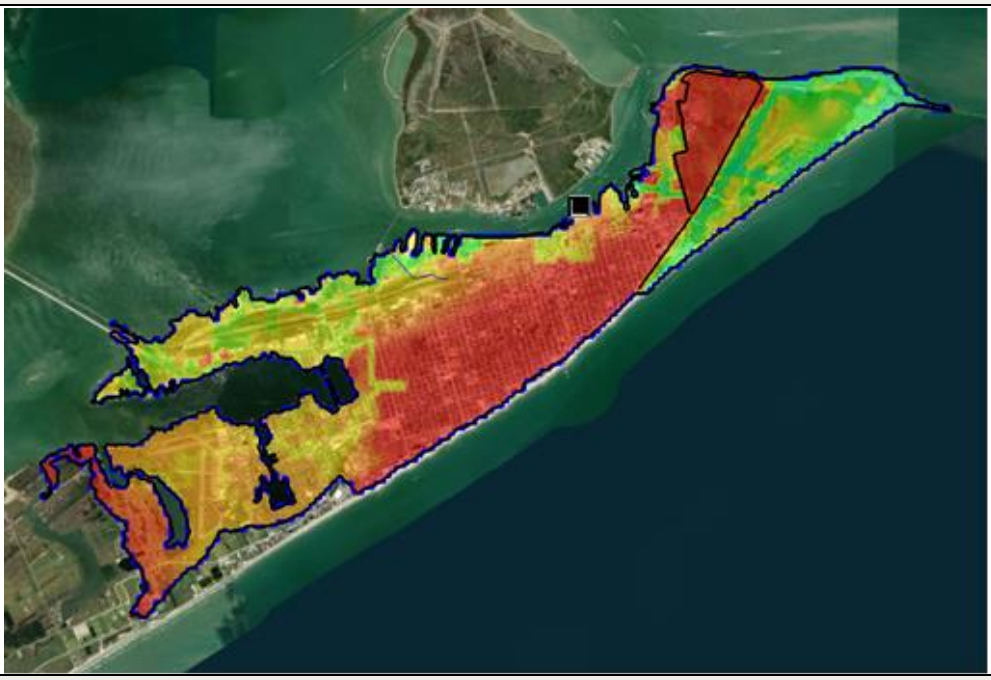
WMS 11.2 Tutorial

GSSHA Overland Flow Variable Stage Boundary Conditions

Define overland flow boundary conditions in a GSSHA model



Objectives

Learn how to use the GSSHA interface in WMS to define known head boundary conditions such as storm surge depths on overland flow cells.

Prerequisite Tutorials

- Developing a GSSHA Model Using the Hydrologic Modeling Wizard

Required Components

- WMS Core
- GSSHA Model

Time

- 15–20 minutes

1 Introduction

The GSSHA model allows for defining sources separate from rainfall with other boundary conditions. Two such types of boundary conditions are hydrographs defined on stream nodes and head boundary conditions defined on overland flow cells. See the "GSSHA Overland Flow Hydrograph Boundary Conditions" tutorial for details on using hydrographs on stream nodes.

This tutorial demonstrates creating a variable stage overland flow boundary condition in a GSSHA model. For the hydrograph boundary condition, an inflow hydrograph was entered at a stream node, letting GSSHA flood the downstream grid cells. In this case, water was put directly onto the grid cell and allowed to flow overland on the grid. The condition being simulated is a coastal tidal surge from Hurricane Ike on Galveston Island, Texas.

The model used in this tutorial has variable overland flow roughness defined and the infiltration is turned off. A precipitation of 10.5 mm/hr is defined for one day. Since it is simulating a large overland flow, the amount of water that infiltrates is negligible by comparison. The model does not currently have a flow boundary condition.

2 Opening an Existing Model

The tidal surge data were obtained from the NOAA Tides and Currents website.[1] Begin with a developed GSSHA model in which the boundary conditions will be updated and run.

1. Open WMS, or click **New** to reset WMS to its defaults.
2. Switch to the **2-D Grid** module.
3. Select *GSSHA* | **Open Project File…** to bring up the *Open* dialog.
4. Browse to the *data files* folder for this tutorial and select "GalvestonBase.prj".
5. Click **Open** to import the project and exit the *Open* dialog.
6. Click **Open** to bring up the *Open* dialog.
7. Browse to the *data files* folder for this tutorial.

