

Biodiversity Threat Mapping using QGIS

Hands on Training Manual

Project: Empowering Civil Society and Governmental Agencies to Mainstream
Biodiversity and Ecosystem Service Values into Development Plans for
the Chindwin River Basin, Myanmar



Training Manual

Disclaimer

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Introduction

Biodiversity is the natural diversity of living organisms and maintaining biodiversity is an essential component of sustainable development. However various unplanned development factors/sectors have an adverse impact on biodiversity. The integration of these various development factors in a GIS provides a powerful spatial decision supporting system which offers opportunity for efficiently producing biodiversity threat map. This manual presents GIS based multicriteria analysis approach for identifying vulnerable biodiversity areas. The manual is designed with step wise instruction with assignments. You need to complete all the assignments to complete the final step.

Different factors related to development activities that have negative impact on biodiversity are identified by consulting experts and literature review. Data related to these factors are collected and/or prepared in GIS format; either in vector format or raster format. These data are then overlaid with their associate weights and range of impact to get the final threat map. Weights here means the degree of impact that a certain sector/factor can have on biodiversity. The weight value ranges from 1 to 10 where 10 meaning highest impact and 1 meaning the least impact. The degree of impact can also vary based on the distance where these sectors are located. For example, area near the mining site will have higher impact compare to area few kilometers from the site. In, figure 1, we see that mining has a weight value of 9 meaning mining sector induces more threat than city and agriculture. Also, the impact from mining can be seen up to 20km where, closer location facing higher impact. The value of weights and range of impact can be obtained from literature or through consultation with expert. The threat map provides an overview of area where biodiversity area is most vulnerable from different development activities.

Maps		Range		Weight	Final	
		Distance	Value			
Agriculture		0-2	10	X	7	70
		2-3	7			49
		3-6	4			28
		>6	0			0
+						
City		0-3	10	X	6	60
		3-5	7			42
		5-6	4			24
		>6	0			0
+						
Mining		0-5	10	X	9	90
		5-10	7			63
		10-20	4			36
		>20	0			0
=						
Final		0-50	LV			
		50-100	MV			
		100-150	HV			
		>150	VHV			

Figure 1: Multicriteria Analysis

This analysis can be done using various tools in QGIS. To conduct the analysis, all the data needs to be in raster format. If the data are available in vector format, it needs to be first converted to raster before processing. To conduct biodiversity threat analysis four tools (*Rasterize tool*, *Proximity tool*, *Raster Calculator tool* and *Clipper tool*) are required assuming all the data are in same coordinate system and of same extend. **Figure 2** shows the schematic diagram for the analysis.

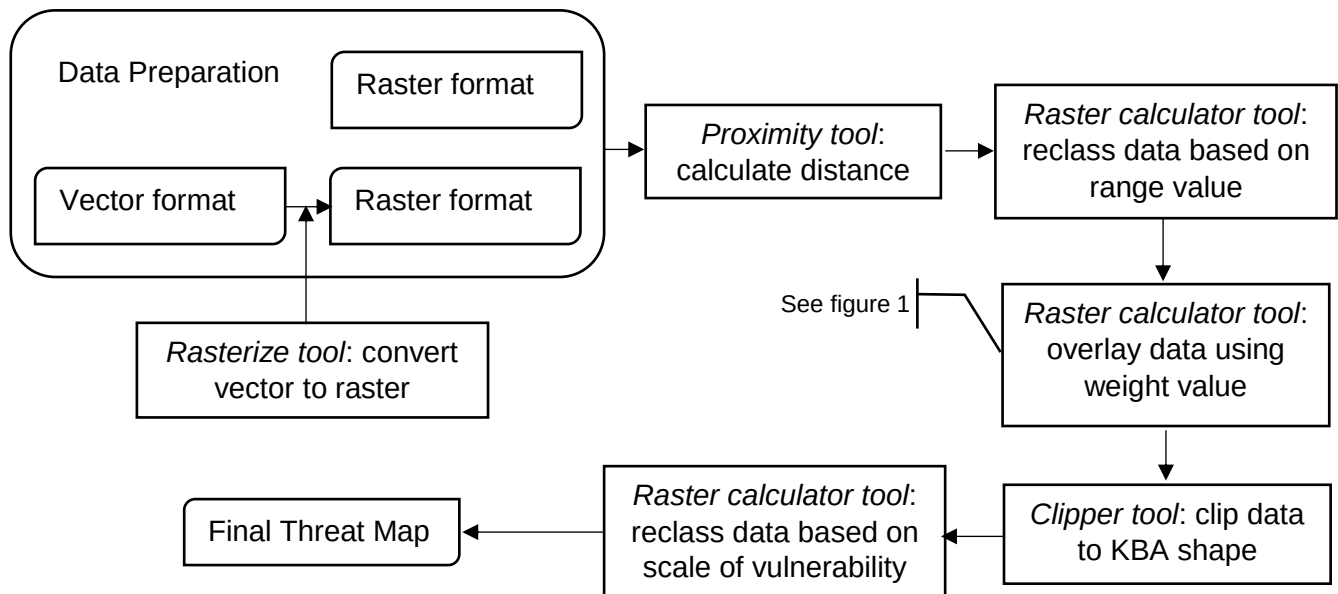


Figure 2: Overview of process

Example data for the exercise can be found inside the folder **Data**. The folder contains the following files:

Data files for the training:

- 0_Chindwin Basin: Vector file of CRB
- 1_Landuse: Raster map of Landuse of CRB
- 2_ Agriculture: Raster map of Agriculture area in CRB
- 3_Mining: Raster map of Mining area in CRB
- 4_ Road: Vector file of Road network in CRB
- 5_Town: Vector file for location of town in CRB
- 6_KBA: Vector file of Key Biodiversity Area in CRB

Case study: Chindwin River Basin

Chindwin River Basin (CRB) in Myanmar is located in the North Western part of the country situated between 21° 30' and 27° 15' N Latitude and between 93° 30' and 97° 10' E Longitude. The catchment spans over 46 townships in 4 regions namely Sagaing, Kanchin, Chin and Magway covering an area of 113800Km². The annual average flow of the Chindwin River is 4500 m³/s which is about 40% of the annual average flow of the Ayeyarwady River. The average rainfall over the catchment varies from 1500-4200mm and the temperature ranges from 23°C in the upper part to 28°C in the lower part of the basin.

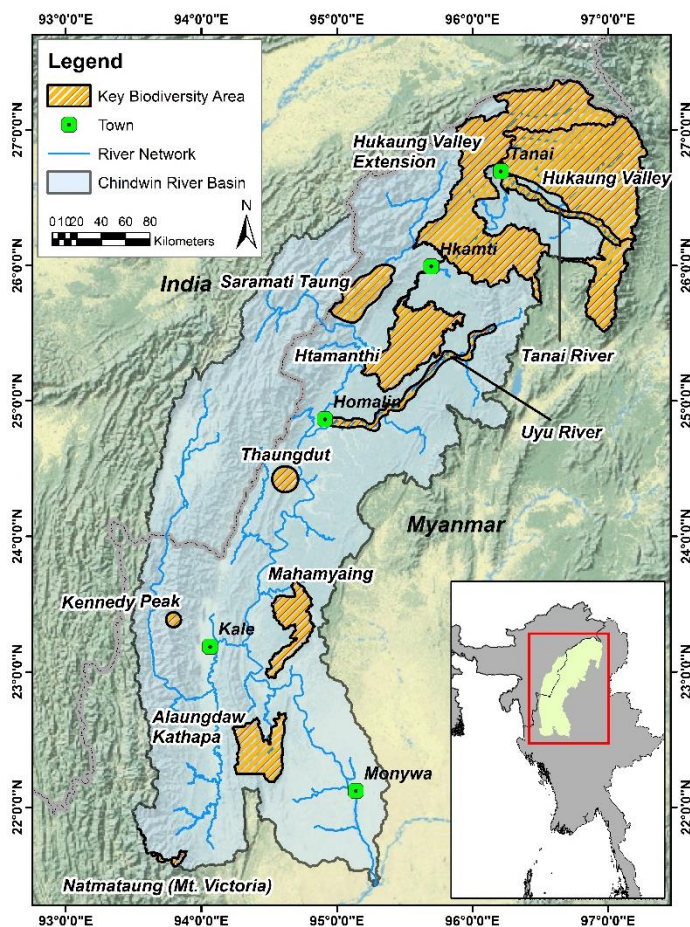


Figure 3: Location of Chindwin River Basin

About 88 percent of the basin is covered by forest and shrubs followed by other land covers as paddy, cropland, urban and water bodies (**Table 1:** Legend for Landuse map used for exercise). About 11% of the basin is covered by agriculture area, where rice, wheat, maize millet groundnut, sesame, pulse and other vegetables are cultivated. The Chindwin River Basin is home to 14 Key Biodiversity Areas (KBA) (

Table 2). KBA are the sites contributing to the global persistence of biodiversity and identified nationally using globally standard criteria and threshold.

