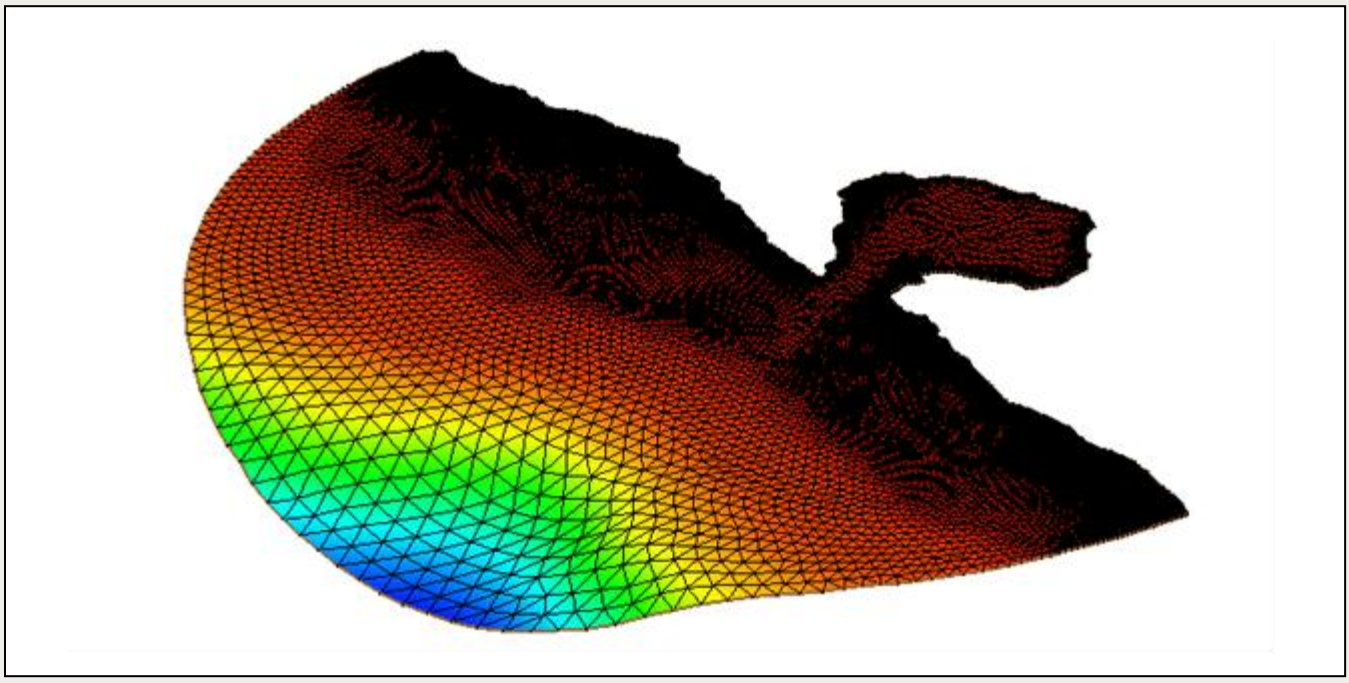
SMS 14.0 Tutorial

Wavelength Based Mesh

Creating a Wavelength Based Mesh



Objectives

Learn how to generate a mesh using a wavelength function.

Prerequisite Tutorials

- Overview
- Map Module
- Mesh Generation

Required Components

- SMS Core

Time

- 15–25 minutes

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1 Introduction

Note this tutorial uses the CGWAVE model interface, but the principles could be adapted to other coastal models such as ADCIRC or STWAVE.

This tutorial begins by opening the “indiana.sms” file containing a set of points with elevation data. This data will be used to create a mesh.

1. Select *File* | **Open…** to bring up the *Open* dialog.
2. Browse to the *data files*\ folder for this tutorial and select “indiana.sms”.
3. Click **Open** to exit the *Open* dialog and open the project.

A scatter set named “ indiana” will be created in the Project Explorer, and the project should appear similar to Figure 1. This data is referenced to a UTM coordinate frame and is in meters.

