GIS TRAINING

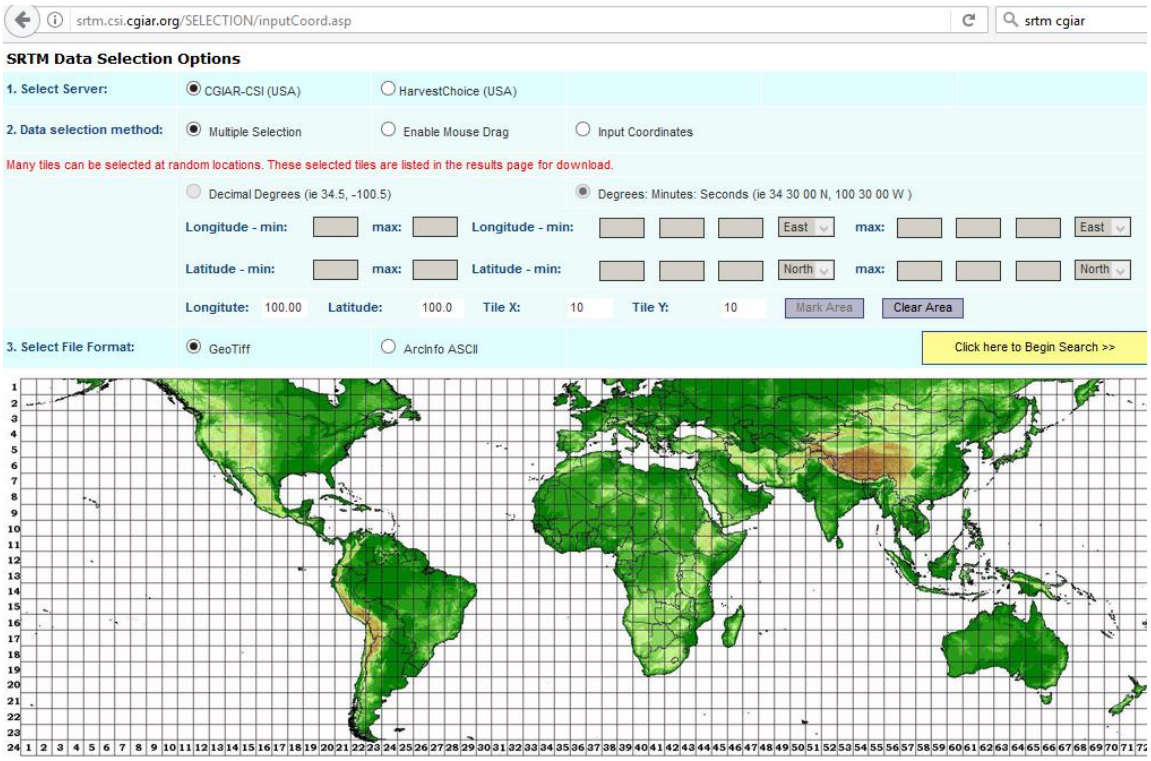
➢ Downloading freely available datasets

- SRTM 30m
- SRTM90m
- MODIS Landcover 500m
- Sentinel 30m
- GEBCO
- Earthquake catalog

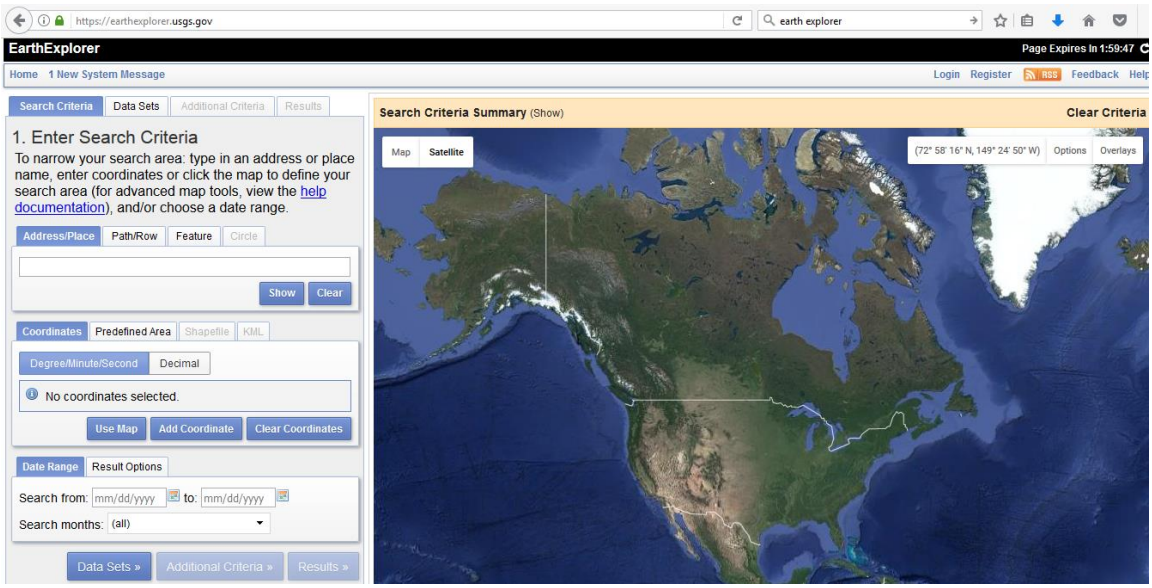
Websites where datasets can be downloaded:

