

# Introduction to Georeferencing: Worksheet

*DMDS Workshop - 28 February, 2019*

Georeferencing is the process of associating phenomena with a location on the Earth's surface, as defined within a given Coordinate Reference System (CRS). In the context of digitized cartographic material such as maps, this process involves matching pixels in the the "target" image with 'real-world' coordinates. This is typically accomplished by identifying a number of Ground Control Points (GCPs) -- features in the target image (road intersections, graticule intersections, etc.), for which their 'real-world' coordinates are known with precision and accuracy.

Once an image (such as a map) has been georeferenced, it becomes possible to transform it into different CRSs, meaning that it can be imported into GIS software and displayed alongside any other sort of geospatial data.

## Task 1: Find and import data; Compare vectors & rasters


**Your task:** Follow along with Jay as he introduces the QGIS user interface. Download some vector and raster data; compare them.

- Open QGIS.
- Go to Project>Properties and set your project Coordinate Reference System (CRS) to NAD83 / UTM zone 17N [EPSG:26917].
  - Check the box to "Enable on-the-fly CRS transformation"
- Download and load a georeferenced raster map
  - Navigate a browser to Scholars Geoportal: <http://geo.scholarsportal.info/>
  - Search for 'index' using the 'Historical Maps' category
  - Load the 1:25,000 topo map index
  - Use the interactive index to download the 1972 map sheet of Hamilton
    - Download to C:/Users/vopublic/Documents/ on a Wong laptop
  - Unzip the sheet
  - Load the file into QGIS using the 'Add Raster Layer' button
- Download and load some vector data from the City of Hamilton
  - Navigate a browser to Hamilton Open Data: <http://open.hamilton.ca>
  - Search for 'Buildings' and open the top selection (named '**Buildings**')
  - Click >Download>Shapefile; Download to the same directory as the topo map sheet
  - Unzip the data
  - Load the file **buildings.shp** into QGIS using the Browser, or 'Add Vector Layer' button, or by dragging it into the layers panel
  - Repeat the process to find, download, unzip and load the **Street Centreline** layer
- Follow along with Jay for a light introduction to vector and raster layers.


## Task 2: Georeferencing with mapwarper; importing to QGIS

**Your task:** Use the web-based georeferencing tool mapwarper.net to turn an image with spatial extent (map, aerial photo, etc.) into a geospatial data layer.

### Sign up for a mapwarper account and sign in

- Navigate to <http://mapwarper.net/>
- New users: Click on CREATE ACCOUNT 
  - Create an account
  - Click on activation link in your new email message
- Registered users: Click on SIGN IN

## Browse the maps; Select an image to georeference

- Click “BROWSE ALL MAPS” 
- Browse maps for our exercise
  - Search Tags for **DMDS-2019**








A search interface with a dropdown menu set to 'Tags' and a text input field containing 'DMDS-2019'. The word 'Year' is visible to the right of the input field.

- Claim a map to georectify with Map Warper in this shared Google Sheet: <https://goo.gl/7yFqRf>
- Once you’ve chosen a map, click “Rectify Map” to begin

## Add control points; warp the image

The mapwarper interface shows two panes: The left pane shows the image to be georeferenced (the “target image”), while the right pane is a web map (the “reference layer”). **Your objective** is to assign spatial coordinates to various points on the target image by matching them with corresponding points on the reference layer. These matching points are called **ground control points** (GCPs). Ideally, more GCPs improve the accuracy and fit of the target image to the reference layer.

- On the reference layer (right pane), select the “Move around map” button  and navigate to the area depicted in your target image (note: this may take a bit of time!)
- Once your reference layer is zoomed appropriately, identify a landmark that is common to both images (e.g. intersections, corners of parks, railroad crossings). Zoom in as close as possible to the landmark on both layers.
- Click the “Add control point” button , click the location of the landmark in the target image (left pane); repeat this for the reference layer.
- Once both control points are placed, click the  button.
- Repeat this process until you have at least 7 control points spread well around the target image.
- View the control point information by clicking “Control Points”. Inspect the Error values provided. Any value noted in red may require repositioning
- Use the “move control point” button  to adjust the location of any control point on either pane.
- When you’ve added enough points and you’re comfortable with their placement, click  to perform the georectification. The newly warped image should appear in the appropriate location in the reference layer.

