

Exploring Storm Surge

by

A. B. Tihansky and A. D. Duerr

U.S. Geological Survey

Open-File Report 95-295

1995

VIDEO TRANSCRIPT

“Exploring Storm Surge...” AUDIO	“Exploring Storm Surge...” VIDEO
<p>all text accompanying each image will be narration an example of the format of the audio track used in this transcript is shown below: This image depicts a satellite image of Hurricane Andrew as it made landfall on August 24, 1992</p>	<p>Source and times will be shown for each image an example of the format of the audio track used in this transcript is shown below: IMAGE SOURCE: NOAA slide #14 TIME: 7sec</p> <p>NOTE: Images described below were selected during planning stages. Actual images that are in the final video may be different.</p>
<p><i>Opening title etc.</i> I think we left about 2 minutes lead in time here.</p>	<p>IMAGE SOURCE: Logo Tape 9. Tape3 fast moving water 38:45-38:55--long segment Tape 3 tiki hut 1948-19:58 Tape 3-- 49:03-49:31 surging action</p>
<p>PART 1 NARRATION TIME: 9 sec Storm surge is one of the most dangerous elements of a hurricane when it reaches the coast. Nine out of ten fatalities are caused by storm surge.</p> <p>2 sec pause</p>	<p>IMAGE SOURCE: Overall the images need to imply the power, danger and devastation of storm surge. surging footage with title text over it.</p> <p>Dramatic images of high water, damage, images of moving water in areas that area normally dry.</p> <p>Tape 3-- 19:18-19:22 Tape 3-- 19:58-20:00 Tape 3-- 38:47-38:57</p>

NARRATION TIME: 20 sec

In 1928, more than 2000 people were killed in the Lake Okeechobee region as the area was inundated by 5 to 10 feet of storm surge. The failure of dikes that normally protected this low lying area resulted from the combined effects of wind tides and wave action that accompanied the storm surge.

2 sec pause

PART 1 continued

NARRATION TIME: 15 sec

During Labor Day weekend, September 1935, another devastating hurricane swept across the Florida Keys killing more than 400 people. This hurricane, now referred to as the Great Labor Day Hurricane was accompanied by a storm surge of over 20 feet.

2 sec pause

NARRATION TIME: 15 sec

The following is a first hand account of the dramatic storm surge. It was documented by E.C. Duane, a cooperative weather observer for the U.S. Weather Bureau, who was lucky to have survived. Mr. Duane recounts his experience of the passage of this powerful storm.

AUDIO: background sound track original audio?? water, wind, storm noises. CH-10 and 98ROCK (WXTB)

Tape 9--Hampton Dunn photos

Give it that dated look as we are talking about historical stuff.

More historical photos or video in Black and white.

Tape 9-- Hampton Duhnn photos mixed with video

surging footage (B&W)

FADE TO BLACK

IMAGE SOURCE: USGS old person in rocking chair on porch. Recounting experience of long ago. Ed and Penny's rocking chair and porch??

Tape 9-- towards the end.E.C. Duane on porch, rocking, open door, move in close. see him reviewing the record.Mix in dated images and

<p>3-4 sec pause</p>	<p>surging images.</p> <p>Tape 11--end of consolidated NOAA (Palms) FADE to black, wind imagery</p>
<p>PART 2 NARRATION TIME: <i>subsection 1 TIME: 26 sec</i> “We are now in the eye of the hurricane. The barometer is reading 27.22 inches, and the wind has lessened significantly. We can now hear noises other than the wind and we know the center of the storm is over us. We are heading for the last and only cottage that I think can withstand the storm. Twenty of us reach this cottage and are patiently waiting for what is to come. During this lull the sky is clear and we can see the stars. A very light breeze continues during the lull in the storm. 1 sec pause</p> <p>PART 2 continued <i>subsection 2 TIME: 10 sec</i> I take this opportunity to get outside and look around. It’s been about 20 minutes since the start of the lull. I don’t know it at the time but the eye has passed halfway at this point. 1 sec pause</p> <p>6 sec In the middle of the eye, the sea begins to lift up, it seems, and it rises very fast from the ocean side of camp.</p>	<p>IMAGE SOURCE: Tape 9-- E.C. Duane taking notes.</p> <p>Tape 9--Packs the notebook into suitcase, images of wind and destruction, back to E.C. entering the house in the dark.</p> <p>images of stormy weather (B&W) mixed in with stills?</p> <p>IMAGE SOURCE: Tape 11-- end of consolidated NOAA Blowing Palms.</p> <p>Dark, blowing trees in the dark (CH-10) had some dark footage on their best of tape. blowing trees, wind water sounds. Nothing specific as an image, let the viewers use their own imaginations</p>

14 sec

The light from my flashlight illuminates towering walls of water approaching the cottage. The cottage is about 60 feet away so I try to beat the advancing water to reach the entrance, but the water catches me waist deep. The cottage is lifted from its foundations and it is floating.

