

# **Comprehensive Emergency Management Plan**



**Section 6-Tsunami Annex**

*January 2024*

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# Annex 6 – 4 Tsunami Annex

## I. PURPOSE

The purpose of this Tsunami Annex is to establish specific procedures to be followed in the event of a tsunami incident in Horry County. This plan has been created to help minimize the loss of life and property in Horry County and the Grand Strand area. This hazard-specific plan is subordinate to the Horry County Comprehensive Emergency Management Plan and will be used in conjunction with the EOP.

The National Tsunami Warning Center (NTWC), located at the Palmer Observatory in Palmer, Alaska, monitors for earthquakes and subsequent tsunami events in both the Pacific and Atlantic Oceans. If a tsunami is generated, the NTWC issues tsunami watches and warnings and tsunami information bulletins for both the U.S. West and East Coast areas.

## II. SITUATION AND ASSUMPTIONS

- A. Horry County is at a slight risk for tsunamis. A tsunami is a series of ocean waves started by a sudden displacement of ocean water, usually by an earthquake or a submarine landslide. A tsunami's waves rapidly travel all directions away from the disturbance and can spread across entire ocean basins. They can also be caused by volcanic eruptions, landslides, undersea slumps, or even meteorites.
- B. The best information indicates two possible scenarios for Horry County concerning its tsunami risk. Unfortunately, those two scenarios are a distant source and a local source.
  1. Distant Source: The source of the tsunami is more than 620 miles (1,000 km) away from the Tsunami Warning Center's Area of Responsibility (AOR).
  2. Local/Regional Source: Source of the tsunami is within 620 miles of the AOR. A local or near-field tsunami has a short travel time (30 minutes or less), and mid-field or regional tsunami waves have travel times from 30 minutes to 2 hours.
- C. A tsunami could create fast-moving run-up and dangerous currents in the surf zone, inlets, river entrances, and other vulnerable locations across the coast.
- D. Horry County is located along South Carolina's Grand Strand Resort area, with over 18 million visitors yearly. Therefore, life safety is the highest priority for residents and visitors in the risk area.
- E. Horry County's most significant risk during a tsunami is the immediate coastline. Many visitors populate the beach during all seasons but particularly during the summer months. At any time during those months, there may be over 100,000 people on the beach at any given time. During the off-season or winter months, that number decreases to several thousand people on the beach at any given time.
- F. To avoid the dangerous tsunami waves, residents and visitors who may be located in the risk area along the coastline will need to evacuate. Evacuation needs to be at least 300 feet inland and/or 15 feet vertically before the arrival of tsunami waves.

G. The prompt and effective evacuation of high-risk areas requires the cooperation and coordination of the Horry County and local jurisdiction Public Safety Departments. Horry County Emergency Management Department will assist in coordinating this effort.

H. Warnings, Advisories & Watches

1. **Tsunami Information Statement** – A tsunami information statement is issued when an earthquake or tsunami has occurred of interest to the message recipients. In most cases, information statements are issued to indicate no threat of a destructive basin-wide tsunami and to prevent unnecessary evacuations. Information statements for distant events requiring evaluation may be upgraded to a warning, advisory, or watch based on updated information and analysis.
2. **Tsunami Watch** – A tsunami watch is issued when a tsunami may later impact the watch area. The watch may be upgraded to a warning or advisory or canceled based on updated information and analysis. Emergency management officials and the public should prepare to take action.
3. **Tsunami Advisory** – A tsunami advisory is issued when a tsunami with the potential to generate strong currents or waves dangerous to those in or very near the water is imminent, expected, or occurring. The threat may continue for several hours after initial arrival, but significant inundation is not expected for areas under an advisory. Appropriate actions to be taken by local officials may include closing beaches, evacuating harbors and marinas, and repositioning ships to deep waters when there is time to do so safely. Advisories may be updated, adjusted geographically, upgraded to a warning, or canceled based on updated information and analysis.
4. **Tsunami Warning** – A tsunami warning is issued when a tsunami with the potential to generate widespread inundation is imminent, expected, or occurring. Warnings alert the public that dangerous coastal flooding accompanied by powerful currents is possible and may continue for several hours after initial arrival. In addition, warnings alert emergency management officials to take action for the tsunami hazard zone. Appropriate actions to be taken by local officials may include evacuating low-lying coastal areas and repositioning ships to deep waters when there is time to do so safely. Warnings may be updated, adjusted geographically, downgraded, or canceled based on updated information and analysis.

