Exercise 5

Raster Data Structure

Objective – Work with the Raster Data Model

5.1 Introduction

Raster data is a data model in which the data is presented in a grid. Each grid cell contains one data value or attribute. For example, a digital elevation model (DEM) has cell values that represent the elevation. One important characteristic of raster data is the resolution. Raster resolution is a measure of the cell dimensions, which means the area that each cell covers in the real world. For example, a satellite image may have a resolution of 30 meters, which means that each cell covers 30 square meters in the real world. You can use raster data simply as cartographic backdrops, as datasets for digitizing, or for analysis.

This exercise includes the following tasks:

- Task 1 Merging and Clipping Raster Data
- Task 2 Raster Pyramids

5.2 Objective: Work with the Raster Data Model

This exercise focuses on working with raster data within QGIS.

5.3 Task 1 - Merging and Clipping Raster Data

Raster data are often provided in tiles, such as USGS Topographic Map Quadrangles. In such cases, it is necessary to merge the raster tiles together to form a seamless raster covering the study area.

1. Open QGIS and add the four DEM raster datasets (`35106-A4.dem`, `35106-A5.dem`, `35106-B4.dem` and `35106-B5.dem`) (shown in figure 5.1, on the following page).

Each of these has cell values representing the elevation above sea level and is styled with the values stretched across a black to white color ramp. Since each dataset has different minimum and maximum cell values, the boundaries between datasets is obvious.

2. Save your project as `exercise5.qgz`.

3. Double-click on the `35106-B5.dem` layer to open the Layer Properties.

4. Click on the Information tab.

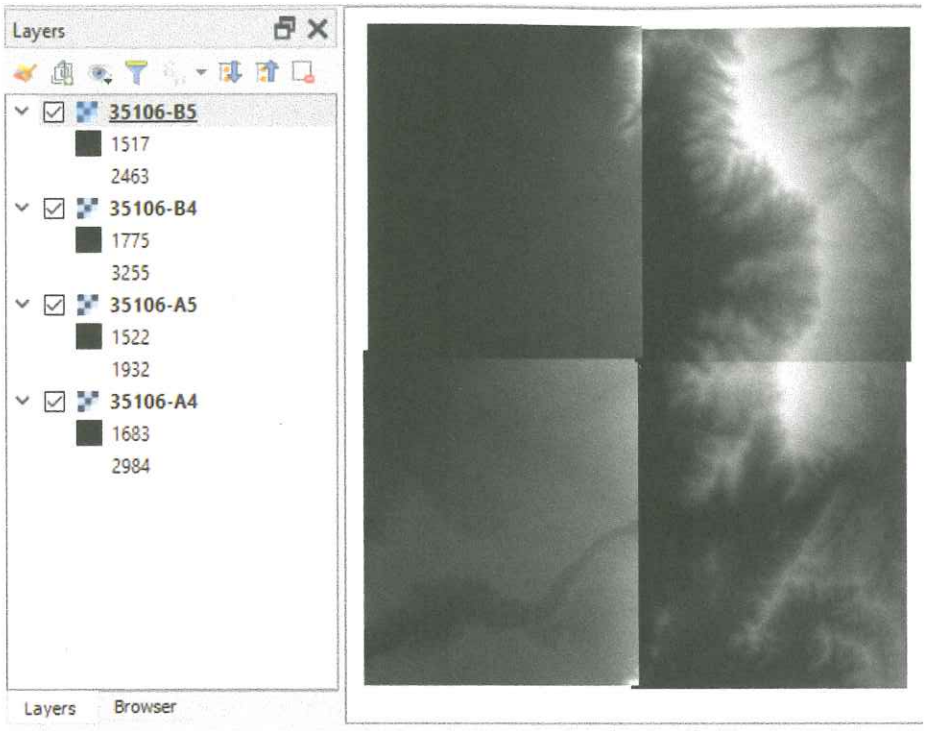

Figure 5.1: Four DEMs Added to QGIS

In the topmost Information from provider section you will find information about the file format (GDAL Driver Description), cell statistics (Band 1), Dimensions, Origin, Pixel Size (10 meters) and the Data Type.