2 sec pause

subsection 3 TIME: 20 sec

The barometer has now dropped to 27.02 inches; the wind is beginning to blow. The first blast of wind is from the south-southwest.

It's full force.

The house is now breaking up and the wind seems stronger than ever. The barometer reads even lower at 26.98 inches. I drop the barometer and am blown out into the sea.

1.5 sec pause

PART 2 continued

subsection 4 TIME: 8 sec

Tape 3 Water flooding shelter half-screen

Tape 13--NOAA Louisiana slide of house, removed from foundation, steps standing alone.

IMAGE SOURCE: More dark water and winds
Background audio needs to be more winds, waves sounds, sloshing water etc. (B&W)

Tape 3-- 39:30-39:31 v. stormy weather

Tape 3-- 41:18-41:22 horiz. rain

Tape 3-- 42:00-42:04

Tape 3-- 42:06-42:10 wind at camera

Tape 3-- 41:55 horiz. rain

Tape 9-- E.C. Duane notation with flashlight limits what we can see,

Tape 3-- 36:58-37:00 Dark, palm blowing hard

Tape 3-- 41:18-41:22 to 41:25

Tape 3--background noise of sloshing water, dripping, howling winds, banging noises, the major part of the storm. Dramatic imagery of waves and wind

I become hung up in the fronds of a coconut tree and I hang on for dear life. It's 10:15 PM. Then something strikes me on the head and I go unconscious.

4 sec pause

13 sec

After what seems like minutes, I glance at my watch. It's 2:25 am. I can hardly believe 4 and a half hours have passed. As I regain consciousness, I find that I am lodged about 20 feet above the ground in a coconut tree."

2-3 sec pause

Everything goes black and silent for a second. resume video and audio much lower winds and noise levels.

FADE OUT

Tape 3-- 34:10-34:15 pan out to tall lone plam tree.

FADE OUT

PART 3

NARRATION TIME: 11 sec

The dramatic storm surge which E.C. Duane described is the result of a rise in sea level as the storm drives water onto land.

The tide range is shown here under normal tidal conditions.

1 sec pause

21 sec

When storm surge conditions exist, coastal regions experience the combined effects of tide and storm surge., as shown in this image.

The storm surge is a measure of the level of water above normal high tide.

Storm tide is the measure of total increased water levels resulting from both the

normal tide level

and the additional water level from the storm

IMAGE SOURCE: Continue the slow fade as transitional text is read. Fade into Figure 1.

AB ROLL to Figure 2.

AB ROLL for Figures 3
Figure 4

Figure 5

Figure 6

Figure 7

<p>surge. 2 sec pause</p>	<p>Figure 8</p>
<p>PART 4 NARRATION TIME: 21 sec</p> <p>A number of factors control the height of the storm tide and surge.</p> <p>The two most dominant forces responsible for creating storm surge are: the direction and strength of the winds or wind stress, and the depth of the water offshore.</p> <p>The wind stress, which is a maximum in the hurricane's eye wall, pushes the water forward with the storm.</p> <p>14 sec</p> <p>In areas where the continental shelf is narrow, shown here, deep water is close to shore. The waves associated with storm surges in these regions are large but the overall surge levels are low since the water is unable to move inland.</p> <p>10 sec</p> <p>In contrast, coastal regions with a wide continental shelf experience shorter wave heights but greater storm surge levels that can inundate</p>	<p>TEXT GENERATOR IMAGE SOURCE: Bullet #1.</p> <p>BACKGROUND: water surging images</p> <p>DOMINANT FORCES:</p> <ul style="list-style-type: none"> - Direction and Strength of the wind - Depth of water offshore <p>Tape 3 -- graphics into eye of hurricane Tape 11 -- clouds and eyewall Tape 13 -- clouds from slides</p> <p>Tape 3 -- surging at gate & tiki hut.</p> <p>IMAGE SOURCE: USGS COREL graphics Figure 9</p> <p>Figure 10</p>

low-lying coastal areas.

