

# TWO COASTAL FLOOD INUNDATION MAPS- WHICH SHOULD I USE?

## HURRICANE EVACUATION STUDY - STORM SURGE INUNDATION MAPPING

VS.

## NATIONAL FLOOD INSURANCE PROGRAM - FLOOD INSURANCE RATE MAP

### An Overview and Comparison

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*Storm surge is an abnormal rise of water generated by a storm, over and above the predicted tide level. Storm Surge Inundation Maps (SSIMs) and Flood Insurance Rate Maps (FIRMs) both identify areas that are subject to inundation from coastal storm surge. Often, community officials ask which of these products they should use and in what situations. The purpose of this paper is to explain the differences between these two products.*

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#### **Hurricane Evacuation Study - Storm Surge Inundation Maps:**

SSIMs are created as part of a Hurricane Evacuation Study (HES), which are often conducted by the Federal Emergency Management Agency (FEMA) and the United States Army Corps of Engineers (USACE), in coordination with the state and local counties/municipalities. The SSIMs are an important component of the HES and are used as a basis for the identification of hurricane evacuation zones.

SSIMs are based on storm surge from hurricanes. Hurricane storm surge heights are influenced by many factors, including: hurricane intensity (categorized by the Saffir-Simpson (SS) Hurricane Wind Scale, ranging from category 1 to category 5), size (radius of maximum winds), forward speed, the angle of approach to the shoreline, width and slope of the continental shelf, astronomical high tide level, and local geographic features.

The National Oceanic and Atmospheric Administration (NOAA) Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model is used to calculate storm surge water surface elevation values used to create SSIMs. Since many factors influence storm surge heights, the maximum calculated surge heights are composited for thousands of different types of hurricanes within an SS category. Occurrence probabilities of these hurricanes are not considered.

The results from the simulations are used to identify possible areas of storm surge inundation and maximum surge heights from various combinations of hurricane forward speed, trajectory, storm size, and high tide level within each SS category. The surge height outputs from SLOSH are then compared to local high resolution ground elevation data to finalize the areas of possible storm surge inundation for each SS category. These areas of potential inundation are shown on the SSIM. The SLOSH output, and therefore the SSIM, does not include any impacts from wave action.

The inundation zone for an SS category shown on the SSIM does not depict the expected storm surge from any one particular type of hurricane with that SS category. Rather, the SSIM depicts areas of possible flooding from thousands of hypothetical hurricanes within an SS category. The map provides an upper threshold estimate of potential storm surge inundation during a high tide landfall, which is important for the purpose of developing hurricane evacuation zones for HES. The SSIM is intended to be used for long range hurricane planning and population protection, and is not intended to be used for regulatory or insurance purposes.

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### **National Flood Insurance Program - Flood Insurance Rate Maps:**

FIRMs are produced by FEMA in support of the National Flood Insurance Program (NFIP). The FIRMs are regulatory documents that identify the Special Flood Hazard Areas (SFHA) where land use and building requirements of the NFIP need to be enforced, in order for a community to participate in the NFIP. The SFHAs identify areas of possible inundation due to both riverine flooding and coastal flooding. The FIRMs establish flood zones that are used for floodplain management regulations, to set flood insurance rates, and to identify where flood insurance is required as a condition of a federally insured mortgage. Flood inundation areas shown on the FIRMs for coastal areas are based on the storm surge and wave action (where applicable) from the flood that has a 1% chance of being equaled or exceeded in a given year (also known as the 100-year flood or base flood). The regulatory and insurance requirements of the NFIP are based on the flood data shown on the FIRM. The maps may also show the extent of stillwater inundation (without consideration of wave height) from the flood that has a 0.2% chance of being equaled or exceeded in a given year (also known as the 500 year flood).

FEMA Region III is in the process of updating the coastal FIRMs within the Region III domain. This work is being completed by the USACE and private contractors. For this update the storm surge elevations are determined using the ADvanced CIRCulation Model for Oceanic, Coastal, and Estuarine Waters (ADCIRC) coupled with the Simulating Waves Nearshore (SWAN) model. Historical extra-tropical and tropical storms, along with a suite of hypothetical tropical storms representative of possible storms that could affect Region III, are simulated with the ADCIRC/SWAN models and other calculation methods to determine the 1% annual chance stillwater level. The Wave Height Analysis for Flood Insurance Studies (WHAFIS) model is then used to calculate base flood elevations that include the impacts of wave action.

The flood inundation areas shown on the FIRMs are created by comparing the calculated 1% annual chance stillwater elevation to local high resolution ground elevation data. The FIRM shows the area of the 1% annual chance floodplain, and within the floodplain it shows base flood elevations and flood risk zones that include the impacts of calculated wave action.

Although FIRMs can be a useful tool to assist with hurricane/coastal storm planning, they are intended to be used as a regulatory document for insurance, land use, and building requirements. Wave action is included due to the forces that waves and other high-velocity flow impart on buildings and other structures located in the floodplain, therefore having a direct correlation to insurance, land use, and building requirements.

When a hurricane approaches, communities should rely on the SSIMs from the HES and storm surge forecast products from NOAA when making evacuation and other emergency management decisions.