<b>Product</b>	<b>Likely Wave Action</b>	<b>Recommended Actions</b>
Information Statement	Minor waves at most	No action suggested
Watch	The danger level is not yet known	Stay alert for more info
Advisory	Strong currents likely	Stay away from the shore
Warning	Inundating wave possible	Full evacuation suggested

I. Potential Tsunami Events

The Horry County coastline is subject to different types of Tsunami incidents. The first potential scenario is an earthquake occurring on the Puerto Rican Trench, causing tsunami occurrences up and down the Atlantic Coast. It is the subject of the Tsunami Travel chart shown below. This type of occurrence might give Horry County roughly a 4.5-hour notification that a Tsunami will occur and some time to issue appropriate warnings along the coast.



The other possible scenario is a sub-marine landslide that could occur off the continental slope and could be a much worse scenario for Horry County. The USGS simulated a sub-marine landslide in 2012 with the Currituck Slump. The sub-marine landslide was simulated as occurring off the coast of the Outer Banks in North Carolina and resulted in a much shorter notification time for the coast of North and South Carolina and, most definitely, for Horry County. The simulation also increased the risk of larger wave heights along our coast. From the best predictions of the National Weather Service Wilmington, a sub-marine landslide off the coast of South Carolina could produce a tsunami on our coast within an hour. If a sub-marine landslide occurred off the coast of Florida, our coastline could see the tsunami within two hours.

Tsunami products are generally issued 10 minutes after an earthquake occurrence. Below is the U.S. East Coast criterion.

<b>Magnitude</b>	<b>Area</b>	<b>Product</b>
4.0-4.9	Within 50 km (31 miles) of the coast	Tsunami Seismic Information Statement
5.0-5.9	Within 500 km (310 miles) of the coast	Tsunami Seismic Information Statement
6.0-6.75	Within 500 km (310 miles) of the coast	Tsunami Information Statement
6.0+	Inland	Tsunami Information Statement
6.8-7.5	Atlantic Coast	Tsunami warning (350km) (217 miles)
7.6-7.8	Atlantic Coast	Tsunami warning (1000km) (620 miles)
>7.8	Atlantic Coast	3 hour watch/3 hour warning

### III. CONCEPT OF OPERATIONS

#### A. General

1. Response and coordination of action will follow the Horry County Emergency Management Department Emergency Operations Plan.
2. Evacuation notifications will be coordinated through Horry County Emergency Management, E-911 Communications Center, the NWS Wilmington Office, and the Horry County Public Information Office for the entire coastal area, including local jurisdictions.
3. Coordinate beach evacuation notifications through the Horry County Police, Horry County Fire/Rescue departments, and local jurisdictions.
4. Coordinate with State and Federal agencies.

#### B. Operational Issues

1. Once a tsunami wave has been detected that may impact the Horry County coast, the Horry County Emergency Management Director or his designee and the National Weather Service will activate the Emergency Alert System advising the need to evacuate the beach area.

2. The Horry County E-911 Department will be notified to contact the law enforcement and fire/rescue units closest to the beachfront to respond to the beach and announce the evacuation of the beach.
3. The Emergency Management Department will ask E-911 to activate the County’s automated notification system if a tsunami threatens our coastline.
4. In the event of a tsunami or an observation of severe water draw-back by first responders, an evacuation order may be given by the officer in charge. The E-911 Department will be notified immediately. E-911 will contact the Horry County Emergency Management Director and the NWS and activate the Emergency Messaging Service.
5. Once an evacuation becomes necessary, the Horry County Public Information Office will broadcast a warning and evacuation instructions through local media outlets.

