

BRIGHTHE Workshop 2019:

Envisioning Risk of Hurricane Storm Surge and Sea Level Rise

Jennifer Boehnert, National Center for Atmospheric Research

J. Greg Dobson, University of North Carolina at Asheville

Patricia Carbajales, Clemson University

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Exercise 3:

Visualizing storm surge

Storm Surge

Visualizing Storm Surge in ArcGIS Pro

In this exercise you will work with storm surge forecast data from the National Hurricane Center (NHC) map services as well as data that has been downloaded. You will experiment displaying the data in a number of ways to help communicate the risk of storm surge.

You will then create a 3D scene for Tybee Island in Georgia and display the storm surge alongside realistic looking buildings to better understand the impact from flooding.

Sub-Sections in Exercise:

1. Add NOAA SLOSH model data to ArcGIS Pro from AGOL
2. Mapping surge using different display methods
3. Mapping the landscape on Tybee Island
4. Publish the 3D data to ArcGIS Online

Mapping Surge Model Output

In this exercise you will explore different ways to display storm surge risk data from NOAA's National Hurricane Center. Using different cartographic techniques and symbology, you will create a number of different visual products.

Step 1 Creating an ArcGIS Pro project.

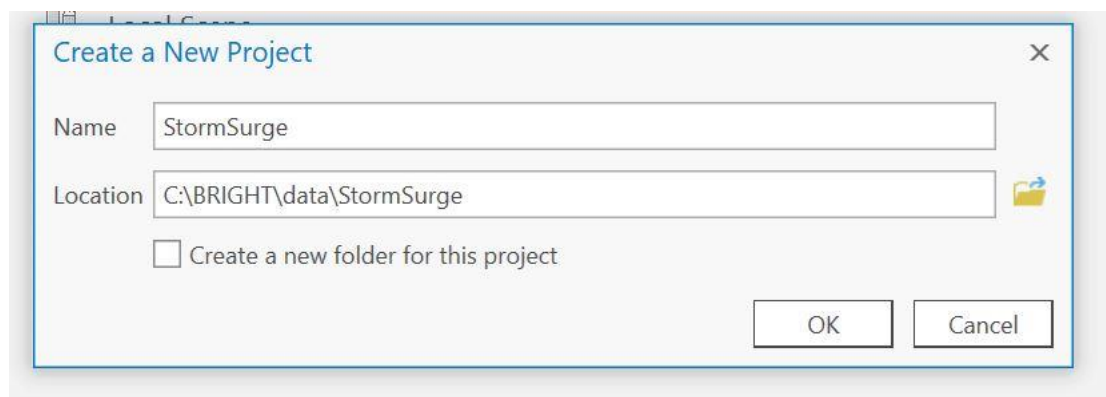
In this first step you will create a blank map in ArcGIS Pro.

ArcGIS Online organizational account credentials

- Start ArcGIS Pro.

In this first step you will create a new project in ArcGIS Pro.

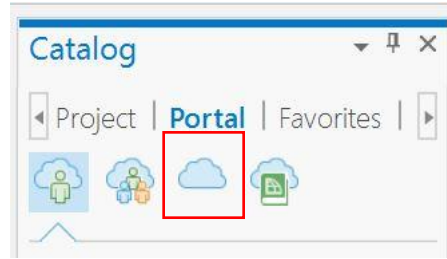
- **Create A New Map.**
- Create a project named **stormSurge** and for Location, browse to **C:\BRIGHTE\data\StormSurge**
- Uncheck the box **Create a new folder for this project.**
- Click **OK**



Step 2 Add data from ArcGIS Online

In this step you will add data from ArcGIS Online to your map. Data and maps are shared through Esri's cloud based system called ArcGIS Online.