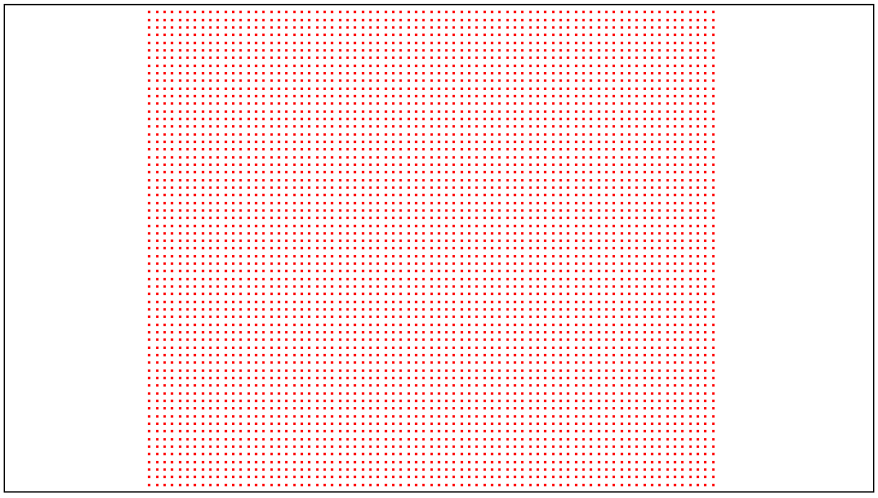

Figure 1 Scatter set from the imported indiana.sms file

2 Creating a Wavelength Function

The first step is to create a wavelength function. The wavelength function is an intermediate step to creating a size function, which is covered in the next section.

The *z* value of each point in the “indiana.sms” data is a water elevation value. The wavelength at each point is calculated from this elevation value. A larger wavelength is calculated from a larger water elevation value.

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To create the wavelength function:

1. Select "  indiana" in the Project Explorer to make it active.
2. Select *Data* | **Data Set Toolbox…** to bring up the *Dataset Toolbox* dialog.
3. In the *Tools* section, select "Wave Length and Celerity" from the tree list.
4. In the *Wave Length and Celerity* section, enter "Transition" as the *Output base name*.
5. Enter "20.0" as the *Period*.
6. Click **Compute**.
7. Click **Done** to close the *Dataset Toolbox* dialog.

Two new datasets—"  Transition_Wavelength" and "  Transition_Celerity"—will be visible in the Project Explorer.

3 Creating a Size Function

The size function is created from the wavelength function. The size function determines the element size that will be created by SMS. Each point is assigned a size value. This size value is the approximate size of the elements to be created in the region where the point is located. The mesh will be denser where the size values are smaller.

The wavelength function created above contains values that are twice as large as the desired size values. The wavelength function will be scaled by one half to create the size function.

To do this:

1. Click the **Toolbox**  macro to open the *Toolbox* dialog.
2. In the *Tools* tab, expand the "  Datasets" folder.
3. Double-click on the **Dataset Calculator** tool to open the *Dataset Calculator* dialog.
4. For *Grid source selection*, set to "Scatter Data/Indiana".
5. For *Data location selection*, set to "Points".
6. Under the *Dataset table*, click the **Add Row**  button.
7. In row *1*, set the *Dataset* to "Transition_Wavelength".
8. For the *Mathematical expression*, enter "d1/5".
9. For the *Output dataset name* enter "size".
10. Click **OK** to run the tool.
11. When the tool finishes, click **OK** to close the *Dataset Calculator* window.

This represents the number of elements generated per wavelength. It is usually more appropriate to use a larger number of elements per wavelength (e.g., 10). The smaller number is used here to allow faster execution of the model.

A new dataset, "  size", based on the "  Transition_Wavelength" dataset will appear in the Project Explorer.

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3.1 Smooth Size Function

The final step in creating a size function is to smooth the size function. This modifies the size function, so its values do not change too quickly. Size functions that change too quickly can create poor transitions in element size.

1. Click the **Toolbox** macro to open the *Toolbox* dialog.
2. In the *Tools* tab, expand the "Datasets" folder.
3. Double-click on the **Smooth Datasets** tool to open the *Smooth Datasets* dialog.
4. In the *Input elevation dataset* section, select "Scatter Data/indiana/size".
5. In the *Smoothing Options* section, select "Element area change".
6. *Set smoothing area change limit* to "0.5" .

This modifies the size function, so the elements created by it are—at most—twice as big or half as small as their adjacent elements.

7. In the *Output dataset,* enter "size smoothed 0.5".
8. Click **OK** to close the *Smooth Dataset* dialog and run the tool.
9. When the tool finishes, click **OK** to close the *Smooth Dataset* tool.

If desired, the differences between the dataset "size" and "size smoothed 0.5" can be visualized by using the data calculator to subtract "size" from "size smoothed 0.5" and contouring the resulting dataset.