#### **IV. ANNEX MAINTENANCE**

Horry County Emergency Management is responsible for coordinating, developing, and maintaining the Tsunami Annex and is the designated Lead Agency. The Tsunami Annex will be updated in conjunction with the CEMP as stated in Section VII, Plan Development and Maintenance.

## **ATTACHMENTS**

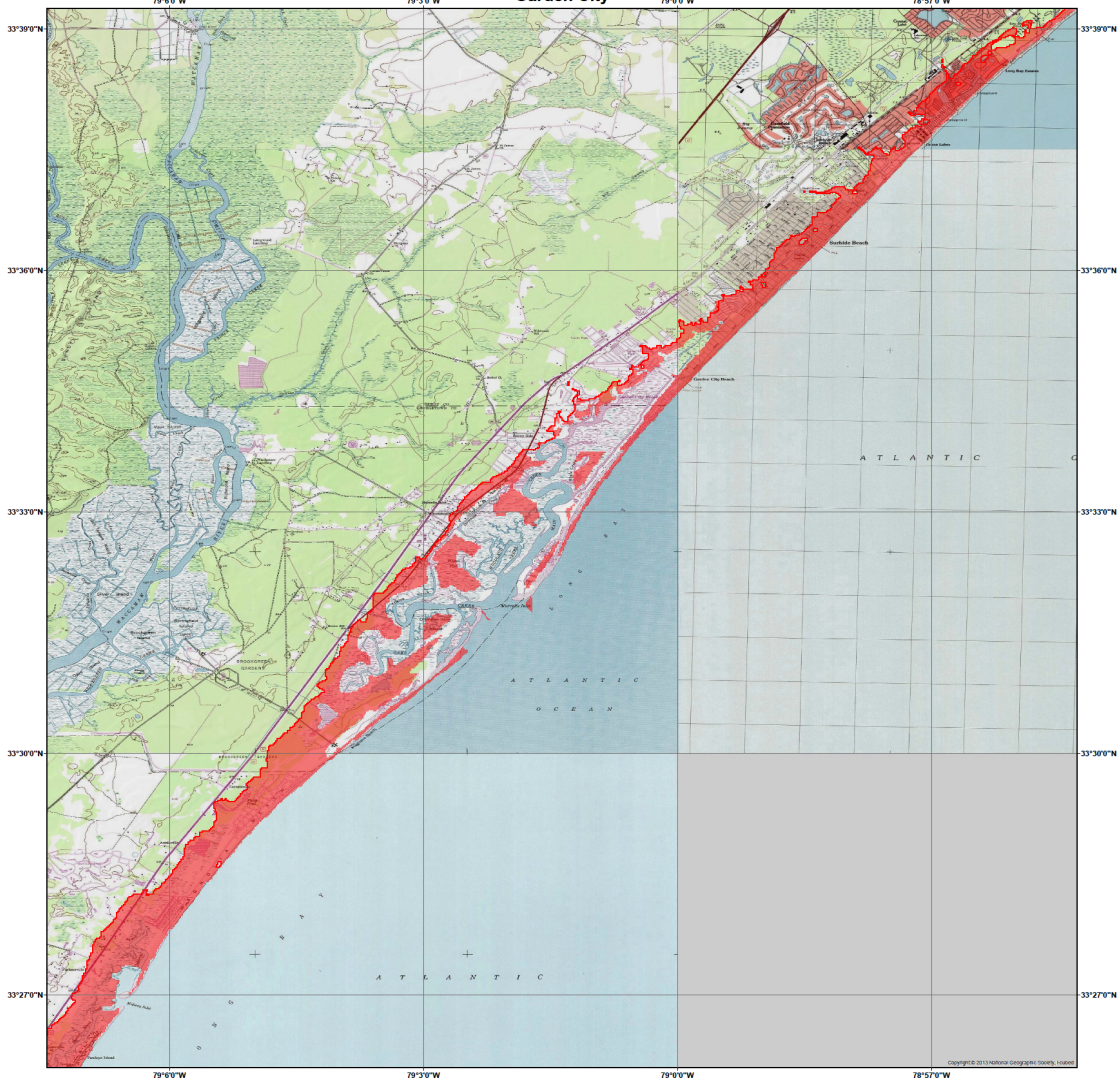
### A. Horry County Tsunami Risk Maps

ATTACHMENT A

National Oceanic and Atmospheric Administration (NOAA)  
National Tsunami Hazard Mitigation Program (NTHMP)  
Center for Applied Coastal Research (CACR), University of Delaware

Tsunami Inundation Map for Emergency Planning  
Garden City

State of South Carolina  
Garden City



METHOD OF PREPARATION

The inundation mapping for Myrtle Beach NGDC DEM was funded by the National Tsunami Hazard Mitigation Program (NTHMP). Here, a brief description is provided about the process this map was generated through. For comprehensive information about the mapping process, one can refer to the inundation report referenced below. Four sources were modeled for this work, two coseismic, a volcanic cone collapse, and a Submarine Mass Failure Source (SMF). Coseismic sources include a large earthquake in the Puerto Rico Trench (PRT) in the Caribbean Subduction Zone (CSZ), and another earthquake located on Azores Gibraltar plate boundary. Both of these sources are generated according to the standard Okada method. Cumbre Vieja Volcanic (CVV) collapse located in Canary Islands is another significant tsunami source which threatens the location of study. A multi-fluid 3D Navier-Stokes solver (THETIS) was used to model this source. Finally, a slide close to Cape Fear location was studied as the SMF tsunami. These landslide sources are all simulated with the NHWAVE model.

The bathymetry data is provided from the integrated bathymetric-topographic digital elevation model ( Myrtle Beach NGDC DEM), generated by National Geophysical Data Center (NGDC) for high-resolution tsunami inundation mapping. For ocean basin tsunami propagation, the depth values were obtained from the 1 arc-minute ETOPO-1 database, while nearshore bathymetry and topography were obtained from NGDCs Coastal Relief Models, which are typically provided on a 3 arc-second grid.