## Import your georeferenced image into QGIS


Once your image is properly georeferenced and warped, there are a number of options for you to load it into GIS software or use it in other software. You can:

- Download as a GeoTiff or PNG image to use in GIS software (QGIS)
- Download as a KML file to use in Google Earth
- Use the WMS link to stream the layer to GIS software or other web platforms (e.g. Neatline)
- Use the Tiles link to add to a webmap like Leaflet.


### Option A: Downloading the GeoTiff

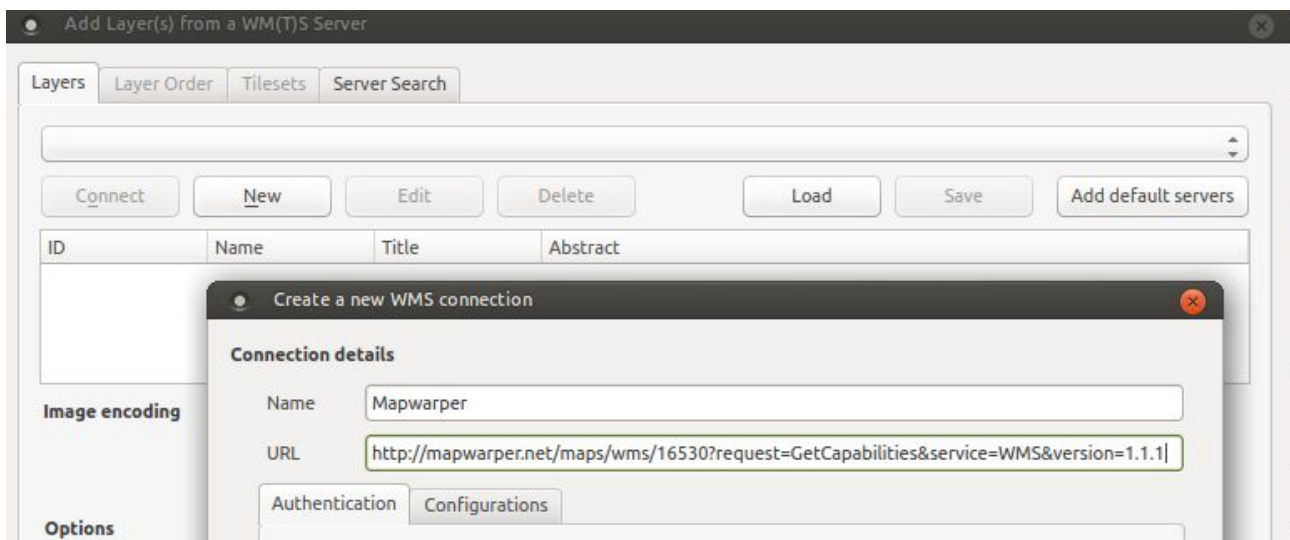
- On the mapwarper page for your image, click on the “Export” tab

Online version: <https://goo.gl/H5vqNs>

- Click "Download rectified GeoTiff"; download the tiff file to your local hard drive
- Open the downloaded GeoTiff file in QGIS using the "Import Raster"  button on the left panel, or simply by dragging the file into the Layers Panel

### Option B: Loading the layer 'on the fly' from mapwarper's WMS server

- On the mapwarper page for your image, click on the "Export" tab
- Right click the "WMS Capabilities URL" and copy the link to the clipboard
- In QGIS, click the "Add WMS/WMTS Layer" button 
- In the dialogue box, click "New"
- Provide a name for the layer (e.g. "Mapwarper")
- Paste in the copied URL
- Click OK to close the "Create a new WMS connection" window



- In the Add Layer(s) from a WM(T)S Server, click "Connect"; the available image should appear.
- Select the image; choose an image encoding (e.g. PNG) and click "Add"
- Close the window and view the image as a layer in QGIS.