1 sec pause

47 sec

Offshore water depth and wind stress affect storm surge levels most significantly, but other factors also may contribute to storm surge development. These are: the shape of the coastline, the forward speed of the storm, the height or stage of the normal tide and the air pressure within the storm.

While the low pressure associated with a hurricane causes the water below it to dome upwards in a mound, the height of the mound created by even the lowest pressures, usually does not exceed 3 feet above actual sea level. The wind stress pushing the water creates the storm surge that leads to inundation and flooding. If the hurricane is fast moving, the flooding may occur suddenly. If the hurricane is moving slowly, the water may move far inland impacting areas that seldom experience flooding.

1 sec pause

17 sec

All these factors together can cause a dramatic increase in sea level. The highest storm surge is created when a fast moving, powerful hurricane with very low pressure reaches shore at high tide along a coastal region with a broad continental shelf and drives water directly up a bay or estuary.

1.5 sec pause

Ch-10 TEXT GENERATED bullet #2
overlay on surge images

LESS DOMINANT FORCES

- 1-shape of the coastline
- 2-forward speed of the storm
- 3-height or stage of normal tide
- 4-air pressure within the storm

IMAGE SOURCE:

Tape 11-- NOAA's Black and white image of the hurricane forming off Africa and scooting across the Caribbean and up the Eastern Seaboard and final North Atlantic dissipation

Surge images:

Images of live surging from all possible sources. Swift moving water, waves inundation, as maximum intensity as we can find.. Coming towards camera.

Tape 3--

Coastal flooding, 3 edited sequences. coastal aerial and ground footage.CH-10

<p>PART 5 NARRATION TIME: 41 sec The Labor Day hurricane of 1935 is still regarded as one of the most violent storms to hit North America in this century. The eye was small (about 10 miles in diameter), and as it passed over the Florida Keys, the air pressure associated with the eye dropped significantly.</p> <p>Continuous record of barometric pressure from the Alligator Reef lighthouse shows the passing of the eye between 6 and 10 PM with a minimum pressure at this site of 27.30 inches.</p> <p>However, lower pressures shown here in red, were measured at Long Key, where E.C. Duane made his observations</p> <p>and at Craig, Florida, where the air pressure was 26.35 inches.</p> <p>34 sec To put this in perspective, this chart shows the minimum barometric pressures for selected hurricanes affecting the United States. Although Hurricane Gilbert broke the record for the lowest barometric pressure in the western hemisphere in 1988,</p> <p>the Labor Day hurricane still holds the record for the lowest barometric pressure for the United States.</p> <p>Storm surge levels for the same set of historical hurricanes are shown here.</p>	<p>IMAGE SOURCE: Stills from Hampton Dunn collection mixed with active very storm weather,</p> <p>Schematics AB-roll: Tape 12 --- Figure 11</p> <p>Tape 12- Figure 12</p> <p>Tape 12-- Figure 13</p> <p>Tape 12-- Figure 14</p> <p>Tape 12-- Figure 15</p> <p>Tape 12-- Figure 16</p>

<p>The surge that accompanied the 1935 hurricane was at least 20 feet . This height was documented by E.C. Duane's experience and verified using wave wash marks on trees.</p>	<p>Tape 12-- Figure 17</p>
<p>PART 6 NARRATION TIME: 11 sec High water marks can be comprised of floating debris, stains, or wave wash marks on trees and structures as high water recedes. Even E.C. Duane himself represents a human high-water mark.</p>	<p>IMAGE SOURCE: Tape 5 -- debris lines, Tape 3 -- CH-10- debris lines, Tape 13 --HWM slides</p> <p>USGS footage from Andrew, slides and video. Add arrows indicating where the lines are. Maybe text overlay indicating characteristics of each mark.</p>
<p>PART 7 NARRATION TIME: 27 sec</p> <p>These marks are measurable evidence of the maximum water levels attained during flooding. These high water marks are extremely useful in describing the maximum height of the storm surge.</p> <p>Immediately after the storm, reconnaissance crews identify areas that experienced high water and place physical markers at any high water locations that were visited.</p> <p>Before these markers are removed or destroyed, the height of each mark is accurately surveyed to relate the flood levels to elevation above sea level.</p>	<p>IMAGE SOURCE:</p> <p>Tape 13 HWM images (USGS footage)</p> <p>Tape 13 slides of surveying ,</p> <p>Tape 13 Debris lines with physical markers in place.</p> <p>Tape 13--JAR at transit.</p>
<p>PART 8 NARRATION TIME: 20 sec The accuracy of the water level elevation depends on how well defined and distinct the mark is. Waves and wind often distort the debris lines. The</p>	<p>IMAGE SOURCE: Tape 5-- Inside house going down the hall turn into bathroom. Tape 13 slide of bathroom john HWM</p>