- CGIAR: http://srtm.csi.cgiar.org/
- Earth Explorer: https://earthexplorer.usgs.gov/
- Google Earth Engine: https://earthengine.google.com/
- https://earthquake.usgs.gov/earthquakes/search/

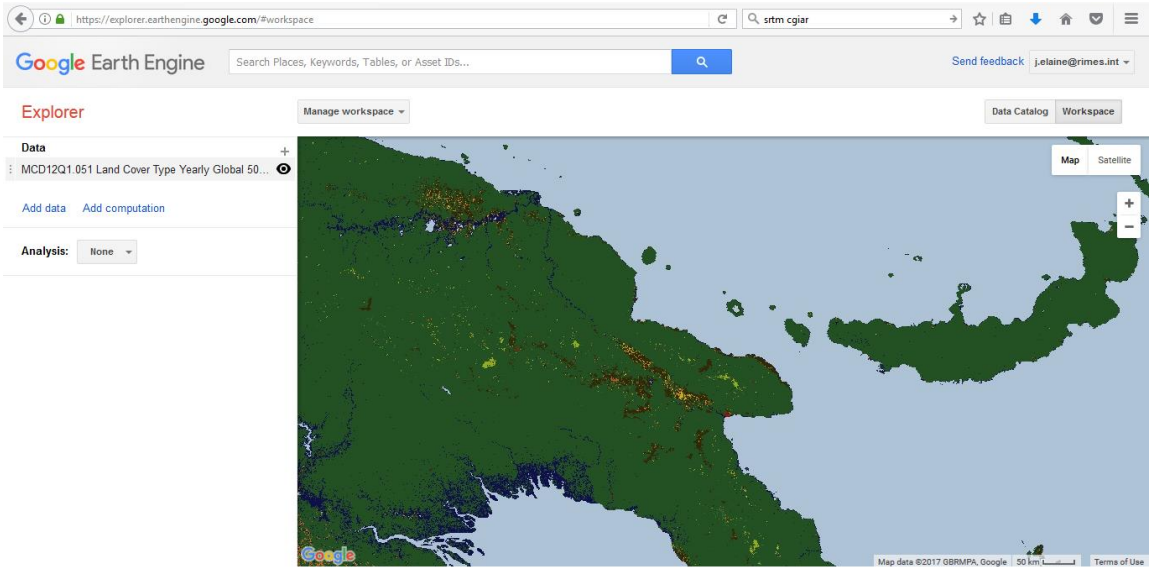
1. CGIAR



2. Earth Explorer (Registration required)

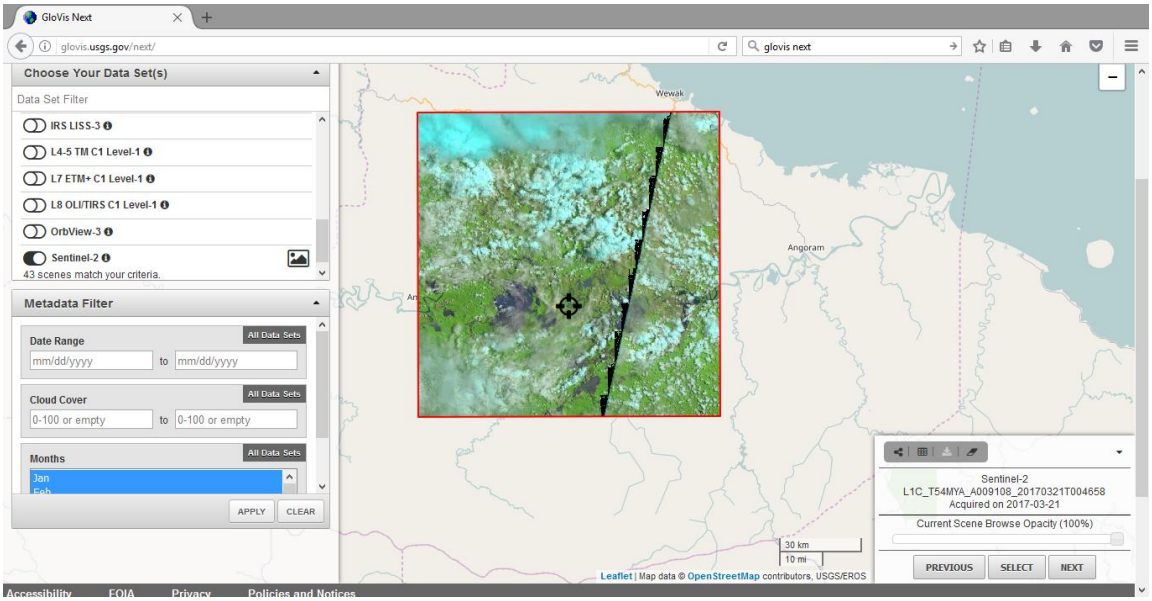


3. Google Earth Engine (Registration required)

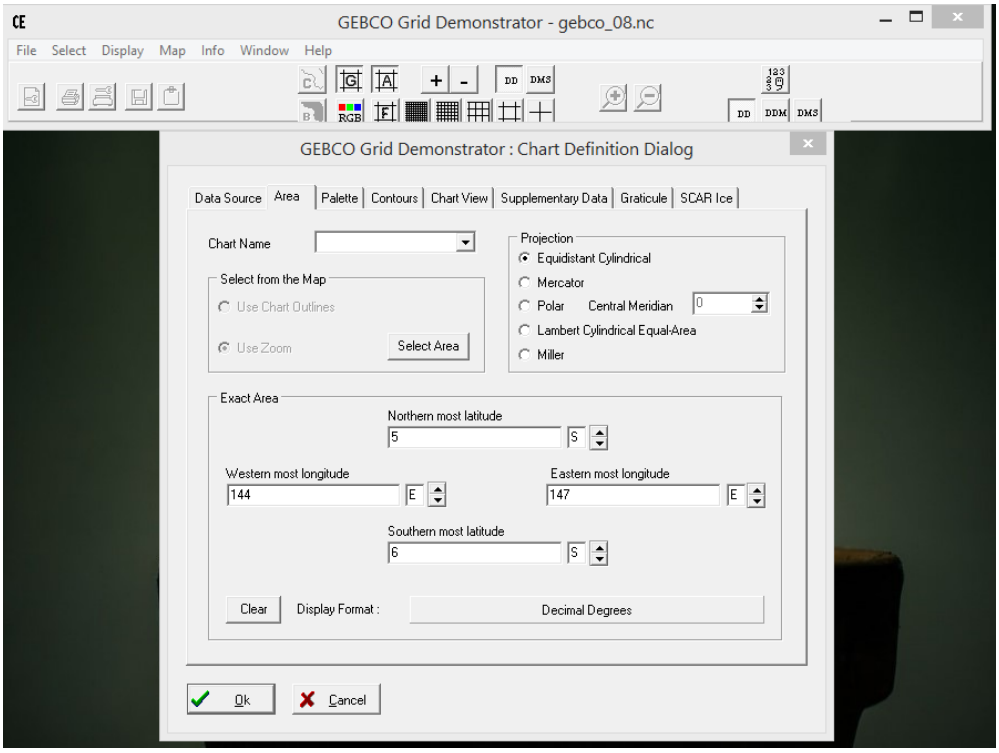


MODIS Land Cover Product link:
https://lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table/mcd12q1

4. Glovis Next (Registration required)



5. GEBCO



➢ **Installation of QGIS software**

Download the OSGeo4W Network Installer for advanced users. This version enables the user to receive latest software/plugin updates.

➢ **Installation of QGIS plugins**

Install the following plugins by going to **Plugins** tab, **Manage and Install Plugins…**

- OpenLayersPlugin
- Points2One
- Digitizing Tools
- Georeferencer
- Interpolation
- Slicer

➢ **Familiarization of QGIS software**

Saving a project:

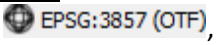
Projects are saved to preserve the settings made by the user. Always save project before finishing work.

1. In **Project** menu, select **Save As…**
2. In **File name**, input project name and browse to the directory where the project will be saved.
3. Click **Save**.

Exploring the interface:

1. Explore contents of each menu: *Project, Edit, View, Layer, Settings, Plugins, Vector, Raster, Web, Processing,* and *Help.*
2. Explore toolbars: *Project, Map Navigation, Attributes, Digitizing*, and *Manage Layers*.

