

Georeferencing and Digitizing Image/Map

Introduction

There is a great deal of geographic data available in formats that can not be immediately integrated with other GIS data. In order to use these types of data in GIS it is necessary to align it with existing geographically referenced data, this process is also called georeferencing. Georeferencing is also a necessary step in the digitizing process. Digitizing in GIS is the process of “tracing”, in a geographically correct way, information from images/maps. The process of georeferencing relies on the coordination of points on the scanned image (data to be georeferenced) with points on a geographically referenced data (data to which the image will be georeferenced). By “linking” points on the image with those same locations in the geographically referenced data you will create a polynomial transformation that converts the location of the entire image to the correct geographic location. We can call the linked points on each data layer control points.

The selection of control points is important. Some guidelines:

- They should be easy to confirm as representing the same geographic location (street intersection, political boundary, landmark, etc.).
- They should be spread across the image to be registered, one suggestion is to select a control point near each of the corners of the image and few throughout the interior will often work well.
- Good overlap between the two dataset is also important.
- Make sure you are clicking as close as possible to the same geographic location, zooming in can help in this process.

As you add points the complexity of the transformation that is possible increases. This is not always a good thing, 1st, 2nd, and 3rd order polynomials can be calculated, usually a 1st or 2nd order transformation is all that is necessary. In order to complete a 1st order transformation you need a minimum of three control points, for a 2nd order you need a minimum of six control points, and for a 3rd order you will need a minimum of ten points. A 1st order transformation will shift, scale, and rotate your image while 2nd and 3rd order transformations will bend and curve straight lines, which might be necessary, but is rare.

Data:

Three file will be used in this training module, NYStreet.shp, ManhattanCensus.shp, and Manhattan.sid. The latter is a raster image of the same type as jpeg, gif, tiff, etc.; it's just a digital picture at this point. The first file is a shapefile that contains the street map for the entire state of NY; the second is a layer that contains only the census tracts and extent for Manhattan, which will be useful for zooming to and initially coordinating the image. The first thing you are going to do is “**Clip**” the part of the street map that intersects Manhattan. The street layer will be used for setting control points.

Creating a New Layer by Clipping

Open Both layers (NYStreet and ManhattanCensus).

Open ArcToolBox (red toolbox on menu) and open Analysis Tools, then Extract. Choose the clip tool.

The input feature is the street map.

The clip feature is the census tracts of Manhattan.

The output class should go somewhere you can find it and be named something you will recognize (ManhattanStreet.shp as an example).

Don't worry about cluster tolerances.

Click Ok.

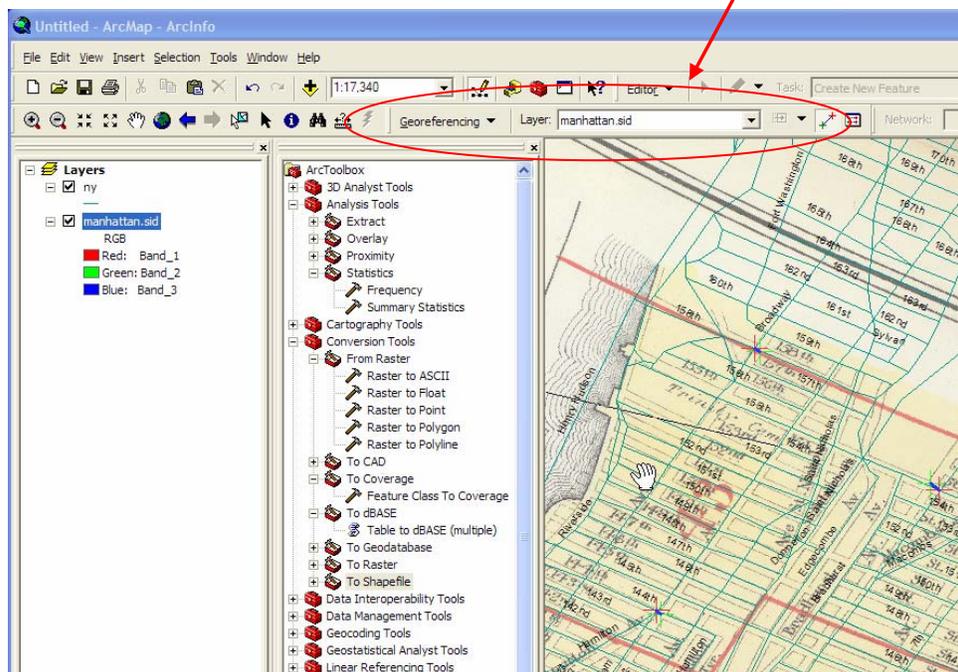
Add the new layer and remove the original street layer.

Georeferencing/Registering an Image

Tools:

The primary tool we will be using is the **georeferencing toolbar**

The georeferencing toolbar is probably not visible when you first open ArcGIS, you can open it by clicking on view, selecting toolbars, then activating the georeferencing toolbar option.



Add the manhattan.sid file.

Right click the shapefile (not image) and “Zoom to Layer,” this is a nice feature you might have used before that let us get to the geographic extent of a specific data layer quickly.