<p>best high water marks are “inside marks” generally found in small rooms of buildings such as bathrooms and closets where the effects of winds and waves are minimized.</p>	<p>High water effects, damages and more, or the same, images of high water marks. Add labels and arrows to video/slide images. Indicating what makes each mark good, bad etc.. Slide of bathroom with high water marks.</p>
<p>PART 9 NARRATION TIME: 32 sec</p> <p>On August 24, 1992, Hurricane Andrew made landfall in the coastal region just south of the Miami area. It was a small but powerful storm classified as a class 4 hurricane with sustained wind speeds of 131-155 miles per hour.</p> <p>Highest wind velocities occur in the hurricane’s eye wall. The eyewall of Hurricane Andrew is shown here. Darkest colors correspond to highest velocities.</p> <p>Winds at these velocities are capable of major destruction.</p>	<p>IMAGE SOURCE: Tape 13 , stills #8 or #12 NOAA radar images of landfall slides 2,5,4,6,7,?? series of radar images hitting the SE Florida coast Tape 3 00:25-00:29 short Animated CH-10 version.</p> <p>Tape 13-- 16:11-16:51 Cloud shots of eyewall and (NOAA slide Andrew set #9) to accompany verbage about the eyewall.</p> <p>USGS images of most dramatic wind damage plywood through trees, pine trees bent over, PBoetcher slide tree farm blown down, Major destruction of trailer parks etc.. CH-10 Tape 3.</p>
<p>PART 10 NARRATION TIME: 28 sec</p> <p>Immediately after Hurricane Andrew swept through southern Florida, the U.S. Geological Survey, in cooperation with the Federal Emergency Management Agency, also known as FEMA, began an intensive project of assessing the effects of the storm. U.S. Geological Survey personnel from the Water Resources Division offices in South Carolina and Florida located and measured</p>	<p>wreckage, aftermath footage,(CH-10 video images) USGS slides and video footage of trucks and surveying crews.</p>
<p>PART 11 (ADD TO PART 10) NARRATION TIME:</p>	<p>IMAGE SOURCE: Tape 13 --- Basemap from NOAA slide set.</p>

<p>more than 336 high water marks left from the storm surge throughout the south Florida area.</p>	
<p>PART 12 NARRATION TIME: 10 sec Pause in narration for high water level mark imagery MUSIC.....</p>	<p>IMAGE SOURCE: More images of debris lines high water evidence?</p>
<p>PART 13 NARRATION TIME: 31 sec</p> <p>The storm surge research group at the National Hurricane Center, created this image using the high water level data collected by the U.S. Geological Survey. This shows the maximum flooding levels in the south Florida area resulting from the storm surge that accompanied Hurricane Andrew in August 1992. The contours are in feet above sea level. The triangles and symbols show the locations where the high water marks were measured. The areas of maximum elevation occurred in the area indicated by the arrow.</p>	<p>Stranded boats, Things are up high and dry, Big ship on Ft. Desoto beach, NOAA boat shoved across the wetland area with track carved into seagrass , Marina shots in Miami.</p> <p>IMAGE SOURCE: Tape 13-- Slide number 11 from NOAA's slide set. Use close up with large type. Contours of max. storm tide elevation.</p> <p>USGS trucks?</p> <p>CH-10 TEXT GENERATOR ARROWS Add arrow to video image showing area and value of max. storm surge elevation.</p>
<p>PART 14 NARRATION TIME: 27 sec</p> <p>Each storm surge is unique. From the U.S. Geological Survey's data collection effort, an image of Hurricane Andrew's storm surge component was created. By placing the water level data on a map, a picture of the maximum storm surge elevation was made. In Andrew's case, the storm tide (both normal tide and storm surge), peaked at about 17 feet above sea-level, approximately 13 miles south of Miami.</p> <p>1.5 sec pause</p>	<p>IMAGE SOURCE: More aftermath storm surge destruction imagery.</p>