Defining projection of data frame to Geographic Coordinate System:

1. In the lower right corner, click on **Project Properties** button 

, which is currently set to *EPSG:3857* (Pseudo Mercator Projection).
2. In **Project Properties** dialog, tick on **Enable 'on the fly' CRS transformation (OTF)**, layers even in different projections can overlay properly.
3. In **Coordinate Reference System**, choose *WGS 84* to transform the current projection to the geographic coordinate system. It should already register EPSG:4326 (GCS WGS84).

Inputting vector data:

1. Click **Add Vector Layer** button  .
2. Browse to directory, select file (e.g. *PNG_Geology.TAB*).
3. Click **Open**.

Converting to another vector format:

1. Right-click on layer and select **Save As…**
2. In **Format**, select type to save the vector, e.g. *ESRI Shapefile*.
3. In **File name**, input output filename and save in preferred directory.
4. In **CRS**, select coordinate system for the layer.
5. Click **OK**.

Changing vector layer style in QGIS:

1. To change layer style, right click on the *polygon layer* and choose **Properties>Style**.
2. In the drop down menu, in case the layer only has one type, select default option *Single symbol*.
3. In the **Fill** box, click on *Simple fill* to enable modification of layer style.
4. In **Symbol layer type**, choose Outline: *Simple line.*
5. In **Color**, choose preferred color.
6. In **Pen width**, choose preferred line width.
7. In **Pen style**, choose preferred line style e.g. solid, dashed, etc.
8. Click **OK** to display new style.