Table 1: Legend for Landuse map used for exercise

Landuse class (% of area)	Value
Broad Leaf Evergreen Forest (51.7%)	1
Broad Leaf Deciduous Forest (20 %)	2
Needle Leaf Evergreen Forest (4.5 %)	3
Mixed Forest (10.4 %)	4
Herbaceous (1.90 %)	5
Cropland (10.3 %)	6
Paddy Field (0.7 %)	7
Bareland (0.03%)	8
Urban (0.02 %)	9
Water Bodies (0.4 %)	10

Table 2: Legend for KBA map used for exercise

KBA Name	KBA ID
Kennedy Peak	1
Saramati Taung	2
Thaungdut	3
Hukaung Valley	4
Bumphabum	5
Htamanthi	6
Alaungdaw Kathapa	7
Natmataung (Mount Victoria)	8
Mahamyaing	9
Uyu River	10
Tanai River	11
Hponkanrazi	12
Hukaung Valley extension	13
Upper Chindwin River	14

Exercise 1: Getting Started QGIS interface

Downloading and installing QGIS

QGIS (Quantum Geographic Information System) is a free and open-source cross-platform desktop GIS application that supports viewing, editing, and analysis of geospatial data. Various version of QGIS has been released, for this exercise we will use QGIS version 2.18.20. QGIS can be downloaded using the link <https://qgis.org/en/site/forusers/download.html>. Download the software compatible for your operating system. Once download completes, install QGIS to your desire folder.

Overview of QGIS

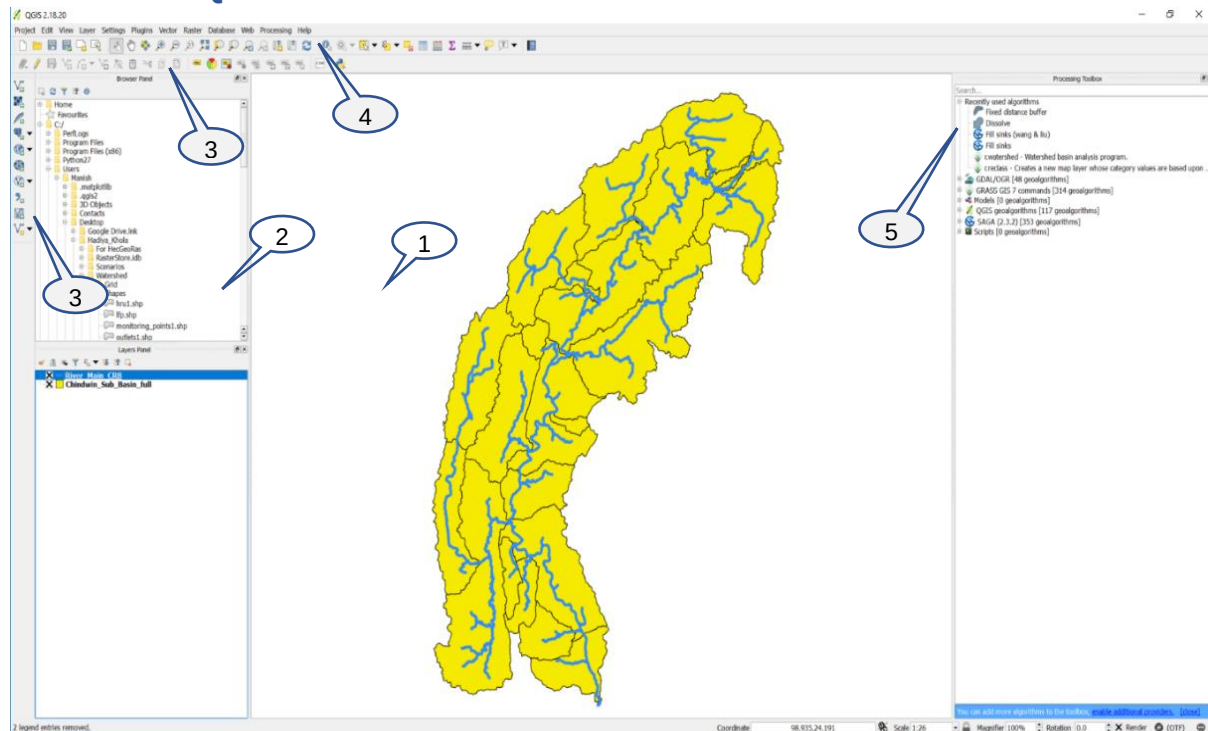


Figure 4 shows the overview of QGIS with numbers referring to different element of software. All the elements can be moved and docked.