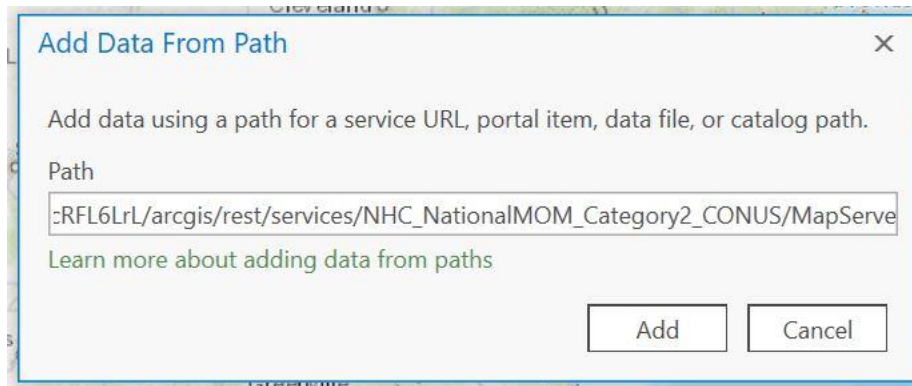
- In the **Catalog** pane, click the **Portal** tab, then the **All Portals** button.



- Search All Portals for “*SLOSH Maximum of MEOWS*”
- Select the **US Gulf and East Coast Category 2 Storm Surge Inundation (SLOSH Maximum of MEOWS)** (Tile Layer) and drag it into your map.

Make sure to select the Tile Layer not the Web Map.

- If the data does not display this way. Then do the following:
- Go to **Add Data > Data from Path**.
- Type in the following path - https://tiles.arcgis.com/tiles/C8EMgrsFcRFL6LrL/arcgis/rest/services/NHC_NationalMOM_Category2_CONUS/MapServer
- Click **Add**.



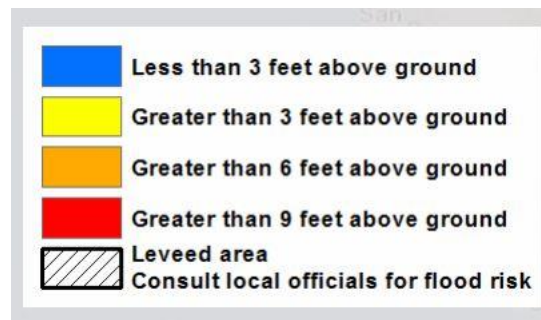
This data is generated by the National Hurricane Center (NHC) to depict storm surge flooding risk along the coast. The data can also be viewed in an online map at <http://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=d9ed7904dbec441a9c4dd7b277935fad&entry=1> or downloaded as a raster dataset from <https://www.nhc.noaa.gov/nationalsurge/#map>

The NHC produce different composite storm surge products. Maximum Envelopes of Water (MEOWs) and Maximum of MEOWs (MOMs).

Description of MEOWS and MOMs from NHC website - <https://www.nhc.noaa.gov/nationalsurge/#map>

“MEOWs are created by computing the maximum storm surge resulting from up to 100,000 hypothetical storms simulated through each SLOSH grid of varying forward speed, radius of maximum wind, intensity (Categories 1-5), landfall location, tide level, and storm direction. A MEOW product is created for each combination of category, forward speed, storm direction, and tide level. SLOSH products exclude Category 5 storms north of the NC/VA border. For each storm combination, parallel storms make landfall in 5 to 10 mile increments along the coast within the SLOSH grid, and the maximum storm surge footprint from each simulation is composited, retaining the maximum height of storm surge in a given basin grid cell. These are called MEOWs and no single hurricane will produce the regional flooding depicted in the MEOWs. SLOSH model MOMs are an ensemble product of maximum storm surge heights. SLOSH MOMs are created for each storm category by retaining the maximum storm surge value in each grid cell for all the MEOWs, regardless of the forward speed, storm trajectory, or landfall location. SLOSH MOMs are available for mean tide and high tide scenarios and represent the near worst-case scenario of flooding under ideal storm conditions. A high tide initial water level was used for the storm surge hazard maps.”