In case the layer has more than one type, the user can choose between 2 options to display different types:

1. In the drop-down menu, choose **Categorized** or **Graduated**.
2. In **Column**, choose attribute field used to display the layer.
3. In case **Graduated** is chosen to represent the layer, select **Mode** of classification and number of classes.
4. Click **Classify** button.
5. Click **OK** to display new style.

In case the user prefers to display the layer with respect to different fields, e.g. magnitude (shape) and depth (color) at the same time:

1. Click **Add Vector Layer** button  to add the filename, *Earthquake.shp*.
2. Right-click on the layer and choose **Properties>Style.**
3. In the drop-down menu, choose **Graduated**.
4. In **Column**, choose attribute field (e.g. depth) used to display the layer.
5. In **Color ramp**, choose the color graduation scheme to represent variation in depth.
6. Select **Mode** of classification and number of classes and click **Classify** button.
7. Go back to the first drop-down menu, this time choose **Rule-based**.
8. Category range may be customized by double clicking on a range, and defining new range for both **Label** and **Filter**.
9. Right-click on one category, select **Refine current rule** and select **Add ranges to rule**.
10. In **Column**, choose second attribute field (e.g. magnitude) used to display the layer.
11. Select **Mode** of classification and number of classes and click **Classify** button.
12. Double click on a range to define a new range.
13. Click **OK** to go back to the main Style properties. This time, the layer style should be categorized in both magnitude and depth.
14. Click on each symbol to change symbol size to represent magnitude variation.

Displaying vector layer properties:

1. Right-click layer, click **Properties**.
2. Explore different categories.
3. In **General** panel, layer source directory and coordinate system can be seen.
4. In **Label** panel, the user can display a layer attribute as label.
5. In **Metadata** panel, detailed information about the selected layer can be seen, e.g. coordinate system, format, resolution (in case raster), etc.

Inputting raster data:

1. Click **Add Raster Layer** button  .

2. Browse to directory, select SRTM DEM file.
3. Click Open.

Changing raster layer style in QGIS:

1. To change layer style, right click on the *raster layer* and choose **Properties>Style**.
2. In **Render type**, select *Singleband pseudocolor.*
3. In **Color**, select preference.
4. Select **Mode** of classification and number of classes.
5. Click **Classify** button.
6. To modify range, double click on a range value and input new value.
7. To make the raster layer transparent, in properties, choose **Transparency**.
8. In **Global transparency**, choose percentage of transparency.
9. Once a standardized style has been developed, this can be saved and applied to similar raster layers, in **Style** button.

Displaying vector layer properties:

1. Right-click layer, click **Properties**.
2. Explore different categories.
3. In **General** panel, layer source directory and coordinate system can be seen.
4. In **Transparency** panel, the user can display a raster layer at certain levels of transparency, usually to overlay with other raster data.
5. In **Metadata** panel, detailed information about the selected layer can be seen, e.g. coordinate system, format, resolution (in case raster), etc.

EXERCISE 1: Developing exposure database

One of the main requirements in developing an exposure database is digitizing the locations of buildings, critical facilities, and integrating attributes of each structure, e.g. structure type, building usage, building population, etc. In case there are no local base map available, the Google Earth image may be used as base layer when digitizing.

Displaying raster base layer:

In **Web** menu, click **OpenLayers plugin** (install if not available), and select **Google Maps>Google Hybrid** or another base layer of preference.

Creating new shapefile layer:

1. Click **New Shapefile Layer** button  .
2. Select a shapefile type, e.g. *Polygon*.
3. Select coordinate system to use, e.g. Pseudo Mercator, in case you plan to use the Google Earth as basemap, or Geographic Coordinate System WGS84 for general mapping, or the coordinate system of the basemap being used.
4. Click **OK**.
5. In **File name**, input filename name e.g. *Buildings.shp* and browse to the directory where the layer will be saved.
6. Click **Save**.

Enabling snapping in QGIS:

To append to a digitized line or polygon, enable *snapping* for accurate connection to the line/polygon. This is important especially when you plan to use the line data to convert to a polygon layer or to snap to a different layer for seamless connection.

1. In **Settings** menu, choose **Snapping Option**.
2. In **Layer selection**, choose preferred layer. In this case, the *Buildings.shp* layer should be clicked or activated, and choose **Current layer**.
3. In **Snap to**, choose *To vertex*.
4. In **Tolerance**, choose *10 pixels*. When connecting to another line, hovering within 10 pixels from the vertex will activate snapping as indicated by a pink cross.
5. Click **OK** to return to layer editing.