4 Defining the Domain

A domain represents the region that is offshore. In CGWAVE, the domain can be a circular, semi-circular, or rectangular region. In SMS, a feature arc is used to define the coastline. After the coastline is defined, feature arcs and feature polygons are used to define the domain region.

4.1 Creating the Coastline

SMS can automatically create a coastline at a specific elevation or water elevation from a scattered dataset. The active function of the active scattered dataset will be used for this operation. The project should currently have only one scattered dataset. To make the elevation function active:

1. Select the "Z" dataset in the Project Explorer to make it active.
2. Right-click on the "indiana" scatter set and select *Convert* | **Scatter Contours** → **Map** to open the *Create Contour Arcs* dialog.
3. In the *Contour options* section, enter "1.0" as the *Elevation*.
4. Enter "10.0" as the *Spacing along contour*.
5. Click **OK** to close the *Create Contour Arcs* dialog.
6. Select the "Area Property" coverage to make it active.

The display will refresh with an arc representing the water elevation line (see Figure 2).

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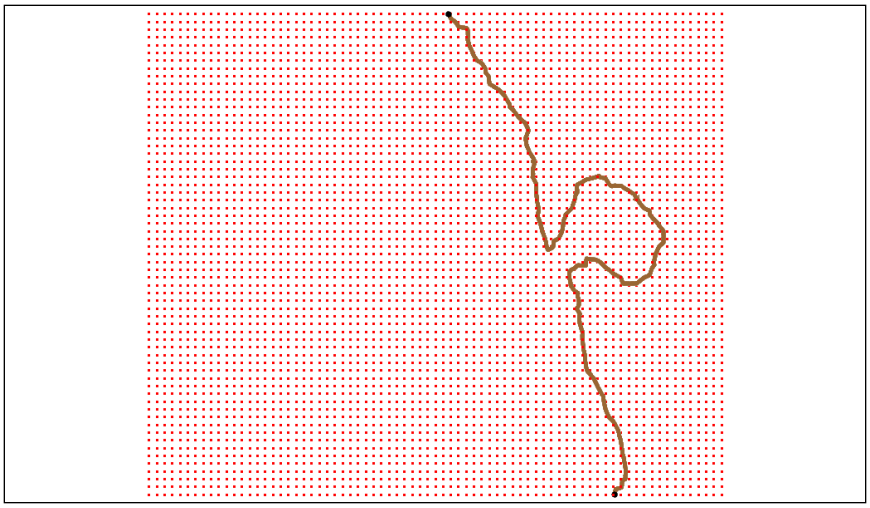

Figure 2 The arc representing the coastline

4.2 Creating the Domain

SMS can create a domain from the coastline. This model will use a semi-circular domain that intersects with the coastline.

To create the domain:

1. Using the **Select Feature Vertex** tool, hold down the *Shift* key and select one vertex near each end of the coastline arc.
2. Select *Feature Objects* | **Define Domain…** to open the *Domain Options* dialog.
3. Select *Semi-circular* and turn on *Switch side*.
4. Click **OK** to close the *Domain Options* dialog.
5. Select *Feature Objects* | **Build Polygons**.

This creates a semicircular arc and a feature polygon (Figure 3). This semicircular arc can have attributes assigned to it based on the coverage type, such as the ocean type could be assigned to the arc for CGWAVE coverage. The feature polygon must be created from the feature arcs. Make sure that the domain does not extend outside the extent of the scatter set. If it does, delete the semi-circular arc and recreate it with points further within the interior of the scatter set.

Because the domain does not extend outside the scatter set, there are now two arcs on the coastline outside of the domain. These need to be removed, otherwise SMS will render these arcs as unwanted nodestrings when the coverage is converted to a mesh.

1. Using the **Select Feature Arc** tool, select the arc at the top of coastline that is outside of the domain and delete it.
2. Repeat the step above for the arc at the bottom of the coastline that is outside of the domain.

