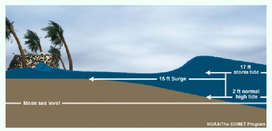
Cataloging all Available Storm Surge Measurements for the State of North Carolina: The National Storm Surge Database

YOUNG, Robert S. and MCDOWELL, Katie L., Program for the Study of Developed Shorelines, Western Carolina University, Cullowhee, NC 28723, kmcdowell@wcu.edu

Introduction

During a hurricane, storm surge is often the greatest factor contributing to loss of life and property along the coast. Therefore, predicting the height of storm surge for an approaching storm is vital for coastal communities.

Predicting a value for storm surge has proven to be extremely difficult, due to the numerous factors that can contribute to the overall rise in water level. One setback for these prediction is the lack of one central location to access past storm surge measurements. Over the years, storm surge data have been collected in a variety of ways by numerous different organizations. Prior to this project, most water level data has been stored within storm specific reports and documents.



What is Storm Surge?

Storm Surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides; storm surge is produced by water being pushed toward the shore by the force of the winds moving cyclonically around the storm.

-NOAA National Hurricane Center

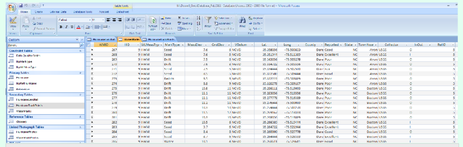
Project Description

The Program for the Study of Developed Shorelines (PSDS) at Western Carolina University (WCU) is using relational tools and geographic information systems (GIS) to build a national storm surge database beginning with a North Carolina prototype. This project will provide one central location for coastal scientists and engineers to access storm surge and high water mark data (HWM).

This queriable database is being built in Microsoft Access and ArcGIS at WCU, but will ultimately be maintained and archived at NOAA's National Climatic Data Center (NCDC). Storm surge data are being obtained from multiple sources including federal agencies, state agencies, academic studies, and the private sector.

Database Fields

Numerous different types of measurements are part of the database, including hurricane tracks, characteristics, and water level data.



Above: Example from the Microsoft Access database, showing several of the water mark characteristics.

Much of the hurricane track and characteristic data was imported directly from NOAA's IBTrACS (International Best Track Archive for Climate Stewardship) Database. Several of the characteristics were calculated internally using existing data in combination with ArcGIS data.

Hurricane Landfall Characteristics:

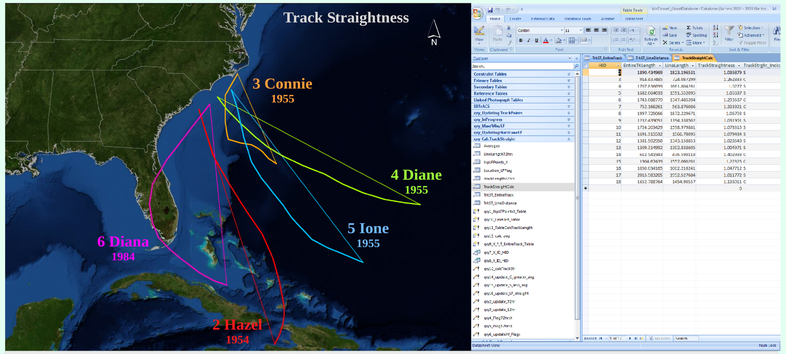
- State/City
- Time
- Winds
- Pressure
- Diameter
- Track Speed
- Storm Impact Angle
- Track Straightness
- Nearshore Slope

Imported directly from IBTrACS database

Calculated by PSDS using data from IBTrACS and ArcGIS

Water Level Characteristics

- Measurement Type (storm surge, HWM, storm tide)
- Elevation of water level
- Latitude/Longitude
- Collector
- County/State
- Vertical Datum
- Reported Quality
- Reference



Above: Track straightness calculation performed internally at PSDS using data from IBTrACS. Track straightness was determined for the 72 hours prior to landfall using hurricane track points in ArcGIS and Access.