Editing a shapefile layer in QGIS:

1. Right click on the line layer and choose **Toggle Editing**. At this point, a pen icon is overlaid on the layer  , to indicate that the layer is editable.
2. Click on **Zoom In** or **Zoom Out** button  to zoom in or out of an area. Take note, effective largest scale when zooming in should be 1:2,500 

. Otherwise, zooming in too much might not be able to overlay layers on the raster base map properly.
3. Click on **Pan** button  to move around an area.
4. To start editing, make sure that the layer to be edited is clicked.
5. Click **Add Feature** button  (in this case, green polygon icon), and start tracing the buildings.
6. To end digitizing a polygon, right click on mouse, click **OK**.
7. To stop editing a layer, right click on layer and choose **Toggle Editing**.

Displaying and managing attribute table:

1. Right-click layer, click **Open attribute table**.
2. Click **Toggle Editing** button  to start editing table.
3. To add new attribute or field, click on **New Field** button  .
4. To delete existing attribute or field, click on **Delete Field** button  .

To select particular features only using an expression:

5. In the attribute table, click **Select features using an expression** button  .
6. Double-click on **Fields and Values**.
7. Double-click on the attribute field to be considered in the selection.
8. Double-click on **Operators**, select preferred operator e.g. '=' equals sign, or '>'greater than sign.
9. Either input category to be selected (use single quotes when selecting string or text attributes) or select **all unique** button in *Load values*, and double click the category preferred.

Sample expression: "BuildingType" = 'Residential'
"Population" > 5

After selecting a number of features, the items will be highlighted. In case you wish to display only the selected features, click on **Show All Features** button> **Show Selected Features**. Selected features can be updated by batch:

1. In the attribute table, click **Open field calculator** button  .

2. Tick **Update existing field**.
3. In the drop-down menu, select the attribute field to be updated.
4. In the expression box, input value or expression or geometry (e.g. area), etc. that will be used to update the field (use single quotes when selecting string or text attributes).

Determining area and perimeter of a polygon:

1. In **Vector** menu, choose **Geometry Tools > Export/Add geometry columns.**
2. In **Input layer**, select polygon layer.
3. In **Calculate using**, select preferred projection system to obtain coordinates from.
4. In **Added geom info**, save new output point shapefile.

Converting polygon to centroid and obtaining centroid coordinates:

1. In **Vector** menu, choose **Geometry Tools > Polygon centroids.**
2. In **Input layer**, select polygon layer.
3. In **Centroids**, save new output point shapefile.

To add x and y coordinates of points:

4. In **Vector** menu, choose **Geometry Tools > Export/Add geometry columns.**
5. In **Input layer**, select point layer.
6. In **Calculate using**, select preferred projection system to obtain coordinates from.
7. In **Added geom info**, save new output point shapefile.

Converting polygon to line:

1. In **Vector** menu, choose **Geometry Tools > Polygons to Lines.**
2. In **Input layer**, choose polygon layer.
3. In **Polygons from lines**, save output shapefile.

Converting line to polygon:

1. In **Vector** menu, choose **Geometry Tools > Lines to Polygons.**
2. In **Input layer**, choose line layer.
3. In **Lines from polygons**, save output shapefile.

EXERCISE 2: Generating a raster surface based on point data

Interpolation can be used to estimate values in a raster surface given only a limited number of sample data, e.g. rainfall, elevation, concentrations, earthquake magnitude, etc.

Displaying table data in csv format:

1. Click **Add Delimited Text Layer** button  .
2. **Browse** csv file (*query.csv)* to upload in QGIS.
3. In **File format**, select **CSV**.
4. If a header has been created, the option **First record has field names** is ticked.
5. In **Geometry definition**, tick the option **Point coordinates** and make sure that **X field** and **Y field** is correctly defined e.g. *Longitude* and *Latitude*, respectively. Point attribute name may be different in other data, especially if it uses a projected coordinate system, e.g. *Easting* in the x direction and *Northing* in the y direction.

6. Click **OK** and choose the coordinates system where the tabular data is based. In case the coordinates of the points are based on the Geographic Coordinate System WGS84, select EPSG:4326 (GCS WGS84) in CRS dialog box to display the points. For other coordinate systems, the user can browse in the **Select CRS** button  .

Converting to another vector format:

1. Right-click on layer and select **Save As…**
2. In **Format**, select type to save the vector, e.g. *ESRI Shapefile*.
3. In **File name**, save new output in preferred directory.
4. In **CRS**, select coordinate system for the layer.
5. Click **OK**.

Interpolation:

1. In **Raster** menu, choose **Interpolation > Interpolation.**
2. In **Input box > Vector layers**, select the vector layer to be interpolated, usually point data e.g. earthquake shapefile.
3. In **Input box > Interpolation attribute**, select attribute where interpolation will be based e.g. magnitude. Click **Add** button.
4. In **Output box > Interpolation method,** select method, usually *IDW*.
5. Click **Set to current extent** button.
6. In **Output box > Cellsize,** input preferred resolution size, make sure to input values based on the coordinate system used by the original data (e.g. degrees, meters). Note that 1 degree is approximately 111120 meters.
7. In **Output box > Output file,** save output raster file. Click OK.

