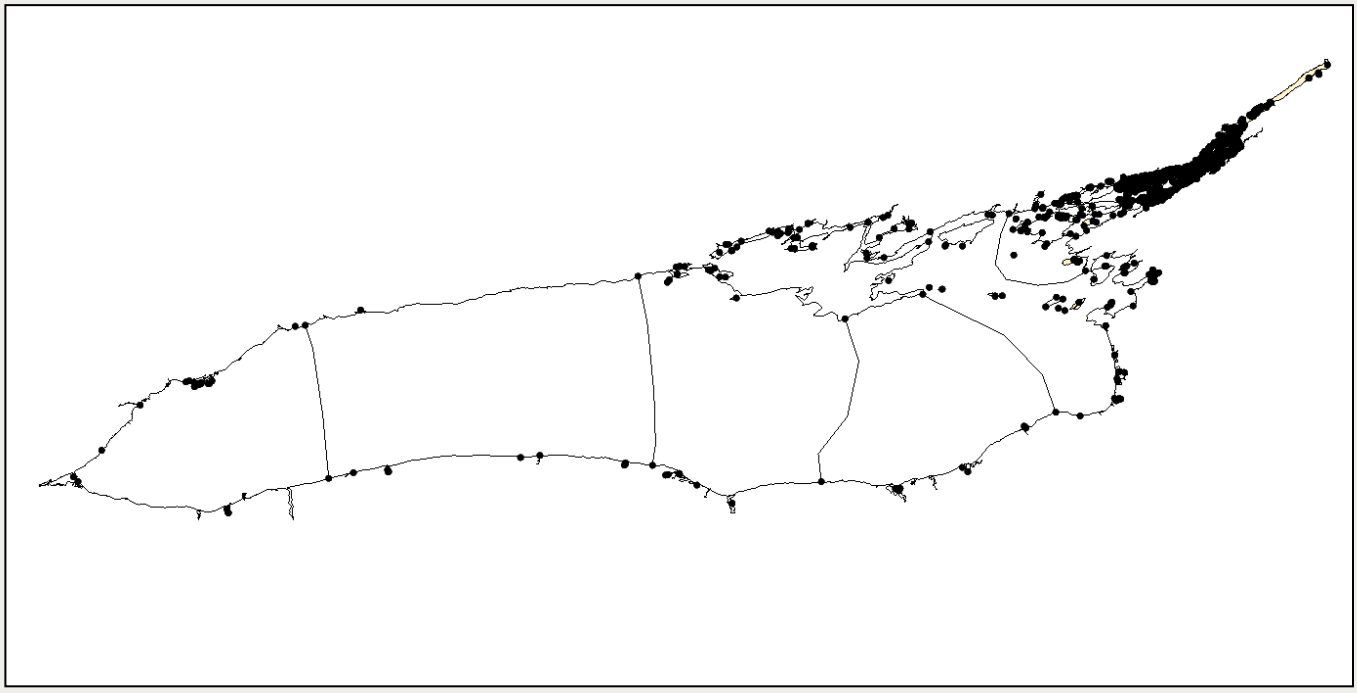
SMS 13.4 Tutorial

Clean Shapes – Data Preparation

Removing Unwanted Complexity and Detail



Objectives

This tutorial demonstrates how to review and modify geographical information system (GIS) data for use in constructing numerical hydrodynamic models.

Prerequisite Tutorials

- Overview
- GIS

Required Components

- SMS Core

Time

- 5–10 minutes

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1 Introduction

Geographical Information Systems (GIS) data has become prevalent in the world with applications to innumerable fields. However, GIS data often includes data that is not at the appropriate level of detail, nor conditioned appropriately for use in the construction of numerical hydrodynamic simulations such as those created in the Surface-water Modeling System (SMS).

This tutorial is the first in a series that illustrates workflows for cleaning and conditioning GIS data for numerical applications.

2 Getting Started

Start by importing a GIS file containing a representation of Lake Ontario.

1. Launch the SMS application.
2. To clear any display projection that may be set, select *Display* | ***Display Projection…*** to open the *Display Projection* dialog.
3. Select the *No projection* option and click **OK** to close the *Display Projection* dialog.

This will allow SMS to set the projection based on the GIS data.

4. Select the **Display Options** macro to bring up the *Display Options* dialog.
5. On the right side of the dialog in the *Polygon* section, turn off the *Fill* option.
6. Click **OK** to close the *Display Options* dialog.

Drawing filled polygons can be a slow operation if the polygons are complex. Turning the polygon fill display off until it is needed improves efficiency.

7. Select *File* | **Open…** to bring up the *Open* dialog.
8. Browse to the *data files* folder for this tutorial and select "lake_ontario_shoreline.shp".

   Note: there are eight files with the prefix "lake_ontario_shoreline". The SHP or shapefile references all of these.
9. Click **Open** to exit the *Open* dialog and import the data.

An entry in the Project Explorer named "lake_ontario_shoreline.shp" appears in the tree. The graphics window should appear similar to Figure 1.