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### **The Important Differences:**

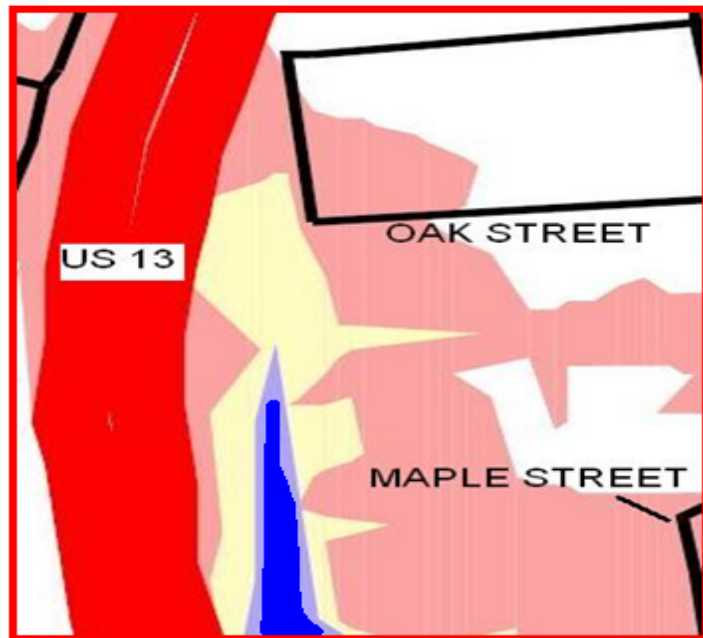
***Storm Surge Inundation Maps*** are a component of a Hurricane Evacuation Study. The areas of surge inundation shown on the maps reflect potential flooding from different types of hurricanes within a SS category, with no consideration of wave action or probability. The result is intended to be a conservative estimate of possible surge inundation from hurricanes within an SS category, which is used for long range hurricane planning purposes and population protection. The SSIM is not intended to be used for regulatory or insurance purposes.

***Flood Insurance Rate Maps*** identify the areas subject to flooding associated with a water elevation that has a 1% chance of being equaled or exceeded in any given year. This FIRM identifies flood risk zones and base flood elevations that include the impacts of wave action. The FIRM is a regulatory and insurance product developed within a Flood Insurance Study and is used to support the NFIP.

***Both maps*** can be looked at when determining where to build as each will help assess the overall flood risk in an area, from different categories of hurricanes and from the 1% annual chance flood with wave action, and the combination of the two will give a more complete picture. Both maps can also be useful for general coastal planning applications if the user understands their limitations.

A major difference between the two products is that the FIRMs are based on a flood with a certain probability of occurring, while the SSIMs are not. The 1% annual chance water level is a statistical measure and varies throughout a region. No single storm event would produce the 1% annual chance water level everywhere in that region. While certain types of hurricanes within a SS category may be capable of producing or exceeding a 1% annual chance water level in a given area, other types of hurricanes within that SS category may not. Additionally, there may be hurricane scenarios within multiple SS categories that have the potential to produce or exceed the 1% annual chance water level for an area. Therefore, the 1% annual chance water level for an area cannot be directly related to any particular category of hurricane.

**Below is an example** of a FIRM (top image) and an SSIM (bottom image) for the same area. On the FIRM, the 1% annual chance floodplain is shown in light blue, and a flood zone and base flood elevation are included. The red box on the FIRM represents the area shown on the SSIM. On the SSIM, the blue designates the areas of possible flooding from Category 1-4 hurricanes, the purple from Category 2-4 hurricanes, the yellow from Category 3-4 hurricanes, and the pink from Category 4 hurricanes. Note that this area is not included in the 1% annual chance floodplain shown on the FIRM. This means that some types of Category 1-4 hurricanes, with certain size, forward speed, and track trajectory characteristics, impacting at high tide, are expected to produce a water level higher than the 1% annual chance water level, and inundate a larger area than the 1% annual chance water level would inundate.



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**For more information:**

NOAA Storm Surge and SLOSH Model: [www.nhc.noaa.gov/ssurge](http://www.nhc.noaa.gov/ssurge); [www.hurricanes.gov/surge](http://www.hurricanes.gov/surge)

ADCIRC Model: [www.adcirc.org](http://www.adcirc.org)

WHAFIS Model: [www.fema.gov/plan/prevent/fhm/dl\\_wfis4.shtm](http://www.fema.gov/plan/prevent/fhm/dl_wfis4.shtm)

SWAN Model: [www.swan.tudelft.nl](http://www.swan.tudelft.nl)

Saffir- Simpson Hurricane Wind Scale: [www.nhc.noaa.gov/sshws.shtml](http://www.nhc.noaa.gov/sshws.shtml)

FEMA Region III Coastal Analysis and Mapping Study: [www.r3coastal.com](http://www.r3coastal.com)

Hurricane Evacuation Studies and SSIMs: [www.iwr.usace.army.mil/nhp](http://www.iwr.usace.army.mil/nhp)

FEMA Map Service Center: [www.msc.fema.gov](http://www.msc.fema.gov)

Flood Insurance Rate Maps: [www.fema.gov/hazard/map/firm.shtm](http://www.fema.gov/hazard/map/firm.shtm)

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