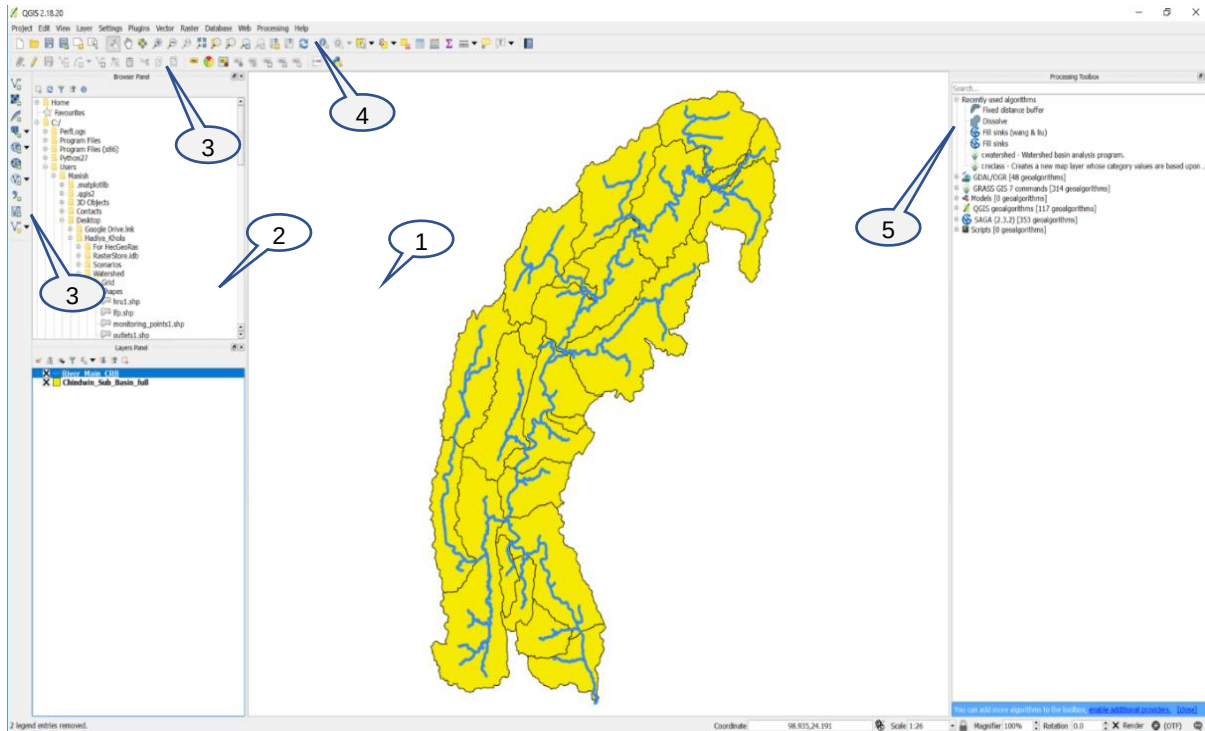


Figure 4: QGIS environment

Table 3: Elements of QGIS

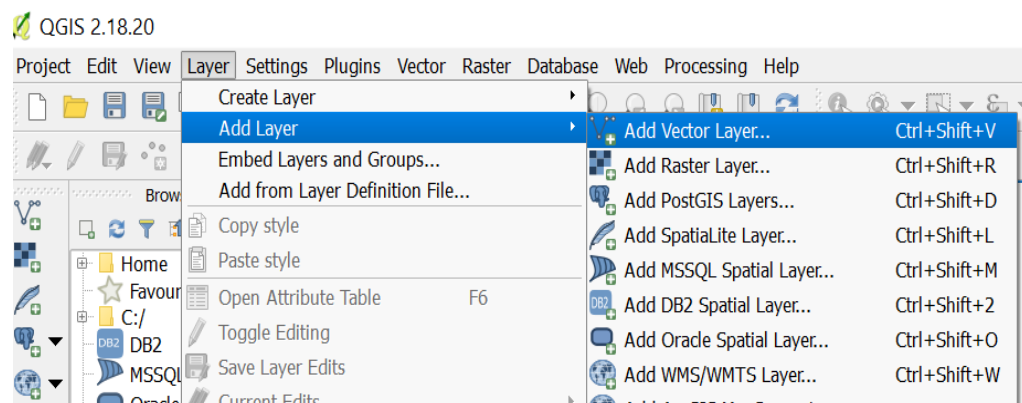
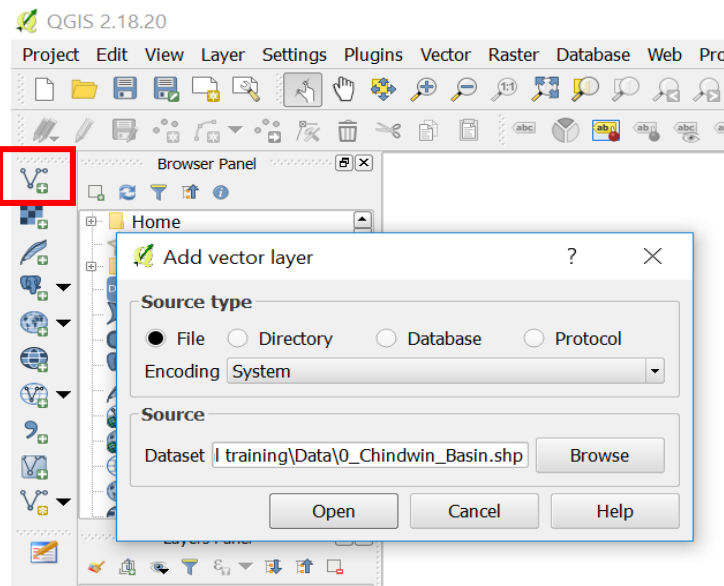
Number	Name	Description
1	Map Canvas	Area where data are displayed
2	Panel	Table of contain for data and location of folders
3	Tool menu	Contain importing and editing tools for data
4	Menu bar	Contain core QGIS tools for analyzing
5	Processing Toolbox	Contain GIS tools from different plugins

Adding Vector data

Vector data represents of the world using points, lines, and polygons. Vector data are useful for storing data that has discrete boundaries, such as country borders, land parcels, and streets. (Source: <http://support.esri.com/en/knowledgebase/GISDictionary/term/vector%20data%20model>)

Vector data can be added using **Add Vector Layer** from tool menu or from Menu bar >> Layer >> Add Layer >> Add Vector Layer.

A dialog box will appear, browse for the vector file (e.g. 4_Road.shp) and click Open.

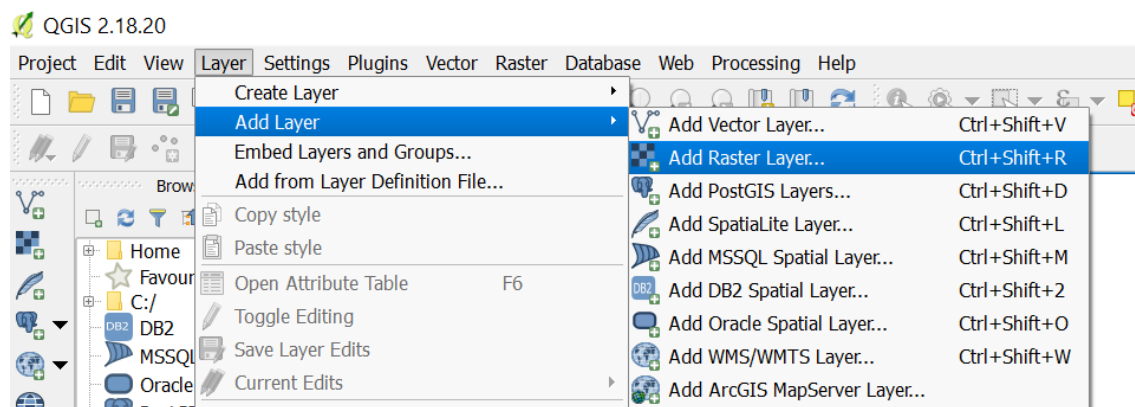
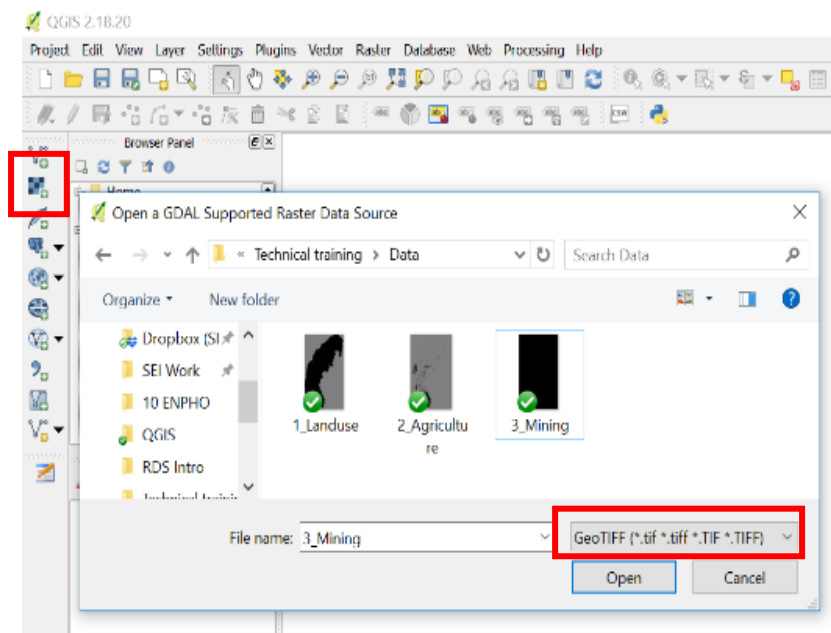


Adding Raster data

Raster data represents of the world as a surface divided into a regular grid of cells. Raster data are useful for storing data that varies continuously, as in an aerial photograph, a satellite image, a surface of chemical concentrations, or an elevation surface. (Source: <http://support.esri.com/en/knowledgebase/GISDictionary/term/vector%20data%20model>)

Raster data can be added using **Add Raster Layer** from tool menu or from Menu bar >> Layer >> Add Layer >> Add Raster Layer.

A dialog box will appear. In file type select GeoTIFF and browse for the raster file (e.g. 2_Agriculture.tif) and click Open.

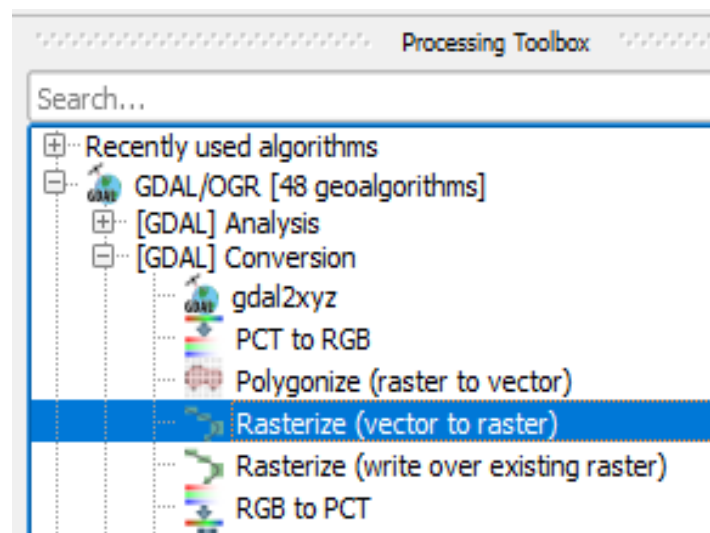


Exercise 2: Converting Vector to Raster

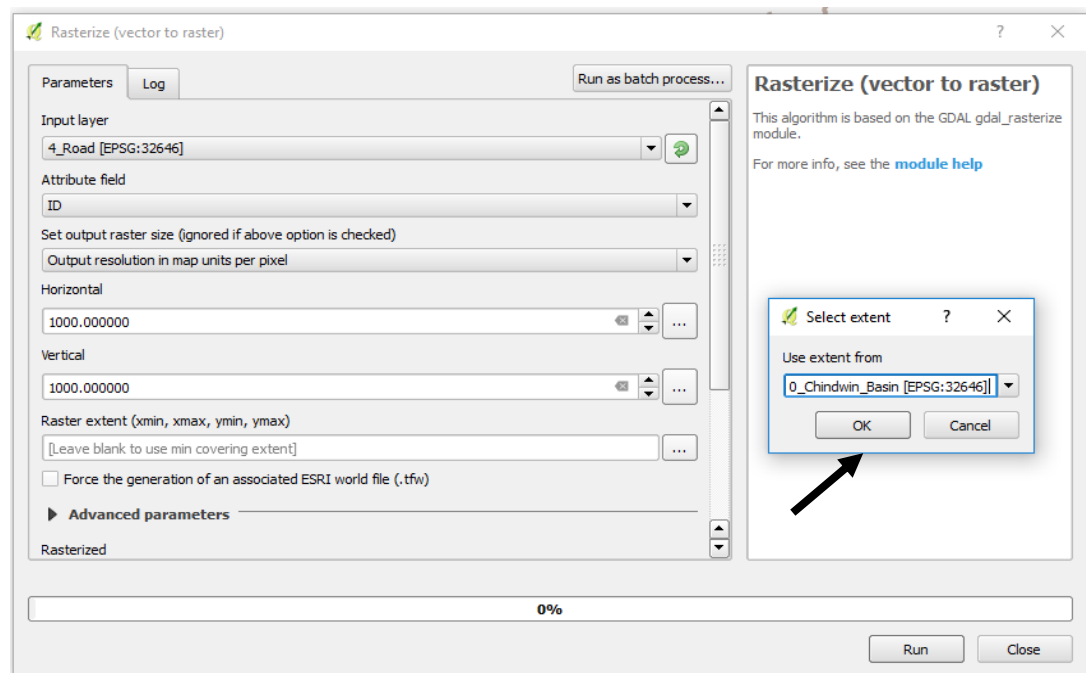
Rasterized (vector to raster) tool of GDAL/OGR toolbox will be used to convert vector data to raster data. For the exercise 4_Road.shp file will be used as an example.