Extracting raster file:

1. In **Raster** menu, choose **Extraction > Clipper.**
2. In **Input file**, choose raster layer.
3. In **Output file**, save as type GeoTIFF the output shapefile.
4. In **Clipping mode**, select **Extent** to input coordinates or drag the mouse, or select **Mask Layer** to extract using a predetermined polygon shapefile.
5. In case **Mask Layer** is chosen, select polygon mask, then input preferred resolution size. Take note coordinate system used to determine if pixel size should be in meters or degrees. Click OK.

Changing raster layer style in QGIS:

1. To change layer style, right click on the *raster layer* and choose **Properties>Style**.
2. In **Render type**, select *Singleband pseudocolor.*
3. In **Color**, select preference.
4. Select **Mode** of classification and number of classes.
5. Click **Classify** button.
6. To modify range, double click on a range value and input new value.
7. To make the raster layer transparent, in properties, choose **Transparency**.
8. In **Global transparency**, choose percentage of transparency.
9. Once a standardized style has been developed, this can be saved and applied to similar raster layers, in **Style** button.

Generating contour layer:

1. In **Raster** menu, choose **Extraction > Contour**.

2. In **Input file**, choose raster layer.
3. In **Output file**, save output shapefile.
4. In **Interval between contour lines**, input preferred interval.
5. Tick **Attribute name** and select the elevation attribute.
6. Click **OK**.

EXERCISE 3: Generating a slope surface and contour layer based on freely available DEM

Slope information can be derived from a DEM surface. Slope is usually generated using the projected coordinate system (meters). Since the z or elevation data is in meters, the x and y coordinates should also be in meters. However, slope can also be derived using the geographic coordinate system, provided that the conversion factor, degrees to meters, is provided.

Contours can be generated from any raster surface for better interpretation of raster data.

Inputting raster data:

1. Click **Add Raster Layer** button  .
2. Browse to directory, select *SRTM DEM* or *GEBCO* file.
3. Click **Open**.

Generating slope layer:

1. In **Raster** menu, choose **Terrain Analysis > Slope**.
2. In **Elevation layer**, choose a raster layer.
3. In **Output layer**, save output shapefile.
4. In **Output format**, select GeoTIFF.
5. In **Z factor**, input 1 (if using projected system, x & y in meters) or input 111120 (if using geographic system, x & y in degrees). Click OK.

Generating contour layer:

1. In **Raster** menu, choose **Extraction > Contour**.
2. In **Input file**, choose a raster layer.
3. In **Output file**, save output shapefile.
4. In **Interval between contour lines**, input preferred interval.
5. Tick **Attribute name** and select the elevation attribute.
6. Click **OK**.

Raster reclassification:

Reclassification is done to separate continuous values in a raster surface into specific ranges, for example, a slope range of less than 30 degrees is considered low in terms of its potential to generate a landslide, while a slope of 30 to 45 is considered high, etc.

1. In **Raster** menu, choose **Slicer > Slicer.**
2. In **Input File**, choose raster layer.
3. In **Output File**, choose output reclassed raster layer.
4. Tick **Add to Raster Layers Panel.**
5. In **Step**, select *Variable*.

6. Input a preferred range and click **Add** button. Repeat as required.
7. Click **Slice** button to execute.

Raster calculation:

Raster calculation is usually done to combine values from different rasters for various applications e.g. suitability analysis, inundation, etc. The process is similar to using a calculator but on a mtrix level.

1. In **Raster** menu, choose **Raster calculator.**
2. In **Output layer**, save output raster file.
3. In **Output format,** select preferred format, usually GeoTIFF.
4. In **Output CRS,** select layer CRS.
5. In the expression box, input equation, using one of more raster layers depending on the equation that will be used to calculate for the new raster output. Note that raster calculation will be pixel-based. Raster layers to be used in the calculation should be based on the same coordinate system.

Converting raster to text file:

1. In **Raster** menu, choose **Conversion > Translate (Convert Format).**
2. In **Input layer**, choose a raster layer.
3. In **Output layer**, save as type *ASCII Gridded XYZ* the output shapefile.

Converting raster to vector:

1. In **Processing** menu, choose **Toolbox > GRASS GIS > Raster > raster.to.vect.**
2. In **Input raster layer**, choose raster layer.
3. In **Feature type**, choose vector format.
4. In **Vectorize**, save output shapefile.

EXERCISE 4: Georeferencing an image

Georeferencing or rectification is a process of relating a raster image from an arbitrary coordinate system with spatial locations on the ground using a projection/geographic coordinate system. This can be seen in a GIS software, where any location on the map is matched to corresponding ground coordinates e.g. longitude/latitude or Easting/Northing in the real world.

Analog/paper maps e.g. topographic maps, land cover maps, etc. are converted to digital format by first scanning, and then georeferencing. The process usually involves simple matching of the tick marks indicating specific locations on the ground. However, some maps especially older ones with low mapping quality may rarely match correctly. Hence, rubbersheeting, a process wherein a layer is distorted to seamlessly match with other spatial data, may be implemented.