Raster datasets are always rectangular. If the data content does not fill the rectangular area, the extra cells will be assigned a value that signifies that there is no data there.

5. Scroll down to the Bands section and you will see that the No Data value is -32767.

6. Close the Layer Properties.

7. Enable the Processing toolbox.

8. From the Toolbox choose GDAL | Raster miscellaneous | Build Virtual Raster.

9. Fill out the Build Virtual Raster tool with the following parameters: (shown in figure 5.2, on the next page)

   a. Input Layers = Click the ellipsis button to open the Multiple Selection window. Click Select All to select all four DEMs. Click OK.
   b. Resolution = average
   c. Uncheck Place each input file into a separate band
   d. Resampling algorithm = Bilinear
   e. Virtual output = Save to temporary file
   f. When parameters match the figure below, click Run.

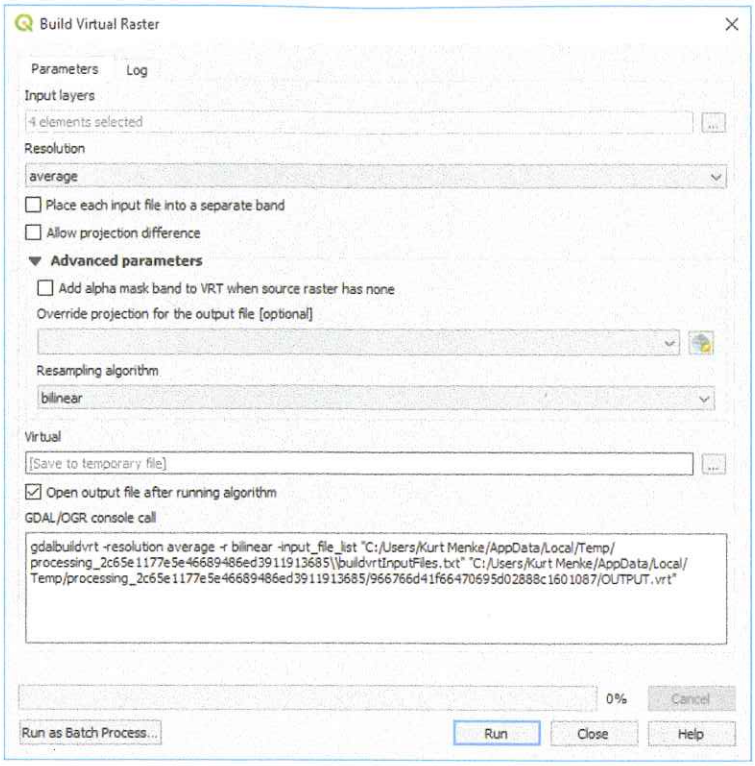

Figure 5.2: Build Virtual Raster

Notice the GDAL/OGR console output section of the Build Virtual Raster tool. This is the syntax for the equivalent operation run from a command prompt. GDAL and OGR come with a series of command utilities (https://www.gdal.org/gdal_utilities.html) (https://www.gdal.org/ogr_utilities.html). This tool is simply a GUI for the command line utility. These utilities are powerful and fast and this is a great way to begin to learn how to use them.

10. Turn off the input DEMs in the Layer Panel. You now have a seamless raster (shown in figure 5.3, on the following page).

11. Now you will clip the virtual raster to the project study area.

12. Add the `StudyArea.shp` shapefile to QGIS.

13. From the Toolbox choose GDAL | Raster extraction | Clip raster by mask layer.

14. Set the following parameters for the Clip raster by mask layer (shown in figure 5.4, on the next page):

    a. Input layer = OUTPUT
    b. Mask layer = StudyArea
    c. Clipped (mask) = StudyAreaDEM.tif
    d. Click Run
    e. Click Close when done.