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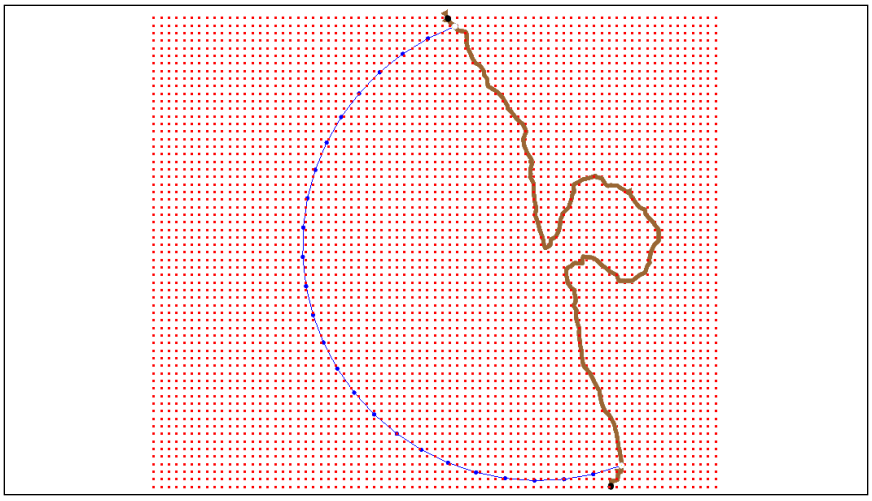

Figure 3 The ocean domain arc

The polygon is formed from the set of arcs that form a closed loop (in this case, from the ocean domain arc and the part of the coastline arc between the ends of the ocean domain arc). The screen will not refresh when polygons are built, so it may appear that nothing happened even though polygons were created.

4.3 Redistribute Vertices

Before generating the mesh, the vertices along the arcs need to be redistributed to match the smoothed size function. To do this:

1. Using the **Select Feature Arc** tool, select the ocean domain arc.
2. Right-click on the ocean arc and select **Redistribute Vertices…** to open the *Redistribute Vertices* dialog.
3. Select “Size Function” for the *Specify* option.
4. Click the **Options** button to open the *Interpolation Source and Options* dialog.
5. For the *Source dataset*, select “Project\Scatter Data\indiana\size smoothed 0.5”.
6. Click **OK** to close the *Interpolation Source and Options* dialog.
7. Click **OK** to close the *Redistribute Vertices* dialog.

The vertices along the arcs will be redistributed to match the smoothed size function dataset.

5 Creating the Finite Element Mesh

There are various automatic mesh generation techniques used to create elements inside a specified boundary. One of these is applied to each polygon, after which a finite element mesh can be generated. For this tutorial, there is only one polygon, which will be assigned the density mesh type.

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5.1 Setting up the Polygon

When using density meshing, SMS determines element sizes from a size function in a scattered dataset. The size function to be used in this example was created in Section 3. To set up the feature polygon for density meshing:

1. Right-click on the "Area Property" coverage and select *Type* | *Generic* | **Mesh Generator**.
2. Using the **Select Feature Polygons** tool, double-click inside the ocean domain polygon to bring up the *2D Mesh Polygon Properties* dialog.
3. In the *Mesh Type* section, select "Scalar Paving (triangles)" from the drop-down.
4. Click **Scatter Options…** to bring up the *Interpolation* dialog.
5. In the *Interpolation Options* section, enter "10.0" in the *Single Value* field.

The value in this field and in the *Min* field—in step 6 below—must be the same. If they do not match when closing the *Interpolation* dialog, a warning will advise they have been changed to match.

6. In the *Other Options* section, turn on *Truncate values*.
7. Enter "10.0" as the *Min*.
8. Enter "10000.0" as the *Max*.

This sets up a minimum and maximum size to be used when creating elements.

9. In the *Scatter Set to Interpolate From* section, select the "size smoothed 0.5" dataset.
10. Click **OK** to close the *Interpolation* dialog.
11. In the *Elevation (bathy/topo) type* section, select "Scatter Set" from the drop-down.
12. Click **Scatter Options…** to bring up the *Interpolation* dialog.
13. In the *Scatter Set to Interpolate From* section, select "Z" from the list of datasets.
14. In the *Other Options* section, turn off *Truncate Values*.

As mesh nodes are created, their elevation values will be assigned from the original water elevation values that were imported from the original XYZ file.

15. Click **OK** to close the *Interpolation* dialog.
16. Click **OK** to close the *2D Mesh Polygon Properties* dialog.

The polygon is now set up to generate finite elements inside the boundary. When more than one polygon exists, the meshing attributes need to be set up for each of the polygons. As only one polygon exists in this tutorial, this process is complete.

5.2 Generating the Elements

The next step is to have SMS generate the finite element mesh from the defined domain.

To create the mesh:

1. Select *Feature Objects* | **Map→2D Mesh** to bring up the *Mesh Name* dialog.
2. Accept the default name by clicking **OK** to close the *Mesh Name* dialog.
3. Turn off "Scatter Data" and "Map Data" in the Project Explorer.

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The Main Graphics Window should now appear as in Figure 4.