Georeferencing an image:

1. In **Raster** menu, choose **Georeferencer > Georeferencer**.
2. Click **Add Raster Layer** button (e.g. *PNG_Soil Map 2.jpg*).
3. Click **Transformation Settings** button , leave default settings and save output file.
4. Click **Add Point** button to add new point.
5. In the **Enter map coordinates**, either input coordinates for x and y *or* use map, **From map canvas**, and match the location on another existing map or using the Google Earth basemap. Note, when using Google Earth images, set *Pseudo Mercator* as coordinate system in **Transformation Settings > Target SRS**.

6. Click **Delete Point** button to delete existing point.
7. Click **Move GCP Point** button to move existing point.
8. When done (choosing at least 4 GCPs), select **Start Georeferencing** button .

EXERCISE 5: Generating land cover layer

Detailed land cover maps may be generated using high resolution images or the Google Earth base map in QGIS. Merging of different layers may be necessary, for example road and river network to the land cover layer, which involves different geoprocessing techniques.

Converting point to polygon shapefile format:

To define an exact region, a separate table containing the coordinates of the polygon to be defined can be prepared first e.g. excel, in notepad, etc. in the following order: ID, X, Y.

1. In **Vector** menu, select **Points2One** (install plugin if not available).
2. In **Input vector layer**, select the table data containing coordinates of the domain, and tick **Create polygons**.
3. Tick **Sort vertices by**, and choose *ID*. Make sure that the order of points in the shapefile/text format should be in the right order, otherwise, resulting polygon will be crisscrossed.
4. **Browse** to preferred directory and save output shapefile.
5. Tick option **Add result to canvas**.
6. Click **OK** to display the polygon.

Enabling snapping in QGIS:

To append to a digitized line, enable *snapping* for accurate connection to the line. This is important especially when you plan to use the line data to convert to a polygon layer or to snap to a different layer for seamless connection.

1. In **Settings** menu, choose **Snapping Option**.
2. In **Layer selection**, choose preferred layer. In this case, the shoreline layer should be clicked or activated, and choose **Current layer**.
3. In **Snap to**, choose *To vertex*.
4. In **Tolerance**, choose *10 pixels*. When connecting to another line, hovering within 10 pixels from the vertex will activate snapping as indicated by a pink cross.
5. Click **OK** to return to layer editing.

Editing a shapefile layer in QGIS:

1. Right click on the line layer and choose **Toggle Editing**. At this point, a pen icon is overlaid on the layer , to indicate that the layer is editable.
2. Click on **Zoom In** or **Zoom Out** button to zoom in or out of an area. Take note, effective largest scale when zooming in should be 1:2,500 Scale 1:2,500. Otherwise, zooming in too much might not be able to overlay layers on the raster base map properly.
3. Click on **Pan** button to move around an area.
4. To start editing, make sure that the layer to be edited is clicked.

Usually, it is recommended to include in the attribute table which kinds of information is required in the layer before digitizing, e.g. type, so that a feature can be updated immediately.

5. Right-click layer, click **Open attribute table**.
6. Click **Toggle Editing** button  to start editing table.
7. To add new attribute or field, click on **New Field** button  .

Start digitizing land cover features.

8. Click **Add Feature** button  (in this case, green polygon icon), and start tracing the shoreline.
9. To end digitizing a polygon, right click on mouse, click **OK**.
10. To stop editing a layer, right click on the layer and choose **Toggle Editing**.

Splitting a polygon layer using a cutter line:

Prepare the cutter line:

1. Create a new line shapefile which will serve as your cutter line.
2. Trace boundaries on the rectified raster map layer. Make sure that starting and end vertex are located outside the main polygon to be divided.

To divide the main polygon:

3. Select the line layer and select the particular line that will be used to cut it using the **Select Features** button  .
4. Select the polygon layer, right-click to select **Toggle editing** and select the main polygon to be cut using the **Select Features** button  .
5. Click the **Split selected features with selected line from another feature** button  .
6. In **splitter layer**, select the line layer that will be used to cut the polygon.

Updating attribute data:

At this point, several polygons have been defined to represent a particular land cover type. However, there is no indication yet which type it represents, hence the attribute table needs to be updated. This also enables the user to display land cover types as labels in the interface.

Buffering:

Buffering is implemented to define an area within a given proximity. For example, digitizing a road network using the line vector cannot simulate the actual road extent. However, buffering it according to its width on the ground can provide a more realistic idea how much area the road covers. Buffering may be implemented using a fixed buffer or varying buffer distances. The latter may be used for example in a road network to differentiate it according to types based on size e.g. national roads, secondary roads, village roads, tracks, etc.

To use a fixed buffer distance:

1. In **Vector** menu, choose **Geoprocessing Tools > Fixed distance buffer.**
2. In **Input layer**, select layer to be buffered.
3. In **Distance**, input distance from feature to be buffered, make sure to input values based on the coordinate system used by the original data (e.g. degrees, meters). Click
4. Usually, **Dissolve result** is ticked to smoothly combine intersections.
5. In **Buffer**, save output shapefile. Click Run.