The legend for MOMs

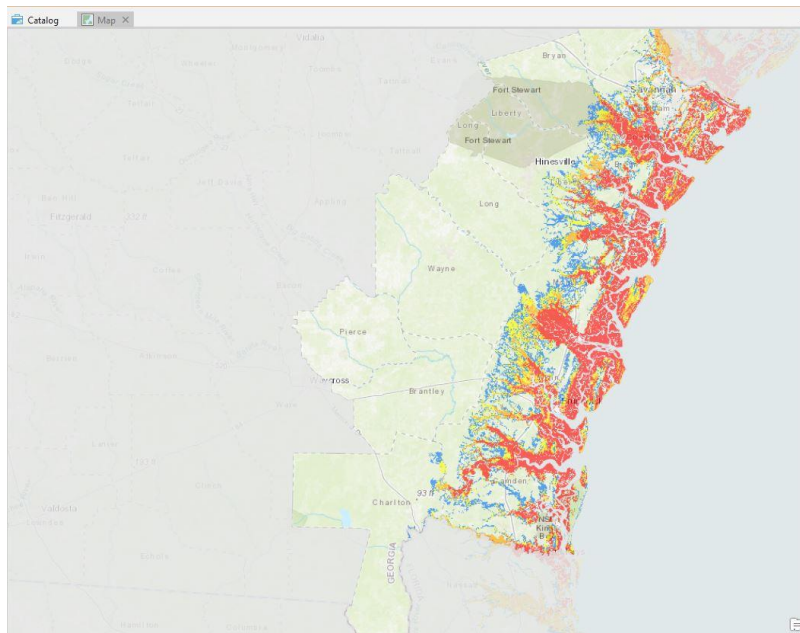


- Create a bookmark by clicking the **Bookmarks** tool on the **Maps** tab.
- Name your bookmark **Regional**.
- Zoom into the east coast of Georgia.

Working with ArcGIS Online layers is very helpful to quickly get access to data that has already been symbolized. However, you do not have too much flexibility to change the symbology or work with this data for analysis.

- Rename the layer '**NOAA Storm Surge Cat2**'.
- With the layer **NOAA Storm Surge Cat2** selected in the Content pane click the **Appearance** tab.

- Change the **Transparency** to 35%
- From the Catalog pane, click the **Project** tab.
- **On the Project tab right click the Folders directory and select Add Folder Connection.**
- **Make a folder connection to C:\BRIGHTE\data\StormSurge\data.**
- **Expand Folders > StormSurge > data > stormSurgeData.gdb**
- **Drag the GeorgiaMask.layer onto your map.**
- Change the color of this layer to Industrial and the transparency to 15%.
- Zoom in so the gray mask fills the entire screen.



Making a map is like telling a story. You have a main character (data) that you are telling the story about. By adding a mask to cover the area that is not within your main focus area makes, your data stand out. This will focus the readers' eyes towards the data (main character) and region that is most important in your map (story).

Step 3 Add data from the National Hurricane

In this step you will add Category 2 storm surge data, downloaded from the NHC.
<https://www.nhc.noaa.gov/nationalsurge/>

- **In the Catalog pane, expand Folders > StormSurge > data > US_SLOSH_MOM_Inundation_v2.**
- **Drag US_Category2_MOM_Inundation_HighTide.tif into your map.**

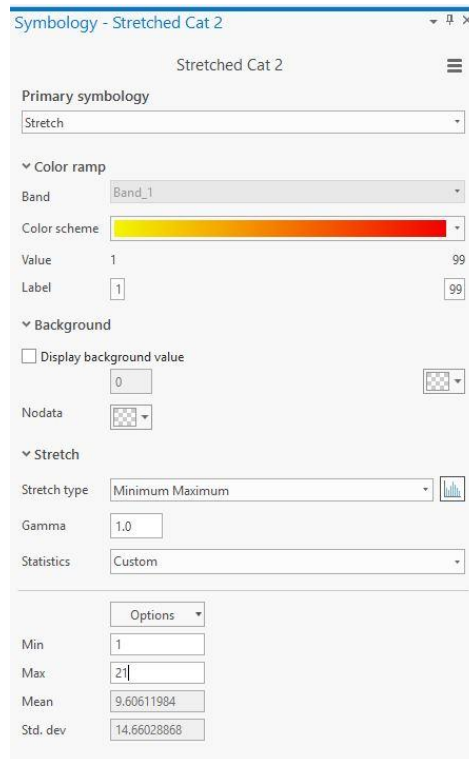
- Rename this layer **Unique Values Cat 2**.