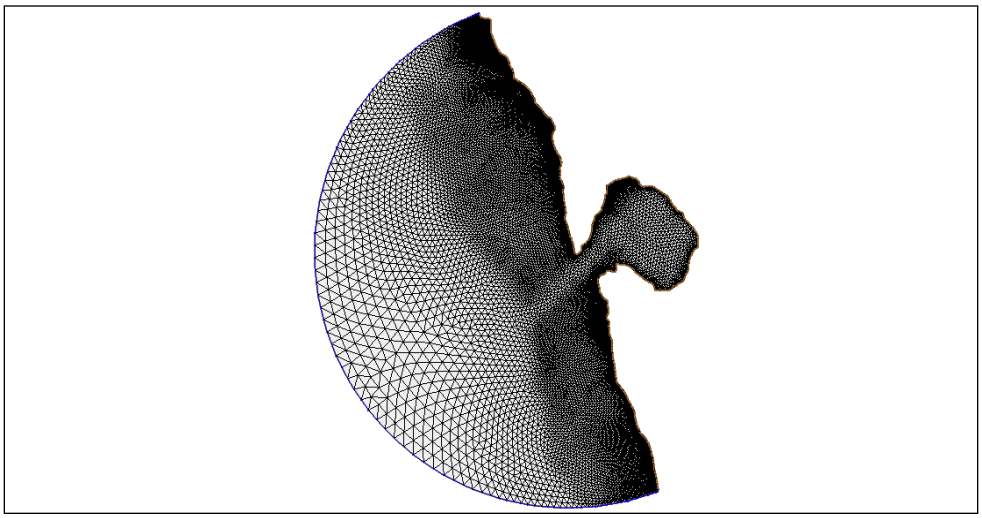

Figure 4 The mesh after turning off scatter and map data

To further declutter the project display, do the following:

1. Click **Display Options** to bring up the *Display Options* dialog.
2. Select “2D Mesh” from the list on the left.
3. On the *2D Mesh* tab, click **All Off**.
4. Turn on *Elements, Contours*, and *Nodestrings*.
5. On the *Contour Options* tab, in the *Contour method* section, select “Color Fill” from the drop-down.
6. In the *Contour interval* section, select “Number” from the drop-down and enter “20” in the field to the right of the drop-down.
7. Click **OK** to close the *Display Options* dialog.

After the display is refreshed, notice the contours of water elevation with the elements drawn on top of those (Figure 5). As the water elevation decreases, so does the element size. A dredged channel can be seen running into the harbor.

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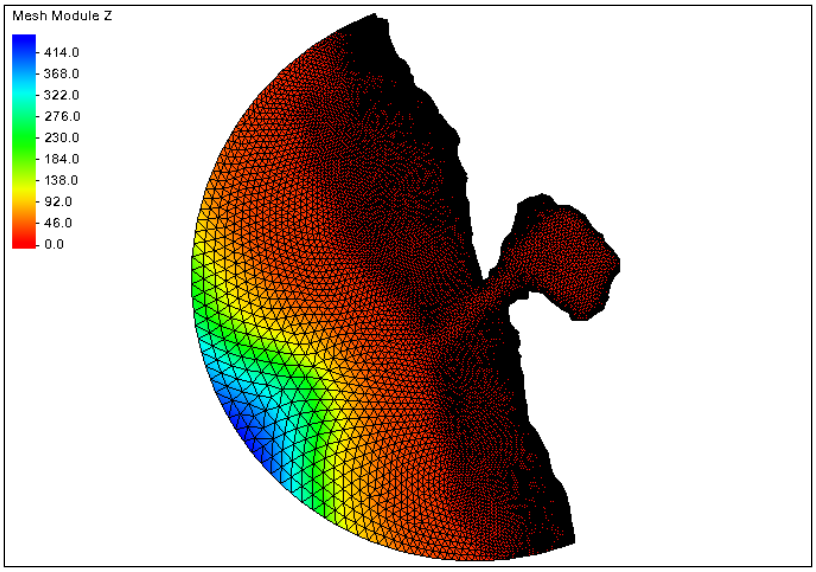

Figure 5 The contour color fill shows the increasing depth

The mesh can now be used to run a coastal model simulation, such as ADCIRC, CGWAVE, or STWAVE. For more information on how to do this, see the “CGWAVE” tutorial.

6 Conclusion

This concludes the “Creating a Wavelength Based Mesh” tutorial. Continue to explore generating wave based meshes, other mesh generation options, or exit SMS at this point.

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