[1] See https://tidesandcurrents.noaa.gov/

8. Select "galvestontopo.jpg" and click **Open** to exit the *Open* dialog.
9. When it finishes processing, right-click on " galvestontopo.jpg" and select **Zoom To Extents**.
10. Turn off " Soil Type" and " Land Use" in the Project Explorer.
11. Switch to the **2-D Grid** module.
12. Select *GSSHA* | **Save Project File…** to bring up the *Save GSSHA Project File* dialog.
13. Select "GSSHA Project File (*.prj)" from the *Save as type* drop-down.
14. Enter "Overland.prj" as the *File name*.
15. Click **Save** to save the project under the new name and exit the *Save GSSHA Project File* dialog.

The project should appear similar to Figure 1.

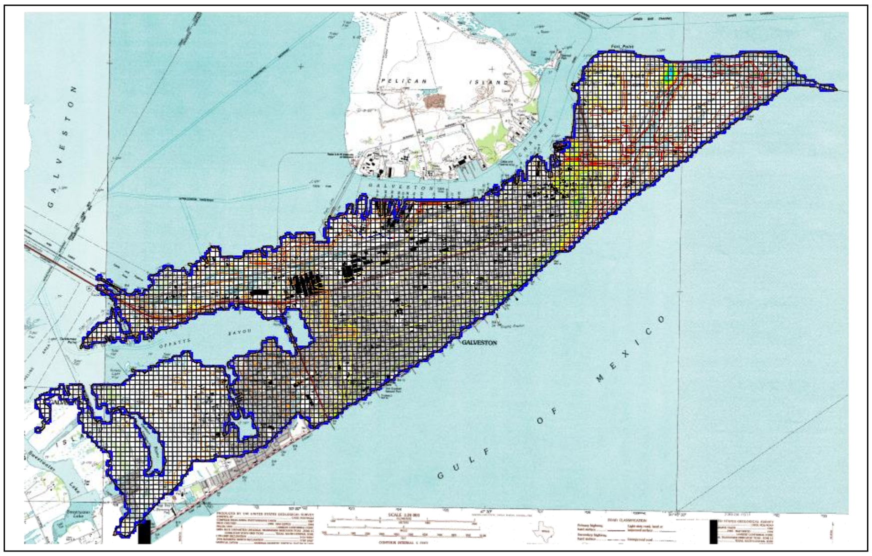


Figure 1 Initial Galveston project

3 Creating Embankments

The first step is to create an embankment by doing the following:

1. Zoom in to the northeast corner of the map (see Figure 2).

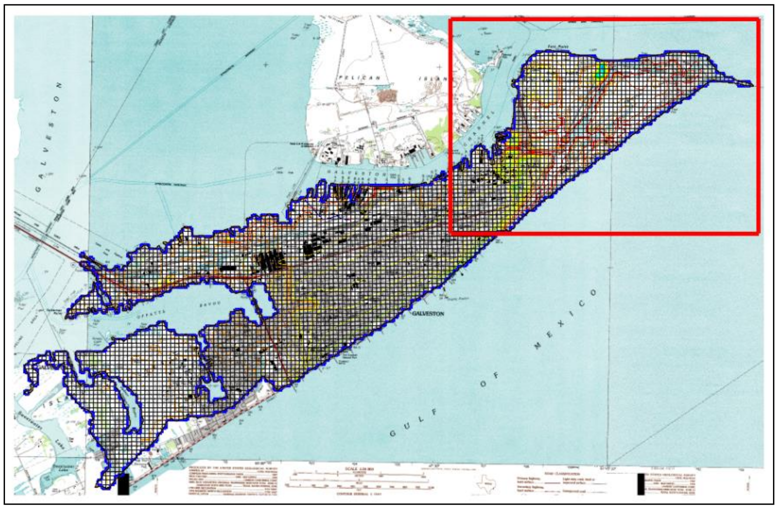


Figure 2 Zoom area indicated by box

2. Switch to the **Map** module.
3. Click **Display Options** to bring up the *Display Options* dialog.
4. Select “2D Grid Data” from the list on the left.
5. Turn off *Cells* and click **OK** to close the *Display Options* dialog.
6. Using the **Create Feature Arc** tool, create an embankment arc representing the levee surrounding Old Fort San Jacinto (see Figure 3).