Processing steps

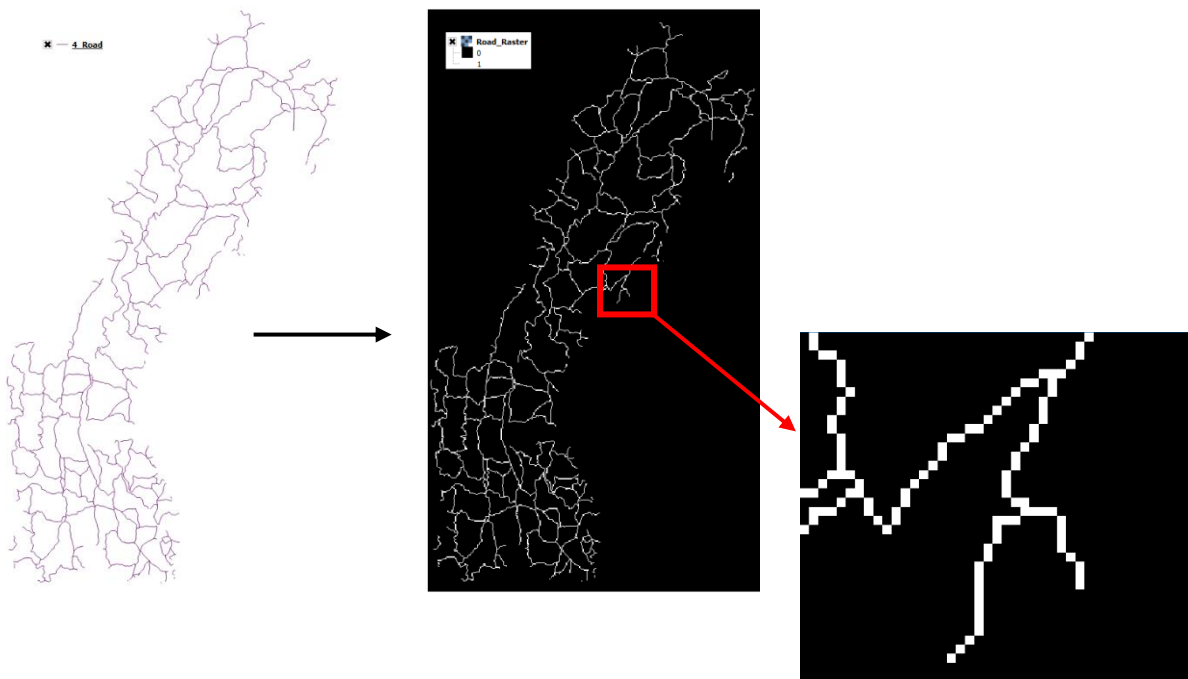
- Input *0_Chindwin_Basin.shp* layer in QGIS
- *Rasterize* tool can be found inside: Process toolbox >> GDAL/OGR >> Conversion >> *Rasterize (vector to raster)* OR Search for *Rasterize* in the search bar



- A dialog box will appear as shown in figure below. Enter the following value:
 - Input layer >> *4_Road.shp*
 - Attribute field >> *ID* [value for road will be assigned based on this field, in this case value is 1]
 - Set output raster size >> Output resolution in map units per pixel >> *1000* [meaning resolution of 1km X 1km]
 - Raster extend >> Use layer/canvas extent >> Select: *0_Chindwin_Basin* [this will extend the result covering the whole Chindwin Basin]
 - Rasterized >> Save in working folder as *Road_Raster.tif*
 - Click *Run*



- Raster file of resolution 1km X 1km with value 1 corresponding to road and 0 for others will be generated



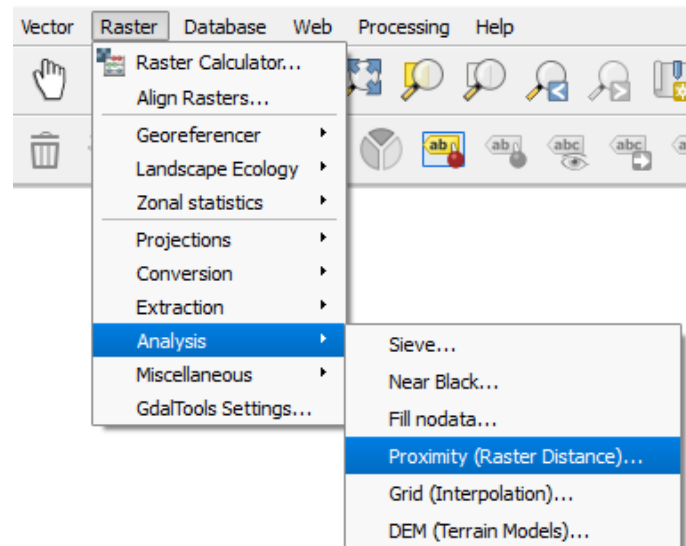
Assignment 1:

Convert *5_Town.shp* file to raster map. Give the raster name as *Town_Raster.tif*.

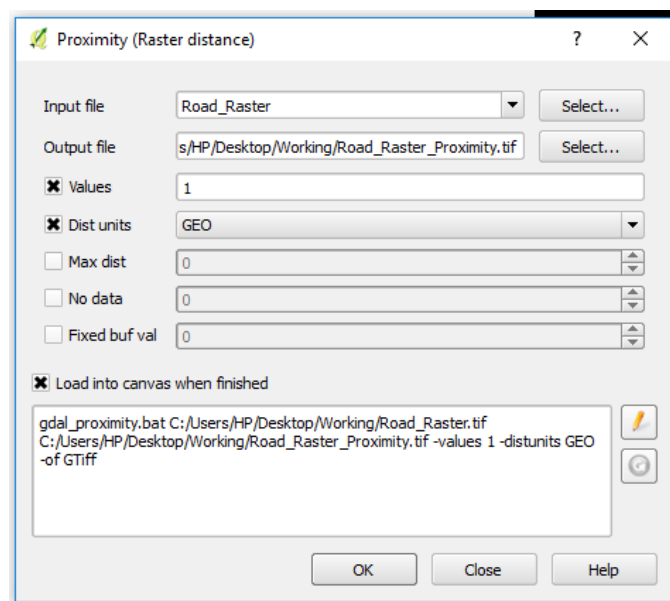
Exercise 3: Calculating raster distance

In this exercise we will learn how to generate distance from the center of each pixel to the center of nearest pixel identified as a target pixel. *Proximity (Raster Distance)* tool under menu bar will be used to generate map of distance. In this case Road_Raster file will be used as an example which was generated in exercise 2

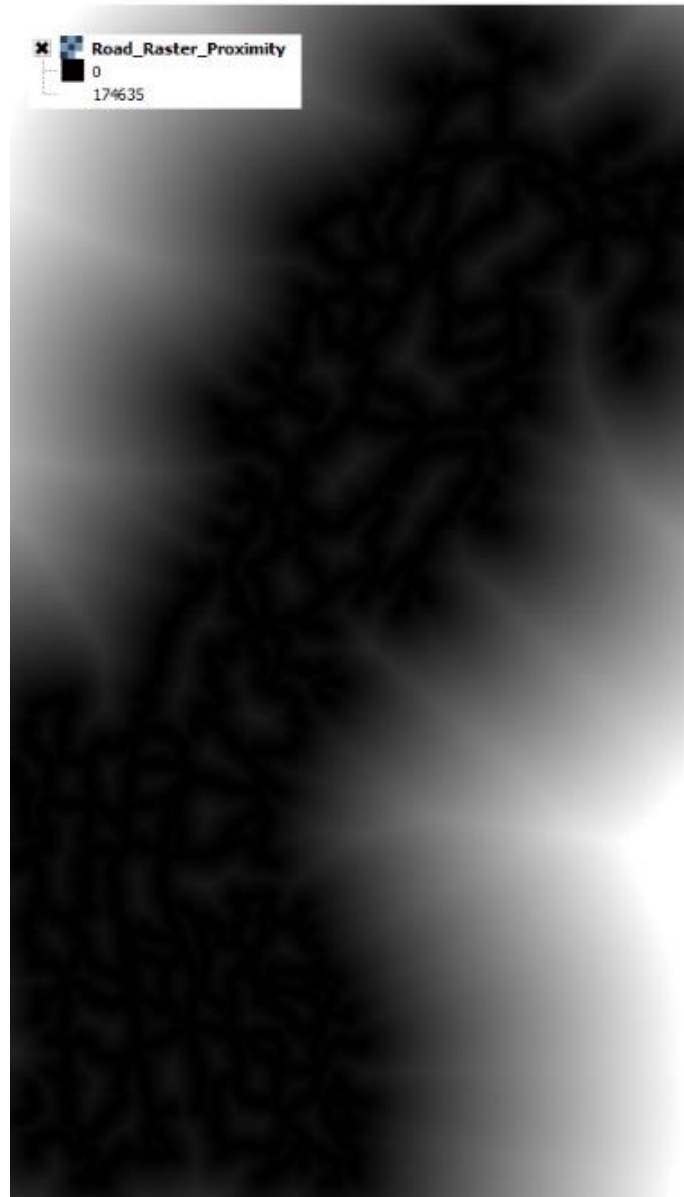
- **Proximity tool** can be found under: Raster >> Analysis >> Proximity (Raster Distance)