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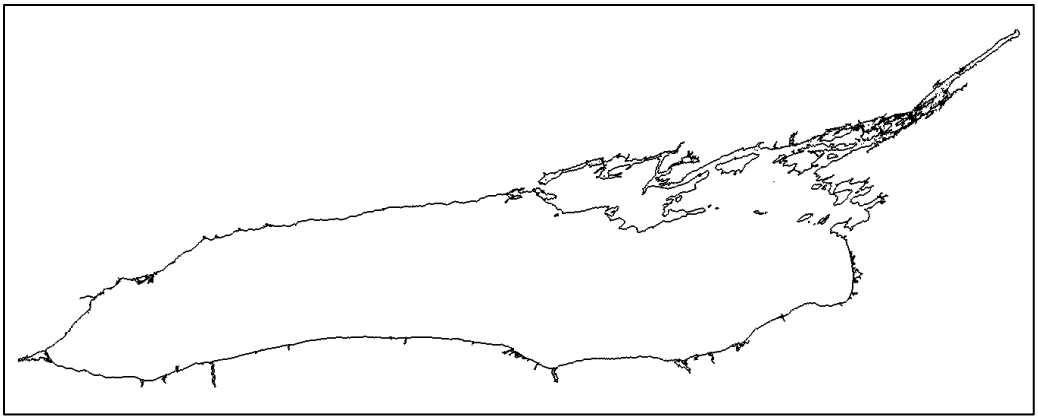

Figure 1 Input GIS data

Refer to https://www.xmswiki.com/wiki/SMS:GIS_Module for information on the GIS module in SMS or review the "GIS" tutorial from the SMS tutorial list. More information can also be found in the "Projections" tutorial.

3 Reviewing the GIS Data

The imported shapefile includes a single complex object which represents the entire shoreline of Lake Ontario including island shores.

To review the data, do the following:

1. Using the **Get Attributes** tool, click on the shoreline in the Graphics Window to open the *Identify* dialog.

SMS highlights the entire shoreline (including all the islands) in blue to show which object has been selected. The *Identify* dialog show the attributes for the select object. The *Identify* dialog only includes an object id and a single field named "Shape_Le_1". This implies that the shapefile only contains geometric data representing the lake and its islands.

2. Click **OK** to close the *Identify* dialog.
3. In the Project Explorer, right-click on "lake_ontario_shoreline.shp" and select *Convert* | **Shapes** → **Feature Objects** to open the *GIS to Feature Objects Wizard*.
4. Accept the default settings and click **Next >** to go to the next step of wizard.
5. Click **Finish** to close the *GIS to Feature Objects Wizard* and convert the data in the GIS file to the " Area Property" coverage.

Since there are no attributes in the GIS data, no other options are available.

6. In the Project Explorer, turn off " lake_ontario_shoreline.shp".

The display will now show the representation of the shoreline as SMS map module data. This should be similar to Figure 2 with arcs and nodes displayed, although this may vary based on the active display options.

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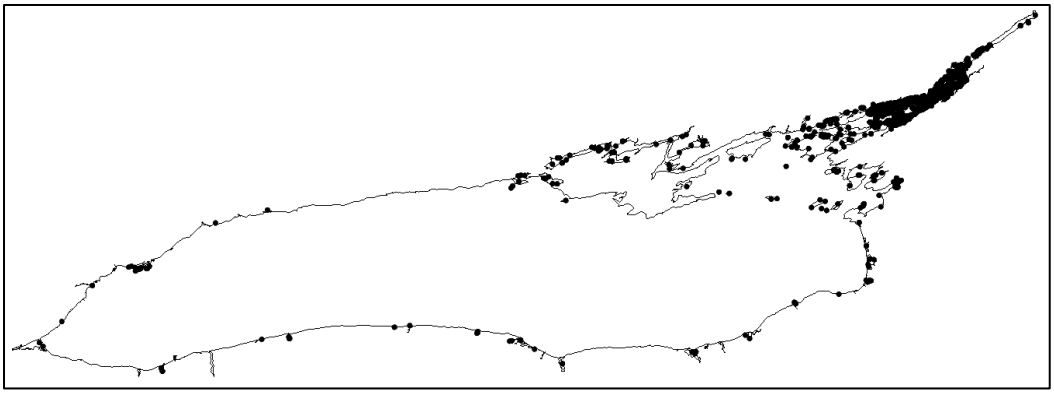

Figure 2 Lake Ontario shoreline converted to SMS Map Module arcs.

7. Right-click on the "Area Property" coverage and select **Rename**.
8. Enter "From Shape" for the new name and press *Enter*.
9. Right-click on the "From Shape" coverage and select *Type* | *Generic* | **Mesh Generator**.
10. Right-click on the "From Shape" coverage again and select *Projection* | *Projection …* to specify the projection of this data. The *Projection* dialog appears.
11. Toggle on the *Global projection* radio button to specify that the data is explicitly referenced to the geographic system defined in the shapefile and click *OK*.