We used the FUNWAVE-TVD model to simulate tsunami nearshore propagation and onshore inundation. FUNWAVE-TVD is a public domain open-source code that has been used for modeling tsunamis inside ocean basin, nearshore, and their related inundation process. Four levels of nesting was performed in this project to bring the resolution from 1 arc minute (about 2 kilometers) in the ocean basin, down to 1 arc-sec (about 30 meters) nearshore. For each region, the highest resolution data was used to generate the inundation line from the extent of the inundated area. The accuracy of the inundation line shown on this map is constrained by several factors such as the accuracy of the models used here, as well as the accuracy of the bathymetry data. The inundation line depicts the envelope of the inundation lines for all the tsunami sources studied, not one particular source.

For further questions about the map contact James T Kirby (kirby@udel.edu).

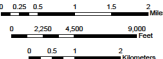
Reference:  
Tehraniard, B., Kirby, J. T., Callahan, J. A., Shi, F., 2015, "Tsunami Inundation Mapping for Myrtle Beach, VA NGDC DEM", Technical Report No. CACR-15-08, Center for Applied Coastal Research, University of Delaware.

TSUNAMI INUNDATION MAP  
FOR EMERGENCY PLANNING

State of South Carolina  
Garden City

August, 2015

Scale 1:40,000



Tsunami sources modeled for Virginia Beach, NGDC DEM

Source	Location	Arrival Time (hrs)
Cape Fear Slide	76.00 W, 33.10 N	2.0
Puerto Rico Trench Zone (M=9.0)	Caribbean Subduction Zone	4.5
Azores-Gibraltar Convergence Zone (M=8-9.0)	Gibraltar Strait	9.0
Cumbre Vieja Volcanic Cone Collapse	Canary Islands	9.0

Center for Applied Coastal Research



MAP EXPLANATION

- Tsunami Inundation Line
- Tsunami Inundated Area

PURPOSE OF THIS MAP

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MAP BASE

Topographic base maps prepared by the U.S. Geological Survey as part of the 7.5-minute Quadrangle Map Series (originally 1:24,000 scale). Tsunami inundation line boundaries may reflect updated digital topographic data that can differ significantly from contours shown on the base map.