15. Turn off the visibility for the StudyArea and OUTPUT virtual raster layers to see the clipped raster. (shown in figure 5.5, on page 247)

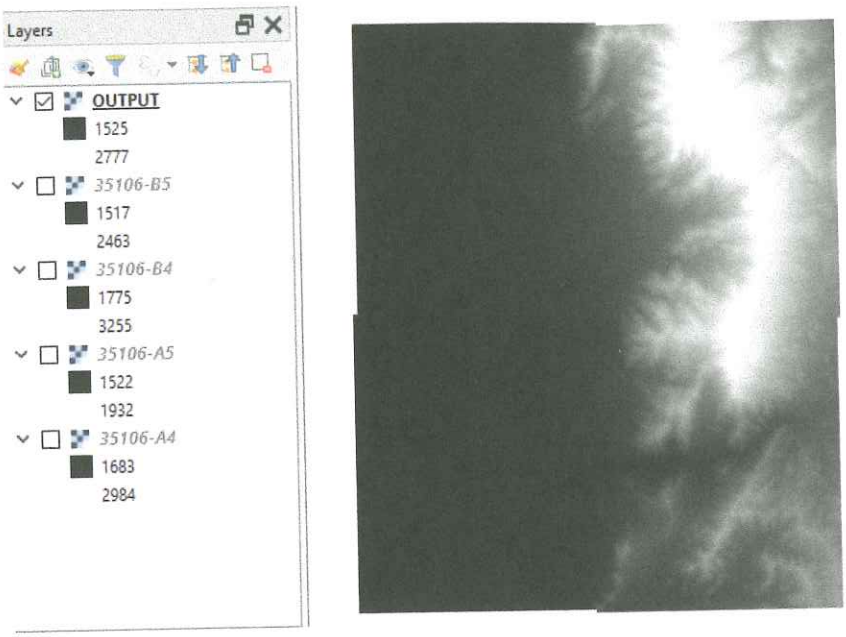

Figure 5.3: Virtual Raster Output

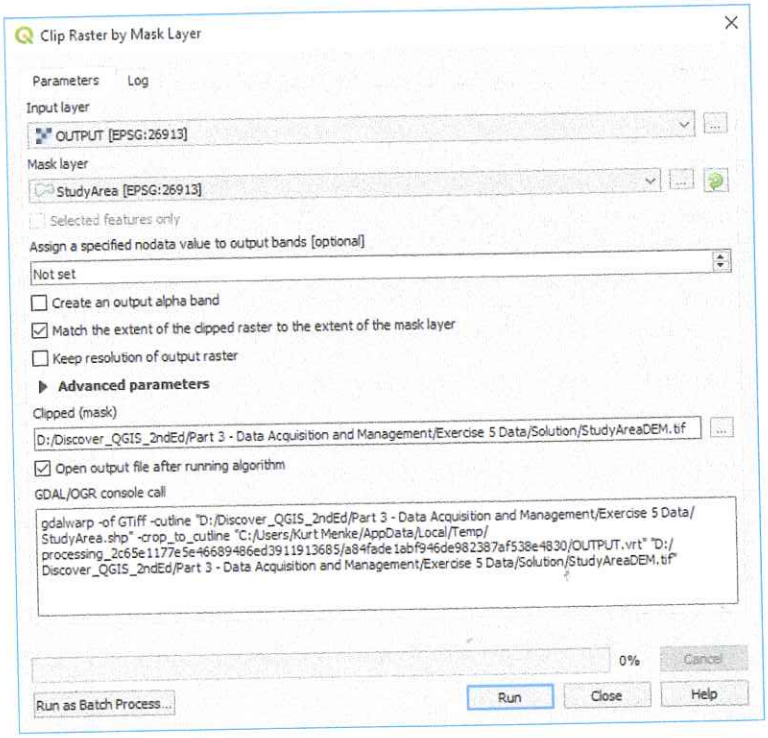

Figure 5.4: Clipping a Raster with a Mask Layer

16. Save your project.

This is a common workflow to get raster data set up for analysis.