### Task 3: Create web tiles from your GeoTiff; embed in a web map

Ensure that you've downloaded your (or someone else's) georectified GeoTiff from Map Warper and loaded it into QGIS (e.g. from [here](#))








- From the QGIS top panel, select >Processing>Toolbox
- When the toolbox appears on the right panel, navigate to and open >GDAL>Raster miscellaneous>gdal2tiles. In the dialogue box:
  - Select the desired input layer
  - If desired, set the zoom levels for which tiles will be created
    - use the format "x-y" (e.g. 7-19)
    - See [this resource](#) for more information
  - Select an Output directory
  - Use all other defaults (unless you know you want to change them)
  - Click "Run in Background"
- When completed, navigate to the output directory
- Open one of the html files in a browser (e.g. leaflet.html) to view your layer on a web map

### Task 4: Create vector files from your GeoTiff

You can use a georeferenced raster as a source file, from which vector data layers can be created.

- Display the raster layer that will serve as a source file (e.g. topo map, fire insurance plan)

Online version: <https://goo.gl/H5vqNs>

- Identify a feature to vectorize (perhaps a building, or a forest, or a parking lot)
  - Note if this feature should be represented as a point, line, or polygon.
- Create a new vector layer by clicking on the “New Shapefile Layer” button  on the left-hand toolbar
  - In the “New Shapefile Layer” dialogue box, browse to the proper save location and give your layer a name.
    - Select the **Geometry type** to be a **Point, Line, or Polygon** feature, depending on your needs.
    - In the CRS dropdown box, select either NAD83 / UTM Zone 17N (ESPG:26917) if you’re vectorizing a local Hamilton layer. Otherwise, use default EPSG:432 - WGS 84.
    - If you’re interested in adding fields to the attribute table, create them using the “New field” tool. For example, this could be useful if you wanted to record addresses for buildings, or the number of floors, or building material.
    - Click “OK” and save the vector file. It should now be added to your layers list.
- In the Layers panel, select (highlight) the new vector layer and click on the “Toggle Editing”  button to turn on editing for this layer.
- Once editing is enabled, click on the appropriate button to the right to add a Point Feature , a Line Feature , or a Polygon feature .
- You should now see a crosshair on the map. Click on the map to draw the vertices of the features, one node at a time. If you make a mistake, you can use the delete button to remove your last vertex.
- You may need to use the “pan” tool to scroll the map view (or you can middle-click and drag the map as needed)
- When you reach the last node, right-click at the end to bring up the Attributes form. Enter appropriate values for each attribute field.
- If at any point you need to modify the location of a node, use the “Move Node” tool .
- To move an entire feature, use the “Move Feature(s)” tool .
- Click the “Toggle Editing” button once more to quit editing the layer. When prompted, agree to **save the changes**.

## Task 5 (optional): Georeference using QGIS

QGIS has built-in functionality to georeference rasters. While it’s not as user-friendly as Map Warper, it is much more powerful; you can use it to georeference rasters using a) web map layers, b) known coordinates on the raster, or c) other georeferenced rasters.

If we get this far, download a non-georeferenced topo map sheet using a download link found on the this list: <https://goo.gl/YfwLRa>.

Follow along with Jay as he demonstrates how to georeference a raster using embedded coordinates.

## Other Useful Resources:

- QGIS Tutorials: <http://www.qgistutorials.com/en/>
- QGIS Quicktips with Klas Karlsson: <https://www.youtube.com/channel/UCxs7cfMwzGZhtUuwHny4-Q>
- QGIS Training Guide: [https://docs.qgis.org/2.18/en/docs/training\\_manual/](https://docs.qgis.org/2.18/en/docs/training_manual/)