<p>PART 15 NARRATION TIME: 11 sec Because storm surge is so dangerous, it is important to understand how it behaves so that we can predict where and when maximum flooding will occur when a hurricane is approaching a populated coastal area.</p>	<p>IMAGE SOURCE: Use the NOAA image slide # 12 and 13 of Sewell Park before and after with palm trees above water and submerged also Mitch #46. Tape 3, pier with spectators during big wave and subsequent damage.</p>
<p>PART 16 NARRATION TIME: 17 sec</p> <p>Storm surges have been studied and mapped for the last 50 years. This long-term data provides researchers with background information that can be used to evaluate future storm surge effects. According to Brian Jarvinen of the National Hurricane's Storm Surge research Group,</p> <p>NARRATION TIME: ___ minutes, ___ sec " This storm surge data serves an important function. It provides information that can be used to construct mathematical models of storm surge. These models are used to recreate storm surge in real time settings.</p> <p>An example of such a model is shown here simulating wind and storm surge conditions during Hurricane Andrew.</p> <p>A hypothetical wind field is shown on the right. As wind speeds increase the arrows become larger.</p> <p>On the left is a hypothetical image of the storm surge associated with Hurricane Andrew. The warmer colors; yellow, orange, and red, represent</p>	<p>IMAGE SOURCE: Trape 11 NOAA plane in hangar, AOC facility, research footage, Scientists at work. Tape 13 14:12 Mitch slide of NHC's (central command)</p> <p>Mike DelCharco narration</p> <p>Tape 11 -- research footage in planes</p> <p>Tape 3-- 17:59-18:08 graphic loop</p> <p>Tape 11--- 39:22-39:49 Animated model that Brian sent.(Tape #3-- 17:59-18:08VIDEO)</p>

<p>higher levels of surge.</p> <p>The maximum storm surge elevation occurs at different times throughout the area of inundation. Coastal areas with bays, canals, and inlets constrict the mound of water generated by the storm. Depending on the coastline's morphology, and the direction and strength of the winds, the mound of water that comprises each storm surge may behave differently as the storm passes through the area.</p> <p>Research from hurricanes and storm surges is used to select locations for Hurricane shelters and evacuation routes and to modify construction techniques that will help minimize loss and damage from these powerful storms."</p> <p>TOTAL TIME: 11:51</p>	<p>Evacuation footage, Loss, people rebuilding, digging out, newscaster, planes in the air? pilot silhouettes etc. winds and palm trees??? I remeber people cuuting up a fallen tree, wading through the street with their belongings Rebuilding and damage footage.</p> <p>Tape 3--8:43-8:48 evacuation sign in puddle Tape 3-- 22:05-22:10 sheriff directing traffic Tape 3-- 51:25-51:27 natiohnal she-guard directing traffic Tape 3-- 51:43-51:46 shelter</p> <p>Palms FADE OUT</p>
<p>CREDITS: 2:30 minutes</p>	<p>EXPLORING STORM SURGE U.S. Geological Survey Open-File Report 95-295</p> <p>Tampa, Florida 1995</p> <p>Written and Produced by Ann Tihansky and Dan Duerr</p> <p>Directed and Edited by Allen Arnold</p> <p>Produced through the facilities of WTSP-TV</p>

St. Petersburg, Florida

Production Coordinator:
Becky Akers

with additional help from:
Ellen Lasher

Computer Graphics:
Ann Tihansky
and
Tim Strong, Art Director WTSP-TV

with additional help from:
James Morgan

SOURCE FOOTAGE:
Dick Fletcher WTSP-
TV

U.S. Geological Survey:
Larry Aucoin, Paul
Boetcher, Mitch
Murray

NOAA: Jeff Hagan,
Brian Jarvinen

Historical Photos from the collection of Hampton
Dunn

Voices:
Ann Tihansky: Narrator
Matthew Danahy as E.C. Duane
Michael DelCharco as Brian Jarvinen

With special thanks to:
the expressive improvisations and musical energies of

Lloyd Goldstein-bass

Daphne Soellner-flute

Bobby DeVito-guitar

Gene Shinn-percussion

Mixed and recorded
by
Bill Dudley

Wind soundtrack courtesy of
**WXTB-FM
98ROCK
Tampa, St. Petersburg, Clearwater**

**E.C. Duane Re-enactment taped on location at:
Hall-Ruark Studios
with
Pennywise Props
and
Edwardian Clothiers**

Special Thanks to:

**Jeff Hagan, NOAA
Brian Jarvinen, NOAA
George Kish, USGS
Gene Shinn, USGS
Arturo Torres, USGS
Denise Wiltshire, USGS
Eileen Smith, Great Explorations**