DISCLAIMER

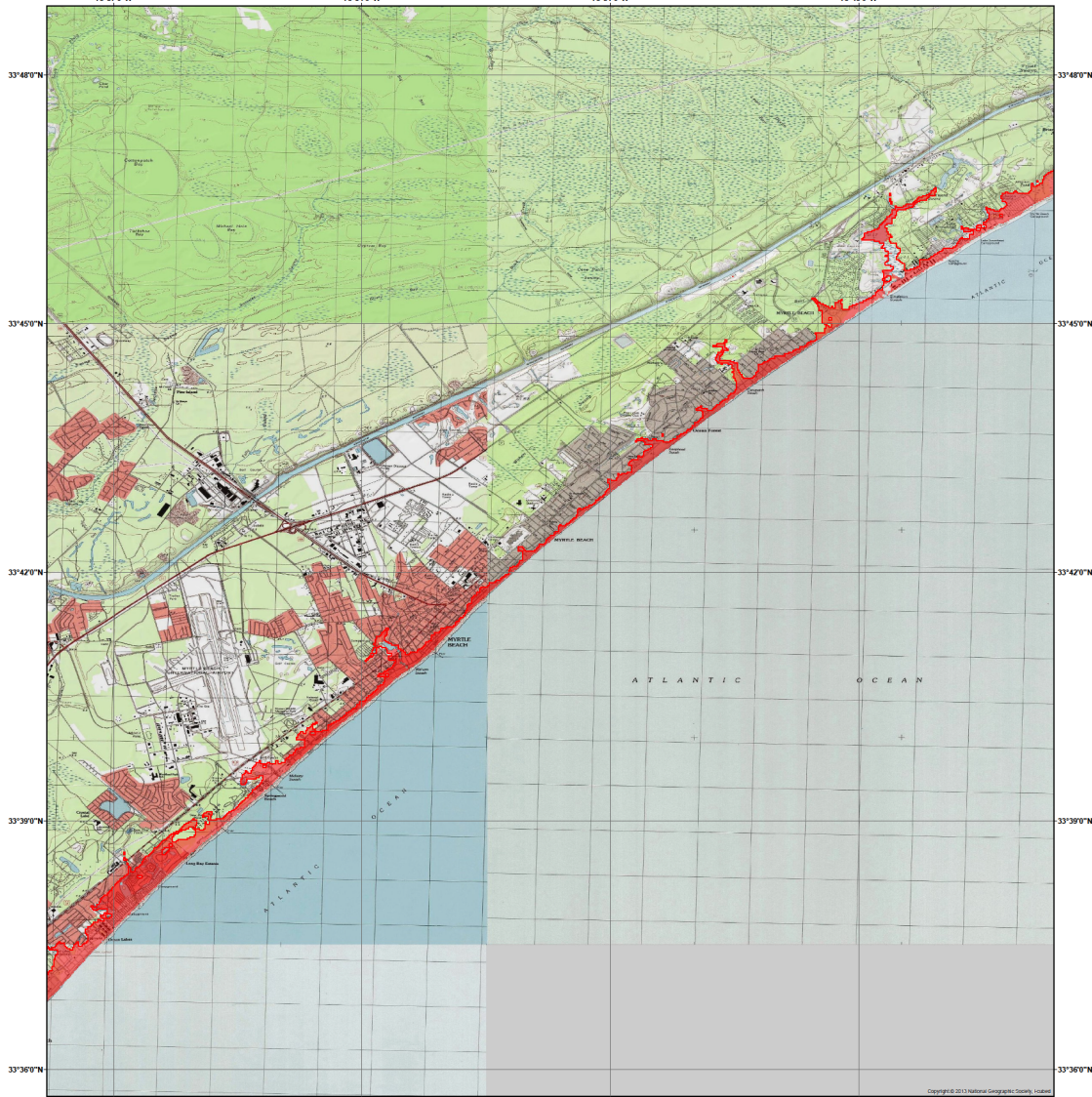
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National Tsunami Hazard Mitigation Program (NTHMP)  
Center for Applied Coastal Research (CACR), University of Delaware