From the georeferencing toolbar, click the “Layer” dropdown arrow and select the manhattan.sid image name.

Click “Georeference” and select “Fit to Display” from the dropdown.

This will display the image in the same general space as the manhattan census tracts layer.

Before adding control points you should move the image around a bit to get it closer to the orientation and position of the GIS layers you are using.

Use the Rotate and Shift tools for this.



Now you are read to add control points. **Click on the control points tool.**

You should be using the clipped data for linking, and use the labels too. (Right click the layer and select label features).

To add a link, click the mouse on the image first, then on a known location on the GIS database. You can use the magnify tools to get a close look at subsets of the data.

You can also turn on the effect toolbar to change the transparency to see both layers at once if you like, or you can turn the layers off and one as you select points from each.

Once you’ve added a few links you can open the link table to see how each has worked. **View Link Table is the final icon on the right of the georeferencing toolbar.**

Link	X Source	Y Source	X Map	Y Map	Residual
1	126.721400	-137.184043	36.000000	38.000000	0.11269
2	481.722997	-157.924424	41.000000	38.000000	0.05880
3	834.185287	-163.037905	46.000000	38.000000	0.15566
4	467.893846	-526.126608	41.000000	34.000000	0.09076
5	835.768849	-530.797717	46.000000	34.000000	0.11519
6	11.682821	-606.819209	34.964005	32.828938	0.12860
7	96.207936	-290.295550	35.792347	36.310738	0.02436

Auto Adjust Transformation: 1st Order Polynomial (Affine) Total RMS Error: 0.10625
 Load... Save... OK

In the link table you can view the **Total RMS Error** as well as the **residual** for each link that contributes to the overall Total. The errors are associated with the amount of disagreement between the two control points for each link once the transformation is set (once you've added more than three links). You have to be sure that the two points that are linked are the same place in world (same street intersection for instance), as you could have a very low error and residuals but not have an accurately registered image.

Once you are satisfied with the registration, and you can delete links or start all over by deleting them all, you can **Update Georeferencing**, this will save your transformation. This process will add a .aux file that contains information about the transformation that is necessary to view this file in the future with other data.

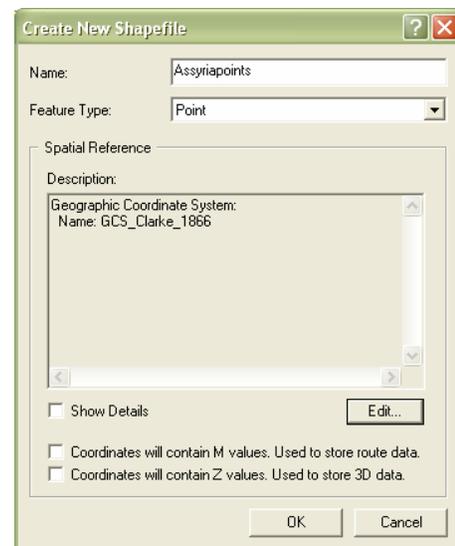
Don't forget to save your work, **save your map as "xxx".mxd**.

Digitizing Features

Introduction

Now you are going to begin digitizing features of this image. Digitizing is the process of making features we can see on the Manhattan image editable and making them features to which additional spatial and non-spatial attributes can be assigned. This means we are going to follow a process of making digital versions of objects that will have an attribute table associated with them. Our primary goal will be digitizing the Wards, which are objects that occupy an area on the map, once they are digitized and have an associated attribute table these objects will also be known as polygon features. In an accompanying document you have data on the home country of Mothers by Ward. When digitizing we can digitize points, lines, or polygons. By digitizing these features, you make them available for mapping once you have added the tabular data to the attribute table (as you know there are a few ways you can do this). The digitizing process is started by creating new layers in ArcCatalog, and then adding features to them in ArcMap.

1. **Creating an empty shapefile.** Open ArcCatalog. We are going to create a new shapefile that we can edit in ArcMap—this will be a polygon feature shapefile to which we will add ward boundaries. In ArcCatalog, browse to **the location of your current mxd file. This is the folder in which you will create your new shapefile**, so select that *folder* and right-click on it. Go to **New → Shapefile...** to open the **Create New Shapefile** window. Give the polygon shapefile an appropriate name such as **ManhattanWard**. Click on **Edit...** to see the Coordinate System of the file. In the **Spatial Reference Properties** window click **Import...** to use the projection of the manhattan street layer. Click OK and OK again to create the shapefile.



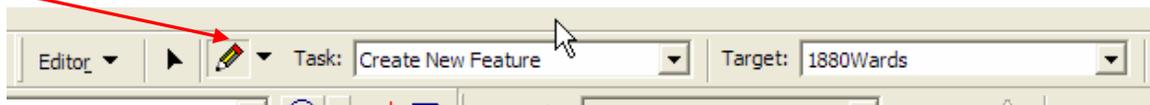
2. **Add a new field in the Attribute Table.** Return to ArcMap, and add your new shapefile to the Data Frame (TOC). If you open the Attribute Tables of this shapefile you will find it empty. We are going to use this empty shapefile to create features from our image.