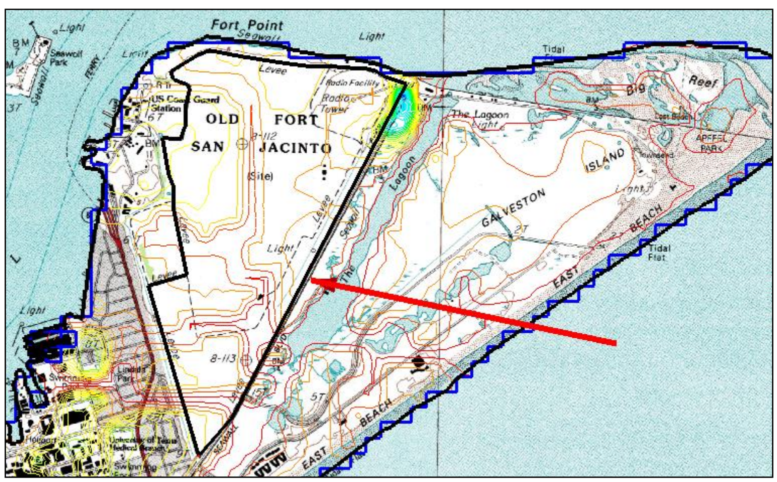


Figure 3 Levee indicated by arrow

Now create the seawall embankment to the southwest of the levee around Old Fort San Jacinto by doing the following:

7. Using Figure 4 as a guide, use the **Create Feature Arc** tool to create a seawall from a point just southwest of the lower corner of the Old Fort San Jacinto levee to just above where the watershed boundary line jogs west.

Note: Make sure the seawall embankment arc does not intersect the Old Fort San Jacinto levee embankment arc or the watershed boundary arc.

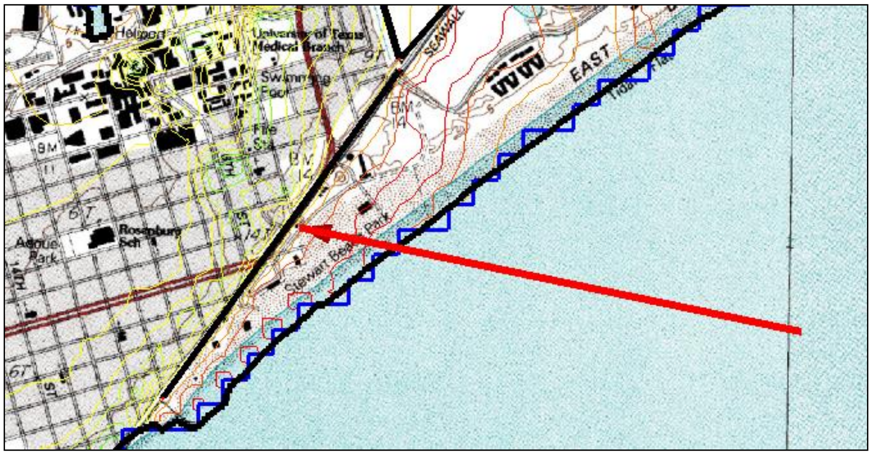


Figure 4 Seawall embankment arc

Now change the type of each arc to be an embankment arc.

8. Using the **Select feature Arc** tool, double-click on the Old Fort San Jacinto levee embankment arc to bring up the *Properties* dialog.
9. In the *Type* column, on the *All* row, select “Embankment” from the drop-down.
10. In the *Embankment* column, on the row below the *All* row, click **Browse** ... to bring up the *Embankment Arc Profile Editor* dialog.
11. In the *Vertical Curve Parameters* section, enter “6.0” as the *PVI Elevation*.
12. Click **Compute Vertical Curve**.

A horizontal line will appear in the plot (Figure 5).

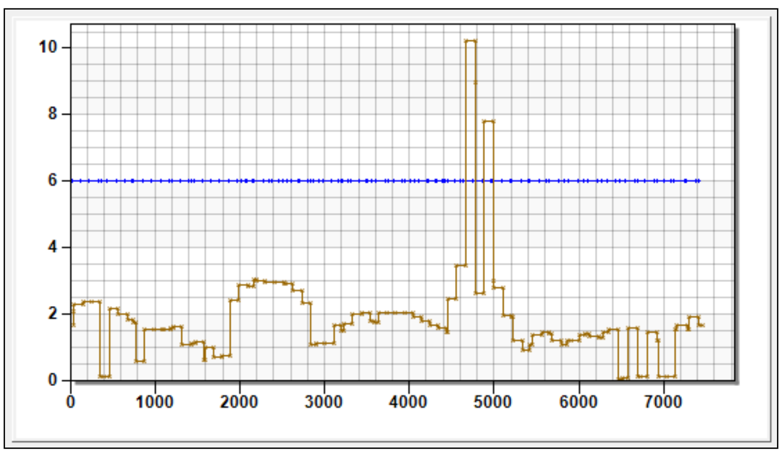


Figure 5 Embankment arc profile with vertical curve computed

13. Click **OK** to close the *Embankment Arc Profile Editor* dialog.
14. Click **OK** to close the *Properties* dialog.
15. Repeat steps 8–14 for the seawall embankment arc.