4 Reviewing the Map Data

SMS represents disjoint line segments as "arcs" with nodes at the ends and vertices defining the interior shape of the polyline. (Refer to the SMS *Map Module* tutorial for more information.)

To review the data that was converted from GIS:

1. Right-click on the "From Shape" coverage and select *Properties…* The *Coverage Properties* dialog appears.

Note: The single arc or polyline entity in the shape file has been converted to 2199 arcs with 577,978 vertices. Also note that there are 1977 nodes. The fact that there are more arcs than nodes indicates that multiple arcs use the same node(s). This means the representation of islands is not "clean" (or 1 arc equals 1 island). Instead, there are intersecting arcs.

Also note that the data does not include any representation of polygons.

2. Click *OK* to close the dialog.
3. Now select the "Select Feature Arc" tool and click on the line representing the main shoreline of Lake Ontario.

Note: The information displayed at the bottom of the graphics window indicates that this shoreline arc consists of 308,214 segments and is 2,856,366 meters long. This level of complexity slows down graphic display, especially if the operation is displaying a polygon of this complexity. In this case, the situation is even more complex because the "polygon" of the lake will include approximately 2000 islands that also contribute to the complexity.

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4. With this arc still selected, right-click and select *Redistribute Vertices…* to see the length of the segments. (This is displayed as information in the *Redistribute Vertices* dialog.)

Note: The shortest segment length is displayed as 0.0. This indicates that the data from the shapefile includes two vertices at essentially the exact same location, or a vertex collocated with a node. The average segment length is 8 meters. Representing this shoreline with that level of precision is not practical or required for numerical processes. A numeric engine such as ADCIRC or SCHISM often have shorelines with spacing in the range of 1-10 kilometers as opposed to meters. Even the highest resolution models usually have a minimum spacing of above 10 meters.

5. Click *Cancel* to close the dialog. (**DO NOT** click *OK* since this would alter the GIS data due to redistribution without local control.)

5 Reducing Complexity

The objective when working with large GIS data is to reduce the complexity and modify precision to levels that are appropriate for application of this data in a modeling project. This includes many possible operations and applies to both the number of individual objects in a coverage as well as the number of segments used to represent those objects.

Possible simplifications include:

- Delete vertices resulting in extremely short segments (or merge segments).
- Delete extremely short arcs or merge them with adjacent arcs.
- Delete very small polygons or merge them with adjacent polygons.
- Subdivide overly complex polygons to improve graphical operations.

The *Clean Shapes* tool illustrated in this series of tutorials is designed to help with these operations. However, before using the tool, it may be beneficial to minimize issues related to very complex polygons. The polygon that would represent Lake Ontario is such a complex polygon. Two methods of working with this data include:

- Subdivide the lake into smaller polygons that can be more easily managed, displayed, and operated on. (This will be demonstrated in this section.)
- Remove the main polygon and only operate on the islands.

This tutorial series uses the first method, because it maintains all of the provided input data. To reduce the complexity of the polygon that will represent the lake:

1. Right-click on the "From Shape" coverage and select *Duplicate*.
2. Right-click on the "From Shape (2)" coverage and select *Rename*. Set the name to "West end".
3. Click on the "West end" coverage to make it active.
4. Select the " Create Feature Arc" tool to make it active.
5. Create an arc that cuts off the west end of the lake from the main lake body as shown in Figure 3 (the image shows an arc with 3 segments which is created with four clicks).

   Note: don't worry about the exact locations defining the arc to split the lake. That type of information would not be available for project work.

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6. Click on the "Build Polygons" macro to have SMS define the polygons for this coverage. (This will build two polygons for the lake and around 1900 polygons for the islands.)

Figure 3 West end of Lake Ontario separated from main lake with simple arc.

Note: The arc you just created illustrates how to subdivide the lake. In the Northeast section of the lake, subdividing also requires that the new arcs don't bisect islands. For consistency, you will now read a "map" file that has subdivided the lake into ten sections as shown in Figure 4. Most of these are in the portion of the lake with the complexity of many islands.

10. Select *File* | **Open…** to bring up the *Open* dialog.
11. Select "Subdivided Lake Polygon.map".
12. Click **Open** to exit the *Open* dialog and import the data.
7. Toggle off the "From Shape" and "West end" coverages.

Figure 4 Lake Ontario subdivided into ten sections.

You may wish to use the *Zoom* and *Pan* tools to review the subdivision of the polygon. Try selecting multiple arcs and reviewing the number of vertices that define those arcs. You may also review the coverage properties.

6 Conclusion

To save this project before moving on to additional operations:

1. Select *File* | **Save New Project…** to bring up the *Open* dialog.

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2. Enter the name “LakeOntario” as the new project name and click *Save*.

This concludes the “Clean Shapes – Data Preparation” tutorial. We now have a coverage that is ready to be cleaned. Several options for cleaning are illustrated in the other tutorials in this series.

Several features have been demonstrated including:

- Loading a GIS shapefile and reviewing the attributes of the data.
- Converting GIS shapefile data to an SMS coverage.
- Subdividing a complex polygon.

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