estimated Building Damage
less than $25,000
$25,000 - $75,000
$75,001 - $150,000
$150,001 - $350,000
$350,001 - $700,000
Simulated Charley Path

Figure 2.

would be difficult, a scenario supported by the literature. Recovery efforts, then, following a large disaster are prolonged and can severely incapacitate a community's ability to respond even to routine emergencies.

Conclusion

The above tables and figures provide just a brief look at the potential economic impact that wind damage from Hurricane Charley could have had on the Tampa Bay Area. The outcome of such a storm would have been catastrophic even given the error associated with the model. Response and recovery activities in the Tampa area would have been difficult with such a significant impact to critical facilities. As shown in Table 4, one of the two emergency operations centers as well as 13 fire stations and 21 police stations could have sustained significant damage delaying response.

Preparedness and mitigation activities can make communities safer, however it does not eliminate risk and vulnerability for all hazards. Understanding risks and vulnerabilities are critical for effective disaster management and response and need to be explored further. The social impacts, for example, although much more difficult to quantify would have been significant and differential vulnerabilities would have contributed significantly to the toll (Wisner et al. 2004). The mental and physical stress associated with disasters is also well documented and would make recovery difficult. Thus, this research is designed to raise awareness and encourage individuals and community's to continue to mitigate and prepare hurricane season.

Disclaimer:

The estimates of social and economic impacts contained in this study were produced using HAZUS loss estimation methodology software, which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

REFERENCES

Federal Emergency Management Agency (2003). *HAZUS-MH Hurricane Model User Manual*, p vii. Federal Emergency Management Agency, Washington D.C.

Gray, W. M. and Klotzbach, P. J. (2004). *SummaryOOf 2004 Atlantic Tropical Cyclone Activity And Verification of Author's Seasonal and Monthly Forecasts.* Department of Atmospheric Science, Colorado State University, Fort Collins, CO.

National Oceanic and Atmospheric Administration (2004), *National Hurricane Center, Hurricane Charley Advisory Archive*, http://www.nhc.noaa.gov/archive/2004/CHARLEY.shtml?

Pasch, R. J., Brown, D. P., and Blake, E. S.(2004). *Tropical Cyclone Report: Hurricane Charley.* http://www.nhc.noaa.gov/2004charley.shtml?

Thompson, J. (2004). Shrinking Core Reduced Storm Surge. *St. Petersburg Times,* 121 (24) p 4a.

Tobin, G.A., Hughey, E.P., Bell, H., Everist, M., Kelsey, C. and Miller, R. (2004) *Hurricane Charley: The Aftermath.* Technical Report. Department of Geography, University of South Florida, Tampa, Florida pp.

Wisner, B. Blaikie, P., Cannon, T. and Davis, I. 2004. *At Risk: Natural Hazards, People's Vulnerability and Disasters.* Routledge, London. 2nd Edition.