- A dialog box will appear as shown in figure below. Enter the following value:
 - Input file >> *Road_Raster.tif*
 - Outputfile >> Save in working folder as *Road_Raster_Proximity.tif*
 - Check Value >> Enter 1 [This will calculate the distance from pixel with value 1]
 - Check Dist unit >> GEO [This option will calculate actual distance rather than number of pixel]
- Click OK



- Raster file of resolution 1km X 1km with values in meters depending on distance from road network will be generated

**Assignment 2:**

Create proximity files for *2_Agriculture.tif*, *Mining_raster.tif* and *Town_Raster.tif* [Generated from assignment 1]. Give the raster name as *Agriculture_Proximity.tif*, *Mining_Proximity.tif* and *Town_Raster_Proximity.tif*.

Exercise 4: Reclass raster

After obtaining the proximity raster for each factor, we need to reclass the data based on the range values. The range value here refers to distance up to which a certain factor can have a high, medium, low or no impact. The value of range can be obtained from literature or through consulting with experts. For this exercise we will use the following value of range and weight.

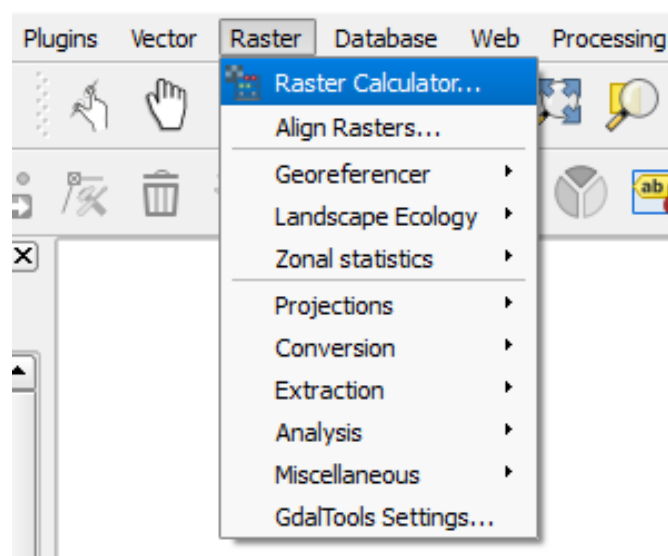
Table 4: Range and weight values for threat analysis

Threat	High (10)	Medium (7)	Low (4)	Weights	Remarks
Range (Km)					
Road	0-2	2-3	3-4	6.00	Loss of habitat
Town	0-3	3-5	5-6	6.67	Human settlement will have high impact
Agriculture	0-2	2-3	3-6	7.00	Loss of habitat and pesticides
Mining	0-5	5-10	10-20	9.33	Loss of habitat, pollution and pits after mining can have negative impact (needs detail study)

Based on the value from **Table 4:** Range and weight values for threat analysis, road will have high impact (signifying value of 10) from distance 0 to 2km from center of road; medium impact (signifying value of 7) from distance greater than 2 and upto 3km from center of road; low impact (signifying value of 4) from distance greater then 3km and up to 4km from center of road and no impact (signifying value of 0) beyond 4km.

Raster calculator under *raster* tab will be used to reclass the value of *Road_Raster_Proximity.tif* file.

- **Raster calculator** tool can be found under: Raster >> Raster calculator

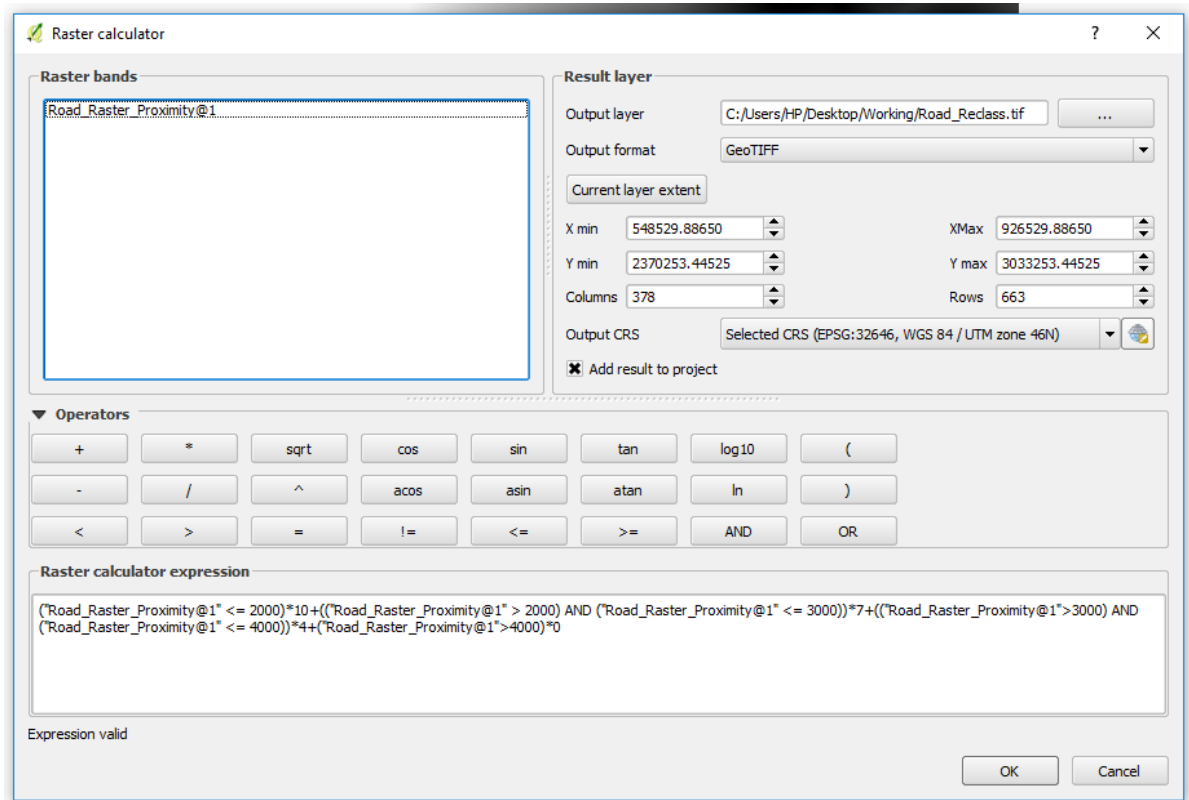


- A dialog box will appear as shown in figure below. Enter the following value:
 - Outputfile >> Save in working folder as *Road_Reclass.tif*
 - Raster calculator expression >> Enter expression

