U.S. Geological Survey Open-File Report 96-674

PRELIMINARY MAPPING OF OVERWASH FROM HURRICANE FRAN, SEPTEMBER 5, 1996 CAPE FEAR TO BOGUE INLET, NORTH CAROLINA

U.S. DEPARTMENT OF THE INTERIOR U.S. GEOLOGICAL SURVEY

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Summary

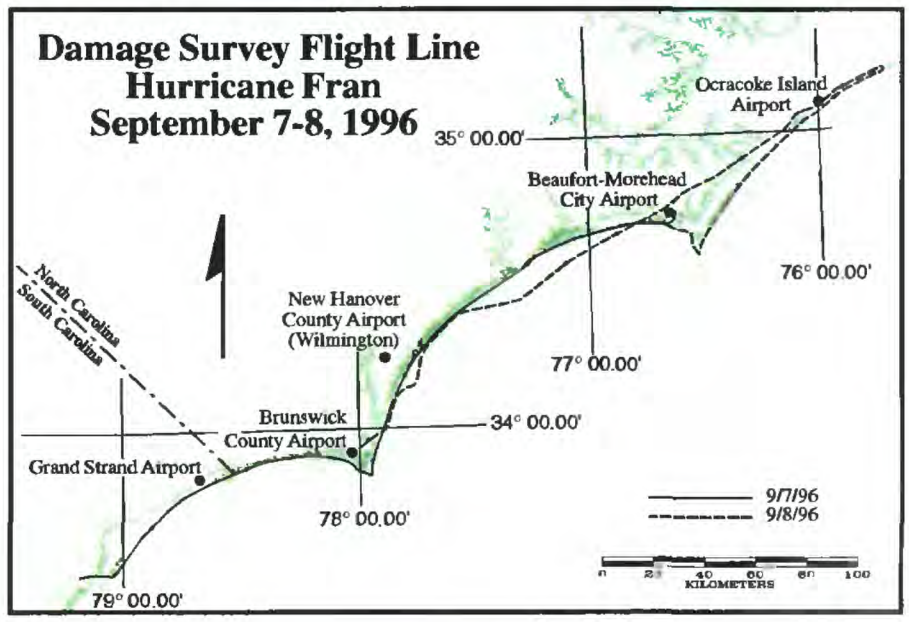
On September 5, 1996, Hurricane Fran, a category 3 hurricane, made landfall on the North Carolina coast at Cape Fear. Two days later, the U.S. Geological Survey flew an aerial survey of the coast north of landfall to document coastal erosion caused by this storm. The survey included oblique video, 35 mm photography, and global positioning system (GPS) locations. A previous survey conducted in July after Hurricane Bertha (a category 2 storm) provides a reference for the impact of Fran. The video was interpreted to estimate the occurance of dune overwash resulting from the storm for a 100-km section of the coast. Example pairs of before and after photography show the erosion impact at five specific locations.

Introduction

The U.S. Geological Survey has begun investigations on the effects of major hurricanes on the US coastline. The current research is intended to determine the erosion potential of major hurricanes. For this, we are using low altitude video and photography to document the erosion and storm impacts along the coast.

On September 5, 1996 at 9:00 PM EDT, Hurricane Fran made landfall near Cape Fear, North Carolina. Fran had maximum sustained winds at landfall of 115 mph (185 km/h) and a minimum central pressure of 854 mb. Fran was only the second major (category 3 or greater) hurricane to strike North Carolina in the last 30 years. Initial reports indicated substantial damage to coastal communities due to flooding, waves, and erosion.

On September 7-8, we conducted a post-storm aerial survey of the coast extending over 300 km starting at the South Carolina line. Pre-storm information was provided by a survey conducted in July following the landfall of Hurricane Bertha, a category 2 storm, just north of Cape Fear. The two surveys permit us to evaluate the impact of Fran and ultimately provide some comparison of the relative effects of the two storms.



Methods

The surveys were made flying in a Dehavilland DHC-6 Twin Otter operated by NOAA Aircraft Operations Center at MacDill AFB, Tampa, at a nominal speed of 100 knots (193 km/h) at an altitude of 500 feet (150 m). Video was collected using a VHS type camera. GPS latitude, longitude, heading, date and time are recorded on the video and on a personal computer. Still photography used 35 mm transparency film with time stamp from an SLR camera. Selected photographs were scanned to Kodak PhotoCD™ format for display and future analysis.

To provide an initial assessment of the erosion caused by the storm, we mapped the extent of dune overwash along the coast. At points spaced approximately 50m apart, a determination of overwash verses no overwash was made. The percentage of overwash was calculated for 500m sections of the coast and tabulated to produce Plate 1. We have mapped the 100 km from Cape Fear to Bogue Inlet, as this was the area of greatest impact.