The data is available at 1 foot increments for finer detail, however, mapping the data using bins is sometimes easier to communicate and to understand. You will now work with different ways to visualize this information.

Step 4 Create a map using stretched values

You will now create a copy of the data and symbolize the data using a stretched symbology.

- Right click on the **Unique Values Cat 2** layer in the Contents pane and select **Copy**.
- Then, right click on Map at the top of the Content pane and select **Paste**.
- Rename this new layer **Stretched Cat 2**.
- Drag this layer under **Georgia Mask**.
- Click on the **Symbology** button in the **Appearance** tab.
- In the Symbology pane change the Primary symbology to **Stretch**.
- Click the Color scheme drop-down and check the box to **Show Names**.
- Select the color scheme **Yellow to Red**.
- For the **Stretch** type select **Minimum Maximum**.
- For **Statistics** select **Custom**.
- Change the **Max** value to **21** and press Enter.



Step 5 Use the Swipe Tool

The Swipe tool allows you to peel away one layer to reveal layers underneath. We will use the swipe tool to take a look at the two ways to visualizing storm surge risk for the Georgia coast to Category 2 storms.

- Create a **bookmark** and call it Georgia.
- Make sure ***Stretched Cat 2*** is selected in the Contents pane.
- Click the **Appearance** tab.
- Click the **Swipe** tool.
- Hold your mouse down on the map and while holding the mouse down move the mouse from left to right.
- Explore how the different symbology looks for the same data using the swipe tool.
- Turn off the ***Unique Value Cat 2*** layer and use the **Swipe** tool again.
- **Save** your project.

Step 6 Symbolize data using a threshold

Now you will symbolize the data using a threshold. Let's see all areas that may experience greater than 3 feet of water.

- Right click on the layer ***Stretched Cat 2*** in the Contents pane and select Copy.
- Right click on Map and select Paste.
- Rename the newly added layer to ***Greater than 3 feet of flooding Cat 2***
- Make sure the ***GeorgiaMask*** is above all storm surge layers.
- Open the symbology pane for ***Greater than 3 feet of flooding Cat 2***.
- ***Change the Primary symbology to Classify.***
- ***Change the number of Classes to 3.***
- ***Set the following class intervals and Labels.***



Color	Upper value	Label
	≤ 3	Less than 3 feet
	≤ 21	Greater than 3 feet
	≤ 99	Leveed areas

- ***Change the color for the Less than 3 feet to NoColor.***
- ***Change the color for Greater than 3 feet to Mars Red.***
- ***Change the color for Leveed areas to Gray 10%.***

The red is very vibrant, it will look better to change the way the red is displayed so it is not too overwhelming.

- In the Enhancement group on the Appearance tab, change the layer Brightness to 35.



You now have 4 layers in your ArcGIS Pro project symbolizing the storm surge for Category 2 hurricanes using 4 different symbology techniques.

- Turn the layers on and off to see the different ways of symbolizing the data.

Using different symbology to display information communicates information to the public in unique ways. There is much uncertainty in the storm surge forecast and risk perception and using color and thresholds are good ways to communicate this uncertainty.

Which symbology do you think is the most effective to communicate risk from storm surge?

- Click the Map tab and the **Locate** button.
- Search for Tybee Island.

You will now be zoomed into the Tybee Island, Georgia.

- Turn the layers on and off to see the risk to the island from storm surge.