To use varying buffer distances:

1. In **Vector** menu, choose **Geoprocessing Tools > Variable distance buffer.**
2. In **Input layer**, select layer to be buffered.
3. In **Distance**, input distance from feature to be buffered, make sure to input values based on the coordinate system used by the original data (e.g. degrees, meters). Click **Run**.
4. Usually, **Dissolve result** is ticked to smoothly combine intersections.
5. In **Buffer**, save output shapefile. Click Run.

Clipping a vector data:

1. In **Vector** menu, choose **Geoprocessing Tools > Clip.**
2. In **Input layer**, select layer to be clipped.
3. In **Clip layer**, select layer used to clip.
4. In **Clipped**, save output shapefile. Click **Run.**

Erasing features in a vector data:

For example, when integrating the road shapefile with the land cover shapefile, the area where the road intersects the land cover will have to be erased in the land cover layer first, before merging both files to ensure no duplicates in the final merged output.

1. In **Vector** menu, choose **Geoprocessing Tools > Difference.**
2. In **Input layer**, select layer to be erased.
3. In **Difference layer**, select layer used to erase.
4. In **Difference**, save output shapefile. Click **Run.**

Dissolving attributes:

Dissolving is done to combine similar types within the same layer.

1. In **Vector** menu, choose **Geoprocessing Tools > Dissolve.**
2. In **Input layer**, select polygon layer to dissolve.
3. To dissolve all, tick **Dissolve all**.
   To dissolve based only on particular fields, untick **Dissolve all**, in **Unselected** box, select attribute to use for dissolving, click right arrow.
4. In **Dissolved**, save output shapefile. Click **Run**.

Merging vector data:

1. In **Vector** menu, choose **Data Management Tools > Merge vector layers.**
2. In **Layers to merge**, select layers to be merged.
3. In **Merged**, save output shapefile. Click **Run.**

Reprojecting a vector layer:

Sometimes the layer being digitized is based on a specific coordinate system, e.g. Pseudo Mercator or UTM system, and it is necessary to project it to a coomon coordinate system to combine with other spatial data baesed a different system.

1. Right-click on layer, click **Save As…**
2. In **File name**, save output shapefile.
3. In **CRS**, choose preferred coordinate system to reproject to. Click OK.

Converting vector to raster:

In some applications, it is necessary to provide the raster version of a vector data.

1. In **Raster** menu, choose **Conversion > Rasterize (Vector to Raster).**
2. In **Input file**, choose polygon layer.

3. In **Attribute field**, choose the field to base the raster data from (should be numbers, not text).
4. Tick **Raster resolution map units per pixel,** make sure to input values based on the coordinate system used by the original data (e.g. degrees, meters). Click OK.

➢ Layouting a map

1. In **File** menu, select **New Print Composer**.
2. In **Layout** menu, select **Add Map** or click **Add new map** button  .
3. To move map, in **Layout** menu, select **Move Item** or click on **Select/Move Item** button  .
4. To move map content, in **Layout** menu, select **Move Content** or click on **Move Item content** button  .
5. To add legend, in **Layout** menu, select **Add Legend** or click on **Add new legend** button  .
6. To customize legend, click on the legend, on the right hand side panel, in **Item properties/Legend**, input legend title, untick Auto update, then re-order legend items using the up and down arrows, add/delete items using the plus and minus signs, rename the legend item by clicking on  button, fonts, frame and background color.
7. To add scale bar, in **Layout** menu, select **Add Scalebar** or click on **Add new scalebar** button  .
8. To customize scalebar, click on the scalebar, on the right hand side panel, in **Item properties/Scalebar**, select preferred style, scale units, label for units, segment, display, fonts and colors, frame and background color.
9. To add north arrow, in **Layout** menu, select **Add Arrow** or click on **Add Arrow** button  .
10. To customize arrow, click on the arrow, on the right hand side panel, in **Item properties/Arrow**, select preferred style, frame and background color. Otherwise, adding north arrow can be done using the add image function and selecting preferred SVG icon, as in the following step.
11. To add image, in **Layout** menu, select **Add Image** or click on **Add image** button  .
12. On the right hand side panel, in **Item properties/Picture**, select image source, preferred style, frame and background color.
13. To add label, in **Layout** menu, select **Add Label** or click on **Add new label** button  .
14. To customize label, click on the label, on the right hand side panel, in **Item properties/Label**, input text, select preferred style, frame and background color.
15. To add attribute table, in **Layout** menu, select **Add Attribute Table** or select **Add attribute table** button  .
16. To customize attribute table, click on the attribute table, on the right hand side panel, in **Item properties/Attribute table**, select layer to display attribute table, preferred style, fonts and text styling, frame and background color.
17. Click on the map, on the right hand side panel, in **Composition** tab, select preferred page size and resolution size.
18. In **Item properties/Map1**, select preferred scale. Click **Update preview** button to refresh.
19. To add grid, in **Item properties**, click on plus sign button. Select preferred grid type, coordinate system, x and y interval, frame style, coordinate parameters, frame color, and background color.