4 Creating Boundary Arcs

The boundary arcs are used to define the variable surge boundary condition that flows directly into the cells overlapping the arc. In this model, use the watershed boundary arc, which already exists but is currently a single arc. Break the arc so that the variable head can be defined only on those locations where the storm surge occurred. Break an arc by converting a vertex to a node at the desired location.

1. Using the **Select Feature Vertex** tool, select the vertex at the northeast end of the gulf side arc (see Figure 6).
2. Right-click and select **Vertex** → **Node** to convert the vertex to a node.
3. Repeat steps 1–2 for both the southwest vertex on the gulf side arc and the southwest vertex on the bay side arc (see Figure 6).

Figure 6 Three vertices that need to be converted to nodes

Notice there is already a node where the watershed outlet is located (Figure 7).

Figure 7 Location of watershed outlet node (circled)

5 Entering Variable Stage Data

Now set the attributes for the arcs created in the previous section.

1. Using the **Select feature Arc** tool, double-click on the gulf side arc (the one on the southeast side) to bring up the *Properties* dialog.
2. In the *Overland Flow BC Type* column, on the row below the *All* row, select "Variable stage (water surface elevation)" from the drop-down.
3. In the *Variable BC* column, click **Browse** to bring up the *XY Series Editor* dialog.
4. Outside WMS, use Windows Explorer to go to the *data files* folder for this tutorial and open "PleasurePier.txt" in a text editor.

This file contains the Galveston Pleasure Pier storm surge time series data.

5. Press *Ctrl-A* to select all of the time series data, then *Ctrl-C* to copy the data to the clipboard.
6. Return to the *XY Series Editor* dialog, select the first cell in the *Time (min)* column, and press *Ctrl-V* to paste the times series into the spreadsheet.
7. Enter "Pleasure Pier" as the *Curve Name*.

The curve should appear similar to Figure 8.

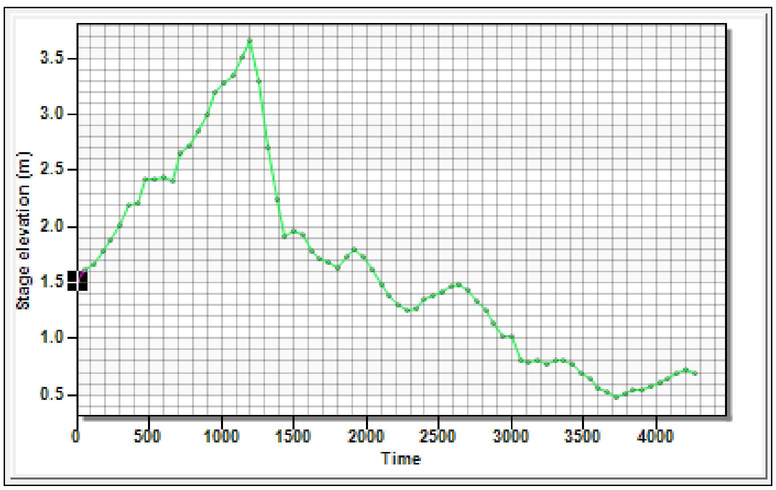


Figure 8 Gulf side storm surge time series curve

8. Click **OK** to close the *XY Series Editor* dialog.
9. Click **OK** to close the *Properties* dialog.
10. Repeat steps 1–9 for the two bay side arcs, using the time series data from the "Pier21.txt" file and entering "Pier 21" as the *Curve Name*.

The Pier 21 storm surge time series curve should appear similar to Figure 9.

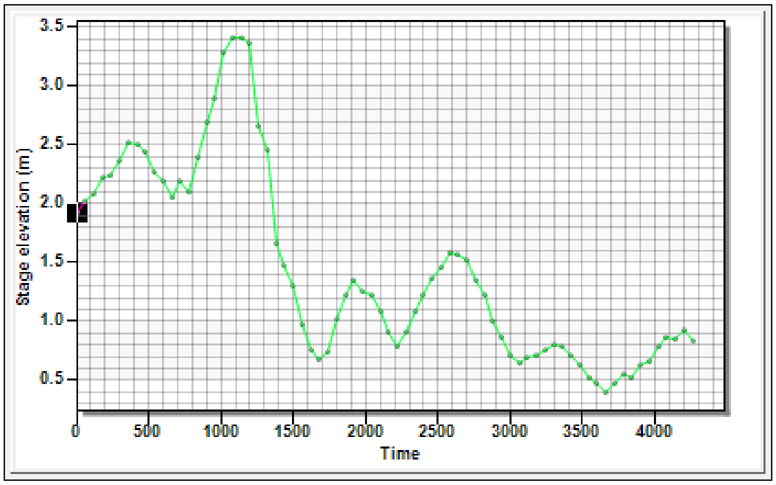


Figure 9 Bay side storm surge time series curve

6 Saving and Running the Model

Before running the model, the project should be saved.