Conclusions

Aerial video surveys permit an immediate assessment of the degree of dune overwash resulting from this storm. Pre- and post-storm photography provide examples of the extent of overwash occurring in both developed and undeveloped areas. Extensive overwash was observed after Hurricane Fran between Cape Fear and Bogue Inlet. The overwash patterns were related to many complex factors including dune geomorphology, wave intensity, storm surge, and offshore bathemetry. Further interpretations will be expanded to cover the rest of the North Carolina coast and provide an in-depth analysis between the aerial photography and other ground based data sets.

BEFORE AFTER

West Onslow Beach Overwash 34° 30.70'N 77° 22.16'W

Bertha 7/16/96 10:34 EDT

Fran 9/07/96 14:38 EDT

Areas overwashed by Bertha were more susceptible to erosion and overwash by Fran. At West Onslow Beach, overwash fans are observed after both storms but are more extensive after Fran. Overwash that initially carried sand into the finger channels behind the first row of houses during Bertha completely filled the channels during Fran. Initially susceptible to erosion during a category 2 hurricane, the area affected by the category 3 storm was greatly expanded. Standing water appears in many areas after Fran.

BEFORE AFTER

Undeveloped beach of Smith Island 33° 53.43'N 77° 57.08'W

Bertha 7/16/96 10:07 EDT

Fran 9/07/96 14:10 EDT

Photographs of an undeveloped coastline illustrate the contrast between Bertha, a category 2 hurricane and Fran, a category 3 hurricane. Some erosion as shown by the dune scarp and minor overwash occurred during Bertha; Fran caused major overwash fan deposits that extended into the back marsh. Finger-like projections visible as small overwash fans after Bertha were greatly extended after Fran. The large difference between these deposits show the value of surveying the undeveloped coastline for understanding geologic processes.

BEFORE AFTER

Topsail Beach Overwash 34° 24.05'N 77° 34.80'W

Bertha 7/16/96 10:27 EDT

Fran 9/07/96 14:31 EDT

The duneline, which was eroded but remained intact during Bertha, was destroyed and overwashed during Fran. Erosion has undercut many houses causing severe damage or total destruction. The force of the waves overwashing the dunes moved one house off its foundation and into the sand covered road behind its former location (red arrows). The storm surge deposited sand within vegetated areas, but the geometry of the overwash is obscured by the canopy. The dark sand on the beach is formed by heavy minerals that are typically concentrated on the beach during erosion. A thin band appears after Bertha with a wide deposit as a result of Fran.

BEFORE AFTER

Topsail Beach Dune Erosion 34° 22.79'N 77° 36.47'W

Bertha 7/16/96 10:26 EDT

Fran 9/07/96 14:30 EDT

The dune line in front of the apartments seems intact with minor erosion at the base after the passage of Bertha. After Fran, the dune was eroded to the first line of houses, leaving a new scalloped scarp line. In a few places the dune was breached.

BEFORE AFTER

Topsail Beach Pier 34° 21.87'N 77° 37.59'W

Bertha 7/16/96 10:25 EDT **Fran 9/07/96 14:29 EDT**

Many piers damaged during Bertha were destroyed during Fran. The pier at Topsail Beach sustained only minor damage after Bertha and was open a few days after the storm. Storm waves from Fran removed the section of the pier closest to the beach. The dune line which held during Bertha (to the left of the pier) was completely removed and the retaining wall behind it destroyed, leaving debris scattered in front of the buildings (light arrows). Further to the right a low dune line is replaced by an erosional scarp (dark arrows). Sand extends to third row of houses and appears to come from the left.

Acknowledgments

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards.

Additional copies of this report and other information are available from:
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http://stimpy.er.usgs.gov/

U.S. Geological Survey

For additional information on Flooding from Hurricane Fran see
USGS Open File Report 96-499,
Aftermath of Hurricane Fran in North Carolina -
Preliminary Data on Flooding and Water Quality

North

Bogue Inlet

West Onslow Beach

West Onslow Beach

Topsail Beach

Topsail Beach, Overwash

Topsail Beach, Dune Erosion

Topsail Beach, Pier

Wrightsville Beach

Wilmington

Path of Eye of Hurricane Fran

Smith Island, Undeveloped Beach

Cape Fear

Preliminary Mapping of Overwash Hurricane Fran, September 5, 1996 Cape Fear to Bogue Inlet, North Carolina

Percentage overwash in 1/2 kilometer increments along the coast.

77° 00.00′

34° 00.00′

1 5 10 15
Kilometers

Open File Report #96-674
Plate #1
Center for Coastal Geology
St. Petersburg, FL