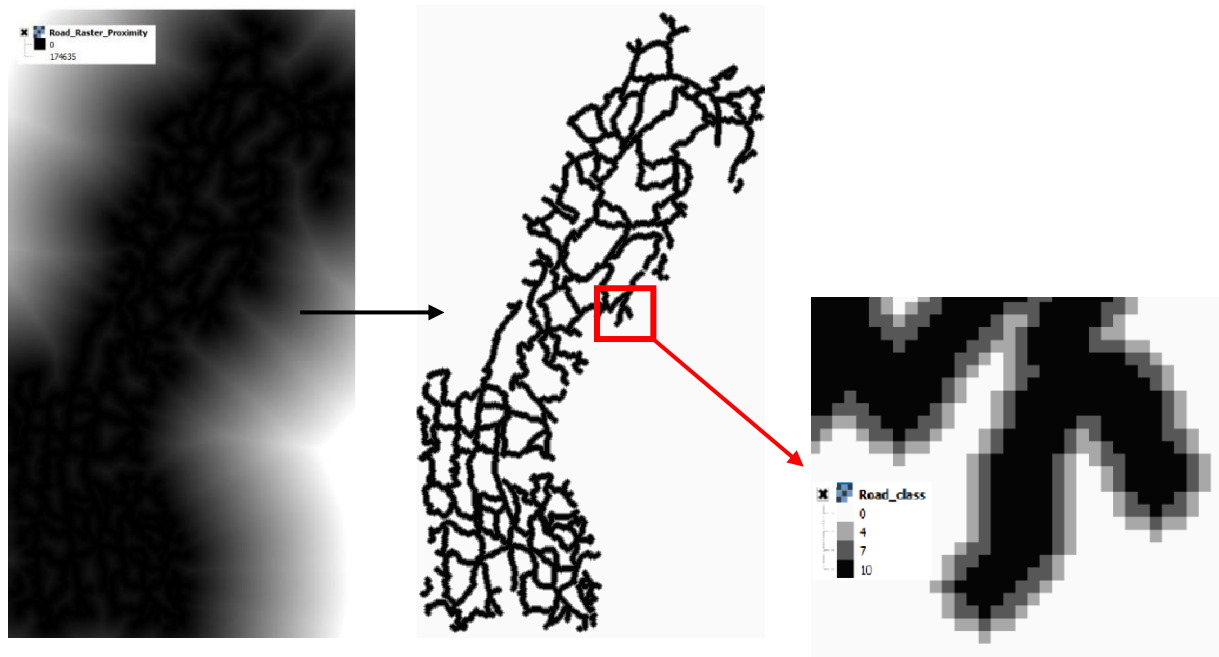
("Road_Raster_Proximity@1" <= 2000)*10 + (("Road_Raster_Proximity@1" > 2000)
 AND ("Road_Raster_Proximity@1" <= 3000))*7 + (("Road_Raster_Proximity@1">3000)
 AND ("Road_Raster_Proximity@1" <= 4000))*4 +
 ("Road_Raster_Proximity@1">4000)*0

[Use operators if required]

- Click OK



- Raster file of resolution 1km X 1km with values 10, 7, 4 and 0 will be generated.

**Assignment 3:**

Reclass the values for *Agriculture_Proximity.tif*, *Mining_Proximity.tif* and *Town_Raster_Proximity.tif* [Generated from assignment 2] using the values from Table 1. Give the raster name as *Agriculture_Reclass.tif*, *Mining_Reclass.tif* and *Town_Reclass.tif*.

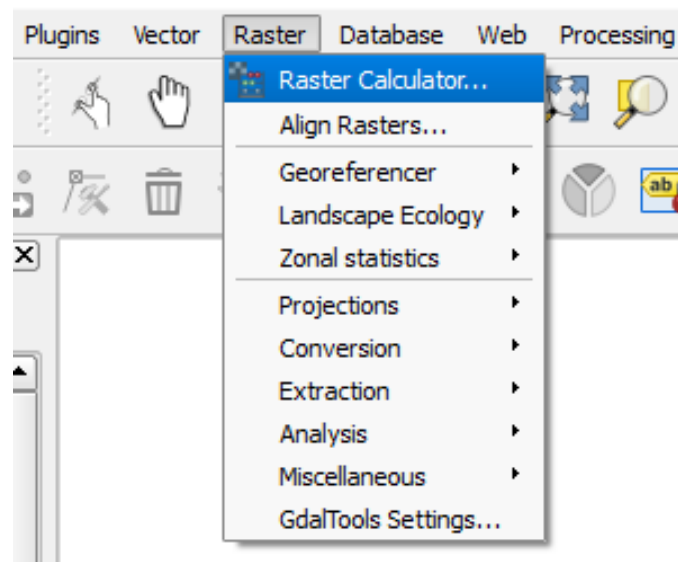
Exercise 5: Overlay

After creating raster data with range value, next step is to overlay all the maps data using their respective weights. The weight value for different development sectors can be obtained from literature or through consulting with experts. For this exercise we will use the weight value as in **Table 4**.

Based on the value from **Table 4**, road has the least to biodiversity impact compared to other sectors with weight value of 6 and mining sector has the highest impact with weight value of 9.33.

Raster calculator under *raster* tab will be used to overlay all the maps to develop a new map by using corresponding weight values of different sector.

- **Raster calculator** tool can be found under: Raster >> Raster calculator

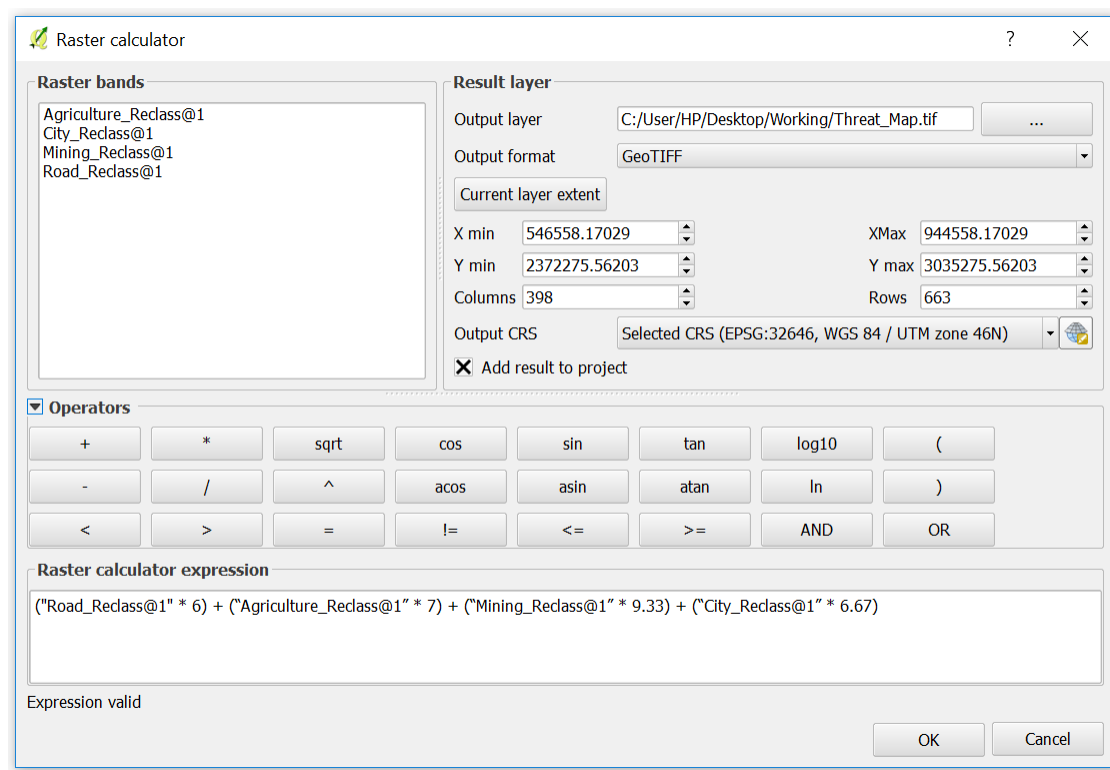


- A dialog box will appear as shown in figure below. Enter the following value:
 - Outputfile >> Save in working folder as *Threat_Map.tif*
 - Raster calculator expression >> Enter expression

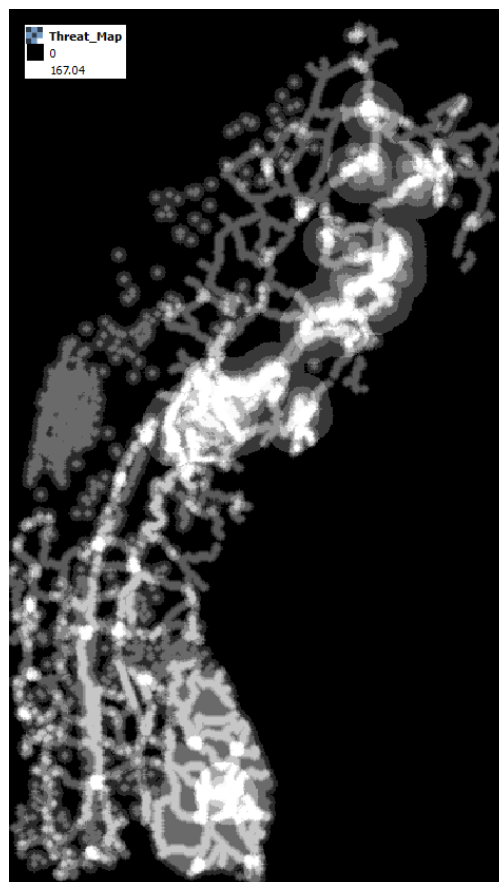
$$("Road_Reclass@1" * 6) + ("Agriculture_Reclass@1" * 7) + ("Mining_Reclass@1" * 9.33) + ("Town_Reclass@1" * 6.67)$$

[Use operators if required]

- Click OK



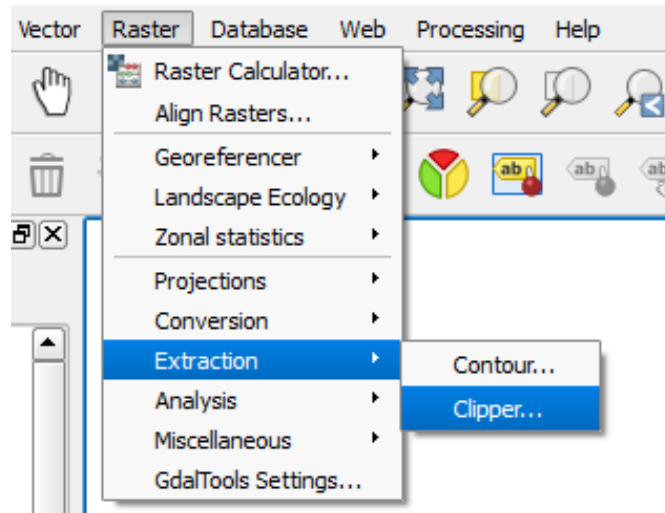
- Raster file of resolution 1km X 1km will be generated.