1. Switch to the **2-D Grid** module.
2. Select *GSSHA* | **Save Project File…** to bring up the *Save GSSHA Project File* dialog.
3. Select "GSSHA Project File (*.prj)" from the *Save as type* drop-down.
4. Enter "Overland.prj" as the *File name*.
5. Click **Save** to save the project under the new name and exit the *Save GSSHA Project File* dialog.

Now run GSSHA:

6. Select *GSSHA* | **Run GSSHA…** to bring up the *GSSHA Run Options* dialog.
7. Click **OK** to close the *GSSHA Run Options* dialog and bring up the *Model Wrapper* dialog.
8. When GSSHA finishes, turn on *Read solution on exit* and click **Close** to exit the *Model Wrapper* dialog.

7 Results Visualization

In order to make the results more obvious, do the following:

1. Select " depth" to make it active in the Project Explorer.
2. Click **Contour Options** to bring up the *depth Contour Options* dialog.
3. In the *Contour Method* section, select "Color Fill and Linear" from the first drop-down.
4. Click **Legend…** to bring up the *Contour Legend Options* dialog.
5. Turn on *Display legend* and *Equal color segment height*.

6. Click **OK** to close the *Contour Legend Options* dialog.
7. Enter “50” as the *Transparency*.
8. Click **OK** to close the *depth Contour Options* dialog.
9. Scroll through the time steps to see how the tidal surge varies over time.

At time step “09/13/2008 05:00:02 AM”, the project should appear similar to Figure 10.

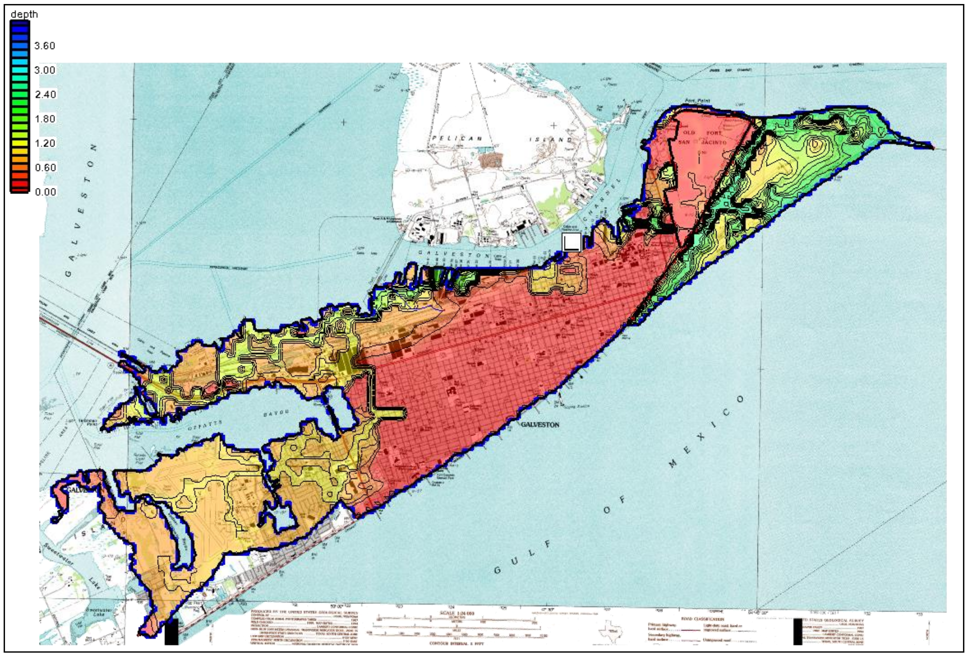


Figure 10 Tidal surge depth varies according to elevation

Feel free to explore other visualization options as desired. Datasets can be exported for use in other projects.

8 Conclusion

This concludes the “GSSHA Overland Flow Variable Stage Boundary Conditions” tutorial. Feel free to continue experimenting, or exit the program.