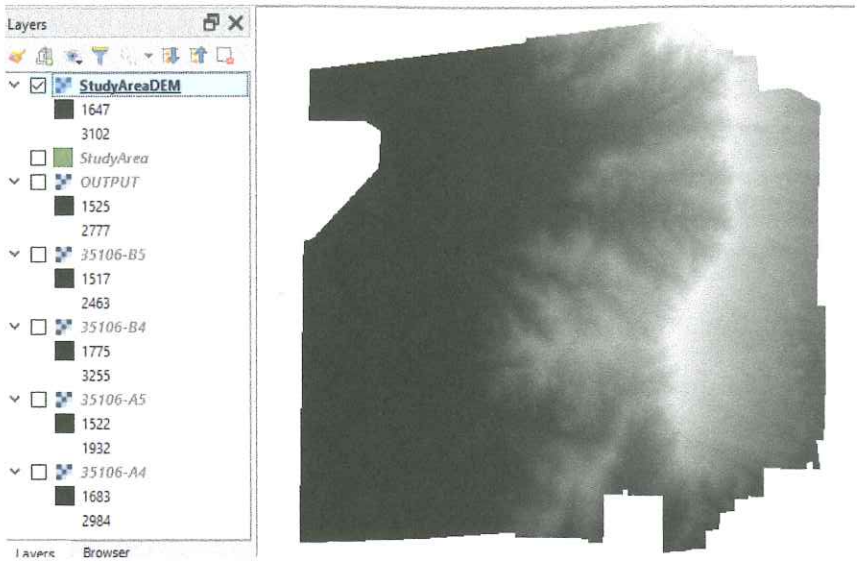

Figure 5.5: Clipped DEM

5.4 Task 2 - Raster Pyramids

Pyramids are lower resolution versions of a raster dataset that are more suitable for display on a monitor. Without pyramids, the computer will attempt to render each and every pixel in a raster dataset, whether the computer monitor can display all the detail or not. Having pyramids greatly decreases the time it takes to render a raster on screen.

1. Open QGIS and open `exercise5.qgz` if it is not already.

2. Open the Layer Properties for the StudyAreaDEM raster layer.

3. Click on the Pyramids tab. Currently this raster has no pyramids. The available resolutions are listed on the right side (shown in figure 5.6).

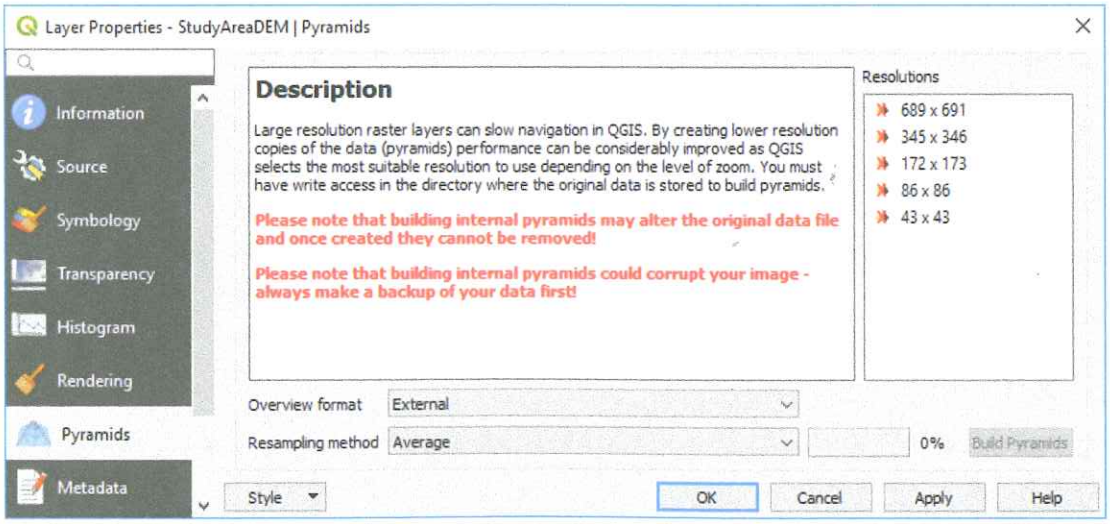

Figure 5.6: Pyramids Tab of Layer Properties

Pyramids can be embedded within the raster file, or built externally. It is safer to build them externally as this does not alter the original dataset. The external pyramid file can always be deleted if it does not have the desired results.