Exercise 6: Extracting KBA

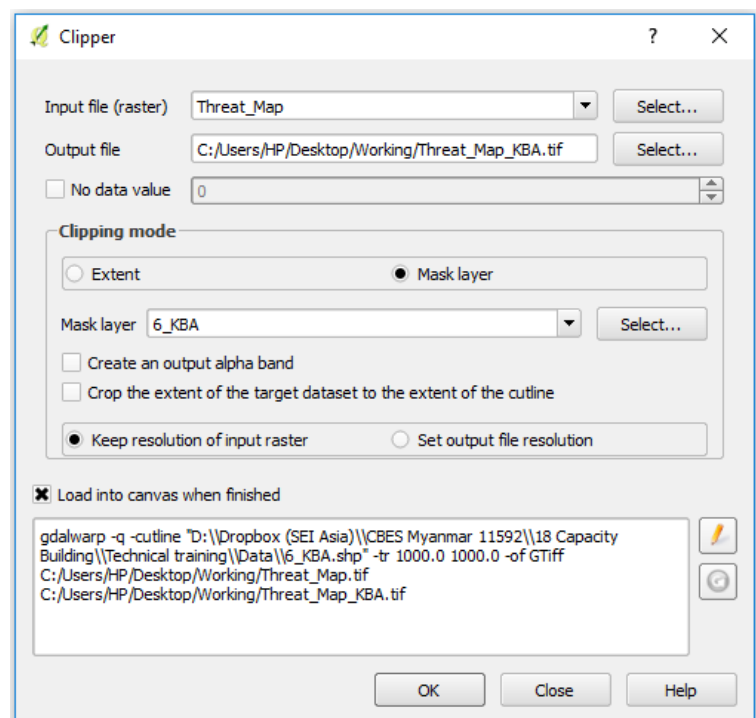
Once we have the final threat map we can clip the area where we would like to focus on. In our exercise, we will focus only on KBA area. Add the vector layer 6_KBA following instruction on exercise 1. There are 14 KBAs in our basin. Clipper tool under raster tab will be used to extract the data to required KBA.

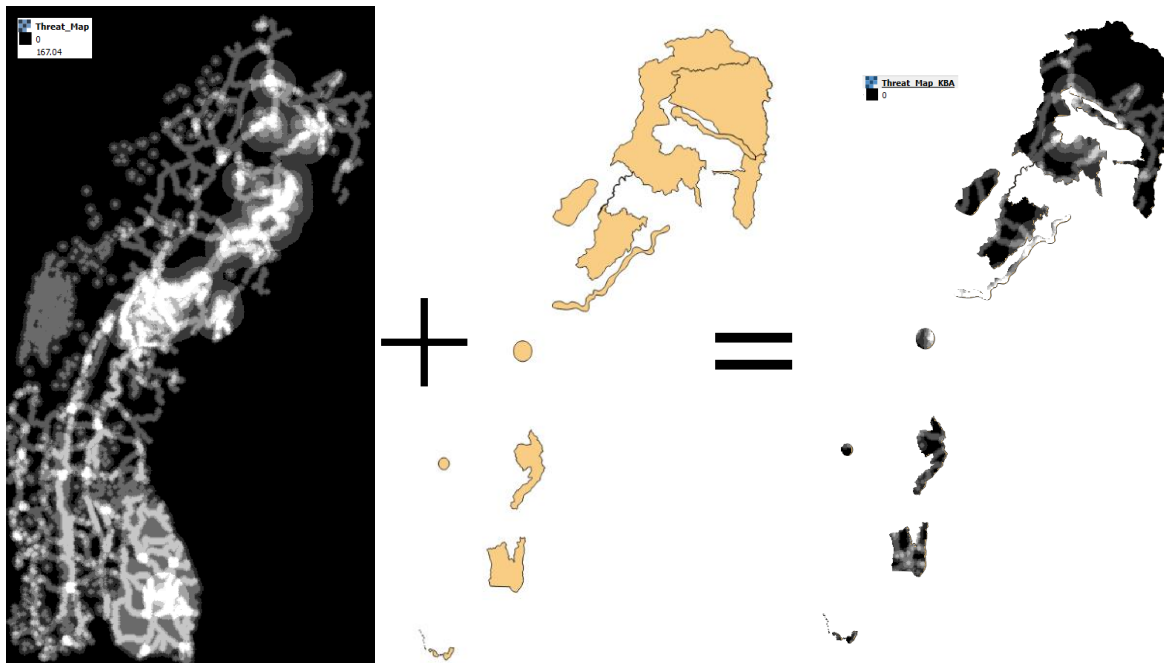
- **Clipper** tool can be found under: Raster >> Extraction >> Clipper



- A dialog box will appear as shown in figure below. Enter the following value:
 - Input file (raster) >> *Threat_Map.tif*
 - Output file >> Save in working folder as *Threat_Map_KBA.tif*
 - Click on Mask layer
 - Mask Layer >> Select *6_KBA.shp*
 - Click OK

- A raster file in shape of KBA will be generated



**Assignment 4:**

Clip the Final_Map.tif using *0_Chindwin_Basin.shp*. Give the raster name as *Final_Map_Basin.tif*.

Exercise 7: Finalizing result

Categorizing result

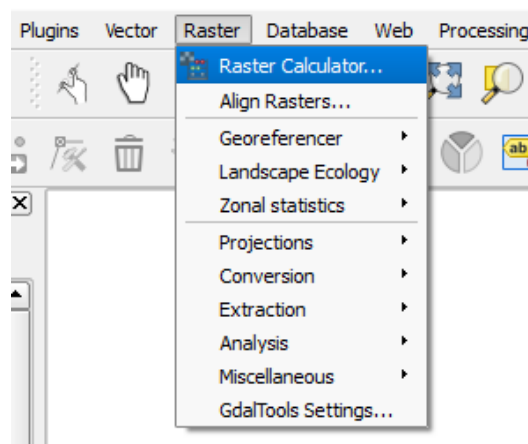
The final step is to display the result based on degree of vulnerability. The result from exercise 5 contains value ranging from 0 to 167. These values can be categorized into different levels of vulnerability. In this exercise, we will categorize the value into five classes based on **Table 5**.

Table 5: Categories for degree of threat

Value	Rate	Degree
0-10	1	No Threat
10-25	2	Low Threat
25-50	3	Medium Threat
50-100	4	High Threat
>100	5	Very High Threat

Raster calculator under *raster* tab will be used to reclass the value as shown in table above

- *Raster calculator* tool can be found under: Raster >> Raster calculator

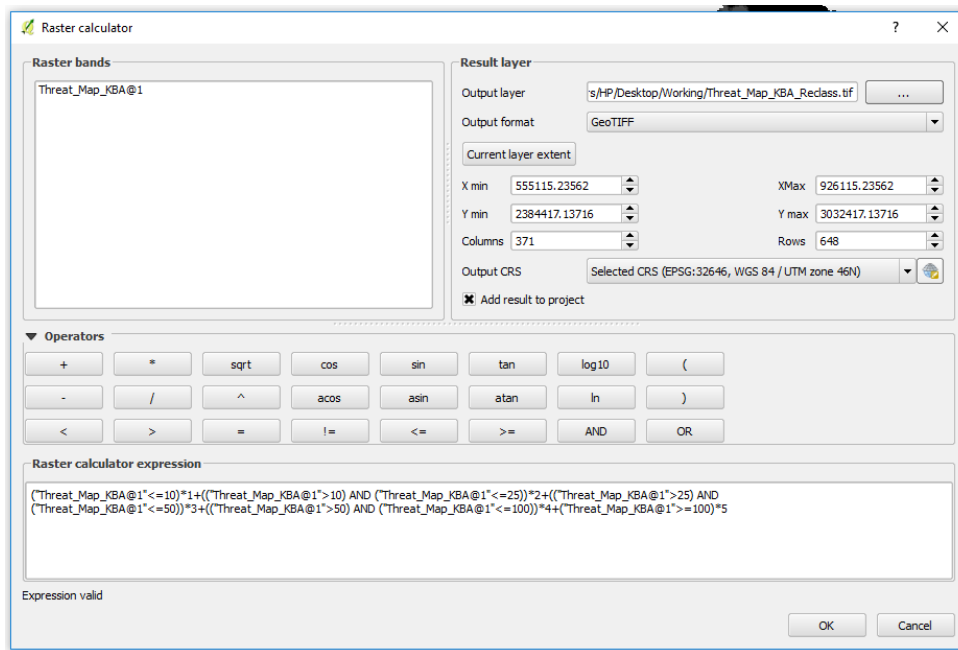


- A dialog box will appear as shown in figure below. Enter the following value:
 - Outputfile >> Save in working folder as *Threat_Map_KBA_Reclass.tif*
 - Raster calculator expression >> Enter expression