Database Fun Facts

Top ten HWM measurements:

Hazel (1954)	Brunswick	18
Hazel (1954)	Brunswick	17.6
Hazel (1954)	Brunswick	16
Hazel (1954)	Brunswick	16
Isabel (2003)	Dare	16.2
Fran (1996)	New Hanover	15.4
Fran (1996)	New Hanover	15.3
Fran (1996)	New Hanover	15.2
Fran (1996)	New Hanover	15.1
Ione (1955)	Craven	15.1

**Hurricane Name (year)*, County, Mark Elevation (ft)

Hurricane with the straightest track (72 hrs prior to LF)
Isabel (2003)

Counties most frequently hit by high storm surge (> 8ft)
Carteret : 6/16 hurricanes
New Hanover : 5/16 hurricanes

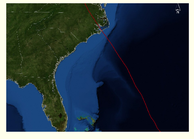
Hurricanes with fastest/slowest approach speed (12 hrs prior to LF)
Hazel (1954) : 49 km/hr
Diana (1984) : 8 km/hr

Highest wind speed
Donna (1960) : 140 knots or 160 mph
Isabel (2003) : 145 knots or 167 mph
*10-min sustained gusts

Lowest pressure:
Gloria (1985) : 920 mb
Isabel (2003) : 915 mb

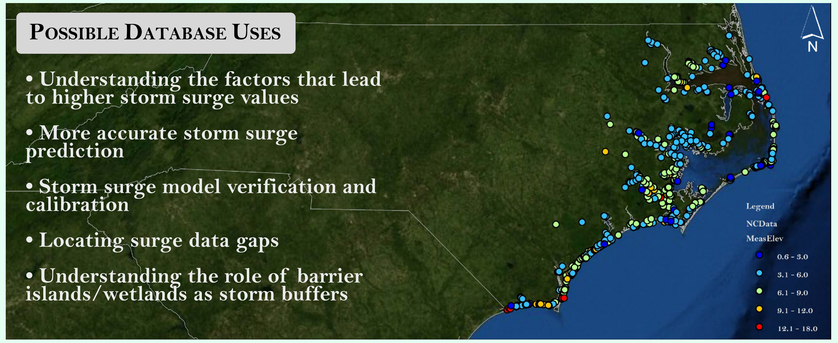
Largest diameter
Isabel (2003) : 400 nmile
*since 2000

Above: Storm surge during Isabel washed out a portion of Hatteras Island just north of Hatteras Village.
Below: Hurricane Isabel (2003) storm track. Notice how straight it approached shore.

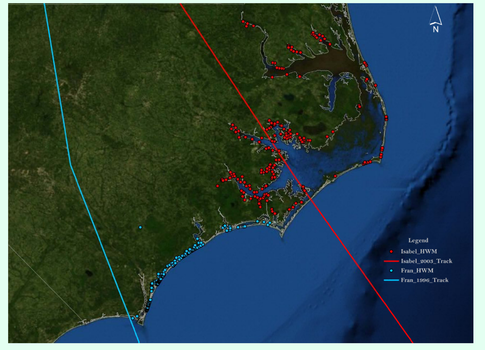


Possible Database Uses

- Understanding the factors that lead to higher storm surge values
- More accurate storm surge prediction
- Storm surge model verification and calibration
- Locating surge data gaps
- Understanding the role of barrier islands/wetlands as storm buffers



ArcGIS Images: Examples of output from the Storm Surge Database.
Above: All of the water mark data points for the North Carolina storm surge prototype. Many of the almost 1400 marks overlap at this scale.
Right: Example query for all of the water marks near Wrightsville Beach. The database web page will include the ability to view all water mark measurements near a location chosen by the user.
Bottom Right: Example query for the storm tracks and water mark measurements for two hurricanes, Isabel (2003) and Fran (1996). The user will be able to hover over a particular point to view the metadata, including water mark elevation.



Current & Future Work

We are currently working on fully completing the North Carolina prototype, including the formation of a user-friendly web page for searching and viewing the database. This will include the ability to filter by many of the storm and high water mark characteristics and to view the results within Google Maps.

We hope to eventually expand the database to include all of the states containing storm surge data.

Acknowledgments

Tanya Holtz
Adam Griffith
David Levinson