4. Select all resolutions: 689 x 691 to 43 x 43.

5. For the Overview format, select External.

6. Set Resampling method to Cubic.

Generally nearest neighbor technique is most suitable for discrete rasters since it will not change the values of the cells. The average, gauss, and cubic techniques are more suitable for continuous rasters such as this DEM. They will cause some smoothing of the data and may result in some values that are beyond the original range.

7. Click the Build Pyramids button.

8. Click OK to close the Layer Properties.

9. Zoom in and out on the raster to see how quickly the raster renders on the screen.

> This dataset is small enough that you may not notice an improvement in drawing speed. However, it can be quite dramatic for larger rasters over 1 GB in size.

10. Re-open the Layer Properties for the StudyAreaDEM raster layer.

11. Switch to the Information tab.

12. In the Information from provider section look for More information. You will see multiple dimension entries indicating that the pyramid resolutions were built.

13. Open a file browser (for example: Windows explorer or Finder) and navigate to the `Exercise_5_Data` folder. You will see a `StudyAreaDEM.tif.ovr` file. This is the file containing the pyramids.

5.5 Conclusion

In this exercise you focused on preparing raster data so that it seamlessly covers a study area. You also learned how to build pyramid files for a raster dataset.

5.6 Discussion Questions

1. What is a raster dataset?

2. Compare and contrast raster and vector data models.

3. Why might you use raster data? Give two examples.

5.7 Challenge Assignment

Install the SRTM Downloader plugin shown in figure 5.7, on the facing page. This allows you to download SRTM DEMs for the current canvas extent. Using the QuickMapServices plugin turn on the OpenStreetMap basemap (Web | QuickMapServices | OSM | OSM Standard). Zoom in to an area of interest and download the DEMs covering that area shown in figure 5.8, on the next page. Keep the area to the size of a large municipality so avoid too large a download. Build a virtual raster from the set of DEMs and build pyramids for the merged DEM. Create a color hillshade effect as you did in Part 2 Exercise 7.

Figure 5.7: SRTM Downloader Plugin

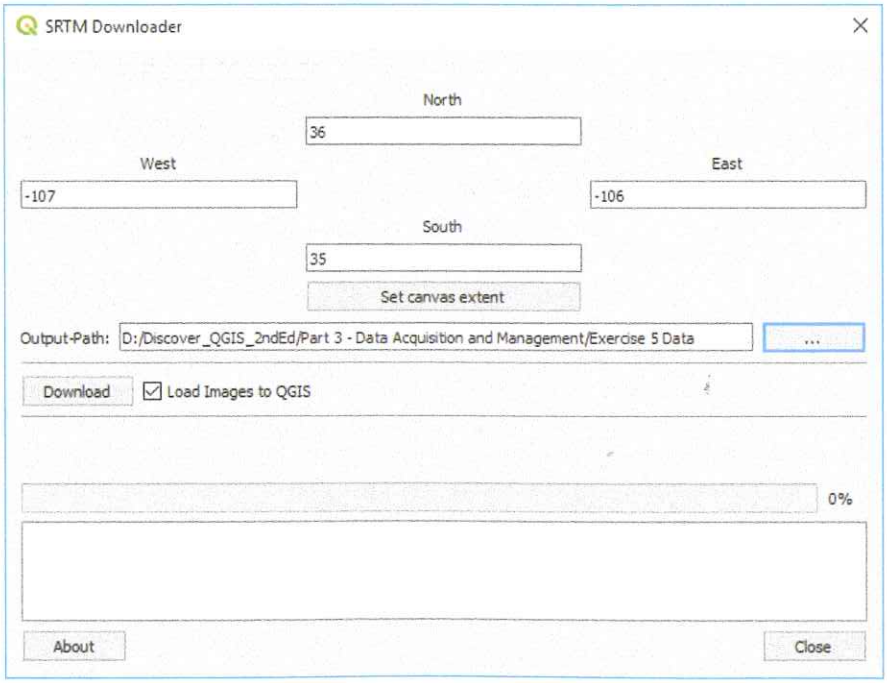

Figure 5.8: SRTM Download