**Tsunami Inundation Map for Emergency Planning  
Myrtle Beach**

State of South Carolina  
Myrtle Beach



**METHOD OF PREPARATION**

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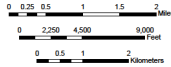
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**Tsunami INUNDATION MAP  
FOR EMERGENCY PLANNING**

State of South Carolina  
Myrtle Beach

August, 2015

Scale 1:40,000





**Tsunami sources modeled for Myrtle Beach, NGDC DEM**

	Source	Location	Arrival Time (hrs)
Local Source	Cape Fear Slide	76.00 W, 33.10 N	2.0
	Puerto Rico Trench Zone (M-R-0)	Caribbean Subduction Zone	4.5
Distant Sources	Azores-Gibraltar Convergence Zone (M-R-9-0)	Gibraltar Strait	9.0
	Cumbre Vieja Volcanic Cone Collapse	Canary Islands	9.0

Center for Applied Coastal Research



**MAP EXPLANATION**

-  Tsunami Inundation Line
-  Tsunami Inundated Area

**PURPOSE OF THIS MAP**

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**MAP BASE**

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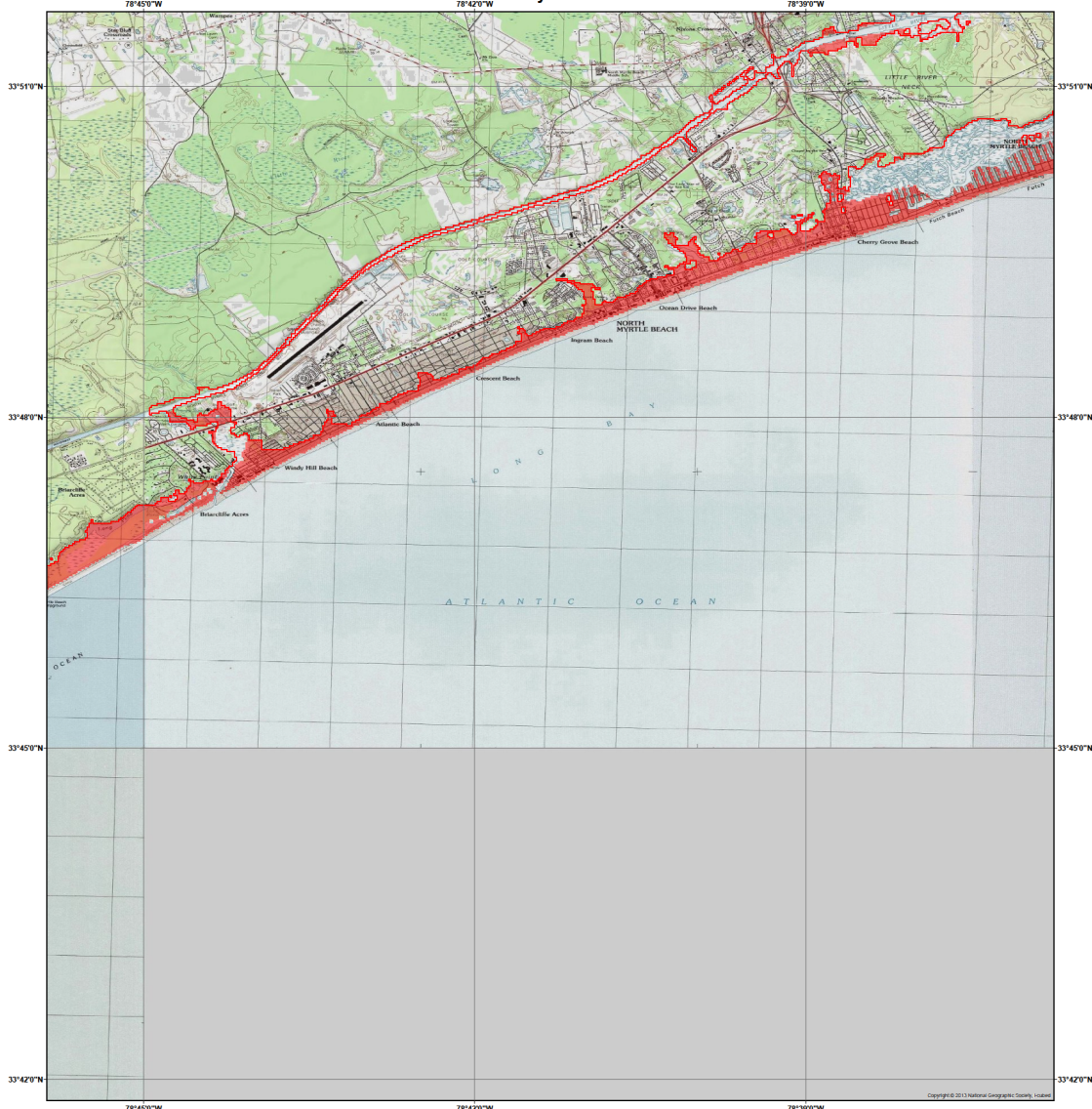
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National Tsunami Hazard Mitigation Program (NTHMP)  
Center for Applied Coastal Research (CACR), University of Delaware