Now you will start working with the new shapefile. Before you start editing, first open its Attribute Table. Click on the **Options** button and **Add Field...** First create

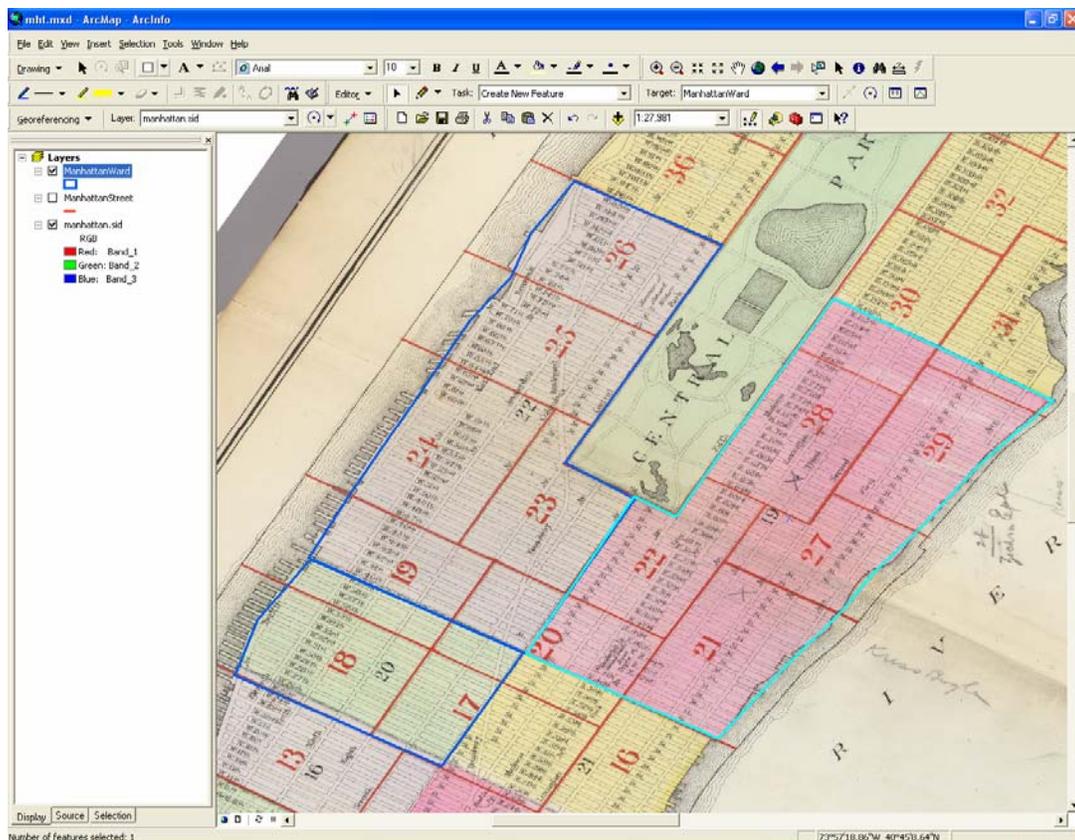
a **Short Integer** (choose in the **Type** drop-down menu) field called **Wards** where the Ward number identifier will be entered. Note that you cannot create new fields while you are editing a layer.

- 3. Digitizing Wards and entering tabular data.** You will need the **Editor** toolbar. **View**→**Toolbars**→**Editor**. On the toolbar, click on the Editor menu and **Start Editing**. You will be prompted to choose the folder that your shapefiles are in, and then click OK. Before you get started creating polygons, turn off all but the **registered manhattan** image layer.

In the Editor toolbar, **Start Editing**. Choose **MahanttanWard (or whatever you named it) layer** as the layer you want to edit. In the Editor toolbar, **Create New Feature**. You are going to create a polygon for individual wards, it is probably easiest to start with some rectangular shapes. There are some good ones south of central park. From the pull down menu next to the Editor pull down choose the **sketch** tool.



By clicking at the four corners (single clicks) of the ward you are digitizing you will create a continuous outline of it. Double clicking when you get back to where you started will finish your **Sketch**. This should make your polygon become an actual, filled polygon. If you make a mistake you can select and delete sketch. You can digitize 3-5 ward boundaries and enter corresponding ward ID numbers into the **Wards** field in the attribute table.



Attributes of ManhattanWard

	FID	Shape ^A	Id	Wards
▶	0	Polygon	0	19
	1	Polygon	0	22
	2	Polygon	0	20

Record: 1 Show: All Sele

Extension Activity

Now that you have digitized a few polygons in ArcGIS you have acquired the skills to create editable features from scanned maps that can be linked with tabular data. If you are interested you can do a number of things to extend what you have learned. You can digitize the rest of the wards, create new fields in the attribute table, and either edit or link the 1890 Ward data in order to create a map of 1890 demographic patterns for Manhattan. You can also do just a subset of this work and map a few wards and link or add the data to create a map of 1890 demographic patterns. What you are doing has not been done before, you will be creating some of the first digital maps of Manhattan in 1890, have fun!!