("Threat_Map_KBA@1"<=10)*1+(("Threat_Map_KBA@1">10) AND
 ("Threat_Map_KBA@1"<=25))*2+(("Threat_Map_KBA@1">25) AND
 ("Threat_Map_KBA@1"<=50))*3+(("Threat_Map_KBA@1">50) AND
 ("Threat_Map_KBA@1"<=100))*4+(("Threat_Map_KBA@1">100))*5

[Use operators if required]

- Click OK

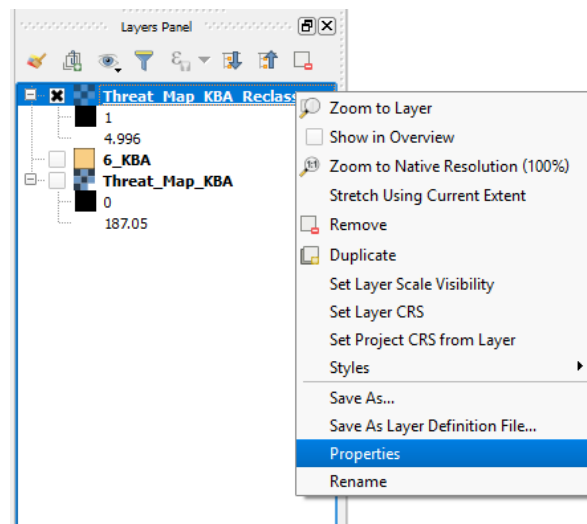


- Raster file of resolution 1km X 1km will be generated with values ranging from 1-5.

Displaying the result

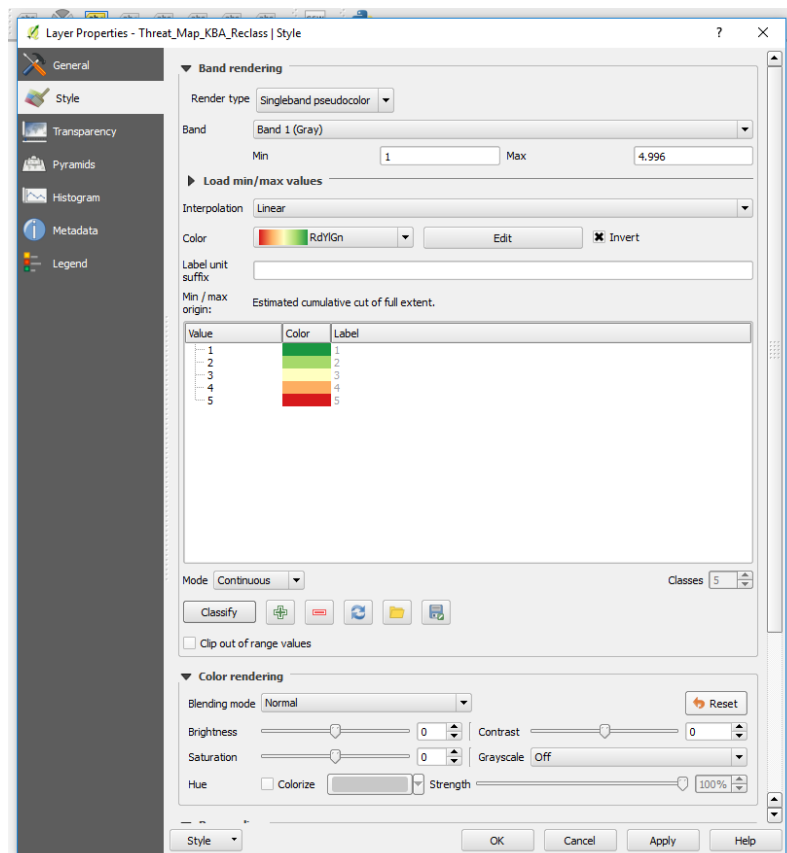
The style of the layer can be changed to display the result in various graphics and colors. To change the color based on degree of vulnerability (value numbered from 1-5), follow the following steps.

- Right click on *Threat_Map_KBA_Reclass* under Layer Panel >> Properties

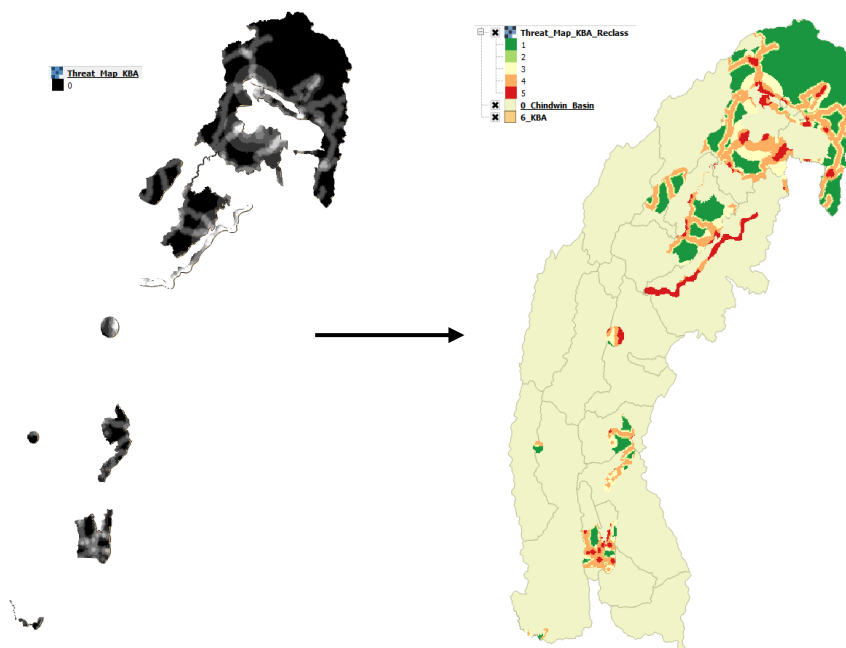


- A dialog box will appear as shown in figure below. Enter the following value:
 - Click on Style menu
 - Render >> choose Singleband pseudocolor
 - Color >> Choose RdYGn (or any color your wish)

- Click Invert (optional)
- Click on classify
- Click OK



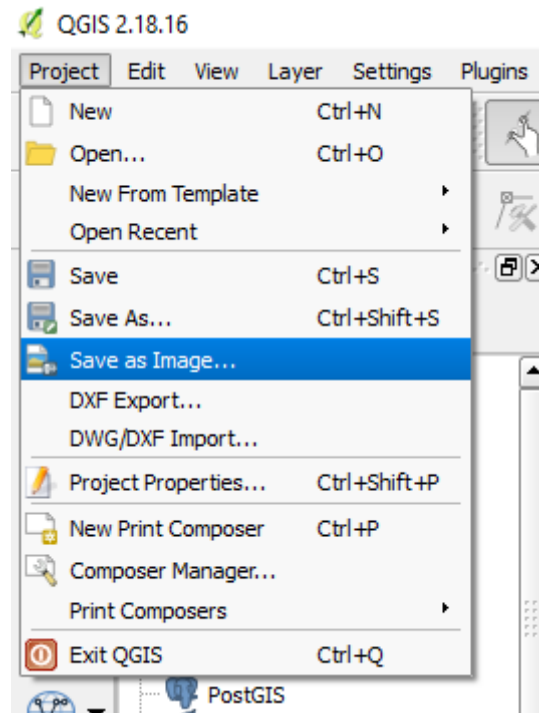
- Add *0_Chindwin_Basin.shp* for background
- Map will be displayed in 5 shaded of color



Export maps

To export the map as image, follow the following steps

- Click on *Save as Image* under Project >> Save as Image



- A dialog box will appear, save you file in the desire location
- Choose either PNG format or JPEGF format
- Click on Save

Acknowledgement:

Funding for this project was provided by the Critical Ecosystem Partnership Fund (a joint initiative of l'Agence Française de Développement, Conservation International, the European Union, the Global Environment Facility, the Government of Japan, the MacArthur Foundation and the World Bank. A fundamental goal is to ensure civil society is engaged in biodiversity conservation) and Sweden Sverige.

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<https://www.sei.org/centres/asia/>