**Tsunami Inundation Map for Emergency Planning  
North Myrtle Beach**

State of South Carolina  
North Myrtle Beach



**METHOD OF PREPARATION**

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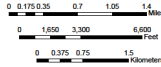
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**TSUNAMI INUNDATION MAP  
FOR EMERGENCY PLANNING**

State of South Carolina  
North Myrtle Beach

August, 2015



Scale 1:30,000



**Tsunami sources modeled for Myrtle Beach, NGDC DEM**

Source	Location	Arrival Time (hrs)
Cape Fear Slide	76.00 W, 83.10 N	2.0
Puerto Rico Trench Zone (M=9.0)	Caribbean Subduction Zone	4.5
Azores-Gibraltar Convergence Zone (M=8-9.0)	Gibraltar Strait	9.0
Cumbre Vieja Volcanic Cone Collapse	Canary Islands	9.0

**MAP EXPLANATION**

-  Tsunami Inundation Line
-  Tsunami Inundated Area

**PURPOSE OF THIS MAP**

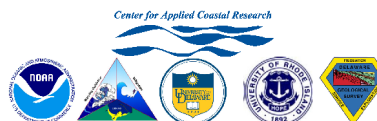
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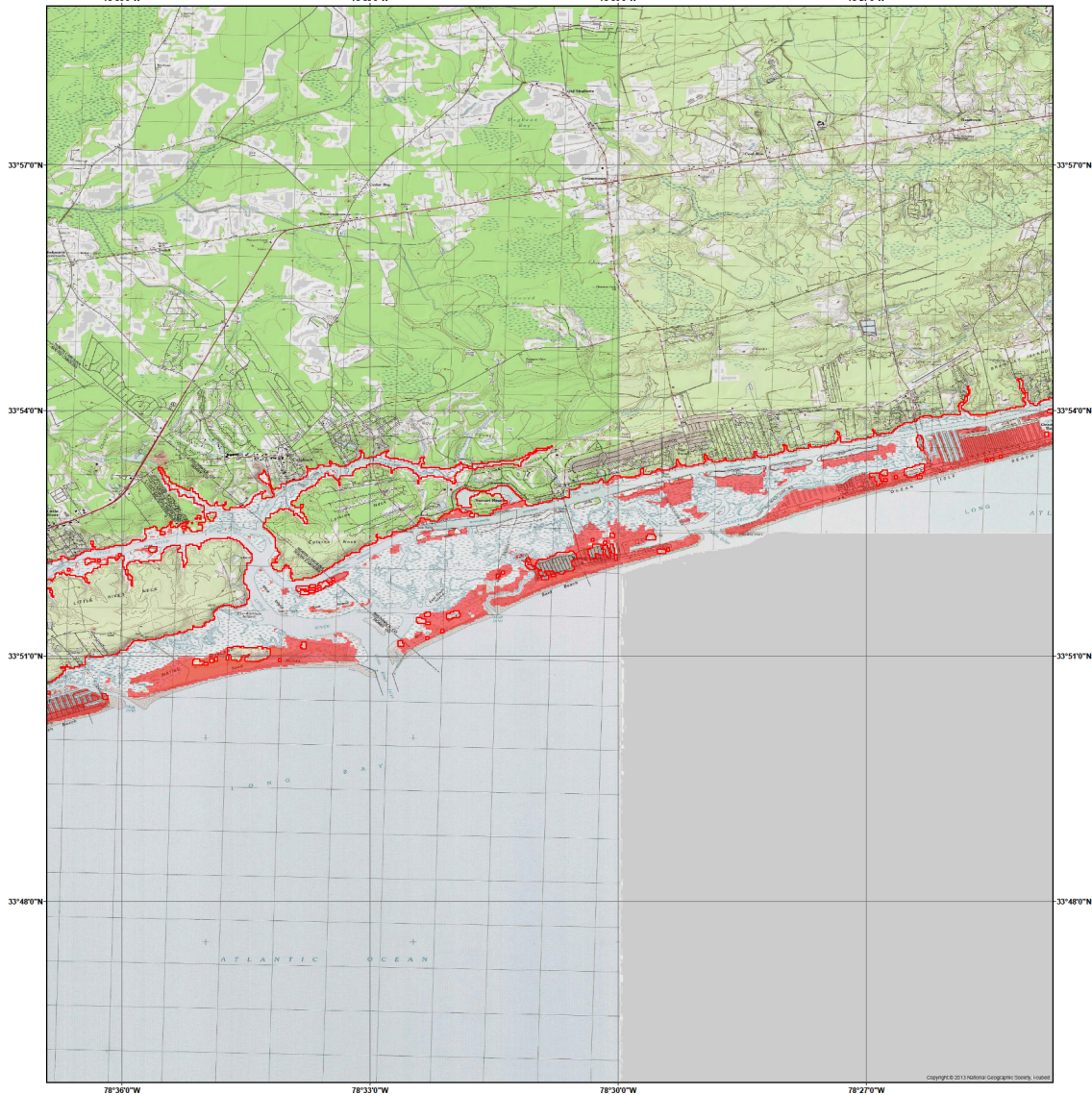




National Oceanic and Atmospheric Administration (NOAA)  
National Tsunami Hazard Mitigation Program (NTHMP)  
Center for Applied Coastal Research (CACR), University of Delaware

**Tsunami Inundation Map for Emergency Planning  
Sunset Beach**

State of North Carolina  
Sunset Beach



**METHOD OF PREPARATION**

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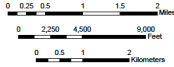
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**Tsunami INUNDATION MAP  
FOR EMERGENCY PLANNING**

State of North Carolina  
Sunset Beach

August, 2015



Scale 1:40,000



**Tsunami sources modeled for Myrtle Beach, NGDC DEM**

	Source	Location	Arrival Time (hrs)
Tsunami Sources	Cape Fear-Slide	76.00 W, 83.10 N	2.0
	Puerto Rico Trench Zone (M8.9-0)	Caribbean Subduction Zone	4.5
	Azores-Gibraltar Convergence Zone (M8.6-9.0)	Gibraltar Strait	9.0
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**MAP EXPLANATION**

-  Tsunami Inundation Line
-  Tsunami Inundated Area

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Center for Applied Coastal Research

