Georeferencing images and scanned maps

In this exercise, we can see how to add georeferencing to scanned maps and aerial photos so that their value can be multiplied through association with other data. Where good georeferenced control layers can be found, the process of georeferencing an image is surprisingly easy.

Scanned topographic maps
Some scanned maps have coordinate system information in the margins that can be used to georeference the image without reference to any other data. This can be useful for beginning a spatial framework for areas where good control layers are difficult to obtain.


2. Add the data element “Scanned_topo.jpg”. You will receive a message indicating that this layer is missing a spatial reference. Click “OK”.

3. It does not show up where we would hope it would. Find it by Zooming to this layer.

We can now clearly see the scanned map, however it is still not obvious where it lies in relation to our georeference Landsat image.

4. Click on the Full Extent button on the main menu. The display will now show the entire Landsat image as a small square, while the scanned topo is not visible (because it is too small).

Because it lacks a spatial reference, ArcMap has arbitrarily placed the topo map.

5. Zoom back to the scanned topo and visually examine the map. Note that lat./lon. notations are made in degrees, minutes, seconds along the margins of the map. Follow major lines of longitude and you will also find several shaped ‘tic’ marks placed at the confluence of major lines of lat./lon. We will georeference this image using solely these notations.

6. Navigate to the bookmark entitled “Cape Henry”. This will restore your display to the proper Cape Henry location.
7. Activate the Georeferencing toolbar by clicking ‘View – Toolbars – Georeferencing’

8. On the toolbar, set your layer to “Scanned_topo.jpg”. Click on the ‘Georeferencing’ dropdown menu, make sure that ‘Auto Adjust’ is checked and then click ‘Fit to display’.

   This will relocate your scanned topo to the current display. However, it is obvious that the image is still not properly referenced.

9. Navigate to the Bookmark titled “Northwest”. This zooms you to the top left of the scanned map, where you will see lat/lon notations.

10. On the Georeferencing toolbar, click on the ‘Add control points’ icon. Use your mouse to click and place a control point directly atop the cross representing 37 00 lat and 76 07 30 lon.

11. A green cross will appear where you have clicked. Now ‘right-click’ and select “Input X and Y…”.

Both the USGS and the FCC have excellent online DMS to Decimal Degree converters. The FCC site can process both at once.


Use the following space to record your conversions for the four map corners.

<table>
<thead>
<tr>
<th>Degrees Minutes Seconds lat/lon</th>
<th>Decimal Degree lat/lon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

For the sake of time, we will just use these four points to georeference our map. Adding additional points using the tic marks in the center of the map would increase our accuracy.
IMPORTANT NOTE: If you are georeferencing from coordinates printed on a scanned map, it is important that you begin by projecting your data frame to the proper Coordinate System/Datum combination.

Most often, you will get this information directly from the map. **Zoom** to the bottom left corner of the scanned topo map and you will find text that provides this, and other information about the map.

Right-click on ‘Layers’ in the table of contents. Select ‘Properties’ and review the ‘Coordinate System’ tab. You’ll see that it’s set to NAD1927 to mirror the topo.

12. As you create control points, they will be added to the ‘Link Table’. Open this table using the ‘Link table’ icon on the Georeferencing toolbar.

You need a minimum of 3 links for a spline or first-order polynomial, 6 links for a second-order polynomial, and 10 links for a third-order polynomial.

Since we will have only 4 links, we will be using a first order polynomial transformation.

By the time you enter the 4th link, you’ll notice that ArcMap shifts the image very little. This is because the ‘Auto adjustments’ applied by the 3 prior links.

13. Your scanned map should now appear to be in an approximately accurate location in relation to the underlying Landsat image. One way to visually confirm this is to activate the ‘Effects’ toolbar and click on the ‘Flicker’ icon at right.
14. Close your ArcMap document and do not save the changes. You can make your georeferencing permanent, but will not be doing so for this image.

_Aerial Photography with unknown coordinate (georeferencing from features)_
If you do not have any latitude and longitude or other spatial reference annotation you still may be able to do successfully georeference and image using features in the map such as the hydrology network, major road junctions, visible landmarks, and other landscape features.

1. Open the ArcMap document “Georeference2.mxd”
2. Navigate to your “Cape Henry” Bookmark and then add the aerial image “NAPP_CHenry.tif” to ArcMap. As was the case with the topo, it does not appear in the proper location.

3. Zoom to the ‘Full Extent’ to see where ArcMap has placed the file (just off of the coast of Africa).

4. Return to the “Cape Henry” Bookmark.

5. On the Georeferencing toolbar ensure that your layer is set to “NAPP_CHenry.tif” and then click ‘Fit to Display’. A second problem is obvious. The image is oriented in the wrong direction.

6. On the Georeferencing toolbar click on ‘Flip or Rotate’ and ‘Rotate Left’.
7. The image should now be oriented correctly (more or less). Now we will need to select at least 3 landmarks or features visible in our photo that we can use as georeferencing links. We will use the georeferenced topographic map “O36076H1.TIF” as our control layer, so we will need to make sure that the features we select will be identifiable on both the photo and the topo map.

We will use the following features (measurements are referenced on the topo map):
Northern tip of the southern tunnel island of the Chesapeake Bay Bridge Tunnel (found at -76.091814 36.956755 Decimal Degrees)

Eastern bank of the Lynnhaven Inlet beneath the Lesner Bridge (found at -76.091080 36.907254 Decimal Degrees)

Center of Great neck Road Bridge where it crosses Broad Bay Island (found at -76.068928 36.903203 Decimal Degrees)

Intersection of US 60 and Atlantic Avenue (found at -75.993757 36.907473 Decimal Degrees)

8. Rather than use these measurements as we did in the prior exercise, we will simply drag the control points to their correct locations.

9. Activate the aerial image and zoom tightly to the bridge tunnel island.

Add a control point to the tip of the island, and then turn off the aerial image in the table of contents.

The topo map is now the visible layer. If the tunnel is not visible, use your mouse wheel to scroll out until you see it.

Once the tunnel island is visible, place your control point on the tip of the island. The cross-hair will turn red. Turn your aerial image back on and you will see that it has been adjusted to the new point.

10. Repeat this process for the other features (Image order: Lesner, Broad Bay, Atlantic).
11. When you are done placing your four control points, the image should have 4 red cross-hairs and should be adjusted to the approximate correct location.

Now your image will align with other GIS data, and it will reproject as necessary to conform to the coordinate system of the data frame.

**ArcGIS Georeferencing Tips**

- Add the data with the existing coordinate system first, so that you do not have to set the data frame coordinate system.
- To display the Georeferencing toolbar, click the View menu, point to Toolbars, then click Georeferencing.
- You can look for road intersections, land features, building corners, or other identifiable objects and match them in your raster dataset and aligned datasets.
- You can delete an unwanted link from the Link Table dialog box.
- Press Esc to remove a link while you’re in the middle of creating it.
- The Rotate and Shift tools are not available after you place the first link.
- You can permanently transform your raster dataset after georeferencing by using the Rectify command; click Georeferencing and click Rectify or use the Warp tool.
- To align your image in the same space as the data in the data frame, click the Georeferencing drop-down menu and click Fit to Display.