Mapping Landscape

Step 7 Create a map of the landscape

In this step you will create a 3D Tybee Island scene. Another way to visualize storm surge is using 3D techniques. It makes it easier to understand risk when you are able to view the surge height next to realistic looking buildings.

- Expand **Folders > stormSurge > data > stormSurgeData.gdb**.
- Drag the following feature classes into the map:
 1. roads_mercator
 2. structures_mercator
- Right click on **structures_mercator** and **Zoom to Layer**.
- **Turn off all the storm surge layers.**

The structures and roads are just a subset for a small area on Tybee Island.



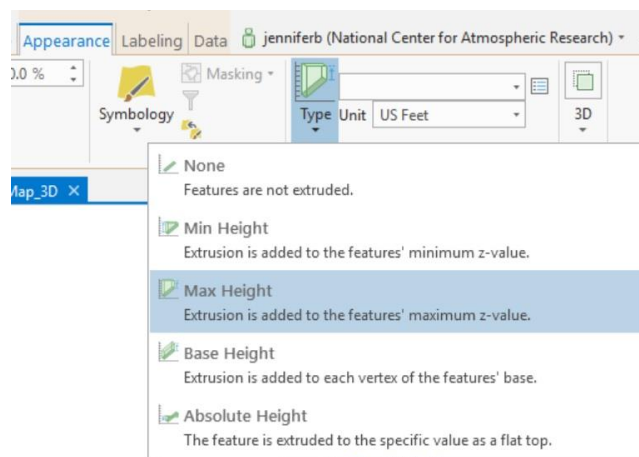
- Save your work by clicking on the **Save project** button.

ArcGIS Pro has the ability to convert 2D maps into 3D scenes. You will now create a 3D scene of a small section on Tybee Island.

- On the **View** tab, in the **View** group, click **Convert > To Global Scene**.
- In the **Contents** pane, drag **structures_mercator** from 2D Layers group to the 3D Layers group.
- Right click on the layer **structures_mercator** and select **Zoom to Layer**.
- **Right click the layer structures_mercator and select Properties.**
- **In the Layer Properties dialog box, click Elevation.**

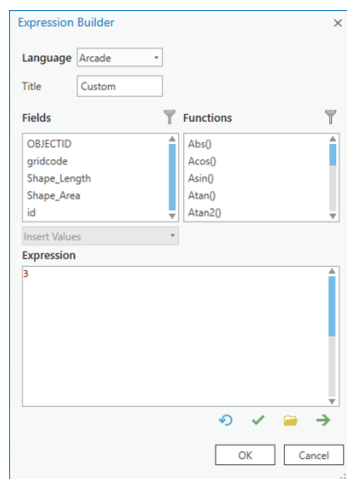
The structures_mercator features are displayed on the ground. The ground elevation layer by default is the World Elevation 3D layer, added automatically from ArcGIS Online when a Global scene is created.

- Click **OK**.
- On the **Appearance** tab, in the **Extrusion** group, click the **Type** button and select **Max Height**.



- Select the field [**BLDGHEIGHT**] for the extrusion expression.

- Change the Units to **US Feet**.
- Use the navigation tools to explore these structures in 3D.
- From the catalogue pane add the layer stormSurge_cat2.
- Drag stormSurge_cat 2 layer to the 3D Layers.
- Change the symbology for stormSurge_cat2 to **Water (area)** and its Transparency to 25%.
- In the Appearance tab, extrude the layer to Max Height
- Click the Extrusion Expression button on the Expression Builder window, change the Expression to “3” and click OK.

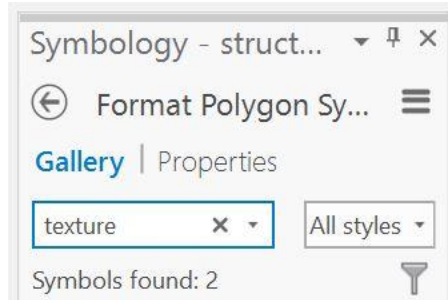


- Explore the scene.

Step 8 Add facades to the buildings faces

Displaying the buildings as boxes is useful to understand where storm surge will occur and which areas may be affected. It can also be useful to put realistic facades on these buildings to better understand what storm surge depth means in relation to real world objects.

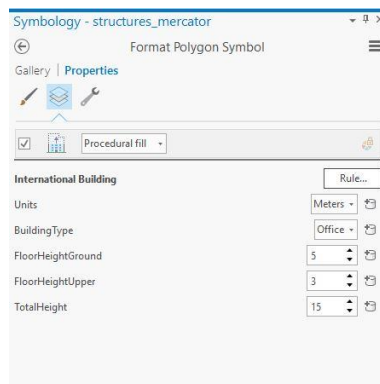
- In the **Content** pane, click the symbol for **structure_mercator**. This will open the Symbology pane.
- In the **Symbology** pane, change the Styles to **All styles** and type **texture** into the search box, press Enter.



- Select **International Building** symbols.

This symbol set contains realistic building facades that will be pasted onto your 3D extruded structures.

- Click the **Properties** tab.
- Select **Layers** icon.

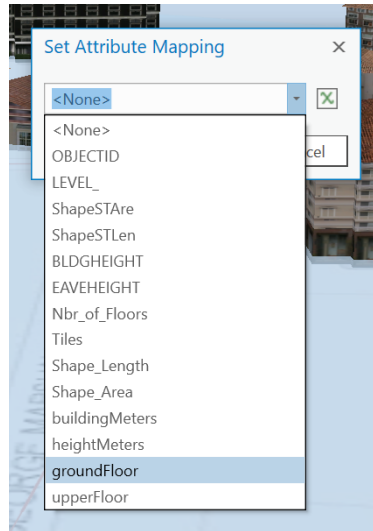


- Change the Units to **Feet**.
- Change the BuildingsType to **Residential**.



- Click the button to change settings to **TotalHeight**
- Select **BLDGHEIGHT** and click **OK**.
- Click **Apply**.

- Click the button to change settings to **FloorHeightGround**
- Select **groundFloor** and click **OK**.



- Click the button to change settings to **FloorHeightUpper**.
- Select **groundFloor** and click **OK**.
- Click **Apply**.
- Change the basemap to **Imagery**.
- Use the navigation tools to explore the map.
- In the Contents pane, right-click **Map_3D** and choose **Properties**.
- In the Map Properties dialog box, click **Illumination**.
- Under Shadow, check the **Display Shadows In 3D** box.
- Click **OK**.
- Navigate around the scene to investigate the shadows and illumination.
- **Save** your project.

Step 9 Realistic changes

In this step, you will make a few small changes to the map to make it look even more realistic.

Now you will add realistic trees to the map. ArcGIS Pro already contains the 3D symbology; you just need to have a point feature class to represent the tree locations.

- On the **Map** tab, in the **Layer** group, click **Add Preset**.

- Choose **Realistic Trees**.
- Navigate to **Folders > stormSurge > data > stormSurgeData.gdb > palm**.
- Click **OK**.
- In the Symbology pane, change the Type to **Palm**.
- Change the Height to **Height**.
- Change the Unit to **Feet**.
- Now follow the same steps and add the Elm, Poplar, and Ash trees.
- **Save** your project.
- Explore the map using the 3D navigation tools.
- On the Map tab click **Select By Attribute**
- Change the Layer Name to **structures_mercator**.
- Click **Add Clause**
- Make your clause **OBJECTID_! Is Equal to 65**.
- Click **Add**.
- Click **Run**.
- Zoom to the selected feature in the structure_mercator layer.
- On the Map tab, in the Selection group, click **Clear**.
- Tilt the view so you can see the height of the water beside the house.



- Change the level of extrusion for the stormSurge to **6 feet**.
- Then change the level to **9 feet**.
- Explore your map in 3D.
- Change the stormSurge back to **3 feet